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BUREAU OF AGRICULTURE.

Farmer's
BULLETIN No. 8.

THE COCOANUT

WITH REFERENCE TO ITS PRODUCTS AND CULTIVATION IN THE PHILIPPINES.

BY

WILLIAM S. LYON,
IN CHARGE OF DIVISION OF PLANT INDUSTRY.

MANILA:
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Letter of Transmittal.

BUREAU OF AGRICULTURE,

Manila, June 1, 1903.

SIR: In responding to numerous inquiries about the cocoanut, its uses, cultivation, and preparation for market, I have prepared, by your direction, the accompanying bulletin, which is intended to cover the general field of the inquiries addressed to this Bureau, and herewith submit the same, with the recommendation that it be published as Farmers' Bulletin No. 8.

Respectfully,

Wm. S. Lyon,

In Charge of Division of Plant Industry.

To Hon. F. Lamson-Scribner,

Chief Bureau of Agriculture, Manila. [5]

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The Cocoanut.

Introduction.

The following pages are written chiefly in the interests of the planter, but the writer feels that the great agricultural importance which the cocoanut palm is bound to assume in these Islands is sufficient to justify the presentation of some of its history and botany.

For that part of the bulletin which touches upon the botany of the cocoanut I am indebted to Don Regino Garcia, associate botanist of the Forestry Bureau; for that relating to its products and local uses, to the courtesy of manufacturers in Laguna; and, for the rest, to personal experience and observations made in Laguna Province and in the southern Visayan Islands where, as elsewhere in this Archipelago, the cocoanut may properly be considered a spontaneous and not a cultivated product.

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History.

The legendary history of the "Prince of Palms,"[1] as it has been called, dates back to a period when the Christian era was young, and its history is developing day by day in some new and striking manifestation of its utility or beauty. It seems not unreasonable to assume that much of the earlier traditionary history of the cocoanut may have been inspired as much by its inherent beauty as by its uses. Such traditional proverbs Or folklore as I have gathered in the Visayas recognize the influence of the beautiful, in so far as the blessings of the trees only inure to the good; for instance, "He who is cruel to his beast or his family will only harvest barren husks from the reproving trees that witness the pusillanimous act;" and, again, "He who grinds the poor will only grind water instead of fat oil from the meat."

To this day the origin of the cocoanut is unknown. De Candolle (Origin of Cult. Plants, p. 574) recites twelve specific claims pointing to an Asiatic origin, and a single, but from a scientific standpoint almost unanswerable, contention for an American derivation. None of the remaining nineteen species of the genus Cocos are known to exist elsewhere in the world than on the American continent. His review of the story results in the nature of a compromise, assigning to our own Islands and those to the south and west of us the distinction of having first given birth to the cocoanut, and that thence it was disseminated east and west by ocean currents. [6]

1 "The Prince of Palms," Treloar.

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Botany.

The cocoanut (*Cocos nucifera* Linn.) is the sole oriental representative of a tropical genus comprising nineteen species, restricted, with this single exception, to the New World.

Its geographical distribution is closely confined to the two Tropics.[1]

Not less than nineteen varieties of *C. nucifera* are described by Miquel and Rumphius, and all are accepted by Filipino authors.

Whether all of these varieties are constant enough to deserve recognition need not be considered here. Many are characterized by the fruits being distinctly globular, others by fruits of a much prolonged oval form, still others by having the lower end of the fruit terminating in a triangular point.

In the Visayas there is a variety in which the fibrous outer husk of the nut is sweet and watery, instead of dry and astringent, and is chewed by the natives like sugar cane. Another variety occurs in Luzon, known as “Pamocol,” the fruit of which seldom exceeds 20 cm. in diameter. There is also a dwarf variety of the palm, which rarely exceeds 3 meters in height, and is known to the Tagalogs as “Adiavan.”

These different varieties are strongly marked, and maintain their characters when reproduced from seed.

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1 The cocoanut palm has been reared as far north as Indian River, Florida, latitude 28° N., but has not proven a profitable commercial venture.

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Uses.

The cocoanut furnishes two distinct commercial products—the dried meat of the nut, or copra, and the outer fibrous husk. These products are so dissimilar that they should be considered separately.

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Copra and Cocoanut Oil.

Until very recent years the demand for the “meat” of the cocoanut or its products was limited to the uses of soap boilers and confectioners. Probably there is no other plant in the vegetable kingdom which serves so many and so varied purposes in the domestic economy of the peoples in whose countries it grows. Within the past decade chemical science has produced from the cocoanut a series of food products whose manufacture has revolutionized industry and placed the business of the manufacturer and of the producer upon a plane of prosperity never before enjoyed.

There has also been a great advance in the processes by which the new oil derivatives are manufactured. The United States took the initiative with the first recorded commercial factories in 1895. In 1897 the Germans established factories in Mannheim, but it remained for the French people to bring the industry to its present perfection. [7]

According to the latest reports of the American consul at Marseilles, the conversion of cocoanut oil into dietetic compounds was undertaken in that city in 1900, by Messrs. Rocca, Tassy and de Roux, who in that year turned out an average of 25 tons per month. During the year just closed (1902) their average monthly output exceeded 6,000 tons and, in addition to this, four or five other large factories were all working together to meet the world’s demand for “vegetaline,” “cocoaline,” or other products with suggestive names, belonging to this infant industry.

These articles are sold at gross price of 18 to 20 cents per kilo to thrifty Hollandish and Danish merchants, who, at the added cost of a cent or two, repack them in tins branded “Dairy Butter” and, as such, ship them to all parts of the civilized world. It was necessary to disguise the earlier products by subjecting them to trituration with milk or cream; but so perfect is the present emulsion that the plain and unadulterated fats now find as ready a market as butter. These “butters” have so far found their readiest sale in the Tropics.

The significance of these great discoveries to the cocoanut planter can not be overestimated, for to none of these purely vegetable fats do the prejudices attach that so long and seriously have handicapped those derived from animal margarin

or margarin in combination with stearic acid, while the low fusion point of pure dairy butters necessarily prohibits their use in the Tropics, outside of points equipped with refrigerating plants. The field, therefore, is practically without competition, and the question will no longer be that of finding a market, but of procuring the millions of tons of copra or oil that this one industry will annually absorb in the immediate future.

Cocoanut oil was once used extensively in the manufacture of fine candles, and is still occasionally in demand for this purpose in the Philippines, in combination with the vegetable tallow of a species of *Stillingia*. It is largely consumed in lamps, made of a tumbler or drinking glass half filled with water, on top of which float a few spoonfuls of oil, into which the wick is plunged. In remote barrios it is still in general use as a street illuminant, and so perfect is its combustion that under a constant flicker it emits little or no smoke.

When freshly expressed, the oil is an exceptionally good cooking fat, and enters largely into the dietary of our own people. The medicinal uses of the oil are various, and in the past it has been strongly advocated for the cure of eczema, burns, as a vermifuge, and even as a substitute for cod-liver oil in phthisis. Its medicinal virtues are now generally discredited, except as a restorative agent in the loss of hair resulting from debilitating fevers. Its value in this direction may be surmised from the splendid heads of hair possessed by the Filipino women, who generally use the oil as a hair dressing.

Cocoanut oil is derived from the fleshy albumen or meat of the ripe fruit, either fresh or dried. The thoroughly dried meat is variously known as *copra*, *coprax*, and [8]
copraz. The exportation of copra is detrimental to the best interests of the planter, tending to enrich the manufacturer and impoverish the grower. The practice, however, is so firmly established that the writer can only record a probably futile protest against its continuance.

