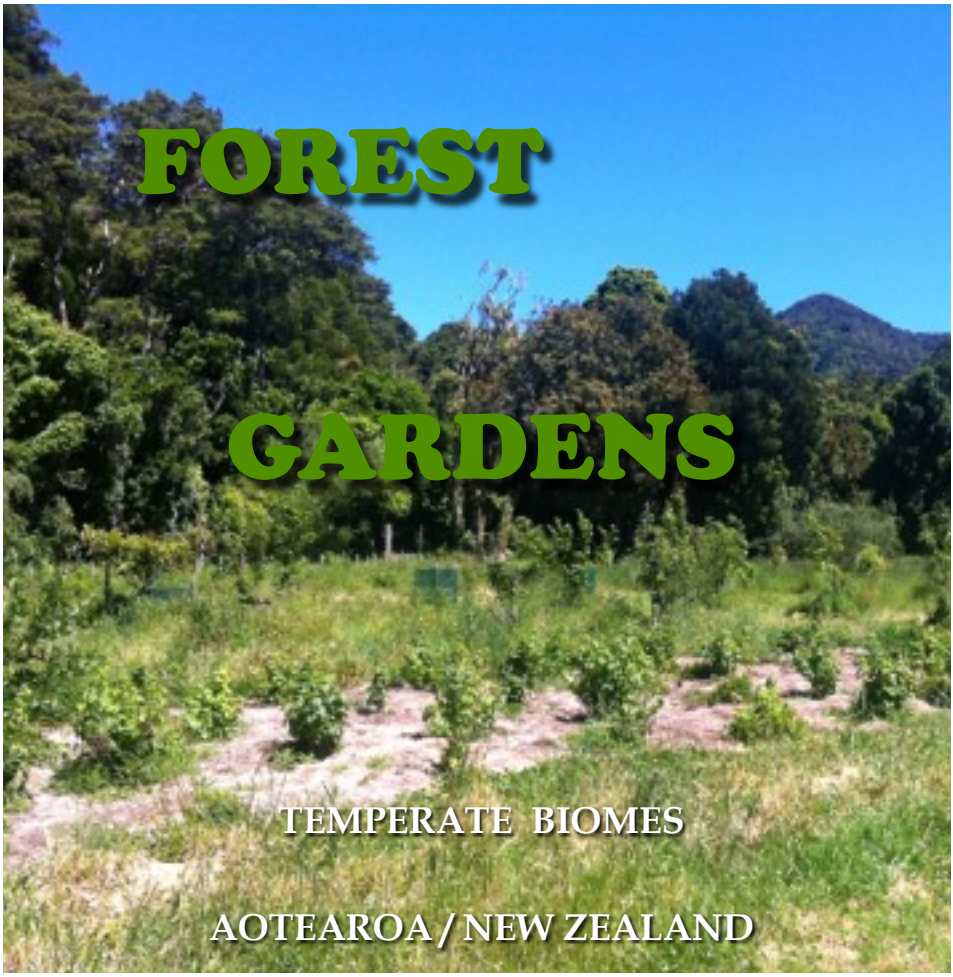

FOREST BASED REGENERATIVE HORTICULTURE

GARY WILLIAMS

Water & Soil engineer - Biodynamic farmer - Permaculture activist - Natural philosopher

Gary and his partner Emily live on a small farm where there is a wide diversity of farming and forestry activities, from home gardens and orchards to staple crops, animal grazing, firewood and plantation forests, and wilderness. Their stewardship of this land is guided by the principles of permaculture and the practices and methods of organic and biodynamic agriculture. They like to experiment and share their land, and have a bio-filtered swimming pool and an eco-building farm stay for short-term use.

Gary is a teacher of permaculture and provides advise and design assistance to people and communities seeking a more resilient and sustaining way of living, which reflects the nature of their place.

Gary works from home as a professional engineer in the field of water and soil resources. His academic qualifications are: Bachelor of Engineering, Bachelor of Science (Physics) and Master of Commerce.

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> "Community Democracy — A Study in Alternative Economics" 1977, 145 pages.
>
> "Patterns of Exchange — A Study in Human Understanding" 1988, 401 pages.
>
> "Out of the Helix — Essays on Cultural Transformation" 2006, 275 pages.

This pamphlet is about the design & implementation of a regenerative horticulture based on forest margins.

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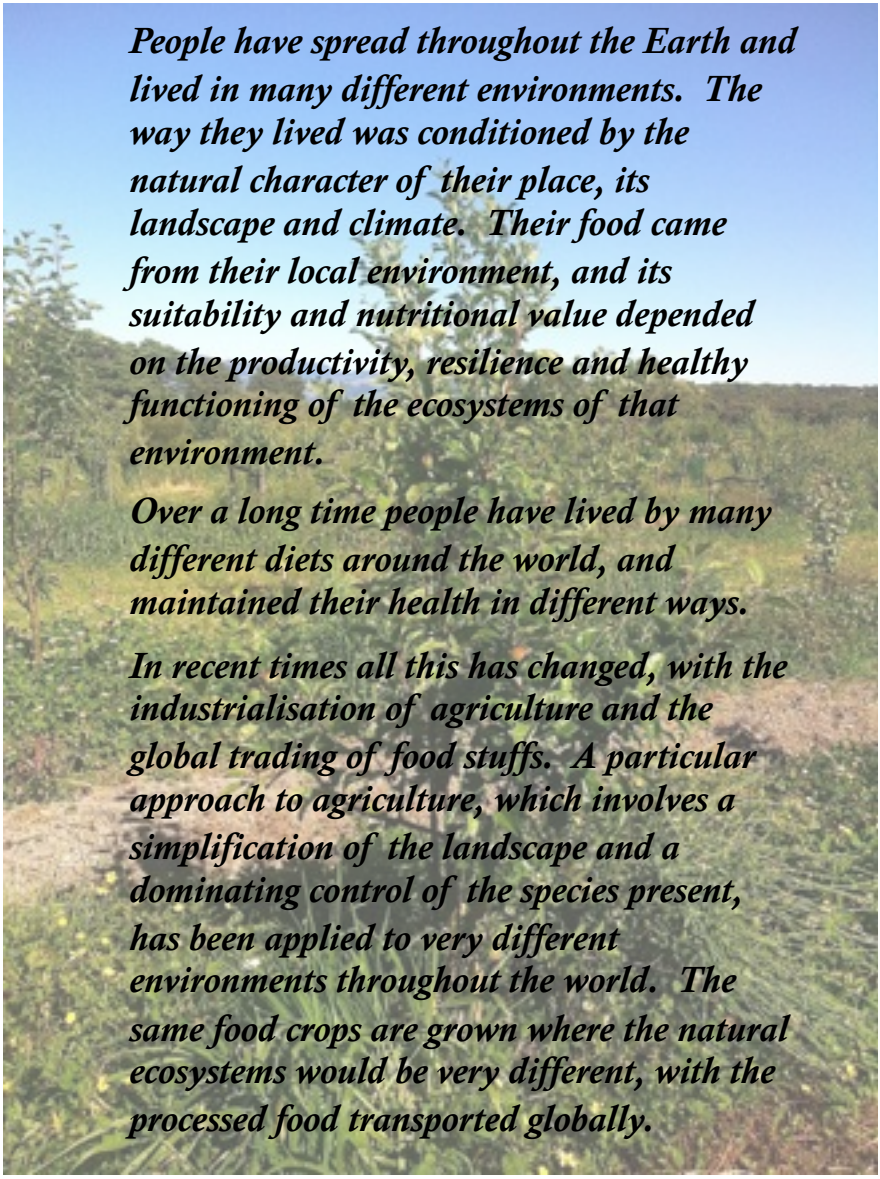

People have spread throughout the Earth and lived in many different environments. The way they lived was conditioned by the natural character of their place, its landscape and climate. Their food came from their local environment, and its suitability and nutritional value depended on the productivity, resilience and healthy functioning of the ecosystems of that environment.

