FACTS CONCERNING RAMIE.

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HISTORY AND DESCRIPTION.

Who has not heard of the “grass cloth” of China, that delicate and most beautiful tissue which since time immemorial has been manufactured in oriental countries? Produced by rude hand manipulation from a fiber of gossamer fineness, extracted by equally laborious methods from coarse, woody stalks, there is, to the popular mind, something of the marvelous in its fabrication. The fiber employed is the ramie of commerce, known in the raw state as China grass, though it is not in any sense a grass further than that a handful of the greenish yellow filaments has a grass-like appearance. The plant from which this delicate and astonishingly strong fiber is produced—one of the strongest and most durable in the fiber economy—may be described as a cluster of tuberous roots surrounded by a mass of fleshy rootlets, supporting a growth of 10 to 80 stalks which shoot upward to a height of 4 to 8 feet. At maturity these stalks vary in dimension from the size of a lead pencil to the thickness of a man’s little finger.

The stalks are clothed with large ovate-acuminate leaves of a warm, green color on the upper surface, and whitish or silvery beneath (in the variety known as Boehmeria nivea), the fiber being formed in the bark surrounding the woody portion, this having a pithy center protected on the outside by a thick epidermis. The plant grows rapidly, producing two to four and even five annual crops without replanting, dependent upon the country and climate where cultivated, and one planting suffices for several years.

Almost a century has passed since the attention of the government of India was first called to the value of this fiber in the textile economy by Dr. Roxburgh. About 1840 a second attempt was made to utilize the plant, but it was not until 1869, when a prize of £5,000 was offered by the British Government for a satisfactory process or machine with which to supersede the laborious hand methods of cleaning the fiber, that serious effort was inaugurated.

Probably no fiber in the vegetable economy has attracted such widespread interest as ramie, for nearly every government on the face of the globe, in countries where the plant will grow, has encouraged the establishment of the industry in one form or another, or capitalists in these
countries have liberally aided invention and private experiment in the hope of securing the golden reward it has offered. Through these unremitting efforts, and the lavish use of private capital, there is now a flattering prospect that the industry will ere long be fairly established, and ramie fabrics will be found in the markets of the world side by side with those from silk, from cotton, and from flax. European concerns even now are running thousands of spindles, turning out hundreds of tons of yarns annually, and are enlarging their works.

THE INDUSTRY IN AMERICA.

It is nearly forty years since the plant was introduced into the United States, and a quarter of a century marks the period of our struggle with the decorticator problem. Experiments in culture during this period have demonstrated that the plant will grow thriftily in the Gulf States from Florida to Texas, and in certain localities in California, such as the valleys of the central and southern portions of the State. It has been shown that after the first year two to four crops annually may be expected from one planting, dependent upon locality, and that the ground will not need to be again disturbed for four or five years.

But it has also been demonstrated that we have yet a great deal to learn regarding the details of cultivation, as the profitableness of the crop must depend wholly upon the yield per acre of spinnable fiber. The cultural problem of the immediate future, then, will be to learn how to produce on a given area the greatest quantity of fiber of spinnable quality at a cost that will allow of competition with other countries. This means careful experiments not only in culture but also with the stripping, cleaning, and after-manipulation of the fiber derived from these experiments, to ascertain the precise yield, quality, cost, and commercial value. In other words, it is not enough to grow a crop of stalks of the requisite height and size—we must know that these stalks contain the proper quality of fiber, in sufficient quantity to make the culture profitable; and we must know all the conditions essential to bringing about such results.

Between the Chinese imported and the home-grown fiber there will always be this disadvantage and difference: The machine-prepared fiber can never be so clean and free from gum, and therefore will bring a lower price, the range dependent upon the percentage of pure fiber it contains and upon the thoroughness of decortication. This difference is clearly shown on Plate V.

COMPARISON OF RAMIE AND FLAX.

Comparison between ramie and flax will illustrate some of the difficulties with which the ramie industry has had to contend, and show why ramie can not be grown, cleaned, prepared, spun, and woven as cheaply as flax and other textiles the production of which are recognized industries.
RAMIE—DRIED STALKS, RAW FIBER, DEGUMMED FIBER, AND MANUFACTURES
Ramie is a coarse, pithy stalk, with an abundance of leaves, often growing as high as a man's head, the fiber of which is extracted with difficulty by costly machinery, and which, after drying, must be further subjected to chemical treatment before it can be sold to the manufacturer in the form of degummed ramie. And according to French experts this degummed ramie represents hardly more than 2 per cent of a given weight of the green stalks with leaves that were harvested from the field. In harvesting a ton of flax the semidried straw is pulled from the ground, and it is only necessary for it to remain in the shocks for a few days when it becomes thoroughly dry like the straw of wheat or barley, having lost only its moisture. In harvesting a ton of green ramie we are handling 80 per cent of water and a mass of leaves and succulent tops equal to a weight of eight or nine hundred pounds to the ton. If the dry system of decortication is to be employed these stalks must be shocked in the field and handled several times, so that all the leaves may fall to the ground and the air reach every part of the shock, and even then the stalks will not sun-dry to brittleness in the Gulf States.