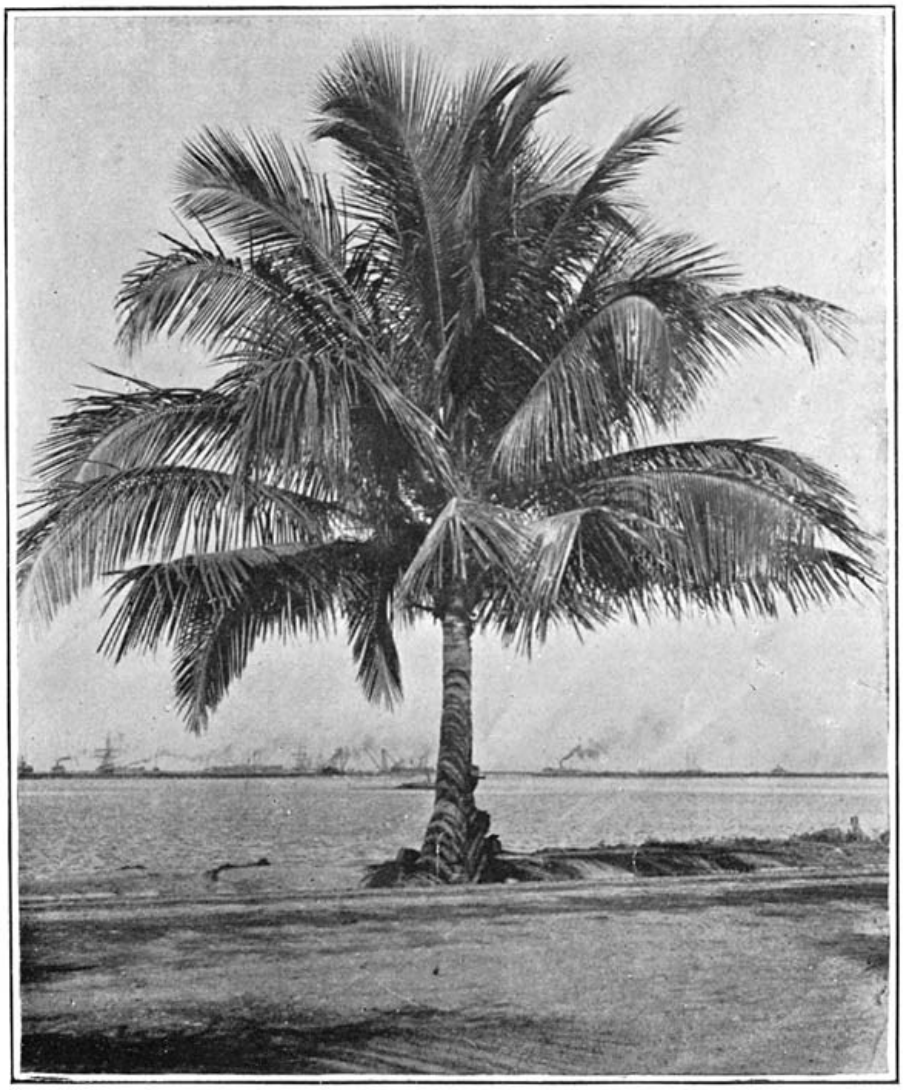
The causes which for a long time will favor the exportation of copra instead of oil in this Archipelago may be briefly stated as follows:

(1) An oil-milling plant, constructed with due regard to economy of labor and the production of the best quality of oil, would involve an outlay of capital of $2,500, gold, and upward, according to capacity. The production of copra requires the labor of the planter’s hands only.

(2) The oil packages must be well-made barrels, casks, or metallic receptacles. The initial cost of the packages is consequently great, their return from distant ports impracticable, and their sale value in the market of delivery is not sufficient to offset the capital locked up in an unproductive form. On the other hand, copra may be sold or shipped in boxes, bags, sacks, and bales, or it may even be stored in bulk in the ship’s hold.

(3) When land transportation has to be considered, the lack of good roads still further impedes the oil maker. He can not change the size and weight of his packages from day to day to meet the varying passability of the trail. On the other hand, packages of copra may be adjusted to meet all emergencies, and the planter can thus take advantage of the market conditions which may be denied to the oil maker.

(4) Perhaps the most serious difficulty the oil maker has to contend with is the continuous discouragement he encounters from the agent of foreign factories, who buys in the open market and, bidding up to nearly the full oil value of the copra, finds an ample manufacturer’s profit paid by the press cake, so valuable abroad, but, unfortunately, practically without sale or value here. The residue from the mill may be utilized both for food and for manure by the oil maker who is a tree owner and who maintains cattle. For either of these purposes its value rates closely up to cotton-seed cake, and the time is not remote when it will be recognized in the Philippines as far too valuable a product to be permitted to be removed from the farm excepting at a price which will permit of the purchase at a less figure of an equivalent in manure. So active are the copra-buying agents in controlling this important branch of the industry, that they refuse to buy the press cake at any price, with the result that, in two instances known to the writer, they have forced the closure of oil-milling plants and driven the oil maker back to his copra.



A young cocoanut tree.

Many copra-making plants in India and Ceylon are now supplied with decorticating, breaking, and evaporating machinery. The process employed in this Archipelago consists in first stripping the ripe fruit of the outer fibrous husk. This is effected by means of a stout, steel spearhead, whose shaft or shank is embedded firmly in the soil to such a depth that the spear point projects above the ground rather less than waist high. The operator then holds the nut in his hands and strikes it upon the spear point, gives it a downward, rotary twist, and thus, with apparent ease, quickly removes the husk. An average operator will husk 1,000 nuts per day, and records have been made of a clean up of as many as 3,000 per day. The work, however, is exceedingly hard, and involves great dexterity and wrist strength. [11]

Another man now takes up the nut and with a bolo strikes it a smart blow in the middle, dividing it into two almost equal parts. These parts are spread out and exposed to the sun for a few hours, or such time as may be necessary to cause the fleshy albumen to contract and shrink away from the hard outer shell, so that the meat may be easily detached with the fingers.

Weather permitting, the meat thus secured is sun dried for a day and then subjected to the heat of a slow fire for several hours. In some countries this drying is now effected by hot-air driers, and a very white and valuable product secured; but in the Philippines the universal practice is to spread out the copra upon what may be called a bamboo grill, over a smoky fire made of the shells and husks, just sufficient heat being maintained not to set fire to the bamboo. The halves, when dried, are broken by hand into still smaller irregular fragments, and subjected to one or two days of sun bath. By this time the moisture has been so thoroughly expelled that the copra is now ready to be sacked or baled and stored away for shipment or use.

All modern cocoanut-oil mills are supplied with a decorticator armed with revolving discs that tear or cut through the husk longitudinally, freeing the nut from its outer covering and leaving the latter in the best possible condition for the subsequent extraction of its fiber. This decorticator is fed from a hopper and is made of a size and capacity to husk from 500 to 1,000 nuts per hour.

Rasping and grinding machinery of many patterns and makes, for reducing the

meat to a pulp, is used in India, Ceylon, and China; and, although far more expeditious, offers no improvements, so far as concerns the condition to which the meats are reduced, over the methods followed in the Philippines. Here the fleshy halves of the meat are held by hand against a rapidly revolving, half-spherical knife blade which scrapes and shaves the flesh down to a fine degree of comminution. The resulting mass is then macerated in a little water and placed in bags and subjected to pressure, and the milky juice which flows therefrom is collected in receivers placed below. This is now drawn off into boilers and cooked until the clear oil is concentrated upon the surface. The oil is then skimmed off and is ready for market.

The process outlined above is very wasteful. The processes I have seen in operation are very inadequate, and I estimate that, not less than 10 per cent of the [12] oil goes to loss in the press cake. This is a loss that does not occur in establishments equipped with the best hydraulic presses. It is true that very heavy pressure carries through much coloring matter not withdrawn by the primitive native mill, and that the oil is consequently darker, and sooner undergoes decomposition; but modern mills are now supplied with filtration plants through which this objection is practically overcome.

The principles of the above process are daily reproduced in thousands of Filipino homes, where the hand rasping of the nut, the expression of the milky juice through coarse cloth, its subsequent boiling down in an open pan, and the final skimming off of the oil are in common practice. Notwithstanding the cheapness of labor, it is only by employing a mill well equipped with decorticating, rasping, hydraulic crushing, and steam-boiling machinery, and with facilities to convert the residue to feeding or other uses, that one may hopefully enter the field of oil manufacture in these Islands in competition with copra buyers.

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Coir.

The fiber of the cocoanut husk, or coir, as it is commercially known, has never yet been utilized in this Archipelago, excepting occasionally for local consumption.

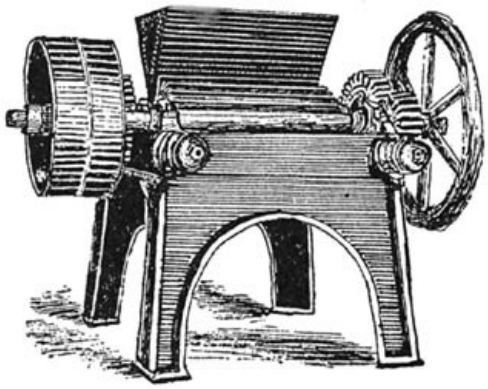

FIG. 1.—Cocoanut husk-crushing mill.

Second in value only to the copra, this product has been allowed to go to waste. The rejected husks are thrown together in immense heaps, which are finally burned and the ashes, exceedingly rich in potash and phosphoric acid, are left to blow away.