Over a long time people have lived by many different diets around the world, and maintained their health in different ways.

In recent times all this has changed, with the industrialisation of agriculture and the global trading of food stuffs. A particular approach to agriculture, which involves a simplification of the landscape and a dominating control of the species present, has been applied to very different environments throughout the world. The same food crops are grown where the natural ecosystems would be very different, with the processed food transported globally.

An agriculture appropriate to the natural environment in which it is undertaken is very different. This agriculture depends on the natural characteristics of its locale, and works with the rhythms and energies of its ecosystems. It varies from place to place and over time as the environment changes, as with traditional food growing.

The nutritional value of this agriculture depends on the whole socio-ecological system from soil to plate. And this is governed at each end by the very small creatures, of the microbes in the soil and in our guts, which are essentially the same.

Regenerating our natural landscapes through an agriculture that is in tune with the natural conditions and variations of landscapes and climates, then requires very different approaches and methods to that of modern industrial agriculture.

A naturally forested environment requires a regenerative horticulture that is ecologically diverse, naturally healthy and productive.

FOREST GARDENS

FOOD GROWING

FOREST BASED

People have obtained their food in many different ways, depending on the climate and landscape of the place they inhabit and the cultural practices they have developed. The food growing or gathering in forested regions is necessarily different to that which is done in open woodlands, grasslands and semi-arid regions. It also depends on the nature of the forests, which can range from tropical rain-forests to deciduous temperate forests and cold region coniferous forests.

Tropical rain-forests are highly productive and diverse, given the strong sunshine and intense rains of the tropics above ground, and the highly complex microbial life below the ground that can develop in the more stable equatorial climates. A forest-based living is a natural response to such a forest environment, with an easy availability of food and other resources. People have then gardened these forests, managing growth, propagating favourable species for human use and selecting productive varieties. People have altered the patterns of rain-forests and extended their range to increase both managed production and wild gathering of plants and animals.

Forest living tends to keep people in small communities, scattered through the forest, with looser networks of resource management and cultural interactions. However, forest gardening has been a way of life that has sustained high population densities, such as in the highlands of the island of Papua, where people were enclosed by landscape and climatic conditions. The vast rain-forests of the Amazon basin supported

an advanced and populous civilisation, connected by the networks of waterways of the river system, prior to European colonisation.

A forest-based living is more difficult in temperate, cold or semi-arid areas, given the seasonal variations in available food, and less complex and productive ecosystems. Seasonal variations means that there is a complex exchange of nutrients and nutrient storages between the forest biomass and the soil life, with deep layers of organic soils providing winter storages, especially in deciduous forests. Large areas of deciduous chestnut and oak forests were, though, highly managed in North America as part of a sophisticated way of life, again prior to European colonisation.

TEMPERATE GRASSLANDS

Agriculture based on the domestication of grassland plants and animals has developed in temperate zones, particularly in the floodplains of large rivers. In these more open environments communities tended to be larger and more hierarchical, with a more invasive alteration of the natural environment. Tilling of the soil to plant crops such as wheat, barley and oats, and remove competing plants (weeds), disrupted the soil ecology. The natural balance of the grassland/grazing animal ecosystem was lost by constant tillage, and a more expansive monocultural approach developed.

As populations increased but the land became increasingly degraded, woodlands and forests were clearly for this grassland type of agriculture. Desertification has resulted over large areas of the warmer temperate zones, such as around the Mediterranean Sea and the Middle East into central Asia.

Some marginal horticulture-based food growing has been retained where there is sufficient water, such as the date palm polyculture, which included olives, figs, pomegranates, vegetables and grain crops, in desert oases. Water margin

horticultural gardens have also been developed, such as the chinampa wetland gardens in central Mexico.

Rice, as a wetland grass, has given rise to very different conditions to those of dry land grasses, but its cultivation has degraded the environments of floodplains and greatly reduced the areas of highly productive wetlands. The huge floodplain in China of the Yangtze and Yellow rivers has been completely altered from a vast forested wetland to rice paddies, albeit with a highly complex and coordinated system of water storage and distribution.

In steeper land in the tropics or warm high rainfall areas, terraced rice paddies have replaced forests, and in places these terraces cover whole mountain sides. This has given rise to very large areas of stagnant water and a much poorer overall ecology.

IMPACTS of CIVILISATION

Settled urban living, supported by an agriculture of grain staples and domesticated animals for food, transport and working the land, had a profound effect on human diseases. The dense populations of people living in unsanitary conditions, the close contact with animals and the degraded environments with large areas of stagnant water where mosquitoes could breed, increased both the number and spread of diseases. Human populations, particularly in urban areas, were constantly reduced by contagious diseases between people or from animals, and by mosquito borne diseases. The mosquito borne diseases of malaria and yellow fever have been the greatest killers of people.

Trade over long distances, migrations and invasions of conquest and displacement of people, have increased the spread and intensity of diseases. Mosquito breeding areas have greatly increased, as degraded wet areas without their natural predators have been created through forest clearing and monocultural cropping, and people have carried their diseases, to spread them far and wide.

Bringing the agricultural practices of temperate zone civilisations to the tropics in recent times has had a devastating effect on tropical and semi-arid environments. Tropical rain-forests have been continually cleared for pastoral animal farming and cropping, displacing the people who have remained in these forests, as forest dwellers. The minimal soils and base rock substrate of these rain-forests, and the intense rains make this pastoral or cropping agriculture a short term enterprise, with a rapid degradation of the landscape.

The naturally adapted forests and animal life of the hot and variable rainfall climates of Australia, which lies on the desert zone between the tropical trade winds and the circulation systems of the mid-latitudes, have been massively degraded by human interventions. The introduction of European-based pastoral and cropping agriculture has mined the land and destroyed the shallow-soil water cycle that had supported diverse and highly productive forest-based ecosystems of this desert zone landmass.

European expansion and colonisation throughout the world has had such massive impacts on food growing techniques and management approaches that natural ecosystems everywhere have been affected. Ecosystem degradation and collapse is taking place at alarming rates, with species extinctions in nearly all places and biomes, on land and in the oceans.

The colonisation and settlement of the Americas was accompanied by forest clearance, to make way for extensive monocultures of commercial crops, including sugar, tobacco, cocoa, coffee and cotton, as well as for pastoral and arable food growing. Forests continue to be destroyed and cleared for pastoral and cropping agriculture, with forest-based food growing being pushed more and more into the margins.

At the same time, hugely increased travel for commerce or recreation, and mega-city populations of dense human living is a time-bomb for disease pandemics. Only improved sanitation and

clear water supplies, plus a repertoire of drugs and medical interventions, is keeping this threat at bay.

The digestion of food and the immune capacity of humans is tuned by their local environment, and its effectiveness depends on the health and nutritional quality of food, the activation of immunities, lifestyle and exposure to disease organisms. People who stay in one place become acclimatised to the area and its microbial life, including potential diseases.

Travel to other places exposes people to new organisms and microbial life, which affects the microbial life they ingest with their food and water, and the type and varieties of disease organisms present. Human health and well being depends on the whole context of our way of life and its environmental setting. The food we eat and the water we drink is a part, if an important part, of this context.

REGENERATIVE HORTICULTURE

Food growing that is inherently part of the natural ecosystems of the place where it is grown, has to be part of a wider cultural understanding and recognition of our place and role in this world. To provide food that is health-giving for people requires healthy ecosystems and methods of growing that add to the productivity and resilience of ecosystems.

