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GROWTH AND PREPARATION OF FLAX: EXPERIMENT STATION AT SELBY.

By F. K. JACKSON, Director.

THE Development Fund Act of 1909 mentioned the growth and preparation of flax as one of those rural industries which the Development Commission were empowered to encourage. Accordingly, after preliminary inquiry, the Commission invited the University of Leeds to take charge of a centre of investigation at Selby, and also promoted the formation of the British Flax and Hemp Growers' Society, which controls another experimental mill at Yeovil, in Somersetshire, and with which the Leeds University works in collaboration.

The first crop, of 120 acres, was grown in 1913, and similar areas have been sown in succeeding years. Grants for capital and working expenses have been made from the Development Fund from time to time through the Board of Agriculture, which exercises a broad control in its examination of the estimates presented annually.

The objects are:—

- (1) To find the cost of growing a flax crop.
- (2) To find the cost of manufacturing flax fibre from the raw material.
- (3) To ascertain whether fibre can be produced of a quality high enough to show a profit sufficient (when sold under normal market conditions) to warrant any extensive revival of the industry.

On first reading, these objects may appear easy of attainment, and this is no doubt true in regard to ascertaining the costs of production. But the third object introduces the question of processes of manufacture. It is evident that any alteration in methods of manufacture which lowered the cost of production or raised the quality of the fibre might have an important effect on the economic conclusions to be drawn from investigations. At the time when I took up this work, I formed the somewhat ready opinion that there was not likely to be any commercial future for flax-growing in England unless fibre of really high quality could be produced. With our relatively high cost of growing the raw material and with a rising labour market, we could not hope to compete with Russia in producing medium and low qualities of fibre. The cheap land and very cheap labour of Russia absolutely precluded this. Therefore, our first aim has always been quality, and in considering any change in process this has always been kept in view. In the past, it has been the fate of practically all attempts at improvement in flax fibre manufacture that the quality of fibre has been reduced and, therefore, the price, in a greater degree than the processes, has been cheapened. The main reason for this is that flax fibre is very easily damaged, particularly when wet; another thing is that it cannot be handled in mass, as in the case of cotton or wool; the straw and fibre must be kept parallel and in neatly-ended bundles if high prices are to be realised for the finished product.

At this stage, it may be interesting to relate, very briefly, a few

facts concerning the history of the cultivation of flax and manufacture. Archaeologists may be left to decide the earliest known instance of the use of flax as a fibre. Linen cloth has been discovered in a Danish tumulus, or prehistoric burial mound, and in the remains of the Neolithic Lake Dwellings in Switzerland. Whether these civilisations were earlier than that of the Captivity of Israel in Egypt, described in the Book of Exodus, in which flax is mentioned, I cannot say. Pliny's description of flax-pulling, retting, drying, scutching and hackling is really a very accurate account of present-day practice, except that the scutching is now done by machinery of a very simple type. It is difficult to think of any industry of as great importance as that of flax where so little improvement has been made in the system of manufacture. I refer, of course, to the production of the raw material—flax fibre—and not to the spinning and weaving. This state of affairs is responsible for the fact that the linen trade is mainly dependent for its raw material upon countries where either labour or land, or both, is cheap. Russia, for example, before the war produced, I think, over three-quarters of the world's flax supply, mostly of medium and lower grades, and worked up laboriously by the hand-labour of the peasants. To generalise, only Belgium, Holland, Ireland, and France have produced any great quantities of high-class fibre. In the last century, flax-growing in England was an industry of some importance. Yorkshire and the Eastern Counties and, in the West, Somerset, Devon, and Wiltshire were the principal districts, while in Leeds there were many large spinning mills. All, however, from one cause or another, went out of existence. The American tariff and the competition of the woollen trade for the labour of the district seem to have been the main reasons for the collapse of the spinning mills, while the loss of the English markets, low prices and the increasing imports of cheap Russian flax, hit the English producer of raw fibre very hard. It is possibly significant that the last flax mills to close down were those run as central retteries, often using a warm-water process.