As the commercial value of the fiber is greater than the manurial value of the salts therein, it is economy to utilize the fiber and purchase potash and phosphoric acid when needed to enrich the soil.

Highly improved and inexpensive power machinery for the complete and easy extraction of the fibers of the husk, either wet or dry, is now rapidly superseding the tedious hand process once in such general use. Good patterns of machinery [13] are shown in the “husk-crushing mill” (fig. 1) and in the “fiber extractor” (fig. 2). The first breaks, crushes, and flattens out the husks by means of powerful, fluted metal rollers and, in the second the broken husks are fed over a revolving drum set with teeth especially devised for tearing out the fiber from the entire mass. Finally, it is fed into one of the many forms of “willowing” machines, which reduces the mass to clean fiber, which is now ready for grading, baling, and shipment. The residual dust and waste from this operation may be used as an absorbent for liquid manures, and ultimately returned to the plantation. The yield of fiber varies from 12 to 25 quintals of coir and 4 to 7 quintals of brush fiber per 10,000 average husks. In the Philippines the nuts yield a large amount of fiber and

a relatively small percentage of chaff and dust. With improved machinery and careful handling, 18 quintals of spinning coir and 5 quintals of bristle fiber from every 10,000 husks is a fair estimate of the product.

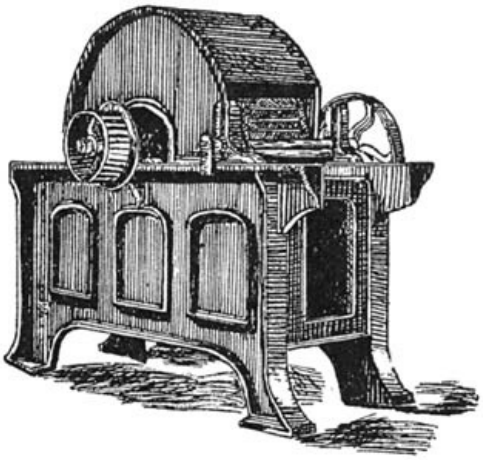

FIG. 2.—Cocoanut fiber-extracting machine.

As the cost of manufacture is generally rated at one-half the selling price, and as we must add a further charge of 20 per cent to cover freight and commission, we have resulting from the sale of the 23 quintals, or 2,300 kilos, at £16 per English ton, a balance of £11 11s. per hectare.

But there are other considerations which should not be overlooked. The husks of 10,000 cocoanuts will withdraw from the land 61.5 kilos of potash and 3 kilos of phosphoric acid, and the restoration of the full amount is called for to compensate for the growing wants of the tree, in addition to that withdrawn by the crop. The necessary fertilizers are worth, approximately, 5½d. per kilo, making a further reduction of £1 8s. and leaving as a net profit £10 3s., or, reduced to American money, nearly $50, gold, per hectare.

The machines above referred to will cost $800, gold, and $1,200 additional will purchase and house the power necessary to operate them. Such a plant will work up 1,000 nuts a day, and handle in a year the output of a grove of 30 hectares. With the addition of two or more fiber extractors the capacity of the plant may be doubled without material expense, and it should rather more than pay its entire cost in one year. [14]

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Tuba.

Tuba is the fresh or mildly fermented sap drawn from the inflorescence of the cocoanut.

There are no figures or data of any kind available as a basis for an estimate as to the importance of this product, but its extent may be inferred from the fact that the outlying groves about Cebu, Iloilo, and the larger Visayan towns are practically devoted to the production of tuba, and not to the manufacture of copra.

Tuba is collected from the unexpanded blossoms as soon as they have fairly pushed through the subtending bracts. To prevent any lateral expansion, the flowers are tied with strips of the green leaf blade and then, with a sharp knife, an inch or two of the extreme tip is removed. The whole flower cluster is now gently pulled forward until it arches downward. In a day or two the sap begins to drip and is then caught in a short joint of bamboo, properly secured for the purpose.

As a healthy tree develops at least one or more flowering racemes every month, and the flow of sap extends frequently over a period of two or more months, it is not uncommon to see a number of tubes in use upon one tree.

The workmen usually visits the tree twice daily to collect the liquor drawn during the preceding twelve hours in the larger tube, which he carries upon his back. He slices daily a thin shaving from the tip of the flower, in order that the wound may be kept open and bleeding. This process is kept up until nearly all of the flower cluster has been cut away, or until the sap ceases to flow.

More than a liter a day is sometimes drawn from one tree, and 5 hectoliters is considered a fair annual average from a good bearing tree.

In its fresh state tuba has a sweetish, slightly astringent taste; but, as the vessels in which it is collected are rarely cleansed, they become traps for many varieties of insects, etc., and it is, therefore, not a very acceptable beverage to a delicate stomach. When purified by a mild fermentation it is far more palatable.

A secondary fermentation of tuba results in vinegar, and on this account, chiefly, so much space has been devoted to this feature of the industry. The vinegar so produced is of good strength and color, of the highest keeping qualities, and of unrivaled flavor. Its excellence is so pronounced that upon its inherent merits it would readily find sale in the world's markets; and, although the local demand for the tuba now exceeds the production, its conversion into vinegar will probably prove the more profitable industry in the future. [15]

Spirits are distilled and in some places sugar is still made from the flower sap; and, while the importance of these great staples may not be overlooked, their commercial value as products of this tree are relatively insignificant.

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Minor Uses.

In addition to eighty-three utilities described by Mr. Pereira,[1] it is in very common use in the Philippines for:

1. Cocoanut cream. The freshly ground fruit, reduced to a pulp and strained, is consumed in that form or made into cakes with rice. It makes a delicious and nutritious food. According to Dr. W. J. Gies, in experiments lately published,[2] its nutritive value is due to 35.4 per cent of oil, about 10 per cent of carbohydrates, and 3 per cent of protein. The amount of cellulose (fibrous matter) is only 3 per cent, and its digestibility is easy when the mass, by grating, is reduced to a fine degree of comminution.

2. The "milk" or water is used sparingly as a beverage. It is also fermented and converted into inferior vinegar.

3. The hard shell is used as fuel. When calcined, it produces a black, lustrous substance, used for dyeing leather.

4. The same shell, aside from many uses quoted by Pereira, is used here for every conceivable form of cup, ladle, scoop, and spoon.

5. From the tough midrib of the leaf, strong and beautiful baskets of many designs are made, also excellent and durable brooms, and from the part where the midrib coalesces with the petiole pot-cleaning brushes are made.

6. The roots are sometimes used for chewing, as a substitute for Areca. They also furnish red dyestuff and with one end finely subdivided may be used in making toothbrushes.

7. The leaves and midribs, when burned, furnish an ash so rich in potash that it may be used alone in water as a substitute for soap or when a powerful detergent is required.

8. The fiber of the husk is used extensively by the natives for calking boats.

9. The milk is used in the preparation of a native dish of rice, known as "casi." It is an excellent and highly prized dietary article, prepared with rice or in combination with chicken or locusts.

10. The oil, melted with resins, is an effective and lasting covering for anything desired to be protected from the ravages of white ants.

11. The timber is used to bridge streams and bog holes, and the slowly decaying leaves to fill them up and render them temporarily passable.

12. The fiber is used in cordage and rope making, but to a far less extent here than in India. [16]

Its further uses are, in general, those current in the Orient. Briefly summed up, its timber is employed in every form of house construction; its foliage in making mats, sacks, and thatches; its fruit in curry and sweetmeats; its oil for medicine, cookery, and illumination; its various juices in the manufacture of wines, spirits, sugar, and vinegar; while not to overlook a final and not inconsiderable Filipino product, the splinters of the midrib are used in making toothpicks.

1 Quoted in “Watts’s Dict.,” II, 456.

2 Bull. Torr. Bot. Club, 1902.

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Cultivation.

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Selection of Location.

In the selection of a site for a cocoanut grove it is best to select land near the seashore and not extending inland more than 2 or 3 miles. Within this narrow zone there is commonly a deposit of rich, permeable, well-drained alluvium offering soil conditions of far greater importance to successful tree growth than the mere exposure to marine influences. The success that has followed cocoanut growing in Cochin China, remote from the seaboard, in Annam and up the Ganges basin one hundred or more miles from the coast, and in our own interior Province of Laguna, definitely proves that immediate contiguity to the sea is not essential to success.

