U. S. DEPARTMENT OF AGRICULTURE.

FIBER INVESTIGATIONS. REPORT NO. 4.

A REPORT

ON

FLAX CULTURE FOR FIBER

IN

THE UNITED STATES,

INCLUDING

SPECIAL REPORTS ON FLAX CULTURE IN IRELAND, IN BELGIUM, AND IN AUSTRIA, WITH STATEMENTS RELATIVE TO THE INDUSTRY IN RUSSIA.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE ASSISTANT SECRETARY,
Washington, D. C., June 1, 1892.

SIR: I have the honor to transmit herewith, for your approval, the report on flax culture for fiber in the United States, which has been prepared under my direction by Mr. Charles Richards Dodge, special agent in charge of the fiber investigations of this Department. In view of the widespread interest in this industry, as evidenced by the numerous inquiries received, I take pleasure in recommending its early publication.

Very respectfully,

EDWIN WILLITS,
Assistant Secretary.

HON. J. M. RUSK,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
Washington, D. C., May 31, 1892.

SIR: I have the honor to submit herewith the manuscript of Bulletin No. 4 of the Fiber Investigation series, referring to flax culture. The bulletin includes my own report on the flax cultural experiments and investigations directed by the Department last season, with some interesting statements relative to household flax manufacture in Virginia. It is supplemented by a special report submitted by Mr. Eugene Bosse, of St. Paul Park, Minn., who was appointed a special agent last season for a period of ten weeks, to visit flax-growing localities in the Northwest, and to instruct farmers as to the proper practice in the cultivation of flax for fiber. The report also includes a special report upon the flax culture of Ireland and Belgium by Mr. Henry Wallace, of Des Moines, Iowa, who was commissioned by the Department last season to visit the countries named in the interest of the flax industry. Another valuable special report, which has been prepared by United States Consul Hawes, of Reichenberg, Austria, relates to the flax culture of that country.

In order to supplement the literature of the subject relating to European culture, as embodied in this and former fiber investigation reports, I have given in the form of an appendix a few facts regarding the industry in Russia, chiefly compiled from a report of Consul-General Crawford, of St. Petersburg, and made to the State Department last year. I have also appended some interesting statements with tables of acreage and production of flax products from the recently published Census Bulletin on Flax and Hemp, prepared by Mr. John Hyde, in charge of the Statistics of Agriculture, Eleventh Census.

I am, sir, respectfully yours,

CHAS. RICHARDS DODGE,
Special Agent in charge of Fiber Investigations.

Hon. EDWIN WILLITS,
Assistant Secretary.

FLAX CULTURE FOR FIBER.

At the time the first flax report was issued from the office of the 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, I regret to say, 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 I secured samples of flax grown twenty years ago, almost, 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, as is shown on other pages of this report.

If fine flax could be produced by the American farmers of fifty years ago there is no reason why the farmers of to-day can not do the same thing as far as soil and climate are concerned, though not by the 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 will hardly be 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 must be built up like a new and untried industry upon the foundation of experience.

A great deal has been accomplished in the past two years, however, in spite of the fact that but little flax has been grown for fiber. Some things have been satisfactorily demonstrated which two or three years ago were considered more or less matters of speculation, and some

experience has been gained. Capital has become interested, and several new manufacturing concerns have been established.

Inventors are studying the needs of the industry in the line of labor-saving devices for economically harvesting and saving the fiber, and the farmers themselves are interested, though hesitating to embark in this culture until better acquainted with existing conditions and the requirements of the culture. And it should be stated that a market which can be relied upon is essential. The time is propitious, as flax culture in the old countries is steadily declining, because under the antiquated and laborious methods of culture there in vogue, with the enormous rentals demanded for the land, flax culture no longer pays save in favored localities. With our cheap and naturally fertile lands, with the use of labor-saving machinery in all branches of the industry, and with a demand for the raw material from both the New and Old World, it is possible for the American farmer to supply a portion of this demand, and in the near future, with profit to himself. I have carefully studied the special needs of the industry during the past year, and these will be fully considered in their appropriate place on other pages of this report.

FIELD EXPERIMENTS IN 1891.

During the past season a series of interesting experiments in flax culture were conducted in various parts of the country, under the auspices of the U. S. 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, 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 sixty such lots were sent out in all. Up to the 1st of January forty 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.

One-fourth of the total number of replies were received from Minnesota, which State has taken the initiative in the reëstablishment of flax

culture in the Northwest, and which may be fairly termed the center of the new flax industry. The questions to which replies were desired are here reproduced:

FLAX-CULTURE INDUSTRY.

Q. 1. What varieties of flaxseed were experimented with?
(In naming these number them 1, 2, 3, etc.)
Q. 2. In what kind of soil was the crop grown?
Q. 3. What soil preparation was given?
Q. 4. What fertilizers were used and in what quantities?
Q. 5. What quantity of seed was sown to the acre? (If different quantities were sown and samples of the product are submitted, refer to each by label number.)
Q. 6. How was seed sown? If machine broadcaster was used, please name the make.
Q. 7. At what date did the sowings commence?
Q. 8. Was any attempt made to control weeds, and what principal weeds affected the crop?
Q. 9. At what stage in the development of the plant was the crop harvested?
Q. 10. How was the crop harvested and cured?
Q. 11. What was the date of the harvest?
Q. 12. Was the seed saved, and if so, how separated? What quantity of seed (estimated) was obtained per acre?
Q. 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.
Q. 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.)

Q. 15. If the retted straw was cleaned for fiber, please state how broken and scutched, submitting samples of same. (Name make of machines.)
Q. 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 I have no hesitancy in saying 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. The replies to questions 15 and 16, relating to manufacture, were not expected until the flax had been spun and woven, and at this date none of these have yet been received.

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 can be raised in the State, but that it will 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. I 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 this season, and will be more carefully conducted.

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. The special reasons for such a statement are given in the summary of the season's work on another page.

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 in the ground for about a week, and was doubtless injured, as the straw is very dark, the fiber showing little strength. A better report comes from the German Southern Land and Colonization Company, a corporation interested in settling people from Europe. Mr. Henry Lemcke, of Simpson County, says that the experiment was not successful in its entirety, owing largely to the lateness of the season when the seed was received. Mr. Lemcke says, 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 explains the reason of failure of the experiment at La Fayette:

> 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., comes 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 reports 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 closes with the statement that there is no reason why good crops in quantity may 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 says:

> 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 states that when the fiber can be marketed it will be one of the most profitable crops that can be grown in his section of the State.

Kansas (*Grosvenor Park*).—The results of this experiment are 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 sample of the products were received by the Department. The report ends 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., are 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 are favorable. The details of culture, with methods employed, etc., will appear in their appropriate place in another portion of the report.

The following are some individual opinions regarding the possibilities of flax culture in this State. Mr. A. Van Hemert thinks that the flax-fiber industry is to be 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 states that there is 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, has 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, thinks the culture of flax can be made very profitable when proper machinery is to be had to pull the flax and scutch the prepared straw. There is no doubt as to cultivation.

Nebraska (*Agricultural Experiment Station*).—The results were fairly successful. The agriculturist in charge of the experiments thinks there is a future for the industry in this State, though the hemp industry at present is creating more interest.

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 reports 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 makes a very interesting showing regarding the possibilities of this industry. The few failures, attributable to natural causes, indicate 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 requirement 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 ex-

periments 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, I can only say, judging from the straw submitted, in comparison with the samples grown east of the Rocky Mountains, that they are 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 are 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 my report on vegetable fibers, issued by this Department over twelve years ago, Oregon was especially named as a most desirable State for the growing of fine flax. The result of last season's experiments proves that the matter was not overstated.

Another point is 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.

METHODS OF CULTURE.

As has been stated over and over again in the reports of this Department, success in flax culture for fiber depends upon thoroughness and attention to the little details of practice. Three things are essential: A most careful selection of the soil with a thorough soil preparation and fertilizing; the use of the best seed that can be purchased; and, lastly, careful and intelligent handling and manipulation of the crop from the time the flax is pulled until the straw is ready for the operation of cleaning or scutching. The first two considerations only interest the farmer, the third consideration belonging properly to the manufacturing side of the industry, although some foreign flax farmers do pull and ret their crops.

In the present experiments the practice has been so varied, and in a majority of cases so purely experimental, in the absence of practical knowledge of the situation, that it would be unfair to the experimenters, and misleading to those who are seeking information, to touch,

even briefly, upon the methods pursued by each experimenter. I shall confine my statements, therefore, to those experiments where positive results have been secured, and where the line of practice followed has been most systematic and thorough from the practical flax-growers' standpoint. The varied steps in the industry will therefore be considered under their appropriate heads.

SOIL SELECTION.

The Belgian flax farmer selects 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 a heavy clayey soil it gives greater length, though at the expense of fine fiber. In Ireland, any clean land, in good state of fertility, that will produce a good crop of wheat, oats, or barley is considered suitable for flax. On heavy soils the Dutch seed is thought to give the best results, while Riga seed is sown upon the light or medium soils. See also what is said of soils in the report on the flax culture of Austro-Hungary, in this bulletin.

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.

Mr. Lemcke, speaking for Kentucky, lays stress upon the good results 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 by "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. Plat I, upon very sandy land, tile drained, showed "surprising results" as far as growth was concerned, in some respects being equal to Plat II, 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 the present 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 shows the selection of soil varying 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, I was shown by Mr. Bosse 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 I do not think was 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 advocate 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 I have 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.

PREPARATION OF THE SOIL.

It will not be necessary to go over the whole ground of practice followed in the different States, as a few general statements will cover all. In many instances too little attention has been paid to the importance of deep plowing and reducing the seed-bed to the proper tilth. Many foreign flax-growers urge that the land should be fall plowed, though there are some who are of a different opinion, but it is recognized by all that the land should be brought almost to the condition of garden soil before the seed is sown. On small tracts of a few acres this is accomplished by spading over the land, although such laborious methods will never be practiced in this country, nor are they necessary with the improved implements which are found on every American farm.

For this country I would advocate deep fall plowing, 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, pre-

sent 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.

Enriching the land.—A crop of flax that will scutch out good fiber can not be produced on impoverished lands. In Belgium and other flax-growing countries, where land has been under cultivation for generations, no half-way measures are followed in this matter of keeping up the fertility of the soil. Here is an extract from my report upon Belgian culture, bearing upon this point:

> 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, and to g over the ground with the liquid night-soil in addition.

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.

In the experiments of last season the crops grown on old lands, especially in the East, were properly enriched, and a fair product was the result. It is interesting to note, however, that the fine product received from the Oregon station was grown on soil without manure that had produced four or five previous crops of wheat since cleared of timber. No manures were used in the California experiment, though other conditions are not stated. In the larger number of experiments reported

for the Northwest no fertilizers were used. Doubtless better results would have been secured in some instances if more attention had been paid to enriching the soil. Here are some extracts from the reports secured from those stations where fertilizers were used:

Massachusetts.—Five cords per acre of strong 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 plat I was fertilized with 880 pounds of plaster and 10 bushels of common salt per acre; the remainder unfertilized. One-half of Plat II 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 Plat III 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 Plat IV no fertilizers were used.

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

Regarding the use of stable manure, it should be stated that well-rotted (composted) manure is preferable to the coarse barnyard manures, which are liable to make rank growth at the expense of fiber. Another reason for using well-rotted manures is to avoid fouling the crop with weeds, as the coarse manures are liable to be filled with the seeds of weeds which germinate and grow with the flax. Dr. Ure formerly recommended a mixture of 30 pounds of bone dust, 28 of common salt, 34 of burnt gypsum, 54 of bone dust, and 56 of magnesia, which it was claimed would replace the constituents of an average acre of flax.

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. This is very similar to the formula given by Dr. Ure above.

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. Proctor's report upon flax and hemp culture in Kentucky,* taken

* Geological Survey of Kentucky, published about 1880.

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	Steep water	55	9 6	1 12 7	51	714

And where flax is pool retted, it is 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 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.

As the Egyptians were unable to make good bricks without straw, it is equally impossible to make good flax straw where the soil does not contain the proper plant food; if the elements of fertility are wanting they must be supplied. And above all do not talk of flax being an exhausting crop as long as the practice of taking everything and returning nothing to the soil is pursued. Under such a method of culture, continued even for a very short time, the crop can only be an exhausting one.

ROTATION OF CROPS.

In the circular of inquiries, this point was not considered, and in only a few instances were statements made showing what crops had previously occupied the land for one year or a succession of years. There are as good reasons for following a rotation in this country as in foreign countries, even if little attention is paid to such a practice by the majority of farmers. The danger referred to above, of exhausting the soil, is lessened, even where the fertility is not fully kept up, by some systematic arrangement as to the crops which precede or follow.

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 Belgian farmers are particularly careful in this matter. Regarding the precise order of rotation and even the length of time between two growths of flax on the same land in Belgium, 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 several 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.

There is little in the reports of last year's experiments bearing upon this subject, though a few mention preceding crops. 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 SOWN.

As to quantity, 1½ to 2 bushels per acre is the smallest that should be sown, 2 bushels coming nearest the mark. When sowing for seed alone 2 or 3 pecks will suffice. In the experiments of the last season the range is from 3 pecks to 2½ bushels. Mr. Bosse, 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, 2½ 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 2½ bushels should have been sown. A full series of samples were received with this report, nine in all, which are interesting. These have not yet been examined, comparatively, though the best of the straw is 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 1½, 2 bushels having been sown in the Sioux Falls Linen Mills experiment. The range in other instances is from 3 pecks to 1½ bushels, 1 bushel or less being the quantity reported in a majority of cases. I would say to the Minnesota experimenters if they hope to see this 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. The amount of seed sown in Belgium 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 it is early; at any rate, when planted too thickly, as is sometimes the case, it is afterwards thinned, though such a practice adds to the cost of production. Finer fiber is obtained from early sown flax than from later sown.

SOWING THE SEED.

Owing to the tardy arrival of the seed imported by the Department last season the sowings were late for more southerly stations. Others put off the sowing until too late for best results, in some instances failure following on account of drought overtaking the crop when the plants were small. In the Massachusetts experiment the seed was all put in April 29, and in the experiment by James Thompson & Co., New York State, April 30. In Connecticut it was delayed nearly two weeks and at the New York Experiment Station fully three weeks later; Maryland Station, May 4, which was late; Kentucky, April 29, late for this section; Ohio, sown April 30; Indiana from May 10 to 15, quite too late. At the Experiment Station the crop failed altogether on account of successive dry weather. Illinois Experiment Station sown April 24; Missouri Station May 23, late, though good results were secured. At Yale, Mich., the seed was sown April 20, and at the Michigan Agricultural College from May 10 to 25, the latter date being late. The sowings in Minnesota were from May 10 to June 1; Oregon, May 18, and California April 25.

It would be difficult to name precisely the proper time to sow flaxseed in the different States where flax culture is possible, especially as seasons differ in earliness. 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.

Mr. A. Van Hemert, writing to the Department from Grand Meadow, Minn., says:

> No definite rule can be laid down as to which time in the spring is the best to sow flax, atmospherical conditions governing the growth to a great extent. I consider for myself the first part of May is the best time for seeding it.

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. Proctor 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.

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. And after the seed has germinated, sometimes after it has sprouted, the land is rolled. The implements named in the reports of last season's experiments are 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.

WEEDS.

The growth of weeds will be one of the chief obstacles to successful flax culture in this country. It will be impossible to follow foreign methods of ridding the soil from weeds, as the work is done principally by women and boys, who go over the ground on their knees, picking out the weeds by hand. This work is done usually when the plants are 1 and 2 inches high, though a second and sometimes a third weeding is found necessary. The American flax-grower must avoid the labor of weeding by having clean land, or as nearly clean as possible with careful culture. In this connection reference is made to statements on the subject of rotation, on a preceding page. A practice in vogue in this country by former flax farmers, where the land was much troubled with weeds, was to allow it to lie after being put in condition for sowing until the weeds appeared. Just before sowing a light harrow run over the ground destroyed the large proportion. Where weeding became necessary it was performed when the plants were less than 5 inches high. Mr. Todd,

a practical flax grower in New York State, some years ago advocated for the removal of the coarser noxious weeds, like thistles, dock, etc., to send a man into the field shod with three or four pairs of woolen stockings to avoid injury to the young flax by treading it into the soil—this to be done when the plants are about 8 inches high. In the operation of weeding some attention should be paid to the condition of the soil, as it must be neither too wet nor too dry. On clean soil but one weeding will suffice, but sometimes others will be necessary.

The experience of last year in this particular is sufficiently interesting to give a few extracts from the replies:

Massachusetts Experiment Station.—The worst places once handwed. *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. Rag-weed and so-called rag-weed were named especially.

Kentucky Experiment Station.—Weeds gave little trouble.

Ohio Experiment Station.—The only weed that was particularly detrimental was the bind weed, *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 to any marked degree was "smart weed." No weeds 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 THE CROP.

In Flanders, and throughout Belgium as well, the seed is of secondary importance, and therefore to obtain as strong and fine 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 in June, sometimes a little earlier, for, as the old proverb runs, "*C'est Juin qui fait le lin*" (June makes the flax).

Mr. John Orr Wallace, writing of the practice in Ireland, says, "When the straw begins to turn yellow and the foliage within 6 inches of the ground is drooping, pull at once." To the suggestion that when the seed is saved the fiber is coarse, the same authority says:

> About the fiber being coarse if the seed is saved, this will not be the case if the flax straw is pulled before being too ripe and hard. In France and Belgium our spinners get the finest fiber, and the growers there save the seed.

In the experiments of the past season not more than half of the flax was pulled at the right time, and a little of it was so overripe as to be almost worthless. At the Massachusetts Station the 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" largely. This flax was pulled at the right time.