METHODS OF DECORTICATION.

If the green system of decortication is to be followed, this great bulk of succulent material (8 to 12 tons per acre) must be harvested and hauled to the machines, and if the machines will not strip the leaves automatically—for the stalks must be worked at once, while fresh—the stripping must be accomplished by hand. The requisite number of machines will be regulated by the area under cultivation, for a single decorticator that would even clean the product of an acre in a day would only be able to finish, say, 50 acres in eight weeks of working days. It will readily be seen, therefore, that if the fiber has reached proper maturity when the cutting begins at the end of eight weeks it must suffer a change that will give different grades of fiber in the same crop. Hence, only the farmer who grows a very few acres may expect to harvest his fiber with one machine if he desires to secure an even standard of quality, unless he resort to the dry system, with which the fiber may be extracted at any time, provided the stalks are thoroughly dry.

In comparing the different methods of treatment of these two fibers, flax and ramie, it will be readily seen that one is simple, chiefly mechanical, the retting being accomplished by nature at small outlay for labor; the other quite complex, requiring the handling of 8 to 10 tons, or even more, of green matter per acre, which must either be dried or passed through a machine while in fresh condition, and the ribbons finally subjected to chemical processes requiring more or less of technical knowledge and the employment of special apparatus. Flax, which is treated so simply, yields from 15 to 25 per cent of fiber, while ramie yields hardly 2 per cent of the weight of green stalks and leaves.
harvested. The cost of retting, breaking, and scutching flax, to secure its fiber, is a known quantity; that of ramie, at present, is unknown.

To the advantage of ramie over flax, in our comparison, let it be said that, under proper cultivation, an acre of the former should produce, in its two crops, 16 to 25 tons annually, while 1 or 2 tons of straw is all that can be expected in an annual crop of flax, save 12 or 15 bushels of seed that should be reckoned into the account. Then flax must be grown from the seed annually, while one planting of ramie roots will give crops for several years.

The question is frequently asked, Does the Department of Agriculture encourage cultivation at the present time? The Department certainly advocates experimental cultivation, in order that farmers may become familiar with the growth of the plant, and also to insure a supply of roots for more extensive planting when all the other problems have been solved. And it is true that at the outset, when the time comes that cultivation may be profitably engaged in, there will be a large demand for roots, which for a few years will assure a profitable revenue to those who have a supply to draw upon. But in this experimental culture not over two or three acres should be put under cultivation by one farmer, and he should go to work intelligently, keeping both eyes open, and without expectation of immediate money return. By this statement it will be understood that the United States Department of Agriculture can not encourage cultivation as a money crop, in connection with the regular staples, as long as the decorticator problem remains unsettled and the farmer can not be assured of a ready means of converting the crop into salable fiber that will compete with the hand-prepared China grass of commerce. The foreign product can now be supplied to manufacturers at from 6 to 8 cents per pound, and is almost wholly relied upon as the supply of raw material used in the European ramie-manufacturing establishments, and the same must be said of our own country until the home-grown fiber can be more economically produced and extracted than at present.

CLIMATE, SOIL, AND CULTURE.

In general terms it may be said that the ramie plant requires a hot, moist climate, with no extremes of temperature, and a naturally rich, damp, but never a wet soil, the necessary moisture to be supplied by frequent rains or by irrigation; in other words, a climate and soil in which the growth will be rapid and continuous after it has once begun. In the United States the best localities, so far as experiment has determined, are portions of Florida, Mississippi, Louisiana, and Texas, on the Gulf, and central California, on the Pacific coast. The other Gulf States, doubtless, will prove equally favorable to this culture, when more extensive experiments have been undertaken than are now recorded. Regarding the northern limit of commercial culture, no positive statement can now be made. The plant thrives in South Caro-
lina, and it is fair to suppose that two annual crops are possible, though
the quality and yield of the fiber can only be ascertained to a certainty
by careful tests of the product of both crops.

Mr. William R. Smith, the Superintendent of the United States Bo-
tanic Garden, Washington, D. C., considers the District of Columbia
the northern limit of its growth, botanically speaking. But commer-
cial cultivation in this locality or in Maryland or Virginia is out of the
question, for only in particularly favorable years will the plant make a
good growth, and even then but a single crop will be possible. In 1894
the entire season’s growth of the little plat at the Botanic Garden was
barely 3 feet high, and the clusters of flower racemes had not begun to
mature their seed on the 1st of November; and cultivation northward
from the District of Columbia, for instance in the State of New Jersey,
as recently suggested, must be set down as a mere vagary.

The question of soil is an important one. In the present day the soil
usually chosen in China is a red clay, “with sand mixed in,” and the
plantation is established with roots dug from old plats in the fall. In
India the plant appears to thrive in almost any soil, though preference
is given to rich, light sandy loams, thoroughly worked. In the Kangra
district “rich loams” are chosen. The French experimenters, whose
experience relates to France, Spain, and Algeria, prefer a deep soil—
“silico-calcareous, or sandy alluvial with a permeable subsoil.” But
marshy lands or retentive clay soils are always avoided.

