

REPORT

OF THE

FLAX COMMISSIONERS

ON THE

MEANS EMPLOYED IN THE PREPARATION OF NEW ZEALAND
FLAX.

PRESENTED TO BOTH HOUSES OF THE GENERAL ASSEMBLY, BY COMMAND OF
HIS EXCELLENCY.

WELLINGTON.

—
1870.

COMMISSIONS.

VICTORIA, by the Grace of God of the United Kingdom of Great Britain and Ireland, Queen Defender of the Faith, and so forth :

To Our trusty and loving subjects, the Honorable Arthur Penrose Seymour, Member of the Legislative Council; Nathaniel Edwards, Esquire, Member of the House of Representatives; Charles Christie Graham, Esquire, Member of the House of Representatives; Thomas Kelly, Esquire, Member of the House of Representatives; Thomas Macfarlane, Esquire, Member of the House of Representatives: Thomas Henry Potts, Esquire, Member of the House of Representatives; Arthur William Follett Halcombe, Esquire; Frederick W. Hutton, Esquire; John Kebbell, Esquire; James Kennedy, Esquire; Samuel Locke, Esquire; and Duncan McArthur, Esquire.

WHEREAS the House of Representatives did, on the eleventh day of August, one thousand eight hundred and sixty-nine, adopt a Resolution, recommending a Commission to be appointed to inquire into and report upon the Machinery employed in different portions of the Colony for the preparation of New Zealand Flax, as well as upon the varieties of Flax, both New Zealand and European, which it may be most desirable to cultivate, upon the best method of cultivation and the probable result of the same; and also to make recommendations as to any steps that might with advantage be taken to promote and encourage the cultivation and preparation of Flax within the Colony, and its use for manufacturing purposes within and without the Colony :

Now know ye that We, reposing great trust and confidence in your knowledge and ability, have authorized and appointed, and do by these presents authorize and appoint, you the said

Arthur Penrose Seymour,
Nathaniel Edwards,
Charles Christie Graham,
Thomas Kelly,
Thomas Macfarlane,
Thomas Henry Potts,

Arthur William Follett Halcombe,
Frederick W. Hutton,
John Kebbell,
James Kennedy,
Samuel Locke, and
Duncan McArthur,

to be, during pleasure, Our Commissioners to inquire into and report upon the Machinery employed in the different portions of the Colony, for the preparation of New Zealand Flax, and into the other matters mentioned in the premises and connected therewith: And our further will and pleasure is that you do, within nine months after the date of this Commission, or as much sooner as the same can conveniently be done (using all diligence), certify to Our Governor of the Colony of New Zealand, under your hands and seals, or any one or more of you, your several proceedings, and your opinion touching the premises: And We further will and command, and by these presents ordain, that this Commission shall continue in full force and virtue; that you, Our said Commissioners, or any one or more of you, shall and may, from time to time, proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment; and also, that the before-named

THOMAS MACFARLANE

be the Chairman of you the said Commissioners.

In testimony whereof We have caused these Our Letters to be made Patent, and the Seal of Our said Colony to be hereunto affixed.

Witness Our Trusty and Well-beloved Sir George Ferguson Bowen, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Our Governor and Commander-in-Chief in and over Our Colony of New Zealand and its Dependencies, and Vice-Admiral of the same; and issued under the Seal of the said Colony, at Wellington, this fifteenth day of September, in the year of Our Lord one thousand eight hundred and sixty-nine, and in the thirty-third year of Our reign.

G. F. BOWEN.

Approved in Council,
FORSTER GORING,
Clerk of the Executive Council.

VICTORIA, by the Grace of God of the United Kingdom of Great Britain and Ireland, Queen,
Defender of the Faith, and so forth :

To Our Trusty and Loving Subject, George Williams, Doctor of Medicine, Greeting :

WHEREAS on the fifteenth day of September, one thousand eight hundred and sixty-nine, Sir George Ferguson Bowen, Knight Grand Cross of the Most Distinguished Order of St. Michael and St. George, Governor and Commander-in-Chief in and over Our Colony of New Zealand, did issue in Council a Commission in Our name appointing certain persons named therein to inquire into and report upon the Manufacture of New Zealand Flax, as well as the Cultivation of other Varieties of Flax, and to recommend the best means of promoting that Manufacture in the Colony of New Zealand :

And whereas it is desirable to appoint an additional person to the aforesaid Commission :

Now know ye that We, reposing great trust and confidence in your knowledge and ability, have authorized and appointed, and by these presents do authorize and appoint you,

GEORGE WILLIAMS,

to be an additional Commissioner for the purposes and with the powers specified in the said Commission ; which Commission continues in full force and virtue, anything herein notwithstanding.

In testimony whereof We have caused these Our Letters to be made Patent, and the Seal of Our said Colony to be hereunto affixed.

Witness Our Trusty and Well-beloved Sir George Ferguson Bowen, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Our Governor and Commander-in-Chief in and over Our Colony of New Zealand and its Dependencies, and Vice-Admiral of the same ; and issued at Auckland, in New Zealand aforesaid, on the second day of November, in the year of Our Lord one thousand eight hundred and sixty-nine, and in the thirty-third year of Our reign.

Approved in Council,

HENRY D. PITT, Captain, R.A., Private Secretary,
(for Clerk of the Executive Council).

G. F. BOWEN.

REPORT OF THE FLAX COMMISSIONERS.

In obedience to the foregoing instructions, the Commissioners proceeded at once to the discharge of the important duties imposed upon them.

With the view of procuring all the information that could then be got from those engaged, or interested, in the manufacture of the New Zealand flax, the Commissioners issued a circular and relative queries, of the latter of which a copy will be seen in the Appendix (No. 1).

These circulars and queries were sent to the Commissioners in each of the Provinces, who attended to their distribution and collection, and several of the Commissioners afterwards visited all, or the most important, establishments in their respective districts. Unfortunately, the replies to the queries were not so numerous or so complete as might have been expected. But such as they were, the information they afforded was carefully collated and digested; and the result of these replies, and the information received by the Commissioners during their personal visits, were embodied in an Interim Report, which, on being printed, was forwarded to the Commissioners and others interested in the trade, with the view of the former going carefully over that Report, and seeing that all the information received had been embodied in it.

The publication of the Interim Report called forth several other replies, and various criticisms thereon by the Press, and others; and the present Report has been framed after a careful reconsideration of the whole subject referred to the Commission.

The Commissioners may here state that they did not consider it advisable, in the state of the flax industry at the time they were appointed, to hold official inquiries throughout the Colony, because that course would have entailed a considerable expense without securing a commensurate advantage; and the result has so far justified the Commissioners in pursuing this course. Since then, however, a greatly increased interest has been awakened in the matter, and various new methods have been tried, and others are in course of trial, both with regard to machinery and other methods of preparing the flax, so that it will be for Government to consider whether or not this Commission should be re-appointed, or another one chosen; and if so, whether one or two of these Commissioners should not visit every district in the Colony, and carefully inquire into, on the spot, every process now in operation for dressing and preparing flax; and as they go along, impart information and give encouragement to all requiring the one or the other. From what the Commissioners know of the parties engaged in making experiments in the various modes of dressing the flax, they feel assured that such a visitation would be of incalculable benefit to all concerned. While it is to be regretted that so few replies to the queries were received, it is right to state that this, as a rule, arose from no unwillingness to give information, but from the fact that the parties then engaged in the new industry knew very little of the matters referred to in the queries, and did not feel warranted in committing their opinions to writing. There were others who thought that they had discovered something which they thought new, and which they preferred keeping to themselves, and for their own benefit.

Considerable progress has been made in procuring information, both on the principles which ought to regulate the manufacture of flax, and the mode of operation by which the best effects can be obtained, as well as regards the growth and cultivation of the plant; and it is now understood and felt that as quantity, as well as quality, is wanted to enable the demands of the English market to be supplied, it is the interest as well as the duty of every one in the trade to assist his neighbour to produce as good an article and as large quantities as himself. It is on this account anticipated that information will now be more readily imparted than it would have been twelve months ago; and it will have the advantage of being more the result of experience than of mere conjecture. It is also thought that those who have applied for patents to protect their alleged discoveries may abandon any right they may have under those patents, and allow to all the benefit they claim for themselves.

It will also be for the Government to consider whether authority should be given to the Commissioners to make experiments under their own inspection, whenever and wherever it shall be deemed by them to be necessary and useful to do so.

The object of the Queries issued by the Commissioners was to elicit information on the Growth, Culture, and Manufacture of the New Zealand Flax, and the Machinery used in its preparation; and as the information received in answer is arranged under these heads, the same course will be followed in this Report, viz.,—

- I. Growth and Culture.
- II. Manufacture.
- III. Machinery.

I.—GROWTH AND CULTURE.

The mode of growing flax from seed was a matter of considerable doubt; and the Queries were so expressed as to elicit all information possible on this point. The answers were more suggestive than otherwise, and the publication of the Interim Report induced several experiments on this point. Mr. Ludlam, of the Hutt, who has taken a deep interest in the progress of this inquiry, at once tested the first mode hereinafter suggested, and he says—"With a view of ascertaining the best mode of growing New Zealand flax from seed, I tried three experiments:—(1.) With fresh-gathered seed, soaked in warm water, at an even temperature of 110°, until the larger portion of the seed sank. (2.) With seed from the same package, soaked in warm water, at a temperature varying from 110° to 130°. (3.) With seed unsoaked. I sowed the seeds in a box placed in a green-

house, and the result is—No. 1 vegetated in 17 days; No. 2 in 19 days; No. 3 in 21 days;” and he adds, “I found that nearly all the seed vegetated, including that which did not sink in the water. I cannot observe any difference in the growth of the plants.”

Mr. Duncan, of Christchurch, has also been successful in rearing plants from seed, and so has Mr. Armstrong, of the Government Gardens there. And Mr. Francis Williamson, of St. John's Nursery, Wanganui, says, under date 29th June last:—“Having seen various methods of sowing the seeds of the *Phormium tenax* in different papers, I was induced to obtain a small quantity of it, to satisfy myself with regard to the difficulty of raising it. I have now the satisfaction of communicating to you the result. On the 4th of last March I prepared a piece of ground in the usual manner as if for onions, and pared a thin portion of it off, about three-quarters of an inch in depth, the width of a spade, on which I sowed the seed, and again returned the surface-earth equally over the seed. I then gave it a gentle patting to compact it, thus completing the operation. I had the pleasure of seeing, on the 14th of the present month, the young plants coming boldly through the ground; and I have no hesitation in stating that seed gathered directly from the plants when ripe, and sown as herein described, will be certain to vegetate. If sown in the spring, it would probably come sooner than autumn sowing.”

While, therefore, it is thus clearly established that flax seed will germinate and grow, it is equally clear that the process adopted by Mr. Ludlam is much the best, as it saves nearly three months. Parties wishing to grow from seed have now reliable data to go by, and may safely go on with its cultivation where they cannot easily get roots. The Natives, however, never adopt this course, but always transplant it; because it takes at least three years to mature flax from seed, while, by transplanting, it may be ready in two years, especially if planted in suitable soil.

I.—GROWTH AND CULTURE.

The seed should be pulled as the pods begin to open. This occurs in February and March, and it should be sown at once according to one Return, or in spring according to others; but the general impression is that the seed should be tested before being sown, and various modes have been suggested for this purpose.

1. Steep the seed in water of about 110° heat for about five hours, or till it falls to the bottom. What then floats may be considered bad or non-productive.

2. Put seed in a bag and deposit it for about three hours in a bed of refuse of the flax, which heats very much. Then put it in water, as above, to test its vitality.

The seed should be sown in beds or boxes, for convenience, where it remains till it grows to two or three inches in height, when it should be transplanted into nursery beds. When the plants are a year old, they should be planted out in their permanent locality.

Flax will grow in almost any soil, but the more suitable the soil the finer the quality. One Return says it grows best on light rich soil, by the sides of rivers and brooks, where sheltered from the wind.

Another says it grows best on rich, dry, but not deep, clay soil, having yellow clay subsoil, with plenty of light and air. The same authority also says that deep alluvial soil is very suitable, but the greatest crops are reared on high volcanic soil.

Another Return says that a well-drained swamp gives largest returns, and this fact has been verified by observation in the Upper Waikato and elsewhere.

Stagnant marshes are prejudicial to the growth of flax; but as soon as they are drained and the water sweetened, the same flax will grow rapidly. The drains should be open, and the water therein should flow about 12 inches below the surface. If practicable, swamp land should be ploughed as soon as it is dry enough for the purpose, and allowed to remain all summer, or till March, when it should be again ploughed, and planted immediately thereafter. The soil will be well pulverized by that time. Should the land become very dry in summer, the drains might be stopped, so as to irrigate the soil; for any land that is periodically inundated is very suitable for promoting rapid growth. Alluvial soil should also be ploughed in winter or spring, and allowed to dry till autumn, when it should again be ploughed and planted out, that is, in March or April, or as soon as the autumn rains arrive—in fact, the earlier the better, for the plants make roots all winter, and are ready to come away with a vigorous growth in spring.

One Return recommends trenching and subsoil ploughing, but it is thought that at present either process would be too expensive, and might kill the plant by depriving it of the impermeable substratum that retains the water necessary for the rapid development of the flax. If, however, the experiment is wished to be tried, the process is this:—Select a piece of open ground, well sheltered from sweeping winds, near a creek or river; in extent, according to the supply required; dig it two feet deep, and in the course of digging mix plenty of two-year-old manure thoroughly with the soil. As soon as the seed is matured, sow in drills two feet apart. When the plants are large enough to handle, thin them out to four inches apart. In the course of the season water the plants liberally, and keep them free from weeds. If seedlings are used, a crop of cabbages, cauliflowers, mangold, turnips, carrots, or any crop deemed desirable, may be grown alternately with the flax during the first two years; but the suggestor of this plan has evidently never put it to the practical test, or he must have found the expense of the process fatal to its success.

Reverting to the method of cultivating by transplanting, the plants should be sown in rows, and in the same way as trees are planted; but the Returns differ as to the distance from row to row, and from each plant in a row. It seems to be overlooked that planted flax will not be allowed to grow into large bushes, as it does in the uncultivated state. On the contrary, the constant cutting which will be carried on will confine it within a comparatively limited space. The roots thrown out by the first plants will undoubtedly spread around it, but still it will always be practicable to keep the bunches within a small space. With this view the rows might only be four feet apart, and only three feet between each plant in a row. At all events, the quantity of soil that would be saved in this way would justify the experiment on a small scale. In this case, the roots should be planted across the lines in rows. Six

feet is generally recommended to be between each row and each plant, because closer planting might impoverish the soil; but it should be kept in view that flax needs shelter, and the proximity of the plants to each other would afford this, and assist in drawing up the leaves and making finer fibre. If suitable land is chosen, it is thought that impoverishment of soil will not result from the close planting.

With the view of still further economizing space, it is suggested that about ten or twelve rows should be planted, then a break of 10 or 12 feet should be left for drays to pass along and collect flax when cut. Then other ten or twelve rows should be planted, then another break, and so on. The size of the ground to be planted must however regulate this.

About 1,000 roots planted six feet apart each way will cover an acre of land, but if the land is planted 4 feet by 3 feet, as recommended above, about one-third more will be required for an acre.

In one bush of flax there will be from 20 to 50 roots for transplanting.

The Returns differ also as to the number of roots that should be planted together; one, two, and three, are variously recommended. If two or three are planted together, a larger space of ground would require to be left around. Care should be taken to avoid planting the roots from which a seed stem has been thrown out, or planting the centre portion of an old plant, which is not so productive as young shoots, and has a tendency to run to flower, when it requires more nourishment than all the leaves do. The flower-stalk should therefore be cut down as early as possible, and when this is done the cut part should be rubbed over with a little earth to prevent "bleeding," or better still, twisted off.

But if the close planting be adopted, only one root should be planted at one place.

The time it takes for maturing and for cutting the leaves is still an unsettled question. It is pretty certain that flax grown from seed will not be ready to cut sooner than three years; but where suckers are planted, the leaves will be ready in about two years. The quality and position of the soil will greatly affect this question. In favourable circumstances some will be ready in twelve months. Messrs. Rees and Gibson, of Rangitiki, mention in their Return that leaves cut in August were replaced by others in February following, about 4 feet in length; and Messrs. Cummings, Finnimore and Co., Wanganui, after three years' experience, say that succeeding leaves are ready in about eight months after previous cutting. They have even cut one entire bush growing in swamp land, and could cut again in that time. Mr. Jenkins, of the Lower Waikato, says that he has had four crops in two and a half years, even though he cuts down the whole bush. This flax, however, grows on the banks of a river, and so cannot be a guide to others differently situated. Messrs. Jones and Co., of Woodend, Canterbury, showed Mr. Potts flax which had grown from 5 to 6 feet in three months. This was owing to the rich moist soil, as flax cut at the same time from higher and drier soil had not attained more than half the length of the other.

When the rotation of cropping shall be established, from two to six leaves may be cut from each root every six, eight, or twelve months, according to soil, care, and attention.

The maturity of the leaf is ascertained by its texture and firmness, or by its being split at the point, or by the recurving of the blades from the central midribs. The leaf of the best flax should be over five feet in length excluding the butt. The top of the leaf, says Mr. Locke, should feel soft to the touch and droop a little; this occurs in winter.

The Natives say that the flax should not be cut from the time the flowering-stalk shoots until it dies again, as the fibre is then brittle, and of a red tinge; and during winter they carefully preserve their flax swamps. But if a permanent supply is to be kept up, it will be difficult, if not impossible, to comply with their notions; and hence it has been suggested, as one mode of remedying this, that the flower-stalk should be cut, but the best time for cutting it requires experience; it is thought, the sooner the better.

The general understanding is, that in cutting flax only the outer leaves should be cut, and that in doing so great care should be taken not to injure the leaves which enclose the centre shoot. With this view the knife should be inserted at the leaf enclosing the centre shoot, and the outside leaves, two or three on each side, cut downwards and slanting outwards; but no leaf should be cut before maturity, as this also weakens the plant and makes it liable to go to flower.

Another Return says that in uncultivated swamp land all the plant may be cut down, and that in twelve months thereafter there will be an entire new crop ready, and if the land shall be drained, a second crop may be got in eight months; but this probably may be explained by the previous existence of undeveloped plants in the land, which take the place of those destroyed. The same Return says that in cultivated flax only the outside leaves should be cut, and that in four months thereafter another supply could be got. But it will require very favourable circumstances to secure this.

Good soil does not require manure in order to make flax grow, but after the second or third year a top-dressing of refuse of flax, preserved for the purpose and thoroughly decomposed, would keep down weeds, and assist roots by sheltering them from the sun, and by supplying the exact mineral constituents required by the plant. Well-fermented stable or other manure would assist greatly, if the question of expense is of no importance. Bone dust is also very suitable. About twenty tons of decomposed manure would be required for each acre cultivated; but, as already stated, if the land can be periodically inundated by the overflow of running streams carrying sediment, no manure whatever need be used. The Natives do not use manure though they prepare the soil with great care.

A supply of the best kinds of seed may be procured at Whanganui, Taranaki, Hawke's Bay, Waikato, and indeed almost anywhere in the North Island. The Natives, under proper supervision, should be employed to procure these, and roots too, if required. Some assert that the seeds of the different varieties are gradually being blended together by the action of the bees, so that by-and-by it will be difficult to get supplies of any distinct kind. It is also stated that there is a triennial development of the flower-stalks and seeds, which only then reach maturity, and that during the two intermediate years it would be extremely difficult to get the seed in quantity. During the last year the supply has been remarkably abundant all over the country.

It is difficult to name the best kinds of flax for cultivation, as different tribes and localities have different names for the same variety; most probably soil, climate, and cultivation have more to do with the quality of flax than is generally believed.

Mr. Nairn, of Pourerere, Hawke's Bay, says there are four kinds of flax, named by the Natives in his neighbourhood, the *Tapoto*, the *Wharanui*, the *Kauhangaroa*, and the *Wharariki*.

The *Tapoto* is the flax principally used by Natives for dressing. It gives a strong lustrous fibre, and is readily dressed in their way. It is often planted by them. It luxuriates in very rich vegetable soil with plenty of moisture. It will grow, in favourable situations, to the height of four feet. The leaves are narrow and stand erect, have a deep-purple margin, and this kind is planted by the Natives in rows twenty feet apart.

The *Wharanui* is the other kind used by the Natives for the same purpose, and is planted in the same way. This variety grows much better, and has a much wider leaf with a red margin, and is found in the same localities as the *Tapoto*.

The *Kauhangaroa* is a dark green and very tall growing variety, with a black margin to the leaves. The leaves bend outwards. It is dressed by the Natives only for baskets and matting. It is never planted by them, and is very easily broken with a jerk.

The *Wharariki* is very broad and tall in its leaf, and is used by the Natives for the same purpose as the *Kauhangaroa*. The fibre is also very tender, and never used by Natives except for kits, &c. This variety is found in the richest of the soils—bottoms of small valleys, by the sides of streams, and is never planted by the Natives.

In the Province of Nelson there are two or three recognized varieties, distinguished by the colour of their borders—brown or red, black or blue, and green. The red-edged is said to be the best for all purposes. These kinds grow on a great variety of soils, though they thrive best on river banks or drained swamps.

The Rev. Mr. Taylor, of Wanganui, enumerates ten varieties of flax, several of which are cultivated and used by Natives for their own purposes; and Mr. Armstrong, of Christchurch, also enumerates twelve varieties, which, he says, are cultivated in the Government Domain. He says the most distinct varieties are—

- (1.) The *Oue*.—Leaf narrow, very strong, edges of leaves orange-coloured.
- (2.) The *Atirankawa*.—Leaf broad, light green, abrupt at the points, edges light brown.
- (3.) *Huhiroa*.—Leaf very long, tapering at the point, edges light brown.
- (4.) *Tihore*.—Leaves linear, very strong, edges dark red.
- (5.) *Tapoto*.—Similar to *Tihore*, tapering at the points, edges red.
- (6.) *Kauhangaroa*.—Leaves very large, coarse-looking, edges and base of leaf dark brown; and two variegated forms.

Mr. Armstrong has furnished the Commissioners with the weights of several of these varieties, both before and after being dressed, viz. :—

		Weight before dressing.		Weight after dressing.	
		lb.	oz.		oz.
<i>Kauhangaroa</i>	...	0	14	...	2 $\frac{3}{4}$
<i>Kuroa</i>	...	1	12	...	5
<i>Oue</i>	...	1	6	...	7 $\frac{1}{2}$
<i>Tihore</i>	...	1	13	...	5 $\frac{3}{4}$
<i>Rataroa</i>	...	1	6	...	4 $\frac{3}{4}$
<i>Tapoto</i>	...	3	4	...	9 $\frac{3}{4}$
Variegated kind	...	3	5	...	10

But this does not show the relative market value of each variety, so as to show which sort it is most advisable to cultivate, and it may be that Mr. Armstrong's experiments have been performed on several specimens of these plants not indigenous to this Province, and but recently introduced there.

Mr. Jenkins, already named, says, on the authority of Natives around him, that the best kinds of flax for producing good fibre by machinery are—

Ngaro.—Bluish green, with black edge at base.

Ngaro waaka.—Bright green, red edge.

Pupu.—Yellowish green, brown butts, red edge.

Poi Tamuha and *Ngutu Kaka*.—Dark green.

Tumara.—Dark green, red edge, and a kind of wave on the leaf.

He says, too, that all the above have large long leaves, and are very much alike, and that the Natives distinguish them by the base of the leaf plant.

Mr. Kelly, of New Plymouth, gives the names of twenty-two supposed varieties known in his Province, viz. :—

Atiraukawa, *Huhiroa*, *Parekoritawa* (variegated), *Oue*, *Tihore* (I have not been able to satisfy myself whether this is the name of a plant or of a variety), *Ngutunui*, *Atewhiki*, *Korako*, *Taiore*, *Takaiapu*, *Oue*, *Rataroa*, *Raumoa*, *Manunu*, *Tipuna*, *Huruhuruhika*, *Ngutuparera*, *Tito-o-moe-wai*, *Ngaro*, *Tarariki*, *Warariki*, *Pato*.

He says, "I cannot give a description of the whole of the above, the following are the only plants of which I can give any reliable description:"—

Atiraukawa.—This plant is said by the Natives to produce the best and most abundant fibre; it is not large, as compared with *Huhiroa*, but it is said to be a quick grower. The leaf is inclined to bronze colour when at maturity, when young of a light olive-green; the young leaf is Gothic pointed, and the edge of a dull dark brown, a shade lighter on the inner margin; sometimes leaves are seen with the brown relieved by a bright red line.

Huhiroa.—This plant has a bluish green coloured leaf, which narrows gradually to the point, and a narrow edge of black or very dark brown; the keel has a reddish chocolate colour; it grows very luxuriantly and produces good fibre; it is easily separated from the green gummy matter by the Native process of stripping.

Oue.—This leaf is narrow, of an olive green, and the edge and keel orange-coloured. (In the enclosed papers this description applies to *Tihore*, but I think erroneously so.)

Parekoritawa.—This is a very beautiful plant; the leaf is of a bright green, striped longitudinally by a

brimstone colour; the edge and keel is of an orange colour. I think this is a sport, as some of the leaves of the plant are often found green or very partially striped; the fibre is very good.

Manunu has a short leaf and black edge.

Atewhiki.—This plant is easily distinguished; the leaf is narrow, has a reddish tinge, and a narrow line of bright scarlet on the edge and keel; the fibre is very white.

Taiore is abundant in the Opunake District; the leaf is a light green, and has a wide black edge; it is easily distinguished.

Tito-o-moe-wai has a long red-edged leaf, the point of which falls over.

Takaiapu.—The leaf stands erect, has a brown edge; the fibre is very strong, and is used by the Natives for making fishing lines.

Ngutunui.—The leaf similar to the last but has a blunt point, and is red at the butts when split.

Huruhuruhika bears a general resemblance to the *Takaiapu*.

Korako.—The leaf is of a dark green, the edge has a narrow line of dark brown, which appears black, the keel is a pale yellow.

The following list of names have been given by a Native of Taranaki as the best varieties, and formerly used by the Natives for making the best garments; all the other kinds, he stated, were only used for making rough garments and ropes:—

Parikoritawa, Huhiroa, Oue, Atiraukawa, Atewhike, Korako, Ngutunui. To this list other names are added by Natives from other districts, namely—*Rataroa, Taiore, Manunu, Takaiapu*.

Mr. Kelly thinks that the following are the quickest growers of the best varieties, and arrive at maturity earliest, namely—*Atiraukawa, Huhiroa, Ngutunui*, and *Rataroa*. He adds, "All the varieties grow from seed naturally. I have been told by the Natives that they have tried to propagate the best plants by sowing the seed, but have always failed; and it has always been to them a mystery how it was that young plants sprung up where the earth had been disturbed by them when they took up roots for transplanting, and yet they could not get the seed to grow. I think the explanation is a simple one. The conditions necessary to the germination of seed were not fulfilled by the Natives, who, I suppose, had sown them in a seed-bed in the usual manner, and were not embedded in a rich vegetable mould, and kept in that condition of moisture and shade which the seed shed from plants growing in good soil generally obtains. The disturbance of the soil and the letting in of light, by taking away roots for transplanting, probably hastened the germination of those seeds which had been subject long enough to the above condition. I have sown seeds of the *Huhiroa* in an ordinary seed-bed, and although I found that a few germinated, they invariably died off when about two inches high, which I attributed to want of shade from the sun, and a want of uniform moisture in the soil. The Natives also observed that after a fire the young plants came up vigorously."

Mr. Schnackenberg, of Raglan, mentions several other varieties, and considers that the *Ngaro*, which has a black border, is the best of all the kinds for all purposes, and yet none of the other Returns mentions this variety in terms of commendation.

Mr. Locke again says that *Tapoto* or *Takirikau* is sometimes called *Tihore* or *Takiri*, and considers this the best variety known to the Natives on the East Coast. He states, however, that it has scarlet edges, while Mr. Nairn says the article bearing the same name in his locality has a deep purple margin; and Mr. Jenkins says it is a dark-green plant, and much smaller than the other kinds named by him, and is not profitable to dress by machinery. It is difficult to reconcile such statements except by the supposition that *Tihore* is the name of a class and not of an individual plant.

After the *Tapoto* or *Tihore*, Mr. Locke classes the *Oue* and *Wharanui* as next in value, but of these Mr. Armstrong does not give the relative quality of fibre turned out from the same quantity of green leaf. Whether *Tapoto* and *Tihore* are the same cannot be said at present, but Mr. Armstrong shows the quantity of fibre in each is nearly the same.

Mr. Maning, of Hokianga, says that a preponderance of fibre is indicated by the leaf assuming a light colour approaching to straw colour. The only thing, therefore, which intending purchasers of seed or roots can do, is, to ask parties resident in, or acquainted with, the flax districts to select the best kinds for them.

In conclusion, under this branch of the subject, it may be suggested that great care should be exercised in commencing the cultivation of flax, as it is a very expensive operation, and two or three years must elapse before any return can be got. It is also quite certain that exaggerated ideas are everywhere entertained as to the quantity of flax in each locality, and persons have gone into the business in the belief that they had an unlimited supply for several machines, when it turned out, after commencing work, that there was not enough for one. Cultivation must therefore, in such circumstances, be encountered at once; but it should be done judiciously, and according to the means at the disposal of persons commencing the operation. In this way alone will failure be averted, and a permanent supply kept up. Captain Hutton estimates that on good flax land (uncultivated), such as is to be found in the Waikato, about four tons of green flax can be cut per acre, without injury to the plants, where it has not been cut before; so that from 150 to 200 acres of good flax land are required to keep two machines going for a year; and as it is far from certain that the second year's crop will produce four tons per acre, the Commissioners do not consider that it would be prudent to put up a mill without previously securing from 400 to 600 acres of good flax. This would produce from three to four tons per week of fibre.

The question of fencing the cultivated ground must also be considered and provided for. Cattle will not only destroy the outer leaves when food is scarce, but also the very life of the plant, by eating the heart of it. This is an undoubted fact; indeed it was the mode which the cow used to get the epidermis off the fibre which suggested to Mr. Whytlaw the machine he invented for dressing it. It is therefore suggested, with a view of rendering the natural flax fields permanent, that security of tenure should be given to all who hold leases of the Crown, and, as far as possible, security of tenure of flax land substituted for licenses to cut flax.

The reckless burning of flax land should be put a stop to by legislative authority.

II.—MANUFACTURE.

The information received in reply to the queries issued on this branch of the inquiry is rather limited, and not very important. The reason of this is, that up to the time the circulars were issued, comparatively few had engaged in the preparation of flax, and fewer still knew anything about the matter. The cleaning process, with a few exceptions, is pretty much the same all over the Colony, and may be described thus:—"The entire leaf is crushed between rollers, one or both of which are fluted, and then subjected to the operation of the stripping-drum; when it has been thus operated on, the flax is washed, with the view of removing as much as possible the juices which hold gum and colouring matter in solution. The usual way of accomplishing this is to immerse the flax in water (running if possible), and, after rinsing it well, to send it to the green to bleach. This process, however, does not remove the colouring matter from the leaf, the butt-ends of which are red even after two or three weeks' bleaching. This defect in the washing is obviated by soaking the flax in water for about two hours, according to the season of the year, temperature, and quality of the flax. In dry weather more soaking is required than in rainy. A little experience will guide the manufacturer in this matter; but it may be taken for granted that the soaking will to a considerable extent remove the gum and red colouring matter from the butts of the leaves, and make the flax, after being scutched, very soft to the touch, without in the least injuring the fibre. The fibre so produced will be found very well suited for all the purposes to which the flax is usually applied. The crushing of the leaf breaks the cells which contain the colouring matter in the butt, and allows that matter to spread amongst the fibre. It is, therefore, of importance that the leaf should be placed in water as soon as possible after being crushed. The soaking process, as already stated, removes the colouring matter; but the sooner the flax is put in the water the shorter the time it requires to be there, and the less time it will require for bleaching.

Various modes of soaking are in operation at present.

1. Hanging the flax over ropes, fixed in the stream—up and down.
2. On perpendicular poles—hank above hank. Mr. McArthur, of Southland, thus describes that process:—"Taking for granted there is a running stream near the mill, with bends in its course: There is a 'race' cut across the bend, which is lined both sides and bottom with one-inch or two-inch boards, and in the bottom are stuck as many wooden pins as may be considered necessary. The flax from the rollers is doubled across the pegs, and the current playing upon it washes it better than any other way. It has this advantage also, that one boy can do a great amount of work by this mode of washing, as all he has to do is to throw the fibre round the peg."
3. On horizontal poles, across the mill-race; or
4. Placing the flax on open frames, drawn into the stream.

Perhaps the last is the most convenient mode, as a considerable quantity can be placed on each frame and taken to the dam and hauled back without twisting the flax. It is possible, also, that the flax might be tramped on the frames, so as to squeeze or press the colouring matter out of it. These frames might be so made as to be lifted out of the water and carried to the green without touching the flax; or, if it has to be carried any distance, they might be placed on a dray or truck, and taken to the green. It is advisable that the flax, whether taken off the frames at the water-side or carried to the green as above, should be allowed to drip some time, as it is then more easily spread. It may here be remarked that green flax should always be stored standing on its butt ends. In fact, the nearer its position is to the perpendicular, the longer it will keep; and if its butts are amongst water, it will keep fresh still longer, perhaps eight or ten days. It should not be wetted, as these occasions heating and discolouration of fibre, more especially if laid on its side and piled up. For the same reason it should be shaded from sun and rain. Mr. Chalmers, of Lyttelton, washes by hand as the flax comes from the mill. Each hank is then slightly twisted and laid in a sheaf or bundle, which, on being loosely tied, is laid in a pool of still water,—not stagnant, but fenced off from the running water to prevent too much motion. The wet bundles are afterwards lifted by tackle and dipped in the mill race, to remove any earthy sediment that may have adhered in the still water; then left some time to drip before being spread out on the green. The time the flax should be in the water, in order to remove the red colouring matter and prevent the colour getting dark, is from one to two hours. Mr. Chalmers says that the cost of his process is not appreciably more than the ordinary system of washing.

