# Integrated Land-Use Design

## A PERMACULTURE APPROACH FOR WHOLE FARM MANAGEMENT

FARMING 2030 PROJECT

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# Introduction & Overview

## The Players

**Farm**: Located in Kotinga, Golden Bay, South Island NZ

**Client**: Farming 2030, with Wayne & Tyler Langford

**Permaculture Design & Report**: Robina McCurdy (Earthcare Education Aotearoa)

**Maps & Drawings**: Nic Moon

**Photos**: Robina McCurdy, Nic Moon, Debbie Pearson, Jay Horton

**Specialist Consultants**: Trevor James (water management), Meret Weiss (Riparian Area), Jules Matthews (Regenerative Agriculture).

*The specialist consultants' material is incorporated into design recommendations in an identifiable way in the full report (sometimes in a compact or in an expanded way)*

## The Project

Initiated in June 2018, **Farming 2030** harnesses the vision and knowledge of the community, working with the skill and expertise of farm owners **Wayne and Tyler Langford**, to develop **practical sustainable farming practices**.

They have opened their farm as a practical pilot, where chosen sustainable farming practices are applied and closely monitored. The engaged community model offers farmers the support of the local community in practical implementation e.g. riparian planting.

'Farming 2030' promotes a shared understanding of how farming and environmental practices can sit side-by-side for the benefit of all. In the process it fosters a community that is better informed and unified, including through the hosting of presentations, workshops and farm field days, as well as regular media articles and networking.

Community input is generated through an "Environmental Panel". The panel has a diverse range of ages, skills and experiences. Members come to the table with an open mind, a keen eye for solutions that may not have been tried before, and a willingness to listen and work with new ideas. The project aims to keep detailed records and measurements so that successes can be replicated elsewhere in NZ.

## The Farmers

**Wayne and Tyler Langford** are young dairy farmers who are leaders in the community.

Besides being a capable and adventurous mum, Tyler's focus is on education, presentation, office management, hosting, and farm management. She keenly involves interested people who, in her words, "want to come on the journey". Tyler is strongly involved in social good in the community through school groups, Tasman District Council working groups and numerous charities.

Wayne is the 6th generation in a lineage of Langford family dairy farmers in Golden Bay. He grew up with the motto 'the farm comes 1st'. To reclaim a happy life after a serious mental health setback due to financial stress with the farm, he has shifted his priorities to: Family, Fun, Farm. Wayne's philosophy has transferred to his family through direct experience, and his 3 boys 'pull their weight' to make everything function well, participating with their parents in running the farm as a team – and consequently getting more quality time with their dad and mum! Nowadays, under the umbrella of Mental Health, Wayne does presentations to farmers groups around the country about his approach, and more.

In Wayne's role as National Dairy Chair for Federated Farmers and as Climate Change Ambassador for Dairy NZ, he is in an ideal position to disseminate 'Farming 2030' projects successes as they unfold. He considers himself a "bridge between extreme viewpoints".

Recently the Langfords' have employed Sarah, a 5th generation local who knows the ropes of farming in Golden Bay conditions well through experience. Wayne and Tyler are now trying to run the farm on 40 hours per week, instead of the 50 hours they have been putting in recently. So now Sarah is employed 20 hours per week, to run the farm 'on instruction' (rather than being a key decision-maker), her tasks being added to 'bit by bit' as she becomes more familiar with the farm's needs.

## The Farm: Description & Key Resources Inventory

### Land

This is a traditional dairy farm of 120 hectares, 93 of which is grazed by a herd of 250 cows. The remainder of the area is unsuitable for grazing due to regenerating forest, stony creek beds or amenity areas. The surrounding hills were bare from grazing 50 years ago and now are clad in native bush through natural succession. The land used to be a sheep/beef and deer farm and was then converted to dairy with a minimum of financial input. The Langfords' have replaced many fences.

The farm area is essentially in 3 parts – the main area (flats), the back blocks across the creek (hills/pakahi), and the quite separate northern area beyond the neighbours' block (Meads). It is necessary to cross the creek to get to this area with animals, and this becomes impassable during and after heavy rains. Depending on the rainfall, the ground tends to be either quite wet or very dry, as soils are predominantly clayish. However the soils substrate is very diverse (see *Soils map & Characteristics*) so across the farm drainage capacity, mineral composition, stony terrain and suitability for particular pasture species types varies considerably.

## Buildings & Structures

1 farmhouse with small nearby shed, 1 milking shed, with associated effluent system with 2 water storage tanks, 1 large 5 bay hayshed, Dome hay shed, 3 bay woolshed with implement bay attached

Woolshed

## Physical Networks

Well networked internal farm lanes throughout the property, reasonable quality fencing (fixed and electric) everywhere, water flow links are 5 large culverts and several smaller culverts, wifi + phone line

## Energy Systems

Mains power, with the intention to operate solar at cowshed (estimated 9 years 'payback'). The farm area behind the creek has solar fence units to power electric fences for stock containment.

## Main Machinery & Equipment

1 tough quad bike, tractor 80hp, tractor-pulling farm implements: such as feed out wagon, fertilizer spreader, hay feeder, calf feeders, tip trailer, spayer and seed drill. As well as farm jeep (Pajero junior) with car and calf trailers.

## Other Resources

The gum and pine block surrounding the tomo behind the house is for household firewood. The Gravel Pit is one of the farm's resources which brings in some income externally. It's operated for gravel extraction by Sollys – a local firm.

# Farm Economics

Financial success is a key area that is considered in the selection of the sustainable practices that are under trial in the Farming 2030 project.

Wayne and Tyler are open with their financial position. They have only been farming on this land for the past 5 years, and previous to that the farm had become quite run down. Wayne and Tyler currently carry a heavy debt loading, primarily from purchase and infrastructure development. This 90% debt loading weighs heavily, so all change-making decisions need to be considered in this light. In order to 'repay the bank' a focus on financial performance is essential. "Profit is necessary to stay in the industry".

Tyler says that if they were debt-free they "would speed up the Regen journey". She regularly has what she calls "courageous conversations" with the bank, as they consider the returns from Regen to be dubious, due to not having a long track-record in this country. As data is limited, it's hard to get investment, due to before and after data being requested.

Tyler and Wayne are willing for the financial impact of the changes to be measured and shared. They are committed to the economic principle of 'triple bottom line', so carefully weigh up the costs and benefits of considered sustainable systems on the farm's financial forecast, together with the environment, their family and local community.

# Farming 2030 Aims and Goals

## Baseline

- Working pilot farm that is profitable and exemplary in sustainable farming
- Quantified measurement of the impact that the changes have made over time
- The project is well understood and supported by the community and has good community engagement
- The project rigour and documentation is sufficient to duplicate the practices elsewhere
- The project has a profile NZ wide so that it can be rolled out beyond Golden Bay
- As a community we have a shared understanding of how farming and environmental practices can sit side by side for the benefit of all

## Social & Cultural Benefits

The project aims to deliver positive enduring impacts on the rural community, through:

- Strengthening the relationship between farmers and the local community by better understanding of each other's perspectives
- Facilitating important community conversations with a focus on solutions through the development of more sustainable farming practices
- Fostering greater respect for farming and a recognition that we achieve more when we work together practically towards a common goal.
- Improving family and public health by moving away from chemical sprays and additives.

- Minimising stress on the farming families, by creating work/life balance wellbeing through the application of sustainable practices.

## Economic Benefits

Overall goals are:

- Improved farm profitability
- Greater resilience to market fluctuations due to more diverse income streams

## Environmental Benefits

Aims for improvement of environmental health through sustainable practices include:

- Improved water quality in surrounding streams
- Reduced soil erosion
- Improved soil fertility
- Improved biodiversity
- Reduced greenhouse gas emission through reduced methane production and increased carbon sequestration

# Farming 2030 Key Areas

The Environmental Panel has agreed on seven key areas of focus; Soil, Water, Trees, Waste, Animal Health, Family Health and Diversity. Measurements are being developed for each of these key areas. Delivery is through the series of sub-projects below. The # coding identifies those that are the subject of this report.

- **Permaculture design #** to manage water flows, including positioning of dams, swales, plantings and wetlands as appropriate
- **Regenerative holistic grazing approach #**, including sward selection, soil testing and balancing, and cattle rotation plan
- **Buttercup management** using a biodynamic approach.
- **Biochar** application for soil improvement
- **Riparian planting #**, including species selection for fodder and cattle self-medication on planting edges
- **Carbon Credit #** tree block
- **Heritage Orchard #,** preserving generational heirloom trees from farming families in GB.
- **Waste audit** and reduce, reuse, recycle options. Led by the local high school as part of the school learning programme.
- Feasibility study for **commercial hemp**

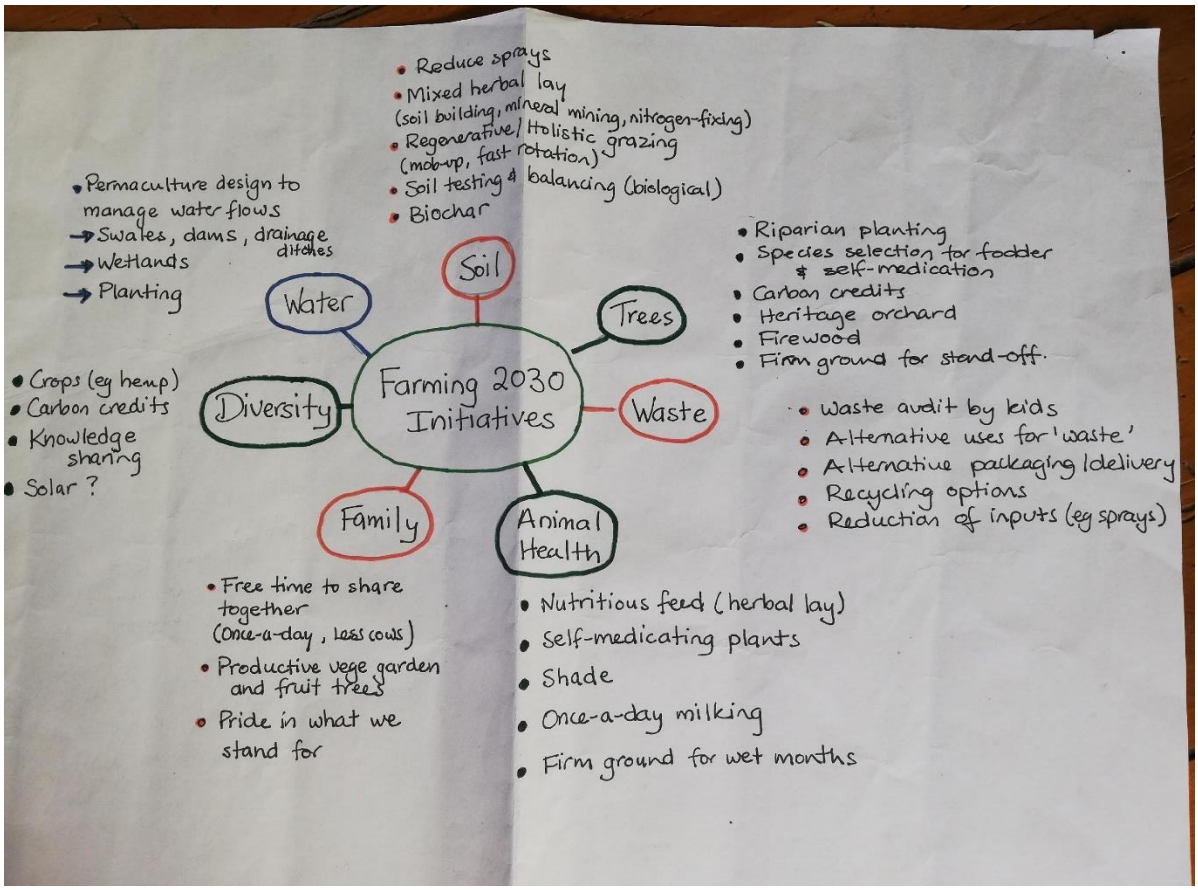
## Permaculture Consultants Wholistic Goal

From the above subcategories marked with # a consultant's Wholistic Goal was developed, from which to reference specific goals, background research, design tasks and create relevant maps. This is:

"To develop a comprehensive permaculture design and implementation plan for Go Ahead Farm which improves production, increases soil fertility, optimises water harvesting and enhances the environment. This plan integrates the work already done by environmental and agricultural specialists. The aim is that Go Ahead farm becomes a demonstration model of wholistic land use management, providing education, economic prosperity and quality of life for the whole family".

