ALPHA 127

HARAKEKE FLAX

Judith Jones

the Royal Society of New Zealand

Flax, or harakeke, has played an important part in the lives of New Zealanders, right from supporting the survival of the very first people who came here. It is a familiar sight in our natural, farmed and garden landscape and a long-time part of our cultural heritage.

Today, people are exploring ways to mix and match generations of knowledge about harakeke and its uses with new scientific ideas and innovation to make the most of this renewable resource. This Alpha looks at how people have found many ways to harness the strength and flexibility of this valuable natural resource, and the development of the New Zealand flax fibre industry.

Flax flower. Sue Scheele

A well maintained pa harakeke at UNITEC, Auckland. Sue Scheele

P. tenax. Geoff Walls

P. cookianum (Poor Knights). Peter Heenan

Harakeke – New Zealand flax

There are two species of New Zealand flax: *Phormium tenax* and *Phormium cookianum*. The key difference is the way their seed pods grow.

Phormium tenax

- known as harakeke, swamp flax or common flax
- the most common species
- leaves are stiff, often broad and can grow up to three metres
- flowers are usually red
- seed pods grow upright.

P. tenax pods. Sue Scheele

Phormium cookianum

- known as whaririki or mountain flax
- grows along exposed coastlines and on mountain slopes
- leaves are narrower and shorter, usually grow up then arch downward
- flowers are usually yellow or a lighter green
- seed pods are droopy, twisted and hang down and become thin and papery with age.

P. cookianum pods. Sue Scheele

The harakeke family

A fan is the unit of the harakeke plant. The way it grows led to conventions about how it could be harvested for sustainability.

Traditionally, it was seen that the inner layers of the fan represented a family: the rito, or central shoot, the middle baby leaf, and the leaves on either side of it, awhi rito, the parents. Only the leaves outside of these were harvested by Maori, as cutting the inner leaves weakens the plant and the younger leaves are not as effective for fibre or green-leaf weaving work.

Some experts believe that harakeke grew tough to avoid being eaten up by moa or trampled by their feet. Others think it evolved to handle the harsh conditions it lives in, in swamps, on high slopes and rough coasts.

P. tenax and *P. cookianum* growing together. Peter Heenan

Experimenting for survival – Maori ways of growing, processing and using flax fibre

"On my arrival in the country the Maoris (who knew nothing, or very little, of any other land) would often enquire about the vegetable productions of England; and nothing astonished them more than to be told there was no harakeke growing there. On more than one occasion I have heard the chiefs say, "How is it possible to live there without it?" also: "I would not dwell in such a land as that."

William Colenso (*Reminiscences of the Ancient Maoris, Transaction and Proceedings of the New Zealand Institute 1891).*

Maori women weaving. Alexander Turnbull Library

When the first Polynesian settlers arrived in New Zealand, they found the climate much colder than they were used to. Their tapa cloth garments made from the aute or paper mulberry were not warm enough for the harsher winters, and the aute plants they brought with them didn't grow well.

To survive in their new country, Maori had to explore the possibilities of the natural materials they found, and modify and adapt the skills they had brought.

The long, strap-like leaves of New Zealand flax looked like *Pandanus*, a plant used in Polynesia for making baskets and mats, and Maori quickly learned to use it in the same way. But plaited green leaves are not so suitable for clothing because they are not very flexible, and don't fit comfortably against the body or hold in warmth.

Maori found that by drawing a sharp edge like that of a mussel shell across a harakeke leaf, they could strip loose the inner fibre, which they called muka. This was soaked in water and pounded to make it soft. Muka was strong and flexible and could be used for containers, twisted into square and round lashing and cords and woven into clothing or shaped items such as nets.

Stripping muka from harakeke. Sue Scheele

Weavers learned to choose leaves from a certain plant or area with particular physical properties depending on what they were making. Strength and length of fibre were often important, and some muka would hold a dye made from mud or boiled bark especially well.

Top biomass. L. Layton, AgResearch

Whero Bailey stripping muka from harakeke. Sue Scheele

Cath Brown, Ngai Tahu weaver, making a rourou (a food basket). Sue Scheele

Maori used cord lashing for buildings and waka and to attach stone heads to tools and weapons. They made mats to cover walls and floors, for warmth and decoration, and as sails for boats. They could craft kete, containers with all sorts of uses such as cradling babies and carrying and storing food. They built traps for birds, lines, traps and nets for fishing. Fibre was used for clothing of all sorts, for all occasions, even footwear. And they used it for creating playthings such as kites, poi and the cord for string games.