In our own country, in the Gulf States, ramie has been grown exper-
imentally in a great variety of soils, ranging from the light sandy
uplands to the rich black lands of the Louisiana bottoms. But light
sandy alluvial soils have always given the best results. In California
deep alluvial, sandy, or loamy lands which, when well prepared, will
hold their moisture through the growing season, or that can be irri-
gated, are most commonly selected.

In preparing the land for a plantation, thorough tilth—that is, deep
plowing and cross harrowing—are essential. The ground is frequently
broken to a depth of 15 inches or more, but never less than 12 inches,
to secure good results; and lumpy land is rolled.

In all countries where ramie has been grown commercially or experi-
mentally the necessity for heavily enriching the soil by the application
of the farm manures or chemical fertilizers is emphasized. It was shown
many years ago by Forbes Watson that the alkalies, especially potash,
amount to almost one-half and phosphoric acid one-tenth of the weight
of the ash constituents from a plant of ramie, or about 80 pounds of
the former to 40 pounds of the latter in a ton of dried stalks. As a
crop of wheat is said to take from the soil but 30 pounds of alkalies
and 28 pounds of phosphoric acid, the importance of properly enrich-
ing the soil will be readily understood. The amount of mineral constit-
uents found in the fiber is very small, and as the fiber is the only valu-
able portion of the crop, the leaves and woody waste, or the refuse of
decortication, can always be returned to the soil. The French writers lay great stress on the use of the leaves for fertilizing material, as they are rich in potash. The leaves alone that are produced upon one acre may amount to 4 or 5 tons weight for each cutting.

Professor Hilgard's experiments at Berkeley, Cal., in this direction are very interesting. He makes the total of mineral ingredients withdrawn from the soil in a single year, four cuttings, 2,143 pounds. Among these are lime, 658 pounds; potash, 252 pounds; phosphoric acid, 156 pounds, and the figures for nitrogen are 370 pounds. The stalks contain about three-fifths of the potash, and the leaves one-quarter of the total. Nearly 87 per cent of the lime, 50 per cent of the phosphoric acid, and 55 per cent of the nitrogen is found in the leaves.

We learn, then, that lime, potash, phosphoric acid, and nitrogen are the constituents of a proper ramie fertilizer, and these elements of fertility may be supplied in several ways. If the refuse of a ramie crop is burned and returned to the land with the leaves a large saving in the purchase of fertilizers will be effected. According to Professor Hilgard, should the leaves and not the stalks be returned to the soil the amount of potash permanently removed from the soil would be increased by 156 pounds—lime, 72; phosphoric acid, 78; and nitrogen, 106.

A good ramie fertilizer recommended by Mr. S. B. Allison, a Louisiana ramie grower, is 300 pounds each of cotton-seed meal and kainit. Professor Stubbs uses two parts cotton-seed meal and one part acid phosphate at the rate of 400 to 480 pounds per acre. In French practice well-decomposed stable manures and well-ground chemical fertilizers, guano, and oil-cake have been used successfully.

The land having been put into proper condition as to tilth and fertility, the preparations for planting follow, but before considering this point in the agricultural practice it will be well to know what the farmer is to plant. Three methods of propagation of the ramie may be followed: (1) By the use of seed; (2) the employment of subdivided roots, and (3) the practice of layering. Ramie plantations are most commonly established by the planting of roots, the stand being supplemented by layering the shoots that spring from these roots, thus rapidly multiplying the individual stools, or hills, from which the clusters of stalks will spring. Thus, by planting roots instead of seed, time is saved and stronger plants are secured at the outset.

If, however, roots can not be obtained in sufficient quantity, the necessary plants must be produced from the seed—an operation requiring the utmost care, as the seed is very small. Outdoor propagation can hardly, therefore, be relied upon, and the young plants must be grown in the hotbed or cold frame. The principal care is to avoid covering the seed with more than a light sifting of fine earth, also to keep the bed moist and to protect the young plants from the sun. When they are 2 or 3 inches high sunlight may be admitted, and in five or six weeks they may be planted out in the field. The Chinese mix 4½ pints of fine
moist earth with 1 pint of seed, and by the use of earth and seed thus mixed no covering is necessary. A pint of seed will suffice for six or seven beds, each containing 4 square feet of surface.

For root planting the supply is obtained from the root masses of old plants, these being subdivided into lengths of 4 or 5 inches, containing several eyes. Twelve hundred bushels of roots have been taken from a single acre in an old plantation, that were sold for $1 a bushel. Reference may be made to the illustration of roots which accompany these pages. The top or crown roots (fig. 111), which resemble small, slender tubers, are never employed, and should be thrown out when the old roots are subdivided. The old roots are shown in figure 112.

