REPORT NO. 10.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF FIBER INVESTIGATIONS.

A REPORT

ON

FLAX CULTURE FOR SEED AND FIBER

IN

EUROPE AND AMERICA.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Fiber Investigations,
Washington, D. C., April 11, 1898.

Sir: I have the honor to transmit herewith the manuscript for Report No. 10 of the Fiber Investigations series, referring to flax culture in Europe and America, with statements relating to the present status of the industry in this country.

The publication of this report is important at this time, because the supply of the earlier and more voluminous reports of this series, on the subject of foreign culture, are now exhausted, and reprints in their entirety are inadvisable. I have therefore condensed and rewritten the accounts of foreign culture, omitting all that is not essential, and adding only such new material as is important to illustrate the recent progress of the industry on both sides of the Atlantic. The demand for flax literature has increased rather than diminished, the announcement of the great success of the Department's experiments on the Pacific Coast having awakened a widespread interest in the culture of flax for fiber. The fact that the raw flax from one lot of experimentally retted Puget Sound straw gave 47 per cent of spinning fiber, worth $500 per ton, is conclusive evidence that this country can produce fine flax in quantity, with skill and good management.

I am, sir, respectfully yours,

Chas. Richards Dodge,
Special Agent in Charge of Fiber Investigations.

Hon. James Wilson,
Secretary of Agriculture.

PREFATORY NOTE.

It is believed that a statement of the circumstances under which the facts presented in the following pages were obtained will be of special interest to those interested in the subject as affording evidence that unusual opportunities were enjoyed and availed of in gathering the information on which this report is based. The writer spent six months in Europe during the season of 1889 under a commission from the Department of Agriculture which, among other things, required him to make a special study of foreign practices of methods of fiber culture, chiefly of flax and hemp, and to investigate machinery for the cleaning of these fiber plants, as well as the important machines or processes for the decortication of ramie. Being officially connected with the American commission to the Paris Exposition, many facilities were afforded to the writer in the pursuit of this undertaking which might not otherwise have been available, and by means of which much valuable information was secured. After the close of his work in behalf of the American commission, the inquiries were continued under an appointment as special agent of the Department, an appointment continued after the writer's return to the United States in November of that year, when a special line of investigation was entered upon in this country in order to secure a knowledge of the status of the flax-fiber industry in the United States with a view to its reestablishment here.

In the presentation of the matter contained in the following report, therefore, dealing largely with foreign practices and methods, the writer enjoys the advantage of presenting the results of his personal experience and studies made on the spot. It is from data thus obtained that the accompanying account is given of the different practices followed in those countries of Europe which furnish the commercial supply of flax. It should be stated that these practices can not be strictly followed in this country, as many of the details are unsuited to our conditions, but by giving us a knowledge of the essentials they enable the laying down of an American practice that may be safely followed, and which is requisite for the success of the industry on American soil.

C. R. D.

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FLAX CULTURE IN EUROPE.

DIFFERENT KINDS OF FLAX.

It is well to consider the different kinds of flax, for representatives of the genus *Linum* are distributed over both hemispheres, though they are chiefly natives of temperate climates. While *Linum usitatissimum* (fig. 1) is considered the cultivated fiber species, botanists recognize upward of one hundred species in this genus, De Candolle describing fifty-four in the first volume of his Prodromus. In many instances the distinctions between these species are so slight that the agriculturist or the industrialist would scarcely recognize them, and they are therefore of botanical rather than economic interest. Renouard, in "Études sur le Culture du Lin.," refers to the fact that our gardens sometimes contain three varieties which differ greatly: Two species with yellow flowers, the *Linum trigynum* (*Reinwardtia trigyna*), originating in India, and the *L. campanulatum*, which comes from southern Europe and from Egypt, and one with red flowers, the *L. grandiflorum*. Plants with white flowers and flesh-colored flowers are sometimes seen. There are still others known by name only, as the species is very rare; such is the *L. catharticum*, the leaves of which have a bitter taste and are sometimes employed as a purgative.

FIG. 1.—Common flax, *Linum usitatissimum*.

But among all these varieties the blue flowering, still designated by the name of *L. commun*, or the *L. usitatissimum* of the naturalists, is the only industrial species and the only one readily cultivated. In the grouping of species two general divisions have been made, those having flowers yellow and those with flowers blue, flesh color, pink, or white, though a special distinction is made in regard to *L. catharticum*, "with flowers always white and leaves opposite." *L. usitatissimum* comes into the group having blue, white, pink, or flesh-colored flowers, though as far as the cultivation of these plants for commercial fiber is concerned it is the only species that interests us. Regarding the distinctions which separate the species of Linum, Renouard says:

But these are so subtle that they evidently have no bearing upon the industrial uses of the flax and are of no value to agriculture. Often the most experienced operator and the countryman most familiar with this culture have had much trouble to classify the plants as above indicated. Moreover, all these species may be obtained from one sort of seed. What has given rise to these distinctions is that when the flax does not appear all in one growth of stem, slender at the top and without branches, bearing one flower, it may remain short and ramify its stalk to a number of branches having several flowers and considerable seed. It is under this aspect that we see the plant designated as "*tetard*" (pollard or branched), also called *petit lin* (small or low flax), in contrast with the ordinary flax, called *grand lin* (tall flax). Besides the above facts we may say that there have never been seen either entire fields or even parts of fields growing only the tetard, or the low flax. We therefore hold it to be inopportune to make such classification of the common flax into industrial species.

FIG. 2.—Ancient flax plant, *Linum angustifolium*.

Some writers recognize *Linum crepitans* as a cultivated species, this form growing less tall than *L. usitatissimum*, with much thicker stems, which have a tendency to branch, and more abundant flowers, and therefore producing more seed. In a report from Consul T. E. Heenan, at Odessa, it is stated that "*L. usitatissimum*, *L. vulgare*, and *L. crepitans* are being cultivated in Russia in several varieties of both kinds, but the difference in these varieties is so slight and they so easily blend that even those initiated in the trade of the article often fail to perceive it."

Several other forms of flax are mentioned by industrial authorities, but they are of little importance. *L. perenne*, which is known commonly as perennial flax, has been the subject of experiment, but beyond the fact that it is mentioned doubtfully as an oil plant in India it does not concern us. And it is also of slight importance from the industrial standpoint that the North American Indians use the fiber of *L. lewisii*, which has a wide range in western North America, the plant differing from the common cultivated flax in producing usually two or three stems from its stout perennial root and in having a capsule two or three times as long as the calyx. The Indians of the Oregon plains make it into a remarkably strong twisted cord, used in the manufacture of fish nets, in the binding of grass mats and basket frames, and for other purposes.

The most ancient cultivated species of flax is thought to be *L. angustifolium* (fig. 2), a form found growing wild from the Canary Isles to Palestine and the Caucasus. This is the species said to have been grown by the Swiss lake dwellers and the ancient inhabitants of the north of Italy, while *L. usitatissimum* was the ancient flax of Mesopotamia, Assyria, and Egypt. In the "Dictionary of the economic products of India" it has been suggested that these two principal forms or conditions of flax exist in cultivation and have probably been wild in their modern areas for the last five thousand years at least. It is not possible to guess at their previous condition. Their transitions and varieties are so numerous that they may be considered as one species comprising two or three hereditary varieties, which are each again divided into subvarieties.

THE PRACTICE IN BELGIUM.

The finest flax grown in Europe is unquestionably produced in western Belgium, and largely in a region of country through which flows the River Lys, the town of Courtrai being the center of the industry. This is the creamy Flemish flax, from which the finest linen fabrics are made, and which owes its peculiar color to the waters of this famed stream, "the golden Lys," in which the Courtrai flax is always retted. Flax is grown, however, in other sections of Belgium, a fine flax, but darker in color, coming from the country of Waes, and retted in stagnant water in specially constructed "pools." In the Brabant, too, considerable quantities of flax are grown, both dew and pool retted, and known as "blue flax" from its very dark color.

The writer, desiring to know by personal experience something of the peculiar methods of handling flax in the Belgium flax-growing districts, visited several of the most important centers of the industry about the 1st of September, 1889, at which time the river retting, as practiced in Courtrai, was in full operation. Through the courtesy of Belgian officials and others he was able not only to see the various operations after harvesting that it was desirable to study, but to learn much that was interesting regarding cultivation and the industry in general.

While the superior quality of Courtrai flax is claimed to be due chiefly to the action of the soft, slowly running, almost sluggish waters of the River Lys, without doubt there are three other important factors which aid in the result: First, a soil preparation, with systematic rotation of crops and extent of fertilizing that few, if any, flax farmers in America have ever practiced; second, the use of only the best seed; and lastly, most careful handling and skillful manipulation from the time the crop is ready to pull until the straw goes to the scutch mill. Nor is the care and vigilance relaxed even here.

It was learned that flax succeeded best in a deep and well-cultivated soil that is not too heavy, experience proving that in a dry calcareous soil the stalk remains short, while in heavy clayey soil it grows very long, although its fiber is not so fine. The ground is plowed either in the fall or spring—plowed or spaded, for a great deal of the flax land is turned with the spade. The work may begin in November, sometimes a little earlier, or it may be put off until February or the first days of March. Both methods had their advocates and opponents, and either season may be advantageous or disadvantageous, according to the kind of winter which follows or precedes.

In the matter of enriching the soil there is no halfway work or turning "short corners." Where stable manure is used it is generally put on before winter sets in. Then in spring before sowing time the ground is heavily treated with fertilizers, or night-soil in solution is poured over it. A great deal of the material is brought from the towns and kept in closed receptacles or reservoirs until the time for using it on the ground. Stable manures are used in connection with chemical fertilizers. Of the latter it is common to employ from 600 to 800 kilograms per hectare, or, roughly, from 500 to 750 pounds per acre, to go over the ground with the liquid night-soil in addition.

But the Belgian flax farmer does not depend upon careful fertilizing or cultivation alone to put the soil in the proper condition for growing flax, a careful system of crop rotation playing a very important part. Regarding the precise order of rotation and even the length of time between two growths of flax on the same land, there is the greatest difference of practice in the several districts and even in different towns of the same district, so no one absolute course of cropping can be laid down. In the Courtrai region the occupancy of the land with flax varies from five to ten years, the average being about eight. In eastern Flanders it is five to nine, and in the Brabant five to eight. In some other sections a much longer time elapses between two crops of flax, and one or two generations back fifteen and even eighteen years were sometimes allowed to intervene.

One informant stated that flax was most generally sown after leafy plants, such as potatoes or turnips, wheat and especially oat stubble being highly approved. A common rotation is clover, oats, rye, wheat, and in some cases hemp. Crops of rape, tobacco, beans, and vegetables (these latter crops on farms contiguous to towns), or even onions and salsify, are grown, as in middle Belgium. Clover is considered one of the best crops to precede a crop of flax, as its numerous roots go deep into the soil and from their decomposition not only furnish nutriment to the growing flax roots, but enable them more easily to push down into the soil. In the pamphlet of instructions published by the Irish Flax Supply Association, the Belgian rotation is given as flax following corn (grain, not maize), after potatoes, mangold, or beet, clover not being mentioned at all.

Here are a few statements of favorite orders or rotation in the several flax-growing districts:

Western Flanders.—(1) Oats, manured; (2) flax and roots; (3) wheat, manured; (4) rye or rape, alone or with clover; (5) clover; (6) wheat; (7) potatoes or kidney beans; (8) oats with clover, and sometimes with wheat.

Eastern Flanders.—(1) Potatoes, hemp, barley, or rye; (2) after potatoes or hemp, rye or wheat; (3) after rye or wheat, flax and clover or flax and carrots; (4) clover, and if carrots have been sown, rye; (5) after oats, after clover, barley or rye; (6) buckwheat or rye. (This rotation is followed in some of the cantons of Alost when flax follows hemp.)

Hainault.—(1) Wheat and clover; (2) clover; (3) flax; (4) after dressing, barley; without dressing, wheat; (5) after barley, rye and clover; (7) wheat; (8) kidney beans or oats; (9) potatoes. (The soil is manured but once during the rotation, but ashes or calcareous compost are spread after clover.)

Brabant.—(1) Oats; (2) flax with "minette;" after the cutting strongly manured with cow dung; (3) wheat; (4) rye and clover; (5) clover dressed; (6) wheat.

Antwerp.—(This rotation is rarely followed.) (1) Flax, with clover or with roots; (2) clover; (3) wheat or rye; (4) roots; (5) rye, but with high manuring previously, and carrots; (6) potatoes or oats; (7) potatoes after oats; (8) rye with clover or carrots, or, if it were sown singly, roots are put in afterward; (9) oats with clover; (10) clover; (11) winter barley; (12) rye; (13) rape; (14) rye. (The soil is highly manured after each crop.)

After spading or plowing, the ground is well broken with the harrow, oftentimes being brought almost to the condition of garden soil. It is then rolled and the seed planted, this being done any time from the last week in February until the latter part of March, dependent upon the weather.

It is considered of prime importance that a good quality of seed be used, and in Belgium the greatest care is taken—it might almost be said that the utmost vigilance is exercised, because so many frauds are perpetrated—to secure only such a quality of seed as will give the best results. The appearance of the grain, its richness in oil, the absence of all foreign odors indicating mustiness or bad condition, purity, and its germinating power, are all considered, and no test neglected that will enable the cultivator to assure himself as to what he is buying. Limited space necessitates dismissing this subject of the selection of seed thus briefly, though the editor of the Irish Textile Journal dismisses it more briefly, as follows: "Select your seedman, for it is an open secret in this age of commercial shams an old or inferior article can be made to look almost equal to new."

The most common and the best course is to import the seed annually, though it was found that in some localities a different custom prevailed, as in the Brabant. Imported seed is planted the first year, Dutch or Russian, and the seed product of this crop planted the second year, giving, it is claimed, a better quality of flax than the first year; but for the next year's sowing new seed is again secured. This is due to the deterioration of the home-grown seed, from the flax being pulled before it is fully mature. And as seed grown in parts of Russia, notably around Riga, attains the most perfect state of maturity, it is considered the best practice to renew annually with the fully matured seed. The sowing must be done with great regularity, the best results being attained only with long experience. A great deal of this work is said to be done in Flanders by special workmen, who, in the flax-sowing season, make it a business, receiving their pay, not by the day, as is usual in this country, but by the number of hectares[1] sown.

The seed is most usually sown in the morning and harrowed with a harrow set with very close teeth. This is considered necessary for giving a uniformity to the stand of flax in the field, insuring the same standard of fineness in the ultimate product for every part of the field.

The amount of seed sown varies ordinarily from 2½ to 3 bushels per acre, though in one district (Hainault) it is claimed that the quantity sown is sometimes double this amount. Probably 3 bushels per acre comes nearer the general practice. Some growers hold that more should be used when the sowing is late than when early; at any rate, when planted too thickly, as is sometimes the case, it is afterwards thinned, though such a practice of course adds just so much more to the cost of production.

After the seed has germinated and the plant is about ready to appear above ground, or sometimes even after it has sprouted, the land is rolled, partly for the purpose of laying the soil firmly and partly to make the surface even to facilitate the next operation that demands the cultivator's attention, the weeding; this is done by women chiefly at a time when the flax plants are from 3 to 6 centimeters high (approximately 1 to 2½ inches), or at the end of eight to ten days from time of sowing The women (sometimes men or boys) work upon their knees in this operation, proceeding against the wind in order that the plants may soon be blown or returned to their normal position again. Some attention is also paid to the time of weeding, as neither a too wet nor two dry condition of the soil is desirable. On good soil, from which weeds have been pretty well eradicated by thorough culture, one weeding suffices, though occasionally two and even three weedings are necessary.

Of the diseases that flax is heir to in Belgium nothing can be said here, owing to limited space. As to accidents due to meteorological causes, as high winds straining and toughening the stems, or heavy

[1] A hectare is 2.471 or almost 2½ acres. All calculations in this report are made on the basis of 2½ acres.

rain storms, which sometimes cause the flax in a whole field to lodge or break down, or hail, which plays worse havoc, there is little that can be done in such cases. Professor Damseau, of the State agricultural experiment station at Gembloux, states that hail does great injury to the growing flax, even when the stalks are not broken, owing to the fact that where the straw is struck by the hailstone a knot or knob forms which "breaks the length" in the final operations of cleaning and dressing. In case of total destruction, when the flax is not more than a foot high, a crop has sometimes been secured by immediately cutting it down to a couple of inches all over the field and letting it grow up again.

In Flanders, and throughout Belgium as well, while the seed is always saved, to be sent to the oil manufacturer, or the best of it to be sold as sowing seed, it is considered of secondary importance to the fiber. Therefore, to obtain as fine and strong a fiber as possible, the flax is pulled before it is fully ripe, or when it is just beginning to turn yellow, coarse flax ripening earlier than fine. The work is done (or begins usually) the last week of June, sometimes a little earlier.

According to statements made to the writer by Mr. G. Loppens, the flax straw when ready is pulled with the greatest care, the ends being kept very even and the straw laid in handfuls upon the ground, where it remains a few hours. It is then put into what is termed a "hedge." The hedges are long rows of handfuls standing on end, alternately inclined to the right and left so that they meet and cross just below the seed heads, the lines of ends being separated at point of contact with the ground sufficiently to keep the hedge firmly upright as it is being formed. These hedges or lines of handfuls when complete are about 10 or 12 feet in length, the end view resembling an inverted V. This arrangement is very efficient to allow the air to circulate through and around the handfuls of straw and to admit of rain running off freely.

When the flax is sufficiently dry, it is tied in small bundles or "beets" and piled something as cord wood is piled in this country, two poles being first laid upon the ground to prevent injury to the bottom layer by dampness and two poles driven at each end of the pile to keep the whole in form. In such piles the flax is permitted to cure, for the air passes through the mass of flax, while protection from rain is afforded with a covering or thatch of rye straw.

In piling it is the custom to reverse the flax in alternate layers. Before the top layer is put on a row of flax is laid lengthwise near the edge of the pile, so that the top layer will be given the proper slant to shed the rain. The flax is left in this position for several weeks, and then either retted very soon or put into immense stacks, or sometimes into sheds, to remain till spring. It was found that a great diversity of practice prevailed in different sections in the method of handling the flax after pulling and before the retting.

The practice detailed above pertains to Flanders more especially, while in the Brabant and elsewhere a very different practice prevails.

M. De Vuyst, of the State agricultural inspection, with whom the writer visited a flax-growing locality in the Brabant, stated that the seed is usually removed soon after the flax is pulled. A common method of accomplishing this is to draw the heads through a hetchel or comb of square iron pickets some 15 inches high. These pickets are about half an inch wide at base, and, as they are pointed at the top, the spaces between them grow narrower as the bottom board into which they are driven is approached by the head of the bundle of flax straw, and the seed capsules are detached. When the seed vessels are dry they are threshed with an instrument made from a square block of wood, either flat on the bottom or fluted to form coarse teeth, a curved handle being mortised into the top. In a scutch mill near Gembloux two other methods of getting out the seed were noticed, this being accomplished in the first instance by means of a machine with large crushing-rolls, the ends of which were free at one side of the piece of mechanism, in such manner that only the heads of the flax could be passed through, the bundle of straw remaining uninjured in the operator's hands. Two or three times passing through sufficed to crush the capsules and clear the seed perfectly. The other method was to go over the straw with a heavy roller upon a slatted floor, through which the seed and chaff fell. In Courtrai the seed is usually mauled out with the contrivance described above. This is done in sheds for the most part or on floors, though the work is often seen going on out of doors at the side of the highway, or on the stone paving in front of the peasants' cottages.

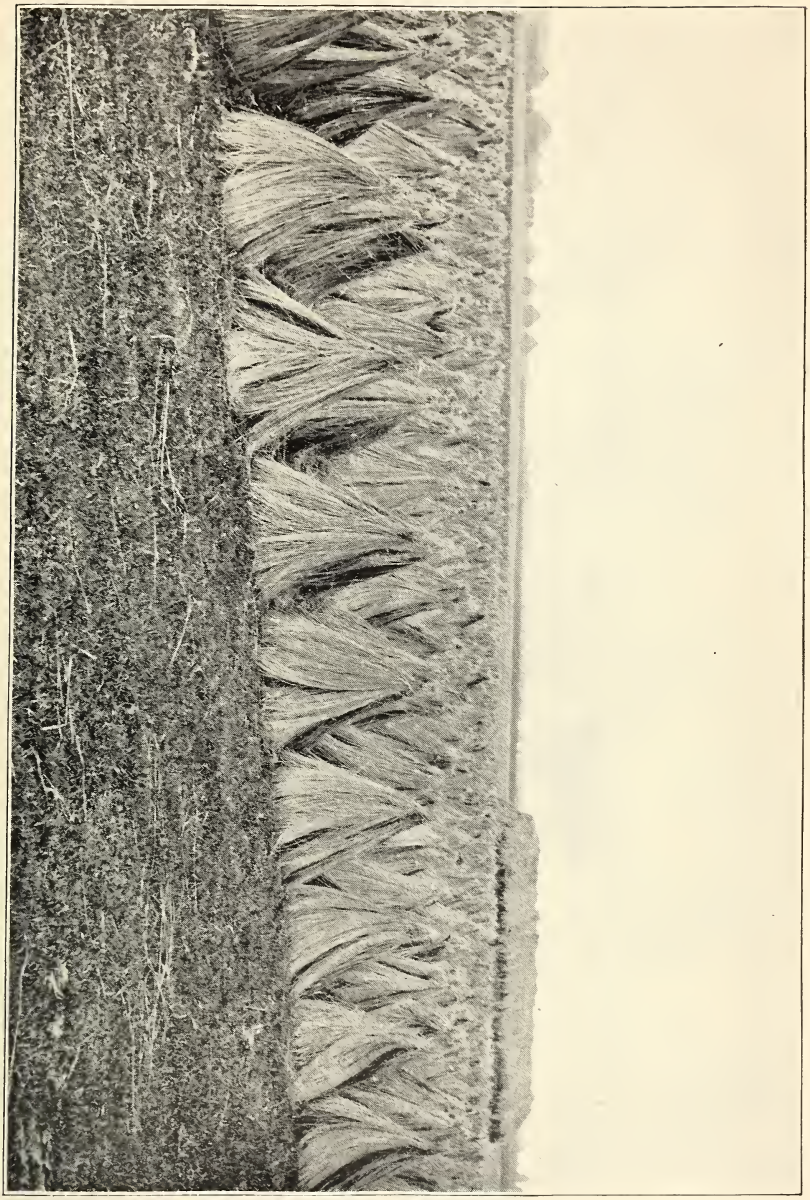
There are three systems of retting practiced in Belgium—the dew retting most commonly followed in the neighborhood of Brussels and in the flax district near Gembloux visited by the writer; the retting in crates anchored in running water (rouissage au ballon), as practiced in the River Lys, in Flanders, and the system of plunging the flax straw into pools or cisterns as soon as pulled, which pertains in the Waes country and some other sections. The dew retting need not be described here, as the practice is the same as that in the United States, giving an uneven and least valuable product of all methods of retting. In the pool retting the pits or reservoirs are dug some months in advance, so that the loose earth will have been washed from the walls and they will be clean. They are of varying dimensions, and are sometimes divided into several compartments by partitions, which are formed either of boards or walls of sod or of earth, the bottom being very clean. Sometimes alder fagots are placed with the flax to influence its color, slight differences in color depending upon many things, all of which are taken into consideration by the operator. The first process is to secure the seed, as has been described, after which the flax is again bound into small bundles, which must be neither too light nor too loose, so that the water will penetrate them freely after they have been placed in the pits. To keep the bundles under water, they are covered with a layer of straw, on which sods, or in some localities stones or boards, are placed. Precisely how long the flax should be allowed to remain in the water must be determined by the operator; five to ten days is the range, the quality of the growth itself, the weather, and other circumstances all being considered. A farmer learns by experience when the flax is sufficiently retted to raise, though tests by breaking a few stalks from time to time must be made. After being "washed out" or "taken out of the rot," and while still wet, the straw is spread upon the neighboring fields to dry, or in order that the process of retting may be completed; the precise duration of time necessary for this operation is also determined by various circumstances. By breaking a few flax stalks or rubbing them between the palms of the hands, however, the farmer can judge pretty nearly when the crop should be housed.