Art and traditions handed down

For Maori, the art of weaving is a specialised art and a way to pass on cultural values, based on respect for the mauri or life force of the natural world. Harakeke and its uses were so important to all aspects of Maori lifestyle that traditions and rituals of care and protection grew up in each hapu or iwi around the plants, the process, the weaver and the finished work.

They followed certain steps, such as not cutting harakeke at night or in the rain when the leaves would be harder and more difficult to work with. There were customs around which leaves to harvest, to support the strength and sustainability of the plant.

One ritual that has changed in some places over time, is returning all unused cut harakeke to the base of the plant it came from to provide mulch and return nutrients to the earth as it breaks down. However, dead leaf material provides a great shelter for pests that attack the plants and it is considered better by some if the trimmings are composted or buried well away from the bushes.

There were traditions to learn around how the work was to be done which also passed along important customs and ideas. These were rules like not eating while weaving, and the importance of sticking with a particular piece of work until it was finished, so the learner could properly master the skills involved.

Weavers who could make fine objects such as kete whakairo or articles that promoted the status of warriors or chiefs were highly respected. Kete whakairo are the finest class of kete decorated using colour and patterns generally based on natural images such as pataiki, the flounder, and putiputi, flower.

Miranui – the 'big mill'

Miranui, on the main road between Shannon and Tokomaru in the Manawatu, was the largest flax mill ever established in New Zealand. Miranui was run by A. & L. Seifert's Flaxdressing Company and was built in an area of 5,800 acres known as the Makerua Swamp, alongside the Manawatu River. This swamp's huge crop of harakeke was harvested by 19 mills and more than 700 workers at the height of the industry in 1916–17. Michael Joseph Savage, later to become Prime Minister, worked for six months cutting harakeke in the Manawatu around 1908.

From farming to trading – a change in the pattern

New immigrants and visitors to New Zealand were very interested in the possibilities of harakeke and its products. This contributed to the shift Maori began to make away from their traditional lifestyle of subsistence farming and food gathering into a more complex trading market. Their long experience with harakeke and its wide range of uses now had a value over and above their own needs.

They could sell or trade the fibre for others to use in manufacture overseas, but found they could make more by creating harakeke products and selling those themselves. Harakeke was probably the country's first export crop, with Maori selling it hand-dressed and made into ropes as early as 1793.

Between the 1820s and the 1860s there was a lot of trade in hand-made fibre. Most of this went to ropemakers in Australia and Britain, but around 1840 some New Zealand ropemakers began to produce ropes and twines to use locally and to export.

Despite starting to explore the benefits of the new commercial environment, Maori were still very much focused on day-to-day subsistence and survival. They traded to get new metals, fabrics and tools. Maori first used muskets to hunt birds from a distance. However, it was not long before they also began to use them for fighting, which happened for a variety of social, political and cultural reasons. From the 1820s most of the arms used in the inter-tribal wars were funded by exports to Sydney-based agents. The going rate at one stage was one musket for one ton of dressed fibre with more needed for powder and ammunition.

Miranui Mill. Alexander Turnbull Library

Some Maori began to change their life routines and social patterns to meet the increasing demands of the harakeke buyers, for example they moved away from their traditional areas to harvest more harakeke and invested more time and people in processing it.

Moving into machinery

Extracting and processing the fibre by hand was hard work – it took 40 tonnes of raw plant to make one tonne of fibre because by hand the fibre is only extracted from the upper surface of the leaf. So the search was on for a faster way to do it. Another impetus for finding new processing methods was that Maori involvement in producing muka dropped away during the Land Wars of the 1860s, so Pakeha traders had to find alternative processing methods.

Lots of people came up with ideas to develop and improve machinery to process harakeke and patented a range of machines. Most of these crushed the leaves between rollers to separate out the fibres. From around the 1870s there was an increasing number of mills using new machinery and processes. By 1873 there were 300 working mills, usually set up close to a harakeke swamp, and on the banks of a river or stream as the process used lots of water.

The working conditions in the swamp were hard – wet and cold in the winter and hot in the summer. The harakeke blades were cut with a sharp hook, tied up in bundles, then lifted onto whatever form of transport the mill used.