In preparing for planting, the first step is to cross-plow, harrow, and roll the ground that has already been fall-plowed and harrowed. This may be done about the 1st of February. Mr. Allison's practice is to allow the land to lie for one month after this is accomplished before laying up the surface in flat beds, which should be 4½ feet from centers, the centers having an elevation of 6 inches. The rows are barred off with a scouter plow to the depth of 4 inches; the roots are then placed in the rows and covered with two furrows. A week later, when the roots have begun to sprout, a harrow with a board at the back of it is run over the ground in order that the plants may push up in mellow soil.

There is the greatest difference of opinion in regard to the proper distances apart that the plants should be set, but a safe mean will be to establish the rows 4 to 4½ feet apart with the plants 1 foot in the row; in California somewhat closer setting is practiced. The close
system of planting recommended by the French requires 14,000 to 16,000 plants to the acre, while the 4-feet by 1-foot system requires only about half as many plants to the acre.

Layering is practiced when the stalks from the first growth are about 3 feet high. The earth is mellowed and made damp, the stalks bent and held in place by crotchets, and covered with about 4 inches of soil. In four weeks they will have become independent plants, which may be left in their places to form new stools or may be transplanted in other plats. Another method of propagation has been recommended in California, which, in brief, is to set out obliquely sections of stalks some 6 inches in length, nearly covering them with earth. It is claimed that if the work is accomplished before the period of hot weather, no special care, as watering and shading, will be necessary, though all weed growth should be kept down. The planting in Egypt, Algeria, and Spain is done from the end of October until April; in France, from March to the end of May.

The only after-cultivation necessary is to plow or hoe between the rows, as may be necessary, to keep the soil free from weeds or in good condition. This work is usually performed in the spring or early summer months. As to the operations of the second year, the detailed account of Mr. Allison's experience will give a hint of the practice that should be followed. Early in April, when the danger of frosts had passed, all young growth was cut off but not saved. Fertilizers were

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Fig. 113.—Ramie stalks ready for cutting.  
Fig. 114.—Stalks of ramie showing new growth of leaves.
applied, and the soil between the rows plowed and hoed. About the first of July the first crop was cut, followed by another plowing and hoeing. The stalks were then allowed to grow until about November 1, the time for the second cutting. I think, however, it would be better not to delay the last cut so late, in order to avoid a "second growth" which takes the form of clusters of leaves, eventually producing branches, which appear at the point of juncture of the leaf and stalk after the old leaves have fallen. The accompanying figures illustrate this: Figure 113, the stalks and growth of alternate leaves; figure 114, with the beginning of a new growth of leaves at the point of contact of the old leaf with the stalk; figure 115 shows clusters of flower racemes and formation of seed.

“What is the expense of establishing a ramie plantation?” asks the farmer. At the present time it is difficult to answer the question, because the cost of roots, the chief expense, depends largely upon demand and supply. It will be a simple matter to figure out the cost of plowing, harrowing, and planting, and we may even assume a price for roots, but the figures must apply only to the present time, when the demand for roots is limited.

In this country ramie has never been grown over large areas, and the records of experiments that appear in the meager literature of the subject are very vague and incomplete. The figures given are made up from a careful analysis of returns received in reply to a special circular on this subject, and while the results will not be found far out of the way, these figures must not be regarded as absolute. By the Louisiana Experiment Station the first year's expense is set down at $20, the cost of fertilizers and of roots not given. The Mississippi Experiment Station figures, including cost of fertilizers but not of roots, are $19.50. Mr. Natho, a Texas grower, makes the statement that the expense of preparing the land, planting, and after-cultivation for the first year will amount to $21.50. Mr. S. B. Allison's figures, including fertilizers to the value of $12 and the labor of layering a part of the first growth, are $24. Mr. Allison's land was very poor, and required a large amount of fertilizer.

The figures of the United States Department of Agriculture, based not only upon the returns from the circular but upon all available information that could be secured from other sources, without counting the cost of roots, amount to $25.88 per acre. This allows for fertilizers $9 and for the labor of planting $8. By these returns the expense of the second year's cultivation, with fertilizers, is shown to be only $13.25.
HARVESTING THE CROP.

In general terms, a crop of ramie is ready for cutting when the leaves can be readily detached by passing the hand down the stems, and when the bases of the stalks have begun to turn brown. The sprouting of the buds at the base of the leaf stem is another indication. No rule as to dates can be laid down, as temperature and climatic conditions vary so greatly in different sections and in the same section in different years. In France the first crop is cut from June to July and the second from September to October.

It is a question whether we can economically harvest in this country by hand cutting, especially if the stalks are stripped of their leaves in the field. Then, too, the system of decortication to be employed, whether the green or the dry, will need to be considered. Mr. Kauffman states that the harvesting can be readily done by reaping machines or self-binders, which will reduce the expense to the minimum. If this mode is adopted without stripping the leaves, the decortication must follow immediately, for the mass of stalks and leaves will soon heat and the stalks rapidly mold or mildew. Personal observation at the time of the ramie trials of 1892 at New Orleans leads to the conviction that heating may begin in twelve hours, and that the bundled stalks will show positive signs of mildew within twenty-four hours. With stripped stalks the heating will be less rapid, but even when denuded of their leaves and lying in heaps, the stalks will soon be affected to an extent that will seriously injure the fiber.

