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A Guide to Growing Pre-European Māori Kūmara in the Traditional Manner

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Abstract

This paper is a guide to growing pre-European Māori kūmara in the traditional manner. It features illustrations based on research undertaken on experimental kūmara gardens over the last decade. A short history of Māori kūmara and its arrival from Polynesia is given, followed by instruction on selecting a site and setting up a traditional kūmara garden. The instruction covers cultivation, planting, weeding, harvesting and storage.

Acknowledgements

This paper is dedicated to my friend and colleague Graham Harris, who died in December 2006. Graham introduced me to Foss Leach and Janet Davidson and was instrumental in initiating the experimental kūmara gardens. Te Atiawa, Ngāti Rarua, Rangitane o Wairau, Ngāti Toa and Ngati Hinewaka all lent their support to the project in the early stages. Thanks to Philip and Sue Woolley, on whose property the Robin Hood Bay garden is located, and Dianne Buckley, on whose property the Whatarangi garden is located. Thanks also to Dianne's pupils from Martinborough School, who helped to plant and harvest the gardens as part of their Enviro School programme. Special thanks to Bob Buckley, who helped maintain the fences and assisted with the harvest, and Tony Tomlin, my colleague from the Open Polytechnic of New Zealand, who has been an integral part of the project since 2007. The research is supported by a Foundation for Research Science & Technology grant administered by Plant and Food Research Ltd. Thanks to Janet Davidson for her amendments to the draft.

Ethical statement

In conducting this research project the author has followed the principles of ethical conduct as stated by Ngahuia Te Awekotuku in *He Tikanga Whakaaro: Research Ethics in the Māori Community* (1991) and as contained in the *Mataatua Declaration on Cultural Property and Intellectual Property Rights of Indigenous Peoples* (1993). It is recognised that some of the information in this paper is mātauranga Māori, and hence the aims of the study and the intention to publish the information were conveyed to the informants at the time the information was collected. Some of the information and plant material was given to the author on the understanding that it was not to be commercially exploited and was solely for the purposes of academic research. The author has applied this principle to all the plant material and information gathered in the course of this study.

E kore te kūmara e kī ake ki a ia he māngaro.
The kumara does not announce it is tasty.
(Mead & Grove, 2001, p. 36)

Contents

Introduction

This working paper provides a practical outline of traditional methods of growing and storing kūmara. It relies heavily on my experiences growing the traditional cultivar 'Taputini' in experimental gardens over the past decade. I attempt to outline and provide guidelines for planting a pre-contact traditional Māori kūmara garden. It is intended as a guide for anyone wanting to establish a similar garden using traditional Māori gardening techniques. I have endeavoured to embellish the paper with photographs, following the principle that a picture is worth a thousand words.

Just as old plant cultivars are replaced by new, so too are garden practices altered by the introduction of new tools, techniques and cultural beliefs. For example, in early post-European contact Māori horticulture, the convergence of the introduction of the 'Waina' kūmara cultivars, with their trailing vine-like habit, coupled with the introduction of the horse-drawn mouldboard plough used for ridging planting rows, is likely to have encouraged the switch to propagating new plants using stem cuttings that were planted out into rows. This eventually replaced the ancient method of planting a single seed tuber in an individual mound (puke) formed using tools similar to a small chop hoe. After European contact with Aotearoa, garden practices and the plants cultivated changed rapidly. Māori were quick to recognise the advantages of new tools, crop plants and higher yielding cultivars, and adapt them for their own purposes.

First, I present a brief history of Māori kūmara. This is followed by guidelines for growing kūmara, covering site selection, windbreaks, soil preparation, mound forming, planting, watering, maintenance, harvesting, curing and storage.

Pre-European Māori kūmara

I have gardened with three surviving varieties or cultivars of Māori kūmara thought to be pre-European. They are 'Taputini', 'Rekamaroa' and 'Hutihuti'. These are three of four cultivars identified by Yen (1963) as 'considered by Maori informants to be of pre-European origin or introduction' (Yen, 1963, p. 33). Harvey, Gill, Crossman and Fraser (1997), in a genetic study using Random Amplification of Polymorphic DNA (RAPD) analysis as a measure of taxonomic relationship, found 'Rekamaroa' and 'Hutihuti' to be very closely related and 'Taputini' quite distinct. All three are distant from modern cultivars. The cultivar 'Houhere' was not included in their study, as it was not available. I too have not been able to source the 'Houhere' cultivar, despite enquiries over the last 10 years.

As reported by Stokes (2007), Crown witness and historian Dr Ashley Gould, in testimony at the Waitangi Tribunal Wai 262 Indigenous Flora and Flora claim, questioned whether 'Rekamaroa' and 'Hutihuti' were survivals of pre-contact varieties. Andrew Clarke (personal communication, 2009) says that the results from his (yet to be published) DNA analysis also raise questions about the pre-European status of and relationship between these cultivars.

Whatever the final scientific verdict, there is no question that these cultivars are Māori kūmara, in the same way that Māori potatoes are considered Māori because they have a long association with traditional Māori growers. Regardless of new or yet to emerge scientific evidence about their origin, 'Taputini', 'Rekamaroa' and 'Hutihuti' will continue to be regarded as Māori kūmara cultivars. In our experimental gardens, the locations of which are shown in Fig. 3, we found 'Taputini' to be the most suitable cultivar for growing in this region (Burtenshaw, Harris, Davidson, & Leach, 2001). Hence 'Taputini' feature prominently in the illustrations.