Unfortunately, the horticulture of the modern industrial food system has followed the monocultural approaches of arable cropping and pastoral farming. Commercial orchards now consist of single tree species, even a single variety, over large areas. Rows and rows of a given fruit tree on ground that is bare or with a very simplified cover.

The lack of the symbiotic soil microbial life of trees and of companion or supporting trees and ground cover, gives rise to weak and poorly developed trees. Adding artificial fertilisers and mineral amendments further suppresses the soil life and

hence the natural fertility of the environment. This horticulture then descends into the same vicious spiral of increasing use of pesticides and herbicides of industrial agriculture. Bees have to be brought in for pollination and removed as quickly as possible to allow the ongoing pesticide spraying program to continue.

This horticulture is the same throughout the industrialised world, with just the particular species depending on climate and landscape. There is the same dependence on inputs of fertilisers and toxic life-destroying chemicals, and often of the basic requirement of water through irrigation. Soils become an inert growing medium, with minimal below and above ground diversity.

Horticulture that relates to place and the nature of particular environments is very different, and the approach and methods used are specific to each place and environment. What is done in one place is not transferrable to another, and a clear minded and engaged observation is essential for regenerative place-based horticulture. It requires well-focused observation that feeds into adaptive responses. It depends on local experience that has been honed over years, and can not be learnt from books and theories.

There are general principles or strategies that can guide the design and implementation of forest-based horticulture, but they are just guidelines that have to be interpreted for each specific place and environment.

Diversity: A diversity of plants, from the ground to the canopy, which forms an integrated whole and provides the connectivity of support and companion sharing that will provide diverse productivity with climatic and disease resilience.

Soil health: A porous soil structure that allows easy root and water penetration, and appropriate soil life that provides the full range of nutrient exchange and recycling, is fundamental to the health of a forest ecosystem. The ecosystem is driven by the soil

microbial life and it is the networks of this life that ensures nutrient sharing and exchange.

Water availability: Water is the medium of life and essential for all organic exchanges and development. Water has to be stored and made available as required to maintain the functionality of the plant-soil life exchanges, given the supplies of water and the moisture holding capacities of the soil. Both plants and soils can manage the variability of supply and the movement of water on and within the ground.

Sun & Air: A forest has to make use of and withstand the energies of the atmosphere, the heat of the sun, the strength of winds and the gases that are present in the atmosphere. Forests provide shelter and shade and a diffusion of air, but the species of a forest have different requirements and capacities. The arrangement of species is critical to the productivity and resilience of the forest. Air provides the basic energy food for trees, of water and carbon dioxide, and the growth of soil life, plants and animals takes in and cycles the carbon, oxygen and water obtained from the atmosphere.

We can reverse the massive loss of forests, and diverse wetlands, by obtaining our food and other resources from forest gardening. Except for cold mountainous regions, different forms of forest gardens could be re-developed in the tropical and temperate zones of the world. The pattern of plants and species composition of these managed forests will depend on climate and landscape characteristics and prevailing ecological conditions.

General principles, such as outlined above, can guide the design and implementation of diverse forest gardens. However, local experience and responsive, more intuitive, observational skills are essential for an effective and productive forest-based horticulture.

The wider context of place provides a starting view, of climate and geo-ecological processes and conditions, with the

particularities of any forest garden coming from the regional and then specific local conditions.

For forest-based horticulture in Aotearoa/New Zealand [A/NZ] the wider view starts with its global location and the climatic, geological and environmental characteristics of this place.

AOTEAROA/NEW ZEALAND ENVIRONMENT

A/NZ is a very isolated landmass in the south-west of the Pacific Ocean. This ocean is the largest on Earth, and covers nearly half the globe. A/NZ is a continent, but much of the continental landmass is beneath the ocean surface, and the present land area consists of two large mountainous islands and scattered small islands, near and far from the two large islands.

It lies on the tectonic boundary of the Pacific "ring of fire", with uplifted mountains, volcanoes and geothermal areas, and the continental landmass has been pushed and shoved, raised and sunk, over long periods of geological time. It has a mountainous backbone along the line of this boundary, with rapidly uplifted and shattered base rocks, and steep gravel-bearing rivers that have a short run from the mountains to the sea. It has a southern mid-latitude oceanic location, where the mountain ranges cut across the westerly circulation of anti-cyclones and depressions of these latitudes, giving rise to high intensity rainfalls and strong winds.

The oceanic climate is highly variable, with an unstable seasonal pattern, and longer term variations from the oscillations of large global circulations, southern oceans circulations (around Antarctica) and circulations around the South Pacific. The back and forth movement of a convergence zone of two large circulations gives rise to decades long variations in the A/NZ climate. The diverse landscape and climatic regions of A/NZ are affected at different times and in different ways through the pulsating dynamic of these natural oscillations.

The global location within the Pacific Ocean of A/NZ is shown on the global image of half of the Earth, of Figure 1.

AOTEAROA/NEW ZEALAND — GLOBAL LOCATION

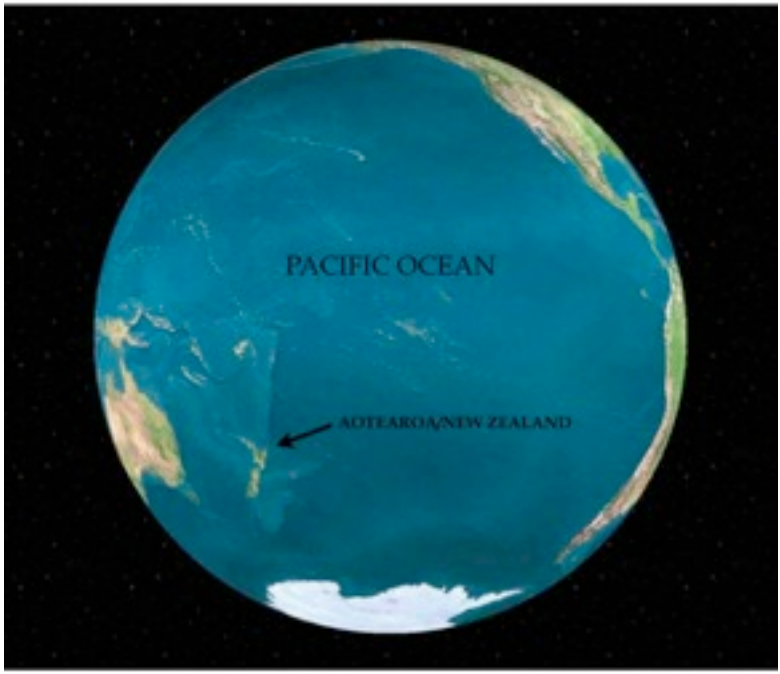

FIGURE 1

As well as the seasonal variations from its mid-latitude position, every year the seasons are different and there is wide variations in climatic conditions from week to week, and even day to day. It is a high intensity climate with much variability, on a rugged, mountainous and geologically active landscape — a high energy place.

The landscape and environment have changed substantially in recent geological times. During the last glacial age, A/NZ was

mostly covered by open grasslands and scrublands, with forests on the margins and ice-fields along the higher mountain ranges. From around 15,000 years ago, there was a progressive covering and diversifying of forests, with the warmer climate and greater rainfall of the present inter-glacial period.

The isolation of A/NZ gave rise to unique and highly diversified temperate climate rain-forests, with its own soil life and a fauna based on highly speciated birds, lizards and snails, and grasslands with a profusion of small flowering plants. The geological submergence of A/NZ meant that mammals had been eliminated from the ecology. Lowland podocarp forests, in particular, are highly diversified, as multi-layered forests with a complex mosaic of species and interactions between plant and soil life. These A/NZ forests have adapted to a high energy regime, with intense rain and strong winds, on steep erodible land, and have high resilience to climatic extremes.