It is not believed that ramie in Louisiana can be sun-dried to a state of sufficient brittleness to give best results in working; and kiln-drying will not only cause additional expense, but may result in injury to the fiber by overhardening the resinous principle or gum holding the filaments together. The dry system seems best adapted to California, where the climatic conditions differ so greatly from those of the Gulf States.

The Chinese strip the fiber by hand, producing, it has been stated, less than 2 pounds per day per laborer. This practice admits of careful selection of the stalks, and no doubt the even quality of the China grass of commerce at the present time is due to such careful selection. It is a question, therefore, if cutting the crop with a harvester, as has been recommended, where the stalks will be of varying lengths, even including short and immature growth, will produce an even quality of fiber. Such careful selection of stalks in our own practice can hardly be recommended, owing to the extra expense it would involve, but there is no question as to the enhanced value of the fiber that would result.

It has been shown that a crop grown in a rainy season will produce a softer, less resistant fiber than one grown under normal conditions, and it follows that there may be similar variation in parts of the same stalks that have been grown in successive periods of inundation and drought.
FACTS CONCERNING RAMIE.

These facts only emphasize the importance of harvesting mature stalks, and it should be the aim of the cultivator to bring about, as far as such control may be in his power, those conditions of growth that will insure even maturity.

YIELD OF RAMIE.

Estimates of yield, as a rule, are overstated. In the past newspaper literature of the subject the tendency has been to "boom" the industry by telling only the bright side of the story, or by advancing alluring "probabilities," the exaggerations, in rare instances, approaching the marvelous. But in spite of the enthusiastic utterances of the mere promoter, and the overzealous assurance of the misinformed news-chronicler, few farmers have gone into cultivation recklessly, though some capitalists have lost money in unwisely conducted experiments.

To get at the truth of the matter a careful study has been made of the figures of our own and other countries, the figures of actual experience being selected as the basis of estimate; and it has been possible to find a key by which the published figures of estimate from small areas may be tested.

According to Hardy's experiments in Algiers it is estimated that an acre of fully grown green stalks, with their leaves, will produce a weight of about 48,000 pounds, which will yield 4,900 pounds of dried stalks and 1,400 pounds of cleaned ribbons from one cutting. This, reduced to equivalents, gives a yield of 229 pounds of dried stalks to a long ton of green stalks with leaves, from which is obtained about 65 pounds of cleaned ribbons, yet to be degummed. This is equivalent to 630 pounds of ribbons from a ton of dried stalks. Professor Hilgard estimates two cuttings in California to yield 12,900 pounds of dry stalks, and that the minimum product of raw fiber from this weight of dry stalks would be about 15 per cent, or, say, 1,935 pounds. This is equivalent to 336 pounds of raw fiber to the long ton of dried stalks. Both the Algerian and Californian figures represent estimates based on the yield of small areas (hardly more than garden plats), and should not be taken as absolute. Indeed, Mr. Hardy's yield per acre of 96,000 pounds of green ramie per year (two cuttings) is not paralleled in any ramie literature that has come to my notice.

In De Mas's Italian experiments two cuttings the second year gave a product of 52,000 pounds of stalks with leaves per acre, or 27,600 pounds of stripped stalks giving 9,800 pounds of dry stalks, and yielding 944 pounds of dry fiber. This means 472 pounds of fiber from one cutting, or 40 pounds of raw fiber from 1 ton of green stalks. Percentage of dry to green stalks 10 per cent, and of dry fiber to dry stalks 17.9 per cent. These percentages are much nearer the mark, and may be more safely taken.

Regarding Dr. Hilgard's figures, it should be stated that the product is estimated from actual cuttings on two plats, about one seventy-first
of an acre. The high rate of yield at Berkeley is readily accounted for by the fact that in these small plats (18 by 34 feet) the crop was grown under the best possible conditions, and doubtless with garden culture. Similarly measured plats of second crop Louisiana ramie, cut at my request by Mr. Allison, when weighed showed a yield equivalent to 23,000 pounds and 25,000 pounds in round numbers per acre, the first lot being white ramie, the second lot green ramie, and Mr. Allison is of the opinion that with good culture this yield may be maintained. This is equivalent to 20 and 22 tons of green stalks and leaves per acre annually.

A careful study of the yield of all countries justifies as a fair estimate 8 to 10 tons of stalks with leaves per acre at a single cutting, or for two cuttings, which is the average for Louisiana, 20 tons; and it is possible, under the most favorable conditions, to secure a yield of even 25 tons per year after the plants are well established.