Polynesia

The sweet potato is an important food crop in Polynesia (Hather & Kirch, 1991). Speculation that the sweet potato was introduced to the islands by the Spanish or Portuguese during the early sixteenth century is now discredited (Green, 2005). The weight of evidence indicates that the sweet potato had a pre-Columbian introduction into Polynesia. The oldest archaeological find is of carbonised remains of tubers from Mangaia Island in the Cook Islands of central Polynesia, dated to AD 1000–1100 (Kirch, 2000; Green, 2005). Sweet potato remains pre-dating European contact have been recovered from Hawaii (Rosendahl & Yen, 1971; Griffin, Riley, Rosendahl, & Tuggle 1971) and Rapa Nui (Skjølsvold, 1961), and the plant is thought to have been in Aotearoa by AD 1150–1250 (Anderson, 2000; Davison, 2000, p. 24). The evidence demonstrates that the plant was not only present in eastern Polynesia in prehistoric periods, but that it was widely dispersed throughout eastern Polynesia.

Arrival in Aotearoa

There is no direct archaeological evidence of Polynesian arrival older than *c.* BP 800 (Anderson 1991). As summarised by McFadgen (2007, p. 5), most authorities now put the settlement date of Aotearoa at around AD 1250. This settlement almost certainly resulted from deliberate voyages from central eastern Polynesia. The food plants these settlers brought with them that survived in the temperate climate of Aotearoa included:

- taro, *Calocasia esculenta*
- hue (bottle gourd), *Lagenaria siceraria*
- ūwhi (yam), *Dioscorea alata*
- tī pore, *Cordyline fruticosa*
- kūmara (sweet potato), *Ipomoea batatas.*

Today kūmara is a widely grown commercial root crop, while hue and taro are grown in small quantities, particularly in the north. Tī pore (or Pacific island cabbage tree) is less common, but has naturalised in northern parts of New Zealand and the Kermadec Islands. Despite constant enquiries over the last few years, I have failed to find anyone growing yam in contemporary New Zealand, although there have been reports of people growing yams in Northland. Yams from Fiji and other parts of Polynesia are sometimes sold in markets such as the Otara Market in South Auckland. Imported and locally grown taro is commonly available at fruit and vegetable markets. Introduced post-contact cultivars of taro and hue are the main ones grown. There are cultivars of Māori hue and taro, but the true provenance of such cultivars is yet to be ascertained with any degree of certainty.

The adaptation of these tropical crops to the temperate climate of Aotearoa was a significant horticultural achievement, leading to many of the practices used in kūmara horticulture and storage in Aotearoa that differ from the traditional Polynesian practices upon which they were based.

(a)

(b)

(c)

(d)

Fig. 1 *(a) Taro; (b) Young fruit of hue (bottle gourd); (c) ūwhi (yam) vine and leaves; (d) Tī pore*

Fig. 2 *Traditional Māori kūmara 'Taputini' leaves and tubers*

Extent of traditional kūmara gardens

In pre-contact times traditional kūmara gardens were common in coastal regions of the North Island and extended inland in some fertile river valleys throughout Northland, East Coast, Auckland, Waikato and Taranaki. The South Island was considered marginal for kūmara, but gardens were established in coastal areas in Nelson, Marlborough, Kaikoura and as far south as Banks Peninsula in Canterbury, at sites where early autumn and late spring frosts could be avoided. It has been suggested that regions that were marginal for kūmara production were abandoned in the fifteenth century when the climate cooled (Leach, 1976). Figure 3 shows the known extent of kūmara gardening in pre-contact Aotearoa, as well as the sites of the experimental gardens established in the Cook Strait region.

Leach (1976) builds on Yen's (1963) three-stage development of kūmara gardening in Aotearoa. The introductory stage consisted of the introduction of kūmara from eastern Polynesia, along with a repertoire of gardening techniques such as gravel and grass mulching, stem and tuber propagation, terrace and slope gardens, and mound cultivation.