When the leaves arrived at the mills they went through the stripping machine to separate the white fibre out from the green material. A rapidly rotating drum beat and tore the leaves against a hard bar with raised scrapers. This machine made a far-reaching shrieking sound. A worker – often an older man or boy – sat underneath the machine to catch the fibre and work it into hanks. The 'glory hole' was a particularly noisy, slimy place to work.

The stripper produced a much coarser fibre than hand-stripping but one machine could produce about 250 kilos of fibre a day – compared with the one kilo of finer fibre that one person could create.

The fibre was then washed in running water and taken to the drying and bleaching paddocks. When the fibre was dry, about 10 days later, it was taken back to the mill. It went through a scutching machine; a revolving wooden drum with beaters attached, to get the cleanest lengths of fibre. It was then pressed into bales, tied with ropes and shipped off to the nearest port or railway station.

Working at a stripping machine. Alexander Turnbull Library

Harakeke bush in flower. Sue Scheele

Bush collapsed from yellow-leaf.
Ross Beever

A well pruned flax bush. Sue Scheele

Boom and bust

The success of an export industry is totally dependant on what overseas buyers want – and how much they are prepared to pay for it. The New Zealand flax industry went through more boom (great prices and strong demand for the product) and bust (low prices, minimal demand) cycles than any other export product.

The social and economic state of the countries that bought fibre and those that provided the products all had an impact. The principal markets were Britain, the United States and Australia. When the buyers couldn't get fibre products from their usual supplier, for example because of war, they would look for other options. The first two boom periods for New Zealand were 1869–70 and 1889–90 and the third began in 1898 when the Spanish-American War cut off the supply of manila fibre from the Philippines.

There was another war-time boom during the First World War when the Allies needed more fibre but could no longer get any from their traditional source in central Russia. Exports and prices fell during the Depression while at the same time developing countries in Africa and Asia were putting new fibres onto the market, especially jute from India and Pakistan and sisal from East Africa.

Changing technology also made a difference to demand, for example, when steam took the place of sail at sea around 1895 and fewer sails and ropes were needed worldwide. The condition of the local crop also played its part – products made from New Zealand flax varied in quality which overseas buyers weren't happy about. And around 1920 yellow-leaf disease attacked the harekeke and destroyed much of the crop while competition from other natural fibres kept growing.

The New Zealand flax export market collapsed during the economic depression of the 1930s. To try and save the flax-milling industry, a local market was developed for woolpacks made of harakeke. In 1936 the New Zealand government supported this industry by restricting the import of woolpacks made from Indian jute so that our farmers would buy more made here.

The Second World War meant it was harder for New Zealand to get imported fibre and the Government gave financial support to make sure New Zealand had enough to meet the needs of farmers and the military. After the war, support for harakeke production, along with import restrictions on fibres from overseas, meant 15–20 mills kept operating through until 1970. Some in the industry did try to keep pace with the changing times and the changing needs of buyers by looking at new uses for harakeke fibre. The mills mainly produced fibre to make woolpacks, but also for underfelt, carpets and upholstery materials and binder twine to tie up hay bales.

Government protection was removed in the 1970s. From then on, the New Zealand flax industry was overtaken by changing policies on importing, economic aid being given to developing countries that produced competing natural fibres, and by the development of cheaper synthetic fibres.

Harakeke in New Zealand today – and into the future

"Harakeke has important cultural, environmental and economic values and we are not making the most of it – yet," says Liz McGruddy, who heads a project linking together pieces of scientific work based on various parts and properties of the plant. "Integrating New Zealand flax into land management systems" received a grant from the Sustainable Farming Fund (SSF) in 2003 as a three-year research project.

"A particularly exciting aspect of the SFF Flax project is linking an ancient, endemic species with cutting edge biotech," she says. "And if harakeke comes back as an industry in rural New Zealand, we would have a fantastic social, cultural, environmental and economic win-win package."

Liz has established in the Wairarapa, prototype plantings of native plants she sees as having potential economic values: mainly harakeke, kanuka and totara. "Key drivers for me have been a love of the land, and the knowledge that 80 percent of our plants are endemic to this country – a treasure trove of properties and potentials," she says. "I believe the way forward for conservation is not to lock our plants up behind fences and covenants, but to bring them forward into the productive landscape. And the key to that is to link to research into the unique properties of our native plants, and then link through to market trends demanding new products, natural products and sustainable production."