## Farmer and Farming 2030 Project Specific Goals

The mindmap below represents key areas of focus for the Farming 2030 project. This mindmap was the result of a session with the farmers and the Environmental Panel.



***Diversity*** – Diverse crops (eg hemp), Carbon Credits, Knowledge Sharing, Solar

***Water*** – Permaculture design to manage water flows, swales-dams- ditches, wetlands, planting

***Waste*** – waste audit by kids, alternative uses for waste, alternative packaging, recycling options, reduction of inputs

***Soil*** – reduce sprays, mixed herbal ley (soil building, mineral mining, nitrogen fixing), Regenerative Holistic grazing (fast rotation), soil testing and balancing (biological), biochar

***Trees*** - Riparian planting, species selection for fodder and self-medication, Carbon Credits, Heritage orchard, firewood, firm ground for stand-off paddock

***Animal Health*** – nutritious feed (herbal ley), self-medicating plants, shade, once-a-day milking, firm ground for wet months

***Family*** – free time to share together (once-a-day, fewer cows), productive vegetable garden and fruit trees, pride in what we stand for.at

# Objectives for the Farm (all quotes from Wayne & Tyler)

## Broad

"To improve existing production and increase production".

"To simplify, diversify and produce abundance, with no bare paddocks".

"Even eventually purchase more farms!"

"Be open 365 days of the year."

"For the wider community to be interested and learn about the way we produce food."

"Have other kids love the farm, like our kids do."

"Make a mountain bike track through the farm

"Have some small enterprises and a Farmstay."

## Specific

Landform – make a laneway to the new triangle back block

Trees – gum trees and pines on the hill might come down

Shade for cows is essential – group of 3 shelter belts most suitable.

Fodder trees lop and drop for supplementary feed

Less supplementary feed

Carbon Credits

Community orchard concept, with trees positioned through the farm for a picking adventure. Some for social service places e.g. local hospital

A home orchard

Increase functionality and use of farm buildings - Dome hay shed needs to get fixed up, and Woolshed only partly used (calf rearing underneath, main floor at top isn't used – storage currently)

Access – no more needed

Happy with amount of stock (maybe a little less)

## Limiting Factors

Cropping is limited due to stony soils and not much topsoil.

Tried cultivating for cropping, but just brings up the stones

Not interested in selling crops (but could lease land so others could grow crops)

Return on timber too slow (but children would benefit)

Orchard tree management challenging when scattered instead of more centralised (pollination limitations, possum management, animal protection, pruning attention, regular harvest when bearing)

Shifting stock often and using tighter spaces (up to 5x per day) as common under Regen Ag approach conflicts with their 'labour down' desire.

# Farmers Future Outlook

## Security

Through his mental health experience, Wayne is clear that his identity and life purpose isn't wrapped up in the farm. As he says: 'The farm isn't who we are." This position has already resulted in moving to lower cow numbers and once-a-day milking. It's about quality before quantity. "We want to be proud of what we produce – including taking care of the land and soil".

## Environment

Wayne wants to be surrounded by more bird life and to offer more kindness to his animals, which he sees as possible by providing trees and shade. Wayne's statement: "I feel happy when the cows are happy".

## Project Development & Management

One vision mentioned was to have an 'Environmentally Sustainable Life' manager living on the farm to assist with development and education. However, there would need to be a funding source to pay that person as an assistant. An idea was to share the role in a rotating way, similar to the farm management 'Gypsy concept' employed throughout the country.

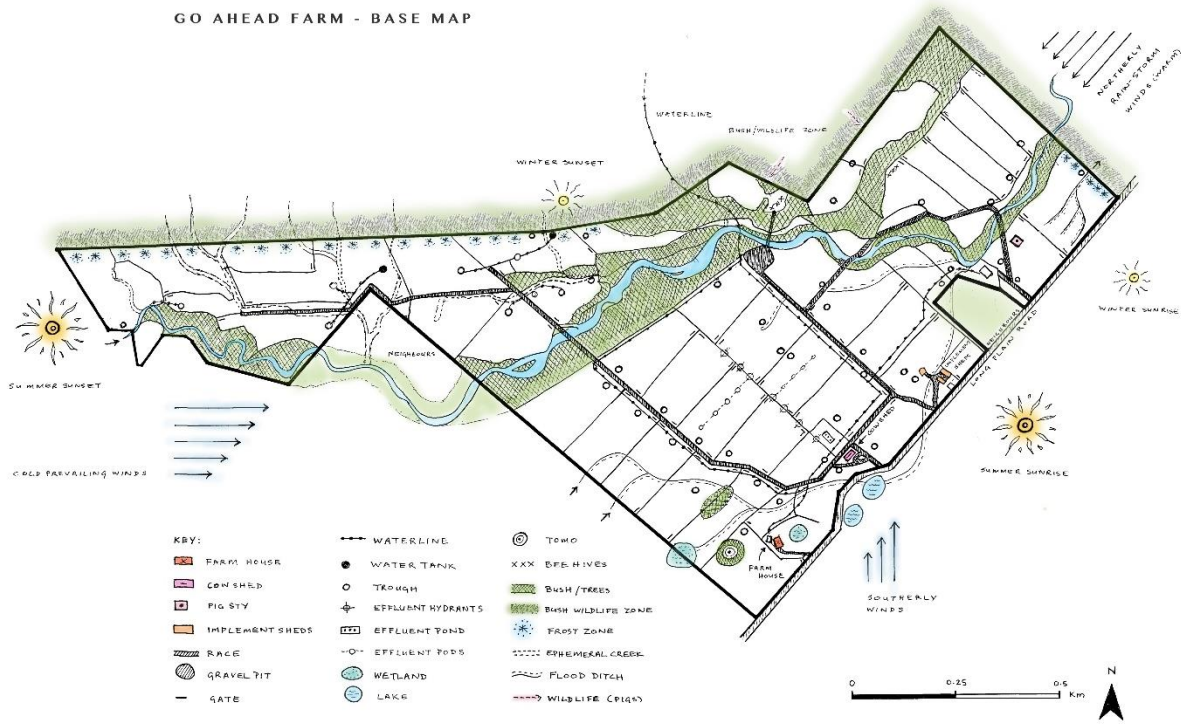
## Facilities

Although Tyler appreciates the small family home she has now, she dreams of having a big, multipurpose family home on the same site (or on the hill on neighbour's farm should it ever become available to purchase!). She wants to host people on the farm in an eco-cottage by the house or in her more spacious home. She is also interested in providing space for her family to build eventually. Subdivision could be possible, with the most conducive paddocks being two towards the northern end of the farm adjoining their neighbour.

# Farmer Family Holistic Goal

Our farm is a national-level demonstration model of regenerative land use and management practices, enabling quality of life together with economic prosperity. Our life and livelihood choices are governed by our priority motto: "Family, Fun, Farm". We are 'bridge-builders', actively strengthening relationships between farmers and environmental protectors through on-site community-wide education and engagement, facilitating a better understanding of each other's perspectives to discover common goals and create sustainable solutions together.

# Outline of Farm Permaculture Design Maps




## 1. Basemap

Includes: property boundaries, fencing, waterways, buildings & other structures, sector (external environmental influences) symbols ***

## 2. Soils & Pasture

Includes: Soil types (with reference to description of characteristics), locations of soil samples (with reference numbers to test results), Lucerne paddocks, Trial Areas with Regen Species species and, Cowshed effluent irrigation, Standing/Sacrifice paddock, Stock movement

Later: Regen Farming recommendations as an overlay.

*Pastures marked are:*

*Regen: in 2.18 on hill, 2.43; 2.43 below the hill; 3.15 in NE corner constructed wetland paddock*

*Lucerne ( in 2.47, 2.41, 2.41, 2.32, 2.56) - all on the flats*

## 3. Trees - Animal Welfare & Revegetation

**(a) Map** Includes: Infrastructure (fences, gates, crossings, roads), Shade & Fodder shelterbelts (with accompanying guild codes & single species codes), Carbon Credit revegetation area

**(b) Profile & cross-section drawings:** 5 tier guild

## 4. Water & Riparian Management

**(a) Map** Includes: farm water source, all water bodies/waterways, sinkholes/tomos, riparian zones, wetland restoration areas, cowshed water treatment, and irrigation distribution.

**(b) Profile & cross-section drawings**

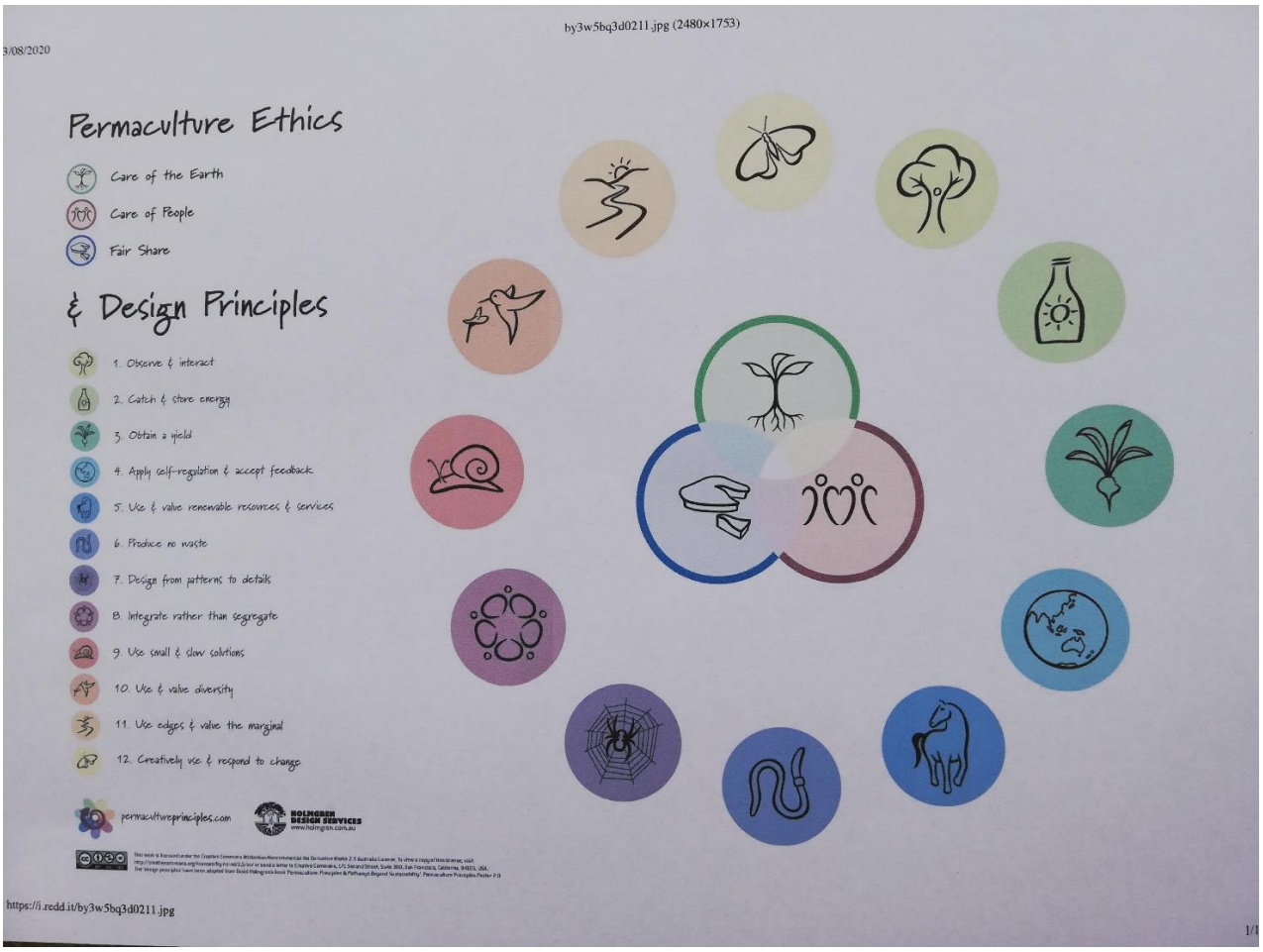
(i) Home Wetland basemap profile including classical zones
(ii) Home Wetland detailed design, including zoning and specific species recommendations with their locations
(iii) Flood Ditch profile

## 5. Orchards

**(a) Broadscale Community Orchard Design** Includes: fencing (and removed fences), relationship to wetlands area, animal fodder edge/shelter, fruit tree species code,

**(b) Intensive Orchard** Includes: fencing (and removed fences), access, structures (existing and proposed) animal fodder edge/shelter (beyond but nearby area), fruit tree species code and positioning,

# Permaculture Design Approach




## Defining Permaculture

The term Permaculture was coined by Australian's *David Holmgren & Bill Mollison* in the late '70s. They defined it in their 1st book: 'Permaculture One', as "Consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for provision of local needs."