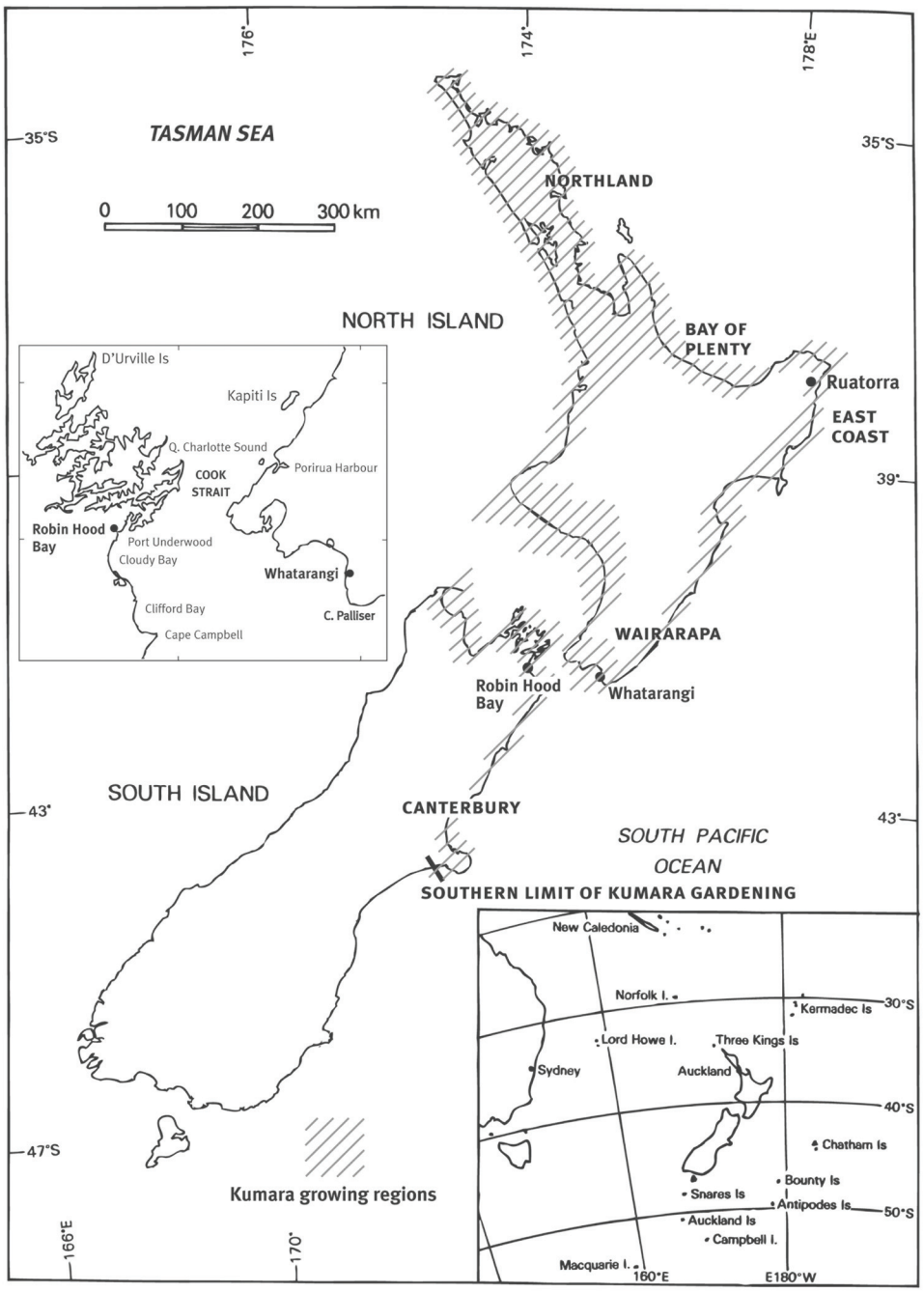

Fig. 3 *Extent of kūmara gardening in pre-contact Aotearoa and the location of the experimental gardens established in the Cook Strait region*

This was followed by a stage of experimentation, with adaptation to an annual production cycle and overwinter storage in pits. The third stage was expansion southwards along the east coast, with regional consolidation and selection of local cultivars and development of local preferences for storage pits. This was

followed by a retrenchment period in which some gardens in the Marlborough Sounds, Wairarapa and on the Kaikoura coast were abandoned. Leach (1976, p. 247) noted that there was a revival of Māori horticulture in the nineteenth century, taking advantage of new European tools and crops, particularly as a result of the introduction of the potato, *Solanum tuberosum*.

Possibly the southernmost garden site, described by Bassett, Gordon, Nobes and Jacomb (2004), is visible on Google Earth. Figure 4 shows garden terraces on a north-facing hill at Okuora Farm near Birdlings Flat, Banks Peninsula. This site was suitable because it has a north-facing slope with full exposure to the sun, and any cold air that might cause a frost drains down the slope.

Fig. 4 *One of the southernmost kūmara garden sites at Okuora Farm, near Birdlings Flat, Banks Peninsula. The terraced garden sites are visible on the north-facing slope at bottom centre of the picture.*

Typical remains of coastal gardens with stone rows on the southern east coast of the North Island are shown in Fig. 5. This garden is described by Jones (2004). The stone rows that mark garden boundaries were formed from big stones collected during cultivation and preparation of the garden soil for planting.

They may also have served to demarcate different family gardens and probably helped support windbreak fences of mānuka, *Leptospermum scoparium* var. *scoparium*, or kānuka, *Kunzea ericoides* var. *ericoides*.

Fig. 5 *Stone rows of traditional kūmara gardens at Waikekeno on the south-east coast of the North Island*

Establishing a traditional kūmara garden

Garden situation

A north-facing sheltered site with a slight slope is ideal. The garden area must have full exposure to the sun. Avoid any site that is shaded on the north by trees. Wind protection is important in coastal and other windy areas. The soil must be free draining. Light, sandy, well-aerated soils are best, because they are free draining and warm faster in spring. You might add sand, small stones and charcoal to the soil, as described later under 'Soil modification', but based on our experimental garden experience this is not a necessary requirement. We were able to produce crops of 'Taputini' at Robin Hood Bay on a clay loam soil without any modification. However, this garden is sited on a stony river terrace that has good underlying natural drainage. Good drainage is essential and is more important than soil type.

Windbreaks and fencing the garden

If animals are likely to be grazing in adjacent fields, the garden must be fenced to keep them out. Our experimental gardens were in rural paddocks and were fenced with a 1 metre high post and wire fence to keep out sheep and cattle. The post and wire fence was covered with wire netting to keep out rabbits.

Windbreak cloth was placed over the wire netting. An electric fence was used around this to further deter cattle, which were a problem at our Robin Hood Bay garden. In the 5 square metre gardens the shelter provided by the 1 metre high windbreak is important in creating a growing climate sheltered from cooling winds.