The Courtrai method of retting is the most interesting, though not as important to us, for (presumably) there is no River Lys in America, and if there were one it would not be desirable to use it for retting flax. There is but one Lys in Belgium, a dark and murky stream, with sullen flow, its waters an indescribable greenish hue, and its odor as pronounced as its color, yet to its banks comes the flax of this entire region, by the wagon load, by the carload, and even by railway trains of twenty to thirty cars, loaded like hay, though in the regulation bundles, and covered with large oilcloths or tarpaulins. The writer took a walk up the Lys on a bright September afternoon in company with M. Frederick D'Hont, director of the Communal Laboratory of Agricultural Chemistry, Courtrai. But 3 miles of the right bank of the river was traversed, though the flax industry occupies its banks for 20 miles. On both sides of the narrow stream, reminding one of a canal more than a river, though there was no towpath, back for 50 rods or more, and as far into the distance as the eye could reach, one saw only flax. There were the immense stacks containing tons and thatched as carefully as the roofs of the peasant cottages. There were acres of "hedges" and long lines of the big bundles made up ready for immersion, while farther back in the fields were the opened bundles, tied at the top and spread apart at the bottom in circular form, like bell tents, the plan always adopted for drying the flax that has been immersed. This is the manner of packing the bundles for immersion: Crates or frames of wood are used, having solid floors of boards, the sides being open. These measure about 12 feet square and perhaps a meter in height, or a little over a yard. First a strip of jute burlap is carried around the four sides, on the inside, coming well to the top rail of the crate. This is to strain the water, or to keep out floating particles or dirt which would injure the flax by contact with it. The bundles, which measure 8 to 10 inches through, are composed of stalks laid alternately end for end, so that the bundle is of uniform size throughout. They are stood on end and packed so tightly into place that they can not move, each crate holding about 2,000 to 3,000 pounds of straw. When a crate is filled, the entire top is covered with clean rye straw and launched and floated into position in the stream. It is then weighted with large paving blocks or other stones until it has sunk to the top rail, when it is left for the forces of nature to do the remainder. The time of immersion is from four to fifteen days, dependent upon temperature of the water and of the air, quality of flax, and other influences.

The frontispiece, from a photograph furnished by Mr. Du Vuyst, illustrates the manner in which these crates are sunk in the stream and held in position by paving blocks. The picture forms an interesting bit of Lys landscape.

There are several delicate tests which indicate when the flax should come out, although the near approach of the time is made, however, by the sinking of the crate, which shows that the fermentation of the gummy matters is diminishing. Before this occurs, however, and when the fermentation is at its highest point, the imprisoned gases cause the crate to rise out of the water oftentimes to the height of a foot or more. These changes must be carefully noted by the attendants in charge, and when the crates begin to sink upon the subsidence of fermentation the stones or weights should be partially removed, in order to keep the crates submerged to the proper point. Mr. Loppens states that this is a critical stage in the retting, and these matters should be carefully attended to.

When ready to empty the crate, it is floated to a convenient place, when the stones or weights and the planks which support them, together with the straw which covers the ends of the bundles of flax, are all removed. A man stands upon the flax or in a small boat secured to the crate and begins drawing the bundles from the packed mass. They are floated and driven to the shore by means of a fork, where they are seized by two men standing to the knees in the water, though sometimes to the waist, taken out of the water and laid upon the bank. During a visit of the writer to the Lys he witnessed, in some instances, the withdrawal of the crate entire by means of a windlass. The bundles are placed standing on the bank close together for at least six hours to allow the water to draw off and to become firm enough to transport to the meadow or place for drying. Upon removal to the field or meadows the big bundles are now broken up and again put into the form of little tent-like stacks, as in Plate II. This work is done by boys, who show great dexterity not only in spreading and standing up the little bundle when it is first opened for drying, but in the subsequent operation of turning the tent completely inside out, so that the straw that was shaded in the interior may be subjected to the air and sunshine and the drying be accomplished evenly.



COURTRAI METHOD OF DRYING RETTED FLAX.

After this drying process is completed, the flax again goes into the big bundles for a second immersion, and sometimes a third, though rarely. It is stated that the work begins in September, continuing until too cool to ret advantageously; then, beginning again in March, it continues until all the flax is retted. Mr. Loppens says, however, that the retting is allowed to be practiced in the river from the middle of April to the middle of October, the work beginning in August, though the largest part of each crop is carried over the winter and retted the next season. This not only improves the flax in quality, but enables the work to be carried on economically with regard to use of the crates and retting plant and the employment of the men. By this system they are occupied practically the year round.

Formerly the farmers did the principal part of the retting, selling their crop to the merchants in the form of fiber. It is said that this custom no longer prevails, the work now being carried on wholly by the flax merchant, who either buys the pulled straw of the farmer or purchases the standing flax, in the field, his own employees doing the pulling. When the farmer does the pulling, he hauls the crop to the Lys, unless he wishes to hold it over, securing the market price that prevails at the time. Many flax merchants are also owners of scutch mills, and have charge of the entire manipulation from the time the crop is ripe until the cleaned fiber is sold.

The writer visited one of these scutch mills in the little hamlet of Wevelghem, and witnessed the entire process of converting the clear, glistening, almost white straw into the beautiful semigolden line fiber which distinguishes the flax of western Flanders. The rude machinery was run by steam, the brake being a primitive affair, with simple fluted rollers, but which did their work perfectly, however, largely due to the splendidly prepared fiber which the operator had to work upon.

There is little hand scutching in Belgium at the present day, although the scutching machines in general use are of the simplest form. Through the center of the mill is arranged a line of scutching berths before which, or rather in which, each operator stands. A single shaft runs through the structure from end to end, and at each berth is arranged a breaker wheel, or simple iron frame (called a "wiper ring"), to which is affixed the beating blades, made of wood. These are about 3 feet long and 4 or 5 inches wide, there being twelve blades to each wheel.

The accompanying illustration, from Spon, will explain the device. (See fig. 3.) *a* is the shaft; *b* the supporting pillars of iron or wood; *c* the wiper ring, to which the blades *d* are attached; *e* is the partition; *f* the bracket at top, by which it is stayed to the beam *g*, which connects the line of pillars; *h* is the opening through which the flax is presented to the blades.

These arms or blades revolve at the rate of 150 to 160 revolutions per minute, dependent upon the quality of flax being cleaned, and move parallel with an upright partition of iron or wood, in which there is a wedge-shaped opening, the lower edge being horizontal and a little above the center of the shaft. The "boon," or broken woody portion of the straw, and the dust are carried back by the action of inclosed exhaust fans (one to three or four berths), driven by power from the same shaft. The boon falls on the ground under and behind the shaft and the dust is blown up into a closed loft where the heavier portion settles while the lighter passes out through an aperture in the roof. As a handful of flax is beaten or "buffed," first one end and then the other, a certain amount of fiber is whipped off, known as scutching tow, or in Irish scutch mills as "codilla." This should not be confounded with the tow proper, which results from dressing or hackling the cleaned fiber, nor with the product of the western tow mills in our own country.

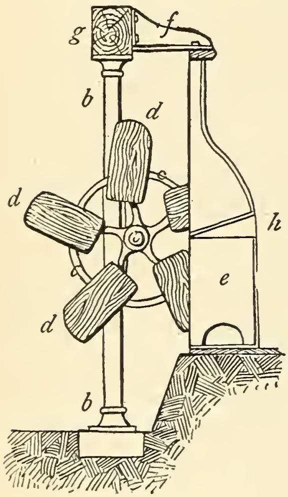


FIG. 3.—Flax-scutching device.

When the handful of flax has been properly buffed, it is snapped or shaken and passed to a second man, who finishes the operation of cleaning on another wheel. Then it is ready for the hackler. But as these operations pertain rather to the manufacturer than the farmer, they need not be considered at greater length here. The agricultural operations of the flax industry, as conducted in Belgium, have been described thus minutely because they illustrate, or rather emphasize, to the fullest degree, the necessity of high cultivation and skill and careful management in the production of this fiber. And while it is hardly possible that our farmers will ever take such pains with, or put so much hard labor into, the growth of this crop, the Belgian practice affords many hints which may gradually lead us into a practice essentially American, which will in time produce good results, with an economy of time, from the employment of labor-saving appliances.

The two principal methods of retting practiced in Belgium have been described on the preceding pages. The third, meadow or dew retting, pertains to the Brabant, to which reference has been made, and which produces the lowest grade of flax. There is, however, another form of retting, by a patented system, which has recently received the highest indorsement of prominent flax spinners in Ireland, and which, on account of its special advantages, will be again referred to on other pages.

The comparative loss by the three forms of agricultural retting practiced in Belgium, as stated to me by Professor Damseau, is as follows: By retting in the Lys (in running water) the loss is 25 to 33 per cent. In pool retting the loss is a little less, while in dew retting the loss amounts to about 18 per cent. The Lys flax is more solid than other kinds, whiter, and more readily colored in dyeing, and in manufacture produces more fiber and less waste, and the fiber is more lustrous. The proportion of flax retted by the three systems was approximately (in 1889) as follows:

	Hectares.
In the Lys	15,000 to 20,000
In pools	20,000
Dew retted	12,000 to 15,000

Here are some of the prices paid for labor in the flax fields of the Brabant, gleaned from an interview with a large grower and scutcher near Gembloux: Workmen in field, 2.50 francs per day, not boarded (equal to 50 cents American money); women, 1.50 francs (30 cents); weeders, boys 80 centimes, and women 1.25 francs per day (16 to 25 cents); spreaders, when flax is dew retted, boys at various wages, from 75 centimes upward, and women 1.50 francs. Seed was quoted by the 100 kilograms, at 24 francs (approximately $4.75 for 220 pounds). Belgian "blue flax," dew retted, 80 francs per 100 kilograms (8 cents per pound), though it is estimated that these prices are too low to pay. Russian flax retted under the snow is sometimes sold in Belgium at 75 francs per 100 kilograms, or a half cent less per pound than the above. Naturally the production of the cheaper grades of flax is declining under this competition.

Regarding the cost of labor, as given above, it should be stated that the difference in wages between this country and Europe is equalized when we come to consider the high rentals paid for flax land in Europe, the great expense necessitated for fertilizers, and the fact that the peasant farmer is slow and plodding, while the American farmer uses the finest and most improved agricultural implements in the world, and his lands are cheap and fertile.

This gives us a hint regarding the possibility of successful competition with the Old World and emphasizes the necessity for using labor-saving devices as far as possible in every branch of the industry. This will be mentioned again in the chapter regarding the American practice, but the subject can not be left without a description of the improved retting system referred to on a former page, because, on account of its simplicity, its employment renders failure less possible.

THE LOPPENS DESWARTE RETTING SYSTEM.

During a visit in 1889 to the State agricultural experiment station at Gembloux, Belgium, the writer learned of a system of retting in Lys water, in perfected reservoirs, known as the Van Mullen Deswarte system. In conversation with Professor Damseau it was learned that there was a current of public opinion against the retting of flax in the Lys, on account of the contamination of its waters, resulting not only in the destruction of the fish, but also in giving off foul odors from the decomposition of the vast amount of vegetable matter liberated by the action of retting. It was stated that there was a positive economy in the use of the proposed system amounting to 10 to 15 per cent, in general improvement of fiber, quality, etc. The matter was fully reported upon by the writer in the United States Reports of the Paris Exposition of 1889, Vol. II, page 513, which see.

The "Van Mullem Deswarte system" has now been superseded by that of Messrs. Loppens and Deswarte, of Neerpelt, Belgium, and made applicable not only to Belgium and the Lys region, but to the flax regions of the world. The Office of Fiber Investigations has pursued with interest the reports that have been received during the past year from disinterested people regarding the success of the system, and, after a correspondence of several months, has recently had the pleasure of a visit from Mr. Loppens, who has explained the system in all its details. Its special advantage to this country is that it supplies a system of retting with running water without the danger of contamination of rivers and streams, which in thickly settled portions of the United States would never be tolerated. Then it is applicable to both flax and hemp, and doubtless jute, should the South ever take up jute culture.

THE SYSTEM DESCRIBED.

The retting tanks are made up of two principal parts. The upper part, which contains the flax to be retted, is separated from the lower part by an open floor. Its walls are vertical, and means are provided to keep the flax straw suitably immersed. These consist of cross-beams working in vertical slides and adjustable at any required height. The lower part, in which the renewal of the water takes place, is situated between the bottom of the tank and the open floor. Fresh water is admitted by an inlet in the upper part just beneath the open floor, and the outlet for the used water is made through the bottom. (See figs. 4 and 5.)

In the accompanying drawings, fig. 4 is a vertical section of a tank or basin for retting or steeping flax and hemp according to the invention, and fig. 5 a similar view with the water let into the tank. *a* is the false bottom of the tank; A the inlet and E the outlet for water. C C indicate the mass of the vertical bundles of flax or hemp, G the boards, and H the retaining crosspieces for the same. B represents the upper layer (of fresh water) and D the lower layer (of impure water).

The flax straw is tied up in double sheaves, the root end of one half being placed alongside the top end of the other, and approximately cylindrical in shape. These sheaves are placed on end on the upper floor moderately close and as regularly as possible. Ordinary straw is then spread over the top to keep off dust or the effects of the weather, and boards are placed on this to equalize the pressure of the cross-beams, which are fixed so as to insure the straw being suitably submerged when the tank is full and working.

The tank is then filled by opening the inlet and closing the outlet, and as the level of the water rises the straw rises also, till it is stopped by the crossbeams, where it remains motionless, pressing upward all the time more or less. The inlet and outlet taps are next regulated so as to insure the water being suitably renewed and maintained approximately at the same level.

The changes which occur in the retting mass may be set down as

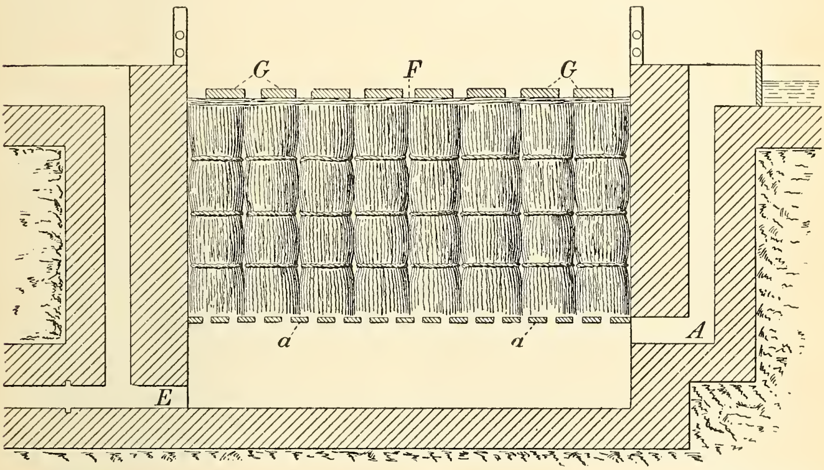


FIG. 4.—Vertical section of a Loppens and Deswarte retting tank, with the bundles of flax straw in position.

follows: The water surrounding the stalks dissolves the various vegetable substances, some of which are naturally soluble, while others become so successively under the action of fermentation. Thin streamlets of heavy juice are thus formed, which flow down the stalks and slowly cross the layer of fresh water below the retting mass, and this without mixing with it, owing to the extreme slowness of their motion. On the bottom of the tank these then form a layer of dirty and denser water, while at the same time the fresh water of the upper layer works its way up into the retting straw, also in the form of thin streamlets, which take the place of the descending ones. Owing to the vertical position of the stalks and the equal pressure all over the tank, these movements take place with equal facility throughout.

As regards textile straw, this system is therefore characterized by the vertical circulation of the water, under the influence of gravitation alone. This circulation, consisting of the natural fall of the heavy juices and the corresponding rise of fresh water, takes place uniformly and to the exclusion of every other motion in all parts of the retting mass.

ADVANTAGES OF THE SYSTEM.

Some of the claims of merit put forth by the inventors, which in a majority of cases are based on experience, may be enumerated as follows: (1) The possibility of natural retting in running water, that is to say, the best possible retting in whatever water is obtainable; (2) the greatest uniformity obtainable in retting; (3) larger yield of fiber; (4) results certain and invariable; (5) the saving of labor; (6) limits the water consumption to what is strictly necessary for natural fermentation; (7) full benefit derived from the water used in retting; (8) rivers not contaminated; (9) the preparation of the fiber preserves

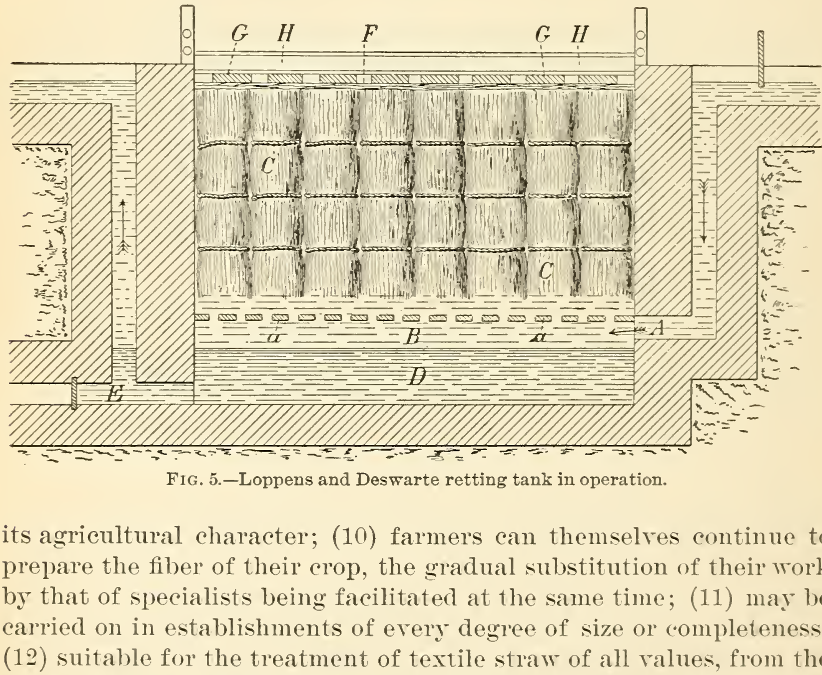


FIG. 5.—Loppens and Deswarte retting tank in operation.

its agricultural character; (10) farmers can themselves continue to prepare the fiber of their crop, the gradual substitution of their work by that of specialists being facilitated at the same time; (11) may be carried on in establishments of every degree of size or completeness; (12) suitable for the treatment of textile straw of all values, from the finest flax to the coarsest, or to hemp; (13) practicable in almost every country in the whole world where flax or hemp is grown.

It has been proved by experiment that to obtain natural fermentation in running water it is necessary and sufficient that the juices emitted by the retting stalks should not remain in contact with them, but as they are formed should be replaced by fresh water. This is exactly what takes place in this system, provided that the water is renewed quickly enough. If this is not done, the effects are first noticed in the layer of dirty water, viz, abnormal fermentation takes place there (putrid, acid, or butyric) before it can take place in the retting straw. The man in charge is warned by the appearance and smell of the outlet water, and can remedy the matter easily before any damage is done to the retting mass.

Mr. Loppens states that the uniformity obtainable in this system is owing to the absolute regularity of the circulation through all parts of the retting mass, which follows inevitably on the pressure being even all over, which evenness is very easily obtained in practice. This is attained, as well as the vertical position of the stalks, in retting in crates, and it is from the retting in the Lys that has been adopted, likewise, the make of the double sheaves. But it must be remarked that the layer of fresh water into which the cases of all the sheaves dip equally is not to be found in the crates used in the Lys, and that the sides of the crates are never quite water-tight, with the result that the circulation of water in the retting mass is quite irregular, the inlet and outlet of the water being haphazard, to a very small extent through the chinks in the floor, but principally through one or more sides of the crate, which are either open or badly closed. The sheaves situated in the stream of water ret faster than the others, and besides this they are washed by the water which flows past them into the interior of the mass, producing water-slain fibers, and often a stain from the settling of the impurities in suspense in the water of the river. "Water-slain fibers" are those wholly deprived of their gum, and thus of all strength. This drawback occurs at the end of the retting, when that portion of the gummy matter which should remain in the fibers is reduced to a mucilaginous state, very soft, and is easily removed by too strong a flow of water or by some kinds of friction.

From this it would appear that the system secures greater uniformity than in river retting, and therefore insures a larger yield of fiber, and of more even quality. As regards water-slain fibers specially, so much feared by retters, and the constant production of which was pointed out in the retting in the Lys, it will be easily understood why such are avoided entirely in the tanks; for during the retting no fiber receives any bruise, or rubbing, or the impact of any current. Through each little duct or capillary channel formed by the spaces between the stalks there is no motion beyond the very feeble and slow circulation proportionate to the quantity of juice each emits. Besides, toward the end of the retting this circulation decreases still further. Another fruitful cause of water-slain fibers is the handling of the straw while the crates are being emptied. In these tanks, when the retting is finished, the water is run off slowly, which allows the sheaves to settle down gently on the open floor and drip without undergoing any injurious treatment, the emptying being only performed when the stalks are firm enough not to suffer from this proceeding. Regarding the certainty of results exceptions are made when the water used varies greatly in chemical composition, according to season.

This system is especially valuable in allowing the retting in running water without the danger of fouling streams that are water supplies of towns. The run-off water is absorbed upon the land, and its fertilizing elements saved, so it is only through filtration that it can reach the stream. Mr. Loppens suggests that it is almost unnecessary to insist on the great advantage hereby obtained, not only from the standpoint of those who for one reason or another are interested in the purity of rivers, but more especially of the retters themselves, to whom it is of great importance to be untrammeled by the reasonable restrictions placed by the authorities on every industry which contaminates open water.

The inventor states that while the tanks may be constructed of either brick or wood, the former being the most serviceable, in the United States the latter material would doubtless be most largely employed.

FLAX CULTURE IN FRANCE.