Bleaching is, perhaps, the most important part of the process of manufacturing flax, and too much attention cannot be bestowed on it. It is decidedly best to bleach on grass, as the flax can be spread thinner and more regularly, is easier turned, catches less wind and more of the dew that falls during the night. The fibre is thus submitted to a process resembling the dew-retting of the Irish flax. In winter and rainy weather wires or poles are necessary, but they should be avoided as much as possible, on account of the waste of time and material in putting the flax on and taking it off the wires. In fact, it is scarcely possible to bleach on poles. Mr. Jenkins, already named, adopts the following plan:—He drives three stakes or posts into the ground one foot apart, the centre one being three feet and the others two feet each high. On these he fixes rails in the form of the roof of a house, and spreads the flax, by which means it catches the sun, rain, and dew, and gets easily dried. Should this mode be adopted, a space of two feet wide should be left between each set of posts. Several flax manufacturers in the North dry their flax on the fern, and this mode answers very well, especially in the winter time. The time for bleaching as well as for turning the flax when on the green, is so entirely dependent on weather, time, place, and circumstances, that it is scarcely possible to fix a period. The colour should decide this, care being taken to have the flax in before the colour begins to get dark.

It should further be kept in view that when flax is dried quickly without exposure to the rays of the sun, as in ovens, or where thickly hung on poles, it always retains a green colour. Even those parts that may dry yellow often become green again when wetted. How long it will retain this green colour is not yet known; but it certainly cannot be taken as a proof that flax is damp, or that it has been stored damp, because it has a green tinge.

Five tons of green flax can be spread on an acre and a quarter of ground. This will yield about one ton of unscutched flax, so that a mill of two machines ought to have about five acres of drying ground.

The flax when taken off the green should be piled, and allowed to remain under cover in bulk for as long a time as possible before being scutched. During this period it undergoes a heating or sweating process, which has the effect of still further pulverizing the gummy matter that may still be in the fibre, and greatly facilitates the scutching operation. Mr. Potts reports that Messrs. Jenkins and Co., of Kaiapoi, after exposing the flax to the action of the sun and air for several days till sufficiently dry, place it in a store for two or three months, or even longer, and that the effect of this is to give the fibre a certain degree of mellowness, which renders it more suitable for scutching. He further explains that this mellowness is imparted by the gradual and gentle sweating which the flax undergoes whilst thus stored in bulk.

If scutched on being taken off the ground, the flax will break off short, and make too much tow, on account of the gummy matter still in the fibre. There are two kinds of scutchers in use, so far as yet known—the arm scutcher and the barrel scutcher. The former mode makes more tow than the latter, and does not dress the article so well. Some manufacturers do not scutch at all, but hackle instead. This appears to be a mistake, as the process of scutching is cheaper than hackling, and if the former is well done there will be no necessity for the latter. The ordinary quantity of tow in a ton of scutched flax is between three and four hundredweight. Mr. Potts mentions a very important fact in connection with the scutching process which requires attention, viz., the ventilation of the place where this process is carried on. The scutching process creates a large quantity of dusty matter, which is very injurious to health; and therefore, unless the premises are so constructed as to carry off all such matter, serious consequences must ensue. Mr. Kelly states that in the Egmont Mills, now in the course of construction at Opunake, on the West Coast, fans will be used to exhaust the air from the scutching-room, and thus carry away the dust out of the building. The attention of the owners of flax mills is particularly requested to this matter.

Many of the mills, it is understood, have given up scutching, and opinions are divided as to the best way of getting up the flax for the English market; but when it is considered that the cost of scutching is only 25s. per ton, and that unscutched flax, from its bulk, must pay at least that sum more in freight, and that a much lower price will be received at home for the one than the other, the obvious inference is in favour of scutching here, and though the tow will assist, so far, to lessen the difference, it is thought the wisest and the cheapest course to adopt this plan.

The packing is another important part of the process, as it is certain that a well-packed article will always command the best price, all other things being equal. Care therefore should be bestowed on this part of the process, and proper presses procured for this purpose.

Messrs. Price make a small press capable of making a bale of flax, containing about 2 cwt., costing about £15. This, however, requires to be filled and pressed down twice.

Messrs. Fraser and Tinne make a screw, 7 feet by 3½ in., which can press a bale down at once. The case must be made by others. The whole may cost about £30.

One of these presses is in operation in the Province of Auckland, having two boxes or cases, the one capable of being removed from under the screw and filled again while the other is being screwed down, thus making one screw do for two cases, and in other ways expediting the operation of packing.

Messrs. Price can supply three machines, water-wheel, all pulleys, scutcher, and everything necessary to start a mill, except buildings and receptacle for water-wheel, for £180.

In a large manufactory a hydraulic press should be used, as it saves re-pressing before being shipped. Indeed, but for the expense, it should be in every mill.

Captain Hutton, of the Waikato, bales with 3-strand galvanized wire, instead of flax lashings. He says that with 12 bales to the ton, and 4 wires on each bale, the cost of the wire (including carriage to the mill) is 6s. 3d. per ton of flax. His reasons for preferring wire are

1. Quickness.—He can turn out two more bales per week than with flax.
2. Strength and non-elasticity.
3. Safety in case of fire, from these lashings not being liable to burn.

He puts four shingles at each corner to prevent the wire cutting the flax, though this is scarcely necessary. Shingles are also used for branding bales, but when the ordinary flax lashings are used, these shingles fall out when the bales are handled in the ship, and those having the contents of each bale marked on them get mixed or lost. It is a better way to mark the contents of each bale on a slip of leather, fastened to the lashings. It would also be advisable to cover all bales with some kind of covering, so as to keep the flax from being soiled. The damage received from neglecting this precaution is often considerable, and, of course, the price obtained is proportionately diminished.

The foregoing is a general description of the usual modes of dressing flax by the machinery now in general use. In the Province of Canterbury several of the flax establishments visited by Mr. Potts adopt peculiarities which are worthy of special notice, viz. :—

1. Messrs. Pavitt pass the stripped flax, after being washed, under a grooved roller, which appeared to facilitate the expulsion of the gummy matter.

2. At Stoneyers Mill care is taken to separate the leaves into three qualities before undergoing any process.

(1.) The young leaves from the centre of the bush, which produced fibre of a clear white colour, and as strong as that from any other part of the bush.

(2.) The ordinary leaf, treated in the usual manner.

(3.) The old dry leaves from the outside of the bush, brown and much discoloured, which were laid aside in heaps to soften; and if too dry, they were now and then wetted. The effect of this was to enable an article of fibre to be produced which in July last was worth £25 a ton in London. This, however, is contrary to evidence obtained elsewhere.

3. At Mr. Wilson's, Rangiora, a water scutching machine was in operation, with favourable results.

4. At Mr. Thomson's mill, Kaiapoi, and at other mills, there are travelling platforms for conveying the flax from the machine to the washers, by which a considerable amount of labour is saved. At the first named mill, the fibre, after being washed, was passed through two plain rollers of considerable diameter.

5. At Leithfield Mills, which Mr. Potts considers to possess the most complete plant in the whole Province, the travelling platform and the water scutcher are in successful operation. Hogsheads are also sunk in the water for the washers to stand or sit in, and where they are perfectly dry, and have not to stoop to their work so much as is usually done. The machinery is also well fenced off, so as to prevent accidents. The scutching and packing were done by contract; and rope is manufactured worth £56 a ton.

6. At Saltwater Creek Mills, where it is reported from experience that during the prevalence of the hot parching north-west winds a greater proportion of tow was made than during the ordinary or average state of the atmosphere.

7. Miles and Co.'s mill at Riverton, constructed to carry out Steart's mode of dressing flax, as protected by patent. Here the flax is tied in small bundles, and is placed in a bath for two hours and boiled: decomposed fish and chemicals in the bath are the agents used to soften the gum and prepare it for its expulsion from the fibre. After the flax has remained some time in the bath, and it acquires a certain condition, which appears satisfactory, it is submitted to the action of a break with several rollers, and, while so passing, it is kept wet with hot water; it is then spread on grass, and, while still in a damp state, or with the dew upon it, it is scutched in the ordinary way. This mode, it is said, entirely frees it from gum. At first the colour was defective; but subsequently that objection has been removed under an improved treatment. It is also said that flax prepared in this way was tested in London as against flax prepared in the ordinary way with the following result:—Steart's bore a strain of 162 lbs., while the other broke at 91 lbs.

8. *Dr. Florance's Solvent*.—This is a discovery by Dr. Florance, of Christchurch, and, if it can be judged of by the small samples forwarded through Mr. Potts, it is certainly deserving of consideration by flax manufacturers. Dr. Florance says that the expense will be from £1 to £2 per ton, according as the stripping is perfect or otherwise—the chemical results being in exact ratio with the mechanical. One great feature in favour of this appliance is that it does away with grass-bleaching and scutching, and saves much time, as it only requires from four to twelve hours for maceration previous to rinsing and drying, when it is fit for hackling and baling.

9. Dumerque's boiling and steaming process has also attracted the attention of the Commissioners, and the samples forwarded are certainly of a superior description; while the expense at which he says it is produced (about £10) places it amongst the cheapest of any of the processes now in use.

Mr. Graham, one of the Otago Commissioners, reports that he visited several of the flax mills in that Province, principally in the neighbourhood of Dunedin, and that there he found that the machines most in vogue were either those made by Price of Auckland, or others made on similar principles by the local manufacturers, of which the best seemed those made by Mr. Wilson, and Messrs. Kincaid and McQueen.

In none of the mills, however, did he see anything striking, or calling for any special comment, with the exception of the Messrs. Booth Brothers' establishment, at Blueskin. The machine in use by these gentlemen is one invented by one of themselves, and for which a patent has been taken out. Mr. Booth previously invented another machine, the principle of which was suggested by the Native mode of scraping the leaf with a pipi shell against the yielding surface of the thigh, and accordingly made the revolving scrapers to act against an india-rubber roller. Finding, however, that in practice the roller soon got fretted and worn by the action of the scrapers, he made a considerable modification of the machine; and now, in his present machine, india-rubber rollers are merely used for the purpose of holding tight the flax while it is being scraped against a number of small steel bars placed alongside each other in a box, like the key-board of a piano, and set in a yielding bed of india-rubber. There are two sets of revolving scrapers, and two sets of steel bars on elastic beds, enabling the leaf to be dressed on both sides, each leaf being split and the two halves being put into the machine separately; and the result, as respects softness, flexibility, and colour, appeared to be satisfactory. After the dressing, the crushed leaf lay for a short time in running water, had a slight rinse with the hands, and then hung on wires to bleach and dry. Before it was taken off the wires, each hank was beaten against the supporting post, and no scutching or hackling process other than this was attempted.

Owing to the difficulty of obtaining suitable india-rubber rollers Mr. Booth was reduced to the necessity of using some with very slight spindles taken from the ordinary American wringing machines, and was consequently only able to feed half a leaf at a time; but he has now obtained stronger rollers from England, and the machine which he is now supplying he reports as strong enough to take in four halves at a time, equal to two full leaves, thus doing nearly double the work of any other machine now in use. The price at which this new machine is supplied is £60.

Messrs. Pownall, of Manawatu, adopt a process peculiar to themselves, which is protected by patent. Mr. Kebbell visited this mill, and his description of it is as follows:—

The raw flax is run from the wharf by tram over weighbridge, and placed on end. The leaf is then split by hand commencing at the point, and passing each half by a piece of iron fixed on the edge of a rail, scraping off the unfixed gum, which drops into a receptacle. The split flax is passed through side of building handy for each machine. After passing through the machine it goes directly to the wires to dry. When dry or nearly, comparatively to hot-air drying, it is placed in heap under a shed for about three weeks to mellow. The points escaping uncleaned from machine are then hackled, divided into qualities, and baled. Although so little labour is expended, the flax from this mill is softer than the produce of any other mill I have compared it with. The scutching machine would greatly improve the appearance; but this mill was started when prices ruled low, and the owners believed it was waste of time to do more, as the scul and dust would separate in the unavoidable operation it must go through at home in manufacture. But at the present prices they intend to go in for colour, softness, and gloss. The principle on which the machines act is, to scrape the leaf on both sides, not beat it on the lower feed-roller. The machine has two scraping rollers, fifteen inches

diameter, with scraping knives projecting, similar to Price's and others, but placed parallel to the axis of the roller. The surface of the rollers between each scraper becomes alternately the bed for scraping on.

Samples of the different varieties of flax prepared by the various processes now in use have been submitted to Dr. Hector for his examination, and his valuable report thereon will be found in the Appendix, No. XIX.

As a rule for the guidance of those intending to engage in this industry, it may be stated that wherever flax cannot be laid down at the port of embarkation at £20, leaving a profit, the manufacture should be discontinued or not commenced; and with a view still further to assist persons engaged in, or wishing to engage in, the manufacture of flax, it may be taken for granted,—(1.) That a man will cut half a ton of green flax a day, though expert cutters will cut a whole ton. This is the only part of the manufacture that should be done by contract—the other parts should be done by day wages. (2.) That six tons of green flax will make one ton of fibre. (3.) That three machines will dress five tons per week. (4.) That the dressing of the flax will cost about £16 per ton of fibre. (5.) That the cost of buildings, machinery, &c., will be, as suggested by Captain Hutton,—

<i>Buildings—</i>				£	s.	d.
Mill, scutch house, and stores	...	...	...	300	0	0
Houses for men	...	...	...	200	0	0
14-horse power portable engine	...	...	...	520	0	0
Four machines	...	...	...	88	0	0
Shafting, pulleys, belts, blocks, &c.	...	...	...	50	0	0
Two scutchers	...	...	...	40	0	0
Press	...	...	...	30	0	0
Poles and wires for drying-ground	...	...	...	40	0	0
Horse and dray	...	...	...	30	0	0
Tools, barrows, &c.	...	...	...	30	0	0
Miscellaneous, clearing ground, fencing, soaking wharf, weighing machine, &c., &c.	...	...	...	120	0	0
				£1,448	0	0

The Weekly Return of—

Five tons of flax, sold at £20 per ton, is	...	...	£	s.	d.
			100	0	0

And the expense of producing the same is stated thus:—

Depreciation of machinery by wear and tear, including oil			£4	0	0
Eight men's wages, at 30s. a week			12	0	0
Engineman			1	15	0
Fourteen lads, at 14s. each			9	16	0
Thirty tons green flax			37	10	0
Packing, baling, &c.			6	5	0
Three tons coal, at 25s.			3	15	0
Freight or cartage, say			7	10	0
				82	11 0
			£17	9	0

This estimate is on the supposition of continuous working, but—

Deduct for stoppages one-fourth, or say	...	...	4	9	0
---	-----	-----	---	---	---

Leaving a profit of	...	...	£13	0	0
---------------------	-----	-----	-----	---	---

per week, or £676 a year; out of which, of course, the interest of the capital must be paid.

Mr. Jenkins estimates the same things at £1,010; but he allows nothing for men's houses, and only £450 for the engine; while his weekly return is £82 3s.

Water-power is, of course, much cheaper, as it saves the expense of engine, engineer, coals, &c. Messrs. Price, of Onehunga, can supply four machines, water-wheel, shafts, pulleys, &c., for a little over £200.

Of course, position and other circumstances will modify or enlarge these figures, but it would not be safe to calculate on a larger return. It will thus be seen what balance there may be at the disposal of the manufacturer to assist in the work of cultivation; and again, extreme caution is urged in commencing operations without a thorough knowledge of the capital and extent of flax land required to carry on three machines, and a smaller number would not pay, except in unusually favourable circumstances.

Mr. Maning thinks that great results cannot be obtained till manufacturers trust entirely to cultivation, by which means an unfailing supply can be obtained; and he suggests planting in alluvial flats, in the vicinity of water-power; and he goes so far as to say that a sufficient quantity should be planted to prevent the necessity of cutting a second time in less than two years from first cutting, though many leaves may be fit for the mill sooner. This is a hint worth taking.

III.—MACHINERY.

The machines used in the Province of Auckland for manufacturing flax are of three kinds, made respectively by Messrs. Fraser and Tinne, of the Phoenix Foundry, Auckland; by Messrs. A. G. Price, of Onehunga; and by Messrs. E. Gibbons and Co., of Onehunga. All these machines are, however, identical in principle, and vary only in details by which the principle is carried out. This principle is, that the flax leaf is held between horizontal feed-rollers, revolving at certain speed, while, as the leaf passes out from them, a drum, armed in its circumference with iron beaters, and revolving more rapidly than

the feed-rollers, strips the epidermis and tissue away from the fibre, means being provided for adjusting the beating drum to a proper distance from the roller or bar against which the flax leaf is stripped, so that the leaf may neither, on the one hand, pass through without being crushed, nor on other, have the fibres cut. Another contrivance common to all the machines is vulcanized india-rubber cushions or spiral springs placed over the journals of the upper feed-roller, so as to allow different thicknesses of leaf to be passed through.

The first essential of a flax machine is, of course, the quality of the fibre it produces. This depends to a certain extent upon the shape and velocity of the beaters, but more particularly upon the ease and accuracy with which the machine can be kept in adjustment. The length of that portion of the tip of the leaf which is left undressed by the machine, depends upon the firmness with which the feed-rollers grip the thin point of the leaf, and the distance of the place where the leaf is crushed from the place where it is held by the rollers.

We know that, on the one hand, simple percussion with a hammer on a block of wood, and on the other, scraping with a knife or shell, can each be made to yield good fibre, so that the limits of the speed at which the beaters strike the leaf, which is necessary for making good fibre, are probably very wide. The velocity with which the beater scrapes the flax is of course the difference of velocity between the beater and the leaf as it passes through the rollers; and as the blow is delivered not at right angles to the leaf, but at first at an acute angle, which rapidly changes to the same direction as the leaf as the beater passes round with the circumference of the drum, it follows that the greater the velocity of the beaters the more will their action be one of scraping, and the smaller the velocity the more will their action be one of percussion, or more properly detrusion.

In Fraser's old machine, and in Price's smaller one, the beating drum is thirteen inches in diameter, armed with fourteen beaters, consequently, when making 1,260 revolutions a minute, the velocity of the beaters is 71.5 feet per second. The velocity of the circumference of the feed-rollers, or, in other words, the velocity of the leaf, is about 2.7 feet a second, thus leaving a velocity of 67.8 feet per second with which the beaters pass the leaf. In Gibbons' machine the beating drum is seventeen inches in diameter, armed with thirty-eight beaters, and revolves at only half the speed of that of Price's and Fraser's smaller machines, the feed-rollers of all moving with the same angular velocity. Consequently, when Gibbons' drum is making 630 revolutions per minute, the beaters have a velocity of 46.7 feet per second.

The feed-rollers of this machine being slightly larger than the others, the velocity is 2.8 feet per second, making a velocity of 43.9 feet per second with which the beaters outstrip the leaf, so that the velocity of the beaters to the feed is as 1.17 in Gibbons', and as 1.26 in Price's and Fraser's old machines. In Price's and Fraser's old machines there are fourteen beaters on each drum, the feed-rollers are 2.5 inches in diameter, and the drum makes five revolutions to one of the feed-rollers, so that each blow of a beater is on an average (as the beaters are not equi-distant), rather more than one-ninth of an inch from the one before it. In Gibbons' drum there are thirty-eight beaters, the feed-rollers are 2.6 inches in diameter, and the drum makes two and a half revolutions to one of the feed-rollers; consequently, each blow is delivered rather more than one-twelfth of an inch behind the former one, and the power saved is proportionately great.

Notwithstanding these differences in velocity and in number of blows to an inch, we are of opinion that all the machines when in proper adjustment make equally good fibre. In Price's and Fraser's old machines the beaters were placed diagonally across the face of the drum, sloping alternately in opposite directions, and the spaces between them were filled with wood. Gibbons' new machine has the beaters set on the angle, but all running parallel, which allows them to be placed nearer together. In Price's new machine the drum is fifteen inches in diameter, with twenty-six beaters, which are of the same kind as in the smaller machines, but being placed closer together increases the rapidity of the blow. Messrs. Price tried the chevroned beaters, but afterwards abandoned them. In all these larger drums the wood between the beaters is omitted. We are of opinion that the position of the beaters on the drum matters but little as far as making good fibre is concerned, provided that the velocity is sufficiently great, and the striking edge of the beater round and smooth. It may here be remarked that Captain Hutton thinks that the beaters on the drum should be hard, but that the bar or plate against which the flax is crushed should be soft. Mr. Booth, of Dunedin, has endeavoured to carry out at least a portion of this idea, but has abandoned it.

The adjustments of the different machines vary considerably, but all are capable, with more or less ease, of adjustment while the machine is in motion; a point of the greatest importance. In Price's machine the flax is crushed between the beaters and the lower feed-roller; and in his earlier machines the distance between the two was regulated by means of screws, which moved the journals of the beating drum forwards and backwards on a sliding bed; now the drum is fixed, and the whole of the standards carrying the feed-rollers is moved in the same way, which allows the feeder to adjust his own machine without moving from his place.

In Fraser's new machine the flax is stripped against a thick plate rounded at the end, which is slipped under the feed-rollers; the back of the plate has a flange, which is pressed forwards by two screws against india-rubber, the elasticity of which pushes the plate back when the screws are loosened. This adjustment is very easily made by the feeder. In Gibbons' machine a round bar with square ends takes the place of the plate, and, being near the beating-drum, it leaves very little of the leaf undressed. The adjustment is given by pinching-screws, which act through the boxes carrying the journals of the beaters.

The wear upon both the surfaces of metal between which the flax is dressed is very great, while a very slight wear prevents the machine from dressing the flax properly, so that the surfaces have to be constantly filed up or changed. In Price's machine the lower roller, against which the flax is dressed, is a cast-iron hollow cylinder. As their roller is three inches in diameter, and by constantly revolving always presents different surfaces to the beaters, it lasts much longer than any other of the machines; but when it is too much worn, the machine has to be stopped, taken to pieces, and the old cylinder ground up, which is a work of considerable time, but they give a spare roller with each machine.

In Gibbons' machine the round bar, having four-sided ends, can be shifted so as to show four different surfaces to the beaters as one after the other is worn out; it is then thrown away and a new one put in. It was at first thought that eight changes might be got from each bar by shifting it end for end, but this is not the case if good fibre is desired, and as the cost of the bar is trifling, there is no necessity for trying it. This bar can easily be shifted while the machine is in motion. As Gibbons has two machines on one shaft, the stoppage of one necessitates the stoppage of the other. In Fraser's machine no change of face can be obtained, but the worn plate can be slipped out, and another put in in a few seconds without stopping the machine, and the old plate can be ground up again, ready to replace the second, when it is in its turn worn hollow. The cost of these plates is also small, being only 2s. 6d. each.

The importance of dressing the leaf out to the tip is considerable, as it prevents great waste. In Gibbons' machine, and also in Fraser's new one, the feed-rollers are deeply and sharply fluted, and hold the leaf firmly to the tip; the distance, however, to the place where the leaf is stripped is rather longer than in Price's, which, beating on the lower roller, reduces this distance to a minimum. On the other hand the lower roller of Price's machine must be made smooth, as the flax is dressed on it, and so cannot take so good a hold of the thin end of the leaf, but allows it sometimes to be pulled through by the beaters. This can, to a certain extent, be remedied by the person feeding, either twisting the thin portion of the leaf round his fore-finger as it enters the rollers, or by "tailing" the butt end of one leaf to the thin point of the one before it, and so increasing the pressure on it. This "tailing on," however, must not be overdone, as the leaves are apt to entangle with the "out-taker" under the machine. Fraser's old machine had the fault of a smooth lower roller, combined with a considerable distance between the beating-plate and the feed-roller. In practice, when the machines are in good order, and working well, we are of opinion that there is little difference between Fraser's, Price's, and Gibbons' machines in this respect.

Next in importance to the quality of the fibre produced comes the quantity of green flax passed through in a given time. This depends not only upon the diameter and velocity of the feed-rollers, but also upon the size and shape of the leaf taken through, the liability to stoppage by flax getting round the shafts, and the ease of clearing the machine when choked. The diameter of the feed-rollers are nearly alike in all the machines, those of Gibbons' being the largest, and the comparative velocity can of course be altered to the wish of the flax manufacturer. It is easy to drive the machines fast, and the "feeder" can put a large number of leaves through in a minute; but our experience is, that from thirty to thirty-five leaves a minute is quite as much as the "out-taker" can manage without entangling or loosing a large part of them, and it is in this direction that improvement is most required. It will be found that feeding at the rate of two and three-quarter feet per second will pass thirty-three average-sized leaves through per minute, or a quarter of a ton per hour per machine.

The size and shape of the butt of the leaf that the machine will allow through is important, for much time is lost when the machine refuses to take in big butts cut square at the ends, and it takes too long to go over all the flax first and cut off the thick ends and point them, to say nothing of the waste of stuff that has been paid for. In this respect both Gibbons' and Fraser's new machines which have both feed-rollers fluted, have an advantage over Price's, the lower roller of which is compelled to be smooth. The merit of this improvement is claimed by Messrs. Gibbons, and is one of the points for which they intend taking out a patent.

Stoppages are sometimes occasioned by flax getting round the shafts of the drum or feed-rollers, and into the bearings; but with the machines in good order, this now seldom occurs except through carelessness. As, however, it will, in spite of all care, happen occasionally, it is of importance that every facility should exist for clearing with as little delay as possible. Fraser's old machine was very deficient in this respect; but his new one, and Gibbons', and Price's, leave little to be desired. Mr. McIntyre, of Onehunga (as instructed by Mr. Dougal, who claims to be the originator of these machines), has recently begun to manufacture flax machines; but as these are on the same principle as Price's, no further notice need be taken of them, except to say that they have been got up with great care, and with a view to durability—the bearings being all brass—and that Mr. Wallace, of the Flat Bush, is now using them, and declares himself perfectly satisfied with their work. Mr. Mills, of Wellington, Mr. Murray, and others, are also making machines; but neither is it necessary to dwell on these, as the above remarks can be easily applied to any other machine, and its merits ascertained.

In erecting machinery to be driven by steam, care should be taken that the machine-house and chimney or funnel should be so placed that the prevailing winds shall carry the soot, smoke, and sparks, away from that part of the establishment where the scutching and packing operations are carried on. Fire-protectors should also be placed on the top of the funnel. Want of attention to these matters has already been the cause of several fires.

Care should also be taken that the scutcher shall be so placed as that the prevailing currents of air through the mill, where no exhaust-fan is used, shall take the refuse and dust away from those feeding the scutcher. With all possible care, the impalpable dust flying about will reach their lungs, and therefore a respirator, as already suggested, should always be worn.

Where it is necessary to work the scutcher and to pack or bale at night, patent lamps should be used, as all unprotected lights are more or less dangerous.

Until very recently, the prevailing opinion was, that the machinery now generally used would produce such an article as would command a remunerating price in the English market. But the fall in price there and other circumstances have led to a change in that opinion; and the opinion now gaining ground in the South is, that mechanical appliances alone will not produce such an article as will secure this object. However excellent many of the machines now in use may be, the article turned out by them is only fit for a few purposes, such as rope, matting, bagging, &c.; and having to compete in these trades with fibrous materials which have already gained favour, the chances are that the prices to be obtained for the New Zealand article will not leave such a profit as will induce capitalists and others to embark in the trade. New appliances must therefore, it is said, be resorted to, in order to procure that which machinery alone has hitherto failed to supply, viz., an article suited to the manufacture of the finer textile fabrics, and for which a very much higher price will be

obtained. Some very strong opinions have been expressed on this point. Mr. Luke Nattrass, of Nelson, says:—

“Firstly, Nothing but chemical preparation is likely, as a rule, to secure its safe arrival after a long passage through extremes of heat, cold, and moisture, or to establish the export of it as a staple of the Colony.

“Secondly, The smallest particle of mechanically prepared fibre contains its proportion of objectionable matter, and is the cause of its ultimately turning black and becoming rotten, particularly if exposed to sea water.

“Thirdly, My data gives one of merchantable fibre from four of fresh-cut green leaf.

“Fourthly, From the time of cutting the leaf, it can be put into condition for packing in twenty-four hours.

“Fifthly, All the fibre of the green leaf is saved; scutching and hackling unnecessary; there is therefore no tow, no waste, with no labour, and no expense in suffering a loss. Where scutching is used, there will be no end to mill conflagrations. This is proved by the fires that have lately occurred, and some of them attributed to incendiarism.

“Sixthly, In September last, the fibre of one leaf prepared by me here and taken to Wellington, was valued at £27 per ton, cash price, for any quantity. What it may be in England, at the present moment, I do not conjecture. Since that date (September) such has been worth in England £52, which since then has declined to about £40. Should mine be worth now there £30, the encouragement to manufacture would be very great; but as I have previously said, ‘the mill must be constructed before only one bushel of wheat can be converted into flour.’”

Dr. Florance, already referred to, after long consideration of the subject, says, in a letter which will be found in the Appendix, No. VI., “You will see by this that my views run counter to what is called the successful ‘dry process,’ as recently adopted by some parties in the North Island. Exposure to the air, which the dry process implies, must effectually fix the gum into the fibre, and so defeat its own ends;” and the writer in the *Press* says that the gum, by the action of the stripper, is driven into and among the fibres as they are partially separated, and carries with it a certain amount of the other substances which help to bind up the structure of the leaf, and causes them firmly to adhere to the fibres, also at the same time occasioning the fibres themselves to cohere to one another, forming a harsh brittle mass that would require a very lengthened immersion to loosen and separate. And he goes on to show that either maceration or chemical appliances must be used to obtain fibre of a fine quality.

It is therefore probable that the machinery now in use will not produce fibre of a quality to compete successfully with Manilla and Russian hemp for the manufacture of some articles of commerce in extensive use, unless it is subjected to subsequent operations which will have the effect of removing the greater portion of the gummy matter which is found to be so detrimental; but if such subsequent operations are successfully achieved, or if the appliances now on trial shall realize expectation, then it will be found that the New Zealand flax is capable of being used not only for making rope, matting, &c., but also in the manufacture of many textile fabrics, and when so used will command a remunerative return; and if so, it is clearly the duty of this Colony to leave no means untested that may be recommended for this purpose. Hence it is that the Commissioners suggest the appointment of a Commission with power and means to test every suggestion that is calculated to accomplish the object in view.

The Commissioners here beg to express their thanks to Dr. Hector, for the readiness, zeal, and skill with which he carried out their wishes in regard to these experiments. Samples of flax prepared in all the modes alluded to in this Report will be found in the Colonial Museum, and a careful examination of these is requested by all who have an opportunity of doing so.

The Commissioners have thought that it would be very useful to republish two articles that appear in the Transactions of the Proceedings of the Colonial Museum:—1. Captain Hutton; App., No. VIII. 2. Mr. Nottidge; App., No. VII. 3. A Letter by Mr. Bust is also published, No. IX.

Since the Commissioners commenced their inquiries several very valuable and instructive papers have been published, bearing directly on the object for which the Commission was appointed. These it was thought desirable should be preserved and read along with this Report; and accordingly they are printed in the Appendix hereto. The Commissioners might have incorporated the information afforded by these papers in this Report; but such a course would scarcely have been fair to their authors, and they therefore prefer to give the papers entire, or nearly so.

These papers are,—

An Article from the *Press* (App., No. X), in which the different modes of dressing the various kinds of fibre now used in the preparation of flax for the market are fully and clearly explained. The defects in the present systems of preparing flax are also pointed out. The writer in this article, however, is decidedly wrong in saying that New Zealand flax, even as at present prepared by several manufacturers, is unsuited for rope. In the Appendix, alongside his own remarks, will be found strong evidence that the reverse is the case; and the Commissioners know that no difficulty is experienced in selling rope made entirely of New Zealand flax, even where Manilla is alongside of it.

Dr. Williams, of Nelson, in a lecture which he delivered before the Scientific Association there, gives some very useful information regarding the uses and value of the New Zealand flax; and in the Appendix, No. XIII., will be found several lengthened excerpts therefrom.

Mr. Thomas Mackay, senior, also of Nelson, has favoured the Commissioners with a copy of an address which he delivered before the Association already named; and as that address contains a description of his own mode of preparing flax, as well as other useful information, it has been printed in the Appendix, No. XIV.

Mr. Mackay has also in preparation a more perfect machine than the one now in use by him; but as it was not completed when he sent his address, no description of it has been given. This is to be regretted; but the investigation into the merits of that machine will be one of the duties of the Commissioners, should they be appointed during the ensuing year.

In the Appendix, No. XV, will be found a letter from Mr. Bromfield, relative to the employment

of very young children in flax mills; and the Commissioners having considered the matter, are of opinion and beg to recommend that it should receive the immediate attention of the Legislature.

In some of the mills now or lately at work, children of a less age than ten have been employed; and though the work is not oppressive, and though there are repeated stoppages during the working hours, still the lengthened confinement of very young children is injurious to health, besides depriving them of the chance of being educated. Some establishments, with the view of preventing smoking inside the mills, allow ten or twelve minutes each forenoon and afternoon for the smokers to go outside; and during these short intervals, the juveniles have generally a romp outside, by which the monotony and drudgery of their toil is so far relieved.

Wherever practicable, evening schools should be established. There will always be found men capable of doing a full day's work at the mill, and of giving two hours' instruction during four or five nights each week. Of course he ought to get extra pay for this, consisting partly of small fees from the pupils, and a fixed salary by the owner of the mill. Such schools would undoubtedly be very useful, not only in preventing the young growing up in ignorance, but from spending their evenings in vicious practices.

One of the Commissioners, Mr. McArthur of Southland, has written a very valuable letter on the necessity for issuing stringent regulations to protect the flax from destruction by burning and otherwise; and on the best way of procuring cheap labour for the mills. That letter will also be found in the Appendix, No. XVI.

The question whether the flax can be so improved as to admit of its being used in spinning some of the coarser fabrics, has been discussed, and the conclusion arrived at is that it can be so employed, and a sample of bags made from it, which has been in use in Mr. Kebbell's mill in Wellington for fourteen years, as well as samples of several other fabrics made by Mr. Nattrass, will be found in the Colonial Museum; and with the view of informing those interested in that question, an estimate of the cost of the necessary machinery for such a purpose is also appended, No. XVII. It will of course be seen that the steam machinery to propel the spinning appliances is not stated there. The estimate is also only approximate, in the absence of the knowledge of the peculiar requirements for the New Zealand fibre.