Traditional gardens were fenced with brushwood or reeds that provided shelter equivalent to or greater in extent than windbreak cloth. Joseph Banks, who accompanied Captain Cook on his first voyage, noted the kūmara fields were tightly fenced with reed material (Beaglehole 1963, Vol. 1, p. 417). These fences may have been constructed from the stems of raupō, *Typha orientalis*, and kākaho, *Cortaderia* spp., or cut branches of either kānuka or mānuka. People probably used whatever materials could be found locally. The cut branches of a number of species might make a good shelter fence and it is possible that one of

the functions of the stone rows was to hold these fences in place. The important point is that we know windbreaks were used around kūmara gardens and that shelter is needed for optimum kūmara crop growth.

In his 1880 lecture to the Hawkes Bay Philosophical Institute, William Colenso stated that: 'Small screens formed of the young branches of *Leptospermum scoparium*, to shelter the young plants from the violence of the winds, intersected the grounds in every direction' (Colenso, 2001, p. 8).

While no mention is made of how these screens were held in place, they would naturally follow the stone row boundaries, and placing stones around the base of branches and posts would help support them.

Preparing the soil

Māori cleared garden areas and prepared the soil for planting as follows. The site was first cleared of existing vegetation and weeds. Coastal areas of forest or scrub were often burnt in order to achieve initial clearance. The heavy work of digging and removing the remaining stumps, roots and large stones would require the most effort. This is where heavy kō, or digging sticks, would have proved useful. Once the soil had been loosened by digging, ketu (a smaller spade-like implement) or timo (grubbers) and paretai (scrapers) could be used to form the puke. In our experimental gardens we found chop hoes most useful for scraping up soil into puke. On many traditional sites sand and gravel were added to the puke as they formed (Gumbley et al., 2004).

The initial burning would be responsible for a proportion of the charcoal found in traditional Māori soils, but extra charcoal was also added to some gardens. Māori did not use manure of any kind on their garden soils. The use of animal by-products was tapu and any contamination by human waste was avoided at all cost. Wake and Adam (2009) give a good description of how this tapu affected early post-contact Māori gardening.

In our experimental gardens at Whatarangi and Robin Hood Bay we did not fertilise or add manure or other materials to the existing soils. We formed the puke by scraping up the natural soil, without making any additions. We were able to produce crop yields of the cultivar 'Taputini' averaging 14 tonne per hectare at Whatarangi on a light sandy soil, and 10 tonne per hectare at Robin Hood Bay on clay loam soil. It is possible that other cultivars required more attention to soil modification.

Any contemporary garden must have the surface vegetation removed. This is achieved by turning over the soil with a spade or other cultivation implement in August or September, and leaving the area bare and exposed to the weather until planting time. This allows the turned vegetation under the surface time to decompose before the mounds are formed.

Soil modification

While the use of animal manure was tapu, many traditional garden soils were modified by the addition of small gravel and sand. Sand or small stones were excavated from borrow pits and sometimes transported considerable distances for incorporation into the puke as they formed. This is another labour-intensive task. It was probably directed by a tohunga or kaumātua, whose job it was to locate and select suitable sands and gravels for use. Figure 6 shows borrow pits at Pararaki in south Wairarapa.

Fig. 6 *Borrow pits at Pararaki in south Wairarapa. Large stones excavated from the borrow pit can be seen.*

William Colenso noted this practice in 1880:

> For the *kūmara* – *Ipomœa chrysorrhiza* – a dry and light sandy, or rather gravelly soil, was selected; and if it were not so naturally, it would be sure to become such, as every year they laboriously carried on to it many weary back-load of fine gravel, obtained from pits or river beds in the neighbourhood, and borne away in large and peculiarly close-woven baskets specially prepared for that purpose only. This labour, however, was the principal heavy one attending their cultivations; as, before they knew the Europeans and for some time after, they never strongly fenced their plantations, not having any need to so; the highly laborious and additional work of making wooden fences around their cultivations in after years arose from the introduction of the pig. They did, however, put up fences and screens of reeds, etc.; this was done to break the force of the winds which blow hard in early summer, the young *kumara* plant being tender. . . (2001, pp. 7–8)

The residual effect of soil additions on the texture of the soil can be seen in Fig. 7. This is a photo taken during the building of a factory at Te Aroha in the Waikato region. The outlines of the planting mounds are clearly visible as circles of modified soil.

A few garden soils in some areas included large quantities of added charcoal that was deliberately created by burning bundles of kānuka, mānuka and other felled timber species on the soil surface prior to forming the planting mounds (Rigg & Bruce, 1923). Best (1976, p. 164) describes how in open land on heavy soils mānuka brush or second growth was cut and spread over the field. This layer of dried brush was burnt on a still day before planting time to leave a layer of charcoal and ash. This in turn was covered with mānuka brush to stop the ash blowing away. This treatment was not considered necessary for friable loam and light sandy loam.

