THE FIBRE INDUSTRY IN HAWAII

No. 2.—Banana Fibre.

The fibre extracted from *Musa textilis,* known in the Philippines as "abaca" and to commence as Manila hemp, is undoubtedly the most satisfactory cordage material in the market. It owes its value chiefly to its great strength and lightness, and these qualities combined with those of color, texture and length have brought it into general demand throughout the world. Nearly half the produce of the Philippines, where abaca fibre is almost exclusively grown, is bought by America, and large quantities are exported to England and other European countries. Many attempts have been made to introduce the cultivation of abaca fibre to other countries but these have as a rule met with

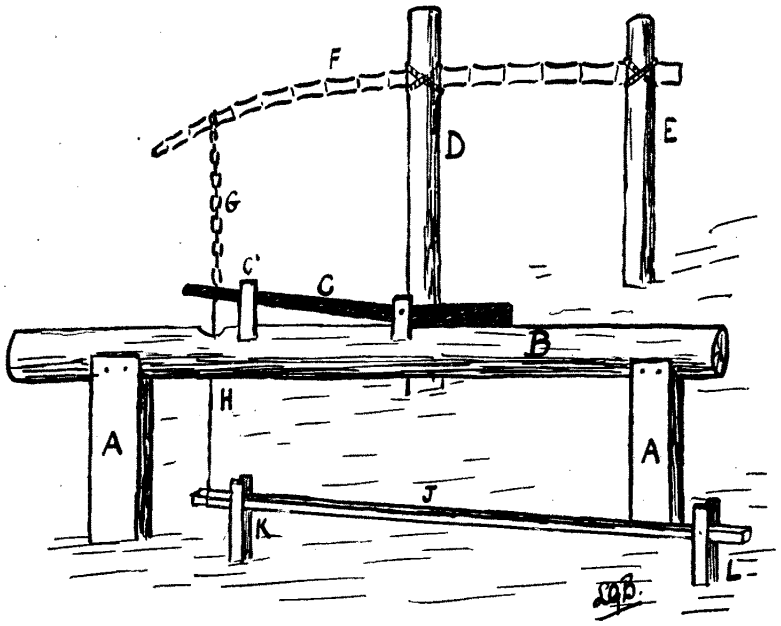
little or no success. In Celebes where large plantings of *Musa textilis* were made, the industry was abandoned in favor of coffee growing which has there proved more profitable, and in other parts similar failure has resulted. In view of the great value of this fibre and the favorable position of the Hawaiian Islands as a source of supply, it is very important to endeavor to ascertain what likelihood of success the cultivation of Musa textilis would meet with here. In the case of this fibre, the market has not to be yet established, as with Ramie, but the grower can be assured that whatever fibre he may produce will be readily disposed of at good prices. In an investigation of this subject it will be well to describe the industry in the Philippines, and then to closely examine the climatic and other conditions there in order to determine whether similar may be found in Hawaii. The results of its introduction to other countries, with the causes of its non-success there, are also matters of great importance, and should be carefully considered wherever information can be obtained.

The plant which furnishes abaca fibre is a variety of the edible banana indigenous to the Philippines. It is chiefly distinguished by its dark green color which pervades the plant throughout, and by the production of a quantity of seeds in an inedible fruit. The fibre belongs to the structural or foliaceous group, as do also Sisal and Pineapple fibres, and is found in the petioles or leaf stalks which ensheath one another and form the supporting trunk of the plant. The petioles contain rows of cells superimposed between fibrous filaments which run the whole length of the stalk. By removing the cells and their component tissue the valued abaca fibre is laid bare.

In the Philippines the plants are grown upon mountain slopes which have often been denuded of forest. Level land is very seldom chosen and low lying and marshy localities are quite unsuited for the production of abaca. The plants are sometimes obtained from seed, but although this method of propagation is by far the most expeditious and inexpensive it is not often resorted to as suckers give the best results. The latter are set out in regular rows at a distance of from five to seven feet apart. Little attention is required when the plantation is once started beyond keeping it free from weeds. It is however very important upon the sloping site which is usually selected to allow some growth to prevent depletion of the land by washing; for this purpose a leguminous crop is excellent and has the additional advantage of enriching the