It is not necessary to produce the experience of the other cultivators. Suffice it to say, that where a good sample of flax straw had been submitted the report that accompanied it showed that careful attention had been given to the matter of harvesting when the straw was in the best condition.

As to the special mode of harvesting the crop, nearly every experimenter states that the straw was pulled. This is not the usual practice of the western flax grower who cultivates for seed, however, and it has been urged that it is absolutely essential where the object is to produce both fiber and seed; or, to state it more precisely, when the object is to produce a common grade of fiber and at the same time save the seed. If the land surface is made very smooth so that the knives of the reaper may be set low, cutting by machine (rather than pulling) may answer. Several inches of the best portion of the stem will be lost, and the square ends of the fiber will not work into the "sliver" as smoothly as pulled flax when the fiber is being manipulated in the first stages of manufacture. A flax-pulling machine is a desideratum, and for the past two or three years inventors have been attempting to work out the problem. The Department has knowledge of four inventions in this direction, one of which, patented by Mr. A. C. Lamar, of St. Paul, Minn., has been recently placed on the market, after careful field trials.

After all has been said, pulling is essential to the production of fine fiber. If pulled by manual labor, the course is to draw the handful of straw out of the ground, and by striking the roots against the boot the earth is dislodged. The straw is then laid in handfuls, crossing each other, so as to be readily made into bundles. In Belgium the method is as follows:

The flax is pulled with great care, the ends being kept very even, and the straw laid in handfuls upon the ground, a line of straw being first laid down, which serves to bind these handfuls when a sufficient quantity has been pulled to tie. When put into stooks to dry, the seed ends being tied together, the bottom ends are opened out, giving to the stook the appearance of an **A** tent. After drying in the stook the handsful of straw are then tied into small bunches 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 "hedge" in form.

SEASON OF GROWTH.

An examination of answers to the questions relating to the duration of time that the crop was in the ground shows 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 reports 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 has been used the past season 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 this season.

In the field experiments of the year 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 flax seed growers.

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. The reports relating to this portion of the work have not yet been received, as it is intended to carry the fiber through to manufacture. 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. This brings us to an important consideration which may be called one of the most urgent needs of the flax-fiber industry in the United States. Something more is required to set the industry on its feet than for a body of farmers to undertake to grow the plant for fiber. There is necessity for a class of skilled workers who shall come between the farmer and manufacturer in carrying on the operations of retting and scutching, or, in other words, the operations of soaking out the gums which hold fiber and woody matter together, and removing this woody core or shive by mechanical means. 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 can not be done here. It is done largely in Russia, and low-grade fiber requiring most careful sorting by the buyers is the result.

As the case stands now 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.

In Canada and in northern Michigan (in the neighborhood of Yale, where there are successful flax 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 (or tow mills) agree to take at a fixed price per ton, in some cases $10 being named.

This relieves the farmer from any other responsibility in the matter further than to produce a good crop of straw. The scutch or tow mills attend to the retting and cleaning of the fiber, which in turn is sold to the spinner. One good scutching mill will prepare the flax grown on a score or more of farms, and as the work is accomplished under one direction or head, the product will be far more even as to standards than would be possible were it prepared by 20 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.

To found an American linen industry, therefore, 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 I may so designate him, 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 recent tour of the linen fabric and flax twine mills of the country, I had the opportunity of examining several samples of flax submitted the present year 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 after-preparation. At the outset of the experiment of reëstablishing this industry there will be many such costly mistakes, and I would, therefore, caution the would-be flax farmer to go slow. Let him put in only a few acres of flax seed (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.

Beginnings have been made in this direction by the formation of several flax fiber companies in the Northwest, who purchase the straw when grown and attend to all subsequent operations. But this is only a beginning, and there is room for many more. The demand for home-grown fiber will steadily increase as the manufacturers gain confidence in the ability of the scutchers to produce a good quality of flax and are assured of a steady supply. 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.

I have already referred 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. There are

two ways in which this object-teaching may be accomplished: First, by visits of experts to the farms—these being either Government special agents or the agents of State governments, or of agricultural experiment stations; and, secondly, through the farmers' institutes.

During the months of July and August and part of September, Mr. Eugene Bosse, a Belgian flax-grower and scutcher of experience, a resident of the United States, was commissioned to visit 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 have been made in the present year's operations. I learn that 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 new 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.

SUMMARY OF RESULTS.

In question 14 of the flax circular the desire was expressed for an opinion favoring or in discouragement of the success of the industry, based upon a careful study of the season's experiments. These are given, without comment, as follows:

William P. Brooks, Massachusetts Station.—We can raise flax of fine quality without doubt; but it will not pay here. Weeding would always be necessary on rich lands and this, together with pulling, would cost a large sum. We have no cheap labor (boys or girls) in this section; all being more profitably employed in picking berries, weeding onions and tobacco, etc. Pulling our crop (weedy) cost $35, and there was no dallying. We have a number of money crops here which will bring in much larger returns than flax, such as fruits, tobacco, onions, etc. To establish a flax industry here is in my opinion wholly impracticable.

C. S. Phelps, Connecticut (Storrs) Station.—The chief difficulties in growing the crop are (1) the labor required in harvesting, and (2) the difficulty in finding land free from weeds. We favor experimenting on a small scale and on better soil than that used this season (1891).

I. P. Roberts (Cornell) New York Station.—From this and former seasons' experiments in flax culture I have no reason to believe that success can be obtained in this part of New York, at least not enough to induce even a small number of farmers to change their rotation or give up a part of their dairy and enter into the cultivation of flax. About twenty years ago great inducements were held out to farmers to continue growing flax for both the seed and fiber. The straw delivered at the mill brought nearly as much per ton as hay. Seed was furnished to the farmers on very favorable terms, and yet the industry died out in spite of all fostering.

James Thompson & Co., Valley Falls, N. Y.—While we have been in a measure successful, we can not see, from the result of our experience, any encouragement for the industry in this section. We have raised a crop of fair quality, but it has cost us considerably more than it is worth. As the fiber has not been extracted we can not give any definite figures, but think the cost will be in the neighborhood of 11 cents per pound or about 2½ cents more than the market value. True, we had to contend against a very unfavorable season, the crop receiving hardly any rain until it reached maturity. Besides our labor the expense was probably 40 per cent larger than that of a farmer who farms it on a large scale. Nevertheless, the uncertainty of our climate and the impoverished condition of the soil, on most farms in this section, are factors which will effectually prevent the culture of flax. We have already alluded to the disappearance of the flax mills, whereas fifteen years ago a mill of this kind could be seen every few miles. Our crop was grown on exceptionally good and well prepared soil. The No. 3 variety did considerably better than the other two kinds, but we attribute this mainly to the fact that it grew on the lowest and therefore

wettest part of the field. We had grown hemp on the same ground the year previous, which crop proved a failure because of drought. We wish to mention a matter or two, which may be of interest, though irrelevant. After the crop of flax had been taken off the field we plowed the ground and put in a crop of fodder corn July 30, the net value of which was about $30, or $20 per acre when harvested two months after. Among the corn some flaxseed had been accidentally dropped from the first crop and several handfuls grew to maturity of this second crop, which because of favorable weather grew to greater length than the first crop. We mention these facts merely to show what can be done by care and judgment and keeping soil in good condition.

Henry A. Alvord, Maryland Station.—On soil reasonably fertile there is no doubt that flax would make a good crop in Maryland. Economical methods of cultivating and securing are needed.

J. F. Hickman, Ohio Experiment Station.—Can only say that our land will produce a fair yield of flax, but quantity is not success if the quality is not good, and I have no means of judging on the latter point.

J. W. Pierce, Peru, Ind.—From close observation of flax culture I have no unfavorable or discouraging report to make, and as to the full success of this industry, I firmly believe, were the farmers of America to give this branch of agriculture a complete study, good paying results would come forth, and I believe it is only a question of a few years when the flax industry will be one of the paying ones of our American farms.

G. E. Morrow, Illinois Station.—The growth was slightly affected by young apple trees, and more by an unusual drought. The yield was light. That of straw and seed was (approximately) No. 1, 1,700, No. 2, 1,500, and No. 3, 4,300 pounds per acre. There is no reason why good crops, in quantity, may not be grown here.

W. L. Harvey, Michigan Station.—In regard to the possibility of growing flax in this State as a profitable farm crop, I must say that it is very good as far as this season's operations go. The one thing we lack, however, is a very essential and indeed indispensable factor in its profitable culture. I refer to a good market. But no doubt after the farmers and the capitalists of the State learn that it can be profitably grown here, the farmers will raise it and the capitalists start the necessary factories.

James Livingston & Co., Yale, Mich.—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 dry cold spring it is poor in quality, the straw being thinly coated with fiber and very towey, which you will observe by sample of scutched flax, we will send later on. At our Croswell mill the flax is very poor, owing to an unfavorable season for lack of rain in June, the principal cause. As to the seed and quantity sown on the ground our experience has been that 70 pounds per acre is sufficient for any land that we have seen in this country, but we sowed the No. 1 seed to your instructions and think it entirely too much, as will be seen by sample we send you. We have imported Holland seed for years until last year and we find it the best in fiber, but it does not yield as much seed as some others.

Zettel Brothers, Jordan, Minn.—Our opinion is that in this section flax should be sowed early, about the 15th to the 20th of April, as May and June are generally so dry that no grain has moisture enough to sprout. It was the same with late oats this year as with flax. Had we sown our flax earlier, when there was moisture in the ground, then we would have obtained a splendid crop. In our estimation the Riga grown in Belgium and the White Blossom Dutch are the best kinds for here, as they seem to stand the drought better.

M. D. Ridgway, Minneapolis, Minn.—Think the culture of flax can be made very profitable as soon as proper machinery is to be had to pull, thrash, and properly scutch the prepared straw.

McMillan & Hastings, Oakland, Minn.—For our land it is unquestionably a profitable crop. We hope to put in 300 to 500 acres another season.

Eugene Bosse, St. Paul Park, Minn.—A fraction of an acre of each variety was set apart, the product of each plat very carefully weighed for each operation, with the following results reduced to the equivalent of one acre, estimated. The following table is appended:

Variety.	Unthrashed.	Thrashed.	Retted.	Seed.	Fiber.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
No. 1 Riga	5,771	3,712	2,835	742	742
No. 2 Belgian	5,619	3,780	2,900	607	810
No. 3 White Blossom Dutch	4,421	2,900	2,126	911	523

A. B. Duncanson, Nebraska Station.—I am confident that flax may be grown successfully and in paying quantities and qualities in Nebraska. However, the hemp industry is creating more interest. I do not know enough about either the flax or hemp industry to say whether or not there may be any antagonism between the two.

H. T. French, Oregon Station.—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 fertilizer.

E. W. Hilgard, California Station.—In our opinion flax culture would be successful in California.

Looking over the whole field of experiment, considering the limited knowledge of the experimenters in many instances, and in connection with a study of the specimens of the product submitted, the results have been very encouraging. 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 coöperation 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.

FLAX CULTURE IN VIRGINIA.

Lee County, Va., is the center of a very interesting flax industry, a remnant of the old household linen manufacture of our grandmothers' day. The Department has had knowledge of the fact that flax is still grown and manufactured by farmers in a few localities, chiefly in middle Southern States, the Virginias especially, though no previous effort has been made to learn the details of the industry.

Recently, however, the Census Office has had considerable correspondence with citizens of Lee County, Va., relative to the matter, and

it is from this correspondence, kindly placed at the disposal of the Department of Agriculture by Mr. John Hyde, special agent in charge of agriculture, that the following interesting facts are gleaned. The returns of the census enumerators having shown not a little flax "manufacture" in this section, where the existence of linen mills was not known, letters of inquiry were sent out, the replies showing quite an extensive home manufacture. In the first of these replies it is stated that a considerable number of the farmers of the section raise flax, which is manufactured by their families into linen of good quality. "They break, scutch, spin, and weave on machinery made by themselves, and all of it is used at home for home consumption."

The following extract from another communication embodying the chief information relative to this industry will suffice:

Concerning the value per acre of the flax product by Lee County, in my opinion there are various reasons why the flax grown in this country in the year preceding the last census was very valuable by the acre.

(1) There were at that time no railroads in the county; but there were then and there are yet plenty of mountains, hills, and bad roads, over which goods brought into the county had to be transported by wagons from 20 to 50 miles. Consequently the people, who consume more flax products than they produce, had to pay the merchants an enormous per cent on nearly all goods, including linens, ropes, thread, and other products of flax; and, very naturally, they valued their own home-made linens, etc. (which were of better quality but coarser than those bought from the store), in accordance with the prices they had to pay the merchant for similar goods.

(2) Generally very small patches of flax are raised on choice spots of land; consequently very good preparation of land, seeding in the right time, and harvesting with care, can all be attended to in a much better manner than could be done if the farmer had large areas in flax; for this reason the yield per acre is much greater on small patches than it would be if large areas were raised.

(3) The flax is watered in swathes on the ground by rain and dew; broken on a bench-shaped wooden break; cleaned on a board set in the ground, with a wooden knife; then hackled on an iron-toothed hackle, spun on a "little wheel", and woven on a home-made wooden loom, or manufactured on wooden ropeworks into linens, ropes, thread, etc., by the producers at home when they have not much else to do but eat and drink the products of their farms, which are not considered very costly, and therefore they do not consider that there has been much cost attached to the manufacture of their linens, etc. If linen can be made without much cost and save paying the store prices the material used is valuable.

The foregoing reasons I hope will give some light upon the fact that the flax product of Lee County, Va., was considered so valuable per acre. It was the case that all, or at least nearly all, the flax raised in this county was used in the manufacture of home-made linens, etc. So far as I am informed, no flax from the county was sent to any factory.

While this report was going through the press I visited this interesting section of Virginia for the purpose of investigating the methods of culture in vogue, the preparation of the fiber, and the home manufacture of linen, the results of which will appear in a future bulletin. Beautiful examples of scutched and hackled flax were obtained; also samples of linen in variety and of the rude appliances used in preparing the fiber and manufacturing it. Altogether, the flax industry of Lee

County, Va., declining as it is, forms a most interesting study in connection with the subject of flax culture for fiber in the United States.

CONCLUSIONS.

There is a lesson in the decline of the flax industry in European countries. Even in Russia there has been a falling off in production, and according to recent advices the crops of last year in the whole of the black belt, and beyond it, both for seed and fiber, have been unsatisfactory. We are informed that in the southern prairie-like lands, the middle, northern, and especially eastern and southeastern black-belt provinces the crop of flax barely equaled the seed sown. Last year there was a considerable falling off in Belgium, one of our correspondents stating that it would be difficult to secure Belgian seed for import to this country should such importation be desired. The French culture, as shown in a recent report issued by this Department, has steadily declined and the production is now limited to almost a single locality, and would cease altogether but for the close proximity of this locality to the river Lys.

Appreciating the situation, our Canadian friends are already looking forward to a time when they will be able to find in Europe a considerable market for Candian-grown flax. We are not even growing what coarse flax we require to supply our flax-twine mills.

As I have shown, the farmer has little incentive to grow flax until a market is assured, and a market can only be assured when scutch mills have been established to take the product off his hands when grown, and put it into a marketable condition. There should be good scutch mills, not tow mills, in every flax-growing locality. With the establishment of these mills in considerable numbers, the farmer will be ready to raise flax for fiber, the manufacturers will avail themselves of the home supply, and the industry will be placed on a substantial footing. Small beginnings have been made, chiefly in Minnesota, but there is a field for a larger enterprise in this direction, in which capital must lend a helping hand.

The importance of reëstablishing the flax-fiber industry in the United States will be fully appreciated by a perusal of the tables of imports of flax fiber and its manufacture in recent years. It is not deemed necessary to reproduce these tables in the present report, but there is food for thought in the statement that these imports amount to over sixteen million dollars in a single year, nearly two millions of this value representing raw flax fiber. A large proportion of the manufactured goods represented in the fourteen millions of imports are brown linens and the coarser fabrics, which can be and should be made at home from home-grown flax.

FLAX CULTURE IN THE NORTHWEST.

In July, 1891, Mr. Eugene Bosse, a practical Belgian flax grower and scutcher, now a citizen of the United States, was commissioned to visit the flax-growing localities of the Northwest, with Minnesota as the center, to acquaint farmers with the best practice in cultivating flax for fiber. During the ten weeks that he was employed as a special agent he visited principal points in Wisconsin, Minnesota, Iowa, and South Dakota, as follows: Waupun, Eau Claire, Markesan, and Green Bay, Wis.; St. Paul Park, St. Anthony Park, Austin, Albert Lea, Wells, Clara City, Heron Lake, Faribault, Sauk Center, Evansville, Alexandria, Breckenridge, Granville, Morris, Litchfield, and other places in Minnesota; Sioux Falls, Egan, Madison, Huron, Ortonville, and a few other small towns in South Dakota; Lake Mills and Forest City, Iowa.

The following brief extracts from Mr. Bosse's weekly reports of progress are interesting:

Minnesota Experiment Station, St. Anthony Park.—In the experiments here a part of the crop has been drilled. Drilling is inconsistent with the purpose of raising flax for fiber because in one way the plants are too close together, have no allowance of space to develop, so remain short and fine, making a different kind and quality of fiber than those in the outsides of the row. These plants, having too much room, grow taller and coarser, giving trouble in retting when mixed with the fine ones, which require twice as much time to be retted. Some of the broadcast is spot sowed or unevenly spread, and is consequently subject to the same remark as the drilled.