The flax culture of France is confined for the most part to the departments of Nord, Pas-de-Calais, and others contiguous in the north, Lille being the center of the industry. It has suffered a considerable decline within two or three decades, having ceased entirely in some departments, while the quantity has diminished in nearly all, save perhaps in Nord, in which the city of Lille is located. It may be stated on the authority of M. Alfred Renouard, jr., of Lille, that the preservation of the industry in Nord is owing to the proximity of the Lys, and to the great sacrifices which the agricultural people of the section impose upon themselves in transporting the product to this stream. Were this form of retting (the river retting as practiced in Courtrai) abandoned, the culture of flax would decline at Lille as in other districts, because the sales from other systems of retting, such as the pool or dew retting, making dark fiber, would bring such return as would only cause a loss to the producer. Since 1875 the culture has ceased entirely in the districts of Cambrai, Valenciennes, Avernes, and to a great extent in Douai, and it has diminished in the districts of Dunkerque and Hazebrouck. The French flax that finds its way to the Lys is retted at Bousbecques, and all along the stream in that part which forms the boundary between France and Belgium. The retting in crates is also practiced at Hasnon, where it takes place in a small, canal-like stream, and likewise at Flines-les-Raches, where the crates are immersed in a considerable lake, the waters of which are sluggishly renewed by springs.

This is the most expensive form of retting practiced and is the same employed at Courtrai, known as "rouissage au ballon;" but, on the other hand, it gives that value to the flax which makes its culture yet profitable in these districts. While a little of the fiber is used in France for sewing thread, the main product goes to Great Britain.

Prices are appended of the different forms of flax fiber produced in France, from M. Renouard:

Dew-retted, 75 to 100 francs per 100 kilograms (about 7½ to 10 cents per pound).
Tank-retted, 100 to 150 francs per 100 kilograms (about 10 to 15 cents per pound).
River-retted, 150 to 300 francs per 100 kilograms (about 15 to 30 cents per pound).

The cultivator receives from 300 to 1,000 francs per hectare for the raw product; that is to say, approximately, $24 to $80 per acre. But the net cost of cultivation per hectare is said to be 600 francs, or in American money about $48 per acre, rental included; so that the farmer grows flax at a loss if his sales fall below this figure, and at a profit if the price realized gives him more than this sum per acre. Unfortunately, there has been loss in many districts in late years, which accounts for the decline of the industry in France.

As to the Courtrai region, a most systematic practice is followed in regard to crop rotation. It is customary to divide the arable lands of the farm into many subdivisions or lots, this parceling of the area being termed "assolement." Regarding the specific crops that are grown on these subdivisions each season a careful record is made, so that flax will follow and be followed by certain crops at stated periods, not only in order that there may be no exhaustion of the soil, but that it may be put in the very best condition for the production of fiber.

A thorough soil preparation is considered absolutely essential, which begins with fall plowing in November.

The fertility of the soil must be kept up, and it is a principle that it pays far better to sow in ground which has been heavily manured the previous year, even if manured to excess, than on one which has had only the average fertility. In addition to the chemical manures and the usual manures of the farm, ground oil cake is used from rape, hemp, and poppy, and even night soil, though the latter is reduced to a liquid form. Great stress is laid upon the importance of spreading the manure evenly, not only that the flax straw will be of uniform length, but that the fiber itself may be of even quality.

As to the amount of fertilizers used, while this depends somewhat upon the condition of fertility from the previous season's manuring, the general practice is to manure heavily, or at least the average American farmer would so regard it. Of oil cake alone, when employed, the ordinary practice is to use about a ton to an acre. When guano is used, though this is not considered altogether a desirable fertilizer for flax, not more than a third of the above amount per acre is employed.

Chemical fertilizers in which there is a predominance of nitrogen, potassium, and phosphoric acid, and some magnesia, in condition to be taken up at once by the plant, are regarded as the most valuable to use on this crop. They are spread a week or two weeks before the last plowing, and the ground oil cake, not being so readily soluble, is applied to the ground several weeks earlier. The cost of manures per acre varies from $8 to $16, reduced to American currency.

In the Department of Nord 3 bushels of seed are usually sown to the acre, though on strong soils, when a strong, stout flax is desired, a less quantity of seed is put in, broadcasted and rolled. Riga and Dutch seed are the favorites. Small farmers, those cultivating only an acre or two of ground, use instead of a roller what is known in French as coquettes (coquer), which are pieces of board 7½ inches by 15, which are bound to the feet. Thus shod, the farmer goes over every foot of ground after seeding, compacting the soil by the pressure of his own weight.

Weeding is the same careful, painstaking operation that it is in Belgium, and begins when the plants are 2 and 3 inches high, women and children doing the work. The practice is to proceed against the wind, in order that the plants may be blown upright again after the weeders pass along. To avoid going back and forth or up and down over the field many times, and at the same time to accomplish the work quickly, a line of weeders starts down the field side by side, so that when the farther end is reached a considerable strip has been cleaned, that will not need to be trampled again. The weeders are armed with knives, with which the young weeds are dug up, and the work is usually done upon the knees, the shoes or sabots having been removed from the feet. Sometimes a second weeding is necessary, but it is given very soon after the first, for the plants are never disturbed after they are 4 or 5 inches high. The weeding finished, the crop is allowed to mature, for nothing further can be done until harvest time.

As to the manner of growth, and even as to quality and yield, much depends upon the season, and in this connection there are many happy sayings, usually in rhyme, which embody a considerable amount of experience. A number of these are found in Studies on the Culture, the Retting, and the Cleaning of Flax, a few of which are quoted:

> Quand Mars bien mouillé sera,
> Bien du lin se récoltera,

refers to a wet March, from which it is inferred that much flax will be gathered. Another assures the grower that if February is a wet month the flax will be good. There is one which refers to the benefits from sowing flax after a crop of hemp, which, by the way, would prove an admirable general practice in our own country, hemp is such a positive weed extirpator. Here are the lines:

> Si tu sèmes ton chanvre en un riche terrain
> Tu tiens déjà de lin récolte en bonne main.

Or, in plain English, "If you sow your hemp on rich land, you have the flax harvest well in hand"—both truth and rhyme. "Cold May, long flax," is another.

To come back to our starting point, after weeding there is nothing to do but wait for the harvest, and "it is June that makes the flax." (C'est Juin qui fait le lin.)

The flax is usually pulled when the blossoms have fallen and the leaves of the plant have begun to turn yellow. Sometimes it is left for a later period; but for the production of fine flax the practice is said to injure the fiber. The precise time to pull is a matter which must be determined by the farmer's judgment and experience, though it rarely is put off later than the last week in June or the first of July. In pulling, as much of the root end is secured as possible, for this is considered the best part of the flax straw. This is the part which, in American practice, where the machine reaper is used in the harvest, is left in the ground in the form of stubble. The pulling is done in the same manner as along the Lys, "hedges" being formed, as explained in a former chapter.

As to the Courtrai region, very few farmers have anything to do with marketing their flax, selling the crop to the merchants in the field, just as some New York State orchardists dispose of their apple crop to the dealers, who send their own men to gather the fruit.

These brokers, or their agents, often drive hard bargains, so that the matter is not settled without considerable discussion, of course after due examination of every part of the field. In regard to these bargains, Mr. Renouard says:

That which grows along the edges of the field is deducted, and frequently two or three of the poorest hectares count for nothing. A very good crop will bring the equivalent of $150 per acre, and in past time as high as $200 an acre has been paid. But there are "ups and downs" in this business as in everything else, and sometimes a farmer only gets $40 for a poor crop, and then he is out of pocket.

After the crop is sold it is in charge of the buyer, though it is customary for the farmer to send the flax to the home of the buyer, it matters not how distant it may be. In some cases it is sold to be delivered during the May of the next year. The flax is put up in stacks by the farmer for the winter, and the seed carefully preserved in the barn for the buyer until the time for delivery. Under such conditions the sale is made by the kilogram, and at prices varying from 10 to 30 centimes, there being 3,500 to 4,000 kilograms of stalks per hectare.

This is equivalent to about 5 to 15 francs per cwt., or $1 to $3, there being from 32 to 35 cwt. of straw to the acre, or an average of $67 per acre. The seed is saved in France, as in other countries excepting Ireland, and is carefully dried to avoid dampness, and is then stored.

There are several systems of retting, the "rouissage au ballon," or retting in submerged crates in running water; the system of the Courtrai region, carried on in the Lys and in the Deûle, a branch of the first-named stream; the pool retting, or retting in cemented cisterns or routoirs, the rouissage au plat, or retting "on the level," which refers to a system of drying in the field until the seed is cured, and, after the seed is taken off, floating the bundles of flax on the surface of the water and turning them daily until the flax is retted. This practice is about obsolete, however, at the present time. Another practice formerly employed was to ret in turf pits or the excavations made in securing peat for fuel. These pits become filled with rain water like the "bog holes" of Ireland, and were considered admirable retting places. One other system remains to be mentioned, the rouissage a la rosée, or dew retting—spreading the flax straw upon the fields, as practiced in America and to a slight extent in Belgium. The system is little practiced in France at the present day.

A word, before closing, upon the method of retting in cisterns or routoirs, which has been before referred to. These cisterns are described as closely cemented vats, open at the top, from 14 to 20 feet in length by 10 to 14 in width, and perhaps 3½ feet deep. They are managed as follows:

The flax is in bundles, which are placed upright in the vats. These are prevented from rising by crosspieces, and condensed steam is then applied from a steam engine, cooled to a point not warmer than 30° to 35° C., until the cistern is entirely filled. Finally there is allowed to run in at the bottom a light stream of tepid water, and this causes the surplus water to flow over the top. In these conditions the process of retting may last four days upon an average. In Brittany there are many of these cemented cisterns or routoirs. The flax is pulled early, the seed sacrificed, and the straw taken directly to the vats without being dried. These cisterns are immense basins, rectangular in form, and built of stone (granite), and contain about 10,000 kilograms of flax in the stalk, and are generally situated near a spring.

THE DUTCH CULTURE.

Little need be said here concerning the Dutch practice, for in its thoroughness and in regard to the attention paid to small details it is not specifically different from the culture of Belgium. The flax is grown chiefly on lands rented from large landowners, and new land is considered best after one crop of rye or a crop of oats that has been preceded by rape. Flax grown on breaking from the sod is considered a risky crop, but such lands after oats are favorable. About 2½ bushels of seed to the statute acre are put in, a little less when seed saved from the previous crop is used. The weeding is very thoroughly done and lasts about six weeks.

In Holland flax is grown both for fiber and seed, and the fact that the seed is to be saved influences largely the time of the harvest.

The time of pulling is principally regulated by the condition of the seed, which is tested by cutting the capsule across so as to sever the seed, the section of which should exhibit a compact, defined form and not appear displaced by the action of the knife.

The care and methods of manufacturing the flax after harvest show thoroughness and good practice in every detail. The retting is usually done on the farm in stagnant ditches previously cleaned out, the mud from the bottom being used as a covering for the flax. Naturally much of the Dutch flax is in consequence dark in color.

THE IRISH CULTURE.

While Irish flax has the reputation of being a superb flax, the Irish flax culture as practiced by the small peasant farmers is slovenly and wasteful to the last degree. The term "Irish flax" is frequently only a trade-mark, for a large portion of the flax of France and Belgium is exported to Great Britain, where it goes into manufactures that are regarded as derived from Irish flax.

Mr. Henry Wallace, who visited Ireland for the Department in 1891, states that the great bulk of Irish flax is grown in the province of Ulster, embracing the seven northern counties. The acreage has been gradually decreasing for the past thirty years, varying considerably from year to year, but declining from 229,178 acres in 1869, to 113,586 in 1888, with an estimated acreage in 1891 of 75,000 acres. The causes of this decrease have been various, but the two principal ones are the decrease in price and the failure of the soil to grow profitable crops except at long intervals. The decline, as shown by the report made by the Irish Textile Journal, has been from 9s. 9d. per stone of 14 pounds in 1869, or $16\frac{3}{4}$ cents per pound of scutched fiber, to about 6s., or $10\frac{2}{7}$ cents per pound, in 1887. Since that time the price has been falling very slowly, and the crop of 1890 sold somewhat lower than 1887. The other factor of chief importance in decreasing the acreage is the obstinate refusal of the land to grow profitable crops of flax except in a long rotation. Few good farmers will even attempt to grow a second crop short of an interval of seven years, and the practice with many of the best farmer is to grow flax only at intervals of twelve years.

The soil is said to be less fertile than in many portions of the Northern and Western States in our own country, and is polluted with weeds—deep rooted and growing in detached pieces—to be eradicated only by hand pulling. Mr. Wallace states that, in the Irish practice, flax does best after wheat and oats, though in heavy soils it does well after potatoes, a crop of oats intervening. When in Ireland, in 1889, the writer was informed that any good soil that will produce a good crop of wheat, oats, or barley will suffice for flax. The soil should be in good condition, but must not have had manure recently applied before sowing, on account of producing uneven growth and a coarse fiber. It was stated that a favorite rotation is to sow flax after oats from lea ground—that is, grass land which has been prepared for and has produced a crop of oats, the stubble plowed in autumn, again in February or March, harrowed and rolled until the soil is thoroughly pulverized. The importance of fine tilth is thoroughly understood, the little plots of flax land receiving, as a rule, almost garden culture. Here are examples of rotation from a former report of this office:

No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Potatoes. Wheat. Clover. Pasture. Pasture. Oats. Flax.	Clover. Pasture. Oats. Potatoes. Wheat. Flax.	Oats. Turnips. Wheat. Clover. Oats. Potatoes. Flax.	Root crops. Barley. Clover. Grass. Wheat. Flax, half field.	Barley. Clover and grass. Grazing. Wheat. Flax, half field.

The advocates of the best culture in Ireland consider medium and alluvial soils the most suitable. Heavy land, naturally drained, when the season is favorable for pulverizing the soil, will produce crops rich in fiber. Poor land produces weak fiber. In selecting land, that which is hilly is avoided, levels with a cool bottom being the most desirable. Peat lands, where clay bottoms do not exist, and sandy land with a gravelly bottom are avoided, as a poor yield and weak fiber could only result from such selection.

Fall plowing is the rule, though light soils are not again plowed until seed time, heavy lands requiring a second plowing and sometimes grubbing. In the matter of pulverizing much depends on the nature of the soil. Michael Andrews says the practice, if excessive, is injurious on light and medium soils. Pulverize such soils to any great depth and the chance of a good crop of flax will be doubtful, unless in a very wet season. If such soils have received a deep plowing in the autumn, and when necessary a shallow winter plowing, a moderate harrowing will leave a proper surface to form a good seed bed. Heavy soils, on the contrary, will need a great deal of pulverizing.

The best of seed that can be obtained is sown at the rate of 2 bushels to the acre. On heavy soils the Dutch seed is considered the most suitable, while the Riga seed is thought to answer better for the light or medium soils. The Dutch seed is Riga seed sown in Holland, just as "Belgian" is Riga seed sown one year in Belgium. Mr. Andrews says that Riga seed should be cleaned with a flax sieve previous to sowing to get rid of the weed seeds, in order to save expense and labor when weeding time comes round. Dutch seed being much better cleaned, seldom requires this operation. The fact that seed is rarely, if ever, saved in Ireland necessitates purchase of fresh seed every year.

Mr. John Orr Wallace, inventor of the Wallace flax-scutching machine, gives the following directions for harvesting the crop, which reflects the general practice in Ireland:

When the straw begins to turn yellow and the foliage within 6 inches of the ground is drooping, pull at once. At this stage the seed in the bolls is changing to a dark green or brownish tinge. Tie the straw in small bundles and stand on end to winnow. When quite hard and dry put in stack. There is a larger and better yield of fiber when the straw is kept until the year following its growth. If fiber is required at once, the seed can be rippled and the straw steeped in soft water, that is, rain water, or, if this is not attainable, in pits of water in which vegetable matter grows, and which has been exposed to the sun's rays for a period of five or six weeks. The straw should be protected from the earth at the sides of the retting pits; place the straw in layers until the pit is quite full; stones, or planks of wood with stones on top to keep the straw entirely under the water, are laid upon the top layer of flax straw. If the temperature of the water is 80° F. or upward, about six days will be sufficient to ret the straw. From the fifth day examine a few straws, at different parts of the pit, several times daily, and when the fiber pulls readily and entirely off the woody core it is time to remove from the pits. Stand the sheaves on end to dry; pull the band or tying on each sheaf close to the top and spread out the root ends, so as to expose to sun and wind. When perfectly dry stack for a few weeks. This improves and mellows, or brings "nature" or a soft silky feeling to the fiber.

FLAX CULTURE IN RUSSIA.

As Russia produces probably 25 per cent more flax than all other flax-growing countries taken together, a few statements, with figures of production, regarding the Russian culture will prove interesting. Until quite recently the literature of the subject has been very meager; but in 1891 the State Department invited reports from United States consuls in Russia and other countries relating to flax culture, the material forming the second part of a special consular report on the beet-sugar and flax industries in foreign countries. The report of Consul-General Crawford, of St. Petersburg, is especially interesting, particularly as American-grown flax fiber competes with the Russian product.

It should be explained that there are two vast areas in Russia over which flax is grown, and in these two areas the culture is widely different and pursued for different purposes.

In the black-soil provinces of Russia flax is grown for seed only, while in the common-soil provinces it is cultivated both for seed and fiber. The reasons for this may be briefly stated: The culture in the black-soil provinces requires virgin land, or plowed fields which have remained fallow for a number of years, a requisite rarely found with land operated by the peasants, and it so happens that the flax crop is frequently less valuable than that of the cereals. In the common-soil provinces, with the existing system enforced by the landowners, the cereal crops are so poor that other forms of culture must be pursued, and nothing pays better than flax, especially in the northern regions. It is stated that flax grown for fiber is raised satisfactorily in ordinary plowed fields, but a larger quantity and better quality of fiber is obtained when sown in waste ground or ravines having a rich surface soil, lands not suited to the growth of cereals proper.

As we have no special interest in Russia's seed crop, detailed statements regarding the extent and value of the flax industry of the black-soil provinces are not necessary, though the figures relative to the yield and value of the fiber and seed produced in the common-soil province is worthy of study. The table is from Consul-General Crawford's report:

Provinces.	Flaxseed.					Flax fiber.			
	Land sown to flax.	Average crop per 2.7 acres.	Average crop per province.	Average price per 36 pounds	Value of total production.	Average yield per 2.7 acres.	Average crop per province.	Average price per 36 pounds	Total value of production.
Black soil. [1]	*Acres.*	*Lbs.*	*Bushels.*			*Eng.lbs*	*Tons.*		
Total	15,516,375	951	8,666,282	$0.57	7,767,861	-------	-------	-------	-------
Common soil.									
Viatka	247,455	612	1,001,604	.57	888,088	468	21,446	$2.09	$2,490,118
Pskoff	220,390	432	629,686	.81	793,405	666	27,182	2.33	3,518,559
Lifland	180,203	504	600,678	.67	621,368	720	24,027	2.08	2,776,453
Kostronia	150 379	432	429,656	.70	467,836	468	13,033	2.50	1,810.132
Vladimir	148,332	792	779,597	.69	836,767	684	18,852	2.17	2,272,713
Koona	136,598	900	813,086	.63	790,500	630	15,937	1.87	1,534,894
Nijini Novgorod	113,687	1,080	812,044	.59	745,276	558	11,748	1.50	918,999
Tver	113,640	720	541,145	.60	505,068	684	14,394	2.05	1,639,315
Yaroslaw	104,895	612	424,575	.71	468,919	540	10,489	2.39	1,391,506
Perm	101,404	576	381,301	.52	312,474	432	7,612	2.13	910,209
Vitebsk	98,747	576	376,174	.62	359,879	594	10,862	1.95	1,176,716
Smolensk	98,188	756	490,941	.64	488,759	720	13,092	1.35	986,900
Vologda	67,041	684	303,281	.67	313,727	612	7,617	2.50	1,057,873
Vilna	58,806	720	280,030	.61	263,538	540	5,880	1.81	591,265
Minsk	52,564	792	275,333	.56	237,704	558	5,431	1.61	485,772
Novgorod	59,559	576	188,794	.65	190,882	684	6,277	2.12	739,291
Mohilieff	44,080	684	199,410	.54	165,954	612	13,991	1 43	1,111,508
Kalouga	40,737	900	242,486	.56	211,232	684	5,160	1.67	378,732
Courland	33,969	756	170,343	.73	192,109	882	5,565	2.07	639,974
Moscow	33,845	864	139,826	.68	203,067	810	5,077	1.60	451,288
St. Petersburg	30,556	540	109,128	.67	112,887	792	4,482	2.25	560,250
Grodno	23,366	828	127,955	.58	114,449	468	2,025	2.75	309,375
Olenets	11,842	720	56,391	1.00	87,720	702	1,539	2.70	230,850
Eastland	7,363	576	28,049	.50	21,816	828	11,173	1.88	1,166,957
Archangel	3,845	576	14,647	.62	14,012	432	307	3.50	42,637
Total	2,171,490	688	9,421,160	9.64	9,407,436	631	10,528	2.05	29,247,286

[1] Includes 25 provinces where comparatively little fiber is produced.

Those who claim that good flax fiber and salable seed can not be produced in the same crop should study the above figures of seed production. In the black-soil provinces, where there is a small fiber product, 15½ million acres produce about 8½ million bushels of seed worth $7,700,000 in round numbers, while in the common-soil provinces, in addition to the 260,000 tons of fiber produced, a little over 2 million acres yield almost 9½ million bushels of seed, worth $9,400,000 in round numbers.

After making some interesting statements regarding local prices Mr. Crawford says in his report:

Because of the difference in prices, the value of the total production according to provinces does not agree with the distribution of the latter according to the quantity produced, leaving out of the question the amount of land sown. For instance, the province of Viatka, which has the largest acreage devoted to the cultivation of flax, occupies, according to the value of fiber produced, only the third place, giving precedence to the provinces of Pskoff and Lifland. The total value of fiber produced in the common-soil provinces exceeds $30,000,000, and if to this amount is added the amount of fiber produced in the black-soil provinces and the annexed provinces, the total value of the production of flax fiber throughout

Russia in Europe amounts to $36,000,000. I have already shown above that the value of the flaxseed produced amounted to $17,175,297; therefore the total gross revenue obtained from the Russian flax industry amounts to about $53,000,000.

As showing the immensity of the flax crop of Russia, compared with the figures of all other flax-producing countries, the following table, prepared by Neiman Spallart, the Austrian statistician, is presented:

Country.	Year.	Acres.	Tons.
Germany	1883	267,534	48,753
Austria	1885	210,834	47,209
France	1884	110,035	38,101
Ireland	1885	107,940	23,366
Belgium	1884	99,014	22,134
Italy	1883	169,287	21,306
Holland	1884	26,082	6,001
Hungary	1885	27,089	4,501
Switzerland	1884	27,664	2,851
Denmark	1881	4,754	613
England	1885	2,487	519
Greece	1875	958	133
Total		1,053,678	215,496

Considering that in Roumania, Servia, Bulgaria, Turkey in Europe, Spain, and Portugal, of which no data are given, the production of flax amounts to about 4,500 tons, still the total produced in Europe does not exceed 225,000 tons, whereas Russia alone produces about 330,000 tons per annum.

In the provinces which produce the most flax fiber—namely, the provinces of Viatka and Lifland—the pood costs about $2.10, and in the province of Pskoff about $2.33.