soil with valuable nitrogenous properties. The broad leaves of the banana render it very susceptible to the influence of wind and seem to point to the origin of these plants in deep secluded mountain ravines subject to only gentle atmospheric movement. For this reason special care is exercised to select a site for the plantation as little exposed to the wind as possible and trees are also frequently scattered among the growing plants to afford protection to the young suckers. When this device is resorted to it is important to select trees which possess small leaves and thus do not cause too deep a shade, and also such as strike their roots deeply enough not to draw upon the food supply of the crop. An average of about three years, varying according to the suitability of the locality, is required for the plants to mature, and after the first year of yielding, one stalk may be cut from each plant every two or three months. The trunks are removed close to the roots and the remaining suckers continue the growth of the plantation and allow a continuous harvest. The best time for cutting is when the blossom is just protruding and, as in the case of most other fibres, it is of importance to remove the filaments as soon as possible. Neglect to do this in the care of the banana not only makes the process of extraction more difficult, but discolors the fibre and depreciates its value. The life of a plantation is from five to seven years, at the end of which time renewal is necessary.

The method of extraction of banana fibre in the Philippines is primitive and wasteful. Although the cultivation of abaca is extensive and by no means a new industry, as yet no satisfactory machinery is available to operate upon the trunks of the plant which produces it. This is the more remarkable as the fibres are not intertwisted but run parallel and direct through the soft juicy petioles, and appear to offer no particular difficulties as have had to be overcome by Ramie machinery. In the Philippines the production of abaca is very largely carried on by hand alone, though in some cases primitive machinery is in use. The mechanism of such appliances, which vary in design, is on the whole similar. Their most characteristic feature is seen in the strong flexible pole, generally of bamboo, which operates as a spring to close the knife upon the material to be cleaned. The machine represented in Figure I is probably most commonly met with. A description of this apparatus, which appeared in the Ceylon Tropical Agriculturist, has been widely copied, and the following data are available.



A-A. Two stout posts fixed in the ground to support the horizontal beam B.

B. Round wooden beam, 8 feet long and 6 to 8 inches in diameter. Upper surface about 2 feet 7 inches from ground.

C. Iron knife, about 9 pounds in weight and 3½ feet long, with a blunt edge, and fixed on an axle to beam B. The blade of the knife closes firmly and evenly on an iron sole-plate, 15 inches long by 2 inches wide, fixed securely to B. The knife is held steady by the grooved block C, which allows it to move up and down freely, but prevents lateral play.

D. Post fixed in ground about 6 feet from B, and about 4 feet 3 inches high, to support the pole F.

E. Post at about 6 feet from D to support the pole F.

F. Bamboo or other stout flexible pole, about 14 feet long, tied to E and F, in such a way as to form a strong spring to which to connect the handle of the knife C.

G. Chain to connect the bamboo spring F to the knife. The chain is lengthened or shortened as required to obtain the necessary pressure. From 1 foot 7 inches to 1 foot 10 inches is an ordinary range.

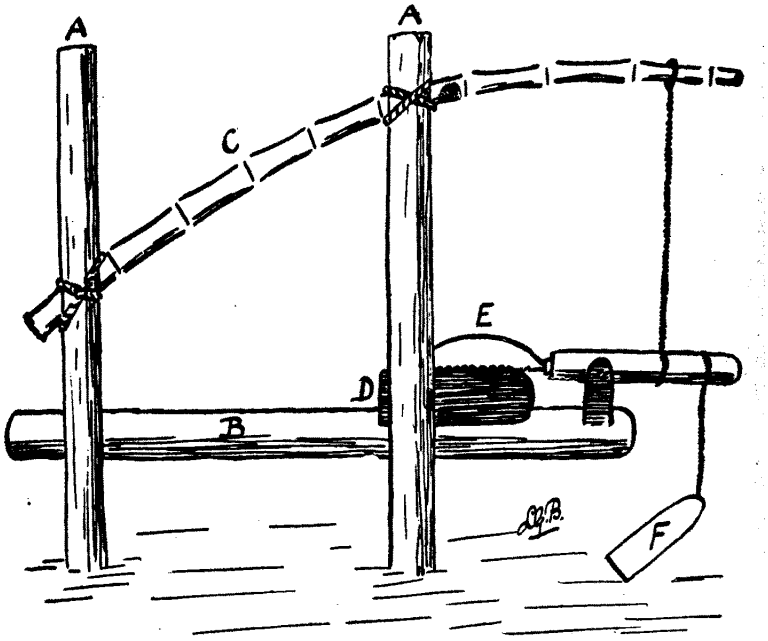
H. Wire fixed to end of C and passing through a hole in B and tied to the long pedal J.