A plethora of definitions have been coined since then, as permaculture design graduates have been designing and implementing these integrated systems within every sphere of society around the world. Here's a simple definition: "Design for sustainable land use (and social systems) based on ecological principles." A complex definition: "Permaculture is the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability and resilience of natural ecosystems. This **regenerative** design approach reflects **patterns** in nature that

build **interconnections** which enable energy efficiency and **abundance** of yield, producing sound economic **outcomes** through efficient integrated **systems** management."

Good permaculture design should always include adherence to **permaculture ethics and principles**, as well as applying sound holistic design processes. There are 3 ethics underpinning permaculture: care for people (Peoplecare), care for the earth (Earthcare) and the sharing of abundance (Fairshare). The 12 Permaculture Principles (*see diagram following*) that rest on these ethics, developed by David Holmgren and Bill Mollison, provide a foundational framework for sustainable land use design on properties of any scale, as well as a guideline for social systems design.

**Bioregion** is an important concept in Permaculture. This term refers to a geographical area which is distinct from its adjacent regions, defined by natural boundaries such as rivers or particular landforms, together with characteristic flora and fauna which are endemic or well-adapted to that region. A permaculture approach never regards a property as an 'isolated island' with its legal boundaries separating it from its neighbours and the neighbours beyond that. Instead, it references that land to the entire **watershed** it nests within, taking into account that catchment's influences on that property and vice versa.

This is particularly significant when it comes to farms. Farmers, as custodians of their land, have the responsibility to enable such actions as develop and maintain 'wildlife corridors' through riparian zones, transmute effluent through wetland restoration and absorb water runoff through managed channels flanked by water-loving trees. Permaculture intentionally designs for **resilient ecosystems**, where each species, no matter how small, has an important role to play, and the biodiversity of plant and animal life in any particular habitat creates a high level of productivity. Permaculture principles can be applied across an entire farm, in combination with Regenerative Agriculture methods, to dynamically increase yield whilst building ecosystem health.

# Permaculture Design Steps

**- with reference to Go-Ahead Farm (***in Italics***)**

**(1) Project Brief**

Defining the project's purpose and parameters, as well as the deliverables outcome scope (*for G-A Farm see Introduction & Overview section*). It is important that the consultant/designer keeps referring back to this during the process, to keep on track.

**(2) Information Gathering & Amalgamation**

Outline the physicality of the project – its location, land characteristics and relationship within the surrounding environment. Gather all maps (e.g. cadastral maps, soil maps), already researched and documented info (e.g. LIM report, water info, climate data, natural resources inventory, seasonal calendar), lists of predominant plant species well-established in the locality, investigative and design work done by any specialists. Find out about people who can provide you with useful information and have some friendly investigative conversations.

**(3) Create (or obtain) a to-scale base map** as a foundation template for future overlay maps. *Refer to G-A Farm Basemap as a clear example of what's included. For a range of types of maps and overlays, see G-A Farm Map Descriptions.*

NB: There should be a maximum of two overlays on top of a base map, for visibility purposes. This limitation doesn't exist with computer-generated maps, which can be viewed independently or as electronic overlays at the click of a button!

**(4) Client Interview**

Do full client interview to determine and form client's wholistic goal, and determine design priorities and elements. This interview can be in two parts: 'Lifestyle Questions' and 'Landscape Questions' (*for details see below*)

**(5) Site Assessment**

Walk the land (with client if possible) accompanied by a Base Map (a copy not the original) and *Sector & Site Analysis guidesheet*, which includes soils, water, microclimates, biodiversity. Mark features and info on base map and/or relevant overlay/s, and taking 'side notes' of details as they come up, and/or recording information as it's spoken. *In the case of G-A Farm, the particular focus was on water flows, flooding zones, water management and animal shelter needs.*

**(6) Identify Resource Base –** existing available resources on and off site - including physical, financial, people, skills. The information should be at your fingertips from the above steps. (Earthcare's PASE template is useful as a recording tool for this).

**(7) Design Ideation, Play & Brainstorm –** very dynamic stage of the process (all ideas are fine, pass no judgment!) Taking each specific goal and brainstorm all of the ideas that come up from the site and client interview e.g. feelings, your design ideas, site prompts, client needs/wants.

Consider creative practicable solutions to address problem areas, generate options, check out limiting factors, do action research, test hypotheses, consider beneficial guilds. Before 'clustering', talk about each idea and testing if it 'held up in reality' (check permaculture principles, ethics, client's lifestyle, site) - and eliminate seemingly non-functional options. Decide on the most sustainable achievable design solutions.

**(8) Cluster Diagram & Bubbles** (do this off map), to explore relationships between what comes up above (could colour code those which have beneficial relationship), identify wider patterns and connect beneficial relationship with another e.g. greywater system with orchard.

**(9) Permaculture Plan**

(a) Typically the 1st step is a **Broadscale Concept Design,** depicting a '**bubble map**' of zoned usage areas, based on the above, followed by a completed aerial-view **overview plan** with a **legend/key**.

(b) The 2nd step is a **Detailed Scaled-up Design** of a specific, selected area. This includes: plant species names and locations, kinds of materials (e.g. for buildings, pathways) and often technical details. *For G-A Farm we have done Broadscale Maps based on each theme needing to be addressed across the whole farm. These also have Detailed Designs accompanying them, and in some cases, example of profiles of one guild.*

***Broadscale and Detailed Designs for G-A Farm are:***

***(i) Water Systems Design***

*Comprehensive water management design - based on actuality and client's needs, with Robina and Jan and incorporating the work of specialists Trevor James and Meret Weiss.*

***(ii) Trees for Stock***

*Based on sectors, soil and stock movement, the best locations for shelter trees, cattle stand-off areas and fodder/medicinal species were determined and drawn up. A list of recommended species is provided, with their qualities and uses.*

***(iii) Orchard***

*Identifying and assessing location options for the community heritage orchard and intensive home orchard, with consideration for environmental factors and management needs. Drawing up broadscale planting patterns with all specified species positioned to scale.*

***(iv) Regenerative Agriculture***

*A specialist role, to make recommendations for the transition of the farm to a full Regenerative Agriculture system with accompanying management practices. This work is still to come. Overlay base map with soils and pastures prepared for consistency of scale and ease of presentation.*

**(10) Schedule of Implementation**

The Broad Design broken up into staging/timeline/rollout often determines what is focused on for the Detailed Design (above). Then the Detailed Design is staged

**(11) Quantity Survey**

Approximate costs of materials and labour for each aspect of the Detailed Design. *This was not part of the G-A Farm Design Brief.*

## Client Interviews

The Wholistic Goal is formed out of structured client interviews and casual conversations. Also the type of land use and amount of land required to optimally fulfil the clients' needs and wants, and the relationship of those areas of land to neighbouring areas, arises out of the Client Interview. Many other considerations and changes commonly arise.

A Client Interview can be done in any order, however it is wiser to ask **Landscape** and **Lifestyle questions** at separate times, to break up the intensity.

Landscape questions are best done actually walking the land together, with map in hand to refer to, and Lifestyle questions are better casually over a cuppa, with the opportunity to engage in trust building prior to this, as these questions could be considered as quite personal.

Our formal Client Interviews with Tyler and Wayne were a mix of both.

Here are some examples of our enquiry:

(a) Asking the clients to mark Sectors and Site (*see guide sheet below*) observations onto a large map, based on their own observations of living and working on the farm.

(b) Gaining an understanding about on-farm water functions, issues and flows. Also where they want flowing and settled water and why.

(c) Learning about their current and aspiring farming regime, especially stock movement

(d) Enquiring about present and aspired to lifestyle, based on the Lifestyle Questions below.

(e) Asking pertinent questions about diversified supplementary income, to determine aspirations and limitations

## Want to do this for yourself?

Here are some questions which can be applied to you and your property. You could even interview yourself! These questions are not specific to a farm.

# Client Interview Questions *Earthcare Education Aotearoa*

## (A) Lifestyle Questions

**1**. **Vision –** what are your life aspirations, and what is your overall vision for your property to support your current and future lifestyle.

**2. Skills & Resources**

- Your relevant **skills** and experience in managing the farm for its particular function/s.
- **Any regular work** and travel away from the property.
- **Time** availability to put into the land (also how this may change through time).
- **Other people's time** and skills (eg other family members, relatives, friends) you can call on.
- Available **money** to put into development and timeframe for when available, including paying for any labour. Of this capital, the approximate amount you would choose to put into property and how frequently.

**3. Family Demographics:**

- **Children -** how many, ages, genders, limitations/handicaps, interest/involvement

in land-based projects,)

- **Elderly dependents** living on-site and energy they require / contribute
- **Domestic Animals** - purely pets or working animals eg sheep dogs.
- **Others** - any other people living on your property / in your house who would have an influence on or be influenced by activities on the land, including participating in the developments themselves

**4. Social activities**: What social, cultural and recreational activities does your household enjoy to engage in, especially outdoors eg barbeques, sports and other kinds of play?

**5. Food Production, Consumption, Diet**

- Is your household's **standard diet**: vegan/vegetarian/omnivore/other
- **Veges** - % of year-round vegetable consumption you want to grow on the property
- What amount of **time** per week and through the year do you have available to tend a vegetable garden (once it's established).
- **Fruit** (i) % of fruit consumed you want to grow on the property (ii) Refer to '*Fruit Chart'* for specific species, marking how much you want it on that: A = plenty, B = some, C = none
- **Animal Consumption**: Would you like to raise animals to kill and consume for your household, or process any animal bi-products for consumption use **Y/N** If yes, what kinds of animals and how many do you estimate you need (including raising extra to share)?
- **Composting:** Do you make your own compost? If yes, what is your experience in doing that? Anything you want to change? If not, would you like to? What's limiting you from doing this?

## (B) Landscape Questions

**1. Relationship with Property:** what do you value and enjoy about this property and what do you find challenging.

**2. Sectors –** what do you observe about when you see first sunlight on property and where that is, and sunset (this week, as well as summer and winter solstice or near to that timing). Where do the prevailing winds come from? Then go through the rest of the sector points outlined on the ***Site & Sector Analysis sheet***, and mark in on the map just outside the boundary line, using symbols for each.

**3. History** of the property: what do you know about how the land was used for before and where specific activities occurred (mark on map). *This question mostly alerts for soil contamination and hard surfaces underneath eg concrete*.