With reference to the application and recommendation by the settlers of Raglan, that the Government should in some way recognize the services rendered by Mr. Dougal, as the inventor of the machines now generally in use in the North Island and elsewhere, known by the name of their makers, the Messrs. Price, the Commissioners believe that Mr. Dougal is the person who invented the machine, and that the principle on which it is constructed has guided others in still further utilizing that principle, and thus giving that impetus which has raised the flax industry to its present position; still, as the value of the principle has not yet been fully established, or rather has been so far impugned, the Commissioners would suggest that further time should be allowed to elapse ere anything be done, in order to see whether that expectation shall be realized, or whether other machines now in course of making shall supersede their use altogether. Before the end of next year the Commissioners will be in a more favourable position to report upon this matter.

With the view of giving the fullest publicity to all applications for patents in connection with the flax industry, the Commissioners have got the permission of the Government to publish a short sketch of the principle sought to be covered by each of these patents, and of the mode of working the same, so far as explained in the specifications lodged in the Patent Office. That document will also be found in the Appendix, No. XVIII.

There are several other applications for patents; but as the law stands at present, no one is allowed to see these applications till they are granted, when it is of course too late to lodge objections by those interested in the invention sought to be protected. This was a great oversight on the part of the framers of the Patent Act; but a new Bill is now under the consideration of the Legislature to rectify this and other defects in the present law, so that in future it will be possible for any one to see all new applications, and to ascertain whether they really contain any new invention or any new application of an old one.

It may naturally be expected, after the opportunities offered to the Commissioners to obtain information with respect to the present condition of the flax fibre manufacture, that some definite conclusions could be arrived at with regard to the course which is best calculated for manufacturers to pursue at the present time. This no doubt is desirable, if it could possibly be done; but it must be recollected that the wants of the English manufacturers is the first thing to be attended to, as to whether the fibre is most in demand for rope or for spinning purposes. During the past year the demand for flax fibre for the purpose of ropemaking unduly stimulated its production, and in consequence an article of an inferior quality was forced on the Home market, and this led in a great measure to the suspension of farther demands. But this can only be of short duration, if manufacturers will take proper care to produce fibre of good quality. The great objection to the fibre seems to be that it is not sufficiently freed from the gummy and resinous matter by which in its natural state it is saturated; the aim, then, ought to be to endeavour to ascertain the best and cheapest way of removing this objectionable matter. The ordinary process of stripping, rinsing, bleaching, and scutching, does not seem to be sufficient to effect this. According to Captain Hutton's paper, printed in the Appendix, the gummy matter as it exists in the leaf is soluble in cold water, provided that it has not become dry before being subjected to its action. If this view is correct, it would appear that the proper course to pursue is to operate on the leaf by some of the ordinary mechanical contrivances which are used to remove the cellular matter which surrounds the fibre, and then, by a series of soakings and compressions by rollers, to dilute and squeeze out the gummy juices from the substance of and from between the bundles of fibre.

It is also stated that besides this gummy matter, there is also a gum resin which is insoluble in cold or warm water, which the previous treatment would fail to remove; the question then arises, Is the fibre injured by the presence of this substance? It can scarcely be so as regards causing the fibre to rot by inducing fermentation. The only way it can prove objectionable is by rendering it brittle, causing it to break short when subjected to a severe strain; of course the same would

result from the presence of gummy matter, in addition to its being liable to rot from fermentation excited by moisture. The only process which appears to be capable to remove both the gummy and resinous matter is the retting process, which is applied to most of the fibrous materials with which the New Zealand fibre has to compete. The description of an improved process of retting is printed in the Appendix to the Report; but before the Commissioners can confidently recommend any distinct process, further exact experiments are deemed to be necessary, not as regards the chemical constituents of the leaf, but as to whether, by mechanical manipulation of the fibre in the presence of cold or warm water, the juices can be sufficiently diluted to enable the greater portion to be easily removed, and thus render the fibre sufficiently pliable for spinning purposes without adding materially to the cost of production. The great object to be aimed at is to produce a soft fibre, capable of being used for spinning purposes, the colour of which is not of primary importance, as the mere operation of bleaching can be much more cheaply effected in England. The Commissioners think also that it is of the utmost importance that fuller inquiries be made in the English market as to the peculiar condition of fibre, as regards length, softness, colour, and fineness, which is best calculated to obtain a ready sale at a remunerative price. This is a task the Commissioners think should be undertaken by the Government; and as it is of vital importance to the manufacturers in this Colony, who are now producing a class of fibre which may be unsaleable, as not being adapted to the wants of the English consumers of fibrous material, this information should be obtained with the least possible delay.

Reported by THO. MACFFARLANE, Chairman.

(Signed)	THOMAS H. POTTS.	JOHN KEBBELL.
	THOMAS KELLY.	A. P. SEYMOUR.
	CHARLES C. GRAHAM.	NATHL. EDWARDS.
	A. W. F. HALCOMBE.	

APPENDIX.

No. I.

NEW ZEALAND FLAX.

Office of Flax Commission, Wyndham Street, Auckland, 1st November, 1869.

[The subjoined questions are forwarded with the view of obtaining the fullest information as to the cultivation and manufacture of flax. It is requested that the replies may be written on the same size of paper as this sheet, or as near thereto as practicable (for binding), and numbered to correspond with the queries.]

I.—GROWTH AND CULTIVATION.

1. What are the names of the different varieties of flax with which you are acquainted, and how distinguished?
2. What are the special uses of each? Do they grow from seed? (Small specimens of any peculiar leaf for microscopic examination are requested.)
3. What is the soil best adapted for each variety?
4. What is the best mode of cultivation—including the time of the year for planting and cutting?
5. What is the distance from row to row?
6. What is the distance between plants in a row?
7. How many roots are planted together?
8. How long after planting before leaves reach maturity or are fit to cut?
9. How long after each cutting before another crop can be cut?
10. How is it known when leaves are fit to cut?
11. Is the entire plant cut down each time, or only the outer leaves? Give length and weight of leaf.
12. At what distance from the ground should the leaf be cut?
13. What digging and manure are required in planting?
14. Where, and how, can a supply of plants of the best sorts, and seeds, be obtained?
15. How and when should seed be gathered; and how and when best sown and transplanted? Give full details of process.
16. Can you give any information as to the Native mode of cultivating flax? If so, state it, and the localities where plants and seeds of the best kind can be procured.

II.—MANUFACTURE.

1. What is the number of flax-works in your Province? State situation and names of owners.
2. How is the flax brought to each of these mills?
3. What is the cost of each ton of green flax at the mill?
4. What are the various processes through which the flax is put? Please to give full details. (See following queries.)
5. What is the number of persons employed? Giving details of each branch of process.
6. Is labour by piece or day-work?
7. Are the lashings worked up as green flax?
8. What is the best mode of carrying green flax to avoid heating?
9. How long may the cut flax be retained before being worked up?
10. How can it be kept fresh and pliable?
11. What is the cost of production of a ton of fibre? State the total cost of machinery, allowance for tear and wear or depreciation, rent, insurance, and other charges.
12. What price is obtained for flax and tow—stating where sold?
13. Cost of transport per ton, and charges for selling and storing?

14. How are the bales made up for carriage, and what is the best mode of packing?
15. What machines are used? State makers' names and addresses.
16. How many do you employ, constantly or occasionally?
17. Are they satisfactory or otherwise? Suggest remedy for defects.
18. What is the annual tear and wear; what the duration of machine?
19. What is the diameter and what are the revolutions of the stripping-drum per minute?
20. What is the diameter and what are the revolutions of the feeding-rollers?
21. How much dressed flax can each machine dress per hour or day of eight hours?
22. By what power are your machines driven?
23. What is the horse-power required by each machine?
24. What kind of scutching machine is used? Describe it, and state cost and amount of work done by it per day.
25. What is the horse-power required to drive it?
26. Do you adopt any mechanical or chemical appliances for washing, wringing, &c.? Describe process of washing flax or freeing it from gum, and cost of same.
27. What time is allowed to elapse between each operation?
28. Is flax allowed to remain any time after being washed and before being spread out?
29. What process do you adopt in bleaching and drying flax—whether on grass, rails, lines, or ovens; and what time is required for each?
30. How many tons of green flax are required to make one of fibre?
31. Are butts and points of green leaves cut off before being manufactured; if so, to what use turned?
32. Is any use made of refuse from machines; if so, what?
33. Is any use made of gum?
34. Is any use made of other products?

No. II.

NEW ZEALAND FLAX CONSIDERED AS A FIBROUS MATERIAL.

From actual observations, and experiments performed in 1863-4, by Dr. Hector and Mr. Skey.

THE flax grows in bunches or groups of plants or shoots: each shoot has five leaves. Ten of these shoots go to a bunch on the average, or, in all, fifty leaves. These vary, according to the soil, from five to ten feet in length, and each consists of a double-bladed leaf, which, when closed, is from two to four inches wide. The lower part of the outer leaves forms a complete sheath or flattened tube, and it is from this portion of the leaf that most of the gum exudes, and where the fibre is of least value.

On rich "flax land" there are over 2,000 bunches of flax to the acre, or 100,000 leaves. When sun-dried, these leaves, after cutting off the gummy and useless lower parts, weigh about five to the pound, so that an acre of ground will yield nearly ten tons of dried leaves. Assuming the outer leaves only to be taken, the quantity will be reduced to four tons. Now, from experiment, it was found that 23·10 per cent. of apparently well-cleaned fibre could be obtained from green flax when all loss was avoided. Mr. Honeyman, of Dunedin, however, only produces about twelve per cent. of fibre, exclusive of tow. We may, therefore, safely anticipate a yield of fifteen per cent. upon these four tons, since they will have gained by their desiccation an additional four per cent. of fibre, calculated upon a loss of fifteen per cent. of water. This will give of clear fibre about twelve per cent., or three-fifths of a ton, only taking the outer leaves. Respecting the proportion of tow to be added to the good fibre no certain data have been obtained, but in ordinary flax the weight of tow is about equal to that of the clean fibre, and from the different character of the New Zealand flax we may expect the proportion to be a good deal less.

On hill land, owing to the shorter growth of the leaves and the wider intervals between the groups of plants, the yield will not average more than three tons to the acre.

The quantity and quality of the flax crop could, no doubt, be greatly increased by artificial culture; and with any permanent establishment for the manufacture of the fibre, it would no doubt be found necessary to undertake the cultivation of the plant, instead of depending alone on the natural supply in the wild state.

The method employed by the Natives for cleaning the fibre is by simply scraping it with a shell or knife when in the fresh green state. By this means a fine quality of fibre is obtained, but only a very small proportion of the whole quantity in the leaf, so that the great loss of material and waste of labour involved in the operation makes it suitable only for the production of such small quantities of fibre as are required by the Natives themselves.

Ever since the foundation of the Colony, attempts have been made from time to time to supplant the Native process for the preparation of the flax fibre by others of more economical application, but as yet, so far as is known, without any successful and practical result; and it is to be regretted that no information was furnished regarding the methods employed in preparing the various samples of fibre that were sent for exhibition, as, without such explanation, it is impossible to form any opinion of the merits of the samples as indicative of a successful solution of the problem.

The relative intrinsic merit of the various samples of fibre is scarcely within the province of chemistry to determine, as those tests which would alone determine them are entirely mechanical, such as the tension the fibre can bear, and the injury it sustains from torsion.

Even without these trials, which would have required peculiar mechanism for their application, it was quite evident that, of all the various samples exhibited, those that had been prepared without the use of chemical re-agents, and especially by the simple method employed by the Natives, were the most superior, in so far that they preserved the qualities of lustre and strength in the highest degree.

In the general absence, therefore, of complete and detailed descriptions of the methods used, we are induced to communicate the results of a few Laboratory experiments, with the methods by which

they were obtained. They were instituted especially for the purpose of ascertaining the precise action of certain chemicals upon the flax plant, and although much of this work will have already been performed by others, some portion may be new, and the whole will possibly have an interest and a value, from the care and exactness with which it has been endeavoured to conduct the inquiry.

Mechanical Preparation.—It was found absolutely necessary to commence the process by bruising the leaves. The leaves chosen were about seven feet long, from old plants, and the whole of the leaf was taken except about one foot of the base. The double leaf was placed upon a smooth block of hard wood and smartly struck over every part with a hammer, the iron head of which had its flat striking part rounded off at the edges to prevent the cutting of the fibre. By this process the bundles of fibres in the thick part of the leaf are easily separated from each other, but the top part of the blade, from its thinness, is much more difficult to break up.

The nature of those two constituents of the plant which are supposed to interfere most with its preparation was first examined into.

Bitter Principle of Plant.—This was found to be a non-nitrogenous, non-crystallizable body, of a pale yellow colour, feebly soluble in water, more soluble in alcohol, and capable of being absorbed by charcoal, and from which it can be dissolved away by alcohol. It refuses to form salts with acids or bases—it has all the character of a neutral substance. It is entirely removed by the repeated washing of the bruised leaf in water. In its concentrated form it is a very pure and intense bitter, and might be used, perhaps, to communicate a bitter taste to beer, in the absence of hops. It would at least be less objectionable than drugs that are said to be used for this purpose.

Nature of Gummy Part.—Soluble in water, but very slightly so when cold, and unless the solution is very much diluted, it thickens, on cooling, to an opalescent jelly. It is insoluble in alcohol; also in aqueous solution of caustic or carbonated alkali, or solution of soap; indeed, a clear solution of gum is rendered turbid and thick by either of these. On the other hand, it is readily soluble in sulphuric acid, strong or dilute, a thick opalescent mixture of it with this acid quickly changing to a limpid and nearly transparent solution, the whole of the gum being dissolved with the exception of a few flakes of some gelatinous substance, which floats freely about in the liquid, and which are probably nitrogenous matters. In its chemical character and physical properties it much resembles gum arabic. When once dried or merely desiccated in a natural way, it is only partially soluble in water, at least it is soluble only with great difficulty, and when in this dry state it is very hard and brittle; probably it is this circumstance that tends greatly to injure badly prepared flax, the delicate fibres of which must be cut as with a knife by such a substance when they are twisted about in the process of manufacture.

ACTION OF VARIOUS CHEMICAL AGENTS UPON THE LEAVES OF THE PLANT.

Action of Sulphuric Acid.—Three ounces of the bruised leaf were warmed up with twenty ounces of water, and two grains of concentrated sulphuric acid, previously diluted with water, were added. But this quantity was found insufficient to produce any result, even on long boiling, and the quantity of acid had to be increased to eight grains before any decided effect took place. With this quantity the green colour of the leaf was turned brown, and the solution also was coloured. Other three ounces of the leaf were therefore taken and treated with eight grains of sulphuric acid as before, and after boiling the whole for two hours, it was found that every part of the leaf was easily scraped clean by the nail, and the fibre did not appear to be damaged; it was, however, very harsh and inflexible.

Further experiments proved that if the boiling process was kept up much longer, or if the amount of acid added to it was largely increased, the fibre was greatly damaged.

Action of Hydrochloric Acid.—Hydrochloric acid was then substituted for sulphuric, with precisely the same results.

The effect of an organic acid was next studied.

Action of Oxalic Acid.—Oxalic acid was selected, as, from its being in a solid form, more exact quantities could be employed. 1,516 grains of the leaf were placed in 20 ounces of water, and boiled with 20 grains of crystallized oxalic acid, and digested for three hours, when the leaf was so much affected that it was easy to scrape it clean with a blunt instrument. This treatment did not impair the strength of the fibre at the time, though afterwards its strength seemed to decrease. The fibre obtained was bright and lustrous, and of a gray colour, but still harsh and inflexible, and, as was the case with the mineral acids, an increased quantity injured its strength. It was therefore evident that the use of organic acids possesses no special advantages over that of the cheap mineral acids.

Action of Alkalies.—1,120 grains of flax were put into 30 ounces of water, and one per cent. of caustic potash added, and the whole warmed for four hours, or until the leaf would scrape clean with the nail. In this case, though the fibre was clean it was very tender, and no matter how the quantities were varied, no useful result was obtained, for simultaneously with the cleansing of the fibre, there was a weakening which could not be avoided. The same results were obtained when carbonate of soda was substituted for the potash.

These results are difficult to reconcile with what is said about the non-detrimental effect of stronger solutions of the alkalies, than those employed as above, upon linen goods in the process of cleansing them for the bleacher, but probably the fresh fibre of plants is more easily affected by the action of alkalies, than the same fibre after passing through the various operations used in preparing it for the manufacturer.

Action of Oil.—The dry leaf was heated with it for some hours, but no advantage was gained, the leaf remaining unaltered.

Action of Alcohol.—The high price of this re-agent would of course prevent its use, even if the re-distillation of it from waste solution for further use was resorted to.

An unbruised leaf was found to be merely discoloured by the loss of its chlorophyll, the external varnish being first removed, nor was the bruised leaf more favourably affected, the gum, as before stated, being quite insoluble in alcohol.

Action of Soap.—The last chemical experimented with was soap, its solvent powers upon many

fatty and resinous substances being well known, and also the unsparing manner in which it is used upon many delicate fabrics without injuring them.

A certain portion of the bruised leaf was taken and digested in hot water for two hours. It was then boiled two hours longer with 12 per cent. of common soda soap, before it affected the leaf so that it would clean with the nail. The fibre so obtained, when scraped, appeared to be everything that could be wished for, being remarkably soft and flexible, but with a faint shade of green colour, indicating probably that no decomposition of the fibre had taken place. When the sample of fibre so prepared had been kept for one year, it appeared to be equally as strong as at first; and indeed flax so prepared four or five years since, still remains unaltered from the state it was in when first dressed.

A much larger quantity of soap did not hurt the fibre, hence its use is free from those objections which attach to the use of acid or alkalis. The high price of the soap, however, would entirely prevent any adoption of this process, as it would entail a cost of twenty pounds upon every ton of clean fibre. The expenditure of soap, however, can be greatly reduced in two ways. 1st. By washing the flax repeatedly in warm water, and then adding the soap to the necessary amount. 2nd. Before adding the soap, by neutralizing with carbonate of soda the water in which the flax has been boiled, as it acquires an acid reaction. In each case the proper quantity of soap is that which gives to the warm solution a permanent froth upon its surface when stirred about. The first process of washing is preferred on account of its greater cheapness, and also because it avoids the danger of using the excess of alkali to which the latter is subject. In regard to the second process, the quantity of alkali necessary will vary with the season, but, at the time of the experiment (autumn), 3·5 per cent. of common washing soda, or 1·3 per cent. of the dry carbonate of soda was found to neutralise the acid substances of the flax. In either case about one or two per cent. of soap would be necessary. The cost of chemicals would be £4 to £5 to produce each ton of clean fibre by the first process, when soap is used alone; and by the second or neutralizing process, about £6 or £7. As will be inferred, an abundant supply of hot water is necessary. Perhaps the readiest and most economical way to maintain this would be to connect the steam pipe of a boiler with a perforated coil lying at the bottom of the vat or tub in which the operation is carried on.

Fermentation.—It has been thought by some that possibly flax might be worked profitably for alcohol; but as it was found to contain but 1 to 1½ per cent. of sugar (grape sugar), even in the autumn, it would not answer at all for this purpose. It was, however, attempted to turn this process to account in the manufacture of prepared fibre in the following manner:—The bruised flax was treated with hot water, and allowed to steep therein for three hours at 130°; sulphuric acid in the proportion of two grains to the ounce of flax being previously added to facilitate the change of the gummy matters, starch, &c., into sugar; the object being to ensure a good and rapid ferment, in order to break up the cells of the plant, if such was possible. The whole was then cooled down to 80°, and yeast added; fermentation soon commenced, and went on pretty fast, but when completed the fibre was found to be still difficult to clean, although considerably altered.

The liquor from the preceding experiment was perfectly clear, of a pale yellow color, and had to a remarkable extent the odour of bitter beer, and undoubtedly a kind of beer could be made from a strong infusion of flax mixed with a moderate quantity of sugar, and then fermented.

Retting.—The last process tried was retting, to which process the varnish on the outer part of the leaf has hitherto proved an insuperable obstacle.

It was thought, however, if the leaves were first broken up by rollers or stampers—or, still better, by a comb with teeth set wider in the back, so as to separate the leaf into filaments without any bruising—so that the gummy matters which bind together the flax fibres could be placed at once in direct contact with water, these would soon enter into a state of decomposition, and communicate this to the more inert portions of the plant, and which, if stopped before it had extended to the fibre of the flax by its removal from the solution, would give us a product as nearly similar as possible to the home flax just after retting, and consequently in a fit state to be scutched, with its natural strength of fibre but little affected. Several experiments were therefore made to test this, and some of the results certainly appeared to be very favourable.

The following is a brief description of the particular methods employed:—

As nearly as possible the first experiment was made to approximate to the ordinary process of retting generally adopted, excepting that the leaves were first well bruised. One week after immersion in cold water the flax was nearly as green as ever, and even three weeks after the commencement of the experiment no decided change in its texture could be discerned, though its green colour had by this time given way to a pale yellow. At this stage the experiment was broken off, on account of the coldness of the weather. No opinion can therefore be formed of the value of the common retting process upon bruised flax; other experiments at a more favourable season of the year are necessary.

In another case the flax, bruised as before, was heated to a temperature of 150° Fah. and then set aside. In one week after the leaf appeared to be much modified, and in a few days more it could be cleaned pretty readily while still moist from the liquid, the strength of the fibre not appearing to have been in the least degree impaired. During the latter portion of the retting, gas was given off in some quantity, attended by an unpleasant smell.

Lastly, another portion of the bruised flax was heated with water to a temperature of 150° Fah. for a short time, after which the temperature was allowed to fall to 100°, at which it was kept for twelve hours, and though suffered to cool each night, was warmed to the same degree each morning, and kept at this for the remainder of the day. By this means the length of time which the operation required was greatly reduced, and the product was even more readily cleansed than before.

There is one circumstance especially worthy of note in these results, viz., the ease with which each bundle of fibres can be resolved into the separate hair-like filaments which compose them; by no other process was their coherence so far reduced.

General Remarks.—On reviewing these experiments we find that acids generally have the property of rendering the gummy matter, which bind the fibres together soluble; but though this makes the leaf more easy to clean, still there is always a hardness and an inflexibility in the fibre so

prepared which must prevent its adoption. In addition, there is a danger of hurting its strength, and unless washed with great care, the result would be its gradual deterioration.

Oil, as might be expected, has little or no action. Alcohol, even if it could be economically employed, is useless, as it exerts no decided action upon those substances which have to be removed.

The use of caustic, or carbonate alkali, alone, though very beneficial in some respects, is very objectionable in others. They enable us to clean the fibre with ease, but at the same time they impair its strength, always indeed imparting to it a brownish tint, which can scarcely be looked upon as other than a sign of decomposition.

In the use of the last chemical experimented on, soap, we have all the advantage obtained by the use of the alkalies above, without their disadvantages, but the high price of this article would prevent its adoption for this purpose if used alone. If, however, as before stated, the acid of the flax was first neutralized with carbonate of soda, the use of a small quantity of soap would effect the rest without incurring the least danger or adding much to the expense of the operation.

The fibre obtained in this way is easily cleaned, is not discoloured, and appears as strong as that prepared without the use of chemicals.

The only remaining process requiring comment is the modified retting process, and which, in our opinion, is likely to be the most promising, as it involves no expense in chemicals, and but little in fuel. When properly performed, it will, without doubt, give results equal to those obtained by any of the other processes, and in one respect superior, the woody tissue which binds the fibres together in bundles being in this case so much affected by the decomposition of the gummy matter, that it offers little impediment to the splitting up of these coarse fibres into hair-like filaments by the hackling machines.

Moreover, in comparing this process with those where the application of chemicals is mainly relied on, or where machinery is the only aid, it will be well to bear in mind that, of the many ingenious methods invented to supplant the ordinary retting of the common flax plant, not one of them has been adopted on an extensive scale; for, though they effect a considerable saving of time, the manufacturer finds there is a deterioration of the product, and prefers the flax which has been prepared by the old process. It is, therefore, not unlikely that so long as attempts are made only by chemicals and machinery to prepare the New Zealand flax for the market, we may never be able to obtain for the fibre that consideration from the manufacturer which the superior strength of the raw material should entitle it to.

The retting process which may, therefore, be recommended as the result of the foregoing inquiries is as follows:—

In the first place, there is the absolute necessity that the leaves of the plant should be thoroughly bruised.

Secondly, the bruised flax must be placed in vats or pits of water till it scrapes clean with the nail, and no longer; it may be found more convenient to accelerate the commencement of decomposition by the use of artificial heat. The decomposed leaves should then be washed by being placed in a running stream, after which the flax is ready for scutching in the ordinary manner. There can be no doubt as to the success of this process, and the only additional expense over that necessary for the preparation of the ordinary flax is the preliminary bruising of the leaf. When the price of labour in the Colony is reduced from the existing high rate of wages, and the New Zealand flax plant is systematically cultivated, the above process should allow of the production of a valuable quality of fibre, for which there would be a steady demand with a large profit.

No. III.

CLASSIFICATION OF PHORMIUM TENAX.

(Extracted from Appendix to "Annals of the Diocese of New Zealand," page 241.)

I. Flax scraped with the finger-nail only (*Tihore*).

1. *Paritanewha*, found chiefly at Maungatautari, N.W. of Lake Taupo.
2. *Ratawa*, found Hauraki (valley of the Thames).
3. *Kohunga*, found Maungatautari.
4. *Rerehape*, found Maungatautari.
5. *Oue*, found Maungatautari.

II. Flax scraped with the shell (*Haro*):—

1. *Raumoa*, found chiefly at Taranaki.
2. *Ate*, found chiefly at Hauraki.
3. Common swamp Flax, found in all parts.

III. Coarser kinds, used only for rough garments and floor-mats:—

1. *Aonga*, variegated Flax.
2. *Whararipi*.

I. All the varieties of flax of the first class must be planted. They require rich, moist, and flat land, but not swampy, and should be planted in rows six feet apart, with spaces of six feet between the plants. The ground must be kept clear of weeds. The best season for planting is April or May. The plants will be fit to cut in two years, and will yield a crop every year afterwards. The flax requires only to be rent with the hand and nails, without scraping, and is prepared with the greatest ease.

II. The more common species of flax requires to be scraped with a shell, then steeped in water for four days, afterwards taken out and beaten to clear it of the refuse, and then dried again and scraped a second time.

III. The third class is of no value for European manufacture.

Flax of the first class is also found in Native plantations on the north shore of Cook Strait, especially in the neighbourhood of Manawatu, Whanganui, and Patea Rivers.

It is the leaves of the plant which contain the valuable fibre resembling that of the European flax.

Many processes, both mechanical and chemical, have been tried by the colonists, and by projectors in England, Belgium, and France, for adequately preparing this fibre; but hitherto complete success has not been attained in separating the fibre from some particles of a gummy nature, which render it brittle and harsh of texture when dried and packed, so that it is as yet considered inferior to the European flax. As now prepared for the London market, small quantities have obtained prices varying from £20 to £28 per ton, which hardly pays the present expense of preparation in the Colony, packing, and freight.

The finer varieties from the fibre of which the Natives were in the habit of manufacturing garments of a beautiful silky texture, were extensively and carefully cultivated by them, until the general adoption of blankets and other articles of European clothing almost put an end to the Native manufacture. The carelessness with which the early trade in this article was carried on has been the cause of its depreciation in the European market; but there is no doubt that if a proper degree of attention were paid to the distinction between the different varieties,—to the soil, climate, and cultivation best adapted for each,—to the proper season of cutting the leaf,—to the best mode of preparing the fibre, as well as the careful drying, packing, and screwing of it when prepared and assorted, this plant would furnish New Zealand with one of the most valuable exports ever possessed by any country.

The fibre as yet imperfectly prepared from the *Phormium Tenax* is extensively used in New Zealand and in the adjoining Australian Colonies, both by Natives and Colonists, for every species of cordage, from sewing-thread to whaling-lines, and a small quantity is still used for cordage in this country; but the finer varieties would furnish a staple resembling silk and linen combined, from which the most beautiful fabrics might be made. Even in its roughest state this plant is most useful to the colonist or the traveller. It abounds everywhere except in the thick forests; and a leaf cut green, either whole or split into the required breadth, serves every purpose for which string might be necessary,—for the repair of a saddle-girth or stirrup-leather, or the bandaging of a wounded limb, to the replacing of a worn-out brace, knapsack-strap, whip lash, or boot lace.

No. IV.

ON THE OBSTACLES TO THE UTILIZATION OF NEW ZEALAND FLAX.

By LAUDER LINDSAY, M.D., F.R.S.E., F.L.S.

THE author's propositions are based on—

1. The results of observations made during a tour in New Zealand in 1861–2.
2. A study of the voluminous literature of New Zealand flax; and
3. A previous study (ten years ago) of the general subject of foreign fibres as substitutes for those currently used in this country in the textile arts.

He assumes—

1. That the value of New Zealand flax as a fibre suitable for the manufacture of cordage, textile fabrics, and paper, has been established.
2. That in Europe alone there is practically an unlimited demand for this class of fibre.
3. That in order to such fibre as New Zealand flax becoming marketable—
 - a. The supply must be both regular and large.
 - b. The quality must equal that of the fibres which at present command the market.
 - c. The cost of production must be such as to leave a considerable margin of profit on its market price.
4. That hence any candidate for preference in the fibre market must submit to be tested rigorously by the following standards:—
 - a. Amount and regularity of supply.
 - b. Quality.
 - c. Market price.

The utilization of New Zealand flax has been stimulated in every conceivable way—by the self-interest of Colonists and Colonial Governments; by the attraction of substantial Government rewards; by the high prices offered in the British market for good samples of dressed fibre; by industrial exhibitions throughout the world, including New Zealand itself; by the perennial encouragements of the local press. So long ago as 1856 the General Government of New Zealand offered premiums to the extent of £4,000 for the production of a marketable fibre; the Provincial Government of Canterbury subsequently offered a bonus of £1,000 with the same object; and still more recently, that of Otago has promised an honorarium of £500 for the production of a marketable paper from New Zealand Flax, or other indigenous fibre; while at least one special book, printed moreover appropriately on New Zealand flax-made paper, has been devoted to the subject. Nevertheless, no progress has been made beyond the products of the crude art and hand-labour of the Maori, with his simple mussel or cockle shell; if, indeed, his results have been rivalled by the best specimens of Colonial art. The endeavour to give New Zealand flax a permanent and satisfactory place in European commerce has hitherto been a signal failure.

The author's object is to discuss the causes of this failure—to indicate the combination of circumstances that has hitherto operated in preventing the practical application in the textile arts of a fibre acknowledged by all authorities to possess a high value. His main propositions are as follows:—

I. Amount and regularity of supply.

- a. There cannot be a sufficiently large or regular supply to meet the requirements, either of the local or European market, till
 1. The plant is systematically cultivated.
 2. Labour is more abundant and cheaper.
- b. It remains to be determined by experiment on a large scale—
 1. What are the most suitable forms and circumstances of cultivation, in reference especially to such practical and important points as (a) the kind of soil, and (b) the artificial aids to growth?

2. What are the methods of cultivation most suitable to those botanical species or varieties which possess the finest quality of fibre?
 3. What is the best time for cutting down and preparing the leaf?
- II. Quality of the fibre.

- a. Varies in different species of *Phormium* and different varieties of *P. tenax*; but it has yet to be determined what species or varieties yield the finest qualities of fibre, whether in the
 - (a.) Cultivated, or
 - (b.) Wild
 } plant.
- b. Is improved by cultivation.

This has long been recognized by the Maoris, who cultivate, solely for its fibre, the New Zealand flax plant as carefully as they do their maize or potato as food-plants.

III. Cost of production and market value.

The present scarcity and high value of labour in New Zealand renders the cost of collecting the wild flax plant, of preparing the fibre, and of transporting it to seaports, too great to enable the colonist to offer dressed flax in the European market at a price nearly equal to that of Russian flax, and other similar fibres, with which it must compete.

The cost of proper cultivation of the plant and proper preparation of the fibre, under present circumstances, would be still greater.

IV. Suitable processes, chemical and mechanical, have yet to be devised for dressing, bleaching, and dyeing the fibre.

It has been obviously a common error of experimentalists to conclude that the processes and machinery which have proved successful in preparing other fibres, should be equally suitable and successful here.

V. Not only has New Zealand flax to compete with many fibres of established reputation, which are easily and cheaply produced in countries where labour is abundant—not only, as regards paper-making, must it enter the market against rags and other waste products of civilization, which are necessarily greatly cheaper than a dressed fibre—but it will have to compete with hundreds of fibres of equal, or nearly equal, value, which abound in all our warmer Colonies, and occur generally throughout temperate and warm parts of the world, whose applications will be developed in proportion as colonization progresses, and as chemistry and mechanics are brought to bear on processes suitable for their preparation.

VI. Labour is likely to become cheaper and more abundant in other Colonies than New Zealand, which are quite as rich in fibre-producing plants, while the difficulties attending the separation and dressing of the fibre will probably be more speedily overcome in the case of these other plants and fibres.

VII. There is therefore no good ground for the too sanguine anticipations of Colonists and Colonial Governments as to the future high value of New Zealand flax as an article of Colonial export. Present data merely afford encouraging ground for experiment.

VIII. One of the most hopeful directions of experiment is the acclimatization of the New Zealand flax plant in countries suited for its growth, where labour is cheaper, and chemical and mechanical skill are more readily obtained.

No. V.

Copy of a Letter from HENRY FIELD, Esq., Wanganui, to the Hon. JOHN HALL.

DEAR HALL,—

Wanganui, 25th August, 1869.

As I see by *Hansard* that you are endeavouring to effect something useful to the Colony in regard to the flax, I sit down to write a few lines as to my own experience on the subject.

When first I came to New Zealand I had, like many others, a great idea of making the flax our great export, and was fired with the ambition of solving the problem by dint of my own mechanical genius and knowledge. Accordingly, during my residence at Waitotara, I tried a great many experiments with the flax, and actually succeeded in producing an article quite as good as the bulk of that which is now exported, and by precisely similar means, the only difference between the little machine I constructed and those now generally in use being, that mine had no feeding-rollers, and that the beaters were of hard wood instead of iron or brass. I, however, abandoned the matter after a time for three reasons:—

1. I found that the fibre of the flax ordinarily growing in the swamps was so defective and variable in colour and strength, that I arrived at the conclusion that any proper supply of leaves for manufacturing purposes could only be got by careful cultivation of the best sorts in the same way as is practised by the Maoris.