That the cocoanut will grow and thrive upon the immediate seashore, in common with other plants, is simply an indication of its adaptability to environment. That it is at a positive disadvantage as a shore plant may be determined conclusively by anyone who will examine the root system of a seashore-grown tree upturned by a wash or tidal wave, and one uprooted from any cause, farther inland. It will be seen that the root system of the maritime plant is immensely larger than the other, and that a corresponding amount of energy has been expended in the search through much inert material to forage for the necessary plant food which the more favored inland species has found concentrated within a smaller zone.

The planting *must* be made in a thoroughly permeable soil.

The thick, fleshy roots of the newly upturned palm are loaded with water, and tell us that an inexhaustible store of this fluid is an indispensable element of success. If further evidence of this were required, the testimony of drooping leaves and of crops shrunken from one-half to two-thirds, throughout the cocoanut districts and upon our own orchard in Mindanao, as the result of drought, confirm it and bespeak the necessity of copious water at all times.

The living tree upon the sea sands further emphasizes this necessity; for, while its roots are lapped by the tides, it never flags or wilts, and from this we may gather the added value of a site which can be irrigated. The careful observer will note that along miles of sea beach, among hundreds of trees whose roots are either in actual contact with the incoming waves, or subjected to the subterranean [17] influence of the sea, there will never be so much as one tree growing in any beach basin which collects and holds tidal water for even a brief time; and that, notwithstanding the large number of nuts that must have found lodgment and favorable germinating influence in such places, none succeed in growing. From this we may derive the assurance that the desired water must be in motion and that land near stagnant water, or marsh land, is unsuitable to the plant.

It may frequently be observed that trees will be found growing fairly thriftily upon mounds or hummocks, in places invaded by flood or other waters which, by reason of backing or damming up, have become stagnant. An examination of the roots of an overthrown tree in such a locality will show that all of those in the submerged zone have perished and rotted away, but that such is the vitality and recuperative energy of the tree that it has thrown out a new feeding system in the dryer soil of the mound immediately surrounding the stem, which has been sufficient to successfully carry on the functions of nutrition, but altogether ineffective to anchor the tree securely, or to prevent its prostration before the first heavy gale.

While this phase of the question will receive more attention when we come to consider the chemistry of suitable manures, it may be said that, although analysis of the cocoanut ash derived from beach-grown nuts shows a larger percentage of those salts that abound in sea water than those grown inland, yet the equal vigor, vitality, and fruitfulness of the latter simply confirm the plant’s exceptional adaptability to environment and ability to take up and decompose, without detriment, the salts of sea or brackish waters. As a victim to the maritime idea, the writer in 1886 planted, far inland, several hundred nuts in beds especially devised to reproduce littoral conditions; shore gravel, sea sand, broken shells, and salt

derived from sea water being used in preparing the seed beds. The starting growth was unexcelled. Then came a long period of yellowing decline and almost suspended animation, ultimately followed by a complete restoration to health and vigor. The early excellent growth was due to the fact that the first nourishment of the plant is entirely derived from the endosperm, and careful lifting of the young plants disclosed the fact that recovery from their moribund condition was, in every instance, coincident with the time that the roots first succeeded in working through the unpalatable mess about them into the outlying good, sweet soil.

The exposure of the plantation is an important consideration, and a maritime site should be selected in preference to one far inland, unless it be on an open, unprotected flat, exposed to the influence of every breeze or the fiercest gales that blow.

The structure of the cocoanut seems well fitted to endure winds of almost any force, and that a remarkably abundant and strong circulation of air is essential to its best development is well shown by comparing a tree subjected to it with the wretched, spindling specimen growing in a sheltered glen or ravine. [18]

Strong confirmation of this may be found within the artificial environment of a plant conservatory, where it is feasible to reproduce, in the minute detail of soil, water, temperature, and humidity, every essential to its welfare except a good, strong breeze. As a consequence, the palm languishes and it has long been deemed, on this account, one of the most rebellious subjects introduced into palm-house cultivation.

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The Soil.

The soils for cocoanut growing are best selected by the process of exclusion. The study of the root development of the palm will prove to be an unerring guide to proper soil selection.

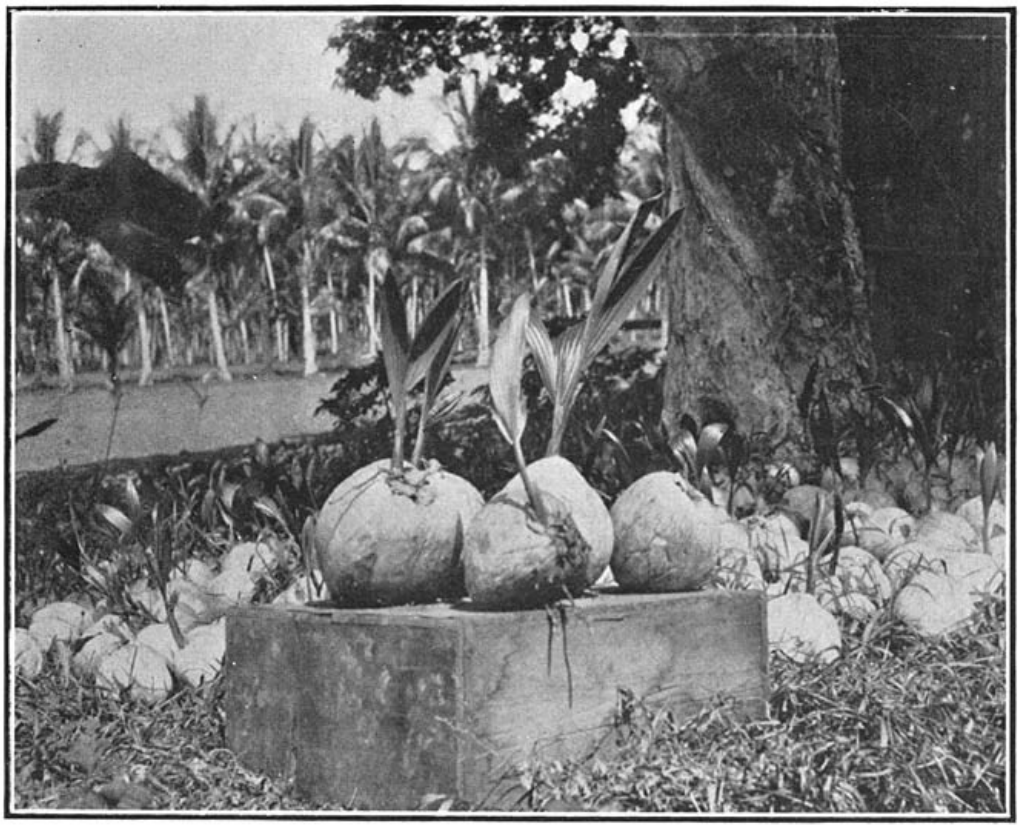
The roots of monocotyledons, to which great division this palm belongs, are devoid of the well-defined descending axis, which is possessed by most tree plants, and is often so strongly developed as to permit of rock cleavage and the withdrawal of food supplies from great depths.

The cocoanut has no such provision for its support. Its subterranean parts are simply a mat-like expanse of thick, fleshy, worm-like growths, devoid of any feeders other than those provided at the extreme tips of the relatively few roots. These roots are fleshy (not fibrous) and can not thrive in any soil through which they may not grow freely in search of sustenance. It then becomes obvious that stiff, tenacious, or waxy soils, however rich, are wholly unsuitable. All very heavy lands, or those that break up into solid, impervious lumps, and, lastly, any land underlaid near the surface with bed rocks or impervious clays or conglomerates, are naturally excluded. All other soils, susceptible of proper drainage, may be considered appropriate to the growth of the palm. Spons (Encyclop.) advocates light, sandy soils. Simmonds (Trop. Agric.) names nine different varieties suitable for this purpose, describing each at tedious length, and laying more or less emphasis upon a sandy mixture. These might all have been covered by the single word “permeable.”

As a matter of fact every grain of sand in excess of that required to secure a condition of perfect permeability is a positive disadvantage and must be paid for by a correspondingly larger area of cultivation and by future soil amendment. For the rest, the richer and deeper the soil the less the expense of maintaining soil fertility.

The preparatory work of establishing an orchard is light, provided the location is not one demanding the opening of drainage canals, and on lands of good porosity it involves neither subsoiling nor a deeper plowing than to effectually cover the sod or any minor weed growths with which it may be covered.

It has long been the reprehensible practice of cocoanut growers to merely dig pits, manure them, set the plants therein, and permit the intervening lands (except immediately about the trees) to run to weeds or jungle. [21]



A group of sprouted nuts.