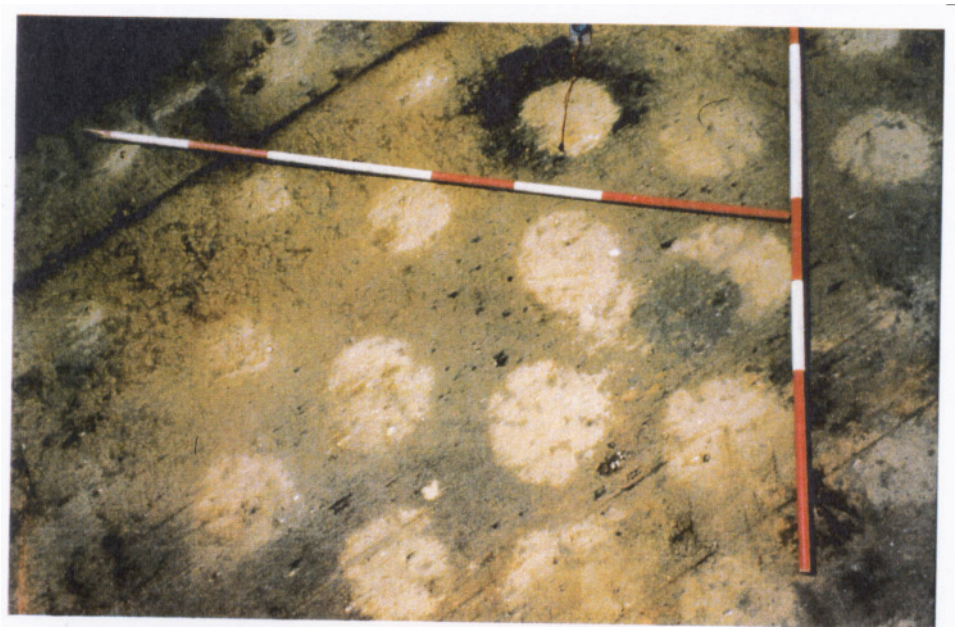

Fig. 7 *The pattern of soil modification with sand and gravel in excavated soil at Te Aroha in the Waikato region. The lighter circular patches are bases of puke in which kūmara were planted. The staggered row pattern of puke layout is also evident.*

Charcoal darkened the soil, which therefore absorbed more sunlight and became warmer. This is the opposite of the albedo effect, where whiteness reflects sunlight. The sand and small stones added to puke would also absorb solar energy. More importantly, their addition created better drainage for the plants and, most importantly, improved aeration. Good aeration is important for the initiation and development of the tuberous roots of kūmara. Small stones help attract and retain heat and moisture.

Lithic (stone) mulch agriculture was practised in other parts of the ancient world (Lightfoot, 1994). This is the practice of mulching the surface of the soil with stones for the purpose of retaining soil moisture and absorbing heat. Whether Māori used stone mulches in this way is not confirmed. There has been a general assumption that the small stones found in modified soils were mixed with soil and sand to make the puke, but stone mulches may also have been applied to the surface of the puke – either to help warm the soil, or to keep the foliage clean and clear of damp soil. No doubt different techniques were tried by people experimenting in different growing areas. Different soil modification techniques were also required for different soil types.

In talking about soil preparation, Best (1976) records the following:

> If the soil is *one matua* [?stiff loam] that *kumara* field should be gravelled; gravel will improve it. The reason why persons dislike that soil is on account of the heavy work of carrying gravel. If a spot having *one paraumu* [dark friable soil] can be found, that is desirable, the work will be light, gravel will be carried only to put under the leaves lest they suffer from mud and wet. If there be no *one paraumu*, and *one haruru* [a light sandy loam] can be found, that will serve as well as a cultivation ground. (p. 164)

In an experiment using a stone pebble mulch (Fig. 8), we found that the mean temperature during the growing season under a stone-mulched puke was 0.95°C warmer than that under a mound with no mulch (Burtenshaw et al., 2001, p. 174). No measure of soil moisture was taken, and therefore the effect of stone mulch on moisture retention was not quantified. As the soil was a free-draining sandy silt, no influence on keeping the top leaves clean was observed.

Fig. 8 *Stone mulched mound at Whatarangi, December 2000. The 'Taputini' plants are just establishing in the puke.*

As Leach (1976) says:

> From archaeological evidence alone it will be difficult to decide whether sand or gravel additions in New Zealand prehistoric gardens were initially water-conservation devices mixed into the topsoil during later cultivation or worm action, or had been introduced as soil-conditioners to warm the ground and improve drainage. Nevertheless the moisture-retention practices of tropical Eastern Polynesia suggest the former function may have been most familiar to early New Zealand gardeners. (p. 184)

However, based on our experience with experimental kūmara gardens (Burtenshaw et al., 2003), I believe that additions to the sand and gravel served primarily to provide aeration, improve drainage and warm the soil in the puke.

There is one interesting account of compost making, reported by the editor at the end of the Rigg & Bruce (1923) article on Māori soils of Waimea West. This is attributed to a Mr W. J. Grey of Okato, Taranaki, and concerns the practice of gathering sand and silt left by storms or floods and mixing them with the leaves of ferns and shrubs to build a pile that was left to mature in readiness for adding to the puke in the planting season. The term applied to this mixture was 'whakaparapara'. The principal ingredient is sand, but the addition of fern and shrub leaves is interesting in that this would break down to provide humus content.