2. I found that the force necessary to crush the woody matter, so as to be easily separable from the fibre by washing, stained the latter to such an extent that no amount of bleaching, short of what would partially rot the fibre, would restore it to anything like what I considered a satisfactory colour. I fancied that the presence of the colouring matter would be very objectionable, as tending to rot the fibre more quickly, and though I tried boiling with soda, as a means of restoring the colour, the result was unsatisfactory, as the strength of the fibre was damaged by the alkali long before its whiteness was comparable to that of the hand-dressed fibre, such as the Maoris were in the habit of bringing to market in considerable quantities.

3. As the Maoris only got from the merchants a penny per lb. for a far better article than there was any possibility of my supplying at that time in any quantity, (for such, in fact, as the accompanying sample No. 4,) it was perfectly clear the manufacture would not then pay.

I therefore turned my attention to ascertaining the best varieties of the flax, and during my walks in the neighbourhood I sampled from time to time, and at various seasons of the year, several hundreds of bushes growing in the Native cultivations. I found that though, as a rule, the fibre tore out of the leaf more easily during spring and autumn, when the growth of the leaves was most vigorous than either

during the summer drought or the dead time of winter, yet there was a very vast difference, even among the cultivated bushes, as to length, proportion, and colour of fibre, as well as to the readiness with which it could be torn from the leaf. After satisfying myself that one particular bush growing by itself in an old deserted cultivation up the Wanganui gully was better than any other I could find, I, when winter arrived, brought a few fans of it and planted them in my garden here, where they are still growing, though now getting decrepid with age. They are of the *Tihore* species, and of the particular variety called by Waitotara natives *Wharariki* (little fellow), from the bushes seldom exceeding five feet in height. The leaves, when the bush is in its prime, are fully four inches broad, and will yield a ribbon of fibre from three feet to three feet six inches long by two inches wide, from each half of the leaf.

I enclose you some samples:—

No. 1 is two small fans which I thought you might like to have to plant out.

No. 2 is a specimen of the fibre, as torn by hand from the leaf.

No. 3 is the refuse of the leaf from which the last was torn. You will see that it contains a great deal more fibre than that which the tearing out process, as practised by the Maori, extracts, and that this is so lightly attached to the woody matter as to be readily separable by such simple means as merely scraping with the finger-nail.

No. 4 is the fibre of a similar leaf, after the woody matter has been removed by a few strokes of a clothes brush.

This is the kind of flax from which the Maoris make their very best mats, but for this purpose they soak the fibre in running water for a night, and then beat it between stones, by which means the fibre such as I now send are subdivided into filaments as fine and soft as silk, and of a dazzling whiteness. I fancy, however, that the Natives higher up the Waitotara River have flax even superior to this, as some persons who had been many years in the Colony, and who formed part of the force which lately went up that river, were so struck with the appearance of some hanks of fibre prepared for weaving which they came across, that they brought a sample away with them, and I think it is superior to any I have ever before seen. I may be mistaken in this, as it is now some years since I saw any fibre that had been so prepared; but still my impression is that the sample I mention is finer and whiter than any I have seen before, and the colour struck me as being of a bluer or more silvery white than I remembered to have noticed previously. I tried the other day to get a piece to send you, but the owner would not spare it, as he had given away so much to one or another as to have very little left.

I am strongly of opinion that though the machines now in use are probably the best that could be employed for dealing with such raw material as now comes to the hands of the manufacturer, yet as I know that fibre now being exported is vastly inferior to what some varieties, such as that which I send, will yield, when those varieties come to be cultivated, and probably improved upon, other machinery (probably a combination of scrapers and brushes) will have to be made use of to produce an article of far higher commercial value. This, I conceive, is the direction in which our attention must be turned, not only because the freight on good and bad would be the same,—every increase in the marketable value of the fibre is a direct gain to the Colony,—but because I am satisfied, from fifteen years experience in growing flax, that it will not pay to cultivate in any quantity at the prices which the manufacturers are giving for the leaves. I gave Hutchison, a few days ago, some memoranda respecting the cultivation and probable yield of flax, for an article he purposed inserting in his paper, and when it appears I will desire him to send you a copy. You will see by it that my estimate of the probable proceeds falls very far short of that lately given in some of the Auckland papers, and which I think must have been based on the yield from previously untouched flax swamps, and not from cultivated land. At all events, my own experience does not lead me to anticipate nearly so quick or large a return from flax cultivation in this part of the Colony.

HENRY FIELD.

The Hon. John Hall,

No. VI.

Dr. FLORANCE to T. H. POTTS, Esq., M.H.R.

Caledonian Road, Christchurch, Canterbury,

New Zealand, 11th May, 1870.

DEAR SIR,—

I have to acknowledge receipt of your communication relative to the flax question and the enclosed Interim Report. It is little, if any, more suggestive, notwithstanding its additional queries, than what has been published in the Official Report, which you are familiar with, called the "Jurors' Reports" for 1865. The queries are doubtless to the point, relative to the commercial aspects of the question; but they are not so satisfactory relative to the chemistry of the Report. This is perfectly excusable, for there is no subject more intricate in its nature than that of vegetable chemical analysis. Truly has the memory of the celebrated Danish chemist, Chevalier Claussen, known as the Camberwell flax lunatic, who died, it is said, with the words "flax-cotton" on his lips, been cited as corroborative of the truth of this remark.

I have turned many a leisure hour to the study of this topic, ranging over a period of not far from twelve years; and so deep an interest do I still take in this question that, at intervals from professional duties, I frequently indulge myself in experiments bearing on this subject, and all the more readily finding as we do that public attention is daily more drawn to the importance of these matters. It must now be about ten years ago that I discovered the best and only true solvent for the so-called flax-gum. I say so because I have tested every other re-agent and found all more or less objectionable or faulty on some point or other until I resorted to the solvent which I claim the right of having originated, and, therefore, designate it after my own name, "Florance Flax-gum Solvent," at the risk of being styled egotistical.

The process adopted by me may be properly designated the chemico-mechanical, because of the

necessity there is of overcoming the law of double cohesion by the assisting mechanical, while acting at the same time by the law of double elective affinity, and while the vegetable juices are in the nascent state, so that nascent affinity (*i.e.*, the proper chemical action,) acts speedily in effecting all that the manipulator requires previous to the drying and common hackling operations. You will see by this that my views run counter to what is called the "successful dry process," as recently adopted by some parties in the North Island. Exposure to the air, which the dry process implies, must effectually fix the gum into the fibre, and so defeat its own ends. In one word, it will be found a failure; for while even a slight amount of the gum remains, the ultimate fibres or fibrillæ will not separate, whereas by the use of my solvent, it will be found that the ligneous covering and the gum pass off together,—in one word, the chlorophyll and all extraneous matters are effectually brought under control. The solvent, rightly assisted, will do all that is required in the run of from four to six hours, at the cost of, upon an average, about £2 per ton of the dressed leaf, when it will, after rough hackling only, be fit for exportation.

Herewith I forward you a few specimens. I reserve to myself the right of manufacturing the solvent.

A few of the specimens, identical with the ones I send you, have been sent to Manchester, coupled with others dressed in the ordinary way, and that which was marked "Florance's process," was pronounced the best.

The following are Messrs. G. and J. A. Noble's report:—"Sample flax, No. 3, dressed with Dr. Florance's solvent is the best, and valued at £8 to £9 per ton more than the best dressed flax yet to hand from Canterbury."

A friend of mine, living near me, who communicated the above information as to the relative value of our flax fibre, as quoted above from his brother's report, dated London, 5th November, 1869, adds,— "I have not given you the quotations for the several other samples sent; they, however, averaged from £22 to £32 per ton."

I might add that, from several specimens of mechanically well-dressed flax by Booth's (Dunedin) improved machine, coupled with the subsequent use of my solvent, very beautiful silky-looking fibre could be turned out, equal to the shell-scraped and then passed through my solvent, a specimen of which I enclose for you. With such a machine and my solvent, the great problem of how perfectly and economically to dress the New Zealand flax for the higher textile usages is answered.

I have, &c.,

To T. H. Potts, Esq., M.H.R.

AUGUSTUS FLORANCE.

No. VII.

ON THE STRUCTURE AND COLOUR OF THE FIBRE OF PHORMIUM TENAX. By T. NOTTIDGE.

[Read before the Philosophical Institute of Canterbury, September 1, 1869.]

As the preparation of the fibre of New Zealand Flax has now become one of the staple industries of this Province, I thought that the following account of certain observations and experiments that I have made on the structure of the leaf, and colour of the fibre, of *Phormium tenax*, might not prove uninteresting to the members of the Institute.

As is well known to all botanists, the fibre of the *Phormium tenax* is the woody tissue or pleurenychyma of the leaf. This woody tissue consists of cells very much elongated, and tapering at each end, arranged side by side in bundles, the ends of the proximate cells overlapping.

When the carefully-cleaned fibre is teased out with a needle, and examined under a microscope by reflected light, with a power of 120 linear, it appears to be white and transparent, like filaments of spun glass, and where it lies in bundles it has a lustre like satin.

When mounted in "Deane's gelatine," and examined by transmitted light with a power of 225 linear, the ultimate fibres appear to be cylindrical tubes of considerable length (probably one and a half to two inches, but I have not succeeded in tracing any one cell through its whole length), the margins extremely smooth and regular, the finest of the fibres quite as fine as the silk of the *Bombyx mori*, or mulberry silkworm. The cells taper gradually to each end, and are slightly rounded at the point. A central canal of considerable size is plainly visible. I observed no transverse or longitudinal markings on the fibre. The central canal appeared to be filled with air only, when I examined the fibre in August, but this may not be the case at all seasons of the year.

Transverse sections of the upper part of the leaf, mounted in "Deane's gelatine," and examined by transmitted light with a power of 225 linear, show that the fibres are not round, but roughly hexagonal, with slightly-rounded angles packed closely together in bundles, but so that small interspaces are left at the rounded angles. The central canal is marked by a well-defined spot on each ultimate fibre; and around this spot are slight indications of concentric lines, showing how the cell has been built up by successive deposits of cellulose.

The ultimate fibres vary considerably in diameter, those near the green or upper surface of the leaf being much finer than those near the dull under-surface of the leaf.

When the ultimate fibres are broken, they break transversely, and the fracture has a ragged edge. I could not discover any tendency to tear longitudinally into finer filaments.

The bundles of fibre are in the form of flattened bands, arranged with tolerable regularity, parallel to each other, lengthwise in the leaf, one edge of the band being close to the green or upper surface of the leaf, the other edge close to the dull or under surface. Some of the bands appear to be incomplete, and extend only to a short distance from the surfaces of the leaf.

In the centre of each complete bundle of fibres is a brown bundle of spiral or vascular tissue; the central canals in this tissue are larger than the central canals in the fibre. This spiral tissue appears to break up very easily, and to separate readily from the woody tissue or fibre.

The bundles of fibre are imbedded in the cellular tissue known as the parenchyma, or, more accurately as the merenchyma, of the leaf, and are immediately surrounded by a layer of cylindrical cells, very similar to the cells just beneath the cuticle of the leaf.

The cells of the cellular tissue are, for the most part, filled with the greenish fluid juices of the plant; the grains of chlorophyll—the waxy, green colouring matter of the leaf—being very conspicuous in the cells near the upper surface.

In the lower or butt ends of the leaf, the ultimate fibres are much coarser, the bundles are cylindrical or oval, there is a great thickness of cellular tissue in which the bundles of fibre are imbedded, and the cells surrounding each bundle are filled with some reddish colouring matter, which, in some cases, seems to pervade the whole cellular tissue.

The fibre appears to be quite white and colourless in every part of the leaf, until the cells in its neighbourhood are ruptured.

From the above microscopic examination of the leaf and fibre, I have come to the conclusion that an erroneous opinion is prevalent on the following points, which are important:—

1. There is no woody matter to be separated from the fibre; the spiral tissue cannot, I think, be considered as woody matter; and from direct examination of the so-called woody matter, on imperfectly cleaned fibre, I have found it to consist of cellular tissue, and portions of the cuticle or skin of the leaf, stiffened and glued to the fibre by the dried sticky juices of the plant.

2. The fibre cannot be indefinitely divided, the cells of the pleurenychyma or woody tissue showing no tendency to tear longitudinally into filaments.

3. The ultimate fibres are shorter than is commonly supposed—probably not more than two inches in length, but on this point I am unable at present to speak definitely.

I have observed that in most of the returns of the sale of New Zealand flax in England, the discoloration of the fibre is alluded to as an objection, and cause of a diminution in price.

From the above microscopic examination of the fibre, and certain other experiments to which I shall allude, I think I have discovered the chief cause of the discoloration of the fibre, as now prepared, and also a means by which that discoloration may be, to a great extent, avoided.

I have formed this opinion from the following considerations:—

The fibre, as it exists in the uninjured leaf, is white, and this is the case, even in the thick butt-ends of the leaves. Any person may satisfy himself on this point by carefully dissecting out a bundle of fibre, with as little injury as possible to the surrounding cellular tissue.

The fibre consists of elongated tubular cells containing air, or perhaps a colourless liquid.

In each bundle of fibre, very minute canals are formed by the interspaces between the separate fibres.

The bundles of fibre are imbedded in, and surrounded by, the cellular tissue of the leaf.

The cells of the cellular tissue are for the most part filled with sticky juices of the plant, containing chlorophyll, albumen, fibrin, pectine, starch, gluten, sugar, all that is popularly called gum, and in the butt-ends of the leaf, the cells immediately surrounding the fibres contain a red fluid (probably altered chlorophyll).

In the process of manufacture, the leaf is beaten or bruised, the cellular tissue is completely broken up, the fluid contents of the cells are set free, and, by the same cause, openings would be forced in the tubular cells of the fibre, whether those cells contained fluid or air; and if they contained fluid, some of that fluid would be pressed out.

The result is obvious: the fluid juices would be drawn into the tubular fibres and into the minute canals between the ultimate fibres, by capillary attraction; and the tubes being so minute, the capillary attraction would act very rapidly, and with great force.

The remedy that I would suggest is simple. It is to dilute the juices of the plant with water the very instant they are set free, so that the tubes may absorb a mixture of juice and water, the more dilute the better, instead of the pure juice.

The following facts tend to show that the above views are to a great extent correct:—

The fibre, as it leaves the beating or stripping machines, is green in colour, and this green colour cannot be removed by mere washing.

When the moist fibre, washed so as no longer to tinge water green, is passed between powerful rollers, a large quantity of green fluid is expressed.

The colour is improved by passing the moist fibre between rollers, or through a beating machine, under a stream of water, and the sooner the water is applied after the fibre has passed through the stripping machine, the greater is the improvement in the colour. For this last statement I am indebted to the manager of the Selwyn Flax Company, who has been making experiments on the washing of the fibre.

If the beating of the green leaf is effected under water, the resulting fibre is quite white.

If the green leaf is half-dried, so that the juices may not flow freely in very minute tubes, and the fibre is then prepared by beating and subsequent washing, the fibre is much whiter than if prepared from the fresh-cut leaf in the ordinary manner, but the difficulty of separating the fibre from the cellular tissue is greatly increased.

Such are my views on the above subject, and the chief reasons which have led me to adopt them. It will be seen that the question goes far beyond the mere discoloration of the fibre. The green colour of the juices, if absorbed as I have suggested, might, no doubt, be removed by bleaching, so as to stain the fibre a light-brown colour only; but the juices could not be washed out, and when dried up would leave a residuum by which the interior of each tubular cell would be coated, and thereby to some extent rendered harsh and brittle, the ultimate fibres of each bundle would be glued together so as greatly to increase the difficulty of adapting the fibre for textile purposes, and this residuum, when exposed to air and moisture, would probably be subject to chemical changes which might have a most injurious effect on the fibre.

I have alluded to the spiral vessels found in the centre of each bundle of fibre, in the leaf of the *Phormium tenax*. This spiral tissue is found in all phænogamous plants and ferns, and from the careful manner in which it is generally protected, I suspect that it serves some very important purpose in the economy of the plant, but physiologists do not agree as to its precise function. It is found most abundantly on the inner bark, in the veins of the leaves, and immediately round the pith in the centre of the stem of exogenous trees. It is very abundant in the *Musa textilis*, a species of banana, from

which the Manilla fibre is obtained; and it is from the uncoiled spiral threads of this vascular tissue that textile fabrics are manufactured, not from the true fibre known as Manilla, and used for rope. I mention this, because from ignorance of this fact it has been suggested that the process, by which fibre from the *Musa textilis* is prepared for fine textile fabrics, might be applicable to the fibre of the *Phormium tenax*.

My principal object in writing this paper was to give publicity to my views. Even if my theory is shown to be erroneous, I hope that it may lead to further experiments, and provoke discussions tending to the improvement of the manufacture of New Zealand flax.

No. VIII.

ON THE STRUCTURE OF THE LEAF OF PHORMIUM TENAX. By Captain F. W. HUTTON, F.G.S.

[Read before the Auckland Institute, 18th October, 1869.]

IN the present paper an attempt has been made to describe the structure of the leaf of our native flax, so as to form a basis for the examination and comparison of the manufactured fibre, as dressed by different machines, and prepared by different processes, on which subject I hope we shall receive communications from many of our members. I have also added some observations on the gum secreted by the leaf, and which is generally looked upon as the *bête noire* of the manufacturer, but which I believe not to be so black as it is painted. While it was in progress, I saw in the newspapers a short abstract of a paper on the same subject, read by Mr. Nottidge, to the Philosophical Institute of Canterbury. Not having as yet had the pleasure of reading this paper, I am not able to refer further to it; but judging from the very short abstract that appeared in the papers, we seem to be pretty well agreed upon all points, except as to the existence of small canals in the fibro-vascular bundles, formed by the interspaces between the ultimate fibres, which I venture to suggest must have been caused by the knife tearing apart the bundles of fibres, when making transverse sections.

Development of leaf.—The young leaf of the flax plant (*Phormium tenax*), when about a quarter of an inch in length, is composed of loose parenchymatous tissue, covered both on the inner and outer surfaces, near the centre, by an epidermis of elongated rectangular cells, the edges of the leaf being crenulated by the jutting out of the young growing cells. Imbedded in this cellular tissue lie about twenty-three vascular bundles, eleven on each side of the midrib. These, in this young state, are composed entirely of spiral vessels, which contain a single spiral fibre, easily unrolled with a needle. These bundles are 0.0013 inch broad, and about 0.004 inch apart from one another. They lie longitudinally in the leaf, towards the central part of it, the outer growing edge being composed only of cellular tissue. The upper end of each bundle runs into that lying next to it towards the centre, and they thus get shorter and shorter as they recede from the midrib. When the leaf gets about an inch long, the vascular bundles are still seen to branch and anastomose with one another; but this soon ceases, and at all later stages they are very nearly parallel, converging slightly towards the point of the leaf. A layer of thin elongated tubes now makes its appearance, surrounding the bundles of spiral vessels. This is the first state of the fibres from which the plant has got its celebrity; but as yet they are exceedingly tender, and break with the slightest touch. When, however, the leaf has attained a length of four inches, the fibres in the upper part of it have acquired considerable strength, while those at the base are still quite weak. When the leaf is about nine inches long, it commences to exude gum, and appears then to be fully formed.

Description of full-grown leaf.—When fully grown, the leaf attains a length of from three to ten feet, according to soil and variety. The colour varies from light-yellow green to deep-blue green, with yellow or red margins and midribs, while the lower part of the leaf is usually pink. In shape the leaf is linear lanceolate, and keeled, with an acute point. At a point rather less than half-way down from the tip, the two superior or inner surfaces of the two halves of the blade begin to coalesce at the midrib, and this coalescence gradually increases until one-half of the leaf is joined together. The coalescence then gradually decreases, until it occupies only about a fourth of the breadth of the half-blade, which breadth it keeps to the bottom of the leaf, the two half-blades being closely appressed as far as the base, where the two marginal edges closely overlap one another, and form a sheath through which the younger leaves grow. It is only the inner surfaces of the lower portion of the leaf, below the place where the coalescence of the two half-blades begins to decrease, that exude gum.

For the sake of convenience, I shall, in this paper, call the upper part of the leaf, the blade; that portion where the coalescence of the two half-blades reaches its maximum, and which is about half-way between the two ends of the leaf, the butt; and the lower portion, the base of the leaf.

The full-grown leaf is composed of parenchymatous tissue, in which fibro-vascular bundles lie imbedded, and remain isolated from one another as fibrous cords, some of which run from one end of the leaf to the other. This cellular tissue is covered, on both surfaces of the leaf, by an epidermis composed of elongated, rectangular cells, of considerable consistence, but without chlorophyll or other colouring matter.

No stomata or other openings are found on either surface, and the gum appears to be exuded by exosmosis.

The fibro-vascular bundles, which form what are commonly called the fibres of the plant, are composed of elongated tubular liber-cells, enclosing a centre of spiral vessels, and vary much in shape in different parts of the leaf. They are surrounded by a layer of elongated cells, that at once turn blue with iodine, and are probably cambium cells. The bundles are thickest at the base, and taper gradually to the point of the leaf.

The spiral vessels are about 0.001 inch in diameter, and contain a single, rarely a double, spiral fibre, which can be unrolled with a needle. They are filled with air, and have no strength, but are readily broken across.

The liber-cells, on the contrary, have great strength, and form the true fibre of the leaf. They are very long, probably an inch or more, while their thickness never exceeds 0.0006 inch, and is some-

times only 0.0003 inch.* They taper each way to a more or less blunt point, each cell being distinct from the rest, and not joined together end-ways. Notwithstanding their strength they are of very delicate structure, colourless, translucent, and almost devoid of secondary deposits, the cell-wall being from 0.0001 inch, to 0.0002 inch, thick. They are hollow, and filled only with the air, but are highly hygroscopic, imbibing water quickly, and during the operation twisting about in all directions. The fibres, although round when separated, are not so when collected into bundles, being then compressed into ovals, polygons, &c., so as to fill up the whole space, and leave no interstices. They have the same thickness in all parts of the leaf.

At the base of the leaf the vascular bundles are scattered through the cellular tissue, in about four irregular rows. They are arranged in ovals of two sizes; the largest, whose major axis is about 0.02 inch, and minor axis 0.014 inch, enclose in their centres a rhomboidal cluster of spiral vessels; while the smaller, whose major axis is 0.015 inch, and minor axis 0.007 inch, contain none. Near the outer surface of the leaf four other irregular rows of fibre bundles, without spiral vessels, are found, whose section is lanceolate, thus making eight rows altogether in the base of the leaf. The fibres here are generally much weaker than in any other part, and can be easily torn across with a needle.

Near the outside of the leaf the cellular tissue, in which these bundles are imbedded, is lax and translucent, but towards the interior it is open and spongy, the cells being arranged in single rows, enclosing irregular intercellular spaces, which are of a tubular form, the tubes running parallel with the vascular bundles. These intercellular passages begin to be developed when the leaf is about four inches long, and they are found only in those parts where gum is exuded. At present I have always found them empty, but it is possible that they may be gum-canals, or the glands or ducts by which gum is secreted.

In the thick part of the butt of the leaf, the internal rows of bundles are reduced to one, the others having died out. They are here club-shaped, with a constriction in the middle, and enclose a rhomboidal bundle of spiral vessels. Besides these there is also a marginal row of bundles, the largest of which alternate with the bundles of the interior row. They are of an elongated clavate form, constricted in the middle, and with a rhomboidal bundle of spiral vessels in the thick part of the club. Between these occur three smaller bundles, of an oval form, also constricted in the middle. The central one of these, which is situated just opposite to the interior bundle is rather more than half the length of the largest, and encloses near its inner end a rhomboidal bundle of spiral vessels. The other two are of the same form as the central one, but not much more than half its length, and the bundles of spiral vessels, which are also near the inner end, are in section like the sector of a circle, or a boy's kite. The cellular tissue which encloses these bundles is rather lax, and of a light-green colour, becoming close, and densely filled with chlorophyll, towards the outer side. All traces of the intercellular passages have disappeared, but in their place two cylindrical bundles of large, loose, translucent cells appear near the end of each of the smallest marginal bundles, and these continue to the point of the leaf. The cells that surround the interior bundles, and the rounded interior ends of the largest marginal bundles, are filled with a red fluid, as are also those of the midrib and margins of the leaf.

The vascular bundles in the free part of the leaf, at the butt, are rhomboidal in section, reaching the epidermis on the outer or inferior surface, but separated by several rows of cells from the inner or superior epidermis; they enclose bundles of spiral vessels that are also rhomboidal in section. Midway between these, and near the superior surface, there sometimes occurs another small cylindrical bundle of liber-cells, without any spiral vessels, but more often this is absent. Between each of the vascular bundles there is also a cylindrical bundle of large loose cells, similar to those in the thick part of the butt. The midrib is formed by an elongated bundle of fibres, enclosing a rhomboidal bundle of spiral vessels near its inner end, and it is surrounded by three circular bundles of fibres alone.

Higher up in the blade, as the free parts of the leaf get larger, the interior bundles of the butt die out, and the medial-sized marginal bundles elongate, until they, as well as the larger ones, reach almost across the leaf from the outer to the inner surface, the smaller ones retaining their relative size. All have, however, now altered in shape; the larger ones are still clavate, but are swollen, instead of constricted, in the middle; and the swollen parts contain their bundles of spiral vessels, which neither in shape nor in relative position have changed with the liber-cells. The smaller or intermediate bundles have become more clavate; but their spiral vessels have still retained their shape of the sector of a circle. Occasionally, on the inner side of the leaf small round bundles, composed altogether of fibre, are found, alternating with the bundles that cross the leaf.

The average thickness of these bundles on the superior or inner surface of the leaf is 0.005 inch, and on the inferior or outer surface, 0.0027 inch, and their distance from one another is 0.018 inch, or fifty-five bundles to the inch. There are, therefore, about two hundred and fifty bundles of fibres in the whole breadth of the leaf, not including the intermediate bundles, which would give about as many more in the lower part of the blade near the butt; but towards the point of the leaf these intermediate bundles die out, leaving only the large ones, that go the whole way across. These also get finer and closer together the nearer they get to the point, so that there are almost as many of them close to the tip of the leaf as there are near the butt. On the inferior or outer surface, the bundles of fibres reach to the epidermis, but on the superior or inner surface, several rows of cells intervene. Each bundle of fibres is separated from the next to it, in the interior of the leaf, by a mass of lax translucent cells similar to those found in the butt of the leaf. The rest of the cellular tissue is densely filled with chlorophyll.

The Maoris, in cleaning the fibre, cut through the outer or inferior surface of the leaf, as far as the lax tissue in the centre, then tearing out that part which contains one half of each of the bundles that cross the leaves, and the intermediate bundles, with the small quantity of cellular tissue between them,

* What are called the cotton-like, or hair-like, filaments of the flax, are far from being the ultimate fibres, but are single bundles containing perhaps 100 or more liber-cells; the ultimate fibres are all but invisible to the unassisted eye.

they throw away the inner or superior surface, together with the other half of the large bundles of fibres. The cellular tissue, already broken up by tearing it away from the rest of the leaf, is easily got rid of, and thus the fibre is both finer and cleaner than that prepared by the machines. Of course the system is very wasteful, and it would never do for us to follow it, but I would suggest that it might be very advantageous to split the leaf longitudinally, so as to divide the inner and outer surfaces before putting it through the machine, as by this means the bundles of fibres would be split into two, and a finer, as well as a cleaner, article obtained.

Gum.—The gum of the flax plant, when first exuded, is a thickish, sticky, colourless fluid, that runs down the leaf when it is cut. It gradually hardens into a semi-solid, jelly-like, viscid substance, and ultimately into a thin tough pellicle, which can be easily peeled off the leaf, and which generally retains the markings of the cell-walls of the superior epidermis. When pure it is colourless, or pale yellow. It shows no microscopical structure, but generally contains small pieces of vegetable tissue, &c., and sometimes several animals, which live in it. On exposure to the sun, it shrinks greatly, and after a few days hardens into a tough solid substance, not easily broken.

In its first or fluid state, in which alone it exists in the interior of the plant, it readily mixes with water. Both in its usual semi-solid state, and after hardening in the sun, it softens and intumescs in cold water, but only partially dissolves. In boiling water, it dissolves readily, when in the semi-solid state, but with difficulty after having been dried. Alcohol fails to dissolve it, but turns it white. It is unaffected by the caustic alkalies, but dissolves easily in acids. Iodine colours a solution of it yellow, without any trace of blue.

Neither alcohol nor neutral acetate of lead produces any effect upon a solution in water; but it is precipitated, of a yellowish white colour, by tribasic acetate of lead, by protochloride of tin, and by nitrate of mercury.

These reactions show that it differs from all the gums, by not being precipitated by alcohol, and further, from the gum-arabic group by its insolubility in cold water; from the cherry-tree gum group, by its being precipitated by nitrate of mercury; and from the gum-tragacanth group by its insolubility in caustic alkali, while it is allied to this latter by its intumescing and partly dissolving in water. On the other hand, on all these points except the solubility in cold water, it agrees with carrageen and linseed mucilage; and the latter, after having been dried, intumescs in water, and only partially redissolves. From all the mucilages, however, our flax gum differs in its behaviour with neutral acetate of lead, which proves that it contains little or no pectin, and in this respect it is like the true gums. It appears, therefore, that flax gum is intermediate between the gum-tragacanth, or Barsorin group of true gums, and the mucilages, and ought, strictly speaking, to be called a gum mucilage.

We are thus led to the following conclusions:—

1. That the object to be aimed at, in manufacturing the fibre, is the separation of the fibro-vascular bundles from the cellular tissue and epidermis of the leaf, and not, by any means, the breaking up of the bundles into their ultimate fibres, which would entirely destroy their strength.

2. That the bundles of fibres in the leaf are of different sizes.

3. That no woody fibre exists in the leaf, but the liber-cells have thin walls of delicate construction, which probably accounts for the quick deterioration of the fibre by over-bleaching, or by the use of chemicals.

4. That the gum appears to offer no peculiar obstacle to the manufacturer, provided the leaves are above the butt; for in the state in which it alone exists in the interior of the plant, it readily mixes with cold water.

No. IX.

PHORMIUM TENAX.

(To the Editor of the *Press*.)

SIR,—Having in a recent letter (that on the burning of the “Blue Jacket,”) stated my intention of offering a few more remarks on the utilization of the above plant, I now ask for space to do so.

Many of your readers will remember something of my former letter on this subject, published in your paper recently, wherein I strongly condemned the state in which nearly all the fibre produced here, up to that period, had been prepared, and some of it shipped, and I then gave some simple directions for improving future supplies, which suggestions were so easy to understand that none but the thoroughly careless, prejudiced, or stupid, need fail in carrying out; yet my hints have mainly passed unheeded, and much equally inferior material has continually been prepared, tending, according to my thinking, seriously to keep the character of the Canterbury production in the background, and by making intending investors dubious, has been keeping back this new industry, to the loss of all.

Some of our flax-dressers have evidently relied more upon weight than quality or price, and have not been over scrupulous about condition; and we all know that flax, when only half-cleaned and put away wet, will rot. Also, that rope made of imperfectly dressed fibre will, when subjected to moisture, soon decay and break, and probably, when in sufficient bulk, may be liable to spontaneous ignition, for the substance generally termed gum is more of a resinous character.

The Auckland merchants are, most properly, very particular about condition, and during land transit the fibre is always most carefully protected by good tarpaulins or other safe covering and if perchance a parcel gets wet, it is opened out, fully dried, and repacked, at the risk and expense of the producer or carrier.

Now, in contrariety to such care, half-cleaned flax is here often delivered while very imperfectly dried, and even at this moist season of the year, heavy loads are to be seen on our roads without any protection against the weather; while if Colonial buyers receive loose flax in so unfit a state, they are bound to experience a considerable diminution in weight when pressing their fibre into bales, as much moisture will evaporate during lightly-packed storage, while fibre so stored is liable to mildew, and our present flax-dressers must be intensely stupid if they do not perceive that such action cannot fail to speedily recoil against themselves.

Another very important point to the shipper is, that a ton weight of well-dressed fibre will occupy much less space than the material hitherto shipped; so that, when properly prepared, the item of freight will, from that source alone, be reduced fully one-fifth, while in many other respects the preparation of a really good, well-conditioned article will obviously benefit all concerned. It will only be by sending the very best that we can expect to compete with the vegetable fibres of other countries and create a lasting demand, thereby rendering permanent a truly profitable industry, which, I think I shall hereafter be able to show, proffers to do more for the future welfare of the country than even the best gold field in the world. Nevertheless a good gold field would speedily populate the place and give a wonderful present impetus to every link in the chain of human usefulness, even to the flax industry.

But I have not yet exhausted the fault-finding portion of my communication, for I am sorry to have already observed some deception in packing; I am, however, pleased to think that such charge cannot be laid upon the proprietors of works beyond a want of vigilance, neither do I think there has been any desire on the part of employers to cheat buyers, but I believe the error has originated from inexperienced workmen being desirous to place the best possible face on their work. However, the result must be equally prejudicial wherever the blame may rest, for being a new article in the market, the character of the whole supply will suffer, and I feel that it is impossible to sufficiently impress upon our flax producers the necessity for getting up their article in the best possible manner, and to adopt brands and adhere to them, so that both colonial and home buyers may know what they are about.

Coming again to the cleansing processes, I need not say much about the machinery, even in this Province; we have several makers, each having their supporters, and who are all gradually improving their mechanism. Nevertheless, the result of the work depends nearly as much upon the management as the machinery, for some hands, although generally diligent and careful, do not possess the necessary experience of machinery, or even mechanical tendencies, and when doing their best frequently injure the fibre and damage machinery.

I pointed out before that there was a wide difference between the fibre as got up in Auckland and that prepared here. I now emphatically repeat that assertion, which I doubt not will be amply borne out by the relative returns for fibre sent from there, and much of that shipped from here. In fact, it has to a certain extent already been verified by Messrs. Henderson and Macfarlane's first consignments, which (although not equal to the material now produced in the North) realized from £32 10s. to £35 per ton; while, on the other hand, it will be a most encouraging feature in favour of the New Zealand fibres, if much of that hitherto shipped from here finds a market at all in Britain.

I also now repeat that it is principally in the treatment or manipulation of the fibre throughout the constant handling, from passing the stripper up to packing, where the fault lies, and that sufficient care was not generally exercised in the fixing and working of the mechanical appliances, which, although of light construction, are necessarily driven at great speed, and yet have to endure a considerable irregularity of strain, consequently they need to be firmly fixed, and so arranged as to the utmost to prevent vibration. Therefore the more detached and firmly the strippers are fixed, and the more substantial the driving shaft, &c., the better, as, when several machines are fixed on one frame, and are driven by one shaft, they will frequently take up the beat of each other, causing largely increased shaking throughout, especially if the driving shaft is not very strong and firmly supported between each pulley; and as constant checks are experienced by each stripper, the vibration of all on the same stand is bound to be affected, and their working rendered more or less imperfect. Firmness in the construction of flax works is of much more importance than neatness without solidity.