The value of keeping up the fertility of the soil, where flax is grown for fiber, and the importance of crop rotation, are fully understood. The peasant who has means keeps his lands well enriched by the use of both artificial and vegetable fertilizers, but no peasant is so poor that he does not practice some system of rotation of crops to keep his lands in condition, the flax crop being put in on the same land once in six or seven years. Crops especially mentioned in this rotation are wheat, clover, and other forms of grass fodder. In many provinces stock farming is combined with flax raising.

PREPARATION OF THE FIBER IN RUSSIA.

Most of the low-grade flax imported into the American market from Europe is of Russian growth. It will be readily understood why an inferior fiber is produced after considering the methods in vogue by the peasants, who as a rule pay too little attention to its manipulation, especially to the retting. Much of the flax of Russia is "dew-retted," and in this particular our own practice in the past has been more nearly akin to the Russian than that of any other country. In former reports of this office the statement has been made that American flax came into competition chiefly with the flaxes of Russia, the system of retting followed in the two countries supplying the explanation. With a better system, there is no reason why some of our flax should not compete with the Belgian.

In general, the manipulation of the flax in Russia is so primitive and poor that, as a result, the price offered for it abroad is much lower than that paid for German, Austrian, Irish, and especially French and Belgian flax. When flax is purchased as it is when it enters the market, the manufacturer can not know what he is purchasing; that is to say, he does not know how much clean flax he will have nor the quality. It is, therefore, easy to understand that the purchaser wishes to guarantee himself against such loss and therefore purchases at very low prices, a fact that causes the Russian farmers to lose needlessly about $15.000,000 a year.

The agricultural department urged the Government to take this question up and to use all means to teach the peasants how to work the flax. It reasoned that in Germany and Austria teachers had been called for by the Government, and that here the same might be done, or at least to organize model farms on the principle of those in vogue in Finland, for the cultivation of flax, or to install stations in the provinces, where the manipulation of flax could be done by experienced hands, such as the one which has already been organized by Mr. Herman Getze, 9 miles from the town of Viaznikoff, in the province of Vladimir. It is said that the filament obtained by Mr. Getze is most perfect, and therefore his flax sells at $3.50 to $4, and the higher quality from $4.50 to $5 per 36 English pounds, against $1.50 and $2.50 paid for local flax worked by the peasants. Again, Mr. Getze obtains 32 Russian pounds of pure filament and 8 pounds of tow from 5 poods of crude flax, whereas the peasants obtain only 33 pounds of filament from 7½ to 8 poods of crude flax and no tow whatever. Besides these facts Mr. Getze's establishment has proved the great advantages that could be reaped from such stations.

The fiber of macerated flax (that is, retted in water) is uniformly strong throughout its whole length when properly handled, which can not be said of flax exposed to the dew; and in general macerated flax fiber is stronger than that obtained by the former process, in consequence of which, in working the flax with machinery, separating the good, from 25 to 30 per cent less yarn is obtained from the flax exposed to the dew than from the macerated flax. This fact very greatly raises the price of the latter compared with that of the former. The yarn obtained from the latter is much rounder and more even than that of the first, in which are often met flat fibers and bits of dried stems.

The obstacle which places itself in the way for changing the method from exposing to the dew to that of maceration is the want of water suitable for the maceration process. And, in reality, every kind of water is not suitable for this purpose. Flax can not be macerated in hard water containing either iron, lime, or salt, nor are stagnant waters, containing slime, clay, sand, and like substances, which injure the color and quality of the flax, to be used for this newer and better process.

The principal obstacle which prevents the maceration of flax from being extended is the ignorance of the best means to accomplish it. And even in these provinces, where maceration of flax has long since become the rule, it generally gives dissatisfaction, in consequence of which fact the splendid quality of Russian flax is spoiled even there, after great precautions were taken for its cultivation.

The Russian flax grower dries his product in ovens, and as these are often overheated or filled with smoke, the fiber loses its "nature" and becomes harsh and discolored. Hand brakes are used to prepare the straw for scutching, and this is likewise a primitive operation, as it is usually performed with a wooden blade in the hand of the operator.

Turning to Renouard's great work on the Flax Culture of Europe, we find additional reasons for the production of low-grade flax in Russia. He shows that the work is not only performed in a haphazard manner, but the frequent low temperature of the water, often descending below zero, affects fermentation most unfavorably.

The icy temperature affects not only the quality of the fiber, but also the work of the laborers. They are obliged to descend to the waist in water if it be in ponds, or to plunge the naked arms into the water when they employ running water. They become chilled and can not give that care to the operation which it should receive.

It very often happens that in time of frost the flax becomes so attached to the dry grass or adheres to the earth so that it is necessary to leave a good part of the fiber on the ground.

The Russian flax farmers pay little or no attention to sorting, mixing all grades together indiscriminately when it is sold to the small buyers who purchase the product. The large merchants do the assorting according to quality, though we are informed that this work is the most thoroughly done at the ports whence it is exported to reach foreign markets. The foreign marks and names given the different grades or standards from their long standing are almost historical.

In Archangel and the localities trading in flax it used to take the name of the locality from which it came, but as all kinds of swindling have been discovered since 1838, flax in Archangel has been purchased under three sorts, named "assorted," kron (crown), and brak or waste. Flax tow is divided into two grades, the first sort being subdivided into three sorts and the second quality into two other sorts.

At St. Petersburg the flax is arranged for export into three sorts, the first of which is according to the number of handfuls, generally contains twelve, and forms a twelve-headed bale; the second is composed of nine heads, and the third sort is composed of a six-headed bale.

In the towns of Rjev and Viaznia and other centers of foreign export the flax is in a crude state and forms four sorts—second, third, fourth, and fifth grades—the first quality being assorted, but there is very little of this grade.

In Riga, according to the rules fixed by the exchange committee in 1872, there are thirty-three sorts, which are divided into four divisions: The kron or crown, brak or waste, dreiband or third sort, and dreiband waste or fourth sort. Each of these sorts has received a special mark and name, and at the same time the price in the exchange report is applied to the kron sort only, which is considered as the base for fixing prices.

As the price of kron flax has remained the same for the last four years, the table given below shows the difference in the prices as they really are.

	Mark.	Price for 10 poods or 360 pounds.		Mark.	Price for 10 poods or 360 pounds.
A. Kron or first quality.			*B. Second quality—Continued.*		
Kron	K.	$22.50	Puik hofs dreiband	P. H. D.	$22.50
Kron hell (light crown)	H. K.	23.00	Puik hofs dreiband weiss.	W. P. H. D.	24.00
Kron weiss (white crown).	W. K.	24.00	Fein puik hofs dreiband.	F. P. H. D.	24.00
Kron grau (grey crown).	G. K.	24.00	Fein puik hofs dreiband weiss.	W. F. P. H. D.	25.50
Puik kron (picked crown).	P. K.	24.00	Superior fein puik hofs dreiband.	S. F. P. H. D.	25.50
Puik kron hell (light)	H. P. K.	24.50	Superior fein puik hofs dreiband weiss.	W. S. F. P. H. D.	27.00
Puik kron weiss (white).	W. P. K.	25.50			
Puik kron grau (grey)	G. P. K.	25.50			
Superior puik kron	S. P. K.	26.00			
Superior puik kron hell	H. S. P. K.	26.50	*C. Third quality.*		
Superior puik kron weiss.	W. S. P. K.	27.50	Dreiband	D.	17.00
Superior puik kron grau.	G. S. P. K.	27.50	Puik dreiband	P. D.	18.00
Spanisch weiss kron (Spanish).	S. W. K.	30.50	Livland dreiband	L. D.	17.50
			Puik Livland (lifland)	P. L. D.	18.00
B. Second quality.			Slanitz dreiband (exposed to dew).	S. D.	17.00
			Puik Livland dreiband.	P. S. D.	18.00
Wrack (waste)	W.	19.50			
Puik wrack	P. W.	21.00	*E. Fourth quality.*		
Puik wrack weiss	W. P. W.	21.00			
Puik wrack grau	G. P. W.	21.00	Dreiband wrack	D. W.	16.00
Hofs dreiband (superior third quality).	H. D.	21.00	Slanitz dreiband wrack.	S. D. W.	15.00
Hofs dreiband weiss	W. H. D.	22.50			

Besides the Spanish crown flax, formerly flax was classified in Riga according to nations in which the flax was grown—Belgian crown, French crown, or English crown—the highest quality being the English crown; but with the increased export to Germany, which reexported the greatest portion of this flax to other European countries, the assortment of Riga flax under classification of different European countries lost all importance.

The marks adopted by the province of Pskoff are those known by the name of Pskoff-Narva brands. The crown quality is divided into four sorts, namely: R., Risten, or very highest; H. D., Hofs Dreiband, high quality; D., Dreiband, ordinary; G. D., Ordinärer Dreiband, ordinary, third sort.

The wrack or waste is not specified, but the above crown marks are subdivided into G., or gray; W., or white; although the difference in color does not alter the price. The letters F and P express the quality of the fiber: F., or fine; and oleaginous P., strong and heavy; thus, W. F. P. R. signifies white, fine, strong, highest quality.

FLAX CULTURE IN THE UNITED STATES.

At the time the first flax report was issued from the Office of Fiber Investigations in April, 1890, considerable doubt was expressed in many quarters as to the possibility or practicability of reviving in the United States the long-neglected flax-fiber industry. At that time some trade journals, the importers, and not a few editors of the agricultural press, East and West, asserted most positively that flax could not be grown for fiber in the United States, owing to unfavorable conditions of soil and climate, and that the production of seed and fiber in the same plant was an impossibility. These misstatements, made partly for political effect, partly through ignorance, and in some cases in the interest of foreign commercial houses, were challenged at the time, and abundant evidence produced to prove their falsity. At the same time the results of the operations of the season of 1891 were looked forward to with considerable interest, as demonstrating how far flax culture might be carried on within our borders, and giving hints as to the methods of culture essential to the establishment of a practice suited to the requirements of our times.

As is well known, flax was grown for household manufacture fifty years ago in nearly every State in the Union. Only recently samples of flax grown twenty years ago, almost, were secured among the mountains of New Hampshire, and fine flax, too. And in the Virginias household linen is manufactured in small quantities, even at the present day, and by old methods.

It was argued at the time the first report was issued that if the American farmers of fifty years ago were able to produce a quality of flax suitable for linen manufacture, there was no reason, as far as cultivation is concerned, that the farmers of to-day could not do the same thing, though not by old methods of cultivation. In the march of progress it was natural that the industry as conducted half a century ago should decline, and that flax growing for fiber should become a lost art. And it was thought hardly possible to revive it again on a substantial basis in a single year, or two or three years, as, under changed conditions, from the very nature of things, it should be built up like a new and untried industry upon the foundation of experience.

It was recorded that a great deal had been accomplished in the two years following the publication of the report of 1890 in spite of the fact that but little flax had been grown for fiber. Some things were demonstrated in that short period which prior to the beginning of the fiber investigations were more or less matters of speculation, valuable experience was gained, and capital had become interested.

THE FIELD EXPERIMENTS OF 1891.

During the season of 1891 a series of interesting experiments in flax culture were conducted in various parts of the country, under the auspices of the United States Department of Agriculture, to determine to what extent flax culture for fiber was possible in the United States, as well as to learn something of the particular conditions, favorable or otherwise, existing in the different sections. Three varieties of flax were imported from Europe and distributed over a territory representing all possible flax-growing localities, and embracing the entire range of Northern States from Massachusetts to the Dakotas, including also Maryland, Virginia, Kentucky, and Missouri, and Oregon and California on the Pacific coast. The distribution was made to the directors of agricultural experiment stations, to farmers known to be successful growers of flax for fiber, and to flax manufacturers especially interested in the establishment of the flax-fiber industry. The three varieties were as follows: Pure Riga or Russian, White Blossom Dutch, and a variety called Belgian, the seed of which was produced from Riga seed grown one year in Belgian soil. This seed was distributed in 2 to 4 bushel lots, allowing the cultivation of half as many acres, and about 60 such lots were sent out in all. Up to the 1st of January 40 replies had been received from the following States: Massachusetts, Connecticut, New York, New Jersey, Maryland, Virginia, Kentucky, Ohio, Indiana, Illinois, Missouri, Iowa, Kansas, Michigan, Wisconsin, Minnesota, Nebraska, North and South Dakota, California, and Oregon. The questions to which replies were desired are here reproduced:

Flax-culture industry.

1. What varieties of flaxseed were experimented with? (In naming these number them 1, 2, 3, etc.)
2. In what kind of soil was the crop grown?
3. What soil preparation was given?
4. What fertilizers were used and in what quantities?
5. What quantity of seed was sown to the acre? (If different quantities were sown and samples of the products are submitted, refer to each by label number.)
6. How was seed sown? If machine broadcaster was used, please name the make.
7. At what date did the sowings commence?
8. Was any attempt made to control weeds, and what principal weeds affected the crop?
9. At what stage in the development of the plant was the crop harvested?
10. How was the crop harvested and cured?
11. What was the date of the harvest?

12. Was the seed saved, and if so, how separated? What quantity of seed (estimated) was obtained per acre?

13. If an attempt was made to ret any portion of the straw, please state the method followed, with a showing of the results, accompanied by a sample of the retted straw.

14. From a study of the season's operations what have you to say favoring or in discouragement of the success of the industry?

(To manufacturers.)

15. If the retted straw was cleaned for fiber, please state how broken and scutched, submitting samples of same. (Name make of machines.)

16. Was any part of the product dressed for manufacture and spun or otherwise used in manufacture? If such was the case, or if it is the intention to prepare and manufacture such fiber, please submit samples at the proper time, duly labeled, and if possible showing the variety of flax straw from which the fiber was prepared. In closing please state your opinions regarding the different kinds of flax experimented upon for purposes of manufacture.

At the same time a request was made for samples of the straw, in full length, blank labels having been inclosed for necessary data regarding the samples, to be numbered to correspond with the number of the varieties reported in the returns. In nearly every instance the reports were accompanied by specimens of the product in sufficient quantity for careful examination and comparison. The larger number of the samples showed a well-grown straw capable of producing a good quality of fiber, and in some cases the straw was so fine and long that with proper after-treatment there is no doubt that it would make fiber fit for fine linen. In a few instances samples of fiber were also sent, but these were exceptional, as the great number of reports secured treated chiefly of matters of culture, the first fourteen questions only being answered.

A quarter of a ton of flax produced by Mr. Eugene Bosse, in Minnesota, was subsequently purchased and manufactured for the Department by the Stevens Linen Mills, Webster, Mass., without cost, and a very good quality of crash was produced.

RESULTS OF THE EXPERIMENTS.

In the limits of this bulletin it will be impossible to give detailed statements regarding each experiment, or number of experiments, in a given State. In some few instances positive failures were reported, the special causes being very dry weather, with late planting of the seed, the selection of soil unsuited to the culture, or a soil full of the seeds of weeds. These failures were exceptional, however, and with more careful management the majority of them would have been averted. The general results, given in epitome, by States, are here reported.

Massachusetts.—The season's experiments with the three varieties demonstrated that flax of fine quality could be raised in the State, but that it would not pay, considering that the labor of this section is very high, the land valuable, and that there are so many money crops which bring in returns larger than a crop of flax grown under the most favorable conditions, such as fruits, onions, tobacco. No fiber was obtained, as the straw was overretted and destroyed, owing to the very warm weather which prevailed at the time. As far as mere matters of culture were concerned, the experiment was successful, all operations having been conducted in a thoroughly systematic manner. The seed was saved.

Connecticut (*Storrs Agricultural School*).—The seed having been received quite late in the season, the best land for the experiment had been planted to other crops. The agriculturist claimed to have little knowledge of flax culture beyond that obtained from books. The writer visited this field in August, finding the straw overripe for the saving of both seed and fiber. The straw was short, though it would have given a flax sufficiently long for spinning purposes, and some of it was quite fine. If the seed had been sown upon better land, the experiment undoubtedly would have given more favorable results. No attempt was made to save seed or to ret the product. The same drawbacks to the employment of flax as a crop in Massachusetts exist in this State. The expense of labor which can be more profitably employed in growing more paying crops and the difficulty of finding clean land are particularly mentioned. The results of the season's operations were so encouraging that the experiments will be continued another season.

New York.—While fair success was attained in the two experiments conducted in this State, the cultivation of flax for fiber can not now be considered a paying crop.

New Jersey.—No special report was sent in from this State, though a quantity of well-grown flax straw, representing the three varieties of seed distributed, was secured from the Shrewsbury Mills, at Kearney, in this State. The straw was so good it is to be regretted that some account of the special methods of culture was not submitted in time to use in this report. New Jersey formerly grew fine flax, and in considerable quantity.

Maryland (*Agricultural Experiment Station*).—The seed was sown May 4, which was certainly too late for this section, and the soil was a heavy clay loam, "poor in quality, but fertilized with barnyard manure and dried fish." The crop was not harvested until overripe, and was cut with a scythe. Naturally the conditions were not favorable to a satisfactory crop, as the results proved.

Virginia.—The season was so far advanced when the seed was sent out that good results could not be expected, and the experiments will be continued another year.

Kentucky.—This is an old flax-growing State, and some fine flax straw was expected. The season was so late, however, and the weather so warm that poor results were obtained at the experiment station, the straw being short, uneven, and woody, with some tendency to branching. The flax lay on the ground for about a week, and was doubtless injured, as the straw is very dark, the fiber showing little strength. A better report came from the German Southern Land and Colonization Company, a corporation interested in settling people from Europe. Mr. Henry Lemcke, of Simpson County, stated that the experiment was not successful in its entirety, owing largely to the lateness of the season when the seed was received. Mr. Lemcke said, however:

This flaxseed, which was grown in red, loamy soil (limestone formation) without fertilizer, and only once plowed in the spring, was of splendid quality and quantity, so that, in my opinion, the culture of the product in the limestone regions of Kentucky must have a brilliant success. I will make full experiments another year and I hope to send you a very satisfactory report.

Ohio (*Agricultural Experiment Station*).—The straw submitted was well grown, though somewhat uneven. With proper treatment would have produced a fair quality of fiber. Was pulled when not quite fully matured. The agriculturist gives the opinion that the land will produce a fair yield of flax, "but quantity is not a success if the quality is not good." On this latter point doubt is expressed. Quality was medium.

Indiana (*Agricultural Experiment Station*).—The following report explained the reason of failure of the experiment at Lafayette:

I have to report to you that the samples of flax sent to this station for testing were duly planted and cared for. However, it was found that nothing could be done with the product for the reason that the plants grew only to a height of 10 or 12 inches or thereabouts, and were altogether too small to be used in fiber production. This is not due to the character of our soil so much as to the excessively dry weather which occurred during the growth of the crop.

A series of plats grown to flax treated with different forms of fertilizer was also planted, but results were entirely unsatisfactory in this case.

A similar report was received from Muncie, in the same State.

From Peru, Ind., came the report that the experiment was quite successful, there being "no unfavorable or discouraging results." The straw was retted and fiber secured, though samples have not yet been received.

Illinois (*Agricultural Experiment Station*).—The director reported that the growth was affected by the close proximity of young apple trees, and more by an unusual drought, giving a light yield. The samples submitted showed a tolerably well-grown, fine, and even straw, but overripe and deficient in fiber. The report closed with the statement that there was no reason why good crops in quantity might not be grown in this State.

The Empire Cordage Company's experiment was a total failure, owing to the near proximity of the field to the low chimneys of a tile factory. The fumes from the kilns destroyed the plants.

Missouri (*College of Agriculture*).—The samples of straw submitted were of even fineness and good quality, though under length. The White Blossom Dutch was very good, the Riga being second best. The Belgian showed a tendency to branch. Of this experiment the agriculturist in charge said:

Our experience has been of such a character that we withhold suggestions or remarks until a trial can be made under more favorable conditions. The result of our present season's work has been unsatisfactory, as was anticipated at the outset, since at the time of the arrival of the seed our most suitable soil had been taken for other lines of work. Again, sufficient time was not allowed for the thorough preparation of the soil deemed necessary to keep down the weeds and insure a satisfactory growth of the flax.

Iowa (*Paulina Flax Mill*).—Three varieties planted made a beautiful stand and promised well, but a severe storm in June and another in July totally destroyed the crop. So far as noticed the Riga seed made the strongest growth. The failure of this experiment is to be regretted, as the manager of the mill desired to carry the experiment through to the finished fiber. There is no doubt that good flax fiber may be grown in this State. Another report, from Forest City, regarding the culture with native seed, was fully successful as far as the growth of the straw was concerned. Samples were not submitted. The reporter stated that when the fiber could be marketed it would be one of the most profitable crops that could be grown in his section of the State.

Kansas (*Grosvenor Park*).—The results of this experiment were summed up in a few words: "The entire flax crop failed this season because of excessive wet weather."

Michigan (*Agricultural Experiment Station*).—The experiment was claimed to be successful, though no samples of the products were received by the Department. The report closed with the statement that after the farmers and the capitalists learn that the crop can be profitably grown here the farmer will raise it and the necessary factories will be started.

The results of the tests of James Livingston & Co., Yale, Mich., were as follows:

From the study of the season's operations so far we must say the prospects are not very encouraging. At our mills at Yale and Fargo we have a fair average crop of flax straw, but owing to the cold, dry spring, it is poor in quality, the straw being thinly coated with fiber and very towey.

The straw submitted was well grown, of good length, and even fineness, the fiber showing good strength, though deficient in quantity, as stated above.

Wisconsin (*Agricultural Experiment Station*).—Crop so much injured by drought, owing partly to late planting, the results were unsatisfactory, and the experiment will be continued the present year.

Minnesota.—In the ten reports received there were several failures, attributed to various causes, as wet weather, soil filled with weed seeds, and, lastly, a lack of knowledge regarding the crop, which in some of the experiments led to unfortunate mistakes, resulting in poor crops. Enough is shown, however, to prove that with knowledge of all the requirements of the culture good results can be obtained. Some very fair samples of straw were submitted, of good length, some of it being very long and capable of producing an average fiber. The Experiment Station plats were visited by me in the latter part of June, and while the growing stalks were found to be short and quite uneven both as to length and fineness of straw, some very good samples have been received, which prove beyond doubt that flax can be successfully grown in this State. The results as a whole were favorable.

The following were some individual opinions regarding the possibilities of flax culture in this State. Mr. A. Van Hemert thought that the flax-fiber industry could be made one of the largest industries of the southwestern part of Minnesota. His experiment was successful.

McMillan and Hastings, at Oakland: For our land it is unquestionably a profitable crop. We hope to put in from 300 to 500 acres another season.

Mr. Eugene Bosse stated that there could be no doubt about the success of flax culture in Minnesota, though capital must become interested to the extent of establishing cleaning mills.

Zettle Brothers, Jordan: Had we sown our flax earlier, when there was moisture in the ground, we should have gained a splendid crop. The Belgian and White Blossom Dutch are the best varieties for this locality, as they seem to stand the drought better than others.

Mr. Ingraham, of the Sioux Falls Linen Mills, had no doubt as to the success of the industry. His samples were well grown, the straw fine, though somewhat deficient in fiber, nevertheless it would work up for coarse uses.

Mr. Ridgway, of the Minnesota Linen Mills, thought the culture of flax could be made very profitable with proper machinery to pull the flax and scutch the prepared straw. There was no doubt as to cultivation.