**4. Pathways** – what do you observe about daily movement on the property (whether using formal pathways or informal routes) especially the usual walking routes (eg house to car, house to clothes line, house to feed chickens).

**5**. **Indoor-Outdoor Interface**: Are there changes to the **house** which would affect its relationship with the **outside environment** eg changes to positioning or use of inside-outside doors, new additions to house eg patio, verandah.

**6**. **Water and Energy Systems:** What is the functional state of these systems and any changes you may want to make.

**7**. **Trees and Outdoor structures**, Any comments about especially intentions to knock down /cut down or modify/add anything – what and where?

**8**. **Resource materials:** Tell me about what is available on site which could be available to use for practical purposes relating to this design.

**9.** Further questions arising from the ***Site Analysis Activity sheet***, which you would be doing together (most likely walking around with the client) or have previously done by yourself through your own observations and testing.

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# Site and Sector Survey Activity Guide

## (A) Sector Survey

Sectors are influences off-site which impact on-site e.g. sun penetration, wind, fire, pollution, wildlife. *Use coloured pens/pencils to mark on the following just outside the map property boundary.*

**1. Orientation & Climate**: North Direction (N arrow) Sunrise & sunset location & angles, Wind Directions, Airflows, Slope context

**2. Water** and its movement: runoff coming from offsite, flooding zone and direction type/s of water body (eg stream)

**3. Some Other Influences**: Noise, Pollution (eg spray drift), Fire Danger Animal Wildlife, Views

4. **Services** entering: eg sewerage, power, water, phone lines – *mark in from road to main buildings or service utility, and name what kind of service.*

## (B) Site Survey (on-site factors)

** **Soil** Sampling & Analysis has a separate sheet.*

1. Identify and name **Fixed Structures** *(if not already marked)*

2. **Topography**, slope, aspect to the sun **–** (*colour in - give your own key)*

3. **Vegetation –** identify major vegetation zones **–** note areas of: dense trees, shrubbery, open trees, grassy areas. Note key **Specimen Trees** *(name any you know)*

4. Identify **Hazards**

5. **Flows and influences** eg waterways on site, frost flows on site *(refer also to Sector influences above*

6. **Water harvesting and distribution** on site eg water tanks, spouting, taps, irrigation lines

**7. Analysis of Existing Zones –** current land use and human activity

**8. Microclimates –** note:

- very shady areas and how what created those would change through the day and through the seasons,
- very damp and very dry areas,
- exposed areas,
- sun traps, heat sinks, wind tunnels

# Animal and Pasture Management

## Regenerative Agriculture: Description and Status

Regenerative Agriculture (Regen Ag) emphasizes adaptive management strategies that seek to optimise the performance of the whole farm, for multiple benefits simultaneously. This whole-systems approach which encourages farmers to pay close attention to what individual pastures, fields, gardens, and plots of land need in order to function more like natural ecosystems, while simultaneously seeking to improve farmer wellbeing and animal welfare. It may include zero tillage, continual cover, increased pasture and crop diversity, the use of nitrogen-fixing cover crops, the avoidance of synthetic fertilisers and pesticides, and longer rotational periods for stock to give plants a longer time to recover. Through Regen Ag ecosystems thrive, the soil is nurtured, animal health and productivity improves, and pests are kept at bay.

The NZ Regenerative Agriculture research team, supported by 'Our Land and Water', MPI and the NEXT Foundation, is developing rigorous scientific methodology specific to Regen Ag in NZ, so that future research is effectively able to share evidence which isn't easily quantified using conventional academic approaches. The aim is to assemble a framework that includes multiple knowledge systems, combining academic knowledge with farmers' observations and analysis in appraising their whole system. This framework will quantify outcomes from regenerative farming activities, including: profitability, productivity, food quality & safety, animal welfare, social wellbeing, land and water quality, and climate change adaptation and mitigation.

## Steps Towards Regen Ag on Go-Ahead Farm

Wayne and Tyler and Farming 2030 are committed to shifting their farm to Regen Ag methods, and they have started by transitioning 5 paddocks to multisward vegetation. In March 2020 they sowed their 1st seed mix of 21 species. This was done by direct seeding into existing pasture. There are 6 paddocks planted in lucerne. The cows are let in to 'strip graze' for 3 hrs every 30 days for a concentrated plant protein treat.

# Soils

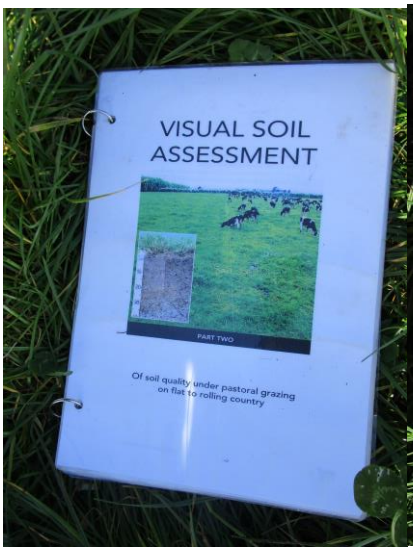

The soils overall are clayish and stony, which makes them unsuitable for commercial cropping, therefore limiting product diversity. The Soil Map (see further on) portrays and describes several soil types across the farm, however their range of characteristics is not huge. It is still worthwhile to take soil type into consideration when determining appropriate species to plant, mineral additives to apply and the best use of the paddock.

A regenerative holistic grazing approach, including sward selection, soil testing and balancing, and cattle rotation plan are all part of Regen Ag.

To obtain 'Benchmark' testing before further changing anything, soil samples were taken in mid June 2020 and sent off for Albrecht mineral analysis testing and Soil Food Web testing. Five Soil-Food-Web were taken and analysed for their soil biology composition. This included bacteria and fungi, protozoa and mycorrhiza balance. One sampling of each was taken from the following paddocks, labelled as: *Lucerne regen, Meads regen, Meads pasture, Pakahi, Home Block*.

12 samples were taken for Albrecht mineral testing – 5 were duplicated samples of the above and a further 7 gave a good spread of mineral testing across the farm.

In addition 4 blocks were analysed using the Landcare Visual Soil Assessment Guidelines.





All of these results will be used by regenerative coach Jules Mathews of Integrity Design, who will give her recommendations for soil improvement as part of whole farm advice regarding Regen Ag transitioning.

## Improving Pastures

The 6 paddocks nearest the milking shed have the best opportunity for increased **soil fertility**. They are irrigated with **filtered cow effluent** after the solids have settled out via the Clean Green Machine. Each irrigation pod covers a 50 metre circle. The system's range is limited by 200 mtrs of 40 mm pipe, which is easily moved around between the paddocks. Wayne is also interested in investigating and experimenting with Slurry Bugs for his cowshed solids, and Dung beetles which draw manure down into the soil in grazing paddocks.

Wayne is interested in experimenting with hardy native or well-adapted benign exotic grasses to provide a more **resilient forbe** than what is currently the main grass type on the farm. He is especially interested to experiment with cocksfoot.

**Buttercup** is an indicator of acidic, compact, waterlogged soil. Changing the pH and structure of the soil to facilitate better drainage, should create conditions unfavourable to its growth. However, meanwhile a biodynamic approach called 'peppering' can be utilised in an attempt to reduce its presence. Currently it is periodically sprayed.


The farm is home to several **noxious weeds** which need to be kept at bay, and are challenging to manage without spraying with herbicides. Gorse on the paddock edges is sprayed, but left alone in the riparian area to perform its succession/nursery role. Barberry and blackberry are persistent and are currently managed by hand.

There is an interest in applying **Biochar** for soil improvement. However it's a major operation to have an on-farm system, as the amount of wood material to process to provide sufficient char for a

significant number of paddocks to make it worthwhile, really needs to accompany a forestry operation. Wayne has been approached by a fledgling Biochar company in Nelson area, interested in using a working farm to trial their new biochar product.

## Animal Management

This is the current grazing pattern on Go-Ahead Farm.

There is one milking per day, after which the cows are moved on to a different paddock. The milking season runs from 10 August to 31st May. The cows are dried off and do not milk from 31st May till they start calving again on 10th August. 250 cows calve from 10 August - 22nd September

The grazing pattern is varied and managed throughout the year based on cow feed demand and grass growth.

For the majority of the season the farm is on a 30 day round and it begins to extend in autumn until we reach out to winter which is a 100 day round. The Paddocks on flats nearest the cowshed are used mostly at night.

The main thing that concerns Wayne is about his animal well-being is heat stress. Hence the focus on shade and shelter trees across the whole farm. The need to protect from cold wind chill is minimal.

Wayne and Tyler like the concept of **Companion Grazing**, where different animals occupy the same paddock but feed at different levels and on different kinds of things, or follow each other eg when the cows move to the next paddock, the chickens move into the one the cows have just vacated. But weighing up the additional workload by having another animal species to manage, against the additional income this would bring, Tyler and Wayne have decided they want to just stick with cows in their broadscale farming system.

This section provides an insight only into some of the aspects of current farming practices, and also aspiring ones. The Regen Ag expert will provide advice on the wholistic farming plan and the next steps in transition.

# Field Medicines for Animal Well-being

## Trees

Fodder trees can provide a range of healthy additives to an animal's diet and help to prevent intestinal worm burdens (anthelmintic). It's the condensed tannins in some trees concentrated in the bark, which have proven to be effective for **deworming**. These plants cause the host animal to expel the parasites' eggs, others prevent the parasite's normal lifecycle, reducing the burden the animal has to carry.

Some trees improve the **protein uptake** in the animal's gut which has been shown to help livestock **grow faster** and **resist infection and disease**. Other trees can **improve digestion**, or help to **prevent bloat** or **facial eczema**. Some can have more general health benefits, like **reducing arthritis**. Other trees can **repel flies** and **other pest insects** from their immediate zone, making them great shade trees.

Research has proven that dairy cows produce more milk if provided with shelter. Commonsense dictates that **shade** on hot days and shelter from cold winds and rain in cold weather will **increase your animal's happiness, health and wellbeing**.

## Pasture

Mixed pastures should provide a **range of forages** (grasses, legumes and herbs) that are palatable at different times of the year. They should be nutritious, containing adequate levels of **proteins and carbohydrates, minerals, trace elements and allelochemicals**. A chemically diverse range of species and a diversity of rooting depths that can bring minerals up from different layers in the soil will contribute to a balanced diet in grazing animals. Diverse pastures are more likely to withstand climatic events, and with sensitive grazing regimes will build soils. Mixed herb pastures typically renewed after 5 or 6 years, usually by ploughing under and re-sowing.



Herbs like *chicory, caraway, Lucerne, red clover and ribwort/plantain* are relatively **large plants with deep roots** and they both have a high competitiveness the year the pasture is established, and they are also the best **survivors** in a long term- perspective. In very dry periods, herbs cope better with drought than grass. Especially deep rooted herbs like *chicory, lucerne* and *alsike clover* have remarkable **drought resistance**.

It seems that the contemporary farming pastures of **ryegrass** and **clover** pastures do not provide all the nutrient requirements for growing stock, and the inclusion of other forages should improve livestock performance.

An analysis of *birdsfoot trefoil (Lotus corniculatus cv Lotanova), red clover (Trifolium pratense cv Rajah), white clover (Trifolium repens), chicory (Cichorium intybus cv Spadona), plantain ( Plantago lanceolata), caraway (Carum carvi cv Sylvia)* and *salad burnet (Sanguisorba minor)* showed that the forage herbs had higher concentrations of most **macro minerals** and some **micro minerals** than grasses and legumes.

Conventional pasture performance may also be improved when an animal is able to temporarily choose different foods from the main nutritional components of its diet to balance its internal state. Stock which are able to **graze widely** may not be exploiting the calculated feed value of a pasture, but this is often lower than the dietary intake anyway as, if they have the opportunity, stock will **pick and choose** the best and most **nutritious parts** of a plant and the best mixtures.