It may also be well to suggest to inexperienced investors that, with the class of machinery now in use, the irregular strain upon them, &c., while driven at such velocity, it would still repay the proprietors of any large concern to employ an expert mechanist as overseer of the stripping department, to keep a vigilant eye upon the machinery, providing also suitable appliances on the spot, to enable such person to effect slight repairs, and thereby often prevent imperfect dressing and save costly damages.

That superior appliances, or even new methods of cleansing the fibre, will eventuate from the rapidly increasing trade, must be both hoped for and expected; but to wait for such would be suicidal, since to defer operations would be once more allowing the industry to slumber, or perhaps to altogether die away, and as, with the present means, returns can be made which ought to satisfy the even greedy minds, there is no need to do so. None of the strippers now in use throughout the Colony may be perfect, but still the system more closely resembles the old Maori system of scraping than anything else.

The practice of dressing out of doors is not calculated to yield favourable results as to condition or profit, for much time must frequently be lost; and according to the present process, it is desirable to strip the leaf when fresh cut, therefore the machinery should, if practicable, be run until the supply on hand is worked up; and taking all things into account, suitable erections are necessary to secure proper and profitable results. It will pay better to cart the green leaf a few miles on fair roads than to carry on the business without proper protection against changeable weather.

Returning to the manipulation. After coming from the mills I explained that the system of bleaching, as practised here, was very faulty. I now reiterate that opinion; a uniform colour cannot be secured, neither can half the fibre be properly cleansed in the process of scutching. Even the washing is faulty, being rinsed in too large quantities; while all throughout the various manipulations the fibre is not kept in regular lengths, being, in fact, made to nearly resemble tow, and in many instances not much better, so that on reaching the manufacturers they cannot do anything without first subjecting it to some combing process, and even then can never satisfactorily sort it. Now in the North the fibre is carefully kept in small hanks, of about three or four leaves, throughout each operation, the butt-ends of each of such parcels being kept evenly together, and finally packed in that manner, so that buyers in the home market can easily examine the quality; and it can be readily assorted according to its capabilities or the requirements of the manufacturer, and it may even have to be cut into two or more lengths, and such lengths of each hank be converted to different purposes, for, like the leaf, the fibre tapers from root to tip, the bottom being coarse and gradually fining upwards. If then the material is forwarded home in the state in which most of the shipments from Canterbury have gone, such classification becomes impossible, its adaptability for various purposes of

manufacture being greatly curtailed, the chances of securing full prices become almost out of the question. I therefore trust that our "Flaxy" friends will arouse themselves to a state of friendly emulation, and strive, at least, to keep pace with our friends in the North.

I calculate that the condemnatory strain of this portion of my communication will be unpalatable to some, but I think it is certain that the longer the present state of things exist, the more seriously the enterprising spirit of the public will be damped and kept back. I have no other object in view than to do good, hoping, by the exposure of existing errors, to thereby guide intending investors for the general benefit of the country in which, like many others, I have a large family to leave behind me.

Since writing the above, I have seen the letters of Mr. Thompson and "Nemo," and deem it better to briefly notice them before proceeding with the remainder of my communications. I am inclined to think that the writers in question must have founded their ideas on the migratory or rough out-of-doors works, as any such cost as £4 or £5 per ton for scutching is far beyond the mark, and a total of £19 as the cost per ton of flax dressing is equally so, while the loss of weight and tow can only happen when the material has been manipulated in the way I have already condemned, and with machinery of the roughest character. I calculate that with a proper scutcher, fixed in a well-organized establishment, requiring little more than one-horse power to drive it, two men and two boys will scutch properly 20 cwt. to 25 cwt. per day, and the diminution in bulk (already alluded to) will save fully as much in freight as will cover the expense of scutching; while the transactions with shippers or insurance agents will be more readily effected. Thus, if we lose in freight what we spend in labour, we benefit the country by the employment of such labour, as we maintain customers for our general producers and traders, and I think "Nemo" will hereafter be found on the scutching side of this question.

It is, however, time to be dealing with the plant, and to glance at the advantages which it holds out. Recent information (re-published in your paper) will have made your readers somewhat acquainted with the vast extent now growing in the North Island; but that report only represented certain districts, which fall very short of the quantity obtainable throughout the whole of the main and minor islands north of us,—an extent, if available, that would suffice to keep fully half their population (European and Maori) in profitable employment for many coming years, and render them good customers for our cereals, &c.

Again, as to the supply on our own island; although not equal to that of the North, there is still sufficient to employ many thousands of hands for years to come. It is true that some of it may be too much detached to be available during the early stages of a new industry, but if properly cut and attended to, the supply of flax from the more convenient blocks can be kept up at a trifling cost; and when machinery is more perfected, and workmen become properly expert in the operations, it will pay to collect the detached patches, especially when the quality of various specimens (to which we shall hereafter allude) becomes recognized, and a brisk demand ensues, of which I for one have not the slightest doubt. It is well known that of late the supply of manilla and other fibres has fallen far short of the demand, thus creating an opening for the producers of this fibre to prove its value for various purposes, which if once established are likely to be permanently maintained. In point of strength, its superiority over manilla has already been successfully established, and to supply the deficiency in the quantity of manilla will alone absorb much more than our present means will allow us to produce; but we have also good reason to believe that well-prepared samples are suitable for higher textile usages, and that a very large demand and highly remunerative prices may be expected as soon as the British manufacturers can rely upon a steady supply. We also have the pleasing knowledge that our enterprising American friends (who first utilized our kauri gum) are anxiously awaiting the supply of bulk samples, in order to test its adaptability for various purposes, and that they are ere long likely to become large customers; so that by-and-by, though the whole of our present young population were engaged in preparing the fibre, we should likely prove unable to supply the demand.

Some persons imagine that our flax is so far inferior to that in the North as to render it less marketable. My observation on this point is not of yesterday; on the contrary, I have been an observer of such things for many years, and I fail to distinguish any noticeable difference in all the most common varieties. Flax grown on swampy ground differs from that produced on the dry ground on our plains, or on the hills. Volcanic soils generally produce a fine quality, as, for instance, on the Peninsular, and even on the Port hills, several fine varieties will be found, some of them closely resembling some of the species so favourably noticed as the choice of the northern Natives. Again, as the main ranges of the island are approached, the fine-fibre plants will be found, and full observation on these points would lead to a belief that altitude has something to do with the fineness and tenacity of the fibre. If I am right in these views, we must conclude that, when the article has secured a place in the home market, the extra quality of such fibre will compensate for the increased cost of carriage from the interior. Many a stockman knows that from such flax as that now alluded to, whip crackers are more silky and durable than from low-land flax, and far exceeding the best hempen whipcord.

The swamp-grown leaf now generally operated upon, produces (under the existing process) a ton of fibre to six tons of green flax, and that from firm soils about one in five, averaging about five and a half, which is about the same as from similar districts in the North.

Although it is clear that flax is generally found in moist situations on the plains and level parts of the country, yet it does not thrive best in very wet localities; and land intended for cropping by flax, dressers will well repay the cost of suitable drainage, which, if done with judgment, will make it produce double the quantity per acre, and also improve the quality.

With respect to any comparison between this place and the North, we may attach more importance to the difference in our winter climate for drying, inasmuch as in this part of the Province the damp hangs until late in the morning, and comes on early towards eventide; but as we ascend into the interior this will scarcely be noticeable, and there is nothing to prevent us adopting suitable means to enable us successfully to compete with less damp localities. I stated in my former communication that bleaching on grass was necessary to secure uniformity of colour, using lines only for the purpose of drying. If this be adopted with lines covered by roofing, like the drying-sheds of brickworks, allowing the air to draw through, the process may be much accelerated, while simple drying machines, which will neither be costly nor require much force to drive them, can easily be adopted so as to

finish that part of the process effectually, and save undue accumulation in the bleaching ground. I am, however, still of opinion that unless an entirely new method of cleansing be speedily adopted, bleaching by solvents will ere long come to pass. In this case rollers for squeezing out the moisture, and the drying machine, would mainly take the place of the bleaching ground, effecting a saving of labour about equal to the cost of the solvents, and saving some time in making the fibre ready for market.

The mode of cutting the flax is also worthy of some notice. Instead of cutting below the fan (or upper part of the root), it should be cut well up the leaf above the red stain, and only such leaves cut as are fit for stripping. In the North this is particularly observed by persons when cutting from their own lands, for which labour they pay as high as 12s. 6d. per ton; and I have seen flax roots thus cut from (not cut down) three times during twelve months, which were larger in circumference, and in every way more luxuriant than ever.

To cut all down, as I have witnessed here, working up leaves of all ages together, must reduce the value of the fibre, and destroy tons of produce per acre, rendering a little more expense in cutting well spent money. Sometimes, however, flax-dressers have to clear ground entirely, in which case it would be well to adopt a system of classification. A cask, with a standard affixed, would answer the purpose, putting in a sheaf at a time, the sorter could grasp all above a certain length first, and descending each grasp, a sheaf would be assorted in about a couple of minutes, then putting each length through the mill separately, they can be kept apart throughout.

With respect to the quantity of green flax which an acre of land is capable of producing, there are patches which may fairly be estimated at thirty tons, or even upwards, while the general run of well planted ground may yield fifteen to twenty tons per acre.

The cultivation of this now valuable plant will, ere long, claim some attention. No doubt some of the first attempts will be to fill up vacant patches in land set apart for the purpose of flax-dressing; and, considering the nature of the plant, I should in such case recommend transplanting, digging the holes two spits deep, and pulverizing the soil with the back of the spade, taking up the roots as deep as possible with a little earth adhering, and cutting down just above the fan part, leaving young leaves just peeping. Two or three fans, or roots, should be planted together. I believe that in moist ground it might be planted nearly all the year round, but certainly with success during the season for planting trees and shrubs. During my peregrinations in search of knowledge on the subject of flax dressing, &c., in the North, (wherein I traversed hundreds of miles to and fro,) I noticed a patch of 40 acres at the base of a scoria volcanic hill, which had been transplanted late in the spring, and yet was thriving nicely.

In planting unflaxed land, I should say that the rows should be 6 to 8 feet apart, according to nature of soil, and in order to get as early a return as possible, the plants might be placed 3 feet apart in the rows, and thinned out when full grown, which, if well planted with good roots, I imagine may be likely to yield five tons or more of leaf during the first year.

Producing from seed will no doubt be found to require very considerable attention, and probably will be best raised in pots or boxes, and carefully transplanted therefrom, care being taken to shield the young plant from a powerful sun. In fact, I believe they need cover generally, although undoubtedly, like most other plants, when once fairly rooted they will be the better for cultivation and earthing. I think that even a cereal crop, occupying about 4 or 5 feet between the rows, would shelter and benefit the young plants. However, I do not profess practical knowledge of this part of our subject. I am indebted for what little I do know to our friend Mr. W. Hislop, of the Woodburn Nursery, who has devoted some attention to it, and will be better able to advise thereon. Whether sown, planted from seedlings, old roots, or natural grown flax, intended for market, it should be carefully kept clear of live stock, particularly of horned cattle and horses.

With reference to the prospects which this new industry holds out to our present and future fellow-colonists, we may just glance at what twelve months are likely to bring forth. At the present time there are upwards of 100 machines being prepared for work in this Province, all of which will no doubt be in operation before the end of two months, and turning out about 100 tons of marketable material per week, employing about 600 hands, and producing, at £20 per ton only, a weekly value of £2,000. This number is, however, likely to be more than doubled by the end of six months, and (including the Timaru District) I feel confident that in twelve months from date, Canterbury alone will possess 500, but say at least 400, machines, yielding about 400 tons of fibre per week, or for fifty working weeks during the year, 20,000 tons, which, taken at the same value, will give us £400,000 per annum; but I am convinced that £25 per ton will prove within the mark, which gives Canterbury a fine lift of £500,000 of export from an entirely new source; and instead of retarding any other industry, it will prove of the utmost help, for these 400 mills will be employing about 2,400 hands, in a position to buy all they need. It is, moreover, a calling that can be performed by that class of labour which is of no use to our farming community, and a business just adapted for many of those occupants of our towns who try to eke out a miserable existence by small trading, by which they create a most unhealthy competition. Such persons could, by joining in the co-operative principle, profitably employ themselves and families in flax-dressing. Even the pastoral tenants of the Crown, who have unfortunately lately suffered much depression, will find a wonderfully beneficial auxiliary; and I consider that my calculations are very far beneath what may be expected before two years more are over our heads. Let us, however, see what the result may likely be to this Island as a whole. We may safely put Otago at the same number as ourselves; with Southland, Marlborough, and Nelson at 200 each, giving an aggregate of 1,400, equal to 70,000 tons per annum, which, at £25, would give an export of £1,750,000, employing labour to the extent of 8,400; and if the North Island could be at peace they would considerably outstrip us, so that in two or three years hence New Zealand has an export before her, in flax alone, of four or five millions sterling per annum; and be it remembered it may be calculated to yield so handsome a return for the money invested in it, that a very large amount of capital will be produced for re-investment in other reproductive channels. But as usual, even this new means of reviving the state of our country has its enemies. There are always some classes of society who cannot give up their ideas without a struggle—among these will be found the scientific, who, when forming opinions or making mistakes, cannot endure to have their visions

falsified. There are also the thoroughly crochetty, who cannot hear their notions gainsayed without a desperate struggle. There is the half-thinking multitude, whose reasoning has no further foundation than street-corner confab; and the extremely cautious man (shall I say merchant) who must feel the shilling come into the empty hand before he lets the sixpenny-piece out of the other. Yet, thanks to the manufacturer of the great human time-piece, we have also the practical, persevering character; for although science and theory have told wonderfully in advancing mankind, yet practice is the main-spring that takes the machine along.

I fear I may have trespassed too much on your columns, and tried the patience of your readers; as for myself, I feel the subject to be of such importance to the welfare of this country, that I could go on scribbling almost *ad infinitum*. One comfort in the matter is that there is more than enough for all who are here at present, and therefore there need be no need of quarrelling in any shape; but, on the contrary, I think it is highly desirable to form, in each centre of population, associations of flax-dressers for mutual instruction, and generally to forward and protect this new branch of industry. There are many points on which such combinations would prove essentially useful. It could (if need be) then aid in getting the products conveyed to market, &c.

I am, &c.,

R. D. BUST.

29th June, 1869.

No. X.

THE PREPARATION OF NEW ZEALAND FLAX.

[Written for the *Press*.]

Now that the flax manufacturers in New Zealand have been forced to recognize the very unpleasant fact that the fibre of the *Phormium tenax* or New Zealand flax, as at present dressed, has been found, from actual experiment, totally unfitted to compete with Manilla hemp in the manufacture of the superior qualities of rope; and that there are even grave doubts that it will be able to maintain a tolerable position alongside of the lower-priced fibres, such as jute, Bombay hemp, &c., &c., which are used in the manufacture of inferior cordage, it behoves all persons interested in maintaining our fibre in the position of an article of profitable export to look the causes of this discouraging failure fully in the face, and by all means in their power endeavour to rectify the errors that have been made. And, after all, to what may our late failure be attributed? Why, to nothing more than sending home the fibre in too humble a guise. We, having a really valuable fibre that, when properly prepared, has been proved to be fitted for the manufacture of textile fabrics of the highest grade, have been content to use only the most preliminary process to disintegrate it; and, having stopped there, have placed the partially-cleaned fibre in the market, where, as might have been expected, it has only taken rank along with the inferior fibres, instead of being placed side by side with the *Linum usitatissimum* or Irish flax, where it certainly would have been, had more attention been paid by our manufacturers to the production of quality in the place of quantity. *Hinc illæ lachrymæ.*

As a matter of course, it is very galling to discover that the gradual, though rapid, rise that took place in the price paid for our flax fibre in the home market, which we fondly attributed to the increasing appreciation of its superior qualities, was after all only due to a little "log-rolling" on the part of the trade, to bring down the price of the more coveted article Manilla, and that our fibre has been used merely as a cat-spaw to effect that object. It would be well, however, if the evil stopped at that; but not being behind the scenes, our manufacturers here only observed that large quantities of their fibre were being absorbed by the trade at home, and naturally looking upon the transaction as a *bona fide* one, it has acted as a stimulus to them to incur fresh expenses, by entering more extensively into the production of quantity (but I am sorry to say with scarcely any endeavours to improve or alter the quality—the one thing needful), persons not already in the trade have been induced, by the apparently large profits that were being made, to embark their capital in flax mills; add to this that the bulk of the fibre exported will have to face not only a largely overstocked market, but also a depreciated character, and I think the difficulties of our position may be realized. If it is any consolation to know that ours is not an isolated case, and that we do not stand alone in the position of having in our possession a most valuable article of export, which up to the present time we have failed to put upon the market in its most remunerative form, we need only look to India, which for the last fifty years has known herself to count among her treasures a plant that produces one of the most valuable fibres known. This plant can be grown through an unlimited extent of country cheaply and easily; yet hitherto she has not been able to obtain the necessary requirements for producing this fibre in its most valuable condition at anything approaching a paying price. However, nothing daunted, the Government of India has now offered two rewards, one of £5,000, the other of £2,000, subject of course to certain conditions, by which means they hope, not without reason, to accomplish their object. The fibre of this plant, namely, the Ramie or Rhea, commonly called China grass (*Urtica tenacissima*), is described as being made into fabrics of so strong and so lustrous a character as to be in universal demand in the home market, where the fibre has already obtained the high price of two shillings and fourpence per pound. It would be well if the Government of New Zealand would endeavour to emulate the liberality of the Indian Government, and follow the example of her policy, of developing the resources of the country; we too might then hope that before very long all our present difficulties would be swept away, and we should see our fibre, properly cleaned and prepared, taking a very high position among the textiles used for spinning purposes, and returning to its producers a large share of profit, instead of, as at present, ranking only on a par with inferior fibres, and making very small, if any, returns for the labour expended upon it.

As there is no doubt that the fibre of our *Phormium tenax*, when properly cleaned and deprived of all extraneous matter, is capable of being worked up into the finest of textile fabrics—(instead of saying

there is no doubt, I should say it is an established fact, for years ago both in Belgium and Ireland it has been already spun into the finest lawn),—I do not think we here in New Zealand could employ our time to greater advantage than in endeavoring to find out in what part of the process our method of separating the fibres of the *Phormium tenax* differs from that employed in the disintegration of all other fibres used for any but the very coarsest and commonest applications, and in what respect our present system is defective, and in endeavouring to discover the means of remedying the part defective, paying all due attention to economy.

The manufacture of the fibre of the New Zealand flax, as at present carried on, consists in first cutting the flax leaves. This is generally paid for at so much per ton weight. Most of the weight of the leaves lies in the butt-ends, and it is obviously to the advantage of the cutter to get as much butt as he can in; by this means he materially lessens the quantity to be cut, and economizes his own labour. With regard to the manufacture, this portion of the leaf contains all the objectionable substances, such as gum, colouring matter, coarse fibre, &c., and is the most difficult and troublesome part to clean through all the subsequent operations. The leaves are then subjected to the beating or scraping action of the quickly revolving stripper, which in a great many cases injures the fibres quite as much as it cleans them, for it is almost impossible so to regulate a machine that revolves with the high speed of the stripper so that it will clean both the thick and the thin ends of the leaf equally. The fibre is then washed and sometimes left soaking in a running stream for, say, one or two hours, certainly not longer, as this steeping, when carried beyond a certain duration, is found to discolour the fibre. As an experiment to show how ineffective this washing process is to do more than clear away the loosened particles of vegetable matter still adhering to the fibre, take some of the gum, which can easily be done by scraping it from the outside of the leaf, and soak it in water, say for two hours, then pour off the water and see if your gum has dissolved. I may here mention that this gum has been found to be one of the most insoluble of mucilaginous substances, and that quality is in great demand as a substitute for the compound now in use for uniting the so-called adhesive envelopes. Now this gum being by the action of the stripper driven into and among the fibres as they are partially separated, carries with it a certain amount of the other substances which help to build up the structure of the leaf, and causes them firmly to adhere to the fibres; also at the same time occasioning the fibres themselves to cohere to one another, forming a harsh brittle mass that would require a very lengthened immersion in water to loosen and separate. When the washed fibre is submitted to the water-scutcher, it is obvious that a greater quantity of gum &c., is scraped off, but as it can only operate upon that portion of the gum, &c., deposited on the outside of these bundles of fibres, it can easily be understood that a very considerable quantity still remains imbedded among the fibres, and which the action of the water-scutcher fails to reach or disturb. After drying, the effect of which is to harden and concentrate the gummy mixture on the fibre, it is operated upon by the dry-scutcher. The process is then considered complete. We have now obtained the fibre in a condition in which each apparently individual fibre is composed of numerous finer fibres which are glued together, and stiffened much in the same manner as the hairs of a brush used in our common mucilage bottle when allowed to dry. It is this adhesive and detrimental compound that we have to get rid of before we can produce fibre in a fit state for the spinner.

Let us now see how a process something similar succeeded when tried upon the Irish flax (*Linum usitatissimum*), and what the best authorities have said upon the subject. In taking our examples from the mode of working other fibres and applying them to the cleaning of the *Phormium tenax*, do not let us lose sight of the fact that all fibres have this gummy substance in their surroundings to be overcome before they can be worked up into textile fabrics.

It appears to me to matter little in what manner the fibre is encased in its natural covering, whether it is embedded in a leaf, like the *Phormium tenax*, *Bromelia penguin*, *Bromelia sylvestris*, cabbage-tree, pine-apple, aloe tribe, &c., &c.; or in the main stalk of the plant, as in flax, hemp, species of nettles, as the *Urtica nivea*, *Urtica tenacissima*, &c.; or in the main rib of the leaf, as in Manilla, plaintain, banana, &c.; this gummy matter is always present, and is in all cases the great and insurmountable obstacle to the effectual and economical extraction of the fibre.

Some fifty years ago a most ingenious machine was invented to separate the filamentous parts of the stalk of flax and hemp, by means of bruising them, instead of previously submitting them to the dissolving action of steeping, and notwithstanding the hopes to which the invention gave rise at its first appearance, its inefficiency was soon discovered. The reason why this and all similar machines must ever be incompetent to perform the office required of them is clearly explained thus by a celebrated and practical writer on the subject. "Maceration," he says, "is an operation indispensable to obtain a tissue for making cloth. It may be said it can be dispensed with in case of fibre for rope-making. I do not admit even this supposition. The portion which furnishes the tissues is composed of an infinity of longitudinal fibres lying one over the other, and joined together not only by the force of adhesion proper to vegetable tissue, but still more strongly by a sort of gummy substance which unites it to the woody part. No mechanism whatever can clear the fibre from this substance. Maceration is the only process capable of dissolving and decomposing this substance, and of giving to the tissue the flexibility, brilliancy, and disposition to subdivide to the greatest possible extreme, according to the nature of the fibres. This operation appears to act in two ways, by fermentation and solution. Chemical processes are the only ones capable of obtaining from unmacerated fibre tissue of fine and supple quality. But it should be remembered that these processes obtain such a result only as far as they are equivalent to the maceration for which they are substituted. The gummy substance remaining on the fibre after it has been prepared by the machines that have been invented, is dissolved by the chemical apparatus, and the fibre experiences the same effects as it would have done from maceration before it was bruised. The only difference in the two cases consists in the greater loss which must necessarily occur in the second instance."

We will now glance at the manner in which Manilla and plaintain fibre is extracted:—

"The fibre is found to be coarse and strong in the outer layer of the sheathing footstalks, fine and silky in the interior, and of a middling quality in the intermediate layers. The fibre is separated by crushing between rollers in a mill, or by fermentation. If by the latter process, the stems when cut down are heaped together near where they are grown, and shaded from the sun by laying leaves over

them. Several weeks elapse before decomposition takes place, when the fibres can be easily separated from the rest of the vegetable matter."

In addition to the process of passing through rollers and washing, it is subjected to a further process of boiling with carbonate of soda and quicklime, in order to get rid of the remaining vegetable matter, and to bleach the fibre. To work four to six tons of fibre daily, the grower requires four large boilers of 800 gallons each. With these he will need to consume about 360 pounds of soda, and a proportionate quantity of quicklime; or the soda, that is, the carbonate, may be first deprived of its carbonic acid. This may be done by preparing in a small separate boiler the quantity of liquid necessary for the day's consumption, which will occupy about one hour, by taking six parts quicklime, ten parts soda, and seventy parts water.

The Hon. J. McLeod Murphy, speaking of the Ixtile fibre (*Bromelia sylvestris*), says—"Since my return from Mexico I have had little or no opportunity of testing the plant practically, but some samples such as I send you were given to an old and experienced maker of fishing-tackle, and he does not hesitate to pronounce the Ixtile fibre as superior in every respect for the manufacture of trout and other fishing-lines, not only on account of the readiness with which it can be spun, its extraordinary strength, but its perfect freedom from kinks when wet. The only secret, if there is one, consists in the preliminary precaution of boiling the fibre."

After perusing the foregoing, it would appear that the only conclusion we can arrive at is, that we have entirely omitted the most important part of the process shown to be required by other fibres, in the methods which we have adopted in carrying on our flax mills, viz., that of maceration or its equivalent; and it only remains for us to compare the different processes now in use, and to adopt without further loss of time, that which appears to us the most efficient and economical.

We have unfortunately discovered that rope made from the raw-dressed and partially cleaned fibre, will not stand wear and tear or weather for any length of time; that when the rope breaks it snaps short off like a carrot (as I once heard the comparison made), which shows that the fault lies with the fibre, and not with the ropemaker; and I also have heard of a case where the fibre being manufactured into halters, they lost all their strength, and became in reality rotten and nearly worthless, merely by hanging in a shop where they were exposed for sale.

On the other hand, we have Dr. Hector's authority for stating that flax which had been bruised and digested in hot water for two hours, and then boiled two hours longer with twelve per cent. of soda soap in the water; that when the sample so treated had been kept twelve months, it was equally as strong as at first, and that flax so prepared four or five years since still remains unaltered from the state it was in when first dressed. Add to this, that at a recent trial made at home, to test the relative strength of the raw-dressed sample of fibre, as compared with the boiled sample, it was decided in favour of the boiled fibre by a difference of about 170 to 90—showing a superiority of nearly 100 per cent.

The first process that we will inquire into shall be maceration, retting or steeping; and we find, to carry out this process successfully, ponds of a certain size would be required, and of a sufficient number so as to insure a certain supply of the material being always in readiness to keep the works going. It must be borne in mind that all waters are not suited for this purpose—hard water charged with selenite is bad. As a rule, water that is preferred by brewers or washerwomen may be considered good; and though the water in these ponds is entirely stagnant, it is desirable that the entire body of water should be renewed by a feeble stream entering at one end of the pond and escaping at the other. Quick running water will not do at all. Steeping is always more quickly performed, and to greater perfection, where the water is alkaline, such as the drainings of the dung-heap or poultry yard, a solution of guano, putrifying fish, or decomposing animal matter, &c., &c. But such water is always coloured, and would cause a depreciation of the fibre on account of the tinge it would thereby receive. The equable temperature of the water is also of great importance. The length of time this process appears to occupy is a serious drawback. Dr. Hector states that after bruising the leaves well, and then submitting them to the retting process, no change in their texture could be discerned, even after three weeks' immersion. It seems to me that the time this operation requires must militate greatly against its economical or general introduction here; but as there may possibly be some persons who have the requisite conveniences, together with suitable water and the means of maintaining it at an even and desirable temperature at their command, I will proceed further to describe the process. One of the chief difficulties of retting flax is to decide the exact time when it should be taken out of the water. This is a very nice point, as by leaving it in the water a few hours too long it may be over-retted.

Mr. Henderson, in his "Practical and Experienced Directions," says (although he refers to Irish flax, still the same hints are equally applicable to the steeping of *Phormium tenax*):—"Flax is subject to injury from neglect in every process; but in the steeping especially. The water brought to the pond in which the steeping is performed should be pure from all mineral substances, clean and clear. Of such importance is this that farmers sometimes send their flax as far as forty miles, by land, to be steeped; and in Holland, by water, much longer distances. The water of large rivers is generally to be preferred; but spring water which has run some hundred yards becomes soft, and will have deposited any mineral impurities it contained. Immediately from the spring, it seldom does well. If the water be good and soft, it is injurious to allow it to stagnate in the ponds before steeping. I put in two layers, each somewhat sloped, with the root end of each downward; one layer is said to be safer, and perhaps it is so, though I have tried both and found no difference. It should be placed rather loose than crowded in the pond, and laid carefully straight and regular. A stream should if possible pass over the pond; it carries off impurities, and does not at all impede due fermentation."

Flax is more frequently injured by too little than too much water.

Bad management in steeping reduces the value of the crop to the amount of one-sixth and often one-fourth. What remains is weak and rotten; it falls to tow under the hackles. If the hemp has not been steeped enough, the residue which is left is harsh and untractable. The latter defect may be corrected, but the former is irremediable.

The leaves which require the most active steeping ought to be placed in the middle of the pile or

heap, because that is the spot where the strongest fermentation takes place, and the best fibre prepared ; as it is also the position in which it soonest receives injury, if through any neglect or mistake the steeping goes on too long. A space ought to be left quite round the stack of steeping flax in case of any unforeseen derangement of the heap, in order that the men who have to enter the water for the purpose may remedy the accident with greater facility. It is wise to prefer the situation which affords an opportunity of washing the bundles in running water after the steeping. The fibre so treated will be easier to work and will give out a smaller quantity of that acid and irritating dust which is so injurious when flax is beaten by the scutchers or finished off by the hackles. For the benefit of scutchers or hacklers, or those whose business makes it necessary for them to be present while the operation is being performed, I will here mention two infallible methods of preventing the irritation caused to the air passages and the lungs, and the consequent evils attendant upon constantly breathing air charged with such quantities of dust. One is to wear a respirator to cover both mouth and nose, made of thin layers or veneers of charcoal. This effectually prevents the passage of any dust, but as these respirators may not be readily obtainable, or may perhaps be too expensive for the bulk of persons requiring them, I will give another and cheaper method by which the same results may be obtained. Take two pieces of thin cotton cloth, sufficiently large to cover well both the mouth and nose. Between these, place a thin layer of cotton wool or the inside of a piece of wadding, tack them together loosely so as to prevent the cotton wool from slipping out of its place ; then tie over the mouth and nose. It will not interfere with the breathing, and will be found to be a perfect dust arrester. When foul the cotton wool may be thrown away, the cloth washed, fresh wool put in to replace that thrown away, and you have a new respirator at a very nominal cost.

We now come to boiling and treating the leaf and fibre with hot water. The remarks made above with regard to the quality of the water, &c., required for retting or steeping apply equally to that used for boiling. There is also another precaution that must be taken in boiling, and that is always to be careful to use a sufficient quantity of water. Great mistakes are apt to be made in this respect. For instance, we try an experiment on a small scale in boiling the flax leaf or fibre with or without chemicals, as the case may be ; we place the leaves, perhaps four or five, weighing together about two pounds, into a pot or boiler containing possibly from two to four gallons of water. Now supposing the result of this experiment to be sufficiently encouraging to induce us to repeat the experiment on a larger scale, let us see how we set about it ; generally thus—we obtain a 400-gallon tank which we convert into a boiler, and put into it half a ton and more of green leaves, and then add the water ; the tank being already nearly filled with flax leaves, will hold perhaps fifty or a hundred gallons of water, certainly not more. Now let us compare the two experiments : in one case we have upwards of a gallon of water to a pound of leaf, in the other we have more than twelve pounds of flax leaf to the gallon of water, or about an ounce (about two table-spoonfuls) of water to a leaf, and yet we are surprised if the results do not tally in colour as well as in all other respects. Most of us know that a given quantity of water will only dissolve a certain ascertained quantity of sugar, salt, gum, &c. Now by way of illustration let us take a pint of water : this quantity will dissolve about two pounds of sugar, forming a thick syrup, but it will only dissolve five and three-quarter ounces of common salt. Thus we see of those substances which dissolve in water some are much more readily soluble than others. In the case of the sugar and the salt, we find it takes only one pint of water to dissolve two pounds of the former, while it requires nearly six pints or three quarts of water to dissolve two pounds of the latter. This rule applies with equal force to the gum, &c., of the flax leaf, and unless there is a sufficiency of water the dissolution will be incomplete. In boiling the flax leaves, either before or after bruising them, (passing them through a stripper set rather wider than they are generally used would, I think, be sufficient, but we must bear in mind that the most difficult part of the leaf to clean after undergoing the operation of boiling is the thin or top end, which we should be careful to have properly bruised—one great advantage accruing from bruising the leaf prior to boiling is, we may confidently rely on obtaining the fibre of a good and bright colour.) I should prefer making use of wooden vats heated by steam pipes. The expenses of iron boilers, setting them in brick, building chimney, &c., &c., would thereby be saved ; furthermore, my experience leads me to avoid the use of any iron vessels in this or other operations, as I have never found the results so satisfactory as when wooden ones are used ; but the wooden vessels must be kept clean.

There is one important item to notice—and that is, the leaf or fibre should not be immersed in cold water and then brought to the boil, but the water should boil before the flax is put into it, for the flax when treated with the cold water first and then boiled is much more difficult to clean, and the steeping is not so thoroughly effected. This applies in all instances, whether chemicals are used or not. There should also be about one gallon and a half of water to each pound of flax leaf or fibre. The boiling is to continue from two to two hours and a half ; the exact time can only be arrived at by experiment. If soap is used, many experiments have shown the best proportions to be one pound of soft soap to forty-eight pounds of flax, and forty-eight pounds of flax to six hundred and fifty pounds of water, equal to eighty-one gallons ; and where the shape and size of the boiler will allow, the flax leaves when unbruised should be tied in bundles and stood upon their butt-ends, and kept in this position during the boiling. On removing the fibre or leaf from the boiler, it should not be exposed to the wind, but be placed under cover, as it is important that it should cool gradually. Among the chemicals that may be used I find soap safest and most effective ; carbonates of soda will greatly increase the colour of the fibre ; guano, or any substance containing ammonia ; all highly nitrogenous substances, such as bean or pea-meal, &c., salts of soda and linseed oil ; wood ash and tallow, &c., &c., will be found to have a certain effect ; but some of them are too expensive and others discolour the fibre. In boiling under pressure ammoniacal water or sulphurous acid may be used to impregnate the water. These at a pressure of from eighty to ninety pounds to the square inch, are known to give good results ; but the expense and trouble attendant upon this operation will, I fear, put a bar to its adoption.