The careful experiments of Mr. Charles Rivière, director of the Botanic Garden of Algiers, have given us a ready basis of estimate of yield where ramie has been properly grown. These figures have been proved by the later experiments of Landtsheer. A French ton (1,000 kilos = 2,200 pounds) of stalks and leaves will yield 520 kilos (1,144 pounds) of stripped stalks; the 520 kilos of stripped stalks will give 104 kilos (228.8 pounds) of dry stalks, and these will yield 20.8 kilos (45.7 pounds) of decorticated product (a little less than 20 per cent), and this weight will give 11.2 kilos (24.6 pounds) of degummed filasse. This means that a long ton of green ramie stalks with leaves will yield 46½ pounds of decorticated fiber, which will give 25 pounds of degummed fiber, and calculations made on this basis will never be overstated or misleading. The figures of De Mas are 40 pounds of fiber per ton of well-grown stalks and leaves for first year's growth, and 44.2 for second year's growth. In our own country Mr. Allison's experiments have given very nearly the same results, having himself grown the stalks and extracted and degummed the fiber.

It is only through such practical experiments, covering the whole ground of production of the fiber, decortication, and degumming, under one direction, that we shall ever be able to solve the many problems that beset the industry.

Regarding the number of cuttings that may be depended upon in the United States there is but one point to consider, and that is the number of crops that will mature sufficiently to produce spinnable fiber of even quality in the different cuttings. Taking ten weeks as the average time required to mature the crop, three crops would require a growing season of thirty weeks. If the climatic conditions of the section where the crop is growing are such that the requisite degrees of heat and moisture can be kept up uniformly for a period of thirty weeks, then three crops can be readily grown. If, on the other hand, the first and third crops are of slow growth, while the second crop, which has
been produced in midsummer, is of rapid growth, a uniform grade of fiber in the three crops can not be produced, and two sure crops will, therefore, be better than one sure and two uncertain crops. In order to grow two sure crops the early spring growth will need to be mowed off, say, from the first to the middle of April.

It is believed, therefore, that two cuttings are possible in Texas and Louisiana, three in portions of Florida, and, as has already been stated by Professor Hilgard, from two to four in California.

**EXTRACTING THE FIBER.**

It is not important to record here the consecutive history of ramie-machine invention in America, particularly as it would necessitate describing almost a score of machines that, one after another, were brought to the attention of the public for a time, only to be practically abandoned when it was proved that they were unable to fulfill the claims of their inventors. Since 1867 the persevering effort to produce a satisfactory machine has naturally resulted in a gradual improvement in mechanical construction; new principles have been worked out and the causes of subsequent failures studied, with the result that substantial progress can be recorded, though full economic success can hardly be claimed.

Ramie machines maybe divided into two classes: (1) Delignators, or simple bark strippers, and (2) decorticators, which not only remove the bark but make some pretense of removing the outer pellicle, or epidermis, and the layer of cellular matter covering the fiber layer proper. The bark strippers produce the fiber in the form of flat ribbons, only the wood of the stalk being eliminated; they are usually constructed with some form of knife, or knives, with which the stalks are split before being subjected to the action of the breakers and beaters. The decorticators usually first crush the stalk by means of metal rollers presenting the flattened mass to the action of the breaking or beating devices, and frequently there is a system of mechanisms for combing the fiber before it is finally delivered to the aprons. The product of the delignators is always the same—a flat ribbon of bark, whether the dry or green system of decortication has been employed. The product of the decorticators, on the other hand, is almost as variable as the machines which turn out the fiber. In some of the worst machines this product is little more than a mangled strip of bark, neither a delignated ribbon nor decorticated fiber, but something more fit for the trash heap. In the best of them, individual filaments, by the green system, somewhat resemble China grass, though darker and less clean, while by the dry system the fiber is already soft enough to spin into coarse cordage without further manipulation. Between these two extremes every quality of ribbon is represented.

Taking China grass, or commercial ramie, as the highest form of the fiber, since it is degummed with a loss in weight of only 15 to 30 per
cent, it will readily be seen that the value to the manufacturers of the machine-cleaned ribbons must be in exact ratio to the degree to which the cleaning and freeing from gum have been carried. The simple delignated ribbon, containing all the gums, cellular matter, and epidermis, must be the lowest form of raw fiber, as it will show the largest percentage of loss (extraneous matters) in the after-process of degumming; and the expense of degumming, according to French experiments, is shown to be in direct ratio to the bulk of foreign matters to be eliminated. This, however, will be referred to in its appropriate place further on. (See Plate V showing hand-cleaned and machine-cleaned fiber.)

But we have considered that these different products or grades of product differ only in the degree to which the elimination of the gum and waste matters has been carried, and that the proportion of gum, cellular matter, and epidermis is the only consideration. In point of fact the product of many machines which otherwise might be called good fiber has been so filled with fragments of the woody portion of the stalks, or so “chewed up” by harsh treatment, or, finally, so snarled and tangled in the delivery that it has had little value for any purpose. The product should be delivered straight, unsnarled, and untangled, free from chips, and without breaks, cuts, or bruises, whether in the form of stripped bark or semicleaned fiber, and its value will be determined by the percentage of pure fiber it contains.