The climate of England is, generally, undoubtedly suitable for flax, and the type of soil most adapted is plentiful. Good, well-drained, medium loams on a clay sub-soil are most suitable; strong land grows good crops if a fine seed-bed can be prepared, but light land is not recommended. Freedom from weeds is of great importance. The belief that flax is a very exhausting crop is of long standing, but careful experiments in various countries have not resulted in support for the belief. It is a fact that wherever the crop has been grown at all extensively this view has not arisen. The seed may be either broadcast or drilled, and when the plants are a few inches high the fields are hand-weeded by gangs of women. Wherever flax is grown for fibre it is invariably pulled out of the ground by hand when ripe. This is a most troublesome operation, requiring a large supply of skilled casual labour for three or four weeks in the year only. A good worker can only pull about a quarter of an acre per day. If not pulled at the proper time, very great loss may ensue; two or three days' delay often changes a good-quality crop into a very poor one. Cutting with a reaper and binder is possible, but a good deal of waste ensues; the cut end is apt to become rotten through resting on the ground and the straw is not easy to handle; furthermore, it is delivered in a very untidy state.

After being dried in the stook, the seed is taken off the straw in

various ways. In Holland and Belgium—and I believe altogether in Russia—a great deal is still done with the rippling comb or by beating the heads on a hard floor with a flat wooden mallet, but a cheaper and more effective way is to pass the heads between a pair of cast-iron rollers. The straw is then bound up ready for retting, the linseed being cleaned and the chaff sold as stock food.

Retting is the process which effects the loosening of the fibres from the central woody core of the flax stem and frees them from most of the gummy matter. It is carried out in different ways. Dew-retting is perhaps the simplest, and consists of spreading the straw in a thin layer over a grass field until rain and dew have effected the loosening. The result, however, is inferior. Much of the Russian flax is treated in this way.

Water retting produces a better quality of fibre. The straw is put in a ditch, pond, or river, until the resultant bacterial fermentation or putrefaction has gone on long enough, when it is taken out and dried. Pliny describes the process most accurately. Usually, no attempt is made to regulate the temperature of the water, which, of course, influences the activity of the bacteria responsible for the fermentation and consequently determines very largely the time taken to ret. There have been, however, a good many attempts at such regulation by the use of tanks and steam-heating devices. It seems undoubted that good fibre has been produced by such means, but there is a strong and widespread objection to it on the part of spinners—an objection which, I fear, amounts to a prejudice. Good-looking fibre has been produced which was not lived up to its appearance on coming to be hackled and spun, and it is therefore undeniable that there has been real justification for this attitude. But my own opinion is that the failure and inferiority have been due to lack of knowledge of the proper conditions for retting. I believe in many cases the temperature of the water used was far too high, which probably induced the development of a kind of bacteria harmful to the fibre; in other cases there was no flow, or, on the other hand, too rapid a flow of water through the tank.

When bacteria are present in a nutrient medium, living and multiplying, they produce substances which, in most cases, if not removed or otherwise dealt with, poison the bacteria and prevent their further development. In the case of flax retting, the harmful substance appears to be butyric and other acids, and as soon as this reaches a certain concentration retting is checked, and a species of bacteria harmful to the fibre may even step in. A suitable flow of water prevents this, but, on the other hand, too great a flow would wash away many retting bacteria from the scene of their labours and would cause the conditions to become unfavourable in other ways.

On the face of it, it seems hard to believe that the same set of conditions obtaining in any of the so-called "natural" retting systems—for instance, the Courtrai system on the river Lys—cannot be reproduced in tanks and maintained at an optimum throughout the year. The conditions of any one of the natural systems vary considerably during a retting season.

Which are the best conditions? The temperature of the River Lys, in Belgium, where the finest flax in the world has been retted, varies from 50 deg. Fah. to over 70 deg. Fah. during the summer. Which temperature produces the better flax? Certainly, at the higher temperature the operation is much quicker and therefore cheaper. The

rate of the current in the river, in which the flax packed in crates is moored, varies according to the rainfall. This variation is bound to affect the rate at which the products of fermentation are removed from the flax. What is the best rate for this removal to take place? It is answers to questions of this character we are endeavouring to obtain at Selby. And it is encouraging to note that similar problems, in the brewing and leather industries, have been solved. Our aim in retting is to standardise a process suitable to English conditions. Undoubtedly, the Irish "ditch" or "pit" system, carried out by each farmer, is not suitable. Rivers similar to the Lys are not common, and, even if they were, retting in them would run counter to the Fishery laws.