In the Philippines the native planter has not yet progressed beyond the pit stage, nor do his subsequent cultural activities include more than the occasional “boloing” of such weeds as threaten to choke and exterminate the young plants.

Fortunately it will not be long till the force and influence of example are sure to be felt by our own planters. The progressive German colonist of Kamerun, German East Africa, and the South Pacific Islands, as well as the French in Congo and Madagascar, are vigorously practicing conventional, modern orchard methods in the treatment of their cocoanut groves, and it is amazing to read of discussions between Ceylon and Indian nut growers as to the best method of tethering cattle upon cocoanut palms in pasture, so as to obtain the most benefit from their excreta.

With an intelligent study of the plant and its characteristics it is believed that our native planter may put into practical use the knowledge that the veteran Indian planter has in fifty years failed to learn or utilize. He will learn that in time the entire superficies of his orchard will be required by the wide-spreading, surface-feeding roots of the trees, and that pasture crops of any kind, grown for any purpose other than soiling or for green manuring, are prejudicial to future success. He will know that the initial preparation of all of his orchard and its continuous maintenance in good cultivation are essential not only to the future welfare of his trees but as a necessary means in connection with a judicious intermediate crop rotation.

Hence the preparatory requirements may be summed up as such preliminary soil breaking as would be required for a corn crop in similar lands, succeeded by such superficial plowings and cultivations as would be required to raise a cotton or any other of the so-called hoed crops.

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Seed Selection.

Preliminary to planting the very important question of *seed selection* calls for close scrutiny on the planter’s part.

The small native planter is often familiar with the individual characteristics of his trees. Owners of small estates in Cuyos and about Zamboanga have pointed out to me trees that have the constant fruiting habit confirmed, others that will fruit erratically, and others that flower yet rarely bear fruit. The fruitfulness of the first class is undoubtedly a result of accidental heredity, for the planter has in the past made no selection except by chance, nor is the characteristic in any way due to his cultural system, which consists in planting the nut and letting nature and heredity

do the rest. One tree in Zamboanga, the owner assured me, had never produced less than 200 nuts annually for fully twenty-three years. Asked as to the bearing of all of his trees (of which he owned some three hundred), he stated that from the [22] lot he averaged 20 nuts at a picking, five times a year, a total of 100 nuts; that the crop of these was very fluctuating, some years falling to 60 nuts, again running as high as 130. The especially prized tree did not vary appreciably. In very dry seasons the nuts shrunk somewhat in size and the copra in weight, but the yield of nuts never fell below 200, and only once had amounted to 220. He had raised a great number of seedlings, but it had never occurred to him to select for planting the nuts from that particular tree.

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Planting.

We have pointed out the necessity of selecting seed trees of known good bearing habits, and equal care should be exercised in selecting those the nuts of which are well formed and uniform. This precaution will suggest itself when one observes that some trees have the habit of producing a few very large nuts and many of very small and irregular size and shape, and it is obviously to the planter's interest to lend no assistance to the propagation and transmission of such traits. In view of what has been previously stated, it is almost superfluous earnestly to recommend planters to sow no seeds from young trees. The principle for this contention—that no seed should be selected except from trees of established, well-known fruiting habits—would seem to cover the ground effectually.

The best seed should be selected and picked when perfectly mature and lowered to the ground. The fall from a lofty tree not infrequently cracks the inner shell, without giving any external evidence of the injury. A seed so injured will never sprout and therefore is worthless for seed purposes.

Freshly collected seed nuts contain in the husk more moisture than is required to effect germination, and if planted in this condition, decay is apt to set in before germination occurs. To avoid this the natives tie them in pairs, sling them over bamboo poles where they are exposed to the air but sheltered from the sun, and leave them until well sprouted. It is, however, more expeditious to pile the nuts up in small heaps of eight to ten nuts, in partial shade, where the surface nuts may be sprinkled occasionally to prevent complete drying out.

Germination is very erratic, sometimes occurring within a month and sometimes extending over four, five, or more months. When the young shoot or plumule (see illustration) has fairly thrust its way through the fibrous husk it is a good practice to go over the heaps and segregate those that have sprouted, carefully placing them so that the growing tip be not deformed or distorted by the pressure of superincumbent nuts. When these sprouts are 30 to 50 cm. high, and a few roots have thrust through the husk, *they are in the best possible condition for permanent planting*.

First. The original preparation of the land should be good and the surface tilth at the time of planting irreproachable; i. e., free from weeds and so mellow that the [24] soil can be closely and properly pressed around the roots by hand.

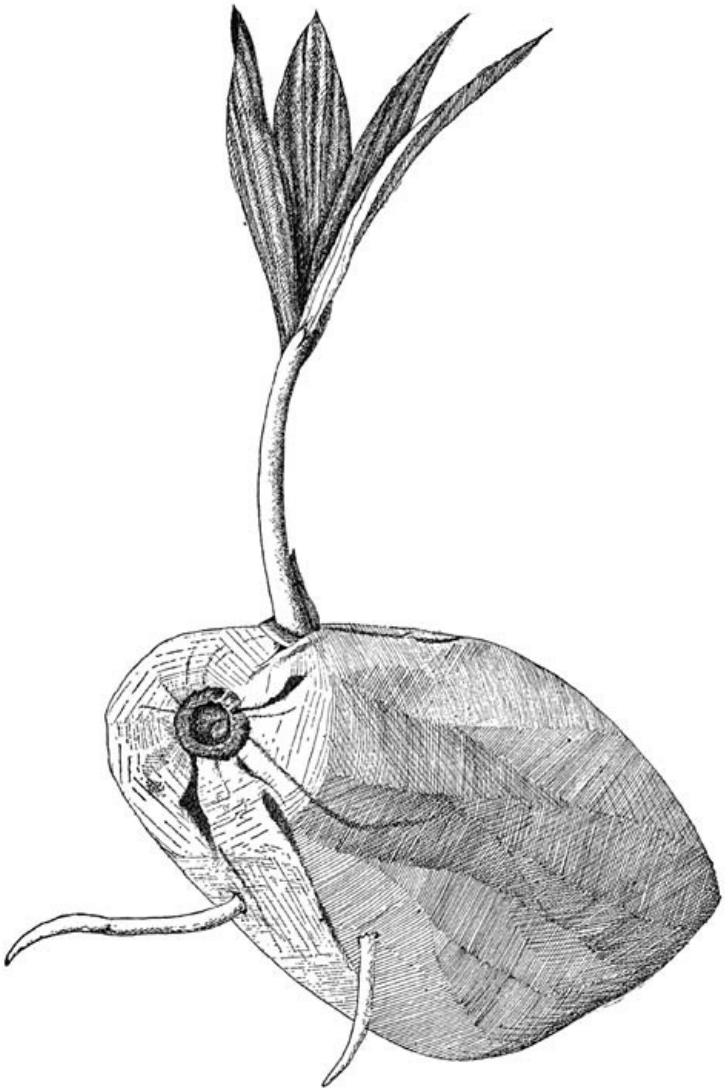

Fig 3.—Germination of cocoanut.

Second. The orchard should be securely protected from the invasion of cattle, etc. It is sometimes impossible to protect orchards against entry of these animals. If the success of these precautions can not be assured, then the nuts had better be grown in a closely protected nursery until about a year old, when the albumen of the seed will be completely assimilated and will therefore no longer attract vermin, and when the larger size of the plant will give it more protection from stray cattle.

In either case planting should be made concurrently with the opening of the rainy monsoon, during which season further field operations will not be required except when an intermittent, drier period indicates the advisability of running the cultivator.

The planting “pit” fetish, in such common use in India, has nothing to commend it. If stable manures of any kind are available, a good application at the time of planting will effect wonders in accelerating the growth of the young plants.

Where the necessary protection is assured, the young seedling planted out as above recommended should start at once, without check of any kind, into vigorous growth.

The nursery-grown subject receives an unavoidable setback. Its roots have been more or less mutilated and, as we may not prune the top sufficiently to compensate for the root injury, it is generally several months before the equilibrium of top and root is fully restored. In most cases, by the end of the second year, it will have been far outstripped in the growing race by the former.

The history, habits, and characteristics of the cocoanut tree indicate that it needs a full and free exposure to sun, air, and wind; and, as it makes a tree, under such circumstances, of wide crown expansion, these indispensables can not be secured except by very wide planting.

Conventional recommendations cover all distances, from 5 to 8 meters, with quincunx (i. e., triangular plantings) urged when the 8-meter plan is adopted. But the writer has seen too many groves spaced at this distance in good soil, with interlacing leaves and badly spindled in the desperate struggle for light, air, and sun, ever to recommend the quincunx, or any system other than the square, at

distances not less than 9 meters and, in good soils, preferably 9.5 meters.