All the flax plats are clean and free from wild morning-glory, a valuable point in this section. The ground has been well cultivated, but the sowing was too late to grow well for both seed and fiber.

Green Bay, Wis.—The farmers here have plowed their flax under on account of it being too short, too fine, and too weedy from the prolonged drought prevailing in this section. But they are not discouraged and propose to recommence next year. I have given them all instructions how to proceed.

Markesan, Wis.—The farmers here grow for seed, 3 pecks to the acre. They are ready to put in any quantity and cultivate in a proper manner, should the assurance be given of a market for their straw. They thrashed last year between 15 and 20 bushels of seed per acre, but will not do so well this season, owing to lack of rain.

Waupun, Wis.—There is an incorporated company here with $10,000 capital, with the object of buying flax from the farmers and turning it into fiber. They have bought some seed of William Livingston, of Yale, Mich., and sold it to farmers who have sowed 53 acres around Waupun, 1½ bushel per acre. I have seen most of these fields of flax; about one-half is fairly good and will be fit to make a second grade of straight fiber; the balance was put in too late and should be turned into tow. The company will build a mill to be ready to work up the crop, beside some of the flax grown at Markesan, and at Beaver Dam. They propose to induce the farmers to sow 500 acres with the proper seed, and may do so next year.

Eau Claire, Wis.—They are putting in new machinery at the mill here and will begin spinning about the first of September. They will use between 500 and 1,000 pounds of flax tow per day, according to the kind of linen made. They expect to be able to pay 7 cents per pound for good, clean tow, and would rather pay that price than buy fiber of inferior grades. They are ready to give preference, in buying, to fiber raised here when at the same price. Judging from the samples and prices they showed me the Canadians will be hard competitors. There is no flax grown around Eau Claire, but I have the names of some of the best farmers and will write them. I saw fields of flax, when passing on the train, near Hammond Station and Baldwin Station, between Eau Claire and River St. Croix.

Northfield, Minn.—Came direct to Northfield this morning and found about 2,000 acres of flax, sown for the seed only, in a radius of 6 miles around the city. They report the flax almost all good. I have seen myself four good fields, 140 acres, at 2, 3, and 5 miles from town, on the farms of Messrs. Norton and Kinney. Another really beautiful field, for the sort of flax grown, was sown with 1 bushel per acre of common seed. The flax is 2 feet high, with big heads, all clean and as even as a floor. The farmers I have seen are ready to follow instructions and raise flax both for seed and fiber, with foreign seed, if they can have a market for their straw.

I consider Northfield a most fitting place to grow and make fiber of the finest grades, with its large, nice fields upon which to ret on the ground, the soft, slow-running waters of the Canon River near, and commodious prairies along its banks.

Faribault, Minn.—They estimate at least 20,000 acres in this county (Rice), but all for the seed only. They expect 12 to 15 bushels of seed per acre. The farmers are all ready to improve the flax crop if they can have a market for their straw. The business men here may put up this season a small flax mill as an experiment, but expect anyway to build one for the next crop.[1] I have given full instructions how to proceed with the culture, and advised the farmers to care for their straw.

Austin,[1] *Minn.*—This is indeed a fine locality for a flax mill, good lands, enterprising farmers with large farms, who are disposed to do anything if they can have a market for their straw. I have seen here nice fields sown the first of May, with 1 bushel per acre of Russian (not Riga) seed, showing superior growth. It is a shame to throw such straw away.

Cresco, Iowa.—Mr. Bosse visited this point in response to a request from prominent flax-growers, and found between 2,000 and 3,000 acres of superbly grown flax. He says: "If competent men would start a mill here, with proper machinery and a little money, the business men of the city, with some farmers, would raise sufficiently large capital to assure the development of the industry."

Albert Lea, Minn.—An exceedingly good location for a mill. In a radius of 10 miles some 2,000 acres of flax have been sown for seed. I saw one field of 25 acres, near the city, that would make good flax. An effort was made to put up a mill here last season, though it failed owing to circumstances having nothing to do with the ability of the farmers to supply the necessary flax straw. The farmers are industrious Scandinavians, with good lands, and there are great facilities for retting their straw in the soft lake waters.

Forest City, Iowa.—The seed from 15,000 acres of flax will be marketed here this year. The flax was sown from the 15th of May up to the last part of June with one-half, three-fourths, and 1 bushel of seed per acre. The last sowings are in blossom (July 28) and the product in seed will depend greatly on the weather. In my opinion, the 1-bushel sowing will give the most seed, from 15 to 20 bushels, and make a good, long straw (2 to 2½ feet) good enough to turn into fine tow; the three-fourths bushel sowing will also give a long straw, but not so clean, and much coarser; and the last sowing will give a very clean straw, but uneven and short, still fit to make into tow.

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[1] The American Fiber Company has since established a mill at this place, and some 1,200 tons of straw were purchased last season.

There is a good class of farmers all around here and they would handle the flax in any way that would insure the greatest return.

Lake Mill, Iowa.—I had a drive of 6 miles into the country with Mr. Williams, a dealer in farm machinery and a flaxseed buyer. He says there will be marketed here the seed of at least 5,000 acres of flax. The flax was generally sown in June on spring sod plowing with three-fourths bushel per acre of Russian seed. It is all in blossom, clean, and of good promise, from 15 to 24 inches high. Most of it will grow 4 inches more. The farmers are ready to do anything, even ret the straw themselves if necessary.

Wells, Minn.—Met here Mr. C. N. Andrews, secretary of the board of trade, who was at my place in St. Paul Park last December desiring information concerning flax. This is a very lively and enterprising little city, set in the middle of a grand country. The land is flat, damp, composed of a deep, rich, black loam, that might be compared with the immense steppes of Russia. A large number of the farmers are Poles. There is not a region of country in the world better adapted to the growing of long, sound, healthy flax than here, with good opportunity for retting. The farmers would do anything to better their crops of flax with a market, and the Russian people are favorable to putting up a flax mill, but they are awaiting the proper time. All the flax here is sown with Russian seed (not Riga) three-fourths bushel per acre, not very clean, coarse, not yet in blossom, but promising 12 to 16 bushels of seed. Mr. A. says there will be marketed here this season the seed of 8,000 acres of flax.

Oakland, Minn.—I came from Wells to Oakland, near Austin, as Messrs. McMillan & Hastings wished me to visit their farm of 6,500 acres, 8 miles northwest of here. They have 200 acres of flax sown with Belgian seed directly imported. They sowed only three-fourths bushel per acre, much too thin, but the flax is very healthy. Straw 30 inches high on an average. Will give 8 bushels per acre. They propose to save the straw, sow 500 acres next year, and build a flax mill.

Clara City, Minn.—Messrs. Kock & Prinn, of St. Paul, who own 78 farms around Clara City, sowed 6 acres last fall with 2½ bushels of Holland seed, but the experiment proved a failure. They have 80 acres which was sown in May last with 2 bushels Holland seed per acre. The flax is of good quality but short, measuring about 24 inches, owing to dry weather during six weeks after the seed was put in the ground. To raise long flax it will be necessary to plow deeper, as I informed them. There is a great quantity of flax which was sown late in June with common American seed; it is clean, but most of it is too short for fiber. However, they propose to use the best of their straw (they pull about 5 acres), ret by snow in winter, and are talking of building a flax mill.

Sioux Falls, S. Dak.—Visited the linen mill here, and saw Mr. Ingram. There are about 2,000 acres of flax in this vicinity, mostly sown with three-fourths bushel of Russian seed. All that I have seen is very clean, 24 inches high, nearly ripe, and of exceptionally good quality for making first-grade tow. Farmers are ready to raise fine flax, starting with a few acres, when assured of a market. They would not be willing to work it up themselves, having no time for such work, and no knowledge of the business.

Egan, S. Dak.—There is a great quantity of flax grown around Egan from common seed; sown three-fourths bushel per acre; would be pretty good for coarse tow, if well managed. The soil is well adapted to flax culture, and the farmers are anxious to do anything, but there is little capital with which to push new enterprises. There are tow mills at Dell Rapids, Hartford, Wentworth, and Brookings, S. Dak., one here, and I am told one at Vilas.

Breckenridge, Minn.—There is not a very great area in flax here, but what there is is good, very sound, 2 feet high, and will give 15 bushels of seed per acre. Should this land be properly cultivated for flax, it would show wonderful results in crop and quality. It is but a repetition of the land at Wells, Minn. The people would be willing to go more extensively into the culture of flax if they could realize from it as much as from wheat. There is a prospect for a flax mill here.

Granville, Minn.—There are about 5,000 acres of flax raised here in a circle of 6 miles around the city; it has been sown for seed only; three-fourths and 1 bushel per acre. Some of it is very good and clean flax which would make good fiber. They expect on an average 12 bushels of seed per acre, and would sell the straw at $3 per ton if wanted.

Morris, Minn.—Little flax raised here and that for seed only, but the country is well adapted to its culture, with good, soft river water for retting. Farmers and business men are ready to push the industry and would do so if proper persons went there to tell them what to do.

Waupun, Minn. (second visit).—They have put up a building here for their flax industry, 32 by 50 by 12, on a 5-acre piece of ground traversed by a small river, with very soft water, in which flax has been perfectly retted in one hundred and ninety hours. It is a fine location for a flax industry, with great advantages as to land, climate, moisture (heavy dews), and is near Green Bay, where there are many Belgian flax-workers. They have 15 acres of flax pulled by hand and that will be threshed by hand, kept straight and worked into long line; also 35 acres cut with the reaper and stacked. This tract was grown from seed from William Livingston, Michigan, but sown too late in May. On account of dry weather it did not come up evenly. They will buy about 200 acres of straw from surrounding flax fields, sown 1 bushel per acre with American seed, and work it into tow. They will thrash with grain-thrasher arranged to save the fiber as far as possible. This tow will be worth from $60 to $100 per ton.

The following report, as applicable to Wisconsin and Minnesota, was submitted by Mr. Eugene Bosse at the close of his labors:

FLAX CULTURE IN WISCONSIN AND MINNESOTA.

By Eugene Bosse.

Flax is now cultivated in the West by hundreds of thousands of acres for its seed only; but successful experiments made in many States have demonstrated the adaptability of our lands and climate to the growth of as good flax as may be demanded for any kind of linen.

Millions of dollars are sent abroad every year to buy our linen and the raw flax to supply our manufactures of yarn and thread in the East, when we waste and burn flax straw in the United States which would be worth double the value of our imports if it was a little better cared for. Should we continue such an absurdity as to give our money away to strangers when we have all facilities and opportunities to make and keep it? Should it not be a matter of the utmost importance to our agriculture to add so valuable an industry to the catalogue of farm industries, and secure a better rotation for our crops; to furnish employment to thousands of workmen in the manipulation of the flax and the manufacture of the fiber?

There is a strong prejudice among some people against the raising of flax. They say the flax is a hard eater of the fat of the ground and a destroyer of land. I am painfully impressed in regard to the wisdom of those who advocate such an untrue thing because of their ignorance of the composition of the plant, its habits and needs. Yes, the flax is hard on the ground when the farmer plows his land shallow. He sows it thin and allows the weeds too much room to fill the spaces.

Then it is not the flax that ruins the land, but that very rapacious enemy, the weeds. Plow the land shallow and you do not let the plant follow its proper course; you force its roots to feed near the surface, and there lies one of the reasons why the flax, as commonly cultivated, remains short and dries up instead of ripening naturally. The moisture it so much requires is too quickly absorbed. It is true I have seen fields of pretty long flax that have been sown on shallow land, but that land was very rich or very open, with a propitious season. I deny that flax is harder on the land than wheat, oats, rye, or barley, when similarly cultivated. It wants a deep soil, 7 or 8 inches at least, thoroughly pulverized in order to allow its main root to go straight into the earth and find there most of the elements essential to healthy growth; a soil that is easily penetrated by the rain and permeated by the moisture of the air; such land must be rolled to keep from drying and remain, as far as possible, a sort of reservoir of moisture. The land need not be so very rich to raise good flax when properly worked, as a recollection of past practice in Belgium proves. When a farmer is too short of manure to raise a crop of winter wheat, he plows his land 10 inches deep in the fall, and in the last part of April he plows it again 6 or 7 inches, working it fine, and about the 5th of May, on a warm, sunshiny morning, he sows 2 bushels of Riga or Belgian seed, harrows his land twice, crossway on the seed, and next day, if not wet, he packs it well with a heavy roller. If he has a tolerably good season he is sure to raise a fine crop of flax and a good crop of winter wheat, without manure, immediately following. Was the flax so hard a crop on the land, assuredly such a result could not be obtained. Moreover, it is a fact well ascertained by science that the flax plant draws its nourishment partly from the ground, and partly from the atmosphere. So, to be sure 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 crossway, 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 crossway 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. I have raised four crops in Wisconsin, two of them in very dry seasons, and two in Minnesota by this method, and all were fully good. I had on an average of 10 bushels of seed per acre. Some I have sold

for seed at $2 per bushel. I had from 3,000 to 4,500 pounds of straw after the seed was off, worth from $10 to $12 per ton at the mill. I had from 500 to 800 pounds of clean long fiber per acre, which I sold from 10 to 12 cents per pound. But that flax was pulled by hand, at a cost of $5 per acre (one man, thirty hours). It was bundled and stood up like grain to dry, eight days, then stacked two weeks, and thrashed, keeping it straight. The usual manner of thrashing is pretty slow, one man doing two-thirds of an acre in ten hours; but we will have suitable machines for this work in the near future.

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. There is a fair prospect that we will have flax-pulling machines ere long. One was experimented with in my field this season, and it showed that the principle was right but the mechanism will need to be perfected.

The agricultural part of the industry completed, we next turn our attention to industrial manipulation. Now, the first operation to deal with, and the most laborious of all, is the retting. This work must be watched carefully, and it requires skill. There are two old, very old, processes of retting, and yet they are the only practically perfect. (I have no confidence in a chemical system, as it leaves the fiber too harsh and dry; but I should be happy to be shown my mistake.) The first system is called grass or dew retting, the other water retting. The fiber from the last is generally stronger, better in quality, and brings a higher price; but it requires more care, and ought to be conducted with knowledge. It consists of putting the flax in small bundles, 24 inches in circumference, in soft water, stagnant or running. It is kept 6 inches under the surface of the water, remaining two hundred and sixty hours, more or less, according to the temperature of the air and the quality of the straw (coarse straw, late sewing, will ret more quickly). To make a fine grade of fiber, when the straw is adapted to it, there must be two operations, viz: Take the flax from the water after one hundred and sixty hours' immersion, stand it up half dry to let the water run off, open the bundle with the band slipped near the top, and let it dry in the sun for half a day; turn inside out for half a day, rebundle and replace in the same water as at first. Now is the time to be vigilant, for if it remains a few hours too long in the water there is danger of injuring the fiber. After two days visit the pool every three hours, take a few stems, draw them between the thumb and finger with a bending motion, and if the wood breaks and the fiber detaches easily the operation is terminated. Then the flax must be taken from the water

with care, stood up to dry in the same way as before, and then sheltered. Where the process just described is considered too tedious, and requiring too much skill for the beginner, I would advise a mixed retting by water and dew. When the flax is taken off the water after one hundred and sixty hours, and stood up half a day, it is spread evenly one-half inch thick on clean short grass, as a meadow, to finish the retting. This fiber should be much appreciated by our spinners of the East for making thread and yarn, and would find a ready market at remunerative prices. But to ret the straw by dew is quite easy. Simply spread it evenly in rows on a meadow or new clover field, or on oat stubble cut short, and in such thickness that the ground may be seen through it. After two or three weeks of dew and showers (sometimes more) the flax will be ready to be turned over, and from three to six days will finish the work. Lift when dry, or stand up to dry, bundle and shelter in a dry place. The above practices are for long line flax which should be raised with the proper seed, Riga or Belgian directly imported, or from that sown no more than three times here, when it commences to degenerate.

Our flax, as it is cultivated at present, is not fitted for fine goods; neither for yarn or thread, but it can be used for coarse linen, ropes, and twine, and would require but little expense or care. When not too weedy, which would render it valueless, cut as low as possible; follow your own way to cure it and thrash it so as not to tangle or shorten the straw. When thrashed, spread the straw as described above, about 1 inch in thickness, but evenly, and when one side is retted turn it with a fork, and a few days more will put it in condition to be raked up like hay. When dry, haul to the barn or to the mill. A good way to ret is to spread late in the fall and let it lie all winter. Early in the spring it will be perfectly retted and ready to be lifted. This plan is for the production of rough fiber only.

Tangled straw, green, from American seed, should be worth $3 or $4 per ton; if retted, $6 to $8, and the tow from $50 to $60 per ton, averaging 30 per cent. If grown from proper seed, it would be worth from $5 to $8 per ton green, free from weeds, and from $8 to $12 retted. The tow would be worth $70 to $100 per ton, averaging 30 per cent, or according to the state of the market.

The United States of America is now confronted with a problem—how to produce and manufacture its own linen. It means by its solution increased wealth for our people. To solve the problem, we must raise the raw material, work it into fiber, and have manufactures. We grow twice as much raw material as we need for our consumption, but we waste it; so we are entirely dependent on foreign countries, and import at great expense to make good what we throw away here. Capital should join with industrious farmers to solve this question of flax production, and add another valuable industry to the resources of this great country.

FLAX CULTURE IN IRELAND AND BELGIUM.

By HENRY WALLACE, *Des Moines, Iowa.*

In pursuance of instructions from the U. S. Department of Agriculture, I have made a personal investigation of the methods of field culture of flax in use by the farmers of the north of Ireland and of Belgium, and beg leave to report as follows:

FLAX IN IRELAND.