"Though the cow cannot classify forage crops by variety name or by tonnage yield per acre she is more expert than any biochemist at assessing their nutritive value" *Albrecht 1958 in Provenza*

## In-Situ Prevention & Cure of Common Health Issues

**Parasitism** is one of the largest problems facing livestock producers worldwide. There is an extensive literature on European herbs as anthelminthics, particularly those containing condensed tannins and phenolic compounds for example *sainfoin (Onobrychis viciifolia), chicory (Cichorium intybus), lucerne (Medicago sativa) and sulla (Hedysarum coronarium).*

Scientifically reviewed literature studies were made on the following herbs: *garden burnet, nettle, chicory, sainfoin, cock's head, birdsfoot trefoil, ribwort/plantain, dill, fenugreek, caraway, dandelion, parsley* and *medic.*

They focused on different plant ingredients, but primarily different phenolic compounds (particularly tannins), phytoestrogens and essential oils. All of these plants were found to have these beneficial qualities. It appears that a moderate **tannin content** in the feed can sometimes have a positive effect on **animal productivity** and health, for example via the effect on **protein degradation** and to overcome **parasite infections**. And there are other compounds in field herbs that can have a positive effect on health, for example for **fighting bacterial infections** or **aiding digestion**.

## Herbal Ley Species Range

The different mixtures of compounds in the herbs can also affect the quality of the animal product such as the **milk quality**. In traditional pastures in the United Kingdom, cows have been observed to like eating *dandelion (Taraxacum officinale), hairy buttercup (Ranunculus sardous), broad leaved dock (Rumex obtusifolius), Yorkshire fog (Holcus lanatus), storksbill (Erodium cicutarium)* and *Californian thistles (Cirsium arvense)* in addition to the pasture provided. These species are usually "unwanted" in the pasture, but they are the cows' preference to standard pasture grasses.

Farmers make their own experiments with herb mixtures in different combinations based on a range of factors, but primarily soil type.

**Common pasture mixtures** are: *11% lucerne (Medicago sativa), 2% red clover (Trifolium pratense), 12% birdsfoot trefoil, 8% yellow sweet clover (Melilotus officinalis), 12% chicory, 24% salad burnet, 12% ribwort plantain, 12% caraway, 2% yarrow (Achillea millefolium)* and *5% starflower (Borago officinalis).*

***Chicory (Cichorium intybus)*** is one herb which has been used continuously. This herb normally establishes quite well in the field, the cows like it, it is believed to have a medical effect on parasites and on ruminant bloat and to have a high mineral content. With its deep tap root, Chicory grows well in clay soils. The type of soil determines the species to select, and their %age of the total pasture seed mix.

***Lucerne*** is more of a 'stand alone' herb and not a part of a traditional grass mixture. It suits cutting for use as hay, as well as limited well managed strip grazing. Overeating can cause severe bloat in cows, potentially resulting in death.

***Mallow*** *(Malva sylvestris L.)* is a well-known medicinal plant, but its use in livestock and especially in rumen complaints are worth further investigation. Leaves and aerial parts are considered helpful for various digestive problems for ruminants - such as abdominal colic, tympanism, digestion, diarrhoea, constipation, and for reactivation of rumination.

**Mallow** and **chamomile** can serve as respiratory agents, likely due to their antimicrobial properties.

***Wormwood (Artemisia absinthium L.)***

Aerial parts and leaves of wormwood are used against ecto- and endoparasites, mainly in cattle. Other antiparasitics plants are *white lupin (Lupinus albus L.)* and *cade (Juniperus oxicedrus L.) Ruta chalepensis L.* and *Ruta graveolens L.* are used as antiparasitic herbs.

**Preferred pasture legumes** included: *kidney vetch (Anthyllis vulneraria), birdsfoot trefoils (Lotus corniculatus, Lotus uliginosus), sweet clover (Melilotus alba), suckling clover (Trifolium dubium), trefoil (Medicago lupulina), alsike (Trifolium hybridum), standard red clover (Trifolium pratense), sainfoin (Onobrychis viciifolia), lucerne (Medicago sativa) and white clover (Trifolium repens).*

**The range of preferred pasture grasses** included: *fiorin (Agrostis stolonifera), meadow foxtail (Alopecurus pratensis), tall oat grass (Arrhenatherum elatius), crested dogstail (Cynosurus cristatus), cocksfoot ( Dactylis glomerata), tall fescue (Festuca arundinacea), hard fescue (F. duriuscula), sheeps fescue (F. ovina), meadow fescue (F. pratensis),Italian ryegrass (Lolium perenne ssp. multiflorum), perennial ryegrass (L .perenne ssp. perenne),timothy/catstail (Phleum pratense), smooth stalked meadow grass (Poa pratensis), rough meadow grass (P. trivialis)* and *golden oat grass (Trisetum flavescens).*

**Favoured herbs** occurring naturally in old pastures include: *ribgrass (Plantago lanceolata), yellow rattle (Rhinanthus minor), sow thistle (Sonchus oleraceus), knapweed (Centaurea nigra), daisy (Bellis perennis), nettle (Urtica dioca),selfheal, ( Prunella vulgaris), wild pansy (Viola lutea), dandelion (Taraxacum spp)* and *hogweed (Heracleum sphondylum).*

| | | | |
|---|---|---|---|
| Thick Stem Kale | | 10 | Wayne |
| Vetch | | 10 | Wayne |
| Phacelia | | 10 | Wayne |
| Linseed | | 10 | Wayne |
| Rape | | 10 | Wayne |
| Black Oats | | 10 | Wayne |
| Radish | | 10 | Wayne |
| Ryecorn | | 10 | Wayne |
| Perennial Ryegrass | | 10 | Wayne |
| Cocksfoot | | 10 | Wayne |
| Broome | | 10 | Wayne |
| Companian Planting Lucerne | | 10 | Wayne |
| Phalaris | | 10 | Wayne |
| Festulolium | | 10 | Wayne |
| Chichory | | 10 | Wayne |
| Plantain | | 10 | Wayne |
| Strawberry Clover | | 10 | Wayne |
| Sheeps Burnett | | 10 | Wayne |
| Timothy | | 10 | Wayne |
| Praire Grass | | 10 | Wayne |
| Fescue | | 10 | Wayne |
| Total Kg/ Ha | 33.75 | 10 | Wayne |

## Herbal Applications

**Internally Administered Herbs**

*Chamomile (Matricaria chamomilla L.)* flowers and aerial parts have been successfully used as decoction or infusion for the treatment of **digestive problems** in livestock and **colic pain**. The major constituents of chamomile flowers are a sesquiterpene-containing essential oil and flavones.

Several plant species seem to be promising **gastrointestinal agents**. *Wormwood (Artemisia absinthium L.), elderberry (Sambucus nigra L.), yarrow (Achillea millefolium L.), and lineseed (Linum usitatissimum* seeds), may be effective for the treatment of gastrointestinal disorders, such as colic, impaired digestion, tympany, and meteorism.

**Externally Applied Herbs**

**Mastitis**, affecting the udder, and genital internal infections, occur mostly after calving, and represent a considerable economic loss for organic dairy herds. Replacement of antibiotics by herbal preparations could be helpful. The emollient properties of ***St. John's wort*** and ***mallow*** may justify their use as a topical agent for udder skin; as its antibacterial and anti-inflammatory properties are known to be effective against mastitis-causing pathogens.

There is a scientific basis for the traditional use of conifer resins for treatment of **wounds** and **ulcers**. *Aleppo Pine Resin (Pinus halepensis L.)* needles, twigs, and buds possess antibacterial activity against different bacterial pathogens so can be used in a preparation for treatment of wounds and ulcers.

Plants against cattle ringworm are *Ilex aquifulium L. and Rhamnus catharticus L. and Lupinus albus L.* which can be directly applied on the skin.

# Addressing Water Management on Go-Ahead Farm

## Critical Problem Areas & Remediation Recommendations

*(Tasman District Council Water Environmental Specialist, Trevor James' quotes are in italics)*

## Water Characteristics & Issues

Managing water is one of the most challenging situations on Go-Ahead Farm (and very likely any farm). There are several water-based aspects needing attention. Turning these into opportunities should enable the whole system 'to flow' well. For their locations and brief description, refer to the 'Soils' and 'Water Management' maps.

### Issue 1: Soils & Limited Water Infiltration

The predominantly clay-based soils on G-H Farm easily lend to soil damage and poor drainage. The destruction of the surface structure of wet soils by cow pugging results in reduced water infiltration capacity and increased surface runoff. This is most extreme in:

(a) the **'Sacrifice Paddock'**, a stand-off paddock where the cows are moved into each day during winter 'feed out'.
(b) around **water troughs**
(c) **races & accessways**

### Issue 2: Runoff Contamination from Pastures & Races

This farm has many places where water and any contaminants it carries builds up during rains, and moves from source point through natural and constructed waterways (e.g. the race between the homestead and the dairy shed) to lower profiles within the farm, or into existing wetland spots or tomos which act as wetlands, holding water then gradually sinking it into the underground aquifer.

There is a storm water channel that flows during high rain events into a sink hole on the next door property. Given that the run off from the farm is likely to feed the Arthur Marble aquifer through sink holes, achieving good water quality leaving the farm is important.

## Issue 3: Inadequate Interception at Hump & Hollow Area

There is one area on the South end of G-A Farm which has been landscaped using the **Hump & Hollow Drainage Technique** (see Appendix *'TJ Water Management Map 4'*).

This approach is the contouring of pastures into long ridges and valleys (similar to 'corrugated-iron') to improve productivity. The aim in doing this is to move water into these wide 'channels' surrounding the higher ground which is built up from the excavation. The advantage is faster water runoff and better draining, lowering the level of the water table, and preventing 'pugging' by grazing livestock. This technique is used on peat and clayish soils, particularly in areas of high rainfall.

This area of the farm needs remediation through the installation of a Constructed Wetland to filter contaminants before the water flows into the nearby stream.

## Issue 4: Poor Functioning of Wetlands across the Farm

There are several known wetland areas, ranging in size. Besides the one near the house which has been fenced and minimally planted, the rest are unfenced and unable to perform their filtering functions to support ecosystem health across the farm.

## Issue 5: Limited Functioning of Riparian Zone alongside Go-Ahead Creek

The vegetation along these ephemeral creeks is 'scrappy' in many places, with minimal diversity. It is also generally unfenced. See Water Management Map for locations.