The former distance will allow for 123 and the latter 111 trees to the hectare. They should be lined out with the greatest regularity, so as to admit at all times of cross plowing and cultivation as desired.

From this time forward the treatment is one of *cultural* and *manurial* routine.

Annual plowings should not be dispensed with during the life of the plantation. These plowings may be relatively shallow, sufficient to cover under the green manures and crops that are made an indispensable condition to the continued [25] profitable conduct of the industry. Nothing is to be gained by the removal of the earliest flowering spikes. Flowering is the congestion of sap at a special point which, if the grower could control it, he would wish to direct, in the case of young plants, to the building up of leaf and wood. Cutting the inflorescence of the cocoanut results in profuse bleeding and, unless this be checked by the use of a powerful styptic or otherwise, it is doubtful if the desired end would be accomplished. The earlier crops of nuts should all be taken with extension cutters or from ladders. No shoulders for climbing should be cut in any tree, the stem of which has not become dense, hard, and woody. Cut when the wood is the least bit succulent, they become inviting points of attack for borers.

With these reservations, there is everything to commend the practice of shouldering the tree, as offering the safest, most expeditious and economical way of making it possible to climb and secure the harvest. It is, of course, understood that the cuts should be made sloping outward, so as not to collect moisture and invite decay, and no larger than is strictly necessary for the purpose.

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Manuring.[1]

The manuring problem must be met and solved by the best resources at our command. The writer has had pointed out hundred of trees that, wholly guiltless of any direct application of manure, have borne excellent crops for many successive years; but he has also seen hundreds of others in their very prime, at thirty years, which once produced a hundred select nuts per year, now producing fluctuating and uncertain crops of fifteen to thirty inferior fruits.

Time and again native growers have told me of the large and uniformly continuous crops of nuts from the trees immediately overshadowing their dwellings and, although some have attributed this to a sentimental appreciation and gratitude on the part of the palm at being made one of the family of the owner, a few were sensible enough to realize that it came of the opportunity that those particular trees had to get the manurial benefit of the household sewage and waste.

Yet, the lesson is still unlearned and, after much diligent inquiry, I have yet to find a nut grower in the Philippines who at any time (except at planting) makes direct and systematic application of manure to his trees.

In India, Ceylon, the Penang Peninsula, and Cochin China, where the tree has been cultivated for generations, the most that was ever attempted until very recently was to throw a little manure in the hole where the tree was planted, and for all future time to depend on the inferior, grass-made droppings of a few cattle [26] tethered among the trees, to compensate for the half million or more nuts that a hectare of fairly productive trees should yield during their normal bearing life.

Upon suitable cocoanut soils—i. e., those that are light and permeable—common salt is positively injurious. In support of this contention, I will state that salt in solution will break up and freely combine with lime, making equally soluble chlorids of lime which, of course, freely leach out in such a soil and carry down to unavailable depths these salts, invaluable as necessary bases to render assimilable most plant foods; and that, on this account, commercial manures containing large amounts of salt, are always to be used with much discretion, owing to the danger of impoverishing the supply of necessary lime in the soil.

Finally, so injurious is the direct application of salt to the roots of most plants that the invariable custom of trained planters (who, for the sake of the potash contained, are compelled to use crude Stassfurt mineral manures, which contain large quantities of common salt) is to apply it a very considerable time before the crop is planted, in order that this deleterious agent should be well leached and washed away from the immediate field of root activity.

That the cocoanut is able to take up large quantities of salt may not be disputed.

That the character of its root is such as to enable it to do so without the injury that would occur to most cultivated plants I have previously shown, while the history of the cocoanut's inland career, and the records of agricultural chemistry, both conclusively point to the fact that its presence is an incident that in no way contributes to the health, vigor, or fruitfulness of the tree.

Mr. Cochran's analysis, based upon the unit of 1,000 average nuts, weighing in the aggregate 3,125 pounds, discloses a drain upon soil fertility for that number, amounting in round numbers to—

	Pounds.
Nitrogen	8¼
Potash	17
Phosphoric acid	3

Reducing this to crop and area, and taking 60 fruits per annum per tree as a fair mean for the bearing groves in our cocoanut districts and on those rare estates where a systematic spacing of about 173 trees to the hectare has been made, we should have an annual harvest of 10,300 nuts, or, stated in round numbers, 10,000, which will exhaust each year from the soil a total of—

	Pounds.
Nitrogen	82½
Potash	170
Phosphoric acid	30

The cocoanut, therefore, while a good feeder, may not be classed with the most depleting of field crops. [27]

To make this clear I exhibit, by way of contrast, the drafts made by a *relatively* good crop of two notoriously soil-impoverishing crops—tobacco and corn—and, on the other hand, the drafts made by an equivalent average cotton crop—a product considered to make but light drains upon sources of soil fertility.

A proportionate tobacco crop of 1,000 kilos per hectare will withdraw from the soil (reduced to the same standard of weights adopted by Mr. Cochran)—

	Pounds.
Nitrogen	168
Potash	213
Phosphoric acid	23

An equivalent crop of shelled corn, say, of 125 bushels per hectare, will withdraw —

	Pounds.
Nitrogen	200
Potash	135
Phosphoric acid	75

while a relative crop of lint cotton of 237 kilos (700 pounds) per hectare[2] will only exhaust, in round numbers—

	Pounds.
Nitrogen	114
Potash	70
Phosphoric acid	30

There is an analogy between these four products that makes them all comparable, in so far as all are largely surface feeders, and, as experience shows that there can be no continuing success with the last three that does not include both cultivation and manuring, we may use the analogy to infer a like indispensable necessity for the successful issue of the first.

Cultivation as a manurial factor should, therefore, not be overlooked, and all the more strongly does it become emphasized by the very difficulties that for some years to come must beset the Philippine planter in the way of procuring direct manures.

When it comes to the specific application of manures and how to make the most of our resources, we shall have to turn back to the analysis of the nut and note that, relatively to other crops, it makes small demands for nitrogen. At the same time it

must not be forgotten that these chemical determinations only refer to the fruit and that, with the present incomplete data and lack of investigation of the constituent parts of root, stem, leaf, and branch, we have nothing to guide us but what we may infer from the behavior of the plant and its relationship to plants of long-deferred fruition, whose manurial wants are well understood.

It is now the most approved orchard practice to encourage an early development of leaf and branch by the liberal application of nitrogen, whose stimulant actions upon growth are conceded as the best. [28]

In temperate regions, the exigencies of climate exact that this be done with discretion and care, in order that the unduly stimulated growths may be fully ripened and matured against the approach of an inclement season. In the Tropics no such limitations exist, and the early growth of the tree may be profitably stimulated to the highest pitch. That this general treatment, as applied to young fruit trees, is specifically the one indicated in the early life of the cocoanut, may be quickly learned by him who will observe the avidity with which the fleshy roots of a young cocoanut will invade, embrace, and disintegrate a piece of stable manure.

Notwithstanding lack of chemical analysis, we may not question the fact that considerable supplies of both potash and phosphoric acid are withdrawn in the building up of leaf and stem; but these are found in sufficient quantity in soils of average quality to meet the early requirements of the plant. It is only when the fruiting age is reached that demands are made, especially upon the potash, which the planter is called upon to make good.

Good cultivation, the application of a generous supply of stimulating nitrogen during its early career, and the gradual substitution in later life of manures in which potash and phosphoric acid, particularly the former, predominate, are necessary.

How, then, may we best apply the nitrogen requirements of its early life? Undoubtedly through the application of abundant supplies of stable manures, press cakes, tankage, or of such fertilizers as furnish nitrogen in combination with the large volume of humus necessary to minister to the gross appetite of the plant under consideration. But the chances are that none of these are available, and the planter must have recourse to some of the green, nitrogen-gathering manures that are always at his command.

He must sow and plow under crops of pease, beans, or other legumes that will furnish both humus and nitrogen in excess of what they remove. Incidentally, they will draw heavily upon the potash deposits of the soil, and they must all be turned back, or, if fed, every kilo of the resulting manure must be scrupulously returned. He must pay for the cultivation of the land, for the growing of crops that he turns back as manure (and that involves further expense for their growing and plowing under), and, in addition, he must be subject to such outlay for about seven years before he can begin to realize for the time and labor expended.