The great bulk of the 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 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 9 shillings 9 pence per stone of 14 pounds in 1869, or $16\frac{3}{4}$ cents per pound of scutched fiber, to about 6 shillings, 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 farmers is to grow flax only at intervals of twelve years. These two considerations are sufficient of themselves to explain the somewhat surprising fact that the whole of Ireland is growing less than one-third the acreage of flax grown in the single Western State of Iowa.

A flax crop in Ireland is grown mostly at an elevation of from 250 feet above down to sea level, and the best flax is grown at an elevation but little above the level of the sea. The climate is moist, but a few days at most intervening between showers. The soil is by no means rich; in fact, is much inferior to most soils of the Northern and Western States. Few of the soils on which flax is grown so successfully will grow red clover, except as a rotation crop, and only at intervals of six or seven years. It is, besides, polluted with weeds to an extent that an American can scarcely comprehend, the weeds being mostly deep-rooted, and growing from detached pieces, which the moistness of the climate pre-

vents being killed by cultivation by any kind of machine. The only known method of destroying these weeds is by careful hand pulling. Given a soil somewhat clayey and retentive of moisture, the absence of winter freezing and a moist climate, with frequent showers during the growing season, and we have the conditions which the flax-grower must meet by the method of culture described below.

SELECTION OF THE SOIL.

In selecting soil for flax, the Irish farmer must consider other things besides this particular crop. While flax will follow many crops, it does best after wheat or oats. In heavier soils it does well sometimes after potatoes, but generally a crop of oats intervenes, and hence a selection must be made of land which has been the previous years in one of the three crops above mentioned.

Again, due regard must be given to the fertility of the soil, or, in other words, to the time at which it has been manured. It will not do to sow land to flax after recent manuring, for the reason that such land grows a coarse fiber and is very likely to be uneven in the growth; nor, on the other hand, is it desirable to risk flax on a soil that has been exhausted by continuous cropping.

It is somewhat surprising that it does not do well on lea—that is, on land broken up from the sod—while it succeeds reasonably well in some districts after oats sown on lea. It requires a soil in good heart and in a condition to secure the finest tilth; in a word, it requires, and must receive practically, garden culture. This is all the more important because it is preëminently desirable to secure an even length of staple, which can be done only by even sowing, even covering, and an equal fertility throughout the entire field. In assigning flax a place in the rotation, farmers modify their custom to suit varying conditions. The following are examples:

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. Wheaty Clover. Oats. Potatoes. Flax.	Root crops. Barley. Clover. Grass. Wheat. Flax, half field.	Barley. Clover and grass. Grazing. Wheat. Flax, half field.

Many other rotations might be given, but we deem the above sufficient to illustrate the principle underlying the practice adopted by the Irish farmer.

PREPARATION OF THE SOIL.

This is one of the essentials of a profitable flax crop, and while the results to be obtained are the same the means vary with local circum-

stances and conditions. If the soil is heavy it is plowed rather deep in the fall, but if light, following, as flax generally does, wheat, oats, or on heavy soils, potatoes, plowing is usually deferred until the spring, while land that requires fall plowing must be replowed in the spring, this time not so deeply; in fact, it must be plowed until it is in the condition of a well-cultivated garden. The harrow is used for the double purpose of killing weeds and thoroughly cleaning the land, and preparing a fine under seed bed, with the surface in the best possible condition to receive the seed and secure its even germination. To what extent the roller should be used depends, as it always does, on circumstances of which the farmer himself is the best judge, the end being in all cases to obtain an ideal seed bed, to secure which he uses whatever implements will best suit his purpose.

SEED.

In Ireland the seed of flax is rarely or never saved, and hence all the seed sown is imported from Riga, Russia, or from Holland, generally from Rotterdam. We find many farmers sowing Riga seed, while preference is generally given to the product of Riga seed sown one or two years in Holland. This is called Dutch seed. By personal inquiry in Holland we find that the seed sown there is constantly renewed from Riga, few farmers venturing to sow their own seed longer than one year, so that Riga may be regarded as the source of all the seed sown in the linen-producing countries.

As the object in Ireland is to produce fiber and not seed, flax is sown very thickly, averaging about 2 bushels per statute acre. By this thick sowing, the plant is pushed upward in a straight stem, with but one or two top branches, and attains a height of from 3 feet to 3 feet 9 inches. As the branch scutches off into tow and the universal practice of pulling the fraying off of the root end, this gives a length and staple of from 27 to 36 inches, an exceedingly important consideration in producing valuable fiber. To what extent the practice of sowing flax thinly to produce a seed crop tends to develop and transmit by the law of heredity the habit of low branching we have been unable to determine, as no flax is grown for seed in Ireland. In Holland it is grown for both seed and fiber, while it is grown mainly for seed in Russia, and it would therefore seem that the tendency to branch is governed by the same law that prevails among trees, thin planting developing a tendency to branch while thick planting compels an upright growth. Our observation among the flax-growers of Belgium and Holland shows that when the climate and conditions are favorable it is possible to secure a moderate crop of fairly good seed, and at the same time a crop of good fiber. The finest fiber in the world is grown in Belgium, where the seed is also saved, although it must be stated that the seed grown in Belgium is quite inferior in quality, everything being sacrificed to the production of the choicest fiber.

COST OF PRODUCTION.

We found great difficulty in obtaining accurate and reliable statements of the cost of production of flax in either Ireland or Belgium. This is not in the least surprising, so many different elements entering into the cost, even in the same locality, that it is extremely difficult to obtain in any country statements of the cost of any crop that do not widely vary. The discrepancies are much wider in countries like Ireland, for the reason that the lands are by no means so uniform in fertility, nor is there anything like uniformity in the size of the farms. 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. A number of estimates were given me, by most of the larger farmers, from which we select the following:

No. 1.—Given by Samuel Wallace, Kilrea, County Antrim, Ireland. (*Farm 60 acres.*)

	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	$0.06¾

No. 2.—Given by H. J. Wallace, Movenis, Garvagh, County Derry, Ireland. (*Farm 150 acres.*)

	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

No. 3.—Given by James M'Henry, Rasharkin, County Antrim, Ireland.

	Per acre.
Plowing	$2.00
Seed	3.50
Harrowing and sowing	1.25
Weeding	.50
Pulling	2.00
Steeping, watering, and lifting	2.00
Mill-dressing	12.50
Rent	12.00
Total	35.75
Yield ..... pounds	600
Cost (nearly)	$0.06

It will be noticed that there are important differences even in the estimates of three men who give more than usual attention to the cost of the various farm products. The "Textile Journal," devoted to flax culture in Ireland, published sometime since reports of the cost of flax-growing, given by a number of representative farmers, which varied from $33.07 to $46.65 per acre, averaging $40.82 per acre. The yield is given after careful investigation by the "Textile Journal" at from 29 to 52 stones of dressed fiber, or from 406 to 728 pounds per acre, and the cost at about 7 cents per pound. By comparing this with current prices it will be seen that there is a profit on the product of from 1 to 2 cents per pound. It must be remembered that all these estimates are made by the best farmers, and we do not believe that the average yield, even in Ireland, will reach 600 pounds per statute acre. It should be borne in mind that the wages paid in Ireland for farm hands are from $10 to $12 per month, without board, and the wages paid for pulling flax are 36 cents for men and 30 cents for women. It should be stated that the only variety of flax grown in Ireland is the Blue Blossom, so commonly grown in America.

From observations continued over two months during the growing period, we are inclined to the belief that the most important of all the operations connected with flax-growing is that of weeding. Weeds are especially pernicious to flax; they not only occupy space that should be occupied by the plant, but they interfere very seriously with pulling, causing more or less loss of staple in separating the flax from the weeds, and, we have reason to believe, not merely exhaust the fertility of the soil, but absolutely poison it. If Sir J. B. Lawes, of Rothamsted, England, can grow successfully crops of wheat greater than the average wheat crop of the world, on land that has not been manured for thirty-seven years, solely by keeping it in fine tilth and absolutely free from weeds, there is at least room to suspect that weeds and lack of proper mechanical culture are among the most potent causes of deficient crops. We did not see either in Ireland, Holland, or Belgium a single good flax crop where weeding had been neglected, nor did we see a poor one where the flax had been kept scrupulously clean and

free from weeds. In growing flax, America will for many years have a great advantage over these countries in this, that the weeds that trouble the Western farmer are mostly annuals, which can be destroyed for the most part in a dry, hot climate by cultivation of the ground previous to sowing, while the soils of the Old World are polluted with many varieties of weeds which grow from root cuttings, and which can not be killed by a brief exposure to the low temperature of these climates.

FLAX IN BELGIUM.

Pursuant to instructions from the Department I visited the main flax-growing district in Belgium, of which the city of Courtrai is the geographical and commercial center. This district does not vary greatly in elevation nor in rainfall from the flax district of Ireland. It has, however, certain very decided advantages, some of which are peculiar to the immediate location. The land is gently undulating, the soil in general a friable loam of easy culture resting on a porous subsoil. The price of labor is much lower than in Ireland; the higher temperature renders the destruction of weeds more easy, while its proximity to the river Lys gives opportunity for retting unequaled in the known world.

The soil and the general principles of this district bear a striking resemblance to the prairie States of the West. The whole region is under the most complete and thorough system of cultivation, fences being used only to inclose permanent pastures and the tillable land being under a most complete system of rotation. Belgian soil gives an opportunity for a more varied rotation than in Ireland, growing, as it does, wheat, rye, oats, barley, sugar beets, clover, chicory, turnips, rape, and smaller crops. The principles followed in adopting a rotation for any particular farm are the same as those adopted by the Irish farmer, few farmers caring to sow flax on the same land oftener than once in eight years, and the greatest success being obtained when the crop is not more frequent than once in from fifteen to twenty years. The following is one of the favorite rotations: wheat, barley, potatoes (with manure), wheat, clover, sugar beets, chicory, flax, in which rotation the flax comes in once in eight years. Others bring in the flax after mangolds or sugar beets. Belgian farmers adopt practically the same policy adopted by the Irish farmer in regard to manure. They avoid the application of coarse rank manures, which would produce an uneven fiber, preferring land that has been kept in a higher state of fertility and not exhausted by previous crops, and when manure is applied it is done a month or more previous to sowing, in the shape of colza cake or liquid manure, which can be applied evenly and with due regard to the wants of each portion of the field.

No pains are spared in the preparation of the soil. The Belgian farmer is practically a gardener, who wastes nothing and leaves no

spot with its resources undeveloped; and to this end he uses whatever implement and whatever kind and amount of labor is necessary to attain the desired end. The greatest care is used in the selection of the seed, adopting practically the same methods as the Irish farmer.

The time of sowing commences about February 20 and extends to April 1. The sowing and covering are done with extreme care in order to secure an even stand, neither too thick nor too thin. The rate of sowing is about 7 bushels per hectare or 2½ bushels per acre. This is heavier than the Irish practice, but the Belgian farmer corrects any excess by removing the surplus plants at the first weeding.

The weeding is regarded as one of the most important operations of the flax-grower. When the flax is about 2 inches high it is gone over by the weeders, mostly women, often from ten to thirty in a field, their elbows touching each other, who remove with the greatest care every weed, however small. Two or three weeks afterwards the operation is repeated and at the end of this weeding the fields are absolutely clean. The wages paid weeders are from 14 to 25 cents per day.

In this district flax is grown for both seed and fiber, and hence the plant is allowed to maintain greater maturity than in Ireland (where the pulling commences when the leaves begin to fall from the lower part of the stem), but is not allowed to attain that degree of maturity that fits the seed for sowing. Belgian seed is always a synonym for poor seed.

The pulling is done with extreme care, the root ends being kept even, and the straw is cured by stooking the handfuls. After this it is tied up in "beets" or small bundles and then placed in what are called "hedges" or ricks of bundles with plenty of air spaces between, and finally stacked preparatory to retting in the river Lys, the sacred river of the Belgian flax-grower.

The practical methods of retting in this district adopted by the flax merchant have been made the subject of a report to your Department by Mr. Dodge, special agent in charge of fiber investigations, and I need not repeat what he has said. It may be well, however, to state that from some cause or causes, as yet not fully understood, the water of the Lys, for a distance of 17 miles, has the peculiar effect of imparting to flax retted in that stream softness and fineness of texture that can be produced nowhere else. Investigations made during the last year show that it rests at this point on a bed of blue clay found by boring at different points to be about 130 feet thick. The investigations have not yet proceeded far enough to determine whether the peculiar value of the water for retting purposes is due to this cause or some other, as yet unknown. On this point it may be well to remark that in Ireland, where the retting is done in stagnant water, a pit with blue clay in the bottom produces fiber of greatly superior value when compared with that produced by other pits in the same neighborhood.

The yield of fiber in Belgium seldom exceeds 500 pounds per statute acre. This is not greatly different from the yield in Ireland when allowance is made for the wasting of fiber by the practice of retting in running water. In Holland, where both systems are followed, we found that retting in water with the slightest possible current led to a decrease in the quantity of fiber of about 15 per cent, while increasing the quality in about the same ratio.

The Belgian flax is mostly bought after thrashing, which is done by pounding the heads off with a block of wood without disarranging the straw, by the flax merchant who supervises the retting process, this step being necessary to secure the application of the highest skill and the greatest uniformity of product. The work of the farmer, therefore, ends when he has separated the seed from the straw.

FLAX CULTURE IN AUSTRO-HUNGARY.

By UNITED STATES CONSUL HAWES, of Reichenberg.

It is not precisely known when flax was first cultivated in Austria, but even in ancient times the linen trade of Bohemia was considered of great importance. As Belgium and France are considered the best flax-growing countries of western Europe, so Bohemia, Moravia, and Silesia stand preëminent in this respect in the Austro-Hungarian monarchy.

The following kinds of flax are cultivated in Austria:

(1) *The common flax*, which is of Russian origin, but, on account of having been cultivated so often on the same soil, has degenerated and is much inclined to ramification. The height of this flax is from 60 to 65 centimeters.[1] The quality is bad and manufacturers do not care much for it on account of its ramification (or branching).

(2) *The Russian flax*, generally known under the name of "Extra Pecik," has no branches, grows very high, and has usually only one capsule at the top of the stalk. The fiber is strong, fine, and of a shiny color.

(3) *The white-blossoming flax*, which is said to be less sensitive to the weather. The fiber is solid, but the stalk never reaches the height of the blue-blossoming variety.

(4) *The rose-linseed.*—This is the name of the seed which is harvested from the original "barrel linseed" (Extra Pecik), and cultivated for the first time in Bohemia. The flax obtained from rose seed has often a finer fiber than that obtained from the original barrel linseed.

There is also the so-called *winter flax*, but it must be remarked that this species can seldom stand the cold of winter, and is therefore little cultivated.

Flax is best cultivated in a damp moderately warm climate, in a country where it rains often, but not too much, and not where a drought is followed by heavy rains. The best locality is damp flat land, near a river, as the cultivation of flax in a dry climate is hazardous. In regard to the best location for flax cultivation, it may be said that level or land slightly sloping toward the west is the best. Descent toward the east dry too soon in the morning, and those toward the south dry up altogether. Steep hills are not good at all for flax cultivation on account of their unequal soil, which causes an unequal condition of the plants.

[1] A little over 2 feet.

SOIL.

Flax grows best in a fresh, rich, loose soil, where sand and loam are mixed, and in a sunny locality. The soil should be warm and damp. In such soils the fibers reach the desired length and acquire strength and fineness. The locality where flax is cultivated should not be shaded or surrounded by trees or forests. Meadows and streams near a flax field are favorable, as they cause constant watery vapors, which influence greatly the quality of the flax. In general, it may be remarked that to produce a long fiber a damp heavy soil is the best, whereas a light loose soil is preferred to produce fineness of fiber.

SUCCESSION OF CROPS.

He who wishes to obtain good flax, not only for one year but also in the future, should possess an orderly arranged table showing what crops should be cultivated before flax, and an interval of eight or nine years should elapse before planting the same field again with flax. In Bohemia the following succession of crops is observed: colza, wheat, potatoes, wheat and clover, clover, beats, beans or potatoes, oats, flax, turnips and wheat. Another rotation is: potatoes, wheat (fertilized), rye (fertilized) with clover, clover, oats, flax, wheat (manured), and rye.

In general it may be stated that oats, rye, wheat, and clover should precede flax, but it is not advisable to cultivate flax after legumes. In some parts of Bohemia flax is cultivated after potatoes, and the farmers are of the opinion that the flax plant thus finds a very loose soil clear of weeds.

The agricultural school for flax cultivation in Trautenau recommends the following series of crops, which has also been approved in other parts of the country: Potatoes (fertilized), oats, clover, clover (fertilized), rye, mixed fodders, flax fertilized with kainit, phosphate and Chile nitrate, and rye.

PREPARATION OF THE LAND.

As has been stated, for the successful cultivation of flax the soil must be moist and warm. Belgium, France, England, and Russia have in this respect a great advantage, as the flax territory of these countries is situated near the sea, which supplies moisture and warm air from the time of planting to the harvest. Farmers in Austria have to accomplish what nature has neglected. This can only be done by cultivating the flax field in the fall as deeply as possible. In the deep furrow remains a great deal of the winter moisture, which not only keeps the field constantly moist but also manures it. He who is not in the position to plow his field deep enough should not cultivate flax, as he will only waste his time and money; the linen manufacturer will not buy from him.