Puke formation and layout

Figures 8 and 9 show the puke layout and size. We aligned our rows north to south. This is a sensible practice, as the layout pattern of the puke exposes the northern side of each to full sun. The puke are formed using a chop hoe to scrape up (earth up) the soil to a height of 30–40 centimetres at the apex, with each mound having a base diameter of 50–60 centimetres. The distance between the apices of the puke should be approximately 80 centimetres (Yen, 1963). When setting out a garden plot, build a centre row of puke first. Take care to ensure that the spacing of the puke in this first row is even, as the spacing of the adjacent rows is determined from the first row. Then earth up puke on each side of the centre row by spacing them in-between the puke in the centre row. This is a staggered row pattern and you will soon have a layout pattern, as shown in Fig. 9. This is known as a quincunx pattern.

Fig. 9 *Puke layout with 'Taputini' plants growing in each mound*

In his 1880 lecture Colenso provided this description:

> The extreme regularity of their planting, the *kumara* and the *taro* being generally set about two feet apart, in true quincunx order, with no deviation from a straight line when viewed in any direction, (to effect this they carefully use a line or chord for every row of *kumara* in making up the little hillocks into which the seed-tuber was afterwards warily set with its sprouting end toward the north . . . (Colenso, 2001, p. 9)

Planting

Once the puke are earthed up and any adjustments of layout pattern have been made, it is time to plant. One seed tuber is planted in each puke, after a trowel has been used to open up a planting hole on the north side of the puke. While kūmara tubers have proximal (top) and distal (bottom) ends, these are hard to see and make no difference when planting seed in puke, although it is important to plant into the north-facing (warm) side of the mound.

Our planting practice followed the description given by Te Rangi Hiroa (Buck, 1974, p. 89):

> One tuber was planted in each mound with the axis in a north south direction so that the morning and afternoon sun would give equal warmth to the two sides of the seed tuber. In modern times, seed tubers were allowed to shoot and the shoots were planted in the mounds instead of tubers.

In the case of tuber-planted kūmara, the shoots are formed from buds arising along the seed tuber. The shoots will push up to the light through the top of the puke regardless of which way the tubers are planted. It was the introduction of new cultivars such as 'Waina' (which had a more trailing vine-like growth that more easily allowed for production of plants from shoots or cuttings) that was a contributing factor to the planting of cutting-produced plants in what Te Rangi Hiroa describes as 'modern times'.

W. C. Berridge, who grew Māori kūmara at the Tauranga Experimental Farm at the beginning of the twentieth century, wrote the following about the introduction of the cultivar 'Waina' in the 1850s by Mr V. Savage of Opotiki (Berridge, 1913).

> Sometime in the fifties he [Mr Savage] was employed repairing boats on the 'Rainbow' whaler, and during dinner he was offered some sweet potatoes very much larger than any he had previously seen among the Maoris. On inquiring from the captain where they were grown he was informed that the vessel had brought them from the South Seas – Rarotonga, I believe. Mr Savage procured some from the captain, and divided them among the Maoris. Some were sent north and some to the bay of plenty. They rapidly became appreciated in many parts of the country. This potato was called 'Waina' by the Māoris because it was propagated by sets or plants or part of the vine (*waina* being the nearest pronunciation the Maoris could make to 'vine'). Previous to the introduction of this variety the kumera was grown from a piece of the tuber, not from sets or plants. (pp. 415–416)

I believe this signalled the move away from the traditional quincunx puke layout – that is, the introduction of the Waina cultivar propagated from stem (vine) cuttings, along with the introduction of the mould board plough, allowed a shift to forming rows of ridges in place of puke formed with chop hoes. It is possible that more site-based settlements, where people could more easily water plants propagated by stem cutting while they established after planting out, also influenced the shift away from planting one seed tuber per puke. Using one seed tuber per puke meant gardens could be planted and left to grow, as the seed tuber provided a source of nourishment and an initial water supply while the new plant established. Plants produced from stem cuttings wilt and may die if they do not get rain or irrigation soon after planting out.

Time for planting

At our experimental gardens we plant in the last two weeks of October, around Labour Weekend, and the first shoots usually appear in late November, about 5 or 6 weeks after planting. Figure 8 shows the top growth in mid-December, and Fig. 9 shows typical top growth in early February. Remember that our experimental gardens were in south Wairarapa and Marlborough, and planting dates may be earlier further north.

Weeding

The experimental gardens are weeded twice a year, in the week before Christmas and in early February. This is achieved by pulling larger weeds growing on the puke, particularly the weeds growing close to emerging kūmara shoots. Then a chop hoe can be used to weed between the puke. Shallow strokes will cut smaller weeds and at the same time the puke can be lightly earthed up. Figure 10, a photo taken at Robin Hood Bay in February 2010, shows a puke containing a 'Taputini' plant, before and after weeding. The weeds pictured growing around the puke are fathen, *Chenopodium album*, black nightshade, *Solanum nigrum*, and fumitory, *Fumaria muralis*.

Fig. 10 *(a) 'Taputini' puke before weeding (b) 'Taputini' puke after weeding*

More attentive and regular weeding will naturally benefit the growth of the crop. Interestingly, all the weeds that grow in our experimental gardens are exotic weeds that arrived with European contact. This suggests that in a traditional Māori garden weeding may have been a task requiring less effort. Tables 1 and 2 list the main weeds growing in our experimental gardens.