But there are expedients to which the planter may have recourse which, if utilized, may return every dollar of cultural outlay. By the use of a wise rotation he can not only maintain his land in a good productive condition but realize a good biennial crop that will keep the plantation from being a financial drag. The rotation that occurs to me as most promising on the average cocoanut lands of these Islands would be, first, a green manure crop, followed by corn and legumes, succeeded by cotton, and then back to green manures. [29]

To make the first green crop effective as a manure, both lime and potash are essential—the former to make available the nitrogen we hope to gather, and the potash in order to secure the largest and quickest growth of the pulse we are to raise for manurial purposes.

Both these elements are generally in good supply in our cocoanut lands; but, if there is uncertainty upon this point, both should be supplied, in some form. Fortunately, the former is cheap and abundant in most parts of the Archipelago, and, when well slaked, may be freely applied with benefit, at the rate of a ton or even more to the hectare.

In default of the mineral potash salts, the grower must seek unleached wood ashes, either by burning his own unused jungle land to procure them or by purchasing them from the neighbor who has such land to burn over. If located on the littoral, he will carefully collect all the seaweed that is blown in, although in our tropical waters the huge and abundant marine algæ are mostly lacking. Such as are found, however, furnish a not inconsiderable amount of potash, and, in the extremities to which planters remote from commercial centers are driven, no source is too inconsiderable to be overlooked.

The first green crop selected will be one *known* to be of tropical origin which, with fair soil conditions, will not fail to give a good yield. He may with safety try any of the native rank-growing beans, or cowpeas, soja, or velvet beans; or, if these are not procurable, he has at command everywhere an unstinted seed supply of *Cajanus indicus*, or of *Clitorea ternatea*, which will as well effect the desired end—to wit, a great volume of humus and a new soil supply of nitrogen. It remains for the planter to determine if the crop thus grown is to be plowed under, or if he will use it to still better advantage by partially feeding it, subject, as previously stated, to an honest return to the land of all the manure resulting therefrom.

He may utilize it in any way, even to selling the resulting seed crop, provided all the remaining brush is turned back to the land and a portion of the money he receives for the seed be reinvested in high-grade potash and phosphatic manures. The plantation should now be in fair condition for a corn crop, and, as a very slight shading is not prejudicial to the young palms, the corn can be planted close enough to the trees, leaving only sufficient space to admit of the free cultivation that both require.

It must not be forgotten that corn makes the most serious inroads upon our soil fertility of any of the crops in our rotation, and, unless by this time the planter is prepared to feed all the grain produced to fatten swine or cattle, it had better be eliminated from the rotation and peanuts substituted. In addition to this, he must still make good whatever drains the corn will have made upon this element of soil fertility.

Cropping to corn attacks the cocoanut at a new and vulnerable point, against which the careful grower must make provision. It will be remembered that an [30]
average corn crop makes very considerable drafts upon the soil supply of phosphoric acid; but, if the grain is used for fattening swine, whose manure is much richer in phosphates than most farm manures, and the latter is restored to the land, serious soil impoverishment may be averted.

The next step in our suggested rotation is the cotton crop. Here, too, limitations are imposed upon the planter who is without abundant manurial resources to maintain the future integrity of his grove. He may sell the lint from his cotton, but he can not dispose of it (as is frequently done here) in the seed.

If the enterprise be not upon a scale that will justify the equipment of a mill and the manufacture of the oil, he has no alternative but to return the seed in lieu of the seed cake, wasteful and extravagant though such a process be.

The oil so returned is without manurial value and, if left in the seed, is so much money wasted. The rational process, of course, calls for the return of the press cake, either direct or in the form of manure after it has been fed. With this is also secured the hull, rich in both the potash and the phosphoric acid[3] which we now know is so essential to the future welfare of the grove.

The above rotation is simply suggested as a tentative expedient.

The ground will now be so shaded that we can not hope to raise more catch crops for harvesting, although it may be possible during the dry season to raise a partial stand of pulses, of manure value only; but, from the fruiting stage on, this becomes a minor consideration.

This stage of the cultural story brings us once more face to face with the principle contended for at the beginning of this paper, namely, that there can be no permanent prosperity in this branch of horticulture until the crop is so worked up into its ultimate products that none of the residue of manufacture goes to waste.

At best the return of these side products is insufficient, and, despite their careful husbandry, we can not ultimately evade a greater or less resort to inorganic manures of high cost and difficult procurement.

The residue from the press cake is rich in nitrogen and humus, which, in the ever-increasing shade of the grove, will become more and more difficult to produce there through nitrogen-making agencies; but the waste from the manufacture of coir and the ashes from the woody shell will go far toward supplying the needed potash.

Such a system would, if closely followed, practically restrict the farmer’s ultimate purchases to a small quantity of acid phosphates, or of bone dust, which, in conjunction with good tillage, should serve to maintain the grove in a highly productive condition for an indefinite term of years. [31]

Irrigation.

As an auxiliary manurial agent of definite, well-proven value in this Archipelago, I will briefly recite some of the benefits that may be expected to follow occasional irrigation during the dry season.

It strongly accelerates growth and early maturity. A few irrigated trees, reputed to be under five years from seed and already bearing fruit, were shown the writer on the Island of Joló. The growth was remarkably strong and vigorous, notwithstanding that the water of irrigation had been applied in such a way that the tree could only hope to derive a minimum of benefit from its application. It had merely been turned on from a convenient ditch whenever the soil seemed baked and dry, at intervals of one to three weeks, as circumstances seemed to require.

Irrigation, but always in connection with subsequent cultivation, may be considered equal to a crop guaranty that is not afforded so effectually by any purely cultural system.

Rarely has a better opportunity occurred to demonstrate the unquestioned benefits that have inured to these few Joló trees from the use of irrigating waters than the present season of 1902–3. From many sources reports come to this Bureau of trees failing, or dying outright, from lack of moisture. While it is true that the present dry season has had no parallel since 1885–86, and that the rainfall during the dry season has been less than half the normal, yet it should not be forgotten that, during the eight months from October to May, inclusive, the average precipitation on the west coast, at the latitude of Manila, is only about 460 mm. and that, when the amount falls below this, the cocoanut is bound to suffer.

Though it is true that the evil effects of drought may be modified, if not altogether controlled, by cultivation, the assistance of irrigation places the cultivator in an impregnable position. If evidence in support of this statement were called for, it might be found to-day in the deplorable condition of those groves that have been permitted to run to pasture, as compared with those in which some attempts have been made to bolo out the encroaching weeds and grasses.

It is probably true that, except on very sandy soils, continued surface irrigation would aggravate the superficial root-developing tendency of the tree; and to what extent, if any, occasional laceration by deep shovel tooth cultivation would injure the tree remains to be seen. There are, however, few economic plants that so quickly repair root damage as the Palmæ, and, unless the seat of injury extends over a very large area, it is probable that the resulting injury would be of no consequence, as compared with the general benefits that would result from irrigation. [32]

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1 Throughout this paper the writer uses this word in preference to “fertilizing” even when speaking of so-called “commercial fertilizers.”

2 Farmers’ Bulletin 114, United States Department of Agriculture.

3 Conn. Exp. Sta. Rep. 1897, Part II.

Harvest.

Harvest of the crop requires but a brief discussion. The nuts should be plucked when ripe. The phenomenon of maturity can not be readily described in print. It frequently is as evident in nuts of a bright green color as in those of a golden-yellow color, and the recognition is one of those things that can only be learned by experience.

The practice, so general in the Seychelles, of allowing the nut to hang till it falls to the ground is certainly undesirable in these Islands. On the contrary, the overripe nuts will seldom fall until dislodged by a storm, and it is no uncommon thing to see nuts that have sprouted and started to grow upon trees in plantations where the harvest is left to the action of natural causes. Such nuts, of course, are entirely worthless for the manufacture of oil or copra, and even the husk has depreciated in value, the finest coirs, in fact, being derived only from the fruits that have not attained full ripeness. In any case, the nuts should be picked and the crop worked up before any considerable enlargement or swelling of the embryo occurs. From this time onward physiological changes arise which injuriously affect the quantity and quality of what is called the meat.

The heaping up of the nuts for some time after harvest favors some milk absorption, which seems to facilitate the subsequent easy extraction of the endosperm.

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Enemies.

Outside of certain insects of the order Coleoptera, cocoanuts in the Philippines are reasonably free from enemies; in some districts, close to forest-clad areas, the raids of monkeys do some damage. A tree-nesting rat, which nibbles the young nuts, is also a source of considerable loss. The rat is best overcome by frequent disturbance of his quarters. This involves the removal of the dead leaves and thatch that form constantly about the base of the crown. But the wisdom of this recommendation will depend entirely upon circumstances. As the planter may find that rats or the rhinoceros beetle are the lesser evil, so should he be governed.