Cultivation differs according to the soil and the preceding crop. In case flax is sown after potatoes or clover, it is usually sufficient to simply plow the field once in the fall. Clover fields ought to be plowed with a Sack or Pracner plow, with one share only, as shown in Figs. 1 and

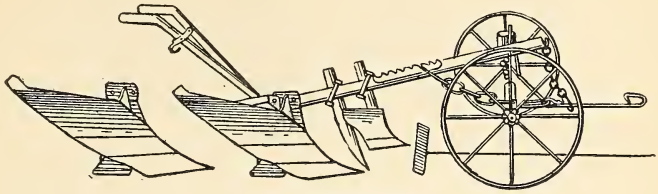


FIG. 1.—The Sack plow.

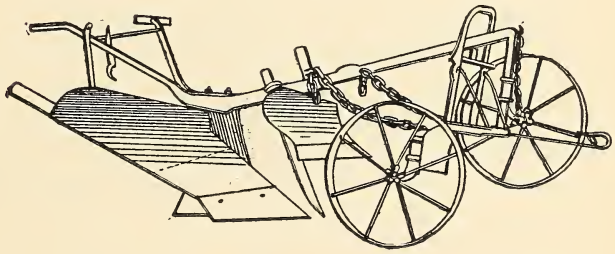


FIG. 2.—The Pracner plow.

2, which have in front a so-called "schöl-share." The little schöl-share cuts up the clover stubble and throws it upside down in the deep furrow. The second or "turning" share, especially made for deep plowing, makes a deep furrow and covers up the stubble.

If oats, rye, or wheat has been grown on land about to be planted in flax, it is advisable to plow the land right after the harvest; this is the

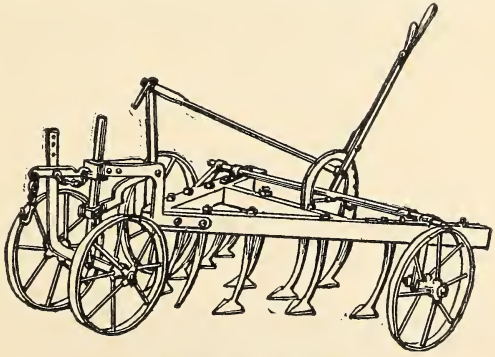


FIG. 3.—The Extirpator.

the usual way in Austria and Bohemia. In a short time, when the weeds appear, the field should be plowed with the Extirpator, as shown in Fig. 3, or harrowed with a so-called "zigzag" harrow, as shown in Fig. 4. This harrow is made entirely of iron.

Then follows in the fall deep plowing, and the land remains with the deep furrow during the winter.

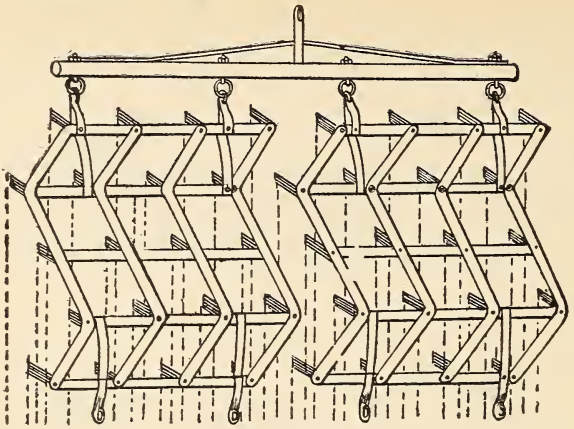


FIG. 4.—The zigzag harrow.

It is not necessary to plow light soil in spring again, as a great deal of the winter moisture would thus be lost. With heavy soils, however, it is

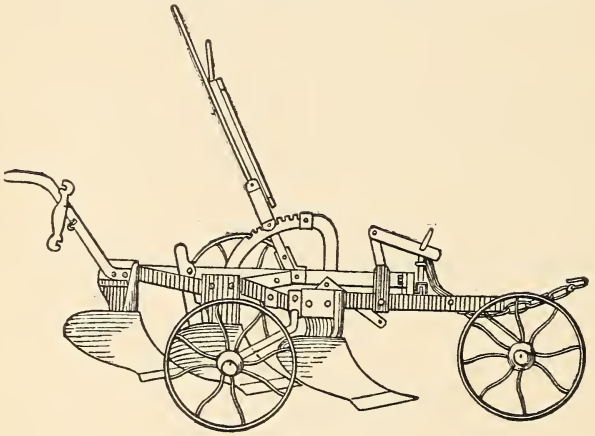


FIG. 5.—The Schöl plow.

advisable to plow again in the spring, and for this work a so-called Schöl-plow, as shown in Fig. 5, is used in order to make the soil loose and brittle. If the soil be crusted, a roller, as shown in Fig. 6, is used.

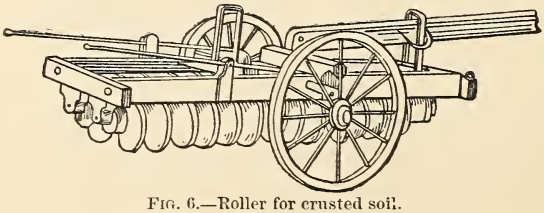


FIG. 6.—Roller for crusted soil.

To produce plants of equal length the land may be cultivated level or in beds.

MANURING.

The plant needs great attention and the soil requires an equally divided amount of nourishment. It is therefore necessary to give the greatest attention to manuring. If we calculate per hectare (2.5 acres) a crop of 4,000 kilograms dry flax, and 1,000 kilograms seed and capsules, there is removed from the ground 65 kilograms potassium and 37 kilograms phosphates. Calculating an average rye crop at 1,800 kilograms and 4,000 kilograms of straw per hectare there will be removed from the ground only 44 kilograms potassium and 30 kilograms phosphates. It is thus seen that flax exhausts the soil very much more than grain.

The direct application of stable manure to flax, be it in fall or spring, is not at all advisable and ought not to be done, as the practice has shown that it causes more weeds, branching stalks, and coarse and brittle fiber. It has further been proven that flax sown in fresh stable manure will produce a high percentage of tow, and a disease may be created called "*rat*," the results being that the points of the plants begin suddenly to dry up. The right time to manure is just after the harvest of the preceding crop of rye or clover. Fertilizing is not as much known here as it ought to be. Trials which have been made showed their advantages; of course fertilizer applied to exhausted soil will not fully substitute manure. Phosphate mixed with potassium, kainit, and Chile nitrate is often used.

A trial made last year at the agricultural school at Trautenau shows the following result and can also be recommended for other localities. Three pieces of land, each of 1,500 meters, were treated as follows:

The first with 50 kilograms phosphate, 25 kilograms ammonia, and 50 kilograms "manure salts"; the second was not fertilized; the third with 50 kilograms phosphate and 25 kilograms ammonia.

The three pieces of land were equally cultivated, sowed one and the same day, and harvested on the 13th and 25th of July and 2d of August. The result is here given in tabular form:

Field.	Raw flax.	Retting flax.	Beaten flax.	Gross proceeds.	Gross proceeds.
				Florins.	*Florins.*
No. 1	49–60	28–53	6–41	448. 60	115. 52
No. 2	33–40	18–84	3–76	284	55. 71
No. 3	39–80	22–35	5–36	311	89. 94

The net proceeds of fertilized field No. 1 was 65 florins per m. ctr., and this price was only paid on account of the fine fiber. For the flax of field No. 3, 56 florins were received, and for the flax of field No. 2 (not fertilized) 48 florins.

A good fertilizer has been put upon the market by A. Schram, of Prague. This is a dry powder composed as follows, and soluble in water: 10 to 12 per cent soluble phosphate, 2 to 3 per cent soluble nitrogen, 2 to 3 per cent soluble ammonia, and 16 to 18 per cent soluble

nitrates. Of this fertilizer 400 to 500 kilograms should be used to one hectare (2.5 acres).

The following is also a good flax fertilizer: 70 to 100 kilograms Chile nitrate, 50 kilograms ammonia, 300 kilograms superphosphate, and 100 kilograms nitrates.

Experiments have shown that it is good to spread nitrates and phosphates in the fall and plow them in. Chile nitrate may be spread at the time of sowing. It is very important to distribute manure equally over the land in order to obtain an equal condition of the plants. Chile nitrate is very important for the young plant, as it causes its quick development, thus enabling it to withstand the attacks of the ground flea *(Haltica nemorum)*.

FLAX SEED.

To obtain a good flax crop good seed is of course a prime necessity. The seed must be absolutely fit to germinate in order to produce the

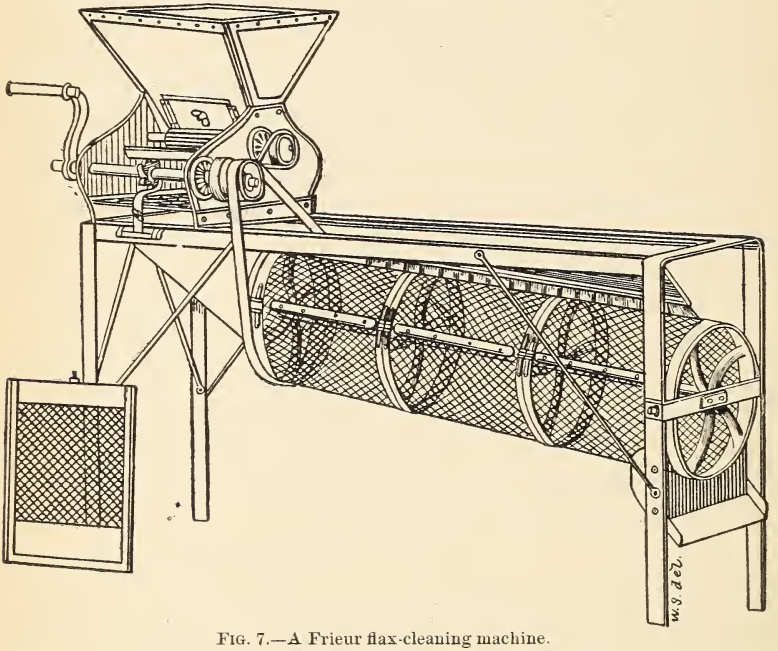


FIG. 7.—A Frieur flax-cleaning machine.

right kind of plants. Of one hundred seeds ninety at least should germinate. The seed should further be fully ripe and developed, for the riper and more developed the seed the stronger will be the plant and the better will it resist exposure to the weather. It should be clean and free of weeds, and it is advisable to clean it before using. This can best be done with a Frieur machine, as shown in Fig. 7.

Old as well as badly stored seed loses its ability to germinate, and it should be tested, which is done as follows: A box is filled with earth and one hundred or two hundred seeds are put in and often sprinkled, the box being kept in a warm place. The number of plants thus obtained

should be counted. A better apparatus is the germinating apparatus of Nobbe, consisting of clay plates with little trays. Good seed should not have a damp or moldy smell; the surface should be smooth and shiny. It must be heavy enough to sink in water. It should contain a sufficient quantity of oil, which can be ascertained by putting it on a hot iron plate, when the good seed will jump up with a peculiar crackling. A frequent change of seed is of great advantage in flax culture.

In Austria the Russian is preferred. When changing the seed the Austrian farmer makes it a rule to select for a rich soil the seed harvested from a poor soil; and where the climate is mild, the seed coming from a locality where the climate is more severe. The Russian seed therefore is preferred in sowing seed in all countries of a mild climate when the field is well cultivated and manured. It produces a flax of the most excellent quality. It is said that the best seed is produced in the territory of Porkowo and Ostrowo. The seed produced in these territories is brought to Riga to be cleaned and from here it is exported to various countries. The largest firm dealing in linseed in Riga is M. M. Mitchel & Co.

There are three kinds of linseed usually exported from Riga: The first is of a green color and the barrel in which it is packed bears a yellow label upon which is printed the letters E P N C S L S; the barrel is also marked with the year of the seed and the name of the firm. The second kind, which is also considered a second quality, is of a yellowish color. The barrels are marked with the letters P N C S L S. The third kind is of a very inferior quality and is shipped in bags; it is sold under the name "Druana."

A barrel of Riga linseed contains 115 to 130 liters of seed and weighs 83 kilos[1] gross. The price is from 20 to 30 florins a barrel (1 florin 40 cents). Besides the Riga seed, Pernua and Lithuanian seed is bought. That from other countries is of no importance. The first seed crop obtained from the above mentioned seed shipped in barrels is in Austria called "rose linseed," and is found to be superior to the original Russian seed. Old farmers here, who cultivate flax, prefer seed which is two or three years old and they claim that with this seed the cultivation is more equal and the plants are much strouger and resist exposure to the weather better.

W. Funke made some very interesting experiments with American and Russian seed on a field of one-fourth hectare (three-fifths of an acre) with the following result:

	Crop per one-fourth hectare.									
	Dried straw.		Of which the crop was—							
			Seed.				Fiber.		Ton.	
	1	2	1	2	1	2	1	2	1	2
	Kilos.	*Kilos.*	*Kilos.*	*Kilos.*	*Kilos.*	*Kilos.*	*Kilos.*	*Kilos.*	*Kilos.*	*Kilos.*
1. White American seed	556	628	31	39	35.5	39	79.3	86	82	93.3
2. Russian seed	582	636	36	38	38	38	72.7	82.7	96	100.1

[1] A kilo is 2.2 pounds.

The above experiment showed that the two year old seed gave a larger crop than that of one year.

Some farmers dry the seed at a temperature of 15° to 50° Celsius, and they claim that by doing so they get a larger crop, but Prof. Haberlandt, of the High School for Agriculture in Vienna, proved by experiment that drying of the seed is no advantage; the results are always uncertain, and in dry localities it should never be done.

SOWING.

Every farmer should first make up his mind whether he intends to cultivate flax for the fiber or the seed. One should always try to obtain a fiber of good quality; the seed is a secondary matter. The Austrian farmer who tries to succeed in both will not accomplish anything.

It would be of great importance to Bohemia if the flax cultivators could be convinced that it is possible to raise in Bohemia just as good seed as in Russia; the seed raised and exchanged among the various localities of Bohemia would be quite sufficient, but in order to accomplish this it would be necessary to distribute the work of flax cultivation so that one locality would raise fiber and another seed, as is the case in Russia. There are many localities in Bohemia well adapted to this purpose. At present, however, efforts are made only to obtain a good, strong, and fine fiber.

Flax sown late in the season, especially that which on account of much rain grows extremely fast, has very long hard cells with thin walls. This explains the fact that the fiber of late flax breaks easily and the farmer obtains, in spite of his nice high plants, only a small quantity of good strong flax, but a large crop of tow.

Director F. Russ, of Trautenau, gives in his work "Gesammelte Erfahrungen auf dem Gebiete der Flax Culture," 1886, a very good example relative to late growing. Two fields of 1 hectare each, in the same condition, were sown with flax, one on May 10 and the other on June 22. The result was as follows: The crop of the first field was 42 m. c. (4,200 kilos*) and that of the second was only 36 m. c. (3,600 kilos) of dried flax stalks. The 42 m. c. was valued at 315 florins, while the 36 m. c. was worth only 216 florins, or 99 florins less. The process of retting the early flax caused a loss of 22 per cent, and with the late flax a loss of 27 per cent. The value of the early flax was 11.50 florins per m. c. (100 kilograms), and that of the late flax 9 florins. The $32\frac{3}{4}$ m. c. of early flax therefore had a value of 376.62 florins, and the $26\frac{1}{4}$ m. c. was worth only 236.25 florins, which shows a difference of 140.37 florins. The early flax produced, after having been swingled, 28 per cent, and the late flax only 23 per cent real fiber; and the fiber of the early flax was sold for 478.40 florins (9.02 m. c. at 52 florins), and that of the late flax for 264 florins (6 m. c. at 42 florins).

* One kilo is equal to 2.2 pounds avoirdupois.

After such trials, made by an experienced man like Director Russ, it can only be recommended to plant the flax early in the season, as soon as the weather allows it. Flax is not so sensitive as one imagines and as soon as the plant is through the earth it can resist even a strong frost.

In order to produce a fine, strong fiber flax must be thickly sown; the more thickly it grows the less apt it is to ramify. The stalk will also have but one blossom on the top of the plant, which will produce only one capsule, and that should be the ideal of him who wishes to procure good fiber. Thick sowing, however, has a limit, as it often happens that when plants are too near together they die, especially if the soil dries rapidly.

It is a well-known fact that plants give out large quantities of water and therefore uncultivated fields possess more moisture than planted ones. It can not be denied that the shadow caused by high plants hinders somewhat the drying of the soil, but the avaporation through the leaves is so great that cultivated fields lose more moisture than uncultivated ones.

An experiment made on July 16 on various thickly planted flax fields showed that the closer the plants the less moisture the soil contained. Further experiments were made on three beds, each containing 4.2 meters, with the following results:

The soil where 60 qr. of linseed was sown showed 9.53 per cent moisture; that where 90 qr. was sown, 9.09 per cent; and the third, where 120 qr. was sown, 8.98 per cent. A record trial made on four beds, each containing 4.2 meters, sowed with 50, 100, 150, and 200 qr. seed respectively, showed that the last bed was dry in June, whereas in the other three beds the plants stood the dry season satisfactorily and the plants developed nicely.

Prof. Haberlandt has made various experiments concerning the strength of the hemp and flax fiber, and he makes the following statements: (1) The favorable influence of irrigation upon the strength of the harl can not be disputed. Harlbands of 2 millimeters breadth obtained from non-irrigated beds showed an average strength of 4.12 kilograms, while those taken from irrigated beds showed a strength of 5.48 kilograms. (2) The nearer together flax is planted the stronger will be the fiber.