Table 1: Main weeds in experimental kūmara garden at Whatarangi, Palliser Bay

Common name	Botanical name	Family	Comment
Black nightshade	*Solanum nigrum*	Solanaceae	Baylis (1958, p. 379) argued that the species seen by Banks and Solander was the now extinct *S. nodiflorum* Jacq., and that the genetically distinct *S .nigrum* L. was introduced in the nineteenth century
Catsear	*Hypochoeris radicata*	Asteraceae	Common
Hawkesbeard	*Crepis capillaries*	Asteraceae	Less common than catsear
Woolly mullein	*Verbascum thapsus*	Scrophulariaceae	Occurring only the first few years
Scrambling fumitory	*Fumaria muralis*	Fumariaceae	Less prevalent than at Robin Hood Bay
Puha/sow thistle	*Sochus oleraceus*	Asteraceae	
White clover	*Trifolium repens*	Fabaceae	Occasional pasture escape
Scotch thistle	*Cirsium vulgare*	Asteraceae	Occasional appearance
Soldier's button	*Cotula australis*	Asteraceae	Occasional appearance
Wild parsnip	*Pastinaca sativa*	Apiaceae	Occurring in the first few years
Cut-leaved geranium	*Geranium dissectum*	Geraniaaceae	Occasional appearance
Prostrate amaranth	*Amaranthus deflexus*	Amaranthacae	Common

Table 2: Main weeds in experimental kūmara garden at Robin Hood Bay, Marlborough

Common name	Botanical name	Family	Comment
Black nightshade	*Solanum nigrum*	Solanaceae	Baylis (1958, p. 379) argued that the species seen by Banks and Solander was the now extinct *S. nodiflorum* Jacq., and that the genetically distinct *S .nigrum* L. was introduced in the nineteenth century
Catsear	*Hypochoeris radicata*	Asteraceae	Common
Sheep sorrel	*Rumex acetelosa*	Polygonaceae	Common
Dock	*Rumex obtusifolius*	Polygonaceae	Common
Puha/sow thistle	*Sochus oleraceus*	Asteraceae	Common
Foxglove	*Digitalis purpurea*	Schrophulariaceae	Occasional appearance
Scrambling fumitory	*Fumaria muralis*	Fumariaceae	Common in spring
White clover	*Trifolium repens*	Fabaceae	Occasional pasture escape
Scotch thistle	*Cirsium vulgare*	Asteraceae	Occasional appearance
Yarrow	*Achillea millefoilum*	Asteraceae	Occasional in early years
Narrow-leaved plantain	*Plantago lancelata*	Plantaginaceae	Occasional appearance
Chickweed	*Stellaria media*	Caryophyllaceae	Common in spring
Fathen	*Chenopodium album*	Chenopodiaceae	Common in summer

Watering

We have never watered the experimental gardens. Part of the experiment was to assess how 'Taputini' performed without irrigation, as it is reported by early ethnographic authors (for example, Best, 1976; Colenso, 1880; Walsh, 1902) that traditional crops were never watered. Colenso (2001, p 10) stated in his 1880 address: 'They also never watered their plants, not even in times of great drought, with their plantations close to a river, when by doing so they might have saved their crops'.

In 2001 the experimental gardens endured a once-in-a-century drought. The pasture surrounding both gardens was burnt white, but the plants survived, producing an average-sized crop.

Of course, where water is available regular irrigation will improve the yield, but it will also encourage additional weed growth. Likewise, if planting stem cuttings, it is preferable to water these in after planting out. The advantages of using seed tubers with respect to the need for irrigation was discussed earlier.

Harvesting

Our season for growing 'Taputini' in the Cook Strait region lasts just over 5 months. Our usual practice is to plant in late October and harvest in mid-April, allowing an average growing season from planting to harvest of 178 days. In northern regions the growing season will be shorter. In the Cook Strait region our crops might have been harvested earlier, but in order to provide a comparable growing time we allowed at least 5 months when growing the 'Taputini'. By this time the top growth starts to look ragged and open. In April 2009, the Robin Hood Bay crop was lightly frosted with browned leaves. A light frost will not affect the quality of the kūmara, as the soil temperature will not have dropped below 10°C. Figure 11 shows recently frosted leaves in April 2009.

Fig. 11 *Frosted leaves on 'Taputini', April 2009*

When digging, care must be taken to avoid breaking and damaging the kūmara. 'Taputini' tend to grow long and thin, and are quite easily broken if not handled carefully at harvest. Lifting is best carried out by two people, with each inserting a fork or spade from opposite sides of the puke and gently lifting the tubers free from the soil. The tubers are then picked by hand and placed in a bag or basket. Work systematically through the garden plot from one row to the next, and avoid walking on any unharvested puke.

Curing

The crop should be spread in the sun to dry for at least one day. Move it to shelter or cover if rain threatens overnight. Before storing, sort any broken or damaged kūmara for immediate use. Likewise, excessively large kūmara should be set aside for early use, as these are not regarded as good keepers.

At this stage you need to think about how much seed you will need for next season's crop, particularly if you grow by planting one tuber per puke. If

growing from slips (stem cuttings), fewer seed tubers need to be kept. Select tubers of average size and shape for next year's seed. We have found no direct correlation between the size of the seed tuber and the yield and size of tubers produced from the resultant plants. Medium-sized tubers of a shape and form typical of the cultivar make the best seed tubers.

There is some speculation that Māori selected small-sized tubers for seed and that this may have led to crops becoming smaller and smaller over time (Leach, 1976 p.195). However, we found no evidence of a direct relationship between tuber size and plant yield with our experimental gardens.

Storage of the crop

Traditionally, crops were stored in semi-subterranean pits, known as rua kūmara by Māori. This practice continues today.