## Issue 6: Stock Crossings

*Two unbridged crossings of the Go Ahead Creek were identified on this farm. The upper one was dry about 95% of the time and the downstream one about 60% of the time, the majority of this time being in the bathing season which means there would very seldom be a discharge likely to cause swimmers in Go Ahead Creek or the lower Takaka River health issues.*

## Issue 7: Fish Passages

*A full assessment of all culverts on G-H Farm was not completed. An impedance to fish passage was noted in the hill block.*

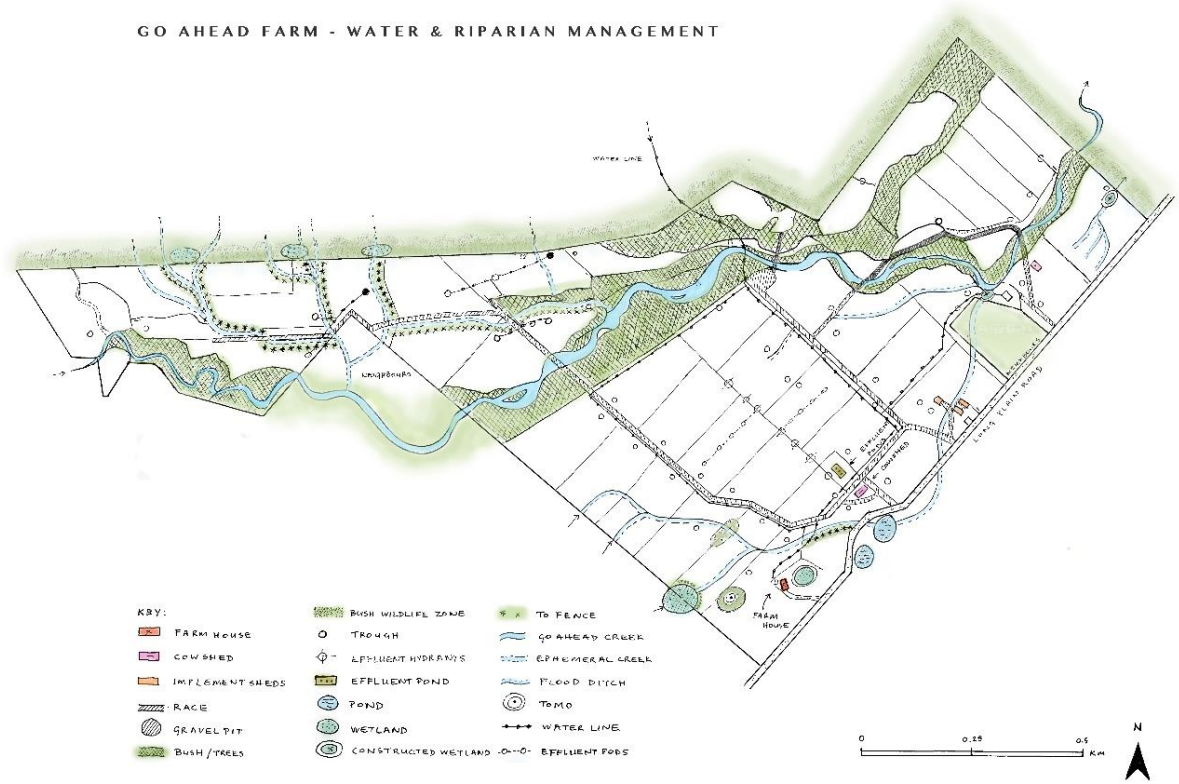
## Issue 8: Summer Drought Impact

The drought conditions over the last few years mean that soils dry out and pasture becomes parched, making the retention of water over summer months very important.

## Issue 9: Dairy Shed Effluent

This is an area to keep an eye on. Keeping up with the collection and distribution technology is paramount to enabling this potential problem to be a solution. It seems to currently be performing as it is meant to.

# Recommended Water Management Actions




KEY:
FARM HOUSE
COWSHED
IMPLEMENT SHEDS
RACE
GRAVEL PIT
BUSH / TREES
BUSH WILDLIFE ZONE
TROUGH
EFFLUENT HYDRANTS
EFFLUENT POND
POND
WETLAND
CONSTRUCTED WETLAND
TO FENCE
GO AHEAD CREEK
EPHEMERAL CREEK
FLOOD DITCH
TOMO
WATER LINE
EFFLUENT PODS

## Issue 1: Soil Damage & Poor Drainage

- Ensure as much soil cover as possible at all times - don't allow bare soil to perpetuate then degrade into a waterlogged pug. This can be remedied using Regen Ag methods – *see Soils section of this document.* Regenerative soil management will reduce water run-off, improve penetration and reduce silt. There should be no need for sacrifice paddock then, as there should be significantly less, or zero 'ponding'. Soil health will also survive droughts better.

- Support vulnerable areas such as mobbing areas around water troughs with limestone or rock platforms to elevate them and to provide a sturdy support base. Install a more effective system for water levels in troughs to prevent overflow.

- Use sawdust on accessways to 'mop up' the standing water and faeces, and in dry conditions scoop this up to sell for orchard fertiliser, or use on your own orchard – should be an ideal carbon-nitrogen ratio!

## Issue 2: Runoff Contamination

- **Sink holes**: *These could be leaky.* It is important to continue monitoring these, particularly as there is the likelihood of leaching into the underground Mt Arthur Aquifer which feeds the Waikoropupu Springs.

***Soil nitrate samples*** *should be taken to determine the likelihood of nitrate leaching.*

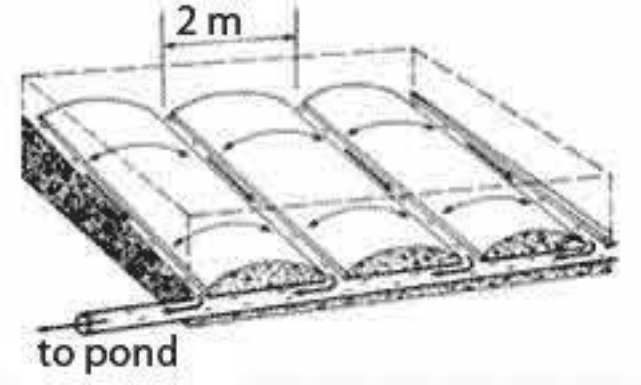
*The **upper sinkhole** by the southern boundary (Wetland 2514) may be **fenced off**, thereby becoming vegetated and less likely to crack and therefore discharge to groundwater.*

- Slow and retain water in channels using planting, fencing, 'islands' and 'sills', to protect vulnerable areas, but in a way that avoids excessive build up in wet periods. Potentially constructed filters could also be used, staged along the channels.
- Once Regen Ag approach has been decided, there might be potential to move the fences to create new paddocks through fence the channel, so a double benefit. So wherever appropriate and practicable, adapt fences and infrastructure according to regenerative grazing practice and accompany this with plantings, to provide shade for animals and water courses, with medicinal access for stock to things like flax. Doing this will also encourage ecological corridors for birds/lizards etc,
- Faecal contamination of waterways can be managed by reducing overgrazing, minimising soil treading and compaction, so as to reduce surface runoff and the concentration of dung there.
- Other farming practices need to include: ensuring **wetland protection** and revegetation, application of levels of nitrogen not in excess of plant intake, not overdoing **irrigation** water, making **subsurface drainage** (eg, mole, tile, or novaflow) systems bypass riparian wetlands, minimising access to streams by livestock.

## Issue 3: Inadequate Interception at Hump & Hollow Area

*There are several areas that would gain from installation of* ***constructed wetlands****:*

*(a)* *The* ***humped & hollowed paddock*** *in the north.* See 'Water Management Map 4'
The humped shape sheds excess moisture relatively quickly while the hollows act as shallow surface drains.




(b) *Prior to the* ***discharge to the sinkholes*** *across Long Plain Road.* This is taken care of by the recommendation of fencing off from stock and wetland species planting.

*(c) Paddocks west of the dairy shed.* The farmer considers this a lower priority.

A remediation design recommendation is the creation of a Constructed Wetland – see section entitled that. In addition, consider fencing around the hollows, though this is a lot of fencing in relation to the short distances across.

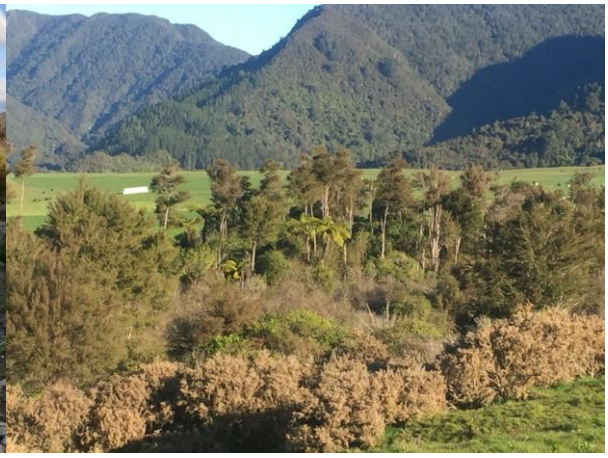
## Issue 4: Poor Functioning of Wetlands across the Farm

Wetlands have so many functions - read the special wetland description. For wetland restoration planting recommendations, look at and follow and **'Wetland Design & Plantings'** and **'Wetland Ditch Area'** sections, with reference to the **Wetlands Maps** and cross-section drawings.

Obviously it's pointless to try to establish a wetland on any farm without fencing it well. Keeping stock out is critical as they will pug and compact the soil, eat and trample native plants, contaminate the water with faeces and urine, raise nutrient levels, disturb native animals and introduce weeds. *Take up Trevor James' wetland mapping service (at no cost), to provide 'certainty for the future'*. The aquifer is a crucial part of why do ecological remediation, as the sinkhole feeds right into the aquifer.

**Current Wetland Status so far**: (refer to 'Water Management Map 6' for numbering code) ***** **Wetland 338** *has already been fenced and others such as WD 3749 may need to be if there is likelihood of damage by stock.*

- **WD 2514** *has little ecological value at present but could need protection from stock damage for water quality reasons (particularly leaching to groundwater). Cooperation with the neighbour is recommended here. There is potential to affect the health of* **Wetland 339** *(on the east side of Long Plain Road) – see Pasture Runoff section.*
- **Wetland 3755** *was not visited – it is possible that this is not a natural wetland.*



## Issue 5: Limited Functioning of Riparian Zone alongside Go-Ahead Creek

- **Plant 'buffer edges' along Riparian Zones**, creating filter strips, wet seepage zones and riparian margins with 'sponge functioning plants'. If surface runoff does occur, then this area can be used to intercept and filter out the solids. Trapped faecal organisms are killed in filter strips by exposure to environmental conditions (eg, sunlight and dehydration). 90% of sediment can be withheld by an effectively constructed filter strip. The most effective filter strips are relatively long, densely covered with grasses and sedges, and lie on land of very gentle slope. The Department of Conservation riparian guidelines (Collier et al, 1995) give details for effective use of filter strips.
- **Riparian Enhancement for Habitat Protection**: *It is not recommended to spray out the gorse in the riparian zones on the hill block, but plant in some gaps and let nature regenerate. Other areas with no gorse could be planted.*

This is addressed in Meret's staged recommendations for the Riparian Zone (see maps). Also refer to her recommendations for all steps, and species. For general information about Riparian Zones, check out sections on: The Ultimate Riparian Zone, and Riparian Zone Restoration and Riparian Area Planting Steps.

## Issue 6: Stock Crossings

Trevor says that *to control for this very small effect appears not to warrant the $20,000 cost of culverting at this stage. The downstream crossing is only used about three times per month, so technically does not need to be addressed. However, there may be options to use the paddocks the crossing accesses for purposes other than grazing*. Any considerations (such as treecrops) need to be able to handle standing water.

## Issue 7: Fish Passages

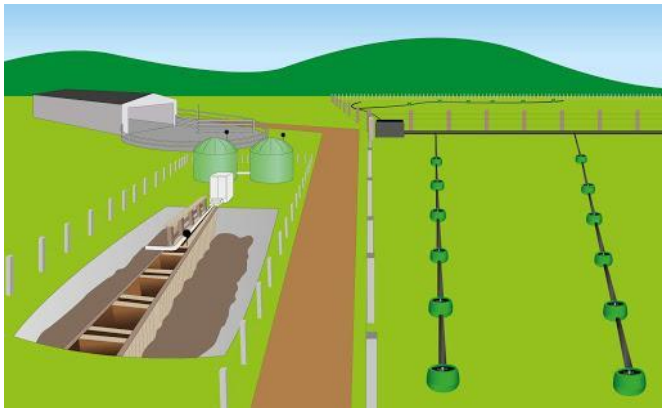
No specific recommendations at this stage apart from *investigating the 50% subsidy from the Catchment Enhancement Fund for a 450-500mm diameter culvert to provide for fish passage.*

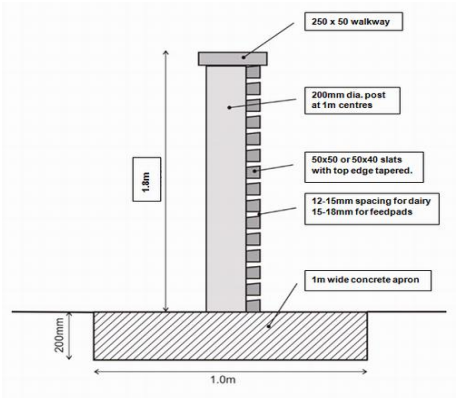
## Issue 8: Summer Drought Impact

Regenerative Agriculture mixed ley pastures are designed and managed to sustain a farm through a drought. See Regen Ag recommendation.