The tectonic location of A/NZ, with its earthquake, volcanic and land uplift and subduction activity, has given rise to a very active landscape, with steep and fractured mountain ranges and fast-flowing and very mobile rivers. Its oceanic location gives rise to a highly variable climate, and its mid-latitude position means that global climate changes have a very pronounced effect on the climate.

There are, then, many different regional climatic regimes and landscapes on the two main islands of A/NZ, from subtropical conditions in the north to cold temperate in the south.

A general zoning of regional climates is shown on the 'Aotearoa/ New Zealand — Climate Regions' map (Figure 2). This excludes mountainous areas and is a very coarse scale mapping as an overall guide to the larger scale climatic conditions in which different approaches to forest gardening could be undertaken.

AOTEAROA/NEW ZEALAND — CLIMATE REGIONS

FIGURE 2

In the north, dense diverse food forests can be grown, which can include main crops like bananas, and involve cycles of 'chop and drop' of the understory and support trees. This is similar to the tropical food forests of syntropic farming in Brazil, which was developed by Ernst Götsch as a regenerative agricultural cropping method that aims to mimic the way forest plants work together symbiotically in diverse tropical rain-forests.

In the more temperate climates, a different approach is necessary, and this can be based on forest margins, with a complex transition from open meadows through herbs and shrubs to canopy trees and a dense tall tree shelter and support backdrop.

At the southern end of A/NZ a forest garden that involves a complex integration of plants from vegetables to canopy fruit trees and shelter trees has been successfully demonstrated.

TEMPERATE CLIMATE FOREST GARDENS

HUMAN IMPACTS on the ENVIRONMENT

Under present climatic conditions much of A/NZ, outside of the mountainous areas, is naturally forested, and on the lowlands with complex and highly diversifies rain-forests. Given its isolation, human habitation has a relatively short history. But most of the lowland forests have been destroyed by the human food production systems undertaken by the people who have come to this land.

A food gathering or growing that was based on forest ecosystems would be very suitable for this land, and different approaches could be implemented in all the climatic regions of A/NZ.

Significant habitation by people, sufficient to significantly alter the environment, is as recent as 1000 years, when large scale migrations by Polynesian colonisers brought the cultivation of sub-tropical vegetables, and the use of fire for cultivation, clearing and hunting. The hunting of large ground birds and the

use of fire, along with climate changes, led to the conversion of large areas of forest to grassland, especially in the South Island, and the extinction of many large birds, including all of the flightless moa, and the large Haast's eagle. The introduction of rats and dogs also led to the extermination of many small birds and invertebrates.

In the last 200 years, European exploration and settlement has had a much larger effect, especially in the North Island, and given rise to a very mixed up ecology, from introduced species and altered ecosystems. There has been the introduction, both by association and deliberately, of a vast array of plants and animals from all around the world, including grazing and predator mammals, game birds, freshwater fish, insects and many viral, bacterial and fungal organisms. At the same time, the large lowland and coastal wetlands were drained for farming use, with over 90% of all wetland areas being drained. Most of the lowland forests have been cut and burnt for pastoral and arable farming, including steep hill country, with forest cutting for timber taking place up into steep range land.

Apart from the remaining native forests on the steep mountain and range land of the main axial ranges of NZ and some volcanic mountains, the environment has been highly modified by human activities, most significantly by pastoral agriculture. Many invasive species of plants have been introduced, and introduced mammals, both domestic and wild, have profoundly altered ecological relationships, and the health of present ecosystems.

TRANSITION to FOREST HORTICULTURE

Converting pastoral land to a forest-based horticulture involves a fundamental shift from an open grassland for animal grazing, and hence animal-based food and produce, to a forest-based horticulture for plant-based food and produce. It is not a modification or reforming of the existing pastoral agriculture, or its replacement with the present conventional horticulture of

single species orchards, but a transformational change to a very different way of growing food.

This requires an involved and complex transitioning, which alters the whole nutrient recycling and fertility regime. The soil life must change to be much more complex and shift to the more fungal based life of forests. A programme of regeneration of the soil and soil life, with the build up of the fungal networks is then required.

The aim is to convert the pastoral land to an horticulture based on diverse forests that have complex and highly productive margins, and provide nutritious plant-based food all year round, as well as fibre, fuel and other natural resources.

The forests will consist of many food producing species, that form a forest ecology, with canopy and sub-canopy trees, understory shrubs and herbs, ground cover and climbers. Plants for fibre and fuel can be integrated into the forests, to allow sustainable yields, through tree coppicing and selective harvesting. There will be additional species for habitat, shelter, and nutrient accumulation, which can also provide useful resources.

As forest gardens, the plants can be laid out in different ways, while retaining the essence of a forest ecology. They can be complex forest guilds, made up of associations of plants that have different ecological niches and together give rise to a functional ecological unit. These guilds can then be laid out around a meadow area, in a horseshoe shape towards the sun (north), or as more open tree alleys on contour across a site. A wide range of crops can be planted in the open meadow or alley areas, to complement the forest food production. In this way food and other produce will be available in the short term from annual crops and in the longer term from perennial shrub and tree crops.

These layouts are like a forest edge, which is the zone of highest productivity, as this is the growth phase of forest succession.

Most of the tree crops and vegetable foods we eat come from this forest edge, and are part of a succession process in nature. It is the grain staples that come from open grasslands, and this is naturally the feed of grazing animals and birds— along with insects and the other creatures of these ecosystems.

Such forest gardens, when mature, become fully functioning ecosystems that recycle all their nutrients and require minimal interventions. This would mostly be clearing of competitive ground cover and invasive climbers, and a 'cut and drop' of vegetation to increase the rate of recycling of nutrients, and hence enhance the overall productivity of the ecosystem.

By using a diverse range of species and varieties that fruit at different times, food and other resources can be harvested continuously throughout the year, giving a wide range of produce.

The available food produced by the forests would be shared with wild animals and birds, as part of the ecology of the forest, and the recycling of nutrients through manure. Animals, birds and insects provide essential ecological services and are part of the overall ecology and its effective functioning. Some management of bird and animal numbers is, though, likely to be necessary to prevent over-grazing and ensure sufficient useable harvests.

Harvesting is more complex given the diversity and interlayering of trees, shrubs and climbers. On the other hand, once a well-functioning ecology is developed, minimal management of pests and diseases would be required. The aim of diverse forest gardens is to mimic forest ecologies and the ability of these ecologies to maintain a healthy and balanced system that is highly productive of many species while having the feedback loops than ensure resilience.

FOREST GARDENS in AOTEAROA/NEW ZEALAND

There are many different forest types in the world, and there are many different ways of arranging forests, as designed

ecosystems, to provide a wide range of food, fibre and fuel for people. Mean and extreme temperatures, and average rainfalls and storm intensities, are major influencing factors in determining land vegetation cover and the type of forest.

Some forests are very complex, with many species in close associations and highly inter-dependent, such as tropical rain-forests. These forests have layers of trees, shrubs, climbers and ground cover plants that form very diverse and multi-dimensional ecosystems. Other forests are more dominated by one or two species, with much less understory, such as the temperate zone deciduous forests of Europe and North America, or even more so the boreal forests of the higher northern latitudes.

The native forests of A/NZ are unusual, as they exist in warm to cold temperate climates, while being very complex and diverse rain-forests. They largely recycle all their nutrients within the forest biomass, like tropical rain-forests, but they also build soil, as deciduous forests do to store nutrients over winter. Within the lowland forests there is a tendency for the main canopy species to clump together, like groves, and there are vigorous understory and edge species such as the many ferns within these forests.