Liz believes there needs to be a whole-plant view of the potential of harakeke both agriculturally and industrially. As part of the project, AgResearch Grasslands are investigating two important aspects of New Zealand flax production:

- the nutritional and other values of the leftover leaf material, such as if it would make nutritious and digestible animal feed. There are stories that early settlers used harakeke leaves to help rid cattle of parasites, and this is also being investigated
- whether harakeke plants can be an effective and economic way for farmers to counter the problems of effluent runoff into waterways. Trials are being done to understand how much nitrogen the plants can soak up, and how and when to harvest them before they break down and re-release the nitrogen.

Gel from harakeke leaves is an important ingredient in the skincare products of Living Nature, a Northland company. The clear, sticky gel is harvested from the base of the leaf blade, where the two sides of the leaf are closed together. The gel form itself is soothing and easy to apply, and the harakeke gel has some healing properties.

Liz in action, harvesting samples for nutrient analysis. L Layton, AgResearch

Liz McGruddy, SFF Project Manager, with Wairarapa Conservation Corps, trimming flax fans ready for planting. P. Nikolaison

A living database – the National New Zealand Flax Collection

The National New Zealand Flax Collection is an important scientific, historical and cultural resource looked after at Landcare Research in Lincoln. At its centre is the Rene Orchiston collection of traditional weaving varieties, gathered by Rene since the 1950s. Rene kept notes about each flax and its special qualities. She also carried out her own experiments to add to information on each variety.

Rene Orchiston and Sue Scheele in National New Zealand Flax Collection at Lincoln. Sue Scheele

Sue Scheele is kaitiaki (guardian) of this collection. She is an ethnobotanist with Landcare Research and says her role is multidisciplinary and involves researching how people use plants. "This collection is a priceless genetic storehouse of plants of known origin and reliability" says Sue. "As well as keeping plants safe for a new generation of weavers to enjoy, they are a resource for researchers wanting to know more about the chemical and physical properties of fibre and gel, and how these properties differ between varieties."

In one experiment, plant divisions were grown at sites around the country. Landcare Research scientists measured the changes in growth in the varieties and weavers set the criteria and used their traditional skills to evaluate the qualities of the leaves for raranga (plaiting), whatu (weaving) and piupiu-making. The results will help weavers know which varieties grow and perform best where they live.

Planting on Roddy McKenzie's dairy farm, north of Masterton. L Feringa, Wairarapa Times Age

Biomaterials for the future

"The world is looking for alternatives to petroleum-based resources, and plants like New Zealand flax can play a major part in this move to renewable products," says Alan Fernyhough, Unit Leader, Biomaterials Engineering at Forest Research. "Natural fibres have good physical and mechanical properties, and are renewable and sustainable if they are well managed. In many cases they can also be biodegradable and relatively low-cost, depending on the processes and modifications used in their isolation and application.

"Our strategy focuses on providing the science behind creating materials from renewable resources. We are working on the next generation of new material development, mixing various forms of natural materials in a range of ways to create alternative materials, products and technologies.

"For example, our team are working on how New Zealand flax fibre can be combined with other materials, how well it mixes with plastic and bioplastics. We are comparing how harakeke performs in such composites with other natural fibres such as hemp and wood and synthetics such as glass fibre. We are looking at how to improve the effectiveness of such natural fibres in strengthening materials they are part of and at their use in a variety of manufacturing methods and composite matrix systems. We want to find out how we can get them to work most effectively together with other materials."

Pa Harakeke, Knights Stream, Christchurch. Christchurch City Council

Further reading

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Websites

http://www.landcareresearch.co.nz Landcare Research (information on The National New Zealand Flax Collection)

http://peopleplants.landcareresearch.co.nz Ngā Tipu Whakaoranga infobase on traditional uses of New Zealand native plants

http://www.techhistory.co.nz/OntheLand/Flax_milling.htm The New Zealand Flaxmilling Industry by Ian Matheson; a history of technological innovation in New Zealand.

http://www.livingheritage.org.nz/schools/secondary/st-peters/opiki/index.html
A brief history of the life of the Opiki Suspension Bridge, including the area's harakeke industry. A Living Heritage site by St Peter's College.

Acknowledgements

Author: Judith Jones
Reviewers: Lois Hawthorne, Christchurch College of Education, Sue Scheele, Landcare Research
Editor: Cris Westrupp, RSNZ
Typesetter: Robert Lomas, RSNZ
Front cover photos: Flax with Kea, Tim Davie; Backpack photo, Murray Parsons
Produced with the support of the New Zealand Government.

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ISSN 0111–1957 2003

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