J. Bamboo or other pole, 7½ feet long, suspended at one end by wire H and supported at other, to form a pedal. When the foot is placed on the pedal, the handle of the knife is depressed, and the blade raised for the insertion of the strip of leaf to be cleaned.

K. Two small stakes about 15 inches high, to act as guides for steadying the pedal J.

L. Wooden support, about 3 inches high, upon which the pedal I is hinged.

If the machine is set up before a rising mound the supports for the bamboo spring F can be made much shorter and the structure consequently rendered firmer. Before commencing to operate, it is important to see that the knife closes squarely and firmly upon the sole-plate and that the blade is well blunted. If preferred the latter may be finely serrated instead of plain.



The original drawing of the machine represented in Figure II was published by M. Ch. Rémery in the Bulletin Economique de l'Indo-Chine of July, 1903. At present the description of this abaca preparing device is not at hand but it will be seen that the general

principle of the machine is much the same as that already described.

A-A are the main supporting posts.

B represents the "table."

C is the flexible bamboo spring.

D is a block, probably of hard wood, to receive the knife.

E is the knife, which is in this case finely serrated, and

F the pedal. This latter in the drawing upon which Figure II is founded is apparently lying free upon the ground. A distinct improvement would be made by hingeing it upon a wooden base.

Although the machines above described are somewhat crude they possess the advantages of being not only simple but inexpensive and easily set up at different parts of the plantation—the latter an extremely important point as the great weight of the trunks renders transportation to a distant mill a matter of difficulty and expense. Little mechanical knowledge is necessary to operate these machines and after a few days experience any intelligent workman can use them properly.

After arrival at the machine the trunks are lopped into lengths of from $3\frac{1}{2}$ to 4 feet and the various layers of petioles removed and separated into qualities, according to their distance from the centre of the trunk. The lengths are now split into strips of from two to three inches broad. This operation may be carried on by a boy while a man is engaged in operating the machine. Upon receiving the strips from the boy, the man holds one in both hands and placing his foot on the pedal of the machine raises the knife and inserts the strip, inner side upmost and for a distance of a little more than half its length, beneath the blade. The latter is well blunted and care is required to know the exact degree of pressure to apply. The strip is now pulled by both hands from the machine and the process repeated two or three times, when it is turned to present the outer and more ligneous surface to the blade. When one end of the strip is divested of fibre, the end first held is presented and is freed from tissue in the same manner. The fibre is now hung upon bamboo frames and dried in the shade. Three distinct grades of fibre are recognized in the Philippines, although there are many intermediate qualities. The first is obtained from the coarser external petioles, is termed *'bandala'* and is reserved for the manufacture of ropes. The second grade *'lupis'* is obtained from the intermediate layers and this quality

and the former are probably the only ones exported. The third '*tupoz*' is yielded by the inner layers and reserved for home use and for weaving into fabrics and gauzes of exquisite quality and fineness. These latter goods are unknown to American and European markets but in the Philippines their value is greatly appreciated and it is said that as much as one thousand dollars is sometimes paid for a costume —though of what this latter consists is not revealed. The extraordinary variation in texture which is noticeable in abaca fibre renders it important to separate the coarse from the fine. The former is found in the outside layers of the trunk and the filaments become gradually finer according to their poximity to the centre. The coarser fibre is more difficult to extract than the finer as the external petioles are less pliable, drier and more ligneous than those situated further in the trunk. With the machinery described two men are able to obtain about thirty pounds of clean fibre a day and from 500 to 1,000 pounds is the average yield per acre. The waste of fibre by this process varies from 20 to 40 per cent. Better and more economical machinery has at times been in use in the Philippines, but the peculiar temperament of the natives of oriental countries and local circumstances and influences little considered or understood by the white man have been unfavorable to its general adoption.

After extraction the fibre is baled in quantities of two piculs, approximating 275 pounds. In 1901 the total export of abaca fibre was 99,000 tons, the United States being the largest customer and much being sent direct to the United Kingdom.

Much stress has been laid upon the wonderful fertility of the districts where Musa textilis is chiefly grown. Although this is in fact true, the conditions of soil requisite for the successful culture of this plant are obtainable in Hawaii. The plantations are for the most part situated upon mountain slopes where copious moisture and regular rain is assured, and where the soil is thoroughly drained and does not retain moisture. In all cases protracted droughts are most injurious and absence of rain for six months will completely destroy the plants. However, a warm humid atmosphere appears to be more requisite than heavy rains. The best results are obtained where the mean annual temperature is from 78° to 81° and the rainfall from 31 to 125 inches. The soil most favorable to

growth is that which is rich, cool, moist and well supplied with humus. Finally protection from wind is an important consideration in the selection of a suitable site for a plantation.