If flax be cultivated for the fiber, broadcast sowing is recommended, either by hand or with the broadcast-sowing machine. If, however, seed is to be raised, it should be sowed in rows, and 190 to 200 liters of seed are sufficient for 1 hectare (2.5 acres). The seed should be covered only to a depth of 2½ to 5 centimeters. Before sowing it is absolutely necessary to harrow the land in all directions several times and once just before sowing. Immediately after sowing the seed should be covered with the harrow and then rolled in order to press the soil firmly upon the seed. This is very necessary to produce quick and equal ger-

mination; the plant will also develop better and stand more exposure to the weather. The roller also breaks the clods, levels the surface, and destroys the ground flea (*Haltica nemovum*), which is apt to damage the plants. Rolling should not be done five days or a week after sowing, as then the seed has germinated and damage would be done. If the soil be heavy, rolling can not be recommended, as a crust will be formed, especially after the rain, which will prevent a quick and equal germination. Sowing with a drilling machine can not be recommended, especially if a fine harl is desired, as the stalk will get too thick and too forky and the harl will be too coarse.

HOEING.

Hoeing is of very great importance. Weeds cause much damage. If the 275 liter seed sowed on 1 hectare of land contain only 5 per cent weeds the quantity of different weeds which would germinate on this land would amount to 300,000. If the flax be sown in the manner above indicated the seed will, with favorable weather, germinate in about one week; the plants will in the next four to six days reach a height of 5 centimeters, and then the time for hoeing has arrived.

With the exception of the sugar beet no plant is so sensitive to weeds as flax. They remove from the soil large quantities of nutritious substances, and the consequence is that the flax plant will soon be stunted and die. A flax crop mixed with weeds is difficult to ripple and harvesting will be delayed. Flax, mixed with weeds, shows much ramification, and the fiber is short and coarse. It is also very difficult to separate flax from the weeds. Hoeing should be done when the land is moderately dry to facilitate the pulling out of the weeds, and it should be repeated once or twice to thoroughly remove the weeds. In Bohemia it is usually done by barefooted, half-grown children.

Just as clover is attacked by the *Cuscuta epithimum* so is flax attacked by the *Cuscuta densiflora*, which, once appearing, usually does great damage. The best remedy is to pull out the plants which have been attacked and to burn them. According to French reports a good remedy against the *Cuscuta densiflora* is the following: Dissolve 25 to 30 kilograms sulphate of iron in 100 liters of water. Wet the land with this wherever the parasite shows itself.

Weeds which damage the flax plant are: *Galium aparine*, *Camelina sativa*, *Lolium linicola*. These three plants are dangerous, as they are difficult to distinguish from the flax. A few others are: *Sinapis arvensis*, *Silene linicola*, *Spercula arvensis*, *Poligonum lapathifolium*, *Chenopodium album*, *Erysimum cheiranthoides*, *Ervum hirsutum*, and several kinds of the *Euphorhia*.

DISEASES OF THE FLAX.

Flax, like the human race, is subject to a variety of diseases.

(1) *The rust.*—A flax plant suffering from rust shows it by the lower part of the stalk becoming yellow and the upper part later becoming

black. The plant dries up and dies. The blossom becomes flabby and of course does not produce good seed.

The principal cause of rust is the use of too fresh stable manure, containing too much straw or some other nitrogenous manure. It is also claimed that rust is caused in some cases by too frequent cultivation of flax on the same land.

(2) *Falling off.*—This disease is characterized by the top of the plant bending and finally falling off; a young shoot springs out of the middle of the stalk, which weakens the plant and injures the quality of the fiber. Should this happen in dry weather it is the more dangerous.

(3) *Faxiness.*—Only the top of the plant suffers by getting red; these plants are not suitable for retting. The causes are heat and drought. Others claim that it is the result of too late harvesting, and that it shows itself usually when the weather during the summer was too wet and cool.

Flax is sometimes attacked by a certain kind of mold known under the name of *Phoma exiguum.* Plants grown from directly imported Russian seed suffer less than others from this mold, which sometimes causes considerable damage.

The most dangerous insect is the ground flea (*Haltica nemorum*) before referred to. The best remedies are cool weather and rolling the land right after sowing. All other of the proposed remedies injure the flax as well. Moles often do much damage and should be destroyed. Another dangerous enemy is the *Plusia Gamma* (night flutterer). It can usually be found in the fall in clover fields, and can be easily recognized by having the Greek letter gamma of a silver-white color on its wings. The caterpillar of the night flutterer eats up the blossoms as well as the leaves of the plants and causes heavy loss.

A second kind of butterfly is the *Conchilis* or *Tortrix epilina.* This is only 7 millimeters long, head, breast, and legs yellow, the lower part of the body gray. The caterpillar is also 7 millimeters long, of a yellowish white color, and has few hairs; the head is dark brown; it has 16 legs. The female lays the eggs in June and July, about evening, in the flax blossoms; the caterpillar bores itself into the seed bud, and the hole thus caused heals over and nothing will be noticed. As soon as the caterpillar has eaten up the seed in the capsule it forms its chrysalis from which the butterfly emerges about harvest time.

HARVESTING.

Harvesting should be done at a time to secure the best fiber, *i. e.*, before it is perfectly ripe or when the leaves and the seed capsules become yellow. After the flax is pulled it should not lie too long upon the ground, but should be put into stocks in the following manner: First, a pole is driven into the ground. Against this pole bunches of flax are placed in a sloping direction, the roots being pressed into the ground and the tops against each other until the stook is of proper

size, when the top is encircled with a band of straw to hold it secure. Plate I shows the formation of stooks as described.

Most farmers in Bohemia spread the flax over the land as soon as it is pulled, which can not, however, be recommended, as the seed becomes damp and moldy and can not be used for sowing; the retting of the stalk will be one-sided, causing an unequal quality and the flax will lose in value. Stooking should only be done in good weather, and care should be taken that the branches are close together.

In some parts of Bohemia it is customary to bind the flax together in small bundles as soon as it is dry, as is done in Belgium, and it is also piled up in the Belgian manner. As this has been described by Special Agent Dodge, in Bulletin No. 1, Fiber Investigations, I do not need to go into particulars.

Stacking in Bohemia is done in the following manner: A few poles are placed on the ground to keep the flax from touching the same, and bundles of flax are laid upon them with the roots outside. Two or three layers are thus placed until the stack reaches a height of about 2 meters and should be perfectly level. Then on one edge should be placed a single row of bundles, not at right angles, but paralleled to the lower branches, and over all should follow the last layer. The top of the stack will now be inclined and better calculated to throw off rain. A layer of straw is then put over the whole. Poles are driven at each end to prevent the stack from being overthrown.

Plate II shows the formation of the stacks as described. In these stacks the flax remains for several weeks to dry, and the buyer lays great stress upon the length of time they so remain. In some parts of Bohemia flax is stored in barns and hung over a framework to dry, and retting is done in the spring. This makes a better quality of flax.

TREATMENT AFTER HARVESTING.

The separation of the seeds from the stalks is usually done by thrashing or with a hammer, as shown in Fig. 8, but neither of these ways

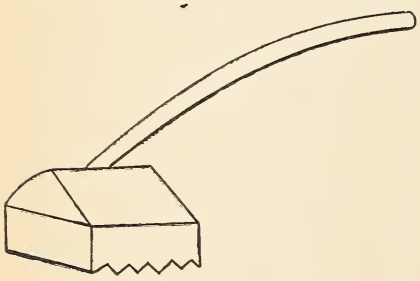


FIG. 8.—Hammer for thrashing flax.

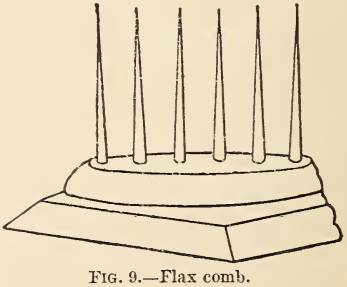
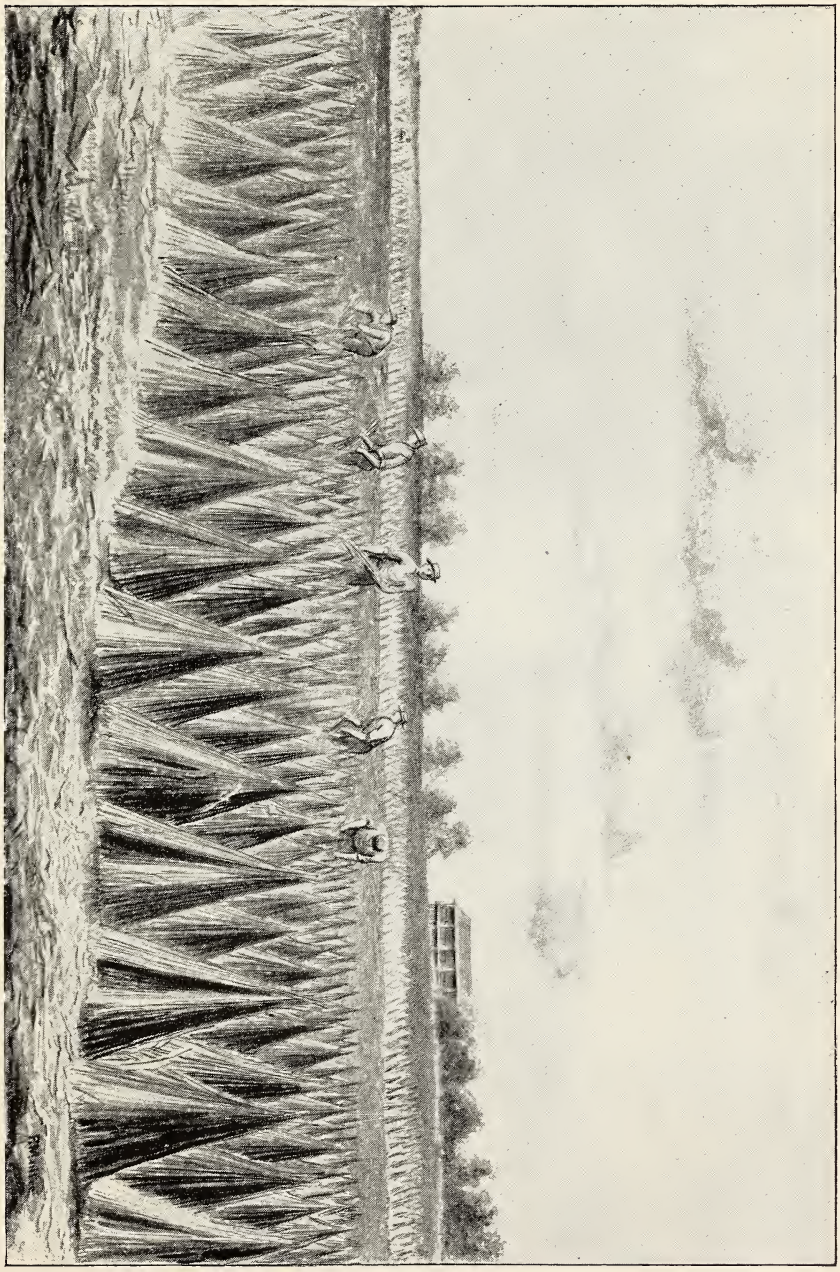
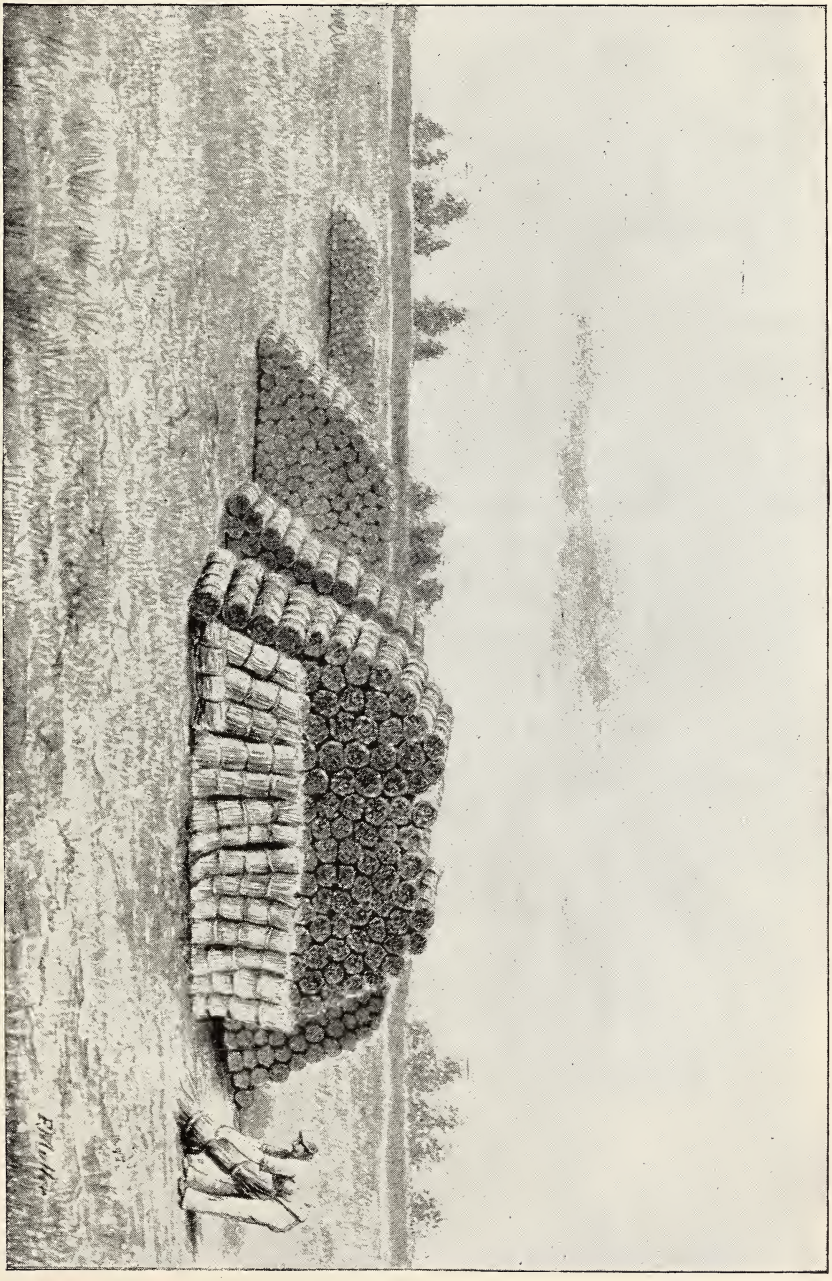


FIG. 9.—Flax comb.

can be recommended, as the stalk gets broken and dirty and the flax loses in value. Another way which has been introduced into Bohemia is by means of the so-called flax comb, as shown in Fig. 9. The flax is



VIEW OF FIELD OF FLAX, SHOWING METHOD OF FORMING STOOKS.



VIEW SHOWING METHOD OF STACKING FLAX.

pulled through such a comb, which causes the seed to fall out. The capsules are placed on cloths, dried and thrashed in the spring.

In rippling too much flax should not be taken at once. At first it should be passed lightly over the comb and gradually pressed deeper and deeper.

When the flax is freed from the stem it should be separated according to fineness, length, ramification, and color. The workman takes a handful of stalks and knocks the lower end (the roots) against the ground or a piece of wood to free it from dirt, etc.; then, holding the upper ends against his body, he examines the stalks and picks out spotted and dark-colored ones. The remainder he knocks against the floor to get them even; then, holding the bunch between his knees with the tops in front of him, he pulls out the stalks of a similar length. Bundles are then made of stalks having the same length.

RETTING.

When preparing the stalk it is necessary to separate the fiber from the various worthless parts of the stalk. The union of the harl and the woody portion of the stalk is not very intimate and it is easy to strip off the fibers by softening the stalk in water. The bark is thin and brittle and can also be easily separated from the harl.

The mechanical manipulation of the flax by drying, breaking, and combing would be sufficient to separate the wood and rind from the fiber, but these are united by a sticky, greenish-yellow gum, which water will not dissolve and which can only be removed by a chemical process, after which it is possible to separate the fibers and prepare it for spinning. There are only two ways of removing the gum from the fiber—treatment with alkaline or dissolved soap or by putrefaction. Experience has shown that the latter process is the best and this is called technically "retting." There are two systems of retting, viz, dew retting and water retting; water retting may be either warm or cold.

Dew retting is done by spreading the dry flax over a meadow or stubble field where it remains until the gum decays and partly disappears, the flax being from time to time turned over with a pole. As soon as the stalk can be easily broken and when the woody portion can easily be separated from the fiber, the flax is sufficiently retted.

The advantage of dew retting is that it progresses slowly and over-retting is not to be feared; the flax must, however, be regularly turned to avoid an uneven retting. Further, no apparatus is necessary and the flax does not become so dark in color, which, of course, facilitates bleaching. The disadvantages are: an increase of labor and loss of time in turning the flax, as retting takes from three to ten weeks according to the weather. Rain, dew, sun, and wind influence the rind in a high degree and cause a loss of weight, fineness, and strength, and the result is a reduced quality and quantity of flax and an increased quantity of tow. The loss of weight from dew retting amounts to 30

or 40 per cent, while water retting causes a loss of 20 to 30 per cent. It is therefore clear that dew retting has more disadvantages than advantages and therefore water retting is preferred.

Cold-water retting has the further advantage that the stalks need not be artificially dried in a kiln before breaking. The expense of water retting and dew retting is about the same; the former requires pits and the latter a kiln.

For water retting the cleanest water should be had, rainwater preferred. Slow running river water is still better, if it can be had. Fast running river water contains too much mud, which would be deposited upon the flax bundles. Hard water should be avoided, especially that containing lime and iron; also water containing rotten leaves, especially oak leaves. If spring water has to be used, the retting pit should be filled some weeks before using in order to soften the water. Green flax is retted immediately after harvesting. Dry flax should be retted when the weather is warmest. In Austria retting is done from the beginning of May to the end of September.