Forest gardens and a forest-based horticulture must be similarly adapted to the climatic and land conditions of the particular place in which it is located.

The diverse regional and local climates and landscapes of A/NZ means that forest gardens will be very different, in species composition and layout, around the country. They can also vary greatly in size, from an urban backyards that can have only a few canopy trees, to a guild of under half a hectare in a semi-rural small holding, to larger multi-guild horticultural growing in rural areas.

FOREST GARDEN GUILD
FOREST EDGE AROUND A MEADOW

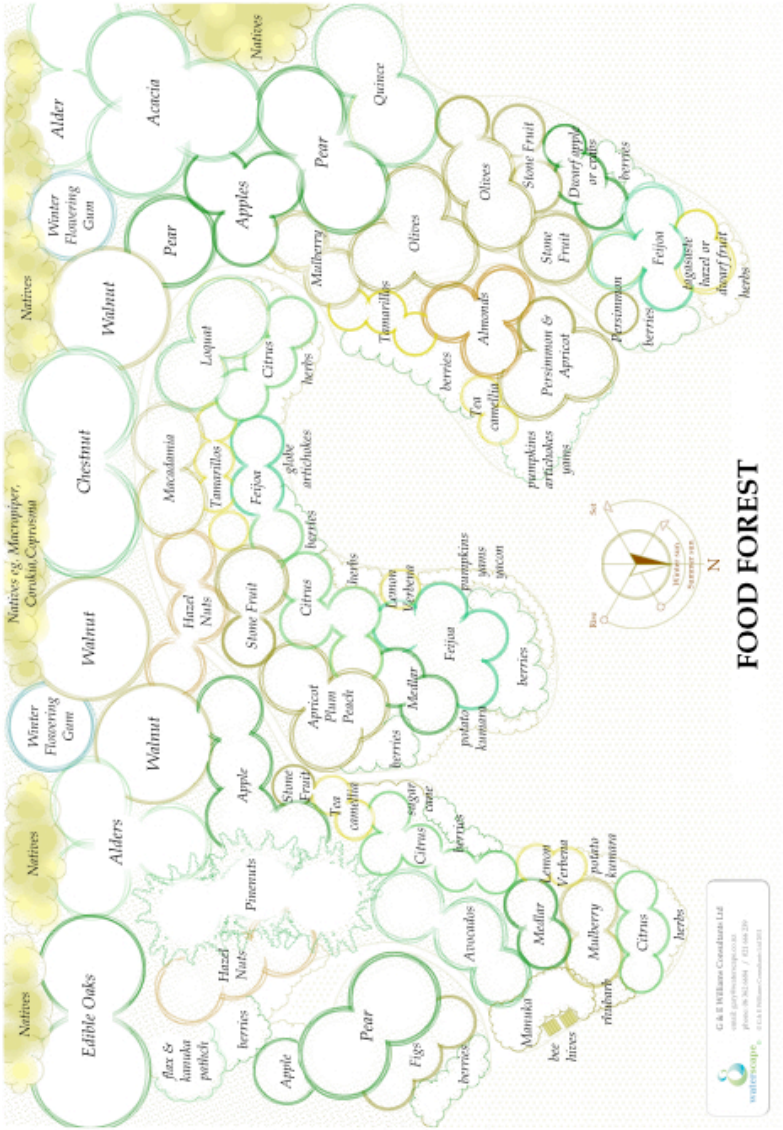

FIGURE 3

There are many small forest gardens, or food forests, throughout A/NZ, where people are experimenting with different layouts, species arrangements, ground cover plants and mulches. There are, though, few larger scale examples.

An example of a horseshoe shaped forest garden, as a forest edge around a meadow facing the sun, is shown in Figure 3. This layout was developed for the lower North Island of A/NZ, and in particular on the western coastal plains.

In 2015 a series of workshops on food forests and a forest-based horticulture were held around A/NZ. These workshops included presentations by Stefan Sobkowiak from Quebec, Canada, who outlined his row-based orchard approach. He uses mini guilds of 3 trees, one being a support tree, and different fruit tree species are separating using these trios. See https://www.permacultureorchard.com/ for a film about this orchard, or the farm website http://www.miraclefarm.ca/).

This trio approach has been used to develop templates for small area forest gardens in A/NZ. In each trio the main fruit trees and shrubs can be selected to ripen at the same time, and different trios can be repeated as mini guilds within the available area. Generalised regional climate zones have been drawn up, as shown on Figure 2, for which different templates would be suitable. As an example, three templates for the Western North Island region are shown on Figures 4 to 6. They have different canopy trees and shrub layer, with the fruit ripening in different months. These trios would also be suitable in areas of the Wairarapa and Tasman regions.

These templates are intended as a guide, to demonstrate how a start towards forest gardening could be undertaken simply. A design based on a site specific assessment would, of course, provide a more effective and well-adapted selection of species. This does, however, require the necessary experience, knowledge and observational skills to undertake effective site designs.

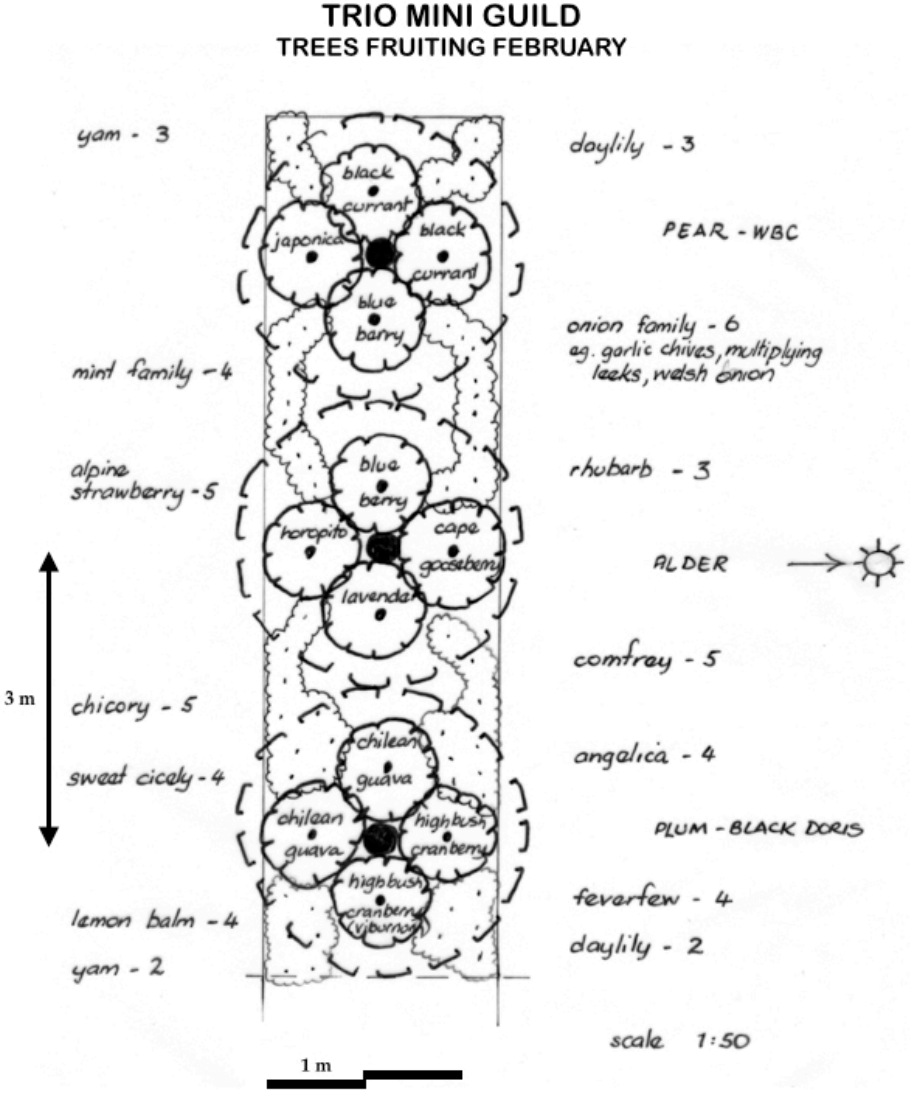
TRIO MINI GUILD
TREES FRUITING FEBRUARY
yam - 3
mint family - 4
alpine strawberry - 5
chicory - 5
sweat cicely - 4
lemon balm - 4
yam - 2
3 m
1 m
black currant
japonica
black currant
blue berry
blue berry
horopito
cape gooseberry
lavender
chilean guava
chilean guava
highbush cranberry
highbush cranberry
viburnum
daylily - 3
PEAR - WBC
onion family - 6
eg. garlic chives, multiplying leeks, welsh onion
rhubarb - 3
ALDER
comfrey - 5
angelica - 4
PLUM - BLACK DORIS
feverfew - 4
daylily - 2
scale 1:50