Highly satisfactory results have been obtained by steeping the flax, &c., in water heated, but not of the boiling point. Dr. Campbell in a recent work on "The Preparation of Vegetable Fibres," and which is now in its fourth edition, says, "The latest improvements in the process of steeping seem to have developed its ultimate properties to the fullest extent ; for by macerating in water heated to 160 deg.

Fahr., it forms an entirely new staple; it becomes silky, more delicate and beautiful than the finest flax, and that when the process is properly carried into execution this new article will supersede cotton. "This great heat has the effect of perfectly disorganizing the cellular tissues, which glue the fibres together, with such tenacity, as to furnish only a comparatively coarse material under the ordinary course of steeping." By this process "the cellular tissue which glues the parcels of tubes together is dissolved, and the ultimate single fibrils are separated, so that the staple produced must necessarily be as delicate as the spider's most attenuated web, seeing that they are so fine as to be visible only through a microscope."

Another good method of steeping in hot water, is to place the flax in a vat filled with water heated to about 90 deg. Fahr., the water to be maintained at that temperature by means of steam pipes; the time required to effect the setting is from three to four days.

This method of steeping would entail constant attention by day and night to regulate the flow of steam necessary to keep the water at the required temperature, with as little fluctuation as possible.

Steaming is the last process that will be referred to; and I am of opinion that steaming holds out such superior inducements, as an operation to be substituted for the maceration of flax, that on its advantages becoming generally known, it will eventually supersede all other modes of attaining by artificial means the results derived from steeping, both on the score of efficiency and economy. I have succeeded in effectually steaming flax under the most unfavourable circumstances, and with the crudest apparatus. Thus with an old oil-can for a boiler, that was not in any way steam-tight,—in fact more steam escaped from the boiler than I was able to conduct to the receptacle in which the flax was placed, the said conductor being a piece of common gas piping about nine feet long, in no way covered or protected; and the steam chest, in which were the flax leaves, a common unlined packing case;—with such unsatisfactory apparatus I contrived to steam effectually as many leaves as I could conveniently arrange in the box; the time occupied was about two hours and a half, and the experiment took place in the open air, in a situation in no way protected from the weather. In erecting some perfect apparatus for steaming flax, I should be inclined to recommend steam chests or closets of the following dimensions:—Inside measurement, breadth, five feet; depth, five feet; height, eight or nine feet, according to the length of the flax leaf likely to be operated upon, this to include a false bottom, six inches to a foot from the true bottom; the false bottom to be made of wood, or if of iron the metal to be covered with wood, so that the flax will rest on the wood without touching the iron. These chests or steam closets should be made of stout boards, and might be lined with zinc. They are then to be enclosed in an outer casing of a size to admit of six or eight more inches of sawdust being packed round the steam chest. The doors of the steam chest will open in the same way as the door of a room. It is necessary that these steam closets should be in some building, not perhaps in the same compartment as the engine or flax-dressing machinery, but somewhere near at hand. It will be found that when once the flax deposited in these steam chests has attained the required heat from steaming (for a time in which experience must be our guide,) after stopping the supply of steam, will retain a high temperature for several hours, so that flax put into the steam chest by 5 o'clock in the afternoon would be quite hot at 8 o'clock in the morning, or even up to 12 o'clock at noon, because the sawdust packing so completely prevents the escape of the heat, and there are no currents of air to carry off any other heat by convection. When the steam has been allowed to flow into the closet for the length of time which will be found necessary, the steam cock is closed, and the rest of the operation is performed by slow digestion, no more heat being added.

Some of the great advantages of this method is its simplicity, economy, and practical application. There is no complication of hot water or air pipes to retain the heat, no mechanical combination whatever for producing a high degree of heat by steam pressure; consequently there is no necessity for steam valves, or other combinations which would render the use of the apparatus difficult or dangerous. Any person will without difficulty be able to use the apparatus to advantage after once having witnessed it in operation. In subjecting the flax leaves to the action of steam in those or any other chests, it should be tied loosely in bundles, not of too large a bulk, and placed upright upon their butt-ends. Two important objects are gained by this position,—

Firstly, the leaf standing on its butt-end has only its own weight to support, and the steam easily and quickly percolates through and among the leaves. It is true the bundles of leaves will seek support by leaning one against the other, but this may be prevented by placing bars across the chest; and when they become softened, will perhaps sink down; but even this may to a great extent be obviated by the exercise of a little ingenuity. However, they can never be subjected to the unequal pressure that is exerted on individual bundles of leaves when they are packed in the chest one on the top of the other. In this case the lower tiers of leaves must have a very heavy pressure on them, which will naturally render them more difficult to steam thoroughly.

Secondly, the butt-ends and the portion of the leaf adjacent is the part where the greater quantity, if not the whole, of the colouring matter and gum of any importance is accumulated. In the case where the leaves stand upon their butts, all the colouring matter, gum, &c., as it is loosened and expelled, together with the sap, juices, &c., of the leaf as they are softened and diluted by the action of the steam, fall at once upon and through the perforated false bottom of the chest, and do not in any way come into contact with the upper portion of the leaf, by which means the fibres therein contained are not subjected to the risk of being discoloured or stained. But when the leaves of the flax are merely laid in bundles one on the top of the other with, most likely, alternate butts and thin ends, all the gum colouring matter, &c., as it exudes from the upper layers, slowly trickles down, and is filtered through the fibres of the lower tiers, not without depositing some considerable portion of its *res impedimenta* among the intervening fibres. Again, it appears that the softening process is accelerated, and all the results are more satisfactory, when the leaves are placed in the steam chest in the natural position of their growth.

In the case of steaming the fibre, after having partially cleaned the leaf, by putting it through the ordinary stripper, or otherwise, you may confidently rely on obtaining a very good colour to your fibre. There are several methods of arranging the fibre in the steam chests. The way in which I should effect this part of the work would be as follows:—Hang several hanks of fibre over rods or

bars of wood, taking care to use only that description of wood of which there is no danger of it transmitting a stain to the fibre. Several of these rods or bars are placed across the steam chest, and are supported by the ends resting on a ledge, which runs along each side of the chest. Chests of the size which I have indicated above would take two tiers of fibre at one and the same time.

The fibre may, if it be considered necessary, before being subjected to the action of the steam, be treated with a solution of soap or alkaline solutions, such as salt of soda, potash, or caustic soda, &c., &c., allowing all superabundant moisture to drain off before admitting into the chest.

Steaming under Pressure.—This operation, though successful in itself, is objectionable on account of the cost of the plant and the time consumed in filling and emptying the steam boiler. The boiler requires a perforated false bottom for the flax to lie in. The action of high-pressure steam renders the leaf very soft, and very greatly facilitates the after process of extracting the fibre, and immensely increases the extent of its division. To use the ordinary shaped boiler for this purpose would be to entail endless labour in filling and emptying it. The only way in which this difficulty could be overcome with advantage would be in employing boilers of the same construction as those used for steaming timber—that is to say, with one end of them entirely removable, so that the flax leaf might be packed up in small cars running on wheels, these wheels being guided by a sort of tramway fixed to the perforated bottom, so that they could be easily run in and out. But, after all, it would be a very expensive undertaking, as the boilers would not contain a very large quantity of leaf, and I do not think this plan likely to be adopted.

This is the last of the chemical processes now in use, as a substitute for the retting of fibrous plant that I shall touch upon. With regard to mechanical operations, I shall merely state that with proper after-treatment there is no doubt that fibre whether steeped, boiled, or steamed, can be produced of a silky-cottony texture, of more than double the value of the ordinary samples that have been hitherto sent home. I do not say it would be of a silky texture, for this reason, that although I have seen several samples of fibre that had a very silky appearance when dry, after being wetted or washed they lost the greater part of their brilliant silky gloss, and bore a very much greater resemblance to cotton.

I think, if not at present, at all events before very long, we shall be ready to admit that however well the fibre of the *Phormium tenax* may be separated, whether by beating or scraping, or by any other entirely mechanical means, so long as the raw leaf is operated upon, and the juices, gum, &c., of the plant which continue to adhere to the fibres, remain in an unaltered condition, that the textile gradually and surely deteriorates, and in a comparatively short space of time—while steeping, boiling, or steaming either the leaf or the fibre, renders powerless and ineffective the action of the substances deposited on the fibres, thereby insuring greater softness and durability. Recent researches made by M. Kolb, on the cleaning and bleaching of vegetable fibres, has led to the establishment of the following facts:—"The gummy substance which adheres to the fibres is nothing else than pectore. The soaking or steeping of the fibre appears to have for its object the determination of the pectic fermentation, and the pectic acid which results remains fixed on the fibre, either mechanically or in part in the form of pectate of ammonia—the caustic alkalies in the cold form gelatinous pectates, which preserve the fibre from being completely attacked. Pectic acid being weak, the alkaline carbonates have in the cold only a feeble action upon the fibre. Ebullition, on the contrary, transforms pectic acid into an energetic acid—metapectic acid; the carbonates are then strongly attacked, and their employment becomes as efficacious as that of caustic alkalies. The carbonate of soda, even in large quantities, is not a cause of the weakening of the fibres, which lose more strength from the employment of caustic soda, especially when the lye is concentrated. The employment of lime, even in the cold, weakens the fibre considerably. But the chief cause of the destruction of the solidity of the fibre is too long digestion, particularly with caustic soda.

There appear to be a great many conflicting opinions as to the proper time for cutting the flax leaf, so as to obtain the fibre when it has arrived at its greatest state of perfection. I was told by Bishop Selwyn, —and I think it will be admitted that he was a good authority on all that relates to Maori matters,—that when the Maoris required good and fine fibre of the best quality, they never used a leaf that was split at the top, as from the time that the leaf commenced to split, the fibre began to deteriorate, until it became harsh, hard, and brittle. I subsequently made experiments upon leaves split and unsplit, by a way of proving their individual merits, and found there was no comparison between the two fibres; that in the unsplit leaf being fine, white, and soft, and was extracted with considerably less expenditure of labour. We could not, of course, put this theory into practice with economy until we began to cultivate. There is also, I am told, a species of the flax plant which thrives both here and in the North Island, the butt-ends of which are comparatively free from colouring matter. In commencing a flax plantation, it would be worth while to try and procure roots of this description. The unsplit leaf is never discoloured at the butt-ends.

The flax plant consists of leaves which radiate from the root in the shape of a fan. When allowed to attain over a certain age before being cut down, the outer leaves of this fan generally yield a fibre coarse, harsh and discoloured, which, however, is found to improve as the leaves approach the centre of the fan, where the very best of the fibre is obtained; so that in one fan or root of leaves we may find four or five different qualities of fibre. Yet we have hitherto in most cases been in the habit of sending home our fibre packed in bales, just as it comes to hand, without the slightest pretence of assorting the different qualities, excepting so far as not to mix scutched stuff with unscutched, or hackled with unhackled. All this is of course taken into account by the buyer at home, as is shown by the following good advice:—"In packing your flax be careful to avoid putting samples of different quality into the same bale; as besides the possibility of its being looked upon as a species of fraud, it is always better to sell each quality separately for what it is worth, than to endeavour to obtain a mean or medium price for the whole, which will always turn out lower than the mean of the highest and lowest prices; for the buyer, in making his estimate of the value, very naturally takes into consideration the time and labour he is obliged to employ in assorting the unequal samples which come into his hands.

In Russia hemp is assorted according to its quality into clean hemp or firsts, out short hemp or

seconds, half-clean hemp or thirds, and hemp codilla. The first sort is quite clean, the out short is less so, and the half-clean contains a still greater portion of shive, and moreover is of mixed quality and colour. The part separated or picked out in cleaning hemp is called codilla hemp. Manilla is also assorted according to colour or quality. Jute in like manner, and even the fibre from the cocoa-nut husk, is assorted.

In conclusion, I do not think there is any great reason to be uneasy about the future in store for the fibre of the *Phormium tenax*. It only requires that the manufacturers on this side of the Line shall send it home to their brethren in the old country dressed in a more perfect manner; and as the fibre itself and the requirements of the Home market come to be better understood, there is no fear but that the ingenuity of our fellow-colonists will speedily devise means to prepare it in the state most in demand in the market to which it may be sent; but to be of any great service to those now engaged in the flax trade, whatever is to be done should be done at once. Therefore I would impress upon those persons engaged in endeavouring to improve the means of extracting the fibre, and at the same time increasing the value of the product, that *Bis dat qui cito dat*.

No. XI.

FLAX AND ITS USES.

[A Paper read at a meeting of the Nelson Scientific Association, by Dr. Williams.]

IN the year 1844, a company was formed in England (having no connection with the New Zealand Company, as has been erroneously stated) for the purpose of producing from the *Phormium tenax* a marketable fibre; machines, and a staff of workmen were sent out, officers to superintend appointed, and land for erecting the necessary buildings was purchased in England. The enterprise, from various causes with which we have nothing to do, failed.

The machines sent out were found to be unsuitable for the purpose for which they were intended—that of dressing the green leaf; and when the operations of this Company came to an end, other machines were improvised with such skill and material as were obtainable on the spot, and flax-dressing was still carried on to a limited extent, and the fibre spun and manufactured into various useful articles, such as wool-packs, sacks, &c. Door-mats, cushions for chairs, and twine were also made from it, and a material for stuffing mattresses, which last has ever since, by a very easy process, been produced here—to obtain it the green leaf is simply hackled and dried.

With the early application of the *Phormium tenax* fibre to manufacture here, Mr. Luke Nattrass's name is associated, for under his superintendence it was commenced. The articles now upon the table are his property, and kindly lent by him. Mr. Sigley wove the yarn spun from the fibre dressed by Mr. Nattrass at the period I allude to, nearly twenty years ago. The colouring matter of the brand upon the sack is composed of black-fish oil and the ash of the Motupipi coal, both Native productions.

Mr. McGlashan, a few years later, adopted a method of preparing the fibre nearly, if not precisely, identical with the process described by Mr. Travers in his highly interesting paper published in the "Transactions of the New Zealand Institute." The leaves were first boiled, then twisted into ropes, passed through rollers, the green refuse washed away, and the fibre hackled and dried. From this Mr. McGlashan manufactured ropes and lines of many kinds.

In connection with the early struggles of flax-dressing in Nelson, many more of our settlers might be named, some of whom formed a company, and succeeded Mr. McGlashan; but after a long and patient trial they were compelled, from want of encouragement, to abandon it at a considerable pecuniary loss, and, with the exception of a very few, all have, ever since that time, looked upon flax-dressing as a profitless industry.

Plants yielding fibrous substances which are capable of being spun and woven into cloth and other fabrics, and useful for various purposes in commerce and the arts, are very numerous, and by no means confined to any particular family or order, or to any one quarter of the globe.

The European flax of commerce is the woody fibre of the stem of the *Linum usitatissimum*, or flax plant of the old country, belonging to the natural order *Linaceæ*. This fibre is spun into yarn and woven into cloth, called linen. Its seeds are valuable for many purposes; linseed oil is obtained from them, also an oil-cake for fattening cattle.

Of the supply of this flax required by the United Kingdom, Ireland and Russia each contributes about one-third, the remainder is imported from Holland, France, and Belgium. In the Great Exhibition year, 1862, the value of linen fabrics and yarns exported from Great Britain and required for the home trade amounted to eleven millions sterling.

Linen manufacture is of so ancient a date that its origin is unknown; the cloth wrappings of Egyptian mummies are of this material.

Hemp is the rind of the woody stems of *Cannabis sativa*, nat. order *Cannabiæ*, to which also the hop plant belongs; this order is botanically nearly allied to the nettle tribe. From the *Cannabis sativa*, grown in India, where it is called *Cannabis Indica*, a highly intoxicating and narcotic drug, called *bang* or *haschish*, is obtained; also a medicinal preparation used in hydrophobia, tetanus, and some other convulsive disorders.

Manilla hemp is the fibre of the stems of the *Musa*, or plantain, nat. order *Musaceæ*. The fruit of this tree, and that of the banana, a smaller variety of it, are, both raw and cooked, universally used for food, and the trees composing this group are amongst the most important of any to the people of those countries where they grow.

The coir of commerce, which is twisted into yarn, spun into ropes of all sizes, and used for matting and many other purposes, is the outer covering of the fruit of the cocoa-nut palm, nat. order *Palmeæ*. The sap of this tree when fermented produces a strong spirit called arrack, which by further fermentation yields sugar. Its fruit, the cocoa nut, is valuable as food, its leaves as thatch, and indeed every part is eminently useful to the inhabitants of tropical countries, to which, like the plantain and banana, it indigenously belongs.

Cotton is obtained from the *Gossypium*, or cotton plant, nat. order *Malvaceæ*, or the mallow

tribe; it consists of the hairs, which are of considerable length, and which grow upon the surface of the seeds, lying between them and the envelope in which they are contained. Thus, unlike linen, which is manufactured from the toughest of vegetable tissues,—the woody or fibrous,—cotton is composed of the most delicate—the cellular; hence the superiority of linen to cotton in point of strength. The cotton plant is valuable also for an oil expressed from the seeds, and for an oil-cake similar to the linseed oil-cake, and used like it for fattening cattle.

Jute, or Bengal hemp, is the inner bark of the *Corchorus Indicus*, nat. order *Tiliaceæ*. In India, rice bags, fishing nets and lines, ropes, and a coarse kind of cloth are made from it. It is put to similar uses in other countries, and is largely imported into England.

The *Phormium tenax* belongs to the natural order *Liliaceæ*, or the lily tribe. The flax plant of Europe, and the *Phormium tenax* or flax plant of New Zealand, are totally dissimilar. In the former the fibre is situated in the cortical part of the woody stem. The stem of the *Phormium tenax* lies underground, and the fibre is situated in the substance of its long and flattened leaves. The similarity and consequent confusion of names, formerly led to misapprehension of the true character of the New Zealand plant, and probably to the faulty construction of the machinery intended to free its fibre.

There are very many other plants from which fibre of varying strength and usefulness can be obtained, but those I have named are such as are most important and best known, and it is with them that our flax fibre will have to compete in the various markets of the world.

With a climate to suit the *Linum usitatissimum*, or flax plant of Europe, and a low rate of wages, it forms a very valuable crop, as in Ireland and other countries from which Great Britain receives her supply; but with anything like the scale of prices for all labour at present ruling in New Zealand, I am afraid the attempt to grow it here would be a speculation almost sure to end in failure. The amount of labour required for cultivation and separation of the fibre is very great; and in Belgium, where the finest kinds are produced, from which the beautifully fine lawn and cambrics (the latter so called from Cambray, a manufacturing town of Flanders) are made, the ground is so worked as to be almost as fine as if intended for an onion bed, and the soil, at each successive crop, is carefully supplied afresh, by the aid of agricultural chemistry, with those constituents of the plant which have been taken by it from the soil to be absorbed as food, and incorporated with its substance.

Ireland possesses a climate particularly favourable to the growth of the *Linum usitatissimum*, and there, from the cheapness of labour—averaging, perhaps, not more than a shilling a day for all employed in its cultivation—it forms a most valuable staple. But to be successful even there, as in all other countries, it requires the greatest care and attention, such as draining, deep ploughing, and reducing the land to the finest possible state, dressing with special manures, weeding; and when ripe, come the pulling, rippling to collect the seed and seed-capsules; steeping in water for from ten to fourteen days that fermentation may take place in the juices of the plant, and the gummy matter which connects the fibre with the stem, that so they may become loosened—during which process a highly offensive odour is emitted. After the steeping, follow the spreading, or grassing and turning, for from six to fourteen days according to weather, for exposure to the sun, air, and the night-dews; stooking or setting it up on end to facilitate the drying; after which it is carried, and either stacked and kept dry for future manipulation, or at once scutched, hackled, spun, and sold to the manufacturer.

In consequence of the constant care and labour which the cultivation of the plant demands, the Irish farmer grows it but as a rotation crop, and this can only be done in from six to ten years, and by that time the necessary constituents which the flax requires to nourish and bring it to such a state of perfection as will give it any chance of being sold at a profit, have accumulated in the soil from the various manures which have been applied to the land for the support of the crops of the intervening years; which crops, not having required those special ingredients which the flax cannot come to perfection without receiving, have therefore not assimilated.

When flax is grown as a rotation crop, the Irish farmer usually stacks and thatches the dried stalks (or straw, as they are called); and the scutching (*i.e.*, the breaking and beating away of the useless woody stem), the hackling, and sometimes the spinning, are carried on under cover by himself and family during the idler winter months, and in this way he makes his crop of flax yield a profit.

Mr. William Charley, a gentleman of Belfast, greatly interested in the cultivation of flax in Ireland, and one of the jurors of the Exhibitions in 1851 and 1862, in his work on "Flax and its Products in Ireland," gives a statement of the cost of growing an acre of European flax, together with the commercial value of the crop; and this will enable our farmers to judge whether it would be more to their interest to cultivate, improve, and utilize our indigenous *Phormium tenax*, or cast it aside for the flax plant of Europe.

The most practical method, however, of deciding the question, will be to grow the two crops side by side as an experiment, and carefully note the result, at the same time remembering that the flax plant of New Zealand is perennial, while that of Europe is but annual. Without doubt, the flax of Europe would be a desirable addition to our list of acclimated crops for rotation at long intervals, even for the sake of its seed, for which, at present, it is chiefly grown in India, where a valuable oil is obtained from it for export; but at the present cost of colonial labour, I fear, from its being such a troublesome crop, that whether for seed or fibre it would not prove sufficiently remunerative to warrant any great outlay in its introduction for exclusive cultivation in New Zealand.

The following is Mr. Charley's statement for one statute acre, under an average crop:—

Total expenses on one acre	...	...	...	£9 15 10
Cr.			£ s. d.	
By sales, 29½ stones, at 8s. per stone	...	...	11 16 0	
By bolls, for feeding, 30 bushels, at 8d.	...	...	1 0 0	
				12 16 0
Leaving on the acre for profit	...	...	...	£3 0 0

With respect to the crop, the above is under the average, and Mr. Charley afterwards states that the average produce in Ulster is 30 to 35 stones of flax to the acre, and the average profit £4 to £5.

Our farmers will be able to judge what the rate of wages is likely to be in those districts of Ireland where the flax plant of Europe is profitably grown, by the amount of labour which the above statement shows was performed for the money.

Mr. Charley describes several other processes as having been of late years adopted, by which the troublesome retting or fermenting may be avoided. The chief of them are briefly as follows :—

Chevalier Claussen's patented plan is to steep and boil the fibre in certain chemical liquids, which give it "a peculiarly bright and cottony appearance."

Mr. Schencks' is to hasten the fermentation by substituting warm water for cold (thus avoiding the unpleasant odour), the entire process only occupying from sixty to seventy hours; but Mr. Charley remarks on this process, that he "thinks it did not pay well, and has nearly been given up."

Mr. Watts' patent is for a newer system—boiling and crushing the flax between rollers are substituted for fermentation, the stalks being taken from the rollers to a drying-room heated by steam, and, when dry, scutched. Regarding this, Mr. Charley says "he much fears the result was not remunerative," and his remarks on the several systems are as follows :—He says "The watering process, troublesome as it undoubtedly is, will extract less of the oily and toughening matter of the fibre, called 'nature' by the spinners, than such a series of boiling and chemical operations as I have just described. The spinners are thoroughly practical men, and they all, I believe, still prefer the old watering process to any yet discovered; not from prejudice or partiality, but from the acknowledged superiority of flax prepared in this way to any other in the *spinning quality* so much esteemed.

The chemical composition of the *Phormium tenax* is proved by analysis to be the same as that of the flax plant of Europe, the only difference being that the proportion of constituents differs in each.

The following is Professor Hodges' analysis :—

Laboratory, Chemico-Agricultural Society,
Belfast, 24th November, 1853.

An Analysis of New Zealand Flax and Irish Flax Straw. One hundred parts of each contain respectively—

					New Zealand Flax.	Irish Flax.
Water	...	...	...	...	60.39	56.64
Organic matters	...	...	...	...	37.88	41.97
Ash	...	...	...	...	1.73	1.39
					100.00	100.00

Ash per cent. in plants dried at 212° Fahrenheit 4.36 3.20

One hundred parts of the dried leaves of New Zealand flax gave 1.64 parts of nitrogen, while 100 parts of Irish flax straw gave 0.53 of nitrogen. The ash of New Zealand flax and of Irish flax respectively contain—

					New Zealand Plant.	Irish Plant.
Potash	...	...	...	...	14.93	20.32
Soda	...	...	...	...	5.38	2.07
Chloride of Sodium	...	...	...	...	8.75	9.27
Lime	...	...	...	...	28.52	19.88
Magnesia	...	...	...	...	1.41	4.05
Oxide of Iron	...	...	...	...	1.21	2.83
Sulphuric Acid	...	...	...	...	4.64	7.13
Phosphoric Acid	...	...	...	...	18.96	10.24
Carbonic Acid	...	...	...	...	13.12	10.72
Silica	...	...	...	...	3.86	12.80
					100.78	99.31

JOHN F. HODGES, M.D.,
Chemist to the Society.

Regarding this analysis, which is given in his work on Flax before alluded to, Mr. Charley remarks :—

"The excess of silica spoken of as the cause of brittleness, does not appear in the analysis, but I think the non-fibrous portion of the *Phormium tenax* is more incorporated with the fibre than in the *Linum usitatissimum*, and this combination may partly account for the brittle nature hitherto generally attributed to the fibre. If the silica exists in combination with the alkalies, potash and soda, which I presume may be the case, I do not see any reason why such silicate should not be soluble in hot water."

The microscope will convince you that the close connection between the parenchyma and fibre, as suggested above, does really exist, and I do not believe that any merely mechanical process will ever effectually separate them.

The home prices of the several fibrous substances I have alluded to are as follows :—

					£ s. d.	£ s. d.	
1. Russian flax	...	...	...	...	44 0 0	75 0 0	per ton.
2. Manilla hemp	...	...	...	...	51 10 0	52 10 0	"
3. Russian hemp	...	...	...	...	39 0 0	45 0 0	"
4. Coir yarn	...	...	...	...	23 0 0	45 0 0	"
5. Phormium tenax	...	...	...	...	20 0 0	38 10 0	"
6. Jute	...	...	...	...	12 10 0	24 10 0	"
7. Cotton	...	...	...	...	0 0 10½	0 2 7	per lb.

By the above, we see that the quoted price for coir is for *yarn* or the spun fibre, and that New Zealand flax, *unspun*, comes next in price; we further see that costly cotton is calculated by the pound; and in connection with this fibre I may remark, that very serious difficulty is apprehended at

home with regard to the supply from America, hitherto depended upon, falling short in consequence of the destruction of negro labour in the South. The value of cotton consumed in the United Kingdom in 1868, amounted to forty-one millions of pounds sterling, and the weight of the cotton was 996 million lbs.

Certain defects are alleged as belonging to the *Phormium tenax* fibre. I will now deal with them. They are—

1. That the New Zealand fibre is brittle and harsh, and therefore has not a sufficiently soft texture called “spinning quality” or “nature,” and is on that account also liable to break at a knot more readily than other rope.

2nd defect: That it will not take tar, and therefore cannot resist wet, but is liable to rot from alternate dryness and moisture.

3rd defect: Its too easy decomposition under the action of alkaline solutions, which might perhaps make it unsafe to attempt to bleach it by the same means employed for linen.

I will now endeavour to rebut these charges authoritatively:—

In Mr. Charley’s “Report on New Zealand Flax,” published in the Journal of the Society of Arts, and inserted in the appendix to his valuable little work, often before alluded to, he remarks:—

“I found the objection hitherto urged against the fibre was its extreme brittleness, owing, it was supposed, to the large amount of silica in its composition; but this brittleness had been successfully overcome by the application of a process invented some years ago by a person named Burns; but that this process, though successful in its operation, was so expensive as to suit only in the laboratory.

“This Mr. Burns asked my informant Mr. Herdman (an eminent Belfast spinner) the modest sum of, I believe, £20,000 for the use of his invention, and showed *on paper* a beautiful theory of profits resulting therefrom, amounting to £14,000 a-year! Mr. Herdman was not sanguine enough to accept this proposal, and the matter fell to the ground.

“By the kindness of the latter gentleman (he continues), I am enabled to forward to you, in different stages, three samples of the *Phormium tenax*—two in a partially prepared state, and one in yarn.

“The half of the rough flax has been treated by Mr. Burns, exhibiting the extraordinary change effected by his process; the other half of the same stem (he did not evidently know it was a *leaf*) being kept unaltered to show the contrast.

“This process is, of course, a secret; but the result is believed to have been effected by the application of some powerful acid on the silica or silicates of the non-fibrous portions of the dried plant. A peculiar quality of the *Phormium tenax* fibre (he goes on to say) is, that it hackles out to almost inconceivable fineness; the divisibility of the fibre appears very great, and the sample thread of yarn sent herewith will show how fine the first experiment in spinning at once reached to.

“The proposal of Mr. Burns occurred so long back as the year 1836 or 1837.

“Mr. Herdman thinks that Burns is alive (1853) and in Manchester, but does not know his address.”

In a foot-note Mr. Charley adds—“Dr. Robertson, of the Observatory, Armagh, was, I understand, the first person to recognize the talents of Mr. James Burns, who was a resident in that town at one time.”

It is not therefore *impossible* to render it fit for weaving; and if, after a fair trial, it is proved to be liable to break at a knot more readily than other ropes, and that this fault cannot be prevented, then, in using it, knotting should be avoided as much as possible, and, if practicable, altogether.

With regard to the second defect—that of not taking tar—quoting again from Mr. Charley’s report, I find the following statement made by Mr. James Lemon, an extensive rope manufacturer of Belfast. He says:—“I think the sample received is capable of much improvement, and, if properly handled and better cleaned, could be used in ropemaking as a *good* (this word is italicised by Mr. Lemon) substitute for Russian hemp; and, from its superior strength, would, I think, in time (when it came to be used and tried) be preferred. I have had the small sample spun into rope-yarn and *tarred*, and I find it receives the tar in equal proportions to that of Russian hemp, which is an important thing for the preservation and durability of the rope.”

By the foregoing we find that the second charge against our fibre is unsustained, and that *it is* capable of absorbing tar *if properly prepared*, so as to render it fit for exposure to the weather; and for all other uses, as in mills, factories, and wherever it can be kept under cover, its exceeding strength has long since recommended it.

We now come to the third and last defect, with regard to the difficulty of bleaching our fibre; and I find that this alleged defect was well known to Mr. Charley, and was considered in his report to the Society of Arts, in which he says concerning it:—

“In my last report I stated, with some hesitation, that the fibre appeared very easily damaged by alkaline solutions.

“The process of bleaching employed on common linen would not, I think, be safe with New Zealand manufactures. This difficulty, however, might in all probability soon be overcome, by instituting a series of careful experiments. The example of fibre No. 2, owing to the dew-retting (a process for preparing the European flax now nearly extinct in Ireland), the use of soap as described, and long exposure to the weather, is almost half-bleached, without the strength of the fibre being much, if at all reduced. The sample No. 5 is nearly bleached white under a very simple process, namely—one immersion in dilute chloride of soda, and afterwards in dilute sulphuric acid, being washed between each immersion with pure water.

“The solutions used were of the customary strength for linen, yet the fibre appeared much weakened when tested *damp*; but, when *dry*, I was rather surprised to find it regain, in a great measure, its original tenacity. It would seem from this that it is the *dampness* of the bleaching process, quite as much as the actual operation of the chemical compounds employed, that is destructive to the New Zealand flax. One of the chief recommendations of lignine, or *pure fibre*, is that it is little acted on by acids or alkalis, unless very concentrated. It is strange, with all its great tenacity, the *Phormium tenax* is so easily acted on by such solutions, and that even simple water, for the time,

impairs its strength, only to be restored by slow drying in the open air. In this respect it resembles jute."

By the foregoing quotations, from an undoubted authority, all the objections urged against our fibre have been satisfactorily answered—the *bleaching evidently requiring further experiment*; and although it is to be feared, from the lapse of time, that Mr. Burns' valuable secret is lost, yet it is not impossible that some ingenious head and dexterous hands may invent and perfect a machine that will secure as good or perhaps a better result; and, to encourage us in this hope, we should remember that, until a hundred years ago, spinning was performed by the hand-wheel, when Hargreaves' invention of the "spinning-jenny" superseded it; this, a few years later, was improved upon by Arkwright; and within ten years of the time when spinning was done entirely by hand, Samuel Crompton invented his machine, which, from its partaking of the characters both of Arkwright and Hargreaves' inventions, he denominated "the mule," by which name it is known at the present day.

"The mule" produces a much softer fibre, and one treble as fine as any known in England at the time of its introduction. In 1812 (a tardy recognition of his services, for it took place thirty-three years afterwards), for his valuable invention Crompton received a Government grant of £5,000.

What appears chiefly to have militated against the successful introduction of New Zealand flax into England, has been its small, intermittent, and uncertain supply; but if a large and constant export of it can be maintained, there is I think no doubt that it will meet with a ready sale, and that in time many new uses will be found for it. There is reason to hope that this will now be the case, for from the table of flax statistics attached to the Colonial Treasurer's financial statement of last July, flax must be leaving our shores in enormously increasing quantities.

The following is the table I allude to:—

Value of flax exported for 1866	...	...	...	...	...	£996
Ditto ditto 1867	...	...	...	...	...	4,136
Ditto ditto 1868	...	...	...	...	...	8,137
And for 1869 (1st quarter)	...	...	...	...	...	7,614

Or at the rate of over thirty thousand pounds sterling per annum; and this quantity will no doubt annually increase, if the fibre be approved of.

No. 14.

LECTURE ON NEW ZEALAND FLAX BY MR. MCKAY, SENIOR, AT NELSON, 1869.

Introductory Remarks.

As this subject is now engaging so much public attention, the present paper, containing some suggestions derived from an experience of the treatment of the *Linum usitatissimum*, as well as from some attention to that of the *Phormium tenax*, may not be unacceptable to those who are interested in the utilization of the latter.

General Deductions on the Relative Nature of the Two Plants.