When retting is completed, the straw must be dried. This is done by spreading on grass land, either flat in thin layers or standing in "steeples" which are turned inside out to dry quicker. The drying in the open air also has the effect of bleaching the fibre to some extent. The flax is then stacked until the winter, when it is passed between eight pairs of fluted iron rollers to break up the woody core or shove before scutching. Scutching is the final process of fibre separation. It is essentially a skilled operation, and a somewhat dangerous one, and consists in presenting a handful of broken straw to the action of a number of blades fixed to the rim of a rotating wheel, the handful being held over a rigid iron stock. By careful manipulation, all the woody particles are beaten and rubbed out, leaving the pure fibre. It is also a slow process, an average worker not usually exceeding 50 lbs. a day.

Since the date of the establishment of the Station at Selby in 1913, on the agricultural side we have been entirely responsible for the carrying out of the cultural operations on nearly 450 acres spread over four crops. This involves great efforts at certain times of the year. Sowing and hand-weeding require constant care and attention, but the harvest brings with it the task of engaging, distributing, supervising, and paying, by piece, large gangs of casual labourers.

Field experiments have been carried out in manuring, trials of varieties of seed, the time of sowing, and the amount of seed sown per acre. One of the most striking results has been given with some seed which had been selected for length of straw by Professor Bateson, of the John Innes Horticultural Institution, and sent by him for trial. For two years, the straw has grown at least nine inches longer than that grown from imported Dutch seed sown alongside it. A result of this kind, if maintained, is, of course, of fundamental importance and forms another illustration of the eventual practical application of pure scientific research, originally undertaken without any commercial end in view.

The scarcity of flax seed for sowing purposes, owing to the war, has enabled us to sell almost the whole of our production of seed for sowing in Ireland. The Irish farmer overcame his distrust of a new thing and we have had excellent reports for two years. The Irish Department of Agriculture included Selby seed in their Variety Trials, and it gave results as good as either Dutch or Russian seed.

In our work on retting, we have been fortunate in the possession of a back-water of the local canal, in which we ret a good deal of flax on the Courtrai system, and from which water is drawn for the concrete retting tanks. In these tanks attempts are made to control

the conditions affecting the retting, some of which have already been mentioned. Experiments have been carried out with the object of finding what influence certain sets of conditions exercise on the quality of the fibre; various combinations of temperatures and flows have been tried. Careful records have been kept of tests of the acidity and oxygen-content of the ret water. These tests have been made at frequent intervals, both in the tanks and in the canal, for comparison. A good deal of special apparatus has had to be designed for regulating temperatures and the flow of water. It has been a rather disappointing feature of some of the experiments that wide differences in the conditions of certain rets did not exercise any noticeable influence on the appearance and handling of the fibre. The experimental lots have been subjected to spinning tests, but results have only very recently been received and are not yet tabulated. An important part of the work of the Station has been the recording of accurate labour costs of different operations. This has been done since the beginning.

So far, few or no departures from standard practice have been introduced in the matter of machinery. I should like, however, to draw special attention to the dust-removal plant in the scutch-mill, which has proved very efficient.

To sum up, the experience of the last three years, which have not been easy years for any concern employing labour, shows that with one exception no real obstacle arises in the growth of flax or the manufacture of good fibre. The one exception is the provision of labour for the pulling operation. No farmer in his senses would attempt to grow a crop of wheat, for example, in these days, if he knew he would be obliged to employ men to cut it with a sickle. Yet flax-pulling is just as slow an operation. Of recent years there has been a good deal of activity in Canada and the United States in the matter of producing machines for this work, and it was felt that sufficient advance had been made with the problem to justify a visit to see these machines in operation in order to obtain an idea as to which was the most likely to prove ultimately successful. I spent the months of August and September in various parts of the American Continent, and was able to see most of the machines that have gone beyond the stage of a patent specification. One or two showed quite reasonable efficiency in trials, and caused me to believe that the solution of the difficulty will soon be achieved. A successful puller would make an enormous difference to the prospects of a future flax industry in this country, not only in cheapening production in various ways but in improving the quality of the flax by rapid harvesting, and taking advantage of favourable weather. Furthermore, if farmers could be free from the difficulties of hand-pulling at harvest many would undertake the growth of flax on their own account and under their own control, instead of the present system, which leaves the responsibility for the crops in the hands of the central rettery.