The main requirement is that the stored kūmara are kept at a temperature above 10°C. If stored at a lower temperature for any length of time, the tubers will start to rot. While darkness is not an essential requirement, it will suppress sprouting in spring, as temperatures warm prior to planting. If the temperature is too warm (above 17–18°C) the tubers will transpire more, and will dry out and start to sprout.

In storage, kūmara are alive, albeit in a semi-dormant stage. This means that they continue to slowly respire (breath) and transpire (lose water). This is one reason why the ideal relative humidity in storage is specified as 85–90 per cent. This helps to reduce the loss of water from the stored kūmara. The temperature should be maintained at between 13–16°C. If you can maintain these conditions your kūmara will last for up to 7 months.

The forming of tubers or storage roots is an evolutionary adaptation that kūmara – or at least its wild ancestor – developed in order to survive a period of unfavourable growing conditions. As it is a tropical plant, the unfavourable condition was a dry season. The plant evolved the capacity to become semi-dormant and store surplus carbohydrates and other nutrients essential for growth in the tissues of swollen roots. The foliage might be burnt off by drought, but once the rains return, the swollen roots sprout stems and leaves to form a new plant, and survival is assured.

This is a common herbaceous plant survival mechanism. Both swollen roots and swollen stems occur. A key difference between the Irish potato and kūmara is that potato tubers are swollen stems, while kūmara is a swollen root. Both evolved to survive an unfavourable season, but anatomically a potato tuber resembles a stem, while kūmara resemble a root.

Kūmara has relatively thin skin compared with main crop potatoes, although there is considerable variation between cultivars. Figure 12 shows the textural difference between 'Taputini' and 'Rekamaroa'. In one season when the experimental crops were stored in an unheated outbuilding, the 'Taputini' suffered greater losses to rot than the 'Rekamaroa'. No doubt Māori applied selection pressure for cultivars that stored well over winter, particularly in southern regions, and this may well have been as important a factor in cultivar selection as yield or size.

Fig. 12 *Textural difference between the skins (epidermis) of 'Taputini' (top) and 'Rekamaroa' (bottom) – the latter has a slightly rougher skin*

Summary

Table 3 provides a summary of the requirements for growing kūmara in the traditional manner.

Table 3: Summary guide to establishing a traditional kūmara garden

Feature/task	Requirements	
	Essential	**Additional**
Site	North facing, sunny, sheltered from prevailing winds	Water available
Soil	Free-draining, well-aerated, light sandy texture preferred	Loam and clay soils also suitable
Soil additions	None required	Sand, small stones and occasionally charcoal were traditional additions
Seed tubers	Store at temperatures above 10°C over winter, with enough stock for one tuber per puke	Modern growers plant cuttings taken from cutting beds set out under cover late September/October
Layout	Set out mounds in staggered spacing in quincunx pattern with 800 mm spacing	Modern growers plant into rows formed by tractor-drawn moulding cultivators
Mounds	Form by grubbing soil; build mounds with 400 mm base and 300 mm height at apex of mound	As above
Planting time	Late October after Labour Weekend from East Cape south; earlier planting time possible further north from Auckland to Northland	
Planting	Open the north side of each mound with a trowel and place seed tuber in the mound with a covering of soil 10–20 mm deep	

Weeding	Remove weeds in December before Christmas and again in late January; by this stage leaf growth should be sufficient to compete with weed growth	Additional weeding will keep the mounds tidy and reduce competition for water and nutrients; as weeds are introduced European species, traditional gardens would not have required as much weeding
Harvest	April, Easter, at full moon	Early
Storage	Dry warm and dark place with temperature between 13–16°C and 85–95 per cent relative humidity	Traditionally stored in rua kūmara (semi-subterranean pits) where temperature was at or above 10°C, with high relative humidity; great care went into the construction of rua to create dry and warm conditions for crop storage

It should be noted that traditional Māori kūmara gardens are organic production systems. Provided no synthetic fertilisers or pesticides are used in the gardens, organic status could be claimed, although registration under New Zealand organic certification schemes such as BioGro NZ would need to comply with their rules. The only pest problem we experienced was a build up of white-fringed weevil, *Graphognathus leucoloma*, larvae at our Whatarangi garden site. The larvae of the white-fringed weevil cause damage by eating cavities into the tubers.

Conclusion

While we can never know exactly what traditional Māori kūmara gardens were like in pre-European contact times, our experimental gardens offer some insight. By replicating techniques such as planting one seed tuber in an individual puke, and observing and recording the results, we can learn from our own experience. In sharing our experience, we hope that this may inspire others to create similar gardens and provide guidance on how to do this.

A decade of data has been collected on the yield for effort from this type of garden. Soil tests showed an initial drop in all major plant nutrients to a low level of soil fertility. Nevertheless, 'Taputini' continued to produce reliable crop yields. Even in the once-in-a-century drought season of 2000–2001, crops equivalent to 8 and 10 tonne per hectare were produced at Robin Hood Bay and Whatarangi respectively. In comparison, the 2005 world average for sweet potato was 14.9 tonnes per hectare (Food and Agriculture Organization of the United Nations, 2005). Thus, in a drought in low-fertility soil, this cultivar produced an acceptable crop yield. This emphasises the importance of conserving old cultivars – not just of kūmara, but of all food plants. They may well have traits that will serve us well when there are water shortages, and supplies of key fertilisers such as phosphate are depleted. The future of 'Taputini' and other ancient cultivars is secure while people continue to grow and take an interest in them.

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