Although the botanical structure of the *Phormium tenax* is of a different class from the *Linum usitatissimum*, its fibrous texture, while similar, is double the strength, verifying its affix of *tenax*, and capable of a much wider range of adaptation.

Professor Lindley gives the comparative strengths of fibre as follows:—

Silk	...	...	...	...	...	...	34
<i>Phormium tenax</i>	...	...	...	...	...	...	23
European hemp	...	...	...	...	...	...	16
European flax (<i>Linum usitatissimum</i>)	...	...	...	...	...	...	11

In the able and exhaustive paper, on "Flax and its Uses," which Dr. Williams has already favoured the Association with, it will be seen in the comparative chemical analysis of the two plants that, while there is little difference in the aggregates of their respective constituents, whether acids or alkalies, when taken singly, an excess of phosphoric acid and lime and a deficiency of sulphuric acid and potash particularly characterize the Native plant, and that therein lie on the one hand its superior vigour and the strength of its fibre as compared with the European, and on the other the greater difficulty experienced in its manipulation into a marketable commodity.

To investigate further at present, however, the relative chemistry of either, would tend rather to the hypothetical than the useful, and the more so when it can be shown that, with some modifications rendered necessary by the botanical and chemical differences just referred to, the most effectual method of treating the *Phormium tenax* is the same as has been pursued from the earliest times in the case of the *Linum*.

If we only look into the history of the latter, from the time of Pharaoh to the present day, we will find that much care was taken of its growth, skilled treatment bestowed on the manufacture of its fibre, and commercial importance attached to the fabrics it produced. See Exodus ix. 31, and 1 Kings x. 28; also Pliny's Natural History, wherein the latter describes the growth and subsequent treatment of flax by the Romans as conducted pretty much in the same manner as at the present time; that the flax of Cumæ, in Campania, esteemed for the fineness and toughness of its fibre, was employed in the manufacture of hunting-nets, and some of these nets were of such a degree of fineness as to allow of their being passed, together with their ropes, through the ring of a man's finger; and also, in his time, a portion of a linen corselet which had belonged to Amassis, a King of Egypt, 600 B.C., each strand of which consisted of the enormous number of 365 fine threads, was exhibited in Rome as a specimen of strength and fineness of fibre, as well as of skill in the preparation and spinning of thread. Much, therefore, as the improvement has been in different appliances for the separation and manufacture of flax fibre, nothing in modern times can compare with the fineness, strength, and complexity of the thread used in making the nets and corselet just referred to.

By no special chemical process, such as Schenck's, Claussen's, or any other, neither by any purely mechanical means, has there ever yet been a satisfactory production of fibre; for in the former it is

corroded, discoloured, and weakened; and in the latter, done such violence to by abrasion and waste, while the gum is but imperfectly removed, that much deterioration is the effect, if not utter uselessness, except for paper pulp.

It would be superfluous here, however, to detail the several modes of treating the *Linum* for the separation of its fibre; suffice it to say, that to dissolve the gummy substance surrounding the fibre in order to detach the latter intact, or nearly so, and render it fit for manufacturing purposes, is the great object of all who desire to produce an article possessing the necessary conditions of fineness, flexibility, and strength. This is also the main difficulty with the *Phormium*, for the relative organic differences already described interpose greater obstacles in the way of attaining with the latter so speedy a result as is experienced with the former.

The real question, therefore, is, what is the best process, as a whole, for producing from the *Phormium tenax*, with the least waste and expense, a clean, soft, and flexible fibre, unimpaired in its strength, of good colour, and of an average length of four and a quarter feet? Such are the conditions of the quality of an article that will be safe and profitable to export to Europe, and by which, no doubt, the merchants of New Zealand will be guided in their dealings with it.

To realize such a result, the following process will be found economical and effective:—

Proposed Method of treating the Phormium tenax.

1st. Cut the leaves from four and a half to five feet long. There is no necessity to cut them longer as they will dress to four and four and a half feet, long enough for any manufacturing purpose; they are also more easily scutched and hackled than if longer; besides, the plant is economized, and left with sufficient portions of the old leaves to nurture the young ones coming on.

2nd. Immediately, if possible, but at latest within twenty-four hours after being cut, the leaves should be subjected to compression, either through rollers, or by percussive action under stampers—a combination of both is the best—which in no way injures the fibre, but greatly assists in breaking up the parenchyma, and furthering its decomposition in the next operation.

3rd. If the climate of New Zealand was less liable to extreme fluctuations of temperature, particularly between day and night, the common *retting* process adopted with the *Linum*, causing by slow and regular fermentation a gradual decomposition of the gummy nitrogenous compound cementing the fibres, would be equally efficacious with the *Phormium*, but it will be found to suit the latter only in the summer months, for the frequent variations of temperature experienced, while this method was lately attempted, have obliged its abandonment in favour of steeping in wooden vats under cover.

To carry on, therefore, the process uninterruptedly throughout the year, a series of vats or ponds, according to the quantity to be operated on, and under cover, are necessary, wherein the flax is to be immersed in warm soft water, maintained at an average temperature of 90° until fermentation has subsided, and the gummy matter appears of easy separation from the fibre. This will take from six to nine days, and require careful attention, *but the value of the fibre, and the profit it yields*, depend more on the manner in which it is performed, than on any other of the operations necessary for its preparation.

It may be here supposed that these two last operations are both tedious and costly, but in the end they will be found neither the one nor the other. They are besides equally practicable and advantageous, whether in the case of one acre or 1,000, as will be pointed out hereafter. It is surprising, however, they should be so much overlooked, and stripping drum machines used instead, that not only mutilate and waste the fibre, but leave much glutinous matter behind in a state highly conducive to spontaneous combustion, and which no subsequent dressing will sufficiently remove. Similar means have hitherto failed to effect the same purpose with the *Linum*; and how much more are they likely to fail with the *Phormium*, where the cellular and fibrous tissues are in far more intimate union?

4th. On taking the leaves out of the steeping vats or ponds, rinse them in a running stream, or under a *douche* of water.

5th. Spread them on grass to bleach from ten to fourteen days, and then hang them under cover, if weather damp, on rails or wire ropes, for three or four days to dry.

6th. When thoroughly bleached and dried, pass them through bruising rollers, or under stampers, to loosen any remaining portions of the gum or epidermis.

7th. Scutch. This process is effected by a different machine, less liable to ravel the fibres and convert so much of them into tow, than the one in general use.

8th. Rough hackle, if better quality required.

9th. Fold in hanks of equal weight.

10th. Pack in bales of two hundredweight, and press same as wool.

Applicability of the Process to Small and Remote Settlers.

There is a class of small and, in many cases, remote settlers throughout the Colony, having a few acres of flax on their sections, who might profitably employ themselves and their families in the preparation of its fibre at leisure times, now spent by many of them in enforced idleness. To enable such persons to *produce three pounds of dressed flax per hour per individual employed*, which by a little skill and arrangement should be easily attained, an apparatus costing from £6 to £8 would be all that would be necessary. By this means many families could produce, according to their numbers, from a half to one hundredweight of fibre per week, worth at least at the rate of £20 to £25 per ton, besides fifteen pounds to thirty pounds of tow, worth 1s. 9d. per stone,† and thereby supplement their otherwise scanty means, as well as train their children at the same time in habits of industry and order.

How can this be initiated? is a question which no doubt will arise in the minds of many. To suggest, therefore, what would perhaps be a feasible means of realizing the object now under contem-

* This will leave sufficient margin for manufacturers fine-dressing the fibre down to three and a half feet, the necessary length for the manufacture of rope, whether by hand or machinery, as well as for its adaptation for other uses.

† Since the above was written, the *Otago Weekly Times*, of 27th November, 1869, received at the Nelson Institute, quotes flax auction sales at above prices in Dunedin.

plation, may not be out of place here. In the Education Act of this Province, there seems to be no restriction on either the Central Board or the Local Committees in extending their organization, and engrafting on their present admirable system a Central Normal School of Industrial Education, for the purpose, in the first place, of training such of the masters of their schools as may be found expedient into the knowledge of dressing flax, and thereby, through them, imparting it to the small settlers and their families in their several districts; and, in the second, of it becoming ultimately an Elementary Technical School, suited to the wants of the Province. The social problem, What is to be done with our Colonial youth? has to be grappled with, and the sooner the better. The facility for educating them in the knowledge of the mechanical and chemical arts would be looked upon as a great boon by many a parent and guardian; and there is no limit to the advantages that would accrue from such an institution to the general advancement and welfare of the community at large. "Where there is a will there is a way;" and it is to be hoped that the Provincial Council would be too glad to vote an additional grant in aid of such a purpose; for what is done freely and extensively in analogous cases by the Home and other Governments of Europe, may surely be followed in a small degree by the Provincial Governments of the "Britain of the South." It would "be casting their bread upon the waters; they would find it after many days,"—aye, an hundredfold.

Applicability of the Process to Proprietors of Extensive Areas of Flax.

For operations on a large scale, there can also be constructed suitable appliances and machinery, combining every possible mechanical arrangement to save time and labour, costing in the end less money, working much cheaper, and turning out the fibre in larger quantity and of better quality than can be done by any proportionate number of machines having stripping-drums. For in these machines the frequent clogging from gum and fibre, requiring a stoppage of at least five minutes every hour to clean them, and the severe wear and tear they are subject to, as well as the unpleasant and deafening noise they make from having to be driven at a very high speed, irrespective of their abrasive action on the fibre, are great objections, whereas the plant (technically meaning the apparatus and machinery) of the steeping process is of simple construction, easily repaired, liable to comparatively slight wear and tear, worked with little noise, and exempt at the same time from unnecessary mutilation or waste of fibre.

It admits also of the gum being saved, and is likewise applicable to the utilization of the cabbage or ti-tree, the kie-kie, and nikau, also the toi and tussock grasses, as well as other suitable fibrous plants, whether indigenous to or cultivated in New Zealand.

Conclusion.

It may be remarked, that although the general run of New Zealand flax is prepared with a view to its being used for rope-making, yet it is capable of being dressed to as high a degree of fineness as the European flax, the best qualities of which realize from £130 to £180 a ton. Coarseness and fineness are only relative terms; but, in the present hastening to get rich of those who have embarked in the preparation of the fibre by stripping-drum machines, the question of fineness is overlooked in the hurry to get the flax into a sufficiently marketable condition for a merchant to make an advance on it. Besides the process is, as already described, at variance with the necessary conditions for the production of a fine fibre, which can only be attained by retting, and otherwise careful manipulation.

Whilst treating such a subject as this, the monition of Horace, "*Dum brevis esse laboro, obscurus fio*," comes frequently to one's mind; for striving after conciseness on the one hand is but merging into obscurity on the other, and hence the obviousness of what might otherwise seem extraneous or prolix. It is nevertheless imperfect in many ways; but if it serves to stimulate inquiry into, or a practical adoption of the suggestions it shadows forth, as well as the particular process it describes, its purpose will be accomplished.

No. XV.

MR. T. BROMFIELD to His Excellency the GOVERNOR.

MAY IT PLEASE YOUR EXCELLENCY,

Auckland, April, 1870.

To pardon the liberty I take in thus troubling you, but perhaps it may not have occurred to your Excellency's mind of a fearful crying evil or calamity that has already begun to spread itself in this our adopted country, viz., the employment of children of tender age in mills and factories. Already little children are compelled to be up at half-past 5 o'clock in the morning, and be in the flax mills at work at 6 o'clock, and work until 6 o'clock at night—those children from six years of age and upwards—but the younger they are, the less wages to pay.

I will not attempt to dictate to your Excellency, but beg to refer you to the English Factory Act, and am your Excellency's humble servant,

His Excellency Sir G. F. Bowen, Governor.

THOMAS BROMFIELD.

No. XVI.

MR. D. McARTHUR to the CHAIRMAN of the FLAX COMMISSION.

SIR,—

Invercargill, 17th June, 1870.

The more intelligent of those interested in the flax question (notwithstanding the somewhat discouraging advices from London) feel confident that the cultivation of flax will be a source of great Colonial wealth, giving employment to multitudes who are now a burden and source of much anxiety in Great Britain, and many of whom, although not very well suited for the rougher work of colonization, could be made useful and valuable colonists in connection with the cultivation and manufacture of flax.

The present prices in London would yield large returns to the colonist, provided he could get labour at what it ought to be, viz., one-half the current rates.

In a previous communication I referred to the necessity for issuing stringent regulations for protecting the flax from destruction, by burning and otherwise. The Crown tenants, in many districts, have hundreds of thousands of tons on their runs, which they burn from time to time; and cattle complete the work of destruction, by eating the young shoots. It is not unlikely some of the leaseholders may think it their interest to hasten the work of extirpation, as well-flaxed land will be considered an object in the selection of farms by intending settlers. In the meantime, and until labour can be had at more reasonable rates, it is desirable that every possible information should be afforded the settlers, with the view of inducing them to cultivate and also to manufacture the article—not in companies as such, but individually, although to a certain extent associated for mutual assistance till ultimately every farmer would have a flax machine, working in connection with his thrashing mill, throwing the one out of gear and the other in as might suit seasons and circumstances. In this way there would be a steady supply for the manufacturer, the increase of production keeping pace with an increasing consumpt, as in most cases the farmer would work off his flax with his own family, or the hands necessary to manage a properly cultivated farm; and there would not be large numbers of people thrown suddenly out of employment as would occasionally take place under extensive companies, as according to the view indicated it would form part of the mixed agriculture and operations of the farm, and the working up the flax would come in its season, just as cereals and other crops would in theirs.

It may be asked how cheap labour is to be had to foster this and other industries, seeing that everything is supposed to have been done to encourage immigrants who now won't come? I believe there could scarcely be anything more done to prevent immigration to this country from home than has been. For years the press of one Province vied with that of another, as a rule, in drawing the most gloomy pictures, not only of neighbouring ones, but of the whole country, colonially and provincially, till at length the class of people most wanted here have been induced to turn their attention to other countries in hundreds of thousands annually. Seeing, therefore, we are not likely, at any rate for some time to come, to get the well-to-do class, who as a rule, are able to provide for themselves on arrival, would it not be desirable to make arrangements for bringing a supply of those who do need assistance for coming, and maintenance also for some months after their arrival in the Colony. To do this it would be necessary to select suitable localities for the erection, by Government, of dwellings which might ultimately become important country towns; each family on arrival having a house of two rooms and a lean-to, with a quarter-acre for garden, and liberty to purchase their own house at cost price within one or two years as might be considered advisable. This would be a great inducement to thrift, and the parents with the younger children being, in a sense, fixtures, the elder members, as a rule, would make the district or the Colony their home. In connection with these establishments there might be fields of suitable extent set apart for spade husbandry, where flax plants, for sale or otherwise, could be reared from the proper kinds of seed—as also potatoes and other kinds of food towards helping to make each little settlement self-sustaining; and this object would soon be attained under the direction of a judicious and practical agriculturist.

If the Colonial Government agreed to make some such provision for poor families on their arrival and distribution throughout the Colony, it is very probable that the associations now organizing in the Home country would provide passages for destitute families in large numbers; and a careful selection of families of good character, however poor on arrival, would be the source from which labour at reasonable rates could be obtained for flax and all ordinary purposes. To show the probable result from a given number of immigrants—say 100 families or 500 individuals, averaging five to a family—outlay, 100 cottages containing two rooms and lean-to—at about £30 each—£3,000; and as it may reasonably be presumed that at least three-fifths of the immigrants would find employment within a few days after their arrival, the remaining 200 would not exceed £10 each, or £2,000 for the first six months' maintenance. Total outlay, £5,000. By such a scheme, properly managed, the whole outlay would be refunded within two years—the cost of buildings by direct payments, and the maintenance indirectly through the Customs' Revenue. Result—the Colony wealthier by the value of 100 dwellings and 500 additional inhabitants; and such establishments could be multiplied indefinitely over the Colony, as need required.

Trusting you will pardon the digression from flax to immigration, as the success of the one is so intimately connected with that of the other, I could not refrain from indicating what in my opinion might be desirable for the promotion of both.

I have, &c.,

Thomas Macfarlane, Esq., Chairman,
Flax Commission, Auckland.

DUNCAN McARTHUR,
Flax Commissioner, Southland.

Mr. J. B. GREIG to Mr. J. BLACKLOCK.

SIR,—

Invercargill, 16th May, 1870.

In or about the year 1855 I bought, in Geelong, a coil or two of New Zealand rope, two inches thick, and rove it for running gear. Although it was badly got up, it lasted longer than Manilla which was rove at the same time, both having been used much alike, and exposed alike to the action of the weather and sea-water. In 1861 I saw in Auckland New Zealand rope exposed for sale, standing side by side with Manilla, and the difference in appearance between the one and the other was hardly perceptible, the price was the same. I had New Zealand flax reef-points put into a new mainsail I got made at the time, and eighteen months afterwards, when I sold the vessel, the said reef-points were still good. I have heard it said that tar will injure New Zealand flax rope. I found it injure some Manilla I had tarred when I was trading on the Australian coast, for the tar dried and rendered brittle the outside fibre, and the rope so treated did not last over half the time it ought to have done. I was consequently astonished to see the steamer "Southland's" tow ropes to be of tarred Manilla, but when I examined them I could see that there had been mixed some greasy substance with the tar. I have therefore little doubt but that a similar compound would answer well with New Zealand flax. I shall, however, make some experiments with it, and let you know the result.

I have, &c.,

John Blacklock, Esq.

J. B. GREIG.

MEMO.—Captain Greig is a master mariner of long standing, and was Harbour Master of Southland when the "Southland" steamer arrived here from Europe. Mr. Blacklock is a member of our local Flax Association, who asked Captain Greig for any information he could give on the subject.—D. M'A.

TESTS OF RELATIVE STRENGTH OF NEW ZEALAND AND MANILLA ROPE.

A MEETING of gentlemen interested in the flax industry took place at Messrs. Hay and Mentiplay's steam mills on Friday afternoon, 3rd, to witness the operation of testing the relative strength of New Zealand and Manilla rope. There were present a good many of our leading citizens, and a sprinkling of nautical gentlemen, all of whom watched the proceedings with much interest, and ultimately expressed themselves very highly satisfied with the result, the comparison showing a decided superiority in the local material. The rope submitted to the competition was of the dimension known as one-and-a-half inch (in circumference, not in diameter, as erroneously stated by a local sheet). The Manilla piece was selected from a coil of sound new rope, as perfect, to all appearance, as could be desired, and the New Zealand was a piece manufactured by Mr. J. Scott, precisely similar in size and make to the imported article. The *modus* was a stout triangle, a strong wooden platform or scale, and a pile of 56 lb. weights. Captain Green, of the "Harvest Home," was on the ground, and fixed the ropes as they were severally arranged for the strain, taking care that each should be tied in the same manner, to secure equal justice. Two trials were given to each rope, without altering the result. The point at which the cord gave way in each case was as follows:—

New Zealand rope, $1\frac{1}{2}$ inch in circumference	...	...	...	12 cwt.
Manilla rope, $1\frac{1}{2}$ inch in circumference	...	...	...	$7\frac{1}{2}$ cwt.

The length of rope on which the strain acted was about four feet, and the "snap" was shorter if anything in the case of the Manilla than in the New Zealand, which parted with a long gradual "tear" rather than a "break." The New Zealand was made from fibre dressed in the mode at present in use in this Province and generally throughout the Colony, and it will be observed that it stood over a half more weight than its rival. A number of other trials were made, all equally favourable to the local fibre. A piece of New Zealand rope of the same thickness, made from some old fibre, manufactured by boiling the leaf, which had been lying about for a considerable time, parted at a strain of ten hundredweight, and another piece, also of the same size, made from fibre manufactured by the Natives, and which had been rendered soft and pliable as kid by three years' wear and tear in a boat, astonished everybody by giving way only when eight hundredweight had been piled on the board. A piece of $1\frac{1}{4}$ inch Manilla broke short with fourteen hundredweight, only two hundredweight, more than the New Zealand rope of one-fourth inch less capacity.

No. XVII.

Messrs. LOWRY and Co. to NEWMAN and EWEN, Auckland.

GENTLEMEN,—

Manchester, 22nd March, 1870.

In reply to your kind inquiry, we beg to hand you annexed estimate for machinery to spin New Zealand flax and weave the same into sacking and bags. Of course it is only an approximate thing; we would have much preferred the exact particulars and purposes for which it is required. The prices we have quoted are delivered at our works. Should we be favoured with your esteemed order, we shall give our very best care and attention.

We are, &c.,
LOWRY & Co.,
Per J. THOMPSON.

Specification of Machinery from Lowry and Co., Salford, Manchester.

SYSTEM of longline machinery to spin New Zealand flax into coarse numbers, &c.:—

- One Lowry's patent hackling machine complete.
- One Spiral fill spreading frame, 4 stevers 32" reach.
- One do. second drawing, 4 stevers 26" reach.
- One do. third drawing, 4 stevers 24" reach.
- Two do. rovings, 48 spindles each, 4 heads each, 22" reach 10 x 5.
- Two dry spinning frames, 100 spindles each, $4\frac{1}{2}$ " pite., $4\frac{1}{2}$ " traverse, 9 to 12 reach.
- One warp winding frame, 20 drums.
- One weft winding frame, 20 spindles.
- One warping machine and creel.
- One dressing machine for warps.
- Eight beams for do.
- One yarn weft softening machine, one boss.
- Ten power-loom, 30 inches reed space.

£1,910.

No. XVIII.

FLAX MACHINERY.

THE various machines by which the fibre is separated from New Zealand Flax may be classified as follows:—

CLASS I.—WHERE THE LEAF IS OPERATED ON IN ITS NATURAL STATE.

Sub-Class A.—By Percussion on Elastic Metallic Surfaces.

1. Metallic beaters are fixed to a drum, and form right and left angles to the axis of rotation; the drum revolves at a high speed, and the beaters operate on one side of the leaf on revolving metallic

rollers, the journals of which are supported by elastic bearings. Price's machine is a type of this class.

2. Metallic beaters are fixed to the face of a drum and form right and left angles to the axis of rotation; the drum revolves at a high speed, and the beaters operate on one side of the leaf on a metallic plate supported by elastic bearings. Messrs. Fraser and Tinne's machine is a type of this class.

3. Metallic beaters are fixed to the face of a drum parallel to each other and at an angle to the axis of rotation; the drum revolves at a high speed and operates on one side of the leaf, on a metallic bar supported by elastic bearings. Mr. Gibbons' machine is a type of this class.

4. Metallic beaters parallel to each other are fixed to pairs of arms radiating from a shaft which revolves at a high speed, and by means of two such sets of revolving beaters both sides of the leaf are operated on, on a series of narrow metallic bars supported by elastic bearings. Mr. Booth's improved machine is a type of this class.

5. Metallic beaters parallel to each other are hung loosely between the outer edges of discs fixed on a shaft which revolves at a high speed, the loose beaters operate on one side of the leaf on metallic rollers, the journals of which are supported on elastic bearings. J. H. Noding's machine is a type of this class.

6. Metallic beaters are fixed parallel to each other and to the axis of rotation on the face of two drums revolving together at a high speed and operating on both sides of the leaf; the beaters of one drum striking on the space between the beaters of the other alternately. Pownall's machine is a type of this class.

Sub-Class B.—By Percussion on Non-elastic Metallic or other Surfaces.

1. Metallic or wooden stampers, with or without springs, are caused to fall on the leaf, on a bed of wood or metal, fixed or moveable, with or without water.

Messrs. Purchas and Ninnis', Mr. Franz Scherff's, and Howland's machines are types of this class.

Sub-Class C.—By Combing on Elastic Metallic Surfaces.

1. Metallic spikes, radiating from the face of a drum, which revolves at a high speed, operates on one side of the leaf on metallic rollers, the journals of which are supported by metallic bearings.

E. W. Trent's and John Cox's machines are types of this class.

CLASS II.—WHEN THE LEAF IS BOILED OR STEAMED.

Sub-Class A.—By Vinous Fermentation.

1. The crushed leaves are softened by a water-bath heated to 190°; then passed between pressure rollers to remove refuse matter; then subjected to vinous fermentations in a water-bath heated to 90°; finally, squeezed, washed, and dried.

John Journeaux's is a type of this process.

Sub-Class B.—By Grooved Pressure Rollers.

1. Metallic rollers, grooved at right angles to the axis, and fixed in rolling contact; squeeze out the refuse matter and divide the fibre.

Mr. Pownall's machine is a type of this class.

Sub-Class C.—By Combing on Elastic Metallic Surfaces.

Similar to Sub-Class C., Class I.

Michael Murray's machine is a type of this class.

Sub-Class D.—By employing Substances which exercise a Chemical Action combined with Mechanical Appliances.

1. Prussiate of potash is the chemical agent used. The machine has metallic beaters parallel to each other and to the axis of rotation fixed on a wood roller or drum, the axis of which is fixed on elastic bearings; the drum revolves in water and operates on the leaf, which is fed in sideways on fixed metallic bars parallel to each other, but at an angle to the axis of the drum.

Mr. L. Natrass's machine is a type of this class.

2. The leaves are first crushed by means of pressure rollers, and are then subjected to a cold water bath to remove impurities; then to a hot water bath raised to 212°, in which fish or other animal substances have been digested.

Cornelius Thorne's is a type of this process.

Sub-Class E.—By Percussion on Elastic Non-metallic Surfaces.

1. Metallic beaters parallel to each other are fixed to pairs of arms radiating from a shaft which revolves at a high speed; and by means of two sets of such revolving beaters, both sides of the leaf are operated on on india-rubber rollers. Booth's patent is a type of this class.

CLASS III.—WHEN THE FLAX HAS BEEN OPERATED ON BY ANY OF THE PREVIOUS PROCESSES TO SOFTEN AND SEPARATE THE DRIED FIBRE.

Sub-Class A.—Friction and Pressure between Metallic Rollers.

1. To a metallic roller, grooved on its face, parallel to its axis, is imparted, by suitable machinery, a reciprocal rotary motion greater in one direction than the other; grooved rollers of smaller diameter, the journals of which work in elastic bearings, are fixed in rolling contact with the large roller, the fibre being operated on between the surfaces of the small and large rollers.

G. A. C. Bremme's and J. E. Hodgkin's machines are types of this class.

REGISTERED LIST OF PATENTS FOR DRESSING NEW ZEALAND FLAX.

CLASS I., *Sub-Class A.*—JOHN HENRY NODING, of Christchurch.—(Dated 16th December, 1869.)

THE invention consists in suspending beaters from the circumference of a drum or lantern, in such a manner that they may swing freely, and so that on a rotary motion being imparted to the drum or lantern, the beaters may radiate from the axis of the drum or lantern. The drum or lantern is so arranged, that when it revolves the beaters either beat upon, just touch, or nearly touch a roller, or other bed of metal, or other suitable material over which the leaves of the *Phormium tenax* are fed, and a blast of air may be conveniently employed to prevent the beaten fibre from being drawn into the machinery; but the construction and arrangement of such rollers, bed, and blast, respectively, form no part of the said invention.

The beaters may be made of metal, or any other convenient material, or combination of materials, and may be of any convenient size, weight, or shape, and they may be suspended from the drum or lantern by springs, or wires, or in any other convenient manner.

NOTE.—This principle appears to be worthy of trial applied to scutching machines, it having been used in England with apparent good effect in dressing fibrous material.

CLASS I., *Sub-Class A.*—CHARLES JAMES POWNALL, of Wellington.—(Dated 8th July, 1869.)

Object of Invention.

To separate the fibre of the *Phormium tenax* and other similar plants from the gummy and resinous matters, so as to render the said fibre fit for manufacturing purposes.

The said invention consists of a mode or modes of mechanically scraping the outer and inner surfaces of the leaves of the *Phormium tenax*, and other similar fibrous vegetable substances, for the purpose of depriving them by one operation of their resinous and gummy matters.

CLASS I., *Sub-Class B.*—FRANZ SCHERFF, of Auckland.—(Dated 30th September, 1867.)

AN endless band, belt, or strap, is passed over two pulleys, sheaves or drums, one on each end of the machine. This endless band may be made of brass, zinc, iron, steel, or other metal, or canvass cloth, leather, gutta percha, or other material found suitable. It is supported at the middle by a meta or other strongly built bed or table over which it travels, as the sheaves or drums are gradually revolving by means of the ordinary mechanical combinations of eccentric motion, rods, levers, &c., known to engineers, and commonly used in self-feeding machinery. Above that portion of the endless band which is supported by the bed or table, one or more pairs of beaters are fixed and these are raised by means of cams fixed upon a revolving shaft or other suitable mechanism, so as to fall freely upon the material lying on the endless band. The beaters or stampers are in this instance shown as being made of wood, but they may be made partially or entirely of any other material.

The flax, either in its green state, or after having been subjected to boiling, steaming, or any other preparatory processes, is laid upon the endless band, passed underneath the beaters, and delivered dressed at the opposite end of the machine.

NOTE.—This process or modification of it appears adapted to washing the gum and colouring matter from the flax, after it has passed through the ordinary stripping machines.

CLASS I., *Sub-Class B.*—ABIEL GIFFORD HOWLAND, of Christchurch.—(Dated 22nd April, 1869.)

DESCRIPTION of an invention in mechanism, for the beating, stamping, or crushing iron, quartz, flax, or any other material, by means of a lever-spring hammer.

The commendatory features of this application are—

- 1st. Its simplicity.
- 2nd. The means of regulating the power to strike a light or heavy blow.
- 3rd. The greater or less speed at which the hammer can be driven at will.
- 4th. The small amount of power required.
- 5th. The unlikelihood of the hammer to get out of order or require repair.

The principle is that of a lever-spring hammer. The hammer working from a lever in the main post, driven by a cam or spiked wheel at the top of the post, the main-spring being fixed to an opposite post, and extending so as to rest upon the end of the lever hammer, with screws to regulate the force of the blow.

The hammer can be driven by hand at a speed of from one to one thousand strokes a minute, and by a most simple contrivance, namely, the regulating spring attached to the main-post under the hammer, with a force varying from a touch to one of immense weight.

CLASS I., *Sub-Class B.*—Messrs. PURCHAS and NINNIS, of Onehunga, Auckland.—(Dated 26th March, 1861.)

THIS invention consists of a method of clearing and separating the fibres of the *Phormium tenax* or New Zealand plants by mechanical means, aided by the action of water.

The principle adopted is that of percussing; the means used are beaters, hammers, beetles, or stampers, with or without springs, constructed either wholly of wood, or partly of wood and partly of iron, or other suitable materials, with plain or wrought surfaces, acting upon beds of wood or iron, or other suitable material, either plain or wrought, fixed or moveable, with or without springs, and the whole machinery worked by any kind of power. The raw material is put in, either fresh or after having been some days in water, and is worked either with or without water. When thoroughly cleaned, the prepared material is dried in any convenient manner, and is then ready for use. If wanted of still finer texture, it is subjected to further percussion in the dry state.

CLASS I., Sub-Class C.—JOHN COX, of Auckland.—(Dated 22nd February, 1867.)

A Machine embracing certain improvements for Hackling and Preparing Flax and other Fibrous Substances.

THE said machine consists of a novel mode of hackling or combing flax, or other fibrous substances, in such a manner as to free the fibre more or less from all vegetable substance, impurities, noxious and other matters pertaining thereto.

The hackles or combs are to be made of steel or other suitable material, sharpened at the point and rounded at the edge, and be of sufficient width to allow of a hole being punched or drilled for an iron to pass through for the purpose of keeping them in exact position.

CLASS I., Sub-Class C.—E. W. TRENT, of Christchurch.—(Dated 17th June, 1869.)

Principle of the Machine.

THIS machine is constructed on the principle of a rotary comb or card; the teeth are made of steel or tempered iron, about one-eighth of an inch in thickness, projecting from the wood, lagging any distance that may be thought desirable; the points are short and sharp. The points enter the leaves and divide the fibres; after which the rapid succession of the bodies of the teeth passing through the flax leaves, impart a continual chafing or rubbing of the fibres, which thoroughly separates the vegetable gum from them. The efficiency of the machine depends upon the high rate of speed at which the drum is run, and the proper speeding of the feed rollers. The principle may be said to consist of combing combined with friction.

In the construction of this machine there is no necessity for any of the working parts to be confined to any particular dimensions.

Description of the Feeding Table.

The feeding table consists of two sides of timber, in which revolve two small wooden rollers; round these rollers is stretched an endless band of cloth which is kept constantly travelling towards the feed-roller, being driven by a pulley which is driven by a belt and pulley from the drum spindle, the flax leaves are fitted in the holder and screwed up tight. They are then laid on the endless band of cloth, which draws the points of the leaves towards the feed-rollers, the holders sliding over the cloth in a groove on each side the feed-table.

Observations.

The flax may be prepared by this machine either from the green leaf, or after having been submitted to the action of steam or water. The teeth may be made either round, square, triangular, octagonal, or in any other form rod steel is manufactured.

The machine is capable of being used either with or without the feeding table.

CLASS II., Sub-Class A.—JOHN JOURNEAUX, of Melbourne, Victoria, now of Wellington, New Zealand.—(Dated 23rd February, 1870.)

1. STEAM pipes are connected to a steam boiler; these pipes are connected to branch pipes, which are introduced into a series of double-bottomed vats. The object of the double bottom is that the steam may be introduced by this means and the mass heated as required without the steam coming in direct contact with the fibre.

That part of the branch pipes which is within the double bottom of each of the vats is perforated with small holes. The steam from the boiler is by this means ejected from the pipes into the space between the double bottom, so as to cause the water in the vats to become heated to a certain degree hereinafter described. The branch pipes are also provided with brass cocks, so as to regulate the amount of steam. The raw leaves of the *Phormium tenax* are first passed through a pair of ordinary grooved rollers. The leaves having been thus bruised are placed longitudinally in one or more of the vats referred to. The vat being half-filled with these bruised leaves, water is admitted in sufficient quantity to cover them.