## Issue 9: Dairy Shed Effluent – satisfactorily remedied

G-A Farm dairy shed effluent is processed using the relatively environmentally friendly Clean Green Effluent Company's system. The solid separator is lined with concrete with the patented Weeping Wall placed down the middle. This makes it easier to clean and a more effective way to separate the solids. After natural treatment, distribution happens onto the paddocks through K-line pods, but with improved valves and other features that deliver effluent at very low application rates (1/4 ml per 24 hours), and with the ability to continue spraying effluent onto paddocks even during rainfall. This eliminates the need for large storage ponds.





**Worthwhile Water Questions to Consider**:

(1) What are the major catchment water issues and where can they best be managed?

(2) Where will the greatest reduction in water contamination be achieved per unit effort?

(3) Where will the greatest improvements be achieved for least cost/effort?

(4) How will the possible courses of action impact on farm management?

(5) What on-farm productivity and profitability benefits, and asset improvements, can be gained from better water management including reducing contaminants?

# Wetland Design & Native Plant Species Recommendations

## for Go-Ahead Farm

Wetland is broad term, including permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions. This term covers an extremely diverse range of environments including swamps, bogs, salt marshes, lakes and some river edges. Wetlands also contain a disproportionately high number of New Zealand's threatened plants and animals, a consequence of extreme habitat loss and ongoing human-induced degradation. Restoration of wetland structure and function is therefore extremely important to provide suitable habitat for wetland species and ensure that biodiversity values will be preserved for future generations.

There are several swamp wetlands on Go Ahead Farm identified by Trevor James, TDC specialist in riparian zones and wetlands. Most are not protected or maintained as wetlands, however Trevor has earmarked the most ecologically significant of these for enhancement and protection. Fortunately there are funding sources for wetland fencing. This farm has already benefited from this and should be able to continue to do so for further areas Trevor has recommended to protect.

Go-Ahead Farm's main fenced and protected wetland is situated near the house. This wetland is quite unusual, as after filling up during heavy rains, the water then moves/seeps/drains out underground into the large tomo wetland across the road. Consequently how the Go-Ahead house area wetland functions varies considerably, hence the species growing there need to be able to handle this range. *(See photo in drier conditions and compare with after two days of heavy rain).* Currently this wetland has minimal species diversity, dominated by the naturalised swamp plant *rautahi* (*Carex geminate)*. More recently several *harekeke* have been planted intermittently more towards the edges.

Besides selecting plants appropriate for moisture levels, these plants also need to be able to cope with the impact of wind, frost and sun. Typical swamp-type wetland plants include sedges, rushes, reeds, flax, and tall herbs often intermingled with forest trees which can handle

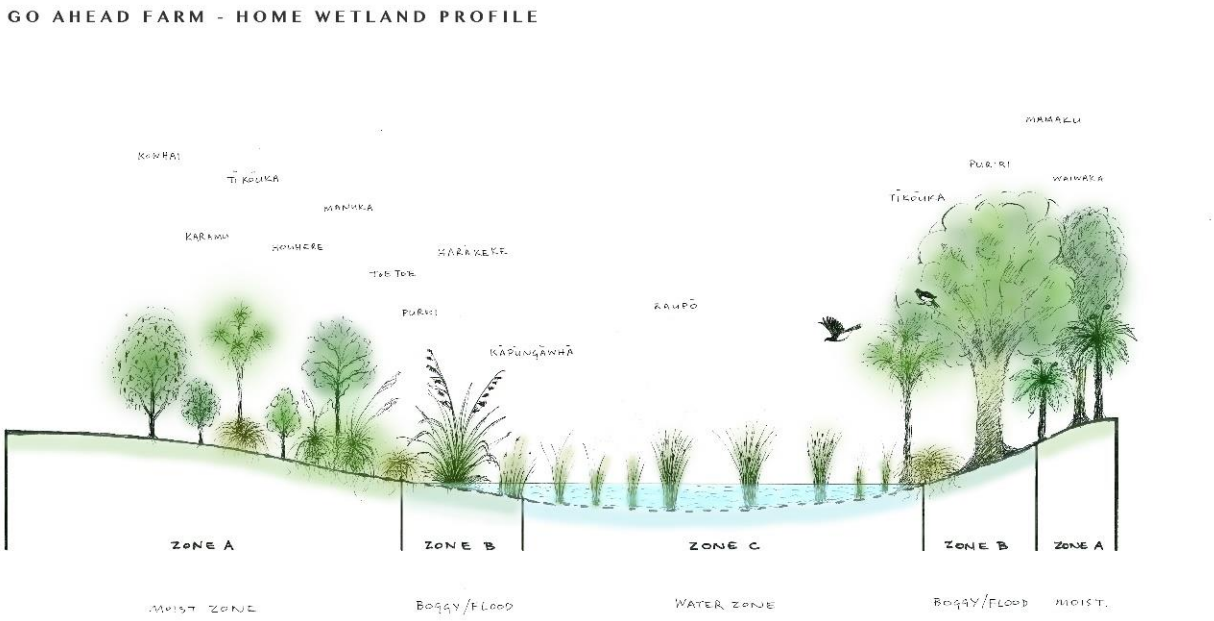
waterlogged ground eg manuka, kahikatea, pukatea, swamp maire (*maire tawake*), and cabbage trees (*ti kouka*).

## Planting & Management

When enriching a wetland, plants can be purchased from a wetlands nursery or personally eco-sourced - uplifted in the wild, if there is an abundance. Plant tough, fast-growing "nursery" species such as flax and manuka first so they can provide shelter for more delicate plants later. Plant smaller plants such as ferns and small sedges three per square metre, but larger plants will need 1-1.5sqm each. Sedges can be split or grown from seed. Emergent plants are generally installed as plants. When planted, they need to have a portion of their leaves or stems above the water surface or they will drown. If seeded, the seed should be placed either on a mud flat or at the water's edge. In the Moist Zone, species can be established as plants or seed.

**Propagation Key**
These codes appear alongside each recommended species below:
S = Seed, D = Division (downward slice at rootzone), R = Rhizome, P = an already propagated or eco-sourced plant.

# Wetland Zones




**WETLAND ZONES**

Typically a swampy wetland is divided into 3 planting zones:

(A) Moist soils surrounding the wetland

(B) Boggy ground with temporary flooding

(C) Standing water

## (A) Moist Soil Zone

Moist soils are saturated seasonally with flooding in winter, or after periods of heavy rain, and dry-down in summer. Suitable for trees and shrubs that can tolerate damp conditions but can still survive when the soil gets a bit drier.

**Recommended Species** (in order of height, tallest to shortest)

(1) Mamaku (*Cyathea medullaris*) [P] (15 m

(2) Cabbage tree (*Cordyline australis*) [P,S] (12 m)

(3) Kowhai (*Sophora microphylla*) [P,S] (up to 7 m)

(4) Mahoe/whiteywood (*Melicytus ramiflorus*) [P,S] (7 m)

(5) Manuka (*Leptospermum scoparium*) [P,S] (5 m)

(6) Lacebark (*Hoheria sexstylosa, H. populne*) [P,S] (5 m)

(7) Karamu (*Coprosma robusta*) [P,S] (3m shrub)

(8) Toetoe (*Cortaderia toetoe, C. richardii*) [P, D] (2 m grass)

(9) Red tussock (*Chionochloa rubra*) [P, D] (1 m herb)

(10) Purei (*Carex secta*) [P, D] (1 m herb)

(11) Harakeke/NZ flax (*Phormium tenax*) [D] (1 - 3 m herb

## (B) Boggy / Temporary Flooding Zone

Typically native sedges, lilies, rushes, grasses, shrubs and trees that can cope with these permanently moist (and sometimes completely saturated) conditions.

**Recommended Species**: (in order of height, tallest to shortest)

(1) Pate/Seven finger (*Schefflera digitata*) [P,S]

(2) Harakeke/NZ flax (*Phormium tenax*) [P,D,S] (*1 - 3 m herb)

(3) Mingimingi (*Coprosma propinqua*) [P,S] (*3 m shrub)

(4) Swamp coprosma (Coprosma tenuicaulis) [P,S]

(5) Pukio (*Carex virgate*) & Purei (*Carex secta*) [P]
(6) Red Tussock (*Chionochloa rubra*) [P,D,S]

(7) Kuta, tall spike sedge (*Eleocharis sphacelata*) [P, R]

(8) Jointed twig rush (*Machaerina arthrophylla, Machaerina articulata, Machaerina rubiginosa)*. [P]

(9) Wire rush (*Empodisma minus*) [P]

## (C) Standing Water / Emergent Zone

Plants which like to have their 'feet' in shallow water. These soils are saturated most of the year with water levels averaging 5 cm, also up to 1 m deep at times, at or near the ground surface. Plants are typically partially submerged with leaves, stems and flowering parts partially or entirely out of the water. These 'saturated' grow well at the water's edge.

**Recommended Species**:

**(1) Raupō** (*Typha orientalis)* [P, R]
2-4m 'herb' growing in up to 1m of water depth. It's a common sight in sheltered fertile waters, has high wildlife value, although dense growths limit access, and dies back in the winter.

**(2) Kāpūngāwhā/lake club rush** (*Schoenoplectus tabernaemontani)* [P, R]
1.2m tall slender blue-green reed that grows in fertile water up to 0.8m deep. Tolerant of fluctuating water levels. Provides good cover for shy wetland birds.

**(3) Pūrei/makura** (*Carex secta)* [P, R]
2m sedge which forms tussocks on pedestal-like stems in shallow open water and boggy margins. It's an excellent food, shelter and nesting niche for ground birds.

## (ABC) NZ Tall Native Trees

These are adaptable to all 3 Zones, so long as moisture is present (height order: tallest to shortest)

**(1) Kahikatea /white pine** (*Dacrycarpus dacrydioides*) [P, S]
Height: 60 m
New Zealand's tallest tree. Plant with side shelter in a moist site. They like companionship (intertwined roots), so plant 5 nearby in a similar area. Slow growing but utilize their eventual height for shade tree purposes and position accordingly. Possum hardy. Red fruit attracts birds in autumn. Can be grown from seed. Separate male and female trees.

**(2) Pukatea** (*Laurelia novae-zelandiae*) [P, S]
Height: 30 m
Likes swampy ground, wet gullies.
This beautiful tall tree is one of the tallest growing native trees. It's able to handle a wide variety of soils, and will tolerate periodic flooding as breathing roots develop in waterlogged soils. As an adult, it has huge buttresses to hold it in wet ground, but as a juvenile its bright red stems and serrated glossy green leaves make a great specimen. It's intolerant of drought and frost.

**(3) Mātai** (*Prumnopitys taxifolia*) [P, S]
Height: 20 m
Berries eaten by birds.

**(4) Puriri** (*Vitex lucens*) [P, S]
Height: up to 20 m
Likes rich, deep, wet soil, wind-tolerant. The puriri is a large canopy tree and a favourite of wood pigeons for most of the year, as it can hold its berries for up to eight months. It is self-fertile and can throw hundreds of seedlings in a good site. Its dark, glossy leaves are a great feature, but are frost-tender when young.

**(5) Pōkākā** (*Elaeocarpus hookerianus*) [P]
Height: 14 m tree.
Often grows with kahikatea in moist conditions.

**(6) Waiwaka / Swamp Maire / Maire Tawake** (*Syzygium maire*)
Height: up to 15 m. [P,S]
Tolerates wet ground as well as dry soil. Forms breathing roots (pneumatophores), which come up above the soil and allow its roots to breath. It had lovely bronze foliage, striking silver bark, white-cream powder-puff flowers and large, bright-red berries.

**(7) Tī kōuka/Cabbage tree** (*Cordyline australis*) [P,S]
Height: 12 m
Tolerates wet and dry soils. Young plants eaten by rabbits. Able to grow from seed. Hardy. Good for erosion control.