Nebraska (*Agricultural Experiment Station*).—The results were fairly successful. The agriculturist in charge of the experiments thought there was a future for the industry in this State.

California (*Agricultural Experiment Station*).—The experiment was in every way successful, and an exceedingly interesting report was submitted with samples of the straw. These were generally good, of superb color, somewhat uneven as to fineness of straw, but giving an abundance of fiber, which was strong and fine. If river retted, this flax would undoubtedly produce a superior fiber, fit for fine linen. The samples were considerably above the average.

Oregon (*Agricultural Experiment Station*).—A careful report was also received from this State, with a lot of admirable samples, closely resembling the preceding. These were of good length, some of the straw quite coarse but well grown and cured, and giving an abundance of clean silky fiber of superb strength. Well prepared, it would make a superior fiber, fit for fine linen. This comes nearest to the Courtrai straw, in appearance, of any examined from the United States; among the best and strongest received. The agriculturist reported as follows:

From the results this year and last, I am of the opinion that flax can be profitably grown in this valley for the seed alone, and the indications are that the fiber production would be of no small moment. The natural fertility of the soil throughout a large portion of the valley would enable the farmer to grow the crop without the aid of commercial fertilizers.

A summary of results made a very interesting showing regarding the possibilities of this industry. The few failures, attributable to natural causes, indicated that in some few sections, in certain years, the crop may be injured by extremes of drought or excessive moisture, but the same may be said of any other staple crop grown in the United States over a wide extent of territory. It should be noted also that some of these failures might doubtless have been averted by earlier seeding, which would have enabled the young plants to get a good start before the moisture had dried out of the soil.

It is worthy of note that, as a rule, where the experimenters were perfectly familiar with all the details of successful flax culture good results were secured and a quality of straw produced which could be worked into merchantable fiber. In many instances those receiving the seed declared at the outset that all knowledge of the culture had been derived from the published literature of the subject, mainly the flax reports issued by the Department, and not from practical experience. Yet average results have been attained; good straw was produced even in New England, and better straw could have been produced if the seed had been sown upon a more carefully selected and richer soil.

The selection of the soil has so much to do with both quality and quantity of fiber that an absolute knowledge of the requirements of the plant must be thoroughly understood to give the best results. I am convinced, by examining the samples of straw submitted, that in too many instances the different operations from the plowing of the land to the harvesting have not been done with sufficient care to demonstrate all the possibilities of the culture in the section where the experiment was conducted. This illustrates the importance of continuing the experiments from year to year, as a full knowledge of all the requirements of successful flax culture can only be gained by observation and experience.

Regarding the Pacific coast samples it can be said that, judging from the straw submitted, in comparison with the samples grown east of the Rocky Mountains, they were remarkably fine; and if such flax straw can be produced economically we need not be troubled concerning future supplies of fiber for the manufacture of fine linen, should there be a demand in this country for the higher grades. The Oregon samples were of such superb color that, if river retted, to preserve the color, the fiber would resemble the flax of Courtrai. There is a far less percentage of woody matter, or shive, which breaks out readily when drawn through the fingers, leaving a clean ribbon, or filasse, that is soft, glossy, and very strong. In a report from this office on vegetable fibers, issued by the Department nearly twenty years ago, Oregon was especially named as a most desirable State for the growing of fine flax. The result of experiments in 1891 proved that the matter was not overstated.

Another point was suggested by these experiments: As in the little country of Belgium three distinct kinds of flax are grown in as many districts, in a country as large as ours it will hardly be possible that the same kind or quality of flax will be grown in the different sections. Local conditions will, in a measure, affect and give direction to the forms of culture and methods of handling the product. And in time, when experiment shall have determined which is the best practice for a given section, it will be followed, naturally, and a standard form of flax for this section will be the result, which will be recognized by the flax buyers, and which will take its legitimate position among commercial products.

STATEMENTS OF EXPERIENCE.

Experience is the best teacher. In the operations of 1891 the practice was so varied, and in a majority of cases, especially at the agricultural experiment stations, the work was so purely experimental, in the absence of practical knowledge of the situation, and done in such a small way, that it would be unfair to the experimenters and misleading to those seeking information to touch even briefly upon the methods pursued in every case. The statements are confined, therefore, to those experiments where the results were positive and where the line of practice followed was systematic and thorough.

SOIL SELECTION.

Experience shows that flax can be grown in a wide range of soils, although a moist, deep, strong loam, upon uplands, is the preferable soil for this culture. Reference is made in this connection to the soil usually selected in European practice, where it is recognized that in a dry calcareous soil the stalk remains short, while in a heavy, clayey soil greater length is secured, though at the expense of fiber.

The Massachusetts experiment was conducted in a deep soil of alluvial origin that was well drained, warm, light colored, and with a slight pitch to the west.

The Storrs Station (Connecticut) experiment was conducted in a medium heavy loam, 6 to 8 inches deep, subsoil yellow, heavy loam.

The experiments in New York were carried on in a clay loam only moderately fertile in one instance, and in a gravelly loam in the other. Old flax-growers in the State formerly gave preference to a heavy clay loam that was well drained, and this soil was chosen in the Agricultural Experiment Station experiments.

In the Maryland experiment the crop was grown upon heavy clay loam, poor in quality.

In Kentucky, good results are secured in the soils of the limestone formation. This is described as a "red-loam soil." At the experiment station the flax was grown in a "black, deep, blue-grass soil," derived from the limestones of the Trenton group of the Lower Silurian. "These limestones in general are rich in phosphoric acid. The subsoil of the farm is a light-colored clay, not easily permeable by water, and the ground is generally wet and cold in the early spring. The farm has been in cultivation many years."

A clay loam was selected for the Ohio experiments, with no special fertilizing, but with thorough soil preparation, which doubtless had much to do with the degree of success attained.

In Indiana heavy sod land was chosen, the soil being a sandy loam, and the Illinois experiments were conducted in a similar soil, the "dark colored prairie soils" of the State being rich in humus, and the very opposite of the clayey loam thought to be essential to success in some of the Eastern States in the old days of flax culture. Barley lands in some of the Western States have been thought admirably suited to flax culture, such land being heavier than what is usually regarded as "an alluvial soil."

At the College of Agriculture of Missouri an upland clay limestone soil, a foot in depth, upon clay subsoil, was employed for the experiments, with no manures. A lighter soil in a better state of fertility would have given better results, or the experiment would have been more successful on the same soil that was employed, with better tilth and more thorough preparation of the seed bed.

The experiments made at the Michigan Agricultural College were very thoroughly conducted, both light and heavy soils having been chosen. The first plat was very sandy land, tile drained, showed "surprising results" as far as growth was concerned, in some respects being equal to the second one, the soil of which was a dark, rich, loamy clay. In another plat where the soil was a rich, black, alluvial loam, and which was devoted to the Belgian Riga and white-blossom Dutch varieties, the flax matured later, but made a thick, heavy stand, though with shorter length of straw. The experiments showed favorable and encouraging results and will be continued another year.

From Wisconsin only general reports were received, and the questions of soil culture, etc., were not especially considered.

A review of the results in Minnesota showed that the selection of soil varied from light, sandy loam to strong black soils or the heavy alluvial of the timber lands, and average samples of straw have been received grown in the two extremes, though the best samples were produced on the heavier lands. About July 1 Mr. Bosse showed the writer a field of flax that was growing, as he expressed it, in almost pure sand. It had made a splendid growth, but later was prostrated by storms and was probably not harvested. Mr. Bosse's best samples, however, were grown in the heavier soil. The managers of the Minneapolis Flax Mills planted on sandy loam, although they advocated a rich, black soil, capable of producing a good crop of corn or wheat. Similar soils to those employed in Minnesota were selected in Nebraska and the Dakotas.

As stated, the very best samples of straw received came from Oregon and California, where the experiments were conducted in heavy soils. At the California Experiment Station adobe soil was chosen, which is of a clayey nature. The "clay loam" selected at the Oregon Station was explained as "rather tenacious in its character, the land having borne from five to six crops of wheat since cleared of timber." Unfortunately no account was given of the preparation of the land, though at the California Station the land was put in the best possible condition by digging and raking.

It would be difficult to draw conclusions in detail regarding "the best soil" for flax culture in the different States where the experiments were conducted, because the conditions varied so greatly, and in many States but a single series of experiments, or, perhaps to state it more correctly, but a single experiment is recorded. Enough has been presented, however, to show that the heavier soils, when well drained and of proper fertility, are preferable to the lighter soils, known as sandy loams. But, as previously stated, more depends upon the soil preparation than upon soil selection, where reasonable care has been exercised. And this leads to the consideration of the replies to the third question in the circular.

SOIL PREPARATION.

Little was learned from the reports of the experiments of 1891 upon this subject that would prove a safe guide in practice. Too little attention was paid to the importance of deep plowing and the careful preparation of the seed bed. In foreign practice there is a division of opinion regarding the special advantages of fall plowing, though there is perfect agreement in relation to the necessity of reducing the ground almost to the condition of garden soil by any possible means, and fall plowing, therefore, has many advocates.

Undoubtedly, in this country, fall plowing will be advantageous with a cross plowing in the spring. Where heavy clay loams are chosen, two plowings in the spring will give better results than one.

The number of harrowings will depend wholly upon the lumpiness of the soil, as all clods must be broken up and the soil made fine and even. The roller should be used to make the ground as smooth and level as possible, and to press into the soil any small stones that may be upon the surface. Heavy lands that from their situation are liable to be more or less covered with surface water during the winter should be avoided. On account of the extra labor necessitated upon heavy land, it is better, therefore, to choose the medium soils that will yield readily to the action of the elements and to the plow and harrow.

The experiments at the Massachusetts Station were conducted in properly prepared soil that had received careful fertilizing, and good results were obtained. The land was fall plowed and manured during the winter with strong cellar manure, from well-fed milch cows, at the rate of 5 cords per acre, spread as drawn; spring plowed, then three times harrowed and once rolled; hand raked after the seed was sown. A similar careful practice was followed in Connecticut, the clod crusher being used to reduce to requisite fineness. The straw was fine and good and showed a fair percentage of good fiber.

On the contrary, many of the Western samples showed a coarse, more or less woody stem, deficient in fiber, and which could only give an inferior product. A stem of Courtrai flax, water retted, drawn between the nails of the thumb and forefinger, gives a soft ribbon of strong, lustrous fiber, the shive yielding readily and falling away in flakes. A few examples of the Western straw, referred to as badly grown, present a coarse stem of woody matter surrounded by a thin coating of harsh fiber that could only be employed in goods of the lowest grade, if indeed it would pay to carry such flax through to the final processes of spinning. And it may be stated here that the poor quality and deficient quantity of the fiber that can be produced from the Western flax straw, grown for seed alone, makes it doubtful whether it will pay to treat it for spinning purposes, unless for such coarse uses as bagging or burlaps. In India, where flax has been grown long years for seed alone, the plant has degenerated into a kind of bush, with such coarse, woody stems that making fiber from it is entirely out of the question. But it produces a superb seed for the oil mills, which forms an important part of the foreign supply. Eugene Bosse says:

To raise a good crop and good quality of flax, both for fiber and seed. choose a clean field, free from weeds, where a good crop of wheat or corn could be grown; plow it late in the fall. 7 or 8 inches deep after small grain or corn, and 5 or 6 inches on timothy and clover lands, and roll this last immediately after plowing; but if the land plowed 7 or 8 inches has never been turned so deep before, it ought to be replowed the same way in the spring. or. better. in the fall. When the land is dry enough in the spring, and as a general thing here in the West about the 10th or 15th of April, cultivate the field for flax twice crosswise. as deep as first plowed, if practicable; let it lie for a few days, and if the weather is warm pulverize fine and deep; sow with the seeder, having the teeth arranged to work but very lightly, 1½ or 2 bushels per acre of Riga or Belgian seed; harrow once crosswise on the seed, and next day, after the dew is gone and the land is dry, roll it well, and be satisfied you can not fail to raise a valuable crop.

THE USE OF FERTILIZERS.

It should be understood as one of the axioms in flax culture that a crop of flax that will scutch out a good quality of salable fiber can not be produced on impoverished lands. The reader is referred back to the practice of Belgium and other European flax-growing countries in this matter, where high fertility is considered of first importance.

On the new lands of the West good crops may be grown for a number of years without manures, though in time fertility must be exhausted and poor crops will inevitably follow. The flax crop of all crops makes heavy demands upon the soil, and for this reason is frequently called an exhaustive crop. It must be so naturally, as flax is usually grown for seed, where the ground is shallow plowed, not cultivated, everything taken from it and nothing returned. The stem of the flax plant is tall and slender, growing rapidly, and the long roots as they push down deeply must have something to feed upon to make vigorous growth and good straw. It is on account of this habit of the plant to extend its roots to such depth in the earth that plowing and fine tilth are so essential; and the roots must find food or the plant will be of slow growth, woody and deficient in fiber, and the product inferior both as to quality and quantity.

It is interesting to note, in the experiments of 1891, that the crops grown in the East were properly enriched, while on the newer lands of the West in the larger number of cases no fertilizers were used. This is no argument, however, against the use of manures, for undoubtedly better results would have been attained in many instances had some attention been given to securing a higher state of fertility. Here are some extracts from the reports which mentioned the use of fertilizers:

Massachusetts.—Five cords per acre of fine cellar manure from well-fed milch cows; cotton-seed meal, 500 pounds; muriate of potash, 150 pounds, and nitrate of soda, 100 pounds—broadcasted and harrowed in.

Connecticut.—Per acre, nitrate of soda, 140 pounds; muriate of potash, 160 pounds; dried blood, 100 pounds, and dissolved bone black, 320 pounds.

New York (*James Thompson & Co.*).—Two tons of stable manure per acre. At the Cornell Station no fertilizers were used.

Maryland.—One-half of the acre sown was fertilized with stable manure—amount not stated; the remainder received about 500 pounds dried fish per acre, sown with drill at time of seeding.

Kentucky.—No fertilizers were used.

Indiana (*J. M. Pierce*).—No manures were used save a heavy top-dressing of horse manure after the seed was sown.

Michigan (*Experiment Station*).—Half of one plat was fertilized with 880 pounds of plaster and 10 bushels of common salt per acre; the remainder unfertilized. One-half of the second plat was fertilized with "the homestead potato grower," of the Michigan carbon works, Detroit, at the rate of 200 pounds per acre. The other half had 180 pounds plaster and 5 bushels wood ashes per acre. The reporter says: "As in the case of the last plat, I failed to see that the fertilizers made any difference in amount of seed, size of stalks, or time of maturity." It is to be regretted that the samples on these different plats could not have been tested for quality and quantity of fiber. One-half of the third plat had 180 pounds of plaster and 5 bushels of wood ashes per acre, and the remainder was fertilized with 200 pounds of the "potato grower" mentioned above. On the fourth plat no fertilizers were used.

Minnesota.—Stable manure was used in but one experiment, the amount not being specified.

The fine product derived from the Oregon experiment was grown on soil, without manure, that had produced four or five previous crops of wheat since cleared of timber.

When stable manure is used well-rotted (composted) manure is preferable to the coarse barnyard manures, and besides, the use of well-rotted manures makes it easier to avoid filling the soil with seeds of weeds, as coarse manures abound with such seeds.

Dr. Hodges, of Ireland, many years ago proposed the following, which he concluded, by analysis, would replace the inorganic matter removed from the soil by 2 tons of flax straw: Muriate of potash, 30 pounds; common salt, 25 pounds; burnt gypsum, 34 pounds; bone dust, 54 pounds; and sulphate of magnesia, 50 pounds.

The advantage of returning to the soil the shive or woody matters from the flax straw has often been urged. Here is a statement from Mr. Procter's report upon flax and hemp culture in Kentucky,[1] taken from the proceedings of the Irish Flax Society, which bears important testimony on this subject:

In 1847 a rood of flax, Irish measure (which had been in oats in 1845, followed by flax in 1846), was divided in four equal parts for the purpose of trying the different application of manures. To No. 1 was applied 28 pounds of manure, recommended by Liebig for flax; to No. 2, 28 pounds of guano, mixed with an equal weight of powdered gypsum; to No. 3, a quantity of shives or woody part of the dried stems of flax, calculated as equivalent to the weight of an average produce on the same breadth of land; to No. 4, a quantity of the water in which the produce of the same estimated weight had been steeped. These manures were minutely incorporated with the soil. On this, Riga seed was sown. The crop grew well and produced a fair return, as will be seen by the following table:

No.	Substance applied.	Product of fiber.	Price per stone.	Value of fiber.	Produce of fiber.	
					Stones.	Pounds.
		Pounds.	*s. d.*	*£ s. d.*		
1	Liebig's manure	61	8 9	4 13 3	61	854
2	Guano and gypsum	55	9 3	1 11 10	55	770
3	Shives	55	10 3	1 15 3	51	714
4	Water from steeping pools	55	9 6	1 12 7	51	714

And where flax is pool retted, it is always well to return to the soil the contents of the steep pools, as the water is rich in organic matter. The Belgian flaxgrower in his practice of returning to the soil that

[1] Geological Survey of Kentucky, published about 1880.

which was "borrowed"—if I may use the term—while the flax was growing, uses large quantities of oil cake, sometimes to the extent of a thousand cakes per acre. Flax is an exhaustive crop only as long as the practice of taking everything and returning nothing is pursued. The soil must contain the proper plant food, and if the elements of fertility are wanting they must be supplied.

ROTATION OF CROPS.

We pay little attention to rotation in this country, although there are as good reasons for following a rotation in the United States as in Europe. The danger of exhausting the soil is lessened by the practice, even where the fertility is not fully kept up.

In our country, especially where there is so much weed-ridden land, it becomes important to precede the crop of flax with such field crops as will clean the soil from weeds as far as possible, to avoid the extra labor of destroying the weeds at a time when the young flax should have the very best start. Hemp is an admirable weed-killing crop with which to put the crop in proper condition for flax culture, and clover is also admirable for the purpose.

A former New York grower used to begin the preparation of the soil for a crop of flax three years before. The rotation that followed was Indian corn, barley, oats, winter and spring wheat, and red clover, the corn being planted on land plowed from clover sod. The cleaning process, to rid the soil from weeds, began with the first crop which followed the clover sod.

It is hardly probable that the American flax farmer will carry the system of rotation to the extent that it is carried in Europe, where, oftentimes, the entire farm is laid off in plats, and the order of planting for the different crops planned for years in advance. It may not be out of place, however, to give a few suggestions relating to the foreign practice for the guidance of those who may wish to follow some kind of rotation.

The reader is again referred to the European practice, described in the earlier pages of this report, for crop rotation in Europe has been reduced to a system. As to the experiments of 1891, there is little said in the reports upon this subject. At the Massachusetts station, prior to 1889, the land was for several years in grass; 1889, mangel-wurzel; 1890, corn; both years kept very clean and well manured with sheep and barnyard manures. At the Missouri station land was selected that had been under cultivation about forty years. Last manuring, with barnyard manures, in 1886. Subsequent crops were: 1886, clover; 1887, corn; 1888, carrots; 1889, corn; 1890, sorghum, and 1891, flax. The soil was capable of producing 40 to 45 bushels of corn or 2½ tons of timothy. These two reports are the only ones giving information of special interest in this particular. Another year it will be well to invite statements regarding rotation, in order to supply helpful hints in establishing a practice for our own country.

QUANTITY OF SEED TO SOW.

In sowing for seed and fiber, $1\frac{1}{2}$ bushels is the smallest quantity that should be used, and 2 bushels will be better. Two- and three-peck sowings, the rule in flax culture for seed, will never give a crop of flax fiber that will return a reasonable profit. Three bushels to the acre is the rule in Europe when a superior fiber is desired, for the more thickly the seed is sown the finer the straw and, other conditions being equal, the higher the grade of fiber that will be yielded. In the reports of experience the range was shown to be from 3 pecks to $2\frac{1}{2}$ bushels. Mr. Eugene Bosse, then a resident of Minnesota, was the only experimenter to sow over 2 bushels. In the more easterly States and on the Pacific coast 2 bushels were sown in the different experiments, and the straw gives evidence of it. In Missouri, where the experiments seem to have been very carefully conducted, $2\frac{1}{2}$ pecks were sown for seed, 5 pecks for seed and fiber, and 2 bushels for fiber alone. Too small a quantity was grown for seed and fiber, and for fiber alone at least $2\frac{1}{2}$ bushels should have been sown. A full series of interesting samples, nine in all, were received with this report. The best of the straw was considerably above the average of the samples of straw received from States adjacent to the Mississippi. At the Michigan station 28 to 32 quarts were sown, which was too little. At Yale, Mich. (Livingston & Co.), 70 to 112 pounds was the rate, or practically 5 pecks to 2 bushels. In the ten localities where experiments were conducted in Minnesota but two experimenters sowed over $1\frac{1}{2}$ bushels, 2 bushels having been sown in the Sioux Falls linen mills experiment. The range in other instances was from 3 pecks to $1\frac{1}{2}$ bushels, 1 bushel or less being the quantity reported in a majority of cases. If the Minnesota experimenters hope to see their State take the lead in the culture of flax for fiber, they must get out of the old ruts and not sow merely sufficient seed to produce a crop of seed for the oil mill, trusting in Providence for fiber, but sow that quantity that will insure fiber first, and the seed product will take care of itself if the harvesting is properly done. In examining the samples submitted to the Department, a glance is usually sufficient to recognize the straw grown with 3 pecks of seed. The five samples from the Oregon Experiment Station were from sowings of 2 bushels of seed to the acre, and this quantity the Department recommends as the proper quantity to sow if a good quality of fiber is desired. The larger the quantity of seed the finer the straw, and likewise the fiber.

SOWING THE SEED.

In regard to the manner of seeding the crop, it is usually put in by hand broadcast in foreign countries, there being experts at the business who go from farm to farm at this season, as their services are required. In many of the experiments of last season the seed was sown broadcast by hand, though in some instances broadcast seeders were employed and a few drilled in their crop. The Department can not recommend the last-named method of seeding. As a rule, the best results are shown in the samples submitted to the Department where hand broadcast sowing had been practiced. The managers of mills who undertook experiments for the Department almost invariably report this practice. The work should be done with great regularity, to secure an even growth of straw and the same standard of fineness for different portions of the field. The objection to drilling in the crop is that the outside straw will always be coarser than that straw in the center of the drill row, with a tendency to branch. The practice in Flanders is to sow in the morning and harrow the seed in with a close-set harrow. After the seed has germinated, sometimes after it has sprouted, the land is rolled. The implements named in the reports of experiments were the "Superior" and the "Buckeye" grain drills, the Thompson (broadcast) clover-seeder and the Vanbrunt broadcaster. The Department has not examined into the special merits or demerits of these machines, and only mentions them as occurring in the reports.

In regard to the time of sowing, no definite rule can be laid down in a country with such diversity of climate, and where the seasons vary so greatly. A former grower in New York State, in the old days of flax culture, advocated sowing when the soil had settled and had been warmed by the influence of the sun and weeds and grass had begun to spring up and the trees to unfold. A Minnesota grower considers the first part of May (in the vicinity of Grand Meadow) the proper time for seeding, but states that no rule can be given, atmospherical conditions governing to a great extent.