The pits are usually 12 feet long, 6 feet broad, and 5 feet deep, that the flax may stand upright. A pit of this size holds 6 to 7 centners (one-third of a ton) of dry flax. The water from such pits is dangerous to fish, and if flowing into a river will do much damage unless discharged very slowly. The best way is to have a delivery pipe run into the bottom of the pit, and as soon as the retting is done the water should run slowly through a small gutter on the upper edge of the pool. This is accomplished by simply turning on the water, which also dilutes the poisonous water discharged. Retting can also be controlled, and over-retting and overcoloring avoided. Two qualities of flax should not be retted in the same pool, as a fine flax needs a longer time to ret than that with coarse stalks.

A crate made of laths is provided, the inside of which is lined with straw to catch impurities. The bundles are packed tightly into the crate, but not so tightly that the water can not reach each bundle.

In order to secure an equal retting it is again necessary to consider the structure of the stalk. The stalk near the root contains much wood and the harl is more extended, more porous and fibrous than the upper end. The root rets faster than the upper end, and as heat furthers fermentation, it is necessary to have the upper ends of the bundles on the surface and the roots on the bottom of the pool. The crate being filled, it is covered with a layer of straw and lowered into the pit and weighted with stones until it is about 6 inches under water. Should the development of gas cause the tank to raise in a few days more stones are employed.

The length of time necessary for retting depends upon the water, temperature, and quality of flax; it may need only a few days or it may require two or three weeks. If the temperature of the water be 14° R. (63° F.), fourteen days will usually be sufficient; with 16° R. (68° F.),

ten to eleven days; with 18° R. (72° F.), eight days. The quicker the retting, the stronger the harl. Quick retting, however, needs great attention or overretting will ensue. This is the reason why many prefer river retting which is somewhat slower but does not need so much attention.

When the harl pulls easily off the woody core and the stalk breaks like glass without the fiber sticking to it, the flax is sufficiently retted and can be taken out. As stated before, retting needs great attention, and large farms employ experienced men who remain by the crates from 3 o'clock a. m. to 11 o'clock p. m. When the period is about over the straw should be examined four or five times daily.

Warm-water retting is done in special tanks, and either warm water or steam is used. The best method is that introduced by Schenk. The flax is put in tanks filled with warm water and fed with steam. The fermentation is, on account of the heat, a quick one, and retting is usually accomplished in sixty or seventy hours. The principal advantages of warm retting are: independence of weather and season, quicker process, larger yield, and better quality.

Warm-water retting, however, causes considerable cost for buildings, etc., and is therefore only practicable for large flax-preparing establishments. Moreover, many doubt that the quality of flax depends largely upon the retting, and as this process needs much attention and experience to make it a success, there have been founded so-called association or community retting pits for which an expert is engaged. The neighboring farmers bring their flax and pay a small fee to have it retted. Such associations are found especially in Moravia and Silesia, and it would seem as if they would prosper in the United States when flax-growing shall really have begun. Such pits should be located where the best water is to be found.

BLEACHING

After retting has been accomplished and the flax has been dried it is spread in a very thin layer over a field and exposed to the influences of the sun, dew, and rain until it assumes an even color. This is often accomplished in a few days, but sometimes it requires several weeks. As soon as the color has changed a little the flax should be turned. In order to force the bleaching the flax must be turned every second day; otherwise only after a rainfall when the flax has again dried. Some farmers put the flax, upon the completion of the retting process, in barns and bleach it the following year; this custom prevails also in Belgium. Bleaching is, however, only necessary in cases where the stalk keeps its green color before retting begins. It is very difficult to remove the color afterwards, and the appearance of black spots and stripes usually can not be avoided. Bleaching can not injure the flax at all, and a second retting has usually no effect; if put into the pits again it will ret scarcely any, if at all.

Bleaching gives the flax an even color and improves the fiber in quality if the weather is favorable. The fogs of spring and fall are especially favorable for bleaching, whereas dew in summer injures the fiber and continued sunshine hardens it, making it brittle, and causing red stripes. In case of rainy weather during bleaching, frequent turning will be necessary to prevent decay. Bleaching may be considered to have been accomplished as soon as the flax is even in color and the harl can be easily separated from the stalk. If the flax has not been sufficiently retted and the harl can not be pulled, the flax must be bleached longer; but in such a case it is impossible to control the color, which is of great importance with the better class of flax.

Flax having been housed in a very dry condition does not need to be kiln-dried. Kiln-drying of flax is not only dangerous on account of fire, but it injures the fiber, which loses in strength, brightness, etc., and becomes brittle. When bleaching has been finished, it is advisable to stand the bundles up or spread the flax if the weather is warm and sunny, to dry thoroughly before breaking, the next step, begins. Dew-retting and sometimes various other causes make it necessary to kiln-dry the flax.

BREAKING AND SCUTCHING.

Breaking has for its object the separation of the fiber from the stalk. The machine used for this purpose in Austria and other countries, where methods are somewhat antiquated, is the so-called "flax-breaker" shown in Fig. 10.

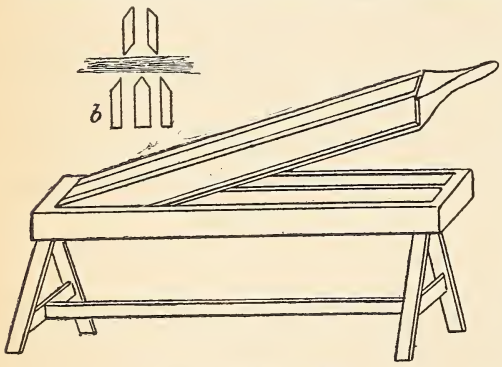


FIG. 10.—Flax-breaker.

Breaking is done by moving the straw backward and forward through this machine, at the same time pressing sharply and quickly with the lever, the object being to free the fiber from the woody matter or "shive." The flax is first worked on a machine with one tooth and the work is completed on a machine with two teeth.

To clean the fiber altogether from the shives it is customary in some localities to knock the handful of broken flax over the machine; but this is not satisfactory, and it is recommended to use the scutching-knife, a short flat wooden knife which is used to beat out the shive.

Breaking often causes the fiber to be torn, and another disadvantage is that it can usually be done only when the flax was dried in a kiln; and as kiln-drying injures the fiber it is obvious that breaking is not a satisfactory process.

Another process with the so-called "Botthammer" or batting hammer is preferred in this country. The batting hammer is made of wood ridged like a cook's implement for pounding a steak. The handle is covered. Batting is usually done in a barn and in the following manner: The workman opens a bundle of flax and divides it into small bunches; these bunches, which should not be too thick, are placed on the floor. Taking one at a time he puts his foot on the upper end of the stalk and spreads the other end out like a fan. The flax is now beaten, beginning near the root, then the other end, and finally in the middle of the stalk, until the woody portion is thoroughly broken. It is then necessary to shake the bunch to rid it of shives and other impurities. Then the bunches are again tied together in bundles. This method is very primitive and cheap in this country. It is not necessary to break the flax again, but it may be scutched immediately, although it is claimed by many farmers that it is advisable to store the flax for some time to improve its quality. Sometimes flax is first beaten and then broken. Breaking and beating should be done in warm pleasant weather.

Prof. Seydecker remarks that it would be a good thing if the farmer could sell his flax after having obtained the seed, the after-process to be conducted by others, as is the case in Silesia, where they have "flax-preparing establishments." These establishments, however, proved to be of little advantage except they were in connection with spinning mills, or when the farmer produced flax on such a large scale that he could have his own machinery. They might, however, prove a success if a number of farmers agreed to cultivate a certain quantity of flax, as they agree to furnish the mills with sugar beets in many localities. Breaking and scutching machines of the better sort are too expensive for the ordinary farmer.

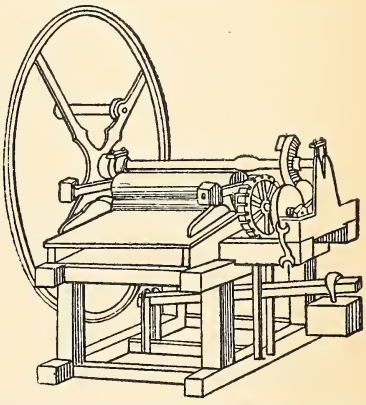


FIG. 11.—The Warneck breaking machine.

In Silesia there have been founded breaking and scutching establishments, where the small farmer may do his work upon paying a small fee for the use of the machines.

The patent Warneck (see Fig. 11) and the Kasclovsky breaking machines are mostly used in Austria. The former may be recommended for small farms because it is also made for hand power; the latter is also run by horse or steam power. A good scutching machine has also been invented by Kasclovsky, requiring 6 persons to work it, viz, 2 to turn the wheel; 1 feeder; 1 to pass the flax to the feeder; 1 who catches and disposes of the broken flax; 1 who ties up the broken flax.

The flax is caught by the first pair of rollers and carried to the second pair, where it is moved backward and forward until the stalk is

completely broken and falls out of the machine. The machine breaks the stalk equally and quickly, and by using afterwards the scutching knife and by shaking the fiber it is soon cleaned. It not only works safely but produces more and better fiber than hand work. It can be worked by grown children, which is an advantage, as at harvest time it is sometimes difficult to procure enough workmen. It is, moreover, not very expensive.

The smaller farmers use for scutching the very simple appliance shown in Fig. 12.

The workman stands behind this machine and inserts the flax in the slit, which is then rubbed with a wooden sickle-shaped knife. The roots are first worked and the bunch is continually turned until it is cleaned of the wood. Some shives will have to be picked out by hand. The manipulation with the scutching knife is not sufficient to produce the finer class of fiber. To accomplish this two other tools are in use in Austria. One is a wooden comb used to clean the butt end of the flax, where it is usually harder to loosen the shives. It is then put through the scutching machine again until its appearance is satisfactory.

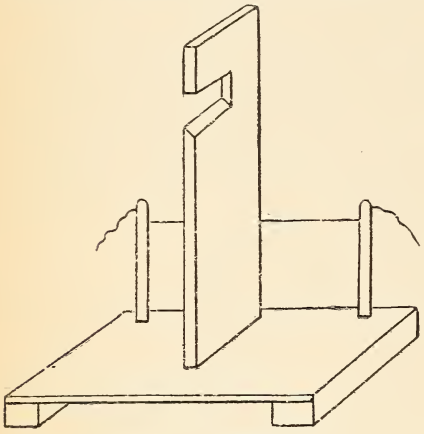


Fig. 12.—Scutching board.

At last follows the process of scraping, which is done with a peculiar blunt knife, on the thigh, which is covered with a leather apron.

RESULTS OF FLAX CULTIVATION.

The best proof that flax cultivation is profitable is shown by the fact that even in those localities where sugar beets are grown many farmers prefer to raise flax. It is, of course, difficult to make up exact calculations comparing the cost of cultivating flax and other crops, as the wages and cost of land vary too much, but a few examples are of interest.

Mr. Joh. Russ, director of the Faltis spinning mill, gives the following figures: One metze (1.75 bushels) of rye sowed on a field of 20 are (1 are = 100 square meters) produces 8 metze each of 48 kilograms of rye. One kilogram of rye is worth 8 kreutzers. The nett proceeds of the 8 metze would amount to 30.72 florins ($12.29). One metze of sugar-beet seed will produce 50 m. ctr. @ fl. 1 – fl. 50, or $20. One metze flaxseed will produce 7 m. ctr. of dry, unretted flax @ fl. 8–56 fl., or $22.40—the gross proceeds of the flax, provided it be sold after harvesting.

The crop of 1 metze of beet-sugar seed may be as much as 60 m. ctr., in which case the proceeds would be 60 florins ($24). One metze of flaxseed brought only 56 florins for the stalks, but by adding the proceeds for the seed crop (1 m. ctr. for 1 metze), or 12 florins, we have as

a result 68 florins, or $27.20. The cost of cultivating sugar-beets is higher than that of cultivating flax.

An experiment made on a farm in the Erzgebirge showed the following results and comparisons. The field consisted of 50 are.

Expenditures.

	Florins.
1. Rent of the field	30.00
2. Preparing the land	11.00
3. Fertilizing in fall—	
34 kilos bone dust	6.50
202 kilos potassic salt	
4. Cost of 52½ kilos of rose linseed	21.63
5. Weeding	6.00
6. Insurance	11.00
7. Stocking	22.25
8. Riffling	15.00
9. Retting, bleaching, and weighing	16.25
10. Breaking and scutching	64.13
11. Cleaning the seed	2.18
	205.94

Crop.

I. For the seed and seed waste—		
(*a*) 294.5 k. I[a] II[a] seed @ fl. 16	47.12	
(*b*) 14.5 k. III quality @ 5 kr	.72	
(*c*) 439.0 k. seed waste @ 1 kr	4.39	
II. For scutched flax—		
(*a*) 402.5 k. a. fl. 50 per m. ctr	201.25	
(*b*) 25.0 k. green retted flax a. 50 kr	12.50	
III. For tow—		
(*a*) of the green retted flax 7.5 k. a. 6 kr	.45	
(*b*) of the green retted flax 10 k. a. 15 kr	1.50	
(*c*) of the dry retted flax 82 k. a. 6 kr	4.95	
(*d*) of the dry retted flax 137 k. a. 15 kr	20.55	
	293.43	

Or—

Crop	293.43
Expenses	205.94
Net proceeds	87.49

The methods of flax cultivation and preparation in Austria are behind the times, and unfortunately there are no indications of improvement. The farmers are not educated up to the times, and freights for flax are so heavy that it interferes sadly with its movement.

The freight charged for transporting flax straw by the Government railways and some private companies, for a carload of 5,000 kilos, is for each 100 kilos:

	Kreutzer per kilometer.
For the first 40 kilometers	0.26
For the second 40 kilometers	0.24
For the next 75 kilometers	0.21
For the next 75 kilometers	0.18
Over 230 kilometers	0.16

This rate is, for a product like flax, very high, but the fact that the freight must be paid on a carload of 5,000 kilos, whereas only 2,000 kilos can be loaded, makes it still higher. It is said that the freight in Germany on flax is 66 per cent cheaper than in Austria. Germany has, however, special cars for flax transportation. Austrian flax freights are from three to five times as high as Russian. All these influences retard the growth of the Austrian industry.

Appendix A.

FLAX CULTURE IN RUSSIA.

In the present and foregoing reports of the Office of Fiber Investigations, the flax culture of Ireland, France, Belgium, and Austria has been considered at length. 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. Last season (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.

It should be stated at the outset that 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 among 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.

The following table, from the report of Consul-General Crawford, of St. Petersburg, shows the area and value of the Russian flax crop, per province, calculated on the average of the five-year period, 1882–'86.

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.	*Acres.*	*Pounds.*	*Bushels.*			*Eng. lbs.*	*Tons.*		
Don District	252,691	756	1,313,455	$0.57	$1,154,383				
Ecatherinoslaw	252,728	720	1,203,669	.62	1,170,038				
Kherson	164,389	648	548,287	.67	717,834				
Tauride	117,607	576	448,025	.65	453,003				
Tamboff	103,736	1,188	815,075	.56	716,359				
Saratoff	68,618	1,116	521,232	.52	421,619				
Samara	67,146	1,188	526,793	.48	393,339				
Poltava	57,891	1,080	413,505	.59	382,722				
Varonej	57,342	1,080	409,590	.57	363,170				
Besarabia	44,666	864	255,235	.58	232,263				
Kazan	40,819	900	242,968	.51	190,865				
Orenburg	39,404	864	225,165	.36	126,092				
Riazan	37,309	1,080	266,490	.50	234,343				
Kharkow	25,377	720	173,224	.58	164,634				
Penza	32,543	1,296	278,941	.50	216,954				
Tchernigow	31,258	1,008	208,386	.52	170,182				
Outa	26,876	1,152	204,768	.42	135,375				
Simberia	22,302	1,080	159,300	.47	116,466				
Volhynia	21,713	1,036	185,845	.57	164,783				
Orel	12,293	1,080	87,808	.65	92,198				
Toula	11,958	828	65,486	.55	56,027				
Astrakhan	10,298	720	49,037	.48	36,996				
Kieff	5,260	1,008	35,064	.56	30,817				
Podolia	3,218	720	15,325	.60	14,304				
Koursk	1,933	1,080	13,809	.61	13,103				
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
Litland	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
Niji-Novgorod	113,686	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	49,559	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

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.

As to local prices of flax in Russia, Mr. Crawford says:

The local prices of flax depend upon the quality of the flax rather than upon the quantity. Thus, according to the data received from the correspondents of the department, the average price per pood or 36 English pounds in 1882 was $1.83; in 1883, $1.85; in 1884, $1.93; in 1885, $2.05; in 1886, $2.03; in 1887, $1.96. If we consider the local autumn price paid for flax in the provinces grouped together, we find that in the black-soil provinces the average for 1882–'86 was about $1.50 for 36 English pounds, while in the provinces of Oufa and Orenburg the price was $2.25. In the common-soil provinces the lowest price was about $1.75 in the western provinces; in the industrial provinces this price rose to $1.85, in the Baltic provinces to $2.07 (that is to say, about equal to the prices paid in the central and transvolga provinces), and to $2.25 in the northwestern provinces. If proprietary flax be taken separately, the difference in prices is excessive; in some places the prices fell 50 cents and in other cases they rose to $5 and $6 per 36 pounds; and also in the provinces taken separately the variations of prices were quite remarkable. From the foregoing tables it is seen that in the provinces of Smolensk and Mohilieff the average price for five years did not exceed $1.50, whereas in the provinces of Kostromo, Vologda, Archangel, Olenets, and Grodno the price rose to $2.50 and higher.