We may fairly assume, then, that the nearer a machine approaches in its product the ramie of commerce, Chinese hand-cleaned fiber, the higher the price of its product and the more desirable the device producing it as an economic agricultural implement.

Having discussed quality of fiber produced let us turn our attention to that other great problem, the question of quantity or output. In my first report\(^1\) is an account of the running of five French machines several years ago, and the record of one of the best of these machines in a field trial (in 1888) was commented upon. A single machine worked twenty-five days on the product of one hectare, or 2½ acres. With 20 acres at this rate it would have required two hundred days, and a farmer with one machine, decorticating three crops produced in a season, on 100 acres, would have to run the machine ten years of three hundred working days each to accomplish it. To state it differently, to decorticate at this rate the product of a single cutting on 100 acres, in one mouth of thirty days, would require 33 machines. Yet one can imagine the French attendant of this machine, who is showing it off to a novice, sending three stalks through the mechanisms in as many seconds, and with a complacent “Voila, Monsieur!” presenting the beautifully cleaned fiber to his delighted gaze. Such an exhibition before a capitalist who has not “read up” is sometimes worth the value of a hun-

\(^1\) No. 1, Fiber Investigations Series, United States Department of Agriculture.
Ramie in detail: 1, Ramie Stalks; 2, Machine-cleaned Fiber; 3, Chinese Hand-cleaned Fiber.
dred shares of stock (at par). But ramie machines have been vastly improved since 1888, and it is now possible to run through the product of an acre in a day, without, however, considering the question of quality. It would doubtless prove interesting to speak of the many machines that have appeared at the official ramie trials held in this and other countries in past years, but limited space forbids.

At the New Orleans machine trials of 1892 the machines ran on stalks that had been stripped of their leaves by hand, and no machine was able to run through the first 500 pounds of stalks weighed out, on account of stoppages, and finally the trial was abandoned. In 1894 the machines took the stalks with their leaves, as hauled from the field, and worked continuously. The quality of the product of decortication at the first trials was little better than simply delignated ribbon, some of it badly bruised and injured; at the second trial the decortication was excellent, though one machine seriously injured its product in the delivery. This shows decided progress, and one of the immediate results of the trials just held will be the further improvement of both machines exhibited, the work having already been undertaken. Reviewing the experience of even the last five years, we are able to record such substantial progress in machine construction that the outlook is hopeful, and experimenters are beginning to feel great encouragement.

AFTER-PROCESSES AND MANUFACTURE.

Those who are familiar with the varied processes of the extraction and first preparation of the fiber of flax and hemp know that there are four stages, or operations, between the work of the farmer and that of the manufacturer, as the retting—in water or upon the ground—breaking, scutching, and finally the hackling, which combs out the tow and leaves the fiber in shape for the manufacturer. With ramie the retting is omitted, and the stalks are broken and cleaned either green or dry with all the gums in their natural condition. This corresponds to the breaking and scutching in the treatment of flax, the two operations being combined in one when the work is done on a machine. Before the ramie fiber is hackled (combed), however, it must be subjected to a chemical operation analogous to retting, to which the French have given the name degommage—hence the English term degumming. The gums holding together the filaments of flax are soluble in water, and therefore the retting accomplishes the separation of these filaments without difficulty. The gums which hold together the structure of ramie bast are not soluble in water, but require peculiar chemical treatment, which can be more economically applied to the extracted fiber than to the fibrous substance as it exists in its natural state in the stalks as harvested. Owing to this fact the retting, or degumming, of ramie is usually done by the spinner, who, knowing the use to which the prepared fiber will be applied, degums the raw product to suit his own special needs. The farmer, then, has nothing to do with this operation
and need not interest himself in it further than to know whether his product when extracted and degummed is fit for spinning, or, in other words, is up to a standard of quality that will insure profit from the culture. This operation is not connected with the work of decortication.

Through the researches of the late M. Fremy, member of the French Institute, it has been shown that the gums and cements holding together the filaments of ramie are essentially composed of pectose, cutose, and vasculose, while the fiber itself is composed of fibröse, cellulose and its derivatives. The theory of degumming, therefore, is to dissolve and wash out the gums without attacking the cellulose. In order to eliminate the vasculose and cutose it is necessary to use alkaline oleates or caustic alkalies under pressure, and even bisulphites and hydrochlorites. The gums being dissolved, the epidermis is detached and can be mechanically separated from the layer of fiber by washing. The larger number of degumming processes in present use embody these general principles.

Lest it may be understood that it is only necessary to place any raw ramie fiber in the degumming bath to separate at once its different constituents, at a fixed cost, it should be recognized that upon the degree of cleanness of the fiber to be degummed depends the expense of the operation. It has been held by some inventors, or others controlling machines for decortication, that it makes little difference whether the ribbon to be operated upon is simply stripped bark or a well-decorticated product, as the resolving agency, followed by a volume of water, may be depended upon to render the separation complete and to wash out all extraneous matters, giving the pure fiber. The quantity that may be turned out in a given time, rather than quantity with quality, has been the main consideration. The waste matters in the bark of the ramie stalks must be wholly eliminated before the fiber is fit for the spinner, and if the machine does not accomplish any part of this work the degumming bath must do it all, but at a cost in direct ratio to the percentage of waste matters that remain in the ribbons after leaving the machine.