FIGURE 4

TRIO MINI GUILD
TREES FRUITING MARCH

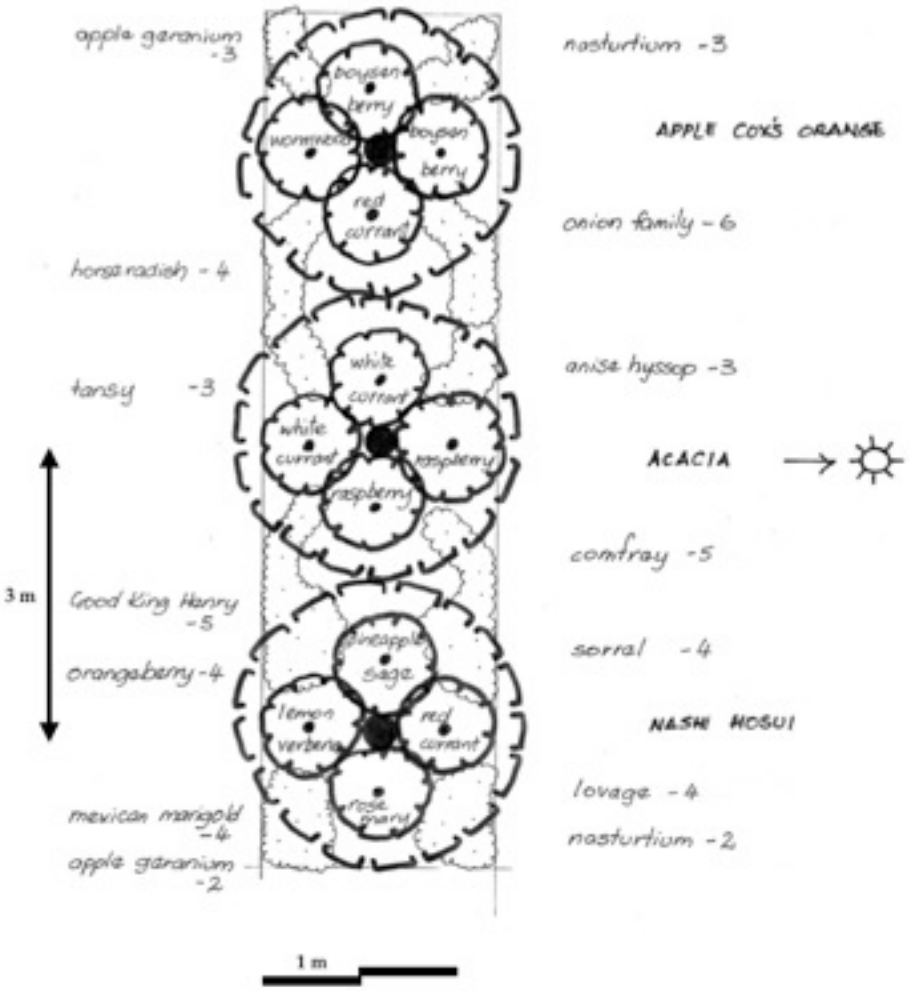

FIGURE 5

TRIO MINI GUILD
TREES FRUITING APRIL

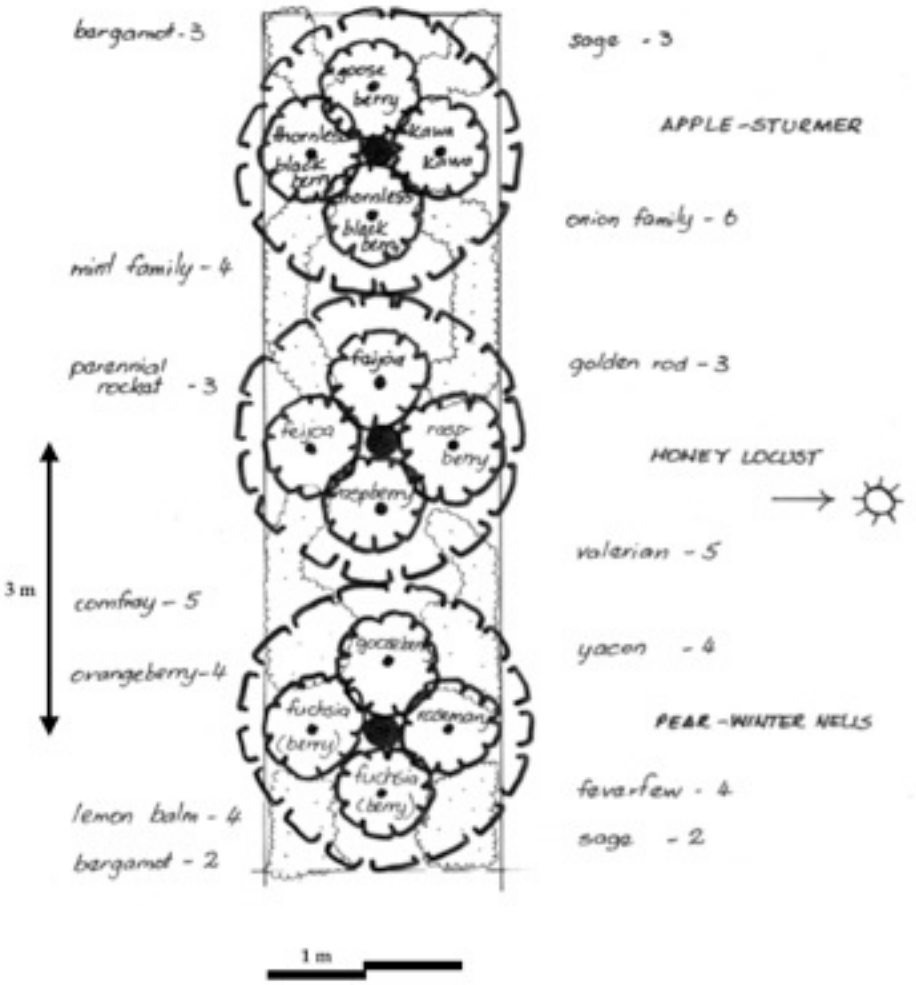

FIGURE 6

Perennial fruit trees and shrubs are reasonably tolerant of different soil types, but the choice of species and varieties should also take into account whether the soils are sandy, silty or clayey and relatively wet or dry. What is most important is the condition of the topsoil, the amount of organic matter and its soil life, and good topsoil can be built up over time on most soils.