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.

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.

It is difficult to learn the net profit of the flax industry, but in many places in the common-soil provinces, where properly managed, it is one of the most profitable of the country.

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.

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. Mr. Crawford's report is interesting reading at this point.

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.

With the maceration system the chances of a good manipulation of the fiber are much greater than when the flax is exposed to the dew. If the flax which has been grown on a well-known soil is macerated in water, whose quality is known, the proprietor may be certain that he will receive a uniformly good quality of fiber in a definite number of days; whereas when the proprietor exposes the flax to the weather he is liable to serious consequences, which may occur as well from the excessive rainfalls of autumn as from continued drought, frost, and cold winds, not allowing the flax thus exposed to lie until the time when it could be properly handled, although in a clear and warm autumn, with occasional rain and great dewfall, the fiber may receive a high quality; but such autumns are very rare.

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. And, likewise, every field is not suitable for the spreading out of the macerated flax, the worst be-

ing reddish clay, red sandy ground, and places covered with slimy and red stagnant water. Some of the best places for maceration are on turf ground and moss ground, as likewise in marshy places of white and blue clay. A very good ground also for maceration is the black soil and sandy soil. In general it is easier to find a ground suitable for maceration than is generally thought, if it be accepted that the maceration should not take place in streams and lakes because of the danger in hygienic relations.

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.

Before being worked, the stalks of the macerated flax, as well as that which has been exposed to the dew, are dried in ovens, and it often occurs that these heated rooms are made too hot or filled with smoke, in which event the filament becomes darker or loses its oleaginous matter and becomes hard and brittle. The working of the flax takes place, in most cases, in the most primitive manner, with simple hand-brakes, which generally injures the too ripe stalks, besides the fact that the most practiced hands can only work about 72 pounds of flax a day. More improved brakes are only to be found in the western provinces, in that of Pskoff and some of the neighboring districts, where some proprietors have installed brakes run by horse-power. Lastly, the final step in the working of the flax, the scutching, takes place in a similar and most primitive manner, for which they use the ordinary wooden scutcher, in the shape of a long, narrow knife or oar.

Scutching by machinery is employed as a rarity, exclusively here and there in the provinces of Lifland, Pskoff, and Vladimir. It may be stated, however, that scutching by machinery only presents an advantage if the flax has already been sorted according to the length, thickness, and maturity of the stalk. Different qualities of flax can not well be scutched at one time by machinery, because it would become thicker and stick faster in one part than in another, and therefore the obstructed bollen in the filament would become uneven. If scutched by hand, the laborer can direct his blows where he sees it is necessary, whereas machinery scutches everywhere evenly, and it can therefore happen that all the bollen in one place will necessitate such long-continued working that at the same time nearly all the residue becomes ruined. And at the same time it must be remarked that flax is rarely assorted by the Russian farmer.

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.

There is no doubt that in our own country the flax-fiber industry would receive a stimulus if the farmers in flax-growing regions could have the opportunity of seeing the crop grown properly by those experienced in the culture.

Turning to Renouard's great work on the Flax Culture of Europe, we find additional reasons for the production of low-grade flax. 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,[1] 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. M. Renouard says:

In the vicinity of Riga the peasants ret the flax in the branches of the Duna, working in the most primitive fashion, without employing the tanks, and holding the flax as best they can. In the vicinity of St. Petersburg the retting of flax in running water is entirely prohibited, and they ret the flax either in stagnant water and bleach it afterwards (this they designate as "mochenets"), or upon the ground (and this they call "slanets"). The ponds in which the retting is done are dug in the meadow bottoms. In ordinary years the water is often renewed, but in very dry years the same water is used five or six times by employing successively the neighboring ponds. The spreading of the flax comes unfortunately, very frequently, in the time of snow or frost. It is quite evident that the laborers, if they had their choice, would not wish for snow, and also ridiculous to see certain authors, who treat the question of retting "on the wing," make a distinction of three or four kinds of retting, one being "retting in the snow as is done in Russia."

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 reader will note particularly what Mr. Crawford says regarding the money loss to the farmers of Russia, through this practice, as cited on a previous page. The foreign marks and names given the different grades or standards from their long standing are almost historical.

The following statements and tables bearing upon this subject are from the report of Consul-General Crawford:

In Archangel and the localities trading in flax, it used to take the name of the locality from which it came; but, as all kind of swindling was discovered, since 1838,

[1] Centigrade, or 32° F. above zero.

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	*C. Third quality.*		
Superior puik kron	S. P. K.	26.00			
Superior puik kron hell	H. S. P. K.	26.50			
Superior puik kron weiss.	W. S. P. K.	27.50			
Superior puik kron grau.	G. S. P. K.	27.50	Dreiband	D.	17.00
Spanisch weiss kron (Spanish).	S. W. K.	30.50	Puik dreiband	P. D.	18.00
			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			
Hofs dreiband (superior third quality).	H. D.	21.00	Dreiband wrack	D. W.	16.00
Hofs dreiband weiss	W. H. D.	22.50	Slanitz dreiband wrack	S. D. W.	15.00

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 reëxported 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: K., Kristen, or very highest; H. D., Hofs Drieband, high quality; D., Dreiband, ordinary; 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.

Appendix B.

STATISTICS OF FLAX CULTURE IN THE UNITED STATES.

The following statements, with tables of acreage and production for the year 1889, are extracted from the recently published Census Bulletin No. 177, on Flax and Hemp, prepared by Mr. John Hyde, special agent in charge of the Statistics of Agriculture, Eleventh Census.

The total fiber production of the United States in 1889 was 241,389 pounds, as compared with 1,565,546 pounds in 1879 and 27,133,034 pounds in 1869. The variations in the relative production of flaxseed and fiber can not be better illustrated than by a statement of the ratio that has existed between them at decennial periods from 1849 to the present time. Thus, in 1849, 1,371 pounds of fiber were produced to every 100 bushels of flaxseed, in 1859 the ratio was 833 pounds to every 100 bushels, and in 1869 it had risen to 1,568 pounds to every 100 bushels. In 1879, however, the ratio was 458 bushels of flaxseed to every 100 pounds of fiber, and in 1889, owing to a greatly diminished production of fiber concurrently with a large increase in the area cultivated exclusively for seed, 4,246 bushels of flaxseed were produced to every 100 pounds of fiber. When the combined fiber production of twenty-one States, from Maine to Nebraska and from North Dakota to Arkansas, amounts only to 6 car loads, it will scarcely be supposed that the industry can be even locally a matter of any considerable importance, and, judged by the ordinary standards of American agriculture, it certainly is not. Fiber, however, has the same peculiarities of geographical distribution, or rather of centralization, that have been shown to distinguish the cultivation of flaxseed, only it has them in a still more marked degree. Illinois, for example, raised 23.93 per cent of the total fiber production of the country, and 99.35 per cent of the crop of the State was produced in three counties. Kansas contributed 14.95 per cent of the whole, and 95.16 per cent of its entire production was derived from two counties. Michigan stood third in rank, but it owed its position entirely to St. Clair County, which produced 79.72 per cent of the crop of the State. Similarly 74.02 per cent of the fiber crop of New York was produced in Washington County, and 58.43 per cent of that of Virginia in Lee County, while the entire production of Indiana and Maine was in each case confined to a single county. In short, although fiber was reported from two hundred and one counties, ten of the number contributed 65 per cent of the entire crop. On the other hand, as must necessarily follow, a large number of counties are reported with a production of only a few pounds each.

Although the agricultural investigations of the Eleventh Census have been, as a whole, nearly two and one-half times as comprehensive statistically as those of any preceding census, such are the magnitude and diversity of the agricultural interests of the country that not a few branches of investigations have still had to be confined within comparatively narrow limits. Accordingly no attempt has been made to ascertain the separate values of flaxseed, straw, and fiber, and the collective values

will be found to vary not only with the variation in the prices of the individual products, but also according to the proportion borne by each of the three to the entire amount sold. In States where but little is realized from the sale of straw or fiber there is a close correspondence between the production of flaxseed in bushels and the amount received by the producer in dollars, the average value of the seed being evidently a trifle under $1 per bushel. It must not, however, be supposed that there was any decided approach toward uniformity in the price received for flaxseed. On the contrary, there appears to have been considerable variation, although there would scarcely be warrant for inferring its precise limits so long as it is impossible to determine the exact value of the straw which is included with the flaxseed in the report. Throughout the greater portion of the principal flax-producing region, however, flax straw is practically of no value, not being utilized even for tow or for paper making. Much of it is got rid of by burning, the small percentage that is turned to good account being used either for thatching purposes or as bedding for stock, although in some instances it is used for feed, a practice greatly to be deprecated.

In the fourteen States having 1,000 acres or upward in flax the average value of all flax products per acre ranges from $3.63 in North Dakota to $12.62 in New York and $13.39 in Wisconsin. Michigan and Virginia, each with a smaller area in flax, average $13.30 and $14.25 per acre, respectively. All the States having a high average value of flax products per acre are comparatively large producers of fiber, with the exception of Vermont, whose 20 bushels of flaxseed were the product of a single acre of land, and California, which had an average of 16.59 bushels per acre, raised mainly on the highly productive lands of the county of San Luis Obispo. The best of the great flaxseed-producing counties of Minnesota, Iowa, or Nebraska shows an average value of flax products per acre of only $12.70 as compared with $15.38 per acre in St. Clair County, Mich., the county containing the Yale flax mills, with $23.82 per acre in Washington County, N. Y., much of the product of which is used in the manufacture of twine, and $31.58 per acre in Lee County, Va., a county in which there still lingers that domestic manufacture of linen which was formerly so important an industry not only in Virginia, but in other of the older States. Lee County has, until within the last two or three years, been entirely destitute of railroads, and almost every family in the county has continued to make its own bed and table linen, towelings, and other linen fabrics of fine quality.

In any comparison, however, either of the fiber production of different States or of that of the entire country at different periods, it is important to remember that but little of the so-called "fiber" produced in the United States within recent years has been fit for spinning, or has really been entitled to the designation that for convenience has been given to it in census and other statistical reports. While flaxseed is a well-defined product, subject only to the same quantitative and qualitative variations as agricultural products in general, flax fiber, as known to the American farmer and manufacturer, has not always had a like uniformity of meaning. Indeed, the utilization of the fibrous portion of the flax plant has varied so widely at different periods that any comparison of "fiber" production based solely upon statistical reports is liable to be misleading. The fiber reported at the various censuses, up to and including that of 1860, was an excellent grade of scutched flax, fit for spinning and able to hold its own against all but the finest imported varieties. The fiber reported at the census of 1870, which was raised to meet the enormous demand for bagging, was, on the other hand, only a very common quality of tow, abounding in woody refuse and so carelessly prepared as doubtless in some measure to have led the way for that adverse legislation which practically put an end to its production. The fiber of the present day is likewise, with few exceptions, only a coarse by-product, used mainly as upholstery tow. As a result, however, of the well-directed efforts of the Department of Agriculture, there are indications of the revival in the United States of a genuine flax industry that should ultimately render the American people the

largest consumers of linen in the world, entirely independent of the foreign manufacturer.

The following table shows the relative rank of flax-producing States in acreage, production of seed, production of fiber, total value of all flax products, average yield of seed per acre, and average value of all flax products per acre:

States.	Acreage.	Production of seed.	Production of fiber.	Total value of products.	Average yield of seed per acre.	Average value of products per acre.
South Dakota	1	3	14	3	21	26
Minnesota	2	1	8	1	8	15
Iowa	3	2	9	2	6	12
Nebraska	4	4	18	4	11	20
Kansas	5	5	2	5	10	17
Missouri	6	6	17	6	13	21
North Dakota	7	7	19	8	25	29
Ohio	8	8	5	7	17	19
Idaho	9	9	.....	9	5	11
Wisconsin	10	10	10	10	3	4
Illinois	11	12	1	12	14	18
Washington	12	11	.....	11	7	13
New York	13	13	6	13	15	6
Indiana	14	14	11	14	19	23
Oregon	15	17	.....	17	18	14
Pennsylvania	16	15	20	15	12	9
Colorado	17	19	.....	19	22	27
Michigan	18	18	3	16	9	5
California	19	16	.....	18	2	2
Kentucky	20	20	7	20	16	10
North Carolina	21	23	13	23	28	24
Virginia	22	22	4	21	23	3
Texas	23	21	.....	22	4	8
West Virginia	24	24	12	24	26	16
Maine	25	26	16	26	30	25
Tennessee	26	25	15	25	27	7
Arkansas	27	28	21	28	20	22
New Jersey	27	29	.....	28	24	22
Vermont	28	27	.....	27	1	1
Massachusetts	28	30	.....	29	24	28
Maryland	28	31	.....	30	29	30

Summary of statistics of flax production, by States and Territories.

States and Territories.	1889.				1879.	
	Area.	Seed.	Fiber.	Total value of products.	Seed.	Fiber.
	Acres.	*Bushels.*	*Pounds.*	*Dollars.*	*Bushels.*	*Pounds.*
United States	1,318,698	10,250,410	241,389	10,436,228	7,170,951	1,565,546
Alabama					52	
Arkansas	2	12	26	14	160	30
California	249	4,130		4,910	45,770	
Colorado	422	1,994		1,960		
Connecticut						
Delaware					4	130
Florida						
Georgia					69	100
Idaho	8,002	83,409		81,521	14,901	
Illinois	4,672	35,013	57,776	40,766	1,812,438	167,807
Indiana	2,737	17,566	4,350	19,120	1,419,172	25,181
Iowa	230,085	2,282,359	6,281	2,323,974	1,511,131	81,354
Kansas	114,069	994,127	36,093	1,008,242	513,616	1,150
Kentucky	186	1,321	12,295	1,928	2,192	48,491
Maine	24	46	1,611	127	88	1,191
Maryland	1	2		3	34	809
Massachusetts	1	4		4		
Michigan	417	3,719	31,610	5,544	2,764	10
Minnesota	303,635	2,721,987	8,609	2,811,384	98,689	497
Mississippi						
Missouri	56,421	450,831	1,458	461,767	379,535	19,452
Nebraska	163,900	1,401,104	1,025	1,392,689	77,805	900
New Hampshire						
New Jersey	2	8		14	5,283	46,701
New Mexico					834	
New York	2,922	21,307	15,826	36,880	72,372	843,965
North Carolina	143	397	3,637	787	503	9,621
North Dakota	43,724	164,319	568	158,609	50	
Ohio	20,553	145,557	18,377	179,288	593,217	123,367
Oregon	563	3,871		5,270	21,742	28,199
Pennsylvania	517	4,183	173	5,772	5,352	19,896
Rhode Island						
South Carolina						
South Dakota	354,951	1,801,114	3,278	1,770,322	26,707	
Tennessee	17	51	2,664	200	787	19,601
Texas	72	794		835	73	150
Utah						4,563
Vermont	1	20		20	362	9,575
Virginia	131	538	27,133	1,867	4,526	66,264
Washington	4,270	42,285		42,131	12,202	25
West Virginia	36	115	4,008	322	1,417	44,393
Wisconsin	5,973	68,227	4,591	79,958	547,104	2,124

Summary of statistics of flax production, by States and Territories—Continued.

States and Territories.	1869.		1859.		1849.	
	Seed.	Fiber.	Seed.	Fiber.	Seed.	Fiber.
	Bushels.	*Pounds.*	*Bushels.*	*Pounds.*	*Bushels.*	*Pounds.*
United States	1,730,444	27,133,034	566,867	4,720,145	562,312	7,709,676
Alabama	2	37	68	111	69	3,921
Arkansas	104	420	545	3,821	321	12,291
California	13,294	31,740				
Colorado						
Connecticut	4	300	109	1,187	703	17,928
Delaware	356	878	2,126	8,112	904	11,174
Florida						50
Georgia	48	983	96	3,303	622	5,387
Idaho						
Illinois	280,043	2,204,606	8,670	48,235	10,787	160,063
Indiana	401,931	37,771	119,420	97,119	36,888	584,469
Iowa	88,621	695,518	5,921	30,226	1,959	62,660
Kansas	1,553	1,040	11	1,135		
Kentucky	14,657	237,268	28,875	728,234	75,801	2,100,116
Maine	227	5,435	419	2,997	580	17,081
Maryland	1,541	30,760	1,570	14,481	2,446	35,686
Massachusetts	52	930	7	165	72	1,162
Michigan	5,528	240,110	341	4,128	519	7,152
Minnesota	18,635	122,571	118	1,983		
Mississippi	2	100	3	50	26	665
Missouri	10,391	16,613	4,656	109,837	13,696	527,160
Nebraska	404	54	2			
New Hampshire	6	177	30	1,347	189	7,652
New Jersey	6,095	234,061	3,241	48,651	16,525	182,965
New Mexico						
New York	92,519	3,670,818	56,991	1,518,025	57,963	940,577
North Carolina	6,756	59,552	20,008	216,490	38,196	593,796
North Dakota						
Ohio	631,894	17,880,624	242,420	882,423	188,880	446,932
Oregon	10,988	40,474	6	162		640
Pennsylvania	15,624	815,906	24,198	312,368	41,728	530,307
Rhode Island						85
South Carolina			313	344	55	333
South Dakota						
Tennessee	4,612	80,930	9,362	164,294	18,904	368,131
Texas	2	25		115	26	1,048
Utah		10	33	4,343	5	550
Vermont	444	12,899	331	7,007	939	20,852
Virginia	9,699	130,750	32,691	487,808	52,318	1,000,450
Washington			30			
West Virginia	2,393	82,276				
Wisconsin	112,019	497,398	4,256	21,644	1,191	68,393

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