Too early sowing may result in injury to the growing plants, and, on the other hand, in localities subject to extreme dry weather, if sown too late, the plants will not have made sufficient growth to withstand the effects of a lack of moisture in the soil, and a stunted growth of straw is the result. Mr. J. R. Procter makes statements in his report on flax and hemp culture in Kentucky as follows:

> Good results, however, can be obtained by sowing, whenever conditions are right, from March to the latter part of May. Never sow during rain or when the soil is wet. To insure even sowing, stake off the land, and mark from stake to stake by drawing a chain across the land after it has been harrowed and rolled. Make the lines about 12 feet apart. Having ascertained the quantity of seed necessary, divide the total quantity in quarts by the number of beds, so as to ascertain the number of quarts requisite for each bed of 12 feet. The sower should proceed with a regular step, taking small, light handfuls, and casting the seed with regular throws, high and fearlessly, letting each cast slightly overlap the preceding one. Care must be taken that the seed, which is very slippery, does not escape in the backward swing of the hand. Some cultivators advise soaking the seed in slightly warm water for two or three hours, and then rolling it in plaster or gypsum. This renders it less slippery, and the gypsum is beneficial to the germinating plants.

Regarding the time of sowing in the different localities where the experiments of 1891 were conducted, the reader is referred to the table on page 56.

WEEDS.

The American flax growers should have clean land, in order to avoid the labor of weeding. (See remarks on the subject of rotation on a preceding page.) On the contrary, the farmer who is not particular in the matter of having clean land had better let flax culture alone and avoid a failure. (See Plate III.) Weeding, as performed on Belgian flax farms, is too laborious an operation to pay in this country, and weeds must be prevented as far as possible through care and good farming. The weed replies included in the 1891 reports were interesting, and a few extracts are here given:

Massachusetts Experiment Station.—The worst places once hand weeded. *Chenopodium album* or pigweed; *Polygonum* of several species not determined; *Ambrosia artemisæfolia* or ragweed. Growth all very rank; some 5 or 6 feet high.

Connecticut (*Storrs Agricultural School*).—Chanloch, *Brassica sinapistrum*, pulled by hand once.

New York (*Cornell University Experiment Station*).—No attempt was made to control weeds, and not very many troublesome ones appeared.

James Thompson & Co.—No attempt to control weeds. Principal kinds were pigweed, *Chenopodium*, and smartweed, *Polygonum hydropiper*.

Maryland.—No attempt to control weeds, as only the richest spots of land were covered. Ragweed and so-called ragweed were named especially.

Kentucky Experiment Station.—Weeds gave little trouble.

Ohio Experiment Station.—The only weed that was particularly detrimental was the bindweed, *Convolvulus arvensis*, and it was necessary to pull this pest from the soil at least twice during the growing season.

Indiana (*J. W. Pierce*).—Weeds gave some little trouble, but not so much from sod land as from stubble.

Illinois Experiment Station.—Few weeds appeared. No attempt to remove them.

Missouri Experiment Station.—Weeds were chopped out between rows with narrow hoe.

Michigan Agricultural Experiment.—Plat I, hand weeded twice. Plat II weeded by hand in spots when weeds were worst. Plat III, when the flax was 8 to 10 inches high we hoed out the weeds between the rows by hand. This was more satisfactory than where the flax was sown broadcast, as all the weeds were practically killed by this, and the culture seemed beneficial to the flax. This could be quite rapidly done, and perhaps a wheel hoe would have done it as well and more quickly still. Plat IV, weeded by hand twice.

Yale, Mich. (*Livingston & Co.*).—Canada thistle.

Minnesota.—In Minnesota Mr. Bosse reports wild buckwheat, which is a great pest to the flax grower in this State.

Another correspondent mentions wild timothy, which, owing to dry weather, gets ahead of the flax, and no attempt was made to eradicate it. Two experimenters report "no weeds," and the other reports barely mention that the weeds were not controlled, their names not being given.

At the Nebraska Experiment Station the principal weed which affected the crop

FIG. 1.—FLAX FIELD PREPARED FOR SEEDING.

FIG. 2.—FIELD OF YOUNG FLAX IN MINNESOTA.

to any marked degree was "smartweed." No weed appeared with the crops at the California Experiment Station, and a similar favorable report comes from Oregon. Dog fennel appeared late in the season, but did no harm.

HARVESTING.

In the experiments of 1891 not more than half of the flax was pulled at the right time, and some of it was totally ruined by being allowed to stand until overripe. The safest guide in this matter is experience, for it is difficult to lay down any rule that may be followed literally.

Referring to Wisconsin and Minnesota, Mr. Bosse says:

> The flax in this part of the West should be ready to pull in from eighty-five to ninety-two days after sowing when sown between the 15th and 25th of April, and from seventy-five to eighty-five generally when sown from the 1st to the 15th of May; but the capsules must be just turned yellow, and the lower half of the plant free from leaves. The richer the land is the earlier the flax may be sown, and the earlier the flax is sown the more seed it will take to have a good stand.

A correspondent in Ireland says: "When the straw begins to turn yellow and the foliage within 6 inches of the ground is drooping, pull at once." In experiments at the Massachusetts Experiment Station flax was pulled "when the lower leaves began to fall and the stalk next the ground had turned yellow and the seed was in the dough." This flax was pulled at the proper time. Regarding the reports from other experiments, it was almost the rule that where a good sample of flax straw was submitted the report which accompanied it showed that careful attention had been given to the matter of harvesting when the straw was in the best condition.

While the usual practice of the flax farmers who grow for seed alone is to harvest with a reaper, it is absolutely essential in culture for fiber that the straw shall be pulled. It will not be necessary to describe this operation further than to state that the straw is drawn out of the ground by the handfuls, the earth dislodged, usually by striking against the boot, and the handfuls laid upon the ground crossing each other. The European practice is so thorough, however, in the matter of harvesting, that I can but refer to the story of European culture, told on other pages of this report, where the details of the practice are given. A flax-pulling machine is a desideratum. Several inventions have been brought to public notice, but, as far as the Department has knowledge, not one has been successful in field trials. This is a promising field for invention, for a satisfactory machine of this description would vastly cheapen the cost of production in the agricultural operations of this industry and avoid a kind of labor that Americans do not take kindly to and to which foreigners in this country are equally averse.

SEASON OF GROWTH.

An examination of answers to the questions relating to the duration of time that the crop was in the ground showed a wide diversity of experience. In the Valley Falls, N. Y., experiment the flax was in the ground between six and seven weeks. At Yale, Mich., where a fair flax was produced, the time was about three months, and this may be taken as a general average, the quality of the fiber submitted being considered as an important factor. The Oregon station reported eighty-nine days and the California fifty-seven days. Both stations submitted superb samples, so after all there is no rule to follow save the rule of good judgment, as there are so many varying conditions which should be taken into the account.

The following table, showing the dates of sowing and harvesting, will be perused with interest:

Place of experiment.	Season of growth.		
	Sown.	Harvested.	Number of days.
Massachusetts station	Apr. 29	Aug. 1-6	94-100
Connecticut, Storrs station	May 11	Aug. 7, 23	88
New York, Cornell station	May 22	Aug. 23, 26	94-97
New York, Valley Falls, Thompson & Co	Apr. 30	July 13-22	45-54
Maryland station	May 4	Aug. 25	About 113
Kentucky station	Apr. 29	Aug. 11	105
Ohio station	Apr. 30	July 15	77
Indiana, Peru, J. W. Pierce	Apr. 10-15	Sept. 5-12	148, 150
Illinois station	Apr. 24	July 30	98
Kansas, Walnut, H. C. Craig	May 20	Aug. 3	76
Missouri station	May 23	Aug. 1-3	71-73
Iowa, Forest City, Thompson Bros	Mar. 15-June 10	Aug. 15-Oct. 1	114-154
Wisconsin, Eau Claire, H. C. Putnam	June 1	Aug. 30	92
Michigan Agricultural College	May 10-25	Aug. 18, 25	97, 101, 103
Michigan, Yale, Livingston & Co	Apr. 20	July 20	92
Minnesota, Minneapolis, J. C. Allan	May 10	Sept. 1	115
Minnesota, Oakland, McMillan & Hastings	May 28	Aug. 27	92
Minnesota, Heron Lake, J. T. Smith	May 10	Aug. 7	90
Minnesota, Grand Meadow, A. Van Hemert	May 7	Aug. 11	97
Minnesota, Jordan, Zettle Bros	May 10	Sept. 5	119
Minnesota, Faribault, E. Kaul	June 1	Sept. 5	97
Minnesota, Sioux Falls, W. A. Ingram	May 25	Aug. 10	78
Minnesota, St. Paul Park, Eugene Bosse	Apr. 30	Aug. 2	95
Nebraska experiment station	May 7	Aug. 3	89
South Dakota, Huron, R. O. Richards	May 15	Aug. 15	93
Oregon experiment station	May 18	Aug. 14	89
California experiment station	Apr. 25	June 20	57

SAVING THE SEED.

In the limited space of this report it is unnecessary to go over the ground so fully covered in former publications of the Office of Fiber Investigations, as to whether both fiber and seed can be obtained from the same crop. It may be briefly stated that there is abundant evidence to prove that good fiber can be produced and at the same time a fair crop of seed secured by harvesting at the proper time, as has already been set forth. For more detailed statements on this subject the reader is referred to the Annual Report of the Department of Agriculture for 1890 (pp. 452 to 454).

The mechanical operation of removing the seed without injuring the fiber has been one of the problems of American flax culture. In the old days of flax cultivation in New York whipping the seed capsules against a sharp rock, set at an angle of 45°, was the method resorted to. In foreign countries various methods are resorted to (as described in former bulletins), from hand thrashing to passing the bundles through powerful machines with iron cylinders so constructed that only the heads are crushed, the straw remaining in the hands of the operator during the entire operation. The common American practice has been to drive the straw through an ordinary thrashing machine, saving the seed but rendering the straw utterly worthless in its tangled and broken condition. Some attempts have been made to save the straw even with the ordinary thrasher by opening the concave. This is done so that the teeth will just come together; then with one man to open and pass in the bundles, another takes them by the butt ends and spreading them fan shape presents the seed end to the machine. The straw is not released, but is withdrawn as soon as the seed is torn off, when the bundles are again tied.

The operation is not fully satisfactory, and the necessity of a rapid flax thrasher has stimulated invention, and several machines have been presented which will do the work in a manner. The most rapid of these is manufactured by the Port Huron Thrasher Company, which was formerly used with a fair degree of success by the American Flax Fiber Company, of Austin, Minn. The Department has had no means of examining or testing this machine, and the statement is made on the authority of officers of the Austin Flax Company, who regard it as economically successful, having cleaned some 1,200 tons of straw with it during one season.

In the field experiments of the year 1891 the seed was saved in a majority of instances with variable results as to (estimated) quantity obtained per acre. The data is unimportant, and the figures of yield are omitted. It may be stated in general terms, however, that an average yield is 10 to 12 bushels per acre, though as high as 20 bushels have been reported by some western flaxseed growers, and in a subsequent experiment in Kansas 28 bushels of seed were obtained by irrigation.

RETTING AND CLEANING.

In only a few instances, where the experiment was conducted by managers of flax mills, was the attempt made to ret the crop and prepare it for fiber. These are not strictly operations of the farm; at least the retting can be better carried on by the purchaser of the crop, who should also attend to the cleaning of the fiber, as this is factory work and not farm work. To found an American linen industry there must be three divisions of labor—the growing of the crop by the farmer, the retting and scutching by the purchaser of the crop or "factor," if he may be so designated, and lastly, the spinning and weaving of the manufacturer. In the old days of household manufacture these three operations were conducted, in a small way to be sure, upon the farm.

In a tour of the linen fabric and flax twine mills of the country an opportunity was had of examining several samples of flax submitted by farmers new to this culture. Some of these samples were made from well-grown flax, but rendered worthless for spinning purposes, save as tow, through ignorance of the proper afterpreparation. At the outset of the experiment of reestablishing this industry there will be many such costly mistakes, and the would-be flax farmer is therefore cautioned to go slow. Let him put in only a few acres of flaxseed (say 3 or 4 acres) for fiber at first, regarding it wholly as an experiment. When he has gained knowledge, and the different wheels in the flax industry have been put in position, and are beginning to move, he will know something then of the demand for flax fiber, and he can extend flax culture accordingly.

The outlook is promising, especially so when we realize that flax culture in the Old World is steadily declining, due to many causes tending to make flax a poor-paying crop in spite of low wages, which, after all, is one of the smallest of considerations, more than overcome in this country by other considerations giving us a positive advantage.

SPECIAL NEEDS OF THE INDUSTRY.

Reference has been made to the necessity for a division of labor in this work—for the establishment of scutch mills by those who will purchase the crop when grown and attend to the retting and cleaning. This makes the farmer responsible only for the growth of the crop. There is yet a great deal of ignorance regarding proper culture even among those who have a general interest in, and some knowledge of, the subject, and who, with an assurance of adequate money return for their labor, would go into flax-fiber production.

Our farmers must know the difference between poorly grown and prepared flax, which is worthless for any purpose, and the grade of flax which a little better practice will give them, and which will be salable for some purpose. This information can not be obtained by them through the medium of the published literature of the subject alone. Object lessons, in many instances, will be necessary, with opportunity to ask questions and examine and handle the well-grown product.

During the months of July and August and part of September, 1892, Mr. Eugene Bosse, a Belgian flax grower and scutcher of experience, a resident of the United States, was commissioned to visit the flax-growing localities in the several Northwestern States, and travel from one district to another to tell farmers what to do, how to do it, and to give proper instruction where mistakes had been made in the previous year's operations. Mr. Bosse's efforts were appreciated by many farmers with whom he came in contact.

In studying the needs of the flax-fiber industry of this country, the necessity for a practice which shall be built up on the lines of the progressive agriculture of the present day has frequently been referred to. We should consider the foreign practices merely as the foundation for a practice suited to our times and people, in which labor-saving machinery will be used in all operations, with a division of labor to the end of economy of production. Improved implements for putting the soil in the best possible condition are already found on nearly every farm in the country. Until a machine has been produced with brains and the reasoning faculty, we need not hope to see a flax weeder, nor will the American flax fields be weeded by women and children working on their knees. The weed question is not a serious one, however, save in some localities. Much will be gained by paying more attention to the question of rotation, in order to learn what special crops will put the soil in best condition for flax culture and clean it of weeds. Both hemp and clover are said to be excellent weed killers. With a more careful rotation in flax culture we shall hear less of flax proving exhausting to the soil. It must prove injurious where everything is taken from the soil and nothing returned, and with only a reliance on the natural fertility of the soil to begin with for elements of plant growth.

The necessity for a careful study of every stage of culture is essential, and we should especially satisfy ourselves as to the best localities for perfect growth as well as to learn the limits of successful culture, outside of which the crop can not be grown successfully from the commercial standpoint.

This means practically a study of the whole field of operations founded on present foreign practices. A study of soils and fertilizers is especially desirable. A strong loamy soil under a high state of cultivation has always been deemed essential to success with flax, yet reference has been made to a field of flax in Minnesota, apparently in superb condition, which was growing in almost pure sand. A study of crop rotation is desirable, at least so far as to learn what crop or crops may be employed to put the land in the very best condition for a following crop of flax. In this connection weed-cleaning crops should be especially considered.

A study of varieties is essential, and experiments might be conducted as to the quantity of seed to be sown to the acre, ranging from 1 bushel to 2½ bushels, though this is not so important, as it is a pretty well established fact that 1½ bushels will give good seed and fiber, while 2 bushels is the proper quantity for fiber alone.

A study of the ripening of both stalk and seed is desirable to determine the precise point at which the pulling should be done to obtain the best results at the same time in both directions. I should also suggest a study of seed deterioration, with experiments to determine whether deterioration may be retarded by special culture, fertilizers, or other agencies.

CONCLUSIONS.

Looking over the entire field of experiment, which covers the first two years of the work of the Office of Fiber Investigations, and considering the limited knowledge of the experiments in many instances and in connection with a study of the specimens submitted, the results were most encouraging. In report No. 4, speaking of the outlook, the special agent made this statement:

> There is much to learn in order that practical information may be given to those who wish to make a beginning with the industry. Our friends of the agricultural experiment stations in flax-growing States can aid us materially in this work and do much toward placing this old industry upon a new and substantial foundation, and their cooperation in the good work is earnestly desired. The small beginnings made at the experiment stations the present year indicate that these institutions will be able to render most valuable aid in the establishment of this industry. The work should be enlarged upon, particularly in flax-growing States, for it is only through intelligent experiment and careful practice, noting all errors and studying how to avoid them, that the system of culture best adapted to our country can be developed.

It is to be regretted that in the six or seven years that have intervened since these words were written the stations have not grasped the opportunity, and that they have done little or nothing on their own responsibility toward the establishment of the flax industry. With two or three exceptions the stations have shown very little interest in the work, and a few have refused to give any time whatever to such experiments. This, in many instances, has been due to the fact that other lines of investigation were considered more important, and there was neither time nor money for everything. But another reason, and the most potent one, is that flax culture for fiber is so new a thing that the station authorities have not had the requisite experience or knowledge of the practice involved to undertake the work, with the result that the Office of Fiber Investigations has stood almost alone in the efforts that have been put forth in the present decade to reestablish this industry. The statement is worth recording that there has been a vast deal of careful experimentation by private citizens with their own means, but working under the guidance and direction of this office, which has given most satisfactory results. In this manner the Department has been able to cover a wide field of experimentation, which has been of great advantage to the localities where such private-official experiments have been conducted. Flax culture, in its practice, is so technical, and there are so many points where failure is possible, even when the grower has had a little experience, that the man who is without either experience or knowledge must hesitate before investing time and money in the industry. Regarding the operation of 1891, therefore, in which effort experiment stations and private individuals worked together in a grand national experiment, the results prove that that year may be regarded as marking a turning point in the American flax-fiber industry. If nothing else was accomplished, the cry was set at rest forever that good seed and good flax can not be produced in the same plant in the United States. But other things were proved, and the good work has gone steadily on since that period.

In the limits of this report it will not be possible to make statements in detail, or even to give an account of all the experimental work of the office. The work on the Pacific coast, however, has been of so important a character and so far-reaching in its results that a special chapter is devoted to it.

THE PUGET SOUND FLAX-CULTURAL EXPERIMENTS OF 1895.

The experiments in flax culture in the State of Washington in 1895 were undertaken after a splendid showing made in a small experiment the previous year. In this initial experiment a quality of straw was produced from American-grown seed derived from a previous year's planting of imported seed, which was fine, long, straight, and tolerably even, resembling Belgian straw, and which gave promise, with more careful culture, of a grade of straw that would compare favorably with that grown in the famous flax region of Flanders.

As the report of Special Agent Thornton regarding the work in this region in 1895 is appended, it will not be necessary either to enter into details regarding the practice followed or to devote any great space to the writer's own conclusions, as the report of Mr. Frank Barbour, of Lisburn, Ireland, who subsequently tested the value of the product by retting and scutching the straw on Irish soil, is appended.

A few points were demonstrated, however, to which particular attention should be drawn. In the first place it was proved that the Puget Sound region affords an ideal climate for flax culture, for, in spite of the many drawbacks to the success of the experiment, some of the straw produced and subsequently shown by me to Belgian experts, has been pronounced of such superior quality as to be capable of yielding scutched flax worth 30 cents a pound. The question of our ability, therefore, to produce high-grade flax straw in this locality is settled beyond argument. Regarding the cost of culture, a perusal of Dr. Thornton's report will show that his work was carried on under disadvantages, and that his expenses were considerably greater than would be the case in ordinary farm practice, where it is not necessary to employ special labor during short periods for a specific crop. Yet the report makes a good showing regarding the expenses of cultivation, which will form a basis of estimate for the cost of commercial culture. It should be noted that much of the flax straw was derived from sowings of 1½ bushels per acre, when the finer grades of European flax are produced from sowings of 3 bushels. The large seed crop in addition to the fiber crop is another interesting point, as it has been asserted over and over again in this country that seed and fiber can not be produced in the same plant.

Without the successful tests of straw, made by Mr. Barbour, the result of the experiment as relating to the value of the fiber would have been left somewhat in doubt, for the retting experiments carried on in the State of Washington did not give the best results. It is not important to suggest the reasons for the poor showing made in this part of the work, though it should be understood that the proper retting of flax straw is a most difficult operation, and is to-day the principal drawback to the success of the new industry. While good flax was produced in the retting experiment, it fell far short in quality of what it should have been, considering the superior grade of straw operated upon. A superb quality of fiber should have resulted, and the truth of this is proved by the fine examples of scutched and hackled flax returned to the Department from the Irish tests. Not to anticipate Mr. Barbour's report, such testimony as this is most encouraging:

If the flax is grown and manipulated under proper conditions and by people who thoroughly understand the business in Puget Sound, we are convinced that the cultivation of it would be of the greatest importance and in a short time would rival the great Belgian district of Courtrai. We congratulate you on the success of this experiment, which is far beyond our expectations, and we believe there is a great future before flax growers in the west of America.

From every standpoint of view, therefore, the Puget Sound flax-fiber experiments must be regarded not only as eminently successful, but as of the greatest importance to the flax-fiber industry of the Pacific coast. Undoubtedly, the present widespread interest in the subject in that region dates from the time that the results of these experiments were made known to the public, though it must be remembered that small experiments have been conducted in these coast States at various times, and with good results. In a paper on vegetable fibers published in the annual report of this Department for 1879, attention was called to the State of Oregon, especially, as possessing a soil and climate admirably adapted to flax culture. The recent experiments under the direction of this office only demonstrate beyond argument that the claims made in the past regarding the advantages of the Pacific coast region for this industry have not been overstated.

REPORT OF DR. A. W. THORNTON ON THE PUGET SOUND CULTURAL EXPERIMENTS.

Mr. Charles Richards Dodge,

Special Agent, United States Department of Agriculture.

Sir: In accordance with your letter of instructions of April 3, 1895, and covering the letter of authorization of the honorable Secretary of Agriculture, I secured, on April 8, 5.17 acres of sandy clay loam bottom land, near Ferndale, in Whatcom County, for an experimental test of flax culture of seed and fiber on Puget Sound, details and results of which I herewith respectfully submit.

THE LAND.

The land secured for this experiment was of high quality, situated upon the Nooksack River bottom, and belonged to Mr. George Slater, jr. It consisted of a strip of level land 80 yards wide and 302½ yards long. This strip I divided into four plots, three of which contained 1¼ acres each, and lot 4 contained 1.14 acres. Lots 1 and 2 consisted of a strong clay loam-made land, while lots 3 and 4 contained more sand, combined with the clay and loam, causing it to dry out more rapidly in dry weather.

THE SEED.

The Riga seed, ordered in Europe, was so delayed that it did not arrive here until the 15th of May, when 1,275 pounds of this seed was delivered to me in good order, 560 pounds of which I had immediately forwarded to Mr. Slater's ranch, and which was sown on the 18th of May.

I may here state that the planting of flax in this climate should take place, if possible, not later than the 8th of April, and as much earlier as possible up to the middle of March, as any delay beyond these dates militates against the success of the crops.

CULTURAL TREATMENT.