Starting slowly with small steps is good practice, and given a chance, nature is very good at responding and flourishing, despite our inadequacies and mistakes.

Alongside these perennial plants, small scale staple crops and vegetables could be added as edge crops. This can include the 3 sisters, of corn, beans and squash or pumpkins, potatoes and sweet potatoes or kumura, and other root crops. The leafy green vegetables would then be grown further away, in a more bacterial soil environment.

FOREST GARDEN EXAMPLE

PLACE

A forest-based horticulture is being developed on a 22 hectare site in southern Wairarapa. The site is at the upper end of a valley, bounded by high terrace faces covered in native forest, with gently sloping flats down the valley. There are native forest remnants on the flats, which have been retained, and wetland areas from flows off the northern side terrace face, which provide water sources for summer watering. A stream flows along the southern side, but is now entrenched below the level of the valley flats. Thus, flooding from the stream no longer affects the flats.

The soils have a typical variability, but with a gravel subsoil in the central area and a deep layer of fine silts along both sides. The aspect of the valley, the surrounding terrace faces and the remnant bush and wetland areas give rise to a range of climatic and landscape zones.

The valley flats are at the upper end of land cleared for farming, with this area being cleared as recently as the 1960s, and was used for the grazing of sheep and cattle.

It has a lowland coastal location, within a terraced landscape, and a wide range of plant species can grow well in this environment.

The design and establishment of this development was undertaken under my project management with a diverse team that included very experienced designers and practitioners of organic and biodynamic farming.

DESIGN

Both the complex multi-species forests of lowland temperate rain-forests and the more open main species deciduous forests would be well-adapted to the climate and landscape of the site.

Two distinctly different approaches have, therefore, been taken in designing forest guilds for the site, with each of them having the character and self-maintenance of forest ecologies. One is based on the complex diversified forest, with different layers of trees, shrubs and ground plants, but as a forest edge, and thus shaped around an open (meadow) area facing the sun (north) direction. This layout and combination of plants then makes up a forest guild, in a horseshoe shape, and these guilds were repeated within the site area, with linked meadows formed into keyholes into the forest horseshoes, like a keyhole garden, but on a much larger scale.

The other approach is more like deciduous temperate forests, with main tree species laid out along the contour, like alley cropping, with wide access ways between giving an openness and edge spaces. The main trees and associated lower trees and shrubs are grouped, like natural groves, and this gives easier access for management and harvesting, while still giving rise to a diversified forest for productivity and fertility maintenance.

The open meadow and alley areas were initially retained as grassland, and mowed. These areas and the mowed grass then

added fertility to the establishing forest areas. Later these areas were used for green-feed cropping before being available for seed or food crops. All the shrub and tree plants were surrounded by mulch layers, and different mulches were used. This included bark chip, woven jute, matted wool and hemp straw, as well as water-permeable synthetic filter matting underneath these natural mulches. The hemp straw was considered the most suitable and effective mulch for the young plants.

The species used for the productive forest guilds come from many different natural ecosystems, and hence do not naturally occur together. The layout and species associations was then based on their ecological position or role in a forest, along with their suitability in terms of climate and the soil and water conditions of the land.

A wide diversity and a designed robustness is then important, and other suitable species were added in to provide ecological services and supply other beneficial produce or outputs. Shelter trees and mineral accumulators, especially nitrogen accumulating plants, were important, with the valley being exposed to the strong north-west winds of the Wairarapa.

A system of shelter zones was drawn up, with broad zones of a diversity of trees laid out across the valley, and aligned just off contour. These tree zones act as living bunds and nutrient accumulators and distributors, with the slight downslope angle allowing cool air drainage of frosts and the deflection and slowing of surface runoff from rainfall.

A regeneration of the native tree remnants was an important part of the whole forest horticultural development. Forests are fungi rich places, and there are intimate connections and relationships between forests and fungi. The regeneration of these remnants, along with a wide diversity of trees in the shelter zones would enhance fungi networks within the site and accumulation of forest nutrients. There were also opportunities for fungi growth and mushroom harvesting within these forest areas.

The surrounding native forests are well established and diversified, and there are many resources that can be obtained from these forests. There is plenty of edible food in the berries and nuts of native trees, but they are not sweet and generally small, being designed for birds and not mammals. The effort to collect this food can then be too much for the energy value of the food. There is, though, harvestable food, and there are very useful plants for medicinal purposes, as well as other useful resources in the native forests.

The two most important constraints to be considered in the design and implementation were the degraded nature of the soils and the strong winds. Establishing shelter and improving the soil structure and life were primary goals of the establishment period.

IMPLEMENTATION

The main focus initially was on the regeneration of the site and the recovery of its natural fertility and nutrient support systems. The first activities, following de-stocking and re-fencing, were to improve water movement through and over the ground, and a transition support program to enhance soil life and structure. A soil monitoring and testing program was set up, with soil amendments selected and applied on the basis of the site soil characteristics. This soil testing and the addition of amendments to stimulate the soil life was continued throughout the 5-year establishment period.

The exchange of nutrients between plants and soil life depends on the flow of liquid water into and through the ground. The initial land regeneration undertaken for the project included measures to improve water flows through the ground and the development of good pore structure.

Keyline ripping was undertaken across the valley floor, just off contour, where this could be undertaken to a consistent pattern. This ripping came off formed waterways down the valley, as

water distributor pathways. These water distributors were formed from the small (water collecting) valleys along the north eastern terrace face, with some small flow regulator ponds being formed at the exit of these steep valleys to the main valley, where they could be practically constructed.

A re-development of wetlands was considered in the larger wet areas, but because this would affect surround natural wetlands and forest margins, this was replaced with a cut-to-fill excavation to develop long water-edge margins to allow a diverse range of water margin plants, starting with native water cress.

The initial planting was of the shelter zones and some complex forest guilds along the more naturally sheltered areas with the better silty soils. The planting programme then continued for the next 3 years. Alders and acacias were planted in the production guilds and alleys as support trees, and there was a dense planting of tagasaste for shelter and nitrogen accumulation. These tagasaste were heavily trimmed in an on-going chop and drop, to manage their size and reduce wind sail area.

The native remnants regenerated by themselves very quickly once grazing stock was excluded — and wild animals restricted by a secure boundary fence, with a low mesh cover and upper electric wires. No native planting was then necessary in these areas. A range of herbs also established very quickly within the non-mowed areas, and except for some trial areas of experimental ground covers, the naturally regenerating cover was allow to grow, and mowed or cut out only as necessary for access and competition management.

The main initial management was securing the tree staking for wind protection, mowing and cutting out adventurous growth between trees, and tree forming and training for future form and fruiting.

The establishment and transforming of the site to a tree environment and the development of natural fertility and

resilience has taken the programmed 5 years. This forest horticulture is now coming into production, with a wide range of fruit species and varieties, giving plant produce all year round.

As the shelter zones become more effective and micro-climates development within the guilds more sub-tropical species could be planted. Given the monitoring of all production plants, the composition of the guilds could be altered on the basis of the success and productivity of different varieties and species at this particular site.

A extensive and detailed manual has been written for the management of this forest horticulture project, giving an overview of the project and its development, and explaining why as well as what to do in managing it.

The project has been designed and implemented with the assistance of digital imagery, and land information with the GIS location of all planted trees. Each tree is coded for species and variety and its location and condition recorded in a digital database. An example map output for a main crop alley guild and a complex forest guild is shown on Figures 7 & 8.