French experimenters have shown that it costs no more to degum the China grass that will fill a kier, or tank, of certain dimensions than the charge of simple stripped ribbons that will fill the same tank. Yet the weight of China grass that will fill this kier will be almost double that of the stripped bark; and while the kier of China grass will show a shrinkage (waste) of only 30 per cent, let us say, the shrinkage for the stripped bark may be 66 per cent. To state this differently, a half-ton charge (1,120 pounds, French) of China grass may give 775 pounds of degummed fiber, the expense of degumming (at $20 per charge, let us say) being about 2½ cents per pound. Now, the same kier, when charged with simple stripped bark, will hold only 660 pounds, and give but 264 pounds of degummed纤维. But as the cost of degumming the contents of the tank will be the same in both instances, the last
FACTS CONCERNING RAMIE.

operation has cost $7.5 cents per pound for each pound of pure fiber turned out. These figures are from French experiments made several years ago, recorded in Mr. de Landtsheer's brochure The Truth About Ramie, and the cost of degumming has since been somewhat cheapened. At the present time the cost of the operation of degumming is about $50 per ton of finished fiber, and the commercial value of the fiber about 13.5 cents per pound.

It should be stated regarding the degumming process in use in this and other countries, that they are either patented or secret processes, and as such the Department has made no special investigation into their comparative merits, and has no official knowledge of the formulas employed. But at the same time, many specimens of the finished fiber produced by these processes have been received, carefully examined, and preserved in the reference collection of the Office of Fiber Investigations, United States Department of Agriculture.

In recent years a number of more or less successful factories have been started for the production of ramie goods from the China grass of commerce, notably the German factory at Emmendigen, the Austrian mill at Bregenz which has recently been purchased by an English syndicate, the French association of Feray et Cie. at Essones, of A. Goulon at Rouen, and others, the companies operated so successfully by Mr. Favier, at Valobre, and latterly in England, where the recent success of French experimenters in economically degumming the fiber has led to the establishment of new companies for the production of ramie goods, one of these being the Boyle Fiber Syndicate of London.

At the present time there are two filatures, or spinning mills, in France, two in Germany, one in Austria, one in Switzerland, and one or more in England.

As to the possibilities of ramie in manufacture there seems to be no limit. Stuff goods for men's wear, upholstery, curtains, laces, and embroideries, plusses and velvets, stockings, underclothing, table damask, napkins, handkerchiefs, shirtings, sheetings, sail duck, carpets, cordage, fishing nets, and yarns and threads for various uses not enumerated. Even the Chinese recognize this wide utility, and while they manufacture the fiber from one variety of the plant into grass cloth and similar fabrics, they use another for fishing lines, nets, and the many useful products that may be classified under the general term cordage.

Regarding these various uses of ramie fiber in manufacture, however, M. Roux says we should not conclude that this textile is destined to be employed so largely. The cost of its preparation will always prevent its common use as a substitute for the textiles that can be more cheaply grown and prepared. He concludes that while it has the brilliancy, it has not the elasticity of wool and silk, nor the flexibility of cotton. But it will always be preferred for making articles requiring the strength to resist the wear and tear of washing or exposure to weather.
This faculty to imitate all other textiles is even one of the principal causes which have kept back the development of the ramie industry; and if, instead of launching out into a series of experiments, attention had been concentrated upon the exclusive manufacture of those articles to which the properties of the plant were peculiarly and naturally adapted, this industry would, probably, be in a more advanced condition than it is at present. The United States Department of Agriculture has held this position since its work in this field was begun. The folly of building up a ramie manufacturing industry on a false basis, that is, by employing the textile as a substitute for something else, is to be deprecated. The fiber should be used in those articles of economic necessity which would appear on the market as ramie, in order that any distinctive merit the textile may possess may become known, not only to the trade, but to the consumers of the product. Even then there will be an abundant demand for the textile, and for the waste fiber or combings, for use in mixing with other textiles, or for employment as out-and-out substitutes for them. Nor will the wearing qualities of these manufactures at all suffer through the substitution.

Ramie manufacture in our own country can hardly be said to have reached the commercial stage, though quite satisfactory results have been attained. The simpler forms of ramie fabrics were experimentally manufactured twenty years ago, but serious effort belongs to the present decade.

But it is needless to dwell on this phase of the industry, as successful growth and the machine question are the vital considerations. The spinning and weaving of ramie are no longer problems, and with these industries fairly established, as they are in Europe, improvements in machinery and processes to enhance the beauty of the products, to supply new forms of fabrics, and to reduce the cost of manufacture, will naturally follow, and the ramie industry will take its place with the linen industry and the other vast textile occupations which are such sources of wealth to the countries where they are carried on. Briefly summarizing the situation, the outlook is most hopeful.