One of the cocks is then opened and steam admitted by means of the branch pipes until the heat of the mass has risen to 190° Fahrenheit. The whole is allowed to remain in that degree of heat for three hours. The liquor is then drained off into a cistern. Fresh water is then admitted into the vat, and heated by the same agency to 90° Fahrenheit. A leaven composed of materials hereinafter described is then mixed with the contents of the vat, and vinous fermentation is allowed to take place. A uniform degree of heat is kept up during 60 or 70 hours. When the fermentation has attained a slight degree of acid, the whole bulk of the fibre is removed and pressed out. It is then placed in an adjoining vat containing water already heated to boiling point which carries away all vegetable matter still adhering to the fibre. It is then taken out and passed through the squeezers which partly dry it. The fibre of the *Phormium tenax* is then by the above process of fermentation found to be entirely deprived of that gum which it naturally produced, and which has become neutralized. It is finally submitted to a drying process and is prepared for the market. The leaven before mentioned consists of—

30 lbs. potatoes,	} to three hundredweight of flax.
2 lbs. sugar, and	
$\frac{1}{2}$ gallon of yeast	

2. The extraneous matter beaten from the leaf as it passes through the rollers contains a large quantity of gum, and is allowed to fall into a bin placed under said rollers, and conveyed through a shoot into the cistern, which contains the liquor drawn from every first soaking of the fibre. These contents are boiled in the said cistern by means of steam injected within the double bottom for two hours. The gum then separates from the vegetable matter and settles to the bottom, and all foreign matter floats on the top and is skimmed off. The gummy substance is then allowed to cool, and proof alcohol is applied in the proportion of one to thirty gallons. The whole is then well stirred and allowed to settle.

After an hour the gum has settled to the bottom sufficiently to allow the liquid part to be drawn off. The gummy produce is then placed in brass or copper pans well tinned, and so fixed that steam made to ply underneath will gradually cause evaporation and leave the gum in a sufficiently solid state to handle. When a sufficient quantity has been obtained, and it is desirable to bring it to a perfect degree of purity, the mass so obtained may be made to undergo the same process by reboiling, as before described, with pure water. Solid blocks of gum, nearly transparent, and of great commercial value, are thus produced and for this purpose and result.

CLASS II., *Sub-Class B.*—CHARLES JAMES POWNALL, of Auckland. (Dated 7th November, 1866.) This invention consists in preparing and cleansing vegetable fibres by first submitting them to the action of dry superheated or wet steam for the purpose of softening the gummy, resinous and other matters contained therein, and then passing them through grooved rollers cut in manner herewith specified.

To effect this object the *Phormium tenax* is placed in a suitable vessel of wood, iron, or other material made steam tight and connected by pipes with a boiler or other steam generator, and in this it is allowed to remain for about four hours subject to a moderate pressure of steam sufficient to percolate thoroughly all through and into the flax, and it is then passed through rollers.

The novelty and peculiarity of these rollers consist in their grooved surfaces and their adaptation for this purpose. Each roller may be about three feet long by one foot diameter and the top roller is cast in solid metal with the addition of weights, levers, or springs attached to it to be used when required. They may be driven by hand, horse, water, or steam power, with any of the well-known mechanical arrangements for that purpose. The grooves upon each roller correspond to each other, and the distance best adapted for the purpose is 1-32 inch apart, and 1-16 inch deep, but may be varied to suit the coarser or finer qualities of fibre. Over the top roller flows a continuous stream of fresh water for the purpose of washing away these gummy and resinous matters as by the pressure they are discharged from the flax.

The flax or other fibre being now thoroughly softened by the action of the stream is passed four times through one pair of these rollers or once through four pair connected together, and undergoes in this operation two distinct processes. 1st, The removal by pressure and a stream of water of the gummy resinous and other matters softened and set free by the action of the steam as hereinbefore described; and 2ndly, an opening or hackling process by passing the flax longitudinally through the grooved surfaces cut into and upon the rollers as before described.

It will now be found, when dried, to have lost about 75 per cent. of its weight in the removal of these resinous gummy and other matters; and the flax or other fibres being well separated into threads by the hackling process before described, is fit for manufacturing into any coarse purposes, such as rope-making, wool lashing, &c., &c.

If the flax or other fibres are required for finer purposes, this operation may be repeated or it may be submitted to the action of cold or warm fermentation or any chemical agents having an affinity for resinous and colouring matters, such as alkalies, caustic soda, chloride of lime, &c., by which means any of the said foreign matters still remaining may be removed.

The combined action of submitting the *Phormium tenax* or other vegetable fibres to the action of steam in a close chamber for the purpose of solving their gummy, resinous, and other matters, and then passing them through rollers as herein described, or other mechanical pressure, with a stream of running water for the purpose of pressing out, opening, or hackling and washing away these gummy, resinous and other matters, contained therein.

CLASS II., *Sub-Class C.*—MICHAEL MURRAY, of Papakura Bridge, near Auckland.—(Dated 29th April, 1867.)

THE green flax first goes through a boiling process; it is then placed in a shoot, and from thence in single leaves (four single leaves at a time) is put between the feeding rollers, and whilst passing through these rollers the hackles of the drum, together with the brush or brushes, clears the glutinous or gummy substance from the plant.

CLASS II., *Sub-Class D.*—LUKE NATTRASS, of Nelson.—(Dated 18th February, 1870.)

THE mode of operation consists of the chemical preparation of the plant (*Phormium tenax*, &c.), afterwards passed through a machine invented for the purpose. By boiling the plant for a sufficient time in a solution of ferro-cyanate of potassa, prussiate of potash, or by subjecting it to steam generated from the same, the plant becomes softened and the non-fibrous portions disposed to separate from the fibrous portions when subjected to friction under water.

The machine consists in principle of a horizontal wood roller, furnished with metal teeth placed lengthwise, to be furnished with a handle for manual use, if necessary, with or without a fly-wheel. Under the said roller are fixed in a frame a sufficient number of teeth from end to end of the said roller, but placed obliquely at a proper angle with the teeth of the said roller.

The fixed teeth under the roller being nearly semicircular and placed obliquely, as before stated, the friction on the plant between them will be perfect. The softened plant, therefore, being dropped *breadthwise*, will be carried downwards by the teeth of the roller, and subjected to pressure and friction in water above, but close to the oblique teeth, and the fibrous parts only forced out *breadthwise*, and fall over into another trough of water. The teeth of the roller are not allowed to touch the oblique teeth, but their closeness to each is regulated by weighted levers resting on metallic bushes placed on each end of the spindle of the toothed roller. The fibre, after being taken out and pressed, is laid out to dry (or bleached if required), passed once through the hackles, when it is ready for pressing into bales.

NOTE.—It is not clear what the Inventor means by steam generated from a solution of prussiate of potash, as it is improbable that the small quantity of salt carried over by the evaporation would have any peculiar effect on the flax, as compared with its being boiled in a solution of that salt. One striking feature of the process is the feeding the leaf into the machine sideways.

CLASS II., *Sub-Class D.*—CORNELIUS THORNE, of London.—(Dated 9th November, 1867.)—Assignee of Letters Patent granted to JAMES STEART.

THIS invention has for its objects to extract, clean and prepare the fibre of China grass, rhea, or Siam grass, flax, and other similar terrestrial fibrous plants or productions, and also of silk in the cocoon, wool, goats, camel, or other hair, and other animal or filamental products; and this object is effected by causing the decomposition or removal of the saccharine or gelatinous or fleshy portion of the plant or weed, and of the oily, gummy, or other coating or covering of silk, wool, hair, and other animal and filamental product through the action of a "pure" bath as hereinafter described, in which the plants or products aforesaid are placed for a suitable length of time, and then subject to pressure or friction by motion created by suitable apparatus, so as to detach any foreign or extraneous matter from the fibre. After having been subjected to this process the fibre is dried, and is then fit for manufacturing purposes.

The plants or products aforesaid are submitted to various degrees of pressure by means of rollers or beaters, for the purposes of bruising or loosening the outer sheath or skin, and the saccharine matter of terrestrial fibrous plants, and of loosening the gummy, oily, or other coating or covering of the animal products aforesaid; but this part of the process, though useful where the coating or covering of the plant or other product as aforesaid is unusually tough or dirty, is not indispensable and need not necessarily be adopted in the case of other descriptions of fibrous plants or other products as aforesaid, as it increases the labour required, and the plant or other product as aforesaid may at once be placed in a wash bath of cold water to be cleansed from external impurities. It is then removed and placed in a bath known in tanning as the "pure," with or without water. The pure bath is that obtained by digesting fish in a vessel through the action of heat and a small proportion of water, or steam alone. This pure bath may also be made from various animal substances or chemicals, as is well understood by persons conversant with the tanning of leather. When the plant, or weed, or other product as aforesaid has been exposed to the action of this bath for a sufficient time, the fibre will be freed, and it may then be removed from the bath, and the fibre detached by motion, washing, or friction, by means of suitable apparatus. By this process the saccharine or gelatinous or fleshy part of the plant, and the oily, gummy, or other coating or covering of the animal product as aforesaid, is decomposed and removed, leaving the fibre in an uninjured state, and experience teaches that 200 or 212 degrees of Fahrenheit is the most suitable and effective temperature of all the operations in the bath, and the length of time required for such operation varies from half an hour to three hours, according to the strength of the bath, the heat at which it is applied, and the nature and tenaciousness of the coating or covering of the fibre, and must be left to the judgment and experience of the operator. The fibre is then washed or cleansed in any manner most convenient, and is then finally dried and fit for manufacturing purposes.

CLASS II., *Sub-Class E.*—JOHN BOOTH, of Dunedin.—(Dated 19th August, 1869.)

THE principle or mode of operation by which the fibre is prepared, namely:—The leaves of the flax plant having been first split into two blades and boiled are laid upon the receiving table with the bottom or butt ends towards the india-rubber receiving rollers, and the gum or hard side uppermost. The machine is then set in motion, and the blades pass between the receiving rollers, and thence between the top knife-roller and the bottom spring-roller, which can be brought as near to the top knife-roller as desired by means of screw-bolts in a block; the top knife-roller scrapes all the gum from the uppermost side of the blades, which then pass between another pair of india-rubber rollers. thence the blades pass between the bottom knife-roller and top spring-roller, which can likewise be brought as near to the bottom knife-roller as desired by means of the screw-bolts in the block; the bottom knife-roller scrapes all the green vegetable matter from the outside of the blades, which then pass out of the machine over the delivery slope or table; the fibre thus delivered by the machine only requires to be rinsed in water, and dried, to render it available for manufacturing purposes, and, from the mode in which it has thus been prepared, can be used not merely for rope but for linen fabrics. The machine can be made of any reasonable width, and the fineness or coarseness of the fibre will be in proportion to the gauge of the spring india-rubber rollers to the knife-rollers, which is one of the material elements of the invention.

1. The scraping process on a spring surface, produced by the united action of the india-rubber spring-rollers and the knife-rollers, and which process is so complete that it dispenses with the necessity of "stampers," "beaters," or "compression rollers," by which all other machines used for the preparation of the flax fibre are distinguished.

2. The width of the machine, which can be increased or decreased without interfering with the design, and will allow of any number of blades being laid side by side, in which respect it not only greatly economizes labour, but also essentially differs from all other flax machines now in use.

3. The motive-power of the machine, which is considerably less than the motive-power of any flax machine now in use, inasmuch as this machine can be driven by about half-horse power, with ten blades of fibre passing through at a time, and the manual labour required in connection with the working thereof being only one man and one boy,—the former to feed the machine, and the latter to clear away the fibre as delivered.

NOTE.—This machine appears to be modified by the inventor: the scraping or percussion on elastic rollers is superseded by the substitution of small steel bars on elastic cushions; the process of boiling the leaf seems also to be abandoned.

CLASS III., *Sub-Class A.*—GUSTAV ALBRECHT CARL BREMME, of Liverpool, England.—(Dated 27th January, 1870.)

THIS invention relates to new and improved apparatus for causing the continuous rotary movement for breaking and softening flax in one direction of a shaft or prime mover to communicate to other parts of the mechanism a reciprocating rotary movement greater in the one direction than in the other, and such improved apparatus is especially applicable.

A toothed wheel is fixed on the reciprocating shaft of the roller, and a pinion is held in gear with this wheel by means of radii or arms connecting the axis of the wheel with the axis of the pinion, allowing both to rotate freely, but keeping their axis always at the proper distance for gearing. The axis of the pinion or any point of arms is connected by a connecting-rod to a crank or eccentric fixed on a continuously rotating shaft or prime mover, so that as this prime mover rotates the pinion is caused to vibrate in an arc described from the centre of the reciprocating shaft. On the reciprocating shaft is mounted loosely a pulley or wheel, which is driven with continuous rotary motion by a band, strap, or by suitable gearing from any convenient prime mover. This pulley or wheel has affixed to it a toothed-wheel or pinion which gears into the vibrating pinion or into a wheel affixed to it; thus, while the pinion is caused to vibrate in an arc to and fro, it is also caused to rotate on its axis in one direction, and it imparts to the reciprocating shaft the reciprocating rotary movement required, namely, a movement alternately in the one direction and in the other, but greater in the one direction than in the other.

Instead of using a vibrating pinion gearing into a toothed-wheel on the reciprocating shaft, a worm may be employed, and a worm-wheel is in that case fixed on the reciprocating shaft; also, the worm itself or the pinion may be driven by worm-gearing or bevil-gearing, as may be readily understood. In cases where it is desired to have a small difference between the opposite movements of the reciprocating shaft, such worm-gearing is to be preferred.

Instead of driving the vibrating pinion from a wheel or pulley mounted on the reciprocating shaft, it is sometimes driven from the shaft or prime mover of the crank or eccentric by means of a crank-motion, in the following manner:—The pinion, which is held in gear with the reciprocating wheel by means of radii or arms as already described, has affixed to it a crank-arm of equal length with that of the crank which gives the vibrating movement to the pinion, or when an eccentric is used for this purpose the radius of the crank fixed on the pinion is equal to the radius or eccentricity of the eccentric; thus there are two equal cranks, one on the pinion and one on the prime mover, the latter of which may be an eccentric of equal radius. The crank-pin of the prime mover crank or the strap of its eccentric is connected by a rod, as already described, with the axis of the prime mover, so as to be always held at a definite distance from it; thus, when the prime mover rotates, it not only gives a vibrating movement to the pinion, but also causes it to turn on its axis in one direction. As in the action of this apparatus there are two dead points, two pairs of shear links are applied to the two connecting-rods for the purpose of bringing the pinion over those dead points. Each pair of these shear links consists of two rods, by preference of equal length, jointed together at one end, and jointed at their other ends to the two connecting-rods respectively; they are so placed that when the cranks are on one of the dead points the links of the one pair are folded up so as to stand perpendicularly to the connecting-rods, while those of the other pair are extended so as to form an angle with one another, and *vice versa*: the rotation of the prime mover crank with its rod past its dead points thus communicates, through the perpendicular links, a motion to the other rod, which carries the pinion past its dead points, the other or unfolded links allowing freedom for the movement. To prevent the links from turning past the position at which they are perpendicular to the rods, projections are formed on one side of each of them, and these projections bearing one against each of the rods on opposite sides act as stops to prevent either of the links from turning in the one direction from the perpendicular, while they leave them free to turn in the other direction, in obedience to the unfolding movement imparted to them by the cranks and rods.

Sometimes, instead of driving the reciprocating shaft of the roller, it is preferable to drive the periphery of the roller directly from the vibrating pinion. For this purpose the end of the roller may be geared either inwards or outwards, as may be found most convenient, with the pinion, the roller or its periphery being mounted loosely on its shaft. By this arrangement the pinion has only to overcome the inertia or momentum of the outer moving part of the roller.

After the fibre has been produced by the ordinary machines at present in use, this machine appears to be calculated to effect a considerable improvement by softening the fibre.

CLASS III., *Sub-Class A.*—JOHN ELIOT HODGKIN, of Liverpool, England.—(Dated 21st January, 1870.)

THIS invention relates, first, to improvements in machinery for breaking, scutching, softening, washing, discharging, and separating the fibres of fibrous materials, (such as flax, hemp, China grass, or other fibrous materials), from the boon, flesh, or woody matter, adhering thereto, in order to prepare the same ready for the subsequent processes of bleaching, carding, combing, and spinning.

A series of three or more rollers are arranged around the circumference of a drum or cylinder of larger diameter; no particular number of such rollers is named. The rollers, and the drum or cylinder, thus arranged to work together, may be either plain, serrated, or have corrugated teeth formed thereon as may be found most suitable for the treatment of different kinds of fibrous materials; rotary motion is communicated to the drum or cylinder by suitable gearing, alternately in opposite directions, the movement in one direction or forwards being greater than the backward movement.

The mechanism for imparting alternate rotary motion to the drum or cylinder consists of toothed sectors acting upon toothed wheels, fixed on each end of the drum or cylinder, the toothed sector for imparting the forward movement being a larger number of teeth than the toothed sector which causes the drum to rotate in the opposite direction. The drum or cylinder communicates motion to the roller or rollers arranged around its circumference, either by surface contact or by suitable gearing. The

fibrous material to be operated upon is fed into the machine between the drum and the roller or rollers upon its circumference; and after moving a certain distance forward, the movement of the drum or cylinder is reversed by the action of the driving gear, so as to cause the fibrous materials to travel backwards part of the distance it had previously been fed forward. The drum or cylinder is then again caused to move the fibrous material forwards the same distance as before, by which a portion of the fibrous material after being operated upon by the rollers in opposite directions, is fed forward a given distance; and it is thus delivered from between the drum and rollers on to a frame of bars, or a perforated surface, where it is subjected to the action of a revolving brush or beaters, in order to brush or beat out the refuse or woody particles separated from the fibres during their passage between the drum and rollers. The fibrous materials may, if desired, be passed first through a machine of this character, in which the surfaces of the drum and rollers are serrated, fluted, or corrugated, and afterwards through a similar machine having a drum and rollers with plain or smooth surfaces. The revolving beaters may be made of vulcanized india-rubber, or other elastic surfaces, or they may be composed partly of beaters, and partly of brush surfaces. Suitable feed-rollers or apparatus may be arranged to work in combination with the machinery previously described. The movement forward of the fibrous materials may, if desired, be arrested for a time whilst the brush or beaters are allowed to act for a time upon the stationary fibrous material previously fed forward to be so acted upon.

When operating upon fleshy fibres, such as the aloe or fibres combined with a considerable quantity of refuse matters, streams or jets of water may be discharged upon the same as it passes over the surface of the drum or cylinder, or the rollers may be arranged to work on the under side of the drum or cylinder in a vessel containing water, an endless band being arranged upon the rollers to conduct the fibrous material below the surface of the water, whilst under operation, in its passage to and fro between the drum and rollers. The fibrous material may thus be subjected to a washing and discharging process if desired.

The second part of the invention consists in arranging machinery similar to that previously described, the drum and rollers in this arrangement having plain polished surfaces suitable for glazing or calendering the woven fabrics passed between them. The drum and rollers are caused to rotate alternately in opposite directions as previously, the forward movement being in excess of the backward movement thereof. The woven fabrics to be glazed or calendered are fed into the machine and operated upon alternately in opposite directions between the polished surfaces of the drum and rollers so as to glaze or calender the same, and the drum and rollers may be heated by steam or otherwise in order to dry the fabrics as they pass between them, the position of the rollers being capable of adjustment in relation to the surface of the drum or cylinder, by which arrangement the fabrics may be caused to travel over a larger or smaller surface of the heated drum or cylinder as may be found necessary for drying the same. The brush and beaters in this arrangement of machinery are dispensed with.

After the fibre has been produced by the ordinary machines at present in use, this machine appears to be calculated to effect a considerable improvement in softening the fibre.

IMPROVED RETTING PROCESS.

BURTON AND PYE'S Modification of Hot Water Steep for Cleaning Flax, near Belfast.

THE flax-straw is first passed through a machine composed of plain and crimped rollers. The fibre is then placed in a vat (of brick, stone, or wood), holding about a ton, which is subsequently filled with cold water. This vat has a perforated false bottom, under which steam, with a pressure of 50 lbs. to an inch, is introduced and disseminated by perforated tubes. Another tube conveys into the vat a cold mixture of Fuller's earth in water. The introduction of the mixture and the steam is continued until the liquid in the vat reaches 80°. The flax remains in it at this temperature for thirty hours, when the surface of the liquid is covered with a saponaceous froth; then an apparatus of cross-bars of wood, closely fitting into the interior of the vat, and pressed by two powerful screws, expresses the impurities from the fibre. The supply of the Fuller's earth is now stopped, and cold water is alone supplied with the steam, so regulated that the temperature is raised by degrees to 150°, the pressure being continued till the water appears free from impurities; the water is then withdrawn from the vat through a valve in the bottom, and a pressure equal to 200 tons is applied to the flax: it remains under this pressure four hours, when it is half dry.

After drying it is easily scutched, and is of a fine and soft appearance, and free from stain.

Mons. Termangae (near Lisle, France,) employs a similar process, but with hot water at 60°, and employs chalk and charcoal placed in the cold water supply instead of Fuller's earth.

M. SCRIVE'S Modification of Warm Water Process of Retting Flax, near Lisle, in France.

IN tanks of wood or stone, each made to contain two and a half tons of flax-straw, placed vertically on a perforated false bottom, slightly pressed together, but allowing free circulation of water and free exit for gases germinated by fermentation. The tank being filled with water, the whole is secured at the tops of the sheaves by narrow strips of wood 4 inches thick catching the tips or the whole length of each row of bundles; these strips of wood are kept firm by cross iron holders, secured by iron bars fastened to pieces of wood worked into the sides of the walls of the tank, leaving a surface of 4 inches deep of water over the top of the flax.

When the tank has been filled with cold water through the wooden shoot, the whole is rapidly heated to 78° Fahr. by means of steam pipes coiled under the false bottom. A second open shoot carries heated water at 90° Fahr. to discharge on the surface, besides two closed pipes, one of which brings hot water of same temperature and the other cold water. When fermentation sets in, which is ordinarily in eight hours, the pipe, as well as the shoot of water at 90°, is set at play: the first, to create a continual current of fresh water through the mass of flax, clearing off the products of decomposition and bringing them to the surface; the second, to drive this foul water to the

openings, where it is discharged by the overflow. The two pipes, with heated and cold water going to the bottom of the tank, as well as the two shoots containing heated and cold water to go to the surface, are also made use of to equalize the temperature during the whole operation, which is ascertained by thermometer in the square wooden box.

The steeping of coarse flax-straw is	...	...	...	36 to 48 hours.
The steeping of medium ditto	...	...	...	50 to 60 hours.
The steeping of fine ditto	...	...	...	60 to 70 hours.

The wet-rolling between cylinders after the steep is accompanied by a shower of water at 78°, not on the flax but on the top of the cylinders; this removes all the impurities, and prepares the flax for being easily dried and scutched.

No. XIX.

REPORT BY DR. HECTOR ON THE SAMPLES OF PREPARED FIBRE SUBMITTED TO HIM FOR EXAMINATION.

THE results obtained from the examination of the fibres submitted to me by the Commissioners are not to be considered as sufficiently reliable to warrant any final deductions as to the comparative value of the samples.

The small size of the parcels, which seldom exceeded a few ounces in weight, and the late period at which the majority of them were received, rendered it impossible to apply a sufficient number and variety of tests.

I have consented to the publication of these imperfect results only in the hope that the attention of millowners may be directed to the practical importance of such experimental and comparative investigations, as being the only method of discovering the various qualities of the fibre under different influences of soil, climate, season, and processes employed.

The results have, therefore, been given without either the names of the senders or the particular localities, but in order that deductions of a general character may be made, they have been grouped as follows:—

1. Foreign fibres for comparison.
2. New Zealand flax dressed by the method of the Natives.
3. New Zealand flax dressed by processes in which chemicals or steeping is employed.
4. New Zealand flax dressed by stripping machine.

The latter class is sufficiently extensive to admit of being sub-divided according to the district where the flax grows, which gives a slight indication of the influence of the climate; but with the small number of the experiments, and the irregular manner in which the samples have been collected, it is questionable how far these indications can be depended on. The examination comprised—

(1.) The observation of the general physical characters, such as length, colour, softness, flexibility, freedom from adherent cellular tissue.

(2.) Microscopic character of the fibre. To effect this a single fibre was soaked and broken by a gentle strain under water and transferred at once to a glass slide and examined. In some cases the same specimen was afterwards carefully mounted for future reference.

(3.) The strength of the fibre was tested. To do this effectually the breaking strain of the straight fibre, the fibre when wound, spun and laid under tension for different periods, when exposed to torsion, and all the above while wet as well as dry, together with many other tests that readily suggest themselves—should have been ascertained; but as already explained, the small size of most of the samples, the absence of reliable data concerning their history, and the haste with which the experiments had to be performed amidst many other distracting employments, limited me to the determination of the single test of their comparative strength when twisted into a cord. After several trials a machine was contrived by which a gradually increasing strain is applied to the cord that is being tested; one end being attached to a spring balance and the other to a frame that is carried steadily down by a screw. The indication of the balance shows the strain on the fibre at the breaking point, while the extension of the cord can also be observed.

The ends of the cord are carried over a smooth metal bar and attached to an iron peg in the same manner as the strings of a violin. The rapidity and certainty with which this test can be applied would render it possible to operate on a very large series of cords of each sample, and so enable a fair average to be obtained.

The quantity of each sample to be tested was carefully obtained by the weight of well-cleaned fibres cut to a constant length. These weighed quantities were then carefully twisted into a double strand twine like the commonly used cracker of a whip. To insure an even twist the whole of the samples were laid by one person, which very laborious operation was undertaken by Mr. Seymour, whose material assistance in performing these experiments enabled me to accomplish them in time for this report.

The test as applied indicates fairly the breaking strain of the specimens operated on; but as only from two to five trials were made of each different kind, the average stated is frequently that of a few discordant results. A glance at the appended table will show that the discordance was greatest in the Manilla and Russian hemp; but that with few exceptions the characteristic breaking strain of the different samples of New Zealand flax, was closely approximated to in all the specimens. All unfair breaks were thrown out, and in nearly every accepted result the break took place between the points of contact at either end.

As might be expected, the scutched flax as a rule gives higher results than the unscutched, as no hand-cleaning can equal that by machinery.

The microscopic examinations disclosed two very characteristic forms of break of the fibre which are evidently caused by the amount of lateral adhesion which the minute fibres possess in proportion to their longitudinal strength.

In most of the samples of machine-dressed flax; the fibre, even though very strong, breaks short across without breaking up into smaller-sized fibres.

The appearance under the microscope in such cases is like the broken end of a straw, and indicates that cellular matter and the dried juices of the plant are still present binding the fibres together, and that, by their liability to chemical and hygroscopic change, they will tend to injure the fibre.

In the case of samples of fibre that have been prepared by a chemical re-agent, steeping, steaming, or fermentation process, the broken end presents a brush-like appearance, showing that the lateral adhesion has given way before the minute fibres themselves broke. This appearance differs in various samples, and varies also according to the velocity with which the break is effected.

Fibres which have this character are not necessarily weaker on the straight strain than the others, while their superior softness and flexibility greatly increase their strength when spun or twisted.

So far as the experiments already made afford an indication, it appears that the object which should be aimed at by the manufacturer is to reduce the fibres and render them independent, so far as they are bound together by cellular matter or the dried juices of the plant, but to avoid if possible separating or fraying out the more minute and shorter fibres which appear to be bound together to form the long close fibres only by atmospheric pressure.

Notes on the Samples Examined.

No. 1. Russia hemp, clean and long.

No. 2. Manilla, very fine sample.

No. 3. Maori-dressed; half a hank; length 4 feet; uniformly white, with silky lustre; fibres downy.

Microscopic—Fibres free, rough in outline, form adherent, cellular tissues; fasciculus broken up.

Nos. 4 to 11. Samples of Maori-dressed flax, not examined.

No. 12. Prepared by a steaming process; small hank; length 6 feet; colour red at base, yellowish white at tips; soft and flexible, but the sample appears to have been rubbed; fibres moderately downy; very free from boon; lustre deficient.

Microscopic—Fibres free and hair-like; fasciculus broken up; no adherent tissue.

No. 13. Prepared by modified retting process; small hank, length 4 feet; greenish; flexible but harsh, and with little lustre; fibres downy; no boon.

Microscopic—Fibres straight and adherent, rough by the attachment of dark bands of connective tissue.

No. 14. Scraped by machinery and soaked; very small sample; length 3 feet; tips and butts cut off; soft, flexible, and downy, but deficient in lustre.

Microscopic—Fibres broken into short lengths; not free; rough from adherent tissue.

No. 15. Machine-dressed, and then treated with chemical re-agents; very small samples; soft but dull, like cotton waste.

Microscopic—Fibres divided freely; very flexible, but breaks short, with ragged ends.

No. 16. Passed through the stripping machine, steeped, sweated, and scutched; one hank; length 7 feet; very bright and soft; white, with a gray tint; glossy; fibres downy.

No. 17. Chemically prepared; small sample cut to a short length; soft, dull, even in quality; dark-green, gray.

Microscopic—Fibres free, but arranged in non-adherent bundles; tabular structure of the minute fibres preserved; no connective tissue.

Machine-dressed.

No. 21. One hank; length 5 feet; colour reddish yellow; bright but harsh; young flax.

Microscopic—Fibres adherent, drawing out slightly, but at last breaking short; band of connective tissue adherent.

No. 22. One hank; length 9 feet; colour reddish; bright but harsh; breaks short.

No. 23. One hank; length 4 feet; colour yellowish white; bright and soft, but great difference in the fibre from the butt and that from the tip, which is like tow; breaks short.

Microscopic—Fibres adherent; breaking short in bundles of five or six fine fibres; cross-barred by tissue.

No. 24. One small hank, unscutched; length 9 feet; colour reddish yellow; fibres unequal in size, bright but harsh; breaks short without down.

Microscopic—Fibres adherent; snaps in bundles, with cross bands of connective tissue.

No. 25. Half-hank; length 6 feet; colour reddish; soft and bright but unequal; breaks short without down.

No. 26. Small hank; length 4 feet; colour red; harsh and unequal; not well scutched; larger fibres divide freely.

Microscopic—Fibres adherent; breaking short in large bundles.

No. 27. Half-hank; length 6 feet; colour yellowish white; bright but slightly harsh; breaks short.

No. 28. Half-hank; length 5 feet; colour pale reddish yellow; fibres coarse, downy, but do not divide freely.

Microscopic—Fibres adherent and break short in bundles, but they fray out along the sides; much connective tissue.

No. 29. One hank; length 6 feet; colour reddish yellow; harsh, unscutched, breaks short.

Microscopic—Adherent in granular bundles, which break short in unequal lengths.

No. 31. Fourteen hanks; length 6 feet; colour reddish yellow; bright but stiff; quality unequal in the length; breaks short.

Microscopic—

No. 32. Small sample in short length; white, transparent and flexible, in hair-like fibres, which fluff in breaking.

No. 33. Small sample; length 6 feet; colour reddish white; bright and soft tips; breaks short, but splits.

No. 34. Small hank ; length 6 feet ; colour white, with red stains ; bright but harsh and stiff ; breaks short.

No. 35. Half-hank ; unscutched ; length 5 feet ; colour reddish ; harsh, breaks short.

Microscopic—Fibres adherent in granular bundles, which break short across.

No. 36. Half-hank ; length 6 feet ; colour reddish yellow ; bright but harsh ; breaks short.

Microscopic—Fibres adherent in bundles, which snap across ; much adherent tissue.

No. 37. Small sample ; short lengths ; colour greenish yellow ; soft but coarse, and unequal in the length.

No. 38. Fifty pounds weight ; length 5 feet ; colour reddish yellow ; bright and equal, but great difference between the fibre of tips and butts ; breaks short in slender fibres, but no down.

Microscopic—Fibres adherent in small granular bundles, but snap across.

No. 39. Small hank ; length 6 feet ; colour reddish yellow ; bright, harsh, breaks short without down.

Microscopic—Fibres adherent in small bundles, which are coated with granular tissue.

No. 40. One hank ; length 6 feet ; colour reddish yellow at butt ; greenish yellow at tips ; very bright and soft ; breaks short.

Microscopic—Fibres adherent ; breaks into short lengths, with bands of connective tissue.

No. 41. Unscutched—One hank ; length 6 feet ; colour red ; very harsh, brittle, but strong on a straight pull.

No. 42. One hank ; length 4 feet ; colour pale yellow ; bright and soft ; divides freely in breaking.

Microscopic—Fibres free, but breaks into short lengths. (Young flax steeped?)

No. 43. Small sample.—Unscutched ; length 5 feet ; colour reddish ; moderately harsh, but has been rubbed ; divides freely but breaks short.

18th July, 1870.

JAMES HECTOR.

TABULAR STATEMENT of the Results of Experiments to determine the relative Strength—Quantity operated on being 40 grains of each fibre, in 2-foot lengths.

I.						Max.	Min.	Average.
No.	Samples.							
1.	Russian hemp	...	...	...	...	254	160	207
2.	Manilla	...	...	...	...	265	144	215
II.								
3.	Maori-dressed	...	...	...	...	235	200	217
4	Ditto, not tested.							
to								
11.								
III.—Chemical.								
12.	Steaming	...	...	...	...	140	134	137
13.	Steaming and fermenting	...	...	...	...	120	106	111
14.	Soft scraping and washing	...	...	...	...	160	152	156
15.	Machine-dressed and chemical	...	...	...	...	...	...	102
16.	Machine and steeping	...	...	...	...	221	162	191
17.	Chemical	...	...	...	...	...	...	171
IV.—Machine-dressed.								
21.	Scutched (Northern District)	...	...	...	...	160	150	155
22.	Ditto ditto	...	...	...	...	160	141	151
23.	Ditto ditto	...	...	...	...	187	118	148
24.	Unscutched ditto	...	...	...	...	164	125	145
25.	Scutched ditto	...	...	...	...	140	133	136
26.	Unscutched ditto	...	...	...	...	139	110	125
27.	Scutched ditto	...	...	...	...	139	104	117
28.	Ditto ditto	...	...	...	...	125	110	117
29.	Unscutched ditto	...	...	...	...	114	105	109
31.	Scutched (Central District)	...	...	...	...	200	174	191
32.	Ditto ditto	...	...	...	...	184	150	167
33.	Ditto ditto	...	...	...	...	181	155	167
34.	Ditto ditto	...	...	...	...	188	148	165
35.	Unscutched ditto	...	...	...	...	172	160	165
36.	Ditto ditto	...	...	...	...	175	155	162
37.	Scutched ditto	...	...	...	...	185	130	157
38.	Ditto ditto	...	...	...	...	176	138	154
39.	Ditto ditto	...	...	...	...	153	123	138
40.	Ditto ditto	...	...	...	...	152	120	136
41.	Unscutched (Southern District)	...	...	...	...	185	172	178
42.	Scutched ditto	...	...	...	...	182	126	154
43.	Ditto ditto	...	...	...	...	174	128	151