There are localities in the Archipelago where the plague of rats is unknown and where the beetles abound. In that case it would be unwise to disturb the leaves which are very tardily deciduous and do not naturally fall till the wood beneath is hard, mature, and practically impervious to the attacks of insects.

Where rats are numerous and insects few, which is the case in some localities, the dead and dying leaves, among which the rat nests, may be advantageously cleared away whenever the tree is climbed to harvest the fruit.

Among serious insect enemies we have to contend largely with the very obnoxious black beetle, *Oryctes rhinocerus*, and, fortunately, to a lesser extent, with *Rhynchoporus ferrugineous* (probably the same as *R. ochreatus* of Eydoux), while [33] *R. pascha*, Boehm, and *Chalcosma atlas*, Linn., are also said to appear occasionally.

However different their mode of attack, the general result is the same, and their presence may surely be detected by the appearance of deformed or badly misshapen or lacerated leaves.

The attacks of all species are confined to the growing point and as far downward as the wood is tender and susceptible to the action of their powerful mandibles.

The black beetle makes its attacks when fully mature, eating its way into the soft tissues and generally selecting the axil of a young leaf as the point of least resistance. Others simply deposit their eggs, which hatch out, and the resulting grub is provided with jaws powerful enough to do the same mischief. Two or three of these grubs, if undisturbed, are sufficient in time to completely riddle the growing tip, which then falls over and the tree necessarily dies.

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Remedies.

Remedies may be described as preventive and aggressive, and, by an active campaign of precaution, many subsequent remedial applications can be avoided.

Most of the beetles attacking the palm are known to select heaps of decomposing rubbish and manure as their favorite (if not necessary) breeding places, and it is obviously of importance to break up and destroy such; nor can any better or more advantageous way of effecting this be suggested than by promptly spreading and plowing under all such accumulations as fast as they are made; or, if this be impracticable, by forking or turning over or otherwise disturbing the heaps, until convenient to dispose of them as first suggested.

A truly preventive and simple remedy, and one that I can commend as a result of close observation, is the application of a handful or two of sharp, coarse, clean sand in the axillæ of the young leaves. The native practice is to mix this with ashes, salt, or tobacco dust; but it is questionable if the efficacy of the remedy lies so much in these additions as in the purely mechanical effect of the sand, the constant attrition of which can not be other than highly objectionable to the insect while burrowing.

Of offensive remedies, probing with a stout hooked wire is the only form of warfare carried on in these Islands; but, as the channel of the borer is sometimes tortuous and deep, this is not always effective. A certain, simple, and easily applied remedy may be found in carbon bisulphid. It could be applied in the holes (which invariably trend downward) with a small metal syringe. The hole should be sealed immediately with a pinch of stiff, moist clay.

It is likely that this remedy and probing with a wire are the only successful ways of combatting the red beetle, whose grub strikes in wherever it finds a soft spot; but, [34] for these species which attack the axils of the leaves, I have great faith in the efficacy of the “sand cure,” and no nut picker should go aloft unprovided with a small bamboo tube of dry, sifted sand, to protect the bases of recently expanded leaves.

In Selangor cocoanut trees now come under the government inspection, and planters and owners, under penalties, are compelled to destroy these pests. Mr. L. C. Brown, of Kuala Lampur, in that State, who writes intelligently on this subject,[1] lays great stress on the value of clean cultivation in subduing beetles, and repeats a cultural axiom that never grows old and that will, consequently, bear reiteration here—that it is rarely anything but the neglected plantation that suffers, and that the maintenance at all times of a healthy, vigorous growth is in itself almost a guaranty of immunity from attacks of these pernicious insects.

While we, unfortunately, know that this is not in all cases an assured protection against diseases or insect enemies, it certainly minimizes the danger and, in itself, is a justification of the high-pressure cultural treatment advocated throughout the preceding pages.

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1 Ag. Bull. Fed. Malay States, February, 1903.

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Renovation of Old Groves.

Material improvement of old plantations may sometimes be effected and, unless the trees are known to be upward of fifty years old, generally repays the labor. Marked increase in crop has followed a heavy thinning out of trees upon the Government cocoanut farm at San Ramon, Mindanao. The improvement that a freer circulation of air and abundant sunlight have effected is very marked. Where it can be done, plowing is also sometimes feasible and should be followed by immediate crop improvement. The average native plow is not so well adapted for working over an old or neglected grove as it is for original soil preparation. It acts more as a subsoiler and will tear and lacerate more roots than is desirable. A single carabao, or one-horse American garden plow, is the better implement for this work. Extensive bat guano deposits are found in Mindoro, Guimarás, and Luzon. Some of them show richness in nitrogen and, when accessible at a moderate cost, would be useful in the renovation of old groves, where the shade would be adverse to the rearing of good crops of nitrogen gatherers.

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Conclusion.

1. There are large areas throughout the littoral valleys of the Archipelago, as yet unexploited, which, in the essentials of soil, climate, irrigation facilities, and general environment are suitable for cocoanut growing.

2. The present conditions present especially flattering attractions to cocoanut growers capable of undertaking the cultivation upon a scale of some magnitude. By coöperation, small estates could combine in the common ownership of [35] machinery, whereby the products of the grove could be converted into more profitable substances than copra.

3. The present production of copra (estimated at 278,000 piculs in 1902) is an assurance of a sufficient supply to warrant the erection of a high-class modern plant for the manufacture of the ultimate (the “butter”) products of the nut. The products of such an enterprise would be increased by the certainty of a local market in the Philippines for some part of the output. The average market value of

the best grades of copra in the Marseilles market is $54.40, gold, per English ton. The jobbing value on January 1 of this year, of the refined products, were, for each ton of copra:

Butter fats	$90.00
Residual soap oils	21.00
Press cake	5.20
Total	116.20

the difference representing the profit per ton, less the cost of manufacture.

4. The minimum size of a plantation, on which economical application of oil and fiber preparing machinery could be made, is 60 hectares.

5. There is no other horticultural tropical product which may be grown in these Islands where crop assurance may be so nearly guaranteed, or natural conditions so nearly controlled by the planter who, knowing correct principles, has the facilities for applying them.

6. The natural enemies and diseases of the plant are relatively few, easily held in check by vigilance and the exercise of competent business management.

7. The labor situation is bound more seriously to affect the small planter, wholly dependent upon hand labor, than the estate conducted on a large enough scale to justify the employment of modern machinery.

8. In view of an ever-expanding demand for cocoanut products, and in the light of the foregoing conclusions, the industry, when prosecuted upon a considerable scale and subject to the requirements previously set forth, promises for many years to be one of the most profitable and desirable enterprises which command the attention of the Filipino planter.

The greatest mine of horticultural wealth which is open to the shrewd planter lies in the heaps of waste and neglected husks that he can now procure from adjoining estates for the asking and cartage.

With labor at 1 peso per diem and at the present price of potash and phosphoric acid, all the husks in excess of 300 per diem which could be hauled would be clear profit. The ashes of these, when burned and applied to the old grove, would have an immediate and revivifying influence.

Many trees in an old plantation have ceased to bear. Whether this is due to exhaustion from old age or from soil exhaustion is immaterial; each should be eradicated and the time-honored custom of replanting a fresh tree in its place abandoned. These renewals are difficult enough in any fruit or nut orchard where [36] the scientific cultural conditions have been of the best. Renewals in a cocoanut grove, unless the vacant space is abnormally large and can be subjected to some years of soil improvement, are unprofitable.

There is a wide range of opinion as to the bearing life of a cocoanut tree. It is said to vary from thirty to one hundred and thirty years. Grown more than forty, or possibly fifty years old, the writer would hesitate to undertake the improvement or renewal of the grove.

Palms, unlike exogenous trees, afford no evidence by which their age may be determined. In general, with advanced years, come great height and great attenuation. In the open, and where fully exposed to atmospheric influences, these form an approximate criterion of age. The so-called annular scars, marking the earlier attachments of leaves, furnish no clue to age.

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Encoding

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Corrections

The following corrections have been applied to the text:

Page	Source	Correction
6	variesties	varieties
6	the the	the
7	[*Not in source*]	to
11	[*Not in source*]	.
12	comon	common
13	[*Not in source*]	”
14	developes	develops
14	[*Not in source*]	to
14	the the	the
16	adaptibility	adaptability
16	or or	or
25	becoming	become
31	geneal	general

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