MAIN CROP ALLEY GUILD

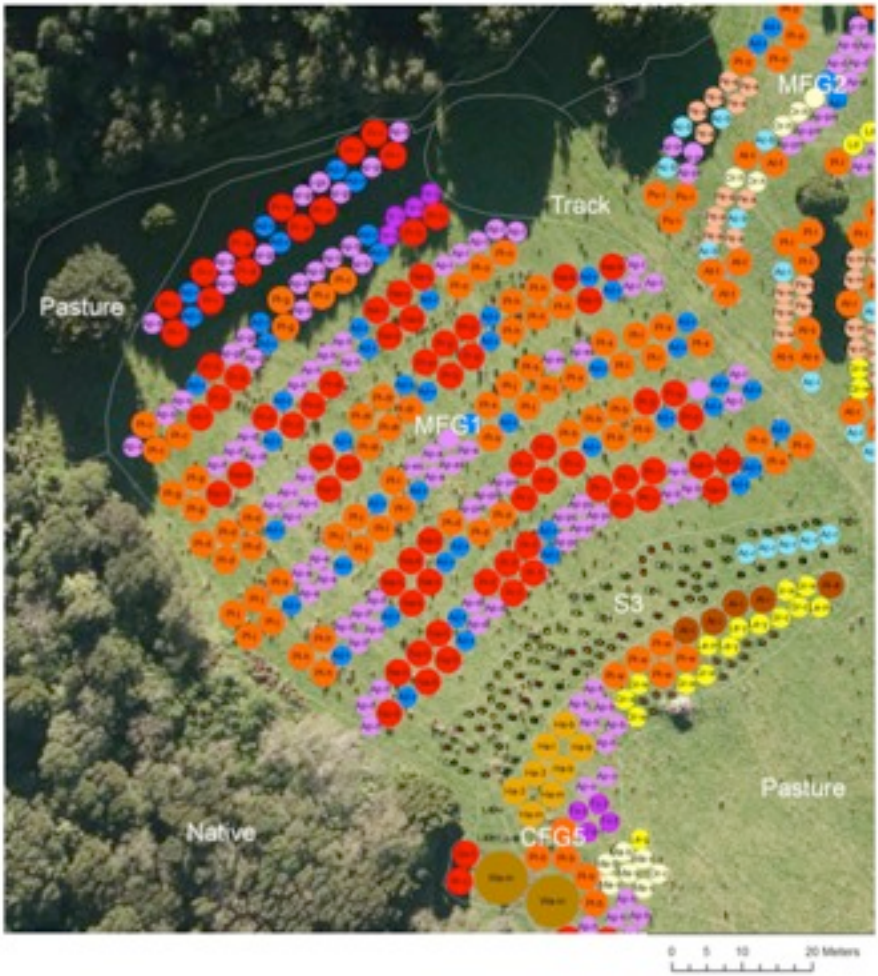

FIGURE 7

COMPLEX FOREST GUILD
AROUND A MEADOW

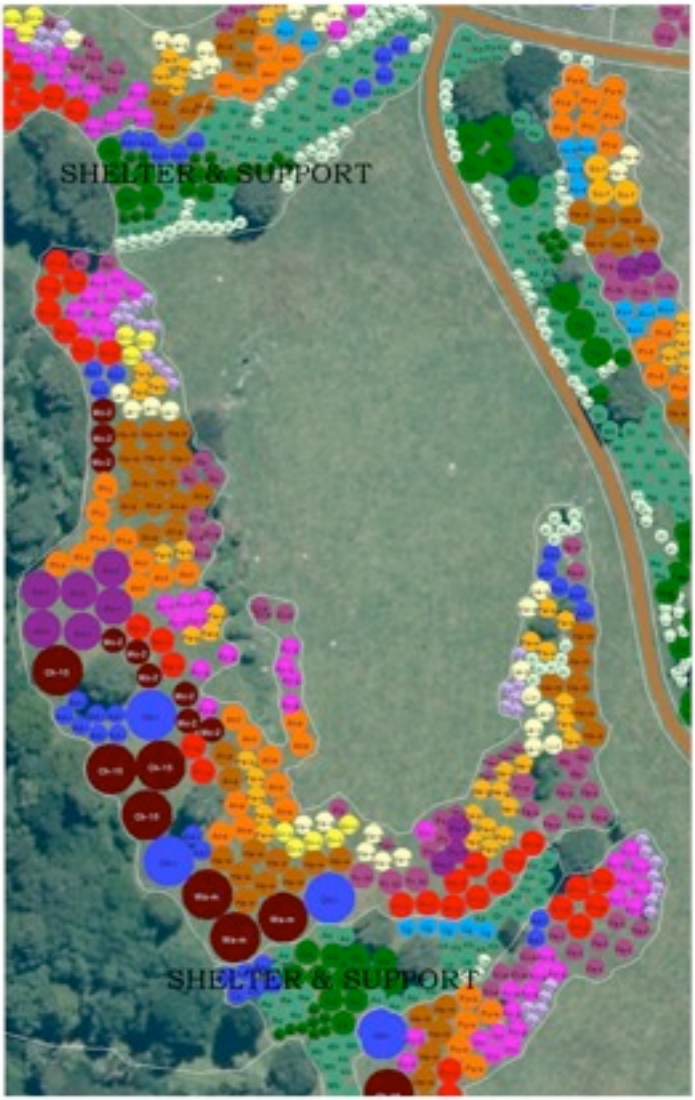

FIGURE 8

LIVING BY FOREST GARDENING

The lowlands of Aotearoa/New Zealand are well suited to a range of forest gardening approaches that can grow a wide diversity of healthy and nutritious food. These forest gardens can mimic the forest ecologies of A/NZ and other temperate biomes, and be self-sustaining with low levels of human management.

No artificial inputs from external sources are required, and machine use can be kept to a bare minimum, depending on the management approach. There is a higher requirement for human labour, but unlike the repetitive low-skill work of conventional horticulture, there is varying and interesting work. This work requires people with inquiring minds and good observational abilities, skill flexibility and an appreciation of the dynamics and continual changes of natural systems.

Instead of displacing people from rural areas, as industrial agriculture does, and continues to do so, a forest gardening horticulture would bring people back into rural areas, doing interesting and diverse work.

The food production per hectare of a forest-based horticulture is also much greater than pastoral grazing or arable cropping, while providing a wide range of food types, as well as medicinal plants, and fibre, firewood, timber and other plant resources.

As a diverse perennial plant vegetative cover it is a much more robust system than conventional horticulture, and more resilient to climatic extremes, such as extended drought, intense rainfall and strong winds. The variable cover catches rainfall and improves the infiltration of rainwater into the ground. A forest cover reduces flood flows in waterways and increases low flows from groundwater recharge. The health of waterways is then maintained along with healthy soils.

The complex root networks and diverse fungal life of the perennial plant ecology of forest gardens gives rise to deep soil

reservoirs of nutrients and moisture. This nutrient and soil moisture capacity allows a self-regulation and sharing of resources, with multiple pathways to cope with windfall, erosion and other disruptions. Any regenerative succession can also be managed to improve productivity and the availability of resources for people.

Forest gardens are also resilient to neglect, and will maintain their ecological integrity and productivity without human interventions. Their productivity of human food and resources can also be re-instated relatively easily after they have developed an untended natural state. In contrast, industrial agriculture is very fragile, and will collapse (in terms of food output) without constant interventions and the application of external inputs.

Forest gardening is, then, an approach to food growing that provides a wide diversity of nutritious plant foods, in a resilient and self-sustaining way. It can provide much more food than modern industrial agriculture, while being integral with natural ecosystems and their functional dynamics.

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www.waterscape.co.nz

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THAT IS

PRODUCTIVE & RESILIENT

ENERGY & NUTRIENT RECYCLING

HEALTHY & DIVERSE

GROWING FOOD AS NATURE INTENDED