In the opinion of Mr. Jared Smith the districts most favorable to the growth of Musa textilis in these islands are the windward parts of Hanalei, Kauai; Nahiku, Maui; and Hilo, Puna, Olaa and portions of Kau and Kona, Hawaii.

Upon the whole, conditions in well chosen localities in these islands, appear to be such as to warrant a belief that the introduction of the growth of abaca fibre would be successful. The plant was introduced here in 1866 and is now found scattered throughout the group, particularly in Maui, where in Iao valley large quantities are said to be flourishing. Mr. Krouse of Kamehameha Schools reports having found a wild plantation (probably *M. textilis*) well established in a valley near Wahiawa on this island. At the time of his visit there last year the valley had been visited by unusually rough weather, and many of the trunks of the plants had not only been broken by the treatment they had received, but in some instances the cellular tissue of the upper part of the petioles had been removed by whipping in the wind and a quantity of free fibre of excellent quality had been exposed. The presence of the abaca banana in Hawaii should afford an opportunity of stocking a plantation with robust plants, which have for nearly forty years been acclimating themselves here. This circumstance alone would appear to place these islands in a more favorable position than those countries where the industry has already failed. The rich mountain slopes and valleys in the districts already mentioned appear singularly fitted for the site of many prosperous plantations. With regard to machinery, there can be no doubt but that in a very short time this will be so improved that the preparation of abaca fibre will be as simple as that of any other. The introduction of American methods to the Philippines will assuredly soon remedy as the fibre, as has been seen, does not render either complicated devices or unusual methods necessary for its extraction.

Although *Musa textilis* is undoubtedly the most valuable of the fibre yielding bananas, there are yet many other species which are well worthy of attention. Indeed, the many varieties of cultivated fruit bananas have probably all been derived from strongly fibred inedible fruited ancestors and have become

modified in character, developing their fruit at the expense of their fibrous quality. A species of bananas which grows wild in West Java is remarkable for the tenacity of its fibre and might probably be more amenable to introduction to other countries than the Philippine abaca plant. The wild Hawaiian banana is also well worthy of attention as a possible source of excellent commercial fibre, and should the cultivation of *Musa textilis* be finally determined unsuited to introduction here, these islands may yet be able to compete in the manufacture of banana fibre with a product of essentially domestic origin.

This hardy plant, of which the old Hawaiians knew many varieties, is found in the depths of many of our mountain gorges. One variety, said to be indigenous and to exude a red juice, yields a very tenacious fibre and, as does also the Philippine abaca plant, produces fertile seed and an inedible fruit. Another Hawaiian variety is remarkable for its variegated foliage. The various cultivated fruit bananas of the Hawaiian Islands also offer an important source of profit from the preparation of fibre from the discarded stems. From actual experiment conducted by the writer, they are capable of yielding about one pound of fibre per stem, of a quality worth about $150 per ton. The vast number of stems available for this purpose, which are otherwise wasted, should with better knowledge of their value be turned into revenue. The local manufacture of a few simple machines on the lines of those figured and their disposal at a low price to the banana growers of these islands would probably be the inception of a large industry in banana fibre, culminating in the operation of large plantations of *Musa textilis*. The implement shown in Fig. I could be made by any intelligent blacksmith at a cost of from $20 to $25. The possessors of such machines should be able to produce fibre at $50 per ton from their waste stems which would afford them a handsome margin of profit. This matter has been attracting considerable notice at Arcot, India, and in Jamaica, and the results of extracting fibre from the stems of fruit bananas in each case are substantially as follows:

Labor per ton	$18
Freight, commission and marketing	15
	$33

The value of the fibre obtained was from $125 to $175 per ton. In both these experiments cheap labor was available, but in the case of Chinese banana planters in Hawaii the operation of similar machinery should be sufficiently remunerative to warrant its adoption. Surely only ignorance of the value of the fibre or lack of knowledge of the facility of its preparation can account for the continual neglect of such a valuable product.

It should be stated that although thoroughly cleaned banana fibre will secure the best price, that which is not prepared with so much care can also be profitably disposed of. The waste fibre and tissue of the banana are also valuable products, and afford the well known Manila paper. When capitalists realize the almost inexhaustible quantities of good paper material now wasted in these islands by the sugar, banana and sisal growers a new enterprise will spring up and Hawaiian paper will hold a reputation far superior to that produced from ordinary wood pulp.