The cultural treatment of the crop consisted of two plowings, three harrowings, sowing, covering, and rolling. The seed was sown on the 18th day of May, and fortunately was followed by showers from the 21st to the 30th, which favored the germination of the seed and gave the crop a start. These few wet days were, however, followed by unusual dry weather. Thus, during the whole period of growth (83 days) only 3.06 inches of rain fell, and on two days only did more than one-half inch of rain occur, rendering the more sandy portions of the land a complete failure, and on the stronger and more clayey portion greatly limiting the crop below what would have been normal had the seed been sown in proper season. Thorough fall preparation of the land was not available in this experiment, although in this climate it is a great advantage and in future experiments should not be ignored. As we generally have short spells of fine weather in March, not of sufficient duration to allow of plowing, but if plowing has been already done in the fall the use of a disk harrow will enable one to get the seed sown in good season, which, if not utilized, will delay the sowing a couple of weeks or more. The seed was sown with a hand broadcasting machine, which did good work, delivering the seed uniformly over the whole area. Plat 1 was sown at the rate of 2 bushels (120 pounds) per acre. Plat 2 at the rate of 1½ bushels (90 pounds) per acre. Plat 3 at the rate of 1½ bushels per acre, and lot 4 at the rate of 2 bushels.

Plats 1 and 2 had no fertilizer applied, while plats 3 and 4 had each 200 pounds of blood and bone fertilizer applied per acre. Owing, however, to the late sowing and dry weather, there was never enough moisture to render the fertilizer available as plant food for this crop. Many portions of these plats were not worth harvesting, and useless as a quantitive test. Plats 1 and 2, however, without manure, gave uniform crops, though much below the normal standard for this climate. That the too-late sowing, and subsequent dry weather, is responsible for this failure is illustrated by the fact that upon the other portions of this 12-acre field, of the same average character, Mr. Slater harvested a crop of 80 bushels of oats and 50 bushels of field peas, both being sown in proper season during the first week of April.

Under these conditions I decided not to separate plats 3 and 4, but to utilize what was available for seed and fiber, without any detailed record, as the data derivable from these lots would be entirely fallacious. While plats 1 and 2 were below average, I have kept a detailed record of costs, weights, and measures.

CULTURAL EXPENSES.

While the sum of $30 per acre was appropriated for cultural expenses in preparing the land and growing the seed, I have been enabled to keep this branch of expense down to $8.56 per acre, to which must, however, be added $10 per acre as rent for land and barn accommodation.

HARVESTING.

On August 5, the flax having attained the proper stage for pulling, I employed all the men and boys (some of them being Indians) I could procure to "rush" the pulling through as speedily as possible, giving them wages ranging from 18½ cents per hour for fullgrown men, 15 cents per hour for youths, and 5 cents per hour for boys. As these were new hands and inexperienced in flax pulling, I had to educate them on the subject, and naturally they did not accomplish as much at first as after they had gained some experience. I commenced pulling on the 5th of August with two men, on the 6th six more men and three boys came to pull, and on the 7th ten more men and five boys came to work. During this time two or three knocked off, others taking their places. Under this arrangement the most feasible mode of keeping a record of the cost of pulling and other work was to keep an account of the number of hours (regardless of the number of hands) in each stage of the work at the different rates of wages paid.

I started on lot 2, which took 152 hours to pull, tie, and stack 1¼ acres, at a cost of $25.85, and for 1 acre it required 132 hours, at a cost of $20.68. Neither boys nor Indians were placed on this lot, as they were employed in different portions of lots 3 and 4. Having finished pulling lot 2, we passed on to lot 1, and by this time, having gained some experience by practice, were able to pull lot 1 in a shorter time and at less expense, although the crop was somewhat heavier than lot 2.

Lot 1 being the same area (1¼ acres), was pulled in 78 hours, at a cost of $14.60, or for 1 acre, requiring 62 hours, at a cost of $11.68. Tying the bundles on lot 1 consumed 20 hours' work and cost $3.37; stacking cost 99 cents; for 1 acre tying required 16 hours, at a cost of $2.70, and stacking 82 cents.

Lot 2 yielded 5 wagonloads of good quality straw with the seed on, which was hauled into the barn at a cost of $2 for the 1¼ acres, or $1.60 for 1 acre, while lot 1 yielded 6 wagonloads of still finer straw and seed, and cost $2.40 to place in the barn, or $1.92 for 1 acre.

The rippling and weighing of lots 1 and 2 were completed in the barn, and was a slow process, requiring the taking off the stack, untying the bundles, rippling the seed, again tying the bundles, weighing in larger bundles with an ordinary steelyard, and again stacking in the barn, and from time to time sacking up the seed bolls for removal. For this work I had 4 men, working upon 2 ripples, and 1 man supplying straw for the ripples, tying bundles, weighing, and putting on stack again. From careful timing of the ripplers for runs of 5 hours at a time, and several times in succession, I found the average, with steady work, range from 38 to 44 pounds of straw per hour per man, the difference depending upon the toughness of the straw from sweating in the stack. The rippling and weighing of lot 1 required 152 hours, at a cost of $23.29, or for 1 acre 113½ hours, at a cost of $18.63, and yielded 4,857 pounds of clean straw of fine quality and 23 bushels of clean seed of good quality, or for 1 acre 3,865 pounds of straw and over 17 bushels of seed, while lot 2 required 121 hours for rippling and weighing, at a cost of $21.09, or for 1 acre 96 hours, costing $16.86. Yield for the lot was 4,447 pounds of clean straw and 21 bushels of seed, or for 1 acre 3,557 pounds of straw and 16.8 bushels of seed. (See flax field, Plate IV.)

LARGE YIELDS OF SEED.

The yield of seed upon lots 1 and 2 has been very satisfactory, lot 1 yielding at the rate of 17 bushels per acre, and lot 2 yielding 16.8 bushels per acre. Lots 1 and 2 yielded in the aggregate 44 bushels of seed, while lots 3 and 4 only yielded 15½ bushels in the aggregate, thus illustrating to what a degree lots 3 and 4 fell below a normal crop, owing to late sowing and dry season. This high yield of seed on lots 1 and 2, under such adverse circumstances, establishes some very interesting and unexpected facts.

FIG. 1.—PULLING FLAX IN MINNESOTA.

FIG. 2.—FLAX FIELD AT WHATCOM, PUGET SOUND REGION OF WASHINGTON.

In the Experiment Station Record, Vol. 7, No. 2, page 131, is this statement extracted from Minnesota Experiment Station Bulletin No. 40, pages 271–275: "Fargo flax afforded the largest average yield of seed, 10 bushels per acre, sown thinly for seed with not over 45 pounds seed per acre." Our Puget Sound crop, sown with 120 pounds per acre, yielded 17 bushels, and that, too, with what may be regarded as only half a normal crop for the quality of land sown. There is no doubt had the crop been a normal one, under best condition of climate and season, the yield of seed would have reached 20 to 25 bushels. Another remarkable and unexpected result appears in the fact that it has been established at the Dakota Experiment Station that the maximum yield of seed was obtained by seeding with 45 pounds per acre, and the yield of seed lessened as the amount of seed sown was increased; nevertheless in our Puget Sound experiment, lot 2, which was sown with 90 pounds of seed per acre, yielded only 16.8 bushels per acre, while lot 1, sown with 120 pounds per acre, yielded 17 bushels per acre. This result illustrates the distinctive character of Puget Sound from any other portion of the United States, and that the experience of other sections is entirely fallacious as a basis for estimating what will result in flax culture on Puget Sound.

LOTS 3 AND 4.

Hitherto I have confined my observations to the details of lots 1 and 2, for the reason that, although they might be regarded as fair average crops from an Eastern or European standpoint, yet, from my previous experience on Puget Sound, can only be regarded as one-half of a normal crop for this section, and to that extent worthy of record. With regard to lots 3 and 4, however, the failure was so disastrous that any data based upon them would be fallacious. I therefore decided to ignore them entirely, although there was some very fine straw in patches upon both of those lots, which I had pulled and retted; yet the condition of these lots, as a whole, may be estimated from the fact mentioned above, that while lots 1 and 2 aggregated 44 bushels of seed, lots 3 and 4 aggregated only 15½ bushels.

HYGROMETRIC CONSIDERATIONS.

It would be well here to mention a local circumstance which has a marked influence upon both the rippling of the seed and the breaking and scutching of the retted flax. I find that after the fall rains commence our atmosphere becomes so humid the seed bolls become sensitive to the hygrometric condition of the atmosphere and are rendered soft, tough, and very hard to break up and shell out the seed, more particularly if pulled in the dough stage. In accordance with European practice. I endeavored to break up the seed bolls with a flail, with a flax mallet, and with hand rollers; but all were so slow and unsatisfactory that I abandoned them and hired boys at 5 cents an hour to run the bolls through a clothes wringer, set flatwise, with an improvised hopper. This worked to some extent better than the other plans, but from the small size of the rollers was too slow, and I abandoned it and hired a steam thrasher, which, by giving the cylinder a high motion, succeeded in obtaining 59½ bushels of seed. The thrashing machine, however, not having any regular flax screen, necessitated my running the seed through a fanning machine. Had a suitable flax thrasher been available, much extra cost would have been saved. This hygrometric condition of the fall months also affects the retted straw, rendering the shive tough and adhesive and hard to separate by hand process of scutching. It will therefore be necessary, when scutching mills are established to run continually in this climate, to have dry kilns to facilitate the work.

WATER RETTING.

In accordance with your instructions to have the flax thoroughly dry, I allowed it to stand in the shock for some days before hauling into the barn or having it retted. A small lot, however, I had put into the water, green, and forward a small sample showing the difference between green-retted flax and that retted after drying on the field. The Irish flax growers are very particular about this point, and endeavor, if possible, to get the straw into the retting pools the same day it is pulled. In this experiment, however, such a method would be impracticable, as it was necessary to save the seed and to weigh the straw, which required time to accomplish.

For retting I secured a chain of water holes about 3 feet deep, the water in which had been standing all summer and was soft and stagnant. The temperature of the water during retting varied from 56° to 68° F., with an average of 60°. In this pool I found the straw retted sufficiently, on the average, in ten days. Though some of the samples would have been better had they remained one or two days longer, for the reason that the pullers were not sufficiently skilled in the work to separate the straw, the fine from the coarse, at pulling, and the finer straw not retting so easily as the coarser, a want of uniformity resulted, which, however, was to some extent modified by the grassing. Some of the retted flax, after being taken from the water, was dried astride the fence, and other lots I had spread on the grass for a week or ten days. In the pool I used green alder poles and logs for keeping the straw submerged, which I think had some slight effect in darkening the fiber, though if so, only to a slight degree, as some samples, retted under the same conditions, came out of the water with a better color than others of the same lot. This, however, is a question requiring further experimenting to decide. Altogether I put three successive lots of flax in the pool, each lot being put in as soon as the other was removed—about four wagonloads in all.

DEW RETTING.

In accordance with your further instructions, to have some of the straw dew retted in the old-fashioned manner, I had one wagonload of straw spread on the grass on the 23d of August, having it turned three times during the process and taken into the barn dry on the 30th of September. I propose to have some samples of it broken, scutched, and hackled as soon as possible and forward you some samples.

RESULTS.

I have now on hand, subject to your order, 4,857 pounds of fine quality clean straw, from lot 1, not retted; 4,447 pounds, from lot 2, not retted; 1 ton (estimated) from lots 3 and 4, not retted; one-half ton (estimated) dew-retted flax, from lots 3 and 4; 1½ tons (estimated) water-retted flax, from lots 3 and 4. I have also 23 bushels of acclimated seed from lot 1, 21 bushels from lot 2, and 14½ bushels from lots 3 and 4. This seed pulled in the dough stage, but good for seeding purposes. Also 1 bushel seed, cut when fully ripe, of lots 3 and 4, and 1½ bushels (estimated) of imported Riga seed left over from the spring.

The result of this experiment, though fairly successful from a European or ordinary American standpoint, is not fairly representative of the distinctive capacities of Puget Sound for fine flax production, and will require a further experiment next season, with the adverse conditions of this season's work eliminated, as we have now seed in hand and can have it sown in proper season.

MINOR EXPERIMENTS.

In addition to the above, I sent varying quantities of seed to fifty experimenters in different portions of Puget Sound, nearly every county being represented. These small experiments consisted of generally one-tenth acre plots, sown with quantities of seed, varying from 1½ bushels to 160 pounds per acre. To each of these experimenters I also sent blanks for recording details. I have received from several of these parties samples of their flax, and in three instances samples of dressed fiber, which I forward for your inspection. There are, however, a number of smaller experimenters, not sufficiently well educated to make complete returns, who will require a personal visit from me to collate their experience and details of investigation, and from whom important and valuable facts may be obtained. As these smaller experiments were arranged for testing the quality of fiber produced upon different qualities of land and under different thicknesses of seeding, I forward you samples of straw produced by some of them, many of which are of remarkably fine quality, although sown too late for best effects. In fact, several parties receiving seed too late declined to sow it this season, and either returned it to me or asked permission to retain it for trial, under better conditions, next season.

A. W. THORNTON, *Special Agent.*

WEST FERNDALE, WASH.,
October 11, 1895.

DETAILS OF DR. THORNTON'S EXPERIMENTS.

APPENDIX A.—*Account in detail of plot 1 of 5-acre experiment, Puget Sound flax, 1895.*

[One and one-quarter acres sandy clay loam river-bottom land sown at the rate of 2 bushels (120 pounds) imported Riga flax and without fertilizer on May 18, 1895.]

	Per plot.	Per acre.
Expenses:		
2 plowings, at $2 per acre	$5.00	
3 times harrowed, at $1 each	3.00	
Hauling seed, sowing, covering, and rolling	2.75	$8.56
	10.75	
Pulling, 78 hours, at various rates	[1] 14.53	11.68
Tying, 20 hours	[2] 3.37	2.70
Stacking, 5 hours	[3] .99	.82
Hauling to barn, 6 wagonloads, 5 hours, at 40 cents	2.40	1.92
Rippling seed and weighing straw and stacking in barn, 142 hours	[4] 23.29	18.63
	44.58	
	55.33	44.31
Rent, at $10 per acre	12.50	10.00
	67.83	54.31
Yield:		
Clean straw	4,857 lbs.	3,865 lbs.
Clean seed	23 bush.	17 bush.

[1] 50 hours. [2] 16 hours. [3] 4 hours. [4] 113 hours.

APPENDIX B.—*Account in detail of plot 2 of 5-acre experiment, Puget Sound flax, 1895.*

[One and one-fourth acres sandy clay loam river bottom land sown at the rate of 1½ bushels (90 pounds) per acre of imported Riga flaxseed without fertilizer on May 18, 1895.]

	Per plot.	Per acre.
Expenses:		
2 plowings, at $2 per acre	$5.00	
3 times harrowed, at $1	3.00	
Hauling seed, sowing, covering, and rolling	2.75	$8.75
	10.75	
Pulling, tying, and stacking, 152 hours	25.85	[1] 20.68
Hauling to barn 5 loads 5 hours, 40 cents	2.00	[2] 1.60
Rippling, weighing, and stacking, 121 hours	21.09	[3] 16.86
	48.94	
Rent, at $10 per acre	12.50	10.00
	72.19	57.89
Yield:		
Clean straw	4,447 lbs.	3,557 lbs.
Clean seed	21 bush.	16.8 bush.

[1] 122 hours. [2] 4 hours. [3] 96 hours.

REPORT ON RETTING EXPERIMENTS BY MR. FRANK BARBOUR.

In the summer of 1896, the year following Dr. Thornton's experiments in the State of Washington, a member of the firm of William Barbour & Sons, Hilden Thread Works, Lisburn, Ireland, visited the Puget Sound region of this State and inspected the flax straw produced by the Department's experiment. Request was made for a ton of this straw, to be sent to Ireland for retting and scutching on Irish soil, at the expense of the firm. The request was acceded to by the Department most willingly, though a condition was required that samples of the flax derived from the tests should be returned to the Department. Upon receipt of the straw a most interesting experimental test to ascertain the value of the fiber was made, and in due time a large series of specimens showing the results of the work were received by the Department. The report of Mr. Frank Barbour, which preceded the specimens, is so valuable a contribution to the flax literature of this country, affording as it does a most interesting study, that it is presented entire. The report is as follows:

LOT NO. 1.

This lot consisted of 910 pounds weight of straw, marked "Puget Sound flax, 2 bushels of seed sown to the acre." This lot was divided into two equal parts of 455 pounds each, which were numbered Nos. 1 and 3.

No. 1 was watered once. Put into the watering pond on June 17, in the evening; taken out on July 1, in the morning, being fourteen clear days in the steep. June 17 was dry, bright sunshine; the temperature of the water 60°. June 18 and 19, wet, cloudy, and dull; 61°. June 20, showery morning, fine afternoon; 62°. June 21 and 22, very warm, bright sun; 63°. June 23, dull, occasional showers; 62°. June 24, thunder, heavy rain, bright sunshine at intervals; 63°. June 25, bright sun all day: 63°. June 26. very warm; 68°. From June 27 to 30 the weather was very changeable, with strong winds and heavy showers; consequently the temperature of the water changed on June 27 to 67°, on June 28 to 64°, on June 29 to 62°, and June 30 to 61°. July 1, heavy rains all day; water 60°. After taking the straw from the retting pond it was set to dry in the fields in the usual way, but owing to the inclement weather on July 1, 2, and 3 drying was retarded. Fine weather on 4th and 5th enabled us to get the straw neatly tied up and stored. It took in all twenty days from the time we put it in the steep until we had it stored up for scutching.

The result of No. 1 lot is as follows: four hundred and fifty-five pounds of straw lost in the watering 18.46 per cent, which left 371 pounds of straw, which produced 60 pounds of scutched flax, 1 pound of tow and combings, and 7 pounds of scutched tow, which equals 13.18 per cent of flax and 1.75 per cent tow from the 455 pounds of dry straw.

The 371 pounds of straw yielded 16.17 per cent of flax and 2.15 per cent of tow and combings. Market value of the above flax is £55 per ton; combings, £18, and tow, £13. The hackling results of No. 1 flax is as follows:

6 pounds of dressed line worth 7¼d. per pound.
20 pounds of dressed line worth 8½d. per pound.
8 pounds of dressed line worth 12d. per pound.
2 pounds dressed line breakings, 5¼d. per pound.
3 pounds of first tool-machine tow, at 3d. per pound.
5 pounds of second tool-machine tow, at 3¼d. per pound.
3 pounds of third tool-machine tow, at 3⅜d. per pound.
2 pounds of fourth tool-machine tow, at 3½d. per pound.
3½ pounds of scutcher's tow, at 4d. per pound.

The 60 pounds scutched flax yielded as follows:

64.285 per cent of dressed line.
29.464 per cent of tow.
6.25 per cent of waste.

The percentages of the various qualities of line and tow produced from the 60 pounds are as follows:

10.714 per cent of dressed line, worth 7¼d. per pound.
35.714 per cent of dressed line, worth 8½d. per pound.
14.285 per cent of dressed line, worth 1s. per pound.
3.571 per cent of dressed line, worth 5¼d. per pound.
5.375 per cent of first tool-machine tow, at 3d. per pound.
8.928 per cent of second tool-machine tow, at 3¼d. per pound.
5.357 per cent of third tool-machine tow, at 3⅜d. per pound.
3.571 per cent of fourth tool-machine tow, at 3½d. per pound.
6.250 per cent of scutchers' tow, at 4d. per pound.
6.250 per cent of waste.

Lot No. 2.

This lot consisted of 790 pounds of Puget Sound flax, 1½ bushels of seed sown to the acre. We also divided this lot into two equal parts of 395 pounds each, and numbered them 2 and 4.

The No. 2 was watered once; the No. 4 twice. The No. 2 was put into the pit on June 17 and taken out on July 1, requiring 14 clear days for retting. The 395 pounds of straw produced 324 pounds of retted flax straw, showing a loss of 17.97 per cent in the watering. The 395 pounds produced 44½ pounds of scutched flax, 2 pounds of combings, and 8 pounds of tow, which equals 11.27 per cent of flax and 2.53 per cent of tow. Or, if we take it from the retted straw, it equals 13.73 per cent of flax and 3.08 per cent of tow and combings. The market value of this flax is £52 per ton, combings £18, and tow £13. The hackling results are as follows:

2 pounds of dressed line, worth 7¼d. per pound.
19 pounds of dressed line, worth 8½d. per pound.
2 pounds of dressed line, worth 12d. per pound.
2 pounds of dressed line breakings, worth 5¼d. per pound.
2 pounds of first tool-machine tow, worth 3d. per pound.
5 pounds of second tool-machine tow, worth 3¼d. per pound.
3 pounds of third tool-machine tow, worth 3⅜d. per pound.
1 pound of fourth tool-machine tow, worth 3½d. per pound.
2 pounds of sorters' tow, worth 4d. per pound.

The percentages produced in hackling are:

Dressed line, 62.5 per cent.
Tow, 32.5 per cent.
Waste, 5 per cent.

The percentages of the different qualities of line and tow produced are as follows:

5 per cent of dressed line, worth 7¼d. per pound.
47.50 per cent of dressed line, worth 8½d. per pound.
5 per cent, worth 12d. per pound.
5 per cent, worth 5¼d. per pound.
5 per cent of first tool-machine tow, at 3d. per pound.
12.50 per cent of second tool-machine tow, at 3¼d. per pound.
7.50 per cent of third tool-machine tow, at 3⅜d. per pound.
2.50 per cent of fourth tool-machine tow, at 3½d. per pound.
5 per cent of sorters' tow, at 4d. per pound.
Waste, 5 per cent.

LOT NO. 3.

The other half of the 910 pounds was watered twice. It was put into the pit for the first steep on June 17 and taken out on June 27, being steeped ten days in the retting pond.

After drying, it was put into the pond again on July 1 and taken out on the 9th, being eight and one-half days in the second steep. On July 1, 2, and 3 the weather was most unsettled and wet and the water only registered 61° each day. July 4 and 5 were very warm and dry, the water registering 62°. July 6 to 9 weather was very changeable, accompanied with heavy showers. On 7th the water registered 64° and fell to 61° on the 9th. The result of the lot is as follows: Four hundred and fifty-five pounds produced 389 pounds after the first watering, equal to a loss of 14.50 per cent. The 389 pounds produced 355 pounds of straw after the second watering, showing a loss of 8.74 per cent in the second watering.

The 455 pounds of straw yielded 65½ pounds of scutched flax, 1 pound of combings, and 7½ pounds of scutching tow, which equals a yield of 14.395 per cent of flax and 1.813 per cent of tow. The yield from 355 pounds of straw would show 18.45 per cent of flax and 2.32 per cent tow and combings. Market value of this flax is £69 per ton, combings £18, and tow £13.

The hackling results are as follows:

1 pound of dressed line, worth 7¼d. per pound.
10 pounds dressed line, at 8½d. per pound.
28 pounds dressed line, at 1s. per pound.
3 pounds dressed line breakings, at 5¼d. per pound.
3 pounds first tool-machine tow, at 3d. per pound.
5 pounds second tool-machine tow, at 3¼d. per pound.
3 pounds of third tool-machine tow, at 3⅜d. per pound.
3 pounds of fourth tool-machine tow, at 3½d. per pound.
3½ pounds sorter's tow, at 4d. per pound.

The percentages produced from the above 65½ pounds are:

Dressed line, 68.85 per cent.
Tow, 27.049 per cent.
Waste, 4.098 per cent.

The percentages of the different qualities of line and tow produced from the above lot are as follows:

1.639 per cent of line, worth 7¼d. per pound.
16.393 per cent of line, worth 8½d. per pound.
45.901 per cent of line, worth 12d. per pound.
4.918 per cent of first tool-machine tow, worth 3d. per pound.
8.916 per cent of second tool-machine tow, worth 3¼d. per pound.
4.918 per cent of third tool-machine tow, worth 3½d. per pound.
3.278 per cent of fourth tool-machine tow, at 3⅜d. per pound.
5.736 per cent of sorter's tow, worth 4d. per pound.
4.098 per cent of waste.

Lot No. 4.

Three hundred and ninety-five pounds was put into the first steep on June 17 and taken out on the 27th, after remaining ten days in steep.

After drying it was again put into steep for the second time on July 1 and taken out on the 9th; in all, eight and one-half clear days in the water for the second steep. The temperature of the water and state of the weather were the same as detailed in the description of No. 3.

The 395 pounds after the first watering weighed 334 pounds, showing a loss of 15.44 per cent in the first watering. After the second watering it weighed 304 pounds, or a further loss of 8.98 per cent. This 395 pounds of straw produced 47½ pounds of flax, 1 pound of combings, and 6 pounds of straw, which equals 12.02 per cent of flax and 1.77 per cent of tow, or, if we take it from the 304 pounds of retted straw, equals 15.62 per cent of flax and 2.30 per cent of tow combings. Market value of this flax is £60 per ton, combings £18, and tow £13.

The result of the hackling is as follows:

1 pound dressed line, worth 7¼d. per pound.
10½ pounds dressed line, at 8½d. per pound.
14 pounds dressed line, worth 12d. per pound.
2 pounds dressed line, worth 5¼d. per pound.
2 pounds first tool-machine tow, at 3d. per pound.
5 pounds second tool-machine tow, at 3¼d. per pound.
2 pounds third tool-machine tow, at 3⅜d. per pound.
1 pound of fourth tool-machine tow, at 3½d. per pound.
3 pounds of sorter's tow, at 4d. per pound.

The yield of hackling was as follows:

Dressed line, 62.5 per cent.
Tow, 31.818 per cent.
Waste, 5.681 per cent.

The percentages of the different qualities of line and tow produced are:

2.272 per cent dressed line, at 7¼d. per pound.
23.863 per cent dressed line, at 8½d.
31.818 per cent dressed line, at 1s.
4.545 per cent dressed line, at 5¼d.
6.818 per cent first tool-machine tow, at 3d. per pound.
11.363 per cent second tool-machine tow, at 3¼d. per pound.
4.545 per cent third tool-machine tow, at 3⅜d. per pound.
2.272 per cent fourth tool-machine tow, at 3½d. per pound.
6.818 per cent sorter's tow, at 4d. per pound.
Waste, 5.681 per cent.

The Puget Sound flax was all well grown and very carefully handled. It has been allowed to ripen a great deal too much before being pulled, otherwise this flax would have given a much finer fiber and been of much higher value. The double retting stands out very prominent in these experiments; the expense in connection with it is very trifling compared with the great results achieved.

If the flax is grown and manipulated under proper conditions, and by people who thoroughly understand the business, in Puget Sound, we are convinced that the cultivation of it would be of greatest importance and in a short time would rival the great Belgian district of Courtrai. We congratulate you on the success of this experiment, which is far beyond our expectations, and we believe there is a great future before the flax growers in the West of America.

FRANK BARBOUR.

LISBURN, IRELAND, *October 28, 1896.*

PRESENT STATUS OF THE AMERICAN FLAX-FIBER INDUSTRY.

It was found by the efforts of this office during the years of experimentation, from 1890 to 1892, that flax fiber and salable seed could be produced over a wide range of territory in the United States, though skill and experience must be acquired before the industry could be successfully launched on a commercial basis. Subsequent larger experiments demonstrated the superior advantages offered for this culture in certain sections, and suggested lines of experiment in others that might enable a practice to be developed that would open up new regions for successful culture.

Regarding the existence of favorable localities for the culture, a few words regarding climate may not be out of place. Much has been said by the opponents of American flax culture in the past concerning the hot, dry climate of the United States in comparison with the cool, moist climate of Ireland; but if the truth must be stated, the best flax is not grown in Ireland, nor is the best flax spun by the Belfast manufacturer produced by Irish farmers, but by the growers of Belgium. The best American flax known to the Office of Fiber Investigations was grown at Green Bay, Wis., where the average temperature for the three growing months was 54° F., and with abundant rainfall. The average temperature of Belfast, Ireland, for the same period was 52.2° F., and for Brussels, Belgium, 55.9° F. The temperature of St. Paul, Minn., near which superb flax was produced in the experiments of 1891, is only a fraction of 1 degree higher.

Studying the figures for humidity, we are enabled to make further interesting comparisons. For Brussels, Belgium, the average for the three growing months is 77.4 and the average annual 83. For Green Bay, Wis., average for three months 72, and for the year 77.9. For Cologne, Germany, the average for April, May, and June is but 67.1, and the annual but 74 (contrast with Green Bay), while for St. Paul, Minn., the averages are, respectively, 65.6 and 71. On the authority of an expert linen weaver, formerly of Belfast, the average humidity for that weather station is stated to be 70 to 72. The humidity of the

State of Washington, as indicated by data from Spokane, Olympia, etc., is found almost as great as of any foreign weather station reported; and from the fact that a fine crop of straw has been produced in "droughty Kansas," with an average of 28 bushels of seed per acre, by irrigation, we may infer that in localities liable to hot, dry spells in the growing season irrigation may be practiced with good results.

The temperature of the leading flax-growing sections of this country and Europe is practically the same, the average for four European weather stations being 54.3°, and for four in the United States 56.3°, or a difference of but 2 degrees. The humidity for the foreign stations given is slightly higher than for those of this country, though stations indicating greater humidity in the States named and near which fine flax can undoubtedly be produced could have been utilized.

Among important considerations the office has been able to demonstrate how utterly helpless is the farmer who would undertake the growth of flax straw and the preparation of the fiber unaided and alone, for there must be cooperation in this industry, the same as in the sugar-beet industry, or in butter and cheese manufacture as at present conducted by the creamery system. This subject, however, will be referred to at length on another page.

The status of the American flax industry at the present time can not better be summarized than by striking a balance sheet between the advantages and the difficulties in its establishment, for it can hardly be said as yet that we have a flax industry. The advantages are fertile lands, which in some parts of the country can be purchased, not rented, for less money per acre than an Eastern farmer spends in a year per acre for commercial fertilizers; the most improved and the best made implements and agricultural machinery in the world for use in producing the crop; intelligence and alertness in the farmer class, many of whom are well posted in all that pertains to scientific agriculture; the advantage of many localities in the country where good flax can be produced, and of some favored sections where a superior product can be grown; possession of a home market for several million dollars' worth of flax fiber—for when we can produce a home supply of fiber American linen mills will increase—and in addition to the supply for home consumption the possibility of a large foreign demand, due to the decline of flax culture in Europe; abundant literature relating to every phase of the subject, with fullest information regarding the proper practice to pursue;[1] and lastly, the present need for diversification in American agriculture.

The disadvantages are: The cultivation of a million acres of flax for the seed alone by shiftless practices, which must needs be unlearned,

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[1]Among the flax literature published by this Department. Farmers' Bulletin No. 27, on "Flax for seed and fiber," was especially prepared to give concise and practical information on this subject. This bulletin is sent free on application.

before cultivation for fiber can be attempted; too great reliance upon virgin fertility of the soil in newer sections; lack of skill and experience in the handling of a new crop; too much experience, as with some Old World flax growers who have settled among us, this being made apparent in nonadaptability to new conditions and requirements; the lack of several machines needed for economy in harvesting the crop, the most important being an improved thrasher and practical flax puller; the timidity of capital, partly through money stringency, partly through lack of confidence, but largely through lack of knowledge of what is required to start the industry, which must be the result of cooperation between grower and spinner; the inability to properly ret the straw when grown, due to carelessness, to lack of knowledge, and to the want of capital with which to secure the proper appliances for this important work, which is the most serious of all the drawbacks.

A serious drawback to the success of this industry is the general lack of practical knowledge regarding the standards of spinning flax by those who undertake experiments, as well as of technical knowledge in retting the straw when grown. Many superb samples of straw have been received by the Office of Fiber Investigations, which, with proper treatment, should have yielded a superior flax product, but from which only a harsh fiber, and, on this account, a fiber of inferior quality and little commercial value, has been secured. The truth of this is proved by samples in our collection from the same lots of straw, but retted and scutched by different operatives under widely different conditions.

These deficient samples show nothing but lack of experience, and, in some instances, carelessness, in the one operation of retting. The best commercial flax is produced by immersion of the straw in river water, with subsequent drying, and frequently with a second immersion. It is not necessary to further explain this operation, but the skill lies chiefly in being able to control the conditions under which the work must be accomplished and in the possession of good judgment regarding the proper time to take the straw out of the water, guided by the appearance of the straw and its action under certain manipulation in the hands. A previous knowledge regarding the temperature of the water and of its softness or hardness, or, in other words, its chemical constituents, and of the mechanical impurities that may be suspended in it, is essential, that adverse conditions may be adjusted or avoided.

Properly prepared flax possesses marked peculiarities, which are at once made apparent to the touch, to the smell, and to the eye. Salable flax must have brilliancy or "life," with softness or oiliness, and an odor which, though difficult to describe, is easily recognizable by anyone who has handled good flax. These points are of first importance, because upon the manner in which the crop is retted its commercial value largely depends. Much has been written concerning quick-retting processes—that is to say, artificial processes, chemical or otherwise—by means of which to lessen the labor of "nature" retting (that is, dissolving out the gums by the natural operation of steeping or soaking), but considering the fact that the great bulk of the world's commercial flax is "nature" retted, it may be assumed that this form of producing the fiber gives the best results. In the present age of scientific investigation it would be unwise to say that a quick-retting system which will give as good results as the nature method is not a possibility, but in any event, when such a system is assured, the flax producer can study the question for himself and decide which method he will employ.

STATEMENTS OF YIELD.

The usual yield per acre of flax in Ireland ranges from 450 to 600 pounds, the average for four principal counties in 1890, by calculation, being 475 pounds.

In Mr. Henry Wallace's report on Irish culture, made to this office in 1892, some interesting figures are given regarding cost of production, which also afford a hint in relation to yield. The first statement refers to a farm of 60 acres at Kilrea, County Londonderry:

	Per acre.
Plowing	$2.00
Seed (8 pecks)	6.00
Sowing, harrowing, etc	2.00
Weeding	.62½
Pulling	3.00
Steeping, watering, and lifting	2.25
Mill-dressing	12.00
Rent of land	12.00
Total	39.87½
Yield per acre ... pounds	600
Cost per pound	$0.6⅔

The second refers to a farm of 150 acres in Movenis, Garvagh, County Derry:

	Per acre.
Plowing	$2.50
Seed	5.50
Sowing, harrowing, and cultivating	5.00
Pulling	2.00
Steeping, watering, and lifting	4.00
Mill-dressing	11.25
Rent	7.50
Total	37.75
Yield per acre ... pounds	630
Cost per pound nearly	$0.06

Mr. Wallace says that three-fourths of the farms in Ireland are small, under 40 acres, and a long rotation, which is essential, necessitates small fields, and as a result 75 per cent of the flax crop is grown in fields of 2 acres or under. The cultivators of these small farms keep few book accounts, and the labor is performed mainly by their families, much of it by boys and girls whose labor would have little market value; and if the work can be done by boys and girls who have nothing else to do, the farmer is disposed to attach little value to the labor, and hence it too often happens that he continues to grow a crop which would be grown at a loss if there were full market value attached to the labor employed.

There are few available statistics derived from recent experience in this country to which reference may be made, but undoubtedly our farmers will be able to make a better showing than Irish farmers, because the Irish practice, for the most part, is shiftless in the extreme. Fifteen per cent is a fair average yield in considering the quantity of fiber that may be derived from a ton of straw, and Mr. Bosse has produced in Wisconsin and Minnesota 3,000 to 4,500 pounds of straw per acre with the seed removed, a yield of 10 bushels of seed per acre at the same time being usual. This straw was worth at the mill from $10 to $12 per ton. Mr. Bosse had from 500 to 800 pounds of clean long fiber per acre, which was sold at 10 to 12 cents a pound. The result of his cultivation of 6 acres of flax at Green Bay, Wis., makes a good showing, though it should be stated that Mr. Bosse had had years of experience in the culture before coming to this country. Mr. Bosse says:

The 6 acres of flax grown on my farm last year, and referred to in the Gazette of Green Bay, February 3, were sown the 1st of May, 1889, with 1½ bushels per acre of Belgian seed (which I consider the very best for this country). I pulled it by hand a little before ripe; let it dry standing on the ground for eight days; then bound it with rye straw, and sheltered. I thrashed it by hand and spread it on land already harvested, and let it ret by dews and rains: then stacked it in the barn again, but bound this time with its own straw. I scutched it by the old system (breaker and knives, still the best in use when the work is done by skilled scutchers). The soil is a black loam mixed with black sand about 10 inches deep, with red clay for subsoil. The result was as follows:

Sowed 9 bushels Belgian seed, at $1.50 per bushel		$13.50
Pulling by hand		32.59
Binding and sheltering		5.00
Thrashing by hand		20.65
Retting on the ground		19.40
Scutching		120.83
Shipping		10.00
Freight to Boston, about		30.00
		251.97
Product:		
60 bushels seed, valued at $1	$60.00	
600 pounds tow, 2 cents per pound	12.00	
3,718 pounds fiber, at 11 cents per pound, as offered by manufacturers, Ross, Turner & Co., Boston	408.98	
		480.98
Net profit		229.01

See also Dr. Thornton's report upon the experiments of this Department in the Puget Sound region of the State of Washington, on page 62.

While a grower who disposes of his crop in the form of straw receives much less for his product than the man who rets the straw and turns it into fiber, it should be borne in mind that the grower in the first instance relieves himself of considerable extra labor and expense—and oftentimes the possibility of failure—which would largely offset the advantage of the better prices he might receive for the crop in the form of fiber. To the farmers of America, who for the most part have little knowledge of the operation of retting, and little capital to invest in scutching mills, with little or no experience on anything beyond culture, the safest course will be to grow the straw and sell it by the ton to the scutch mill; and one good scutch mill in a community will consume the product of several hundred acres of flax straw grown by the farmers of the neighborhood.

VARIETIES OF IMPORTED FLAX.

The following statement concerning the kinds of flax imported into the United States, with the names and marks of grades, has been prepared for this Department by Robert B. Storer & Co., Boston, Mass.:

Russia: Russian flax is known as *Slanetz* (or dew retted) and *Motchenetz* (water retted), and the shipments from St. Petersburg are largely of *Siretz*, or ungraded kinds of the several districts. The flax from these districts is known under the name of Bejedsk, Krasnoholm, Twer, Kashin, Gospodsky, Nerechta, Wologda, Jaraslav, Graesowetz, Kostroma—all *Slanetz*. The *Motchenetz* sorts are Pochochon, Ouglitz, Rjeff, Jaropol, and Stepurin. From Archangel are shipped *Slanetz* sorts, known as First Crown, Second Crown, Third Crown, Fourth Crown, First Zabrack, and Second Zabrack. From Riga shipments are entirely of *Motchenetz* sorts and the marks are graded from the standard mark K, the others being HK, PK, HPK, SPK, HSPK, ZK, GZK, and HZK.

Holland: Dutch flax is graded by the marks $\frac{I}{V}$, $\frac{II}{V}$, VI, VII, VIII, IX.

Belgium: Flemish flax (or blue flax) includes Bruges, Thissalt, Ghent, Lokeren, St. Nicolas, and is graded $\frac{II}{IV}$, $\frac{I}{V}$, $\frac{II}{V}$, VI, VII, VIII, IX. Courtrai flax is graded $\frac{I}{III}$, $\frac{II}{III}$, $\frac{I}{IV}$, $\frac{II}{IV}$, $\frac{I}{V}$, $\frac{II}{V}$, VI. Fernes and Bergues flax is graded A, B, C, D. Walloon flax is graded II, III, IV. Zealand flax is graded IX, VIII, VII, VI. Friesland flax is graded D, E, Ex, F, Fx, Fxx, G, Gx, Gxx, Gxxx.

France: French flax is known by the districts of Wavrin, Flines, Dourai, Hazebrouck, Picardy, and Harnes.

Ireland: Irish flax comes as scutched and mill scutched, and is known by the names of the counties where raised.

Canada: Has no standard of marks or qualities.

COOPERATION WITH CAPITAL ESSENTIAL.

This leads us to a practical consideration of the means by which the flax fiber industry must be established in the United States. But before reviewing the part that capital must play in the establishment of this industry, it will be well to review the scheme of cooperation in the different branches of the industry that the Department recommends as essential to making flax culture in the United States a possibility.

As the case stands, the farmer is hardly in position to grow flax, save in an experimental way, until he is sure of a market, and the manufacturer—that is, the spinner—is not in a position to make offers of purchase or to name a price, because he is not sure that the farmer can grow flax of the proper standard or that he can afford to purchase at any price, for his particular manufacture, such flax as the farmer may produce. This simply means that what isolated farmers can not accomplish alone must be accomplished by the establishment of little local industries—that is to say, capital must establish scutch mills in localities where flax may be profitably grown, farmers of the neighborhood agreeing to produce 5, 10, or 20 acres of straw each, under the direction, if need be, of the managers of the mills, to insure the growth of a quality of straw that will give the proper standard of fiber. It means that there is a necessity for a class of skilled workers who will come between the farmer and the manufacturer in carrying on the operations of retting and scutching. It is futile to expect the farmer to ret and scutch his flax. It is not done on the farm in foreign countries, nor in Canada, save to a very limited extent, and it will not be done here. It is done largely in Russia, and low-grade fiber requiring most careful sorting by the buyers is the result. By such a cooperative arrangement the farmer is relieved from any responsibility in the matter further than to produce a proper crop of straw. The scutch mills or tow mills attend to the retting and cleaning of the fiber, which in turn is sold to the spinner. One good scutch mill will prepare the flax grown on a score or more of farms, and as the work is accomplished under one direction, the product will be far more even as to standards than would be possible were it prepared by twenty men. The scutcher has a money interest in the matter of the production of properly grown straw by the farmer and is in position to aid him by many hints and suggestions. In Canada and northern Michigan (in the neighborhood of Yale, where there are successful scutch mills) the practice is to sell the seed to the farmers at the mills at a fixed price per bushel, the farmers agreeing to sow a certain number of acres to flax, the straw of which the managers of the scutch mills agree to take at a fixed price per ton, in some cases $10 being named.

Having shown the part that capital must perform in this work, the slow advance that has been made in establishing the industry will begin to be appreciated. One of the chief reasons why beginnings have not been made in favorable localities is that the necessity for such cooperation is not understood. The employment of capital in a thoroughly systematized effort to work out a fixed idea to a practical end is one thing, but the organization of a mere "company," with no definite aim beyond a desire to make money out of something, is quite another thing. The capital invested should be home capital, used in the town where the flax is grown by establishing and running a retting and scutching enterprise to turn the farmers' straw into a salable fiber product. The moneyed men of the town may be the stockholders in this enterprise, or the farmers themselves, with a few business men of their community, may establish and conduct the business, the main essential being to secure as superintendent of the mill a practical man—that is to say, one who thoroughly understands retting and scutching flax.

Such men are not readily available; the farmers themselves do not always know just where to begin, and it is not to be wondered at that capital has been "shy," particularly in a period of money stringency such as the country has experienced in the past few years. Some one person in the community must take the initiative, but it should be said most emphatically that only failure will follow the efforts of the man without knowledge whose energy is directed toward selfish ends alone. It is unfortunate that many worthy enterprises in this country have not been able to survive the "boom" stage, for instances might be recorded where a good, healthy beginning in a new industry has been stifled—"boomed" to death—by claims that could not be substantiated, by the advertising of profits that could only appear on paper, and by the heralding of success before it had been assured. The effort to set the flax industry on its feet has not been exempt from this injurious practice, and too often harm has been done in spite of perfectly honest intentions on the part of those who were responsible for the agitation.

CONDITIONS FAVORABLE FOR SUCCESS.

Enough has been demonstrated to prove that little more remains to be done than to bring farmers and capital together for the establishment of small local cooperative enterprises in regions favorable to culture. In this work the Government can do nothing further than to point the way, to explain the difficulties, and give information to those who do not know how to take the first step.

There is no doubt about our ability to grow commercial flax if the people will only make beginnings, and go to work in earnest, with the idea in view first to establish the industry and to make money out of it afterwards. The time is ripe for the establishment of the industry, as is proved by the profound interest that has been awakened in our experiments by foreign manufacturers. The Barbour Company, of Lisburn, Ireland, surely did not transport a ton of the Department straw from the State of Washington to their Irish mills, and ret and scutch it at their own expense, from pure philanthropy, whatever good will may have been shown in making the experiment. During the past three years the Department has had many letters and inquiries from buyers of flax fiber in Europe; and putting all these straws together, the fact is evident that the wind is blowing in our direction, and that we shall be the losers by not taking advantage of the opportunity while it is in our grasp.

This report can not be closed without another reference to the splendid success that may be made of this industry on the Pacific Coast with a little organized effort. The State of Washington is losing a golden opportunity, though her sister State, Oregon, is doing noble pioneer work in the interest of this industry. The culture in Oregon which was taken up last year by Mrs. Governor Lord and the Oregon Woman's Flax Fiber Association has already attracted the attention of the Old World, and the fact that the association has this season been enabled to sell 2 tons of flax in Scotland at more than double the prices offered by American spinners should prove a convincing argument in favor of the future success of this industry on the Pacific Coast. In the face of untold discouragements this association is doing good work; and if there is anything in energy, persistence, and philanthropic endeavor, a commercial industry will surely be developed in the State of Oregon, and a spinning mill is a logical sequence.

CONCLUSION.

The flax plant is now widely distributed throughout the world. It is cultivated in portions of South America, especially in Argentina, though more for seed than for fiber. It is produced commercially to a greater or less extent in Great Britain (Ireland especially), Sweden, Denmark, Holland, Belgium, France, Russia, Germany, Austria, Spain, and Portugal. It has been introduced into Algeria and into Natal. In India large tracts are under cultivation, though more for the seed crop than for fiber. Japan has introduced its cultivation commercially, and it has been experimented with in the Australian colonies, where there is a wide range of soil and climate suited to its growth. For the present, however, our serious competition must be with Europe, and Europe has a failing supply. Is it not wisdom to begin at once, with a view to producing within our own borders the supply of raw flax fiber needed in the home manufacture of twine, flax threads, crash, and linen? The cotton-manufacturing industry is leaving New England for the South, and linen manufacture will eventually take its place, for the movement has already begun. The establishment of a linen-manufacturing industry in New England would soon create a demand for double the quantity of raw flax now consumed, and American farmers should supply this demand.