**(8) Manatu / Ribbonwood** (*Plagianthus regius*) [P,S]
Height: up to 10 m
Likes full sun to semi-shade, wet soil, or poor soil, will tolerate frosts, wind and dry soils, but not severe drought.
The ribbonwood is one of a few deciduous native trees, and one of the most fast-growing NZ natives. It can withstand strong winds, so it is good for borders. It passes through a bushy juvenile stage, and has male and female flowers, followed by berries.

**(9) Putaputaweta / Marbleleaf** (*Carpodetus serratus*) [P,S]
Height: 7-10 m
Likes streamsides, forests, any damp or boggy area
The putaputaweta is so named for the holes in its trunk, created by puriri moth larvae, that are a favourite housing option for weta. This small tree has large bunches of white-cream starlike flowers from November to March, then red-black berries ripen about 18 months later. However, it can be frost tender when young.

## Go-Ahead Farms: Extended Wetland Ditch Area

Two significant wetland areas exist towards the South West back part of the farm which, for environmental health, need to be fenced off from stock intrusion and actively regenerated. Planting patterns for these areas can replicate the Home Area Wetlands, and recommended species for revegetation selected from the lists provided for those three wetland zones.

The ditches emanating from these wetland areas also need to be fenced off and planted. They vary in depth and width from source (where water flows downwards) to 'destination' (see map). From the midpoint of the channel/ditch to the location where it becomes gently rolling again for sustainable grazing, the terrain lends itself to the following area profiles:

## Landscape Profiles

**Profile A**: Standard 6m on the upper (hill) side where the bank is more gently sloping and wider. The planting pattern and species selected to plant out on these banks is similar to the detail of the home wetland area, but with less range of species due to wanting to favour smaller trees/plants, keeping the height lower as the spacing is narrower.

**Profile B**: Fence at a standard 4mtrs on the main road side, where its narrower and steep yet enabling capacity for sufficient water depth and movement

**Profile C:** Where the channel/ditch widens out considerably and holds more standing and slower moving water in rain events, different 'treatment' is needed, utilising larger 'more serious' water-loving trees, which also provide shade for stock from the harshness of the summer sun. Already twelve Eucalyptus trees exist which perform this role. Their uptake of water is reasonably effective and their range of shade is well utilised by stock, proving the importance of adding more such trees into the landscape. In the outer parts of these areas where the terrain opens out, planting similar species as recommended for Profile B would be most effective.

## Recommended Species Selection

Although needing to cope with running and standing water throughout the year, and moist soils throughout a day, species suitable for these areas also need to be able to handle drier summer conditions. For species recommendations for each Wetland Profile (A, B, C) see Home Area Wetland Species list. For Profile B, add (A8) Toetoe (*Cortaderia toetoe, C. richardii*) (2 m grass); (A7) Karamu (*Coprosma robusta*) (3m shrub). For Profile C, select from the following species. These species are also recommended for profile C of the Home Wetland area.

**PROFILE C: Recommended Native Plants**

They should be planted approx 6m apart (Nos 7, 8 and 9 can be planted 4m apart). Besides absorbing largish quantities of water and providing shade, these trees also serve as bird food (berries or nectar). *See Home Wetland section for descriptions and needs of each of these trees.*

(1) Kahikatea /white pine (*Dacrycarpus dacrydioides*) Height: 60 m.

(2) Pukatea (*Laurelia novae-zelandiae*) Height: 30 m

(3) Mātai (*Prumnopitys taxifolia*) Height: 20 m

(4) Puriri (*Vitex lucens*) Height: up to 20m

(5) Pōkākā (*Elaeocarpus hookerianus*) Height: 14 m tree

(6) Waiwaka / Swamp Maire / Maire Tawake (*Syzygium maire*) Height: up to 15 m

(7) Tī kōuka/Cabbage tree (*Cordyline australis*) Height: 12m

(8) Manatu / Ribbonwood (*Plagianthus regius*) Height: up to 10m

(9) Putaputaweta / Marbleleaf (*Carpodetus serratus*) Height: 7-10m

**Profile C: Tall Exotics**

In these open paddock areas, tall particularly water-loving exotics can majorly assist in lowering the water table as well as providing shade for the animals, by their long sweeping shadows. Here are a few suitable species:

(1) **She-oak** - recommend Swamp She-oak (*Casurina glauca*) Height: 8 – 12 m Evergreen.

(2) **Shining Gum** (*Eucalyptus nitens*) 25 – 40 m Evergreen.

(3) **Alder** (*Alnus* spp) Black Alder (*Alnus glutinosa*), Red Alder (*Alnus rubra*), Italian Alder (*Alnus cordata*) Deciduous tree. Height: 15 m (can grow up to 20 m) Deciduous.

## Constructed Wetlands

Constructed wetlands are designed to harness processes that occur in natural wetlands for the treatment of wastewaters, whether they be farm or household systems. They optimise treatment performance per area of land and ensure less variable discharge quality. They are a buffer for natural wetlands, by pre-treating contamination carried by water. Constructed wetlands are most appropriate as a supplementary treatment system for farm dairy wastewaters, after pretreatment in two- stage waste stabilisation ponds or similar.

There are two main types of constructed wetlands:

- ***Surface- flow*** constructed wetlands consist of shallow, sealed channels planted with tall emergent wetland plants.

- ***Subsurface-flow*** constructed wetlands are sealed channels filled with permeable gravel, in which wetland plants grow hydroponically. Wastewaters are treated as they flow along these beds, passing through the shoots and/or root-zone of wetland plants.

**How do constructed wetlands work?**

1. **Particulate matter** (suspended solids) settles out in shallow, slow-flowing waters. Wetland plants enhance particulate removal by dispersing water flow and stabilising sedimentary material. They also shade the water surface, limiting the growth of algae which would contribute to suspended solids levels in the effluent.
2. **Microscopic organisms** (bacteria, fungi, algae, and protozoa) break down organic matter, then mineralise and transform nutrients in the wastewater. In particular, microbial slimes (biofilms) which form on the extensive surface areas provided by plants, detritus, soils and, in the case of subsurface-flow wetlands, gravels, within the wetland rapidly assimilate organic substances and nutrients, enhancing removal and decomposition. The close association of oxygenated (aerobic) and oxygen-free (anaerobic) micro-environments in wetlands promote sequential microbial transformations of organic matter and nutrients (e.g. nitrogen and sulphur) to gases such as carbon dioxide, methane, dinitrogen, nitrous oxide, and hydrogen sulphide, which are released back to the atmosphere.
3. **Nutrients taken up by plants are recycled** both by internal redistribution within plants and by leaching and mineralization of litter fall, with a proportion becoming locked up within the detritus pool of the wetland. At normal wastewater application rates, nutrient uptake and storage by wetland plants, generally only accounts for a small proportion (5-10 % on an annual basis) of the observed nutrient removal of the system. Harvesting of plant biomass is therefore not advocated as an effective nutrient removal strategy, and is not generally required for effective operation or vegetation management.
4. **Plants provide substrates for microbial metabolism** which absorb and are complex with organic and inorganic compounds. These are organic exudates, leachates, litter and humic compounds.

5. **Plants act like snorkels**, enhancing oxygen supply in their root-zones. They have adapted to life in flooded soils by developing internal ventilation systems to oxygenate their submerged tissues. This assists treatment processes by transporting oxygen down to the plant's root-zone, forming a mosaic of aerated microzones in the sediment.

## Requirements for Effective Constructed Wetland Treatment

**Space & Type**

1. **Adequate pretreatment**– the minimum for dairy farm wastewaters is a properly sized, designed and maintained waste stabilisation pond system, operating within the normal range of treatment performance for farm dairy pond systems

2. **Sufficient wetland area** to treat the waste load to the required discharge quality. Generally the larger the wetland area the better the level of treatment that will be achieved.

3. **Appropriate siting** to meet dairy hygiene requirements (>45 m away from farm dairy), ensure site stability, avoid contamination of potable water sources, and co-ordinate with other land uses.

4. **Fencing to exclude grazing** and **trampling** of the wetland by livestock.

5. **Appropriate timing and initial care of plantings** (including pukeko management) to ensure rapid establishment. Planting with species that are hardy and easy to grow, and largely self-maintaining once established, providing a dense sward of vegetation through the year.

**Technical Requirements**

1. **Simple and robust design** able to cope with variations in wastewater loadings and adapted to the specific site conditions, and careful construction

2. **Sealing of wetland base** to limit infiltration losses and groundwater additions, and exclusion of stormwater. Sufficient effluent flow to ensure year-round survival of wetland plants

3. **Appropriate shape and depth** to promote plug flow, minimise short- circuiting and maintain required flow velocities, and allow the establishment and long-term survival of wetland plants

4. **Regular checking and maintenance** to ensure correct operation of all stages of the treatment system

5. **Ensure that low water levels** can be maintained during plant establishment, and can be adjusted later. Care is needed to ensure stop logs are sealed so that water does not leak out around the edges, leaving the wetland plants dry between flow events.

6. **Role of the Weir**: Constructed Wetlands usually contain a sill or weir (also known as a 'drop structure'), as an alternative to using outflow pipes. This allows retention of water over longer periods at a fixed level of the weir crest so there is always a minimum amount of liquid retained. Any excess liquid flows over

the weir. This should enable the migration movement of some fish species eg eels.

Adjustable height weirs can be constructed using concrete and/or durable timber. A triangular V-notch can be added in the centre of the weir to enable flow estimates. This requires addition of a staff gauge to measure the height of water behind the weir. For further information see: www.engineeringtoolbox.com/weirs-flow-rate-d_592.html

DairyNZ has been working with NIWA to produce a set of provisional guidelines for constructed wetland treatment of pastoral farm run-off. The guidelines cover general aspects of sizing and siting a wetland, construction, plant selection, wetland effectiveness. It has also been working with a technical working group, including representatives from regional councils, to agree on a set of design principles and performance estimates for constructed wetlands. Based on these technical guidelines, DairyNZ will prepare practical resources to support landowners who wish to design and install constructed wetlands on their property.

# Why Restoring Farm Riparian Areas is Essential

## Overview

Protecting our valuable water resource is important for dairying in New Zealand. It also benefits the community who use water for drinking and economic, recreational, aesthetic, ecological and cultural activities. Most farmers realise that sustainable farming involves good environmental management. No matter what your water source, without freshwater, you cannot farm the land. So if you have water supplied by a stream, you have an obligation to safeguard the quality of the water leaving your property - for downstream users and for other stream life. Allowing water to leave the property with an increased bacterial count, making it unsafe for drinking and swimming downstream, is not good farming practice.

**Riparian zones** are an important component of a farm's environmental health, and require careful ecological management. They are the **strips of land** beside drains, streams, rivers and lakes. They include areas on-farm where the soils are wettest, such as wetlands, springs or seeps, and swales or gullies.

The definition "three-dimensional zones of direct interaction between terrestrial and aquatic ecosystems", emphasises the importance of the riparian area as a **link** and a **buffer**. The extent of riparian land is most clearly identified in natural unmodified areas by the existence of riparian vegetation - a **distinct assemblage of plants** uniquely suited to **land-water connection zones**.

## Benefits to the Farm Environment

When fenced and planted, riparian zones are a valuable **asset** for your dairy farm. Shade, shelter, animal fodder, timber and firewood production, nut and fruit crops, enhanced native birdlife, native forest restoration, and landscape enhancement are all objectives that are compatible with improved stream riparian (including wetlands) management.

Protected riparian zones are especially valuable for improving **water quality**. A healthy riparian area and good margin management can be very effective at **intercepting and filtering out contaminants**. They function like a sieve, helping to filter out sediment and nutrients that leave farmland in runoff before they enter waterways, and provide valuable habitats for animals.

**Managing waterways** makes practical sense in terms of **reducing soil loss** from **eroding banks**, preventing stock from polluting waterways and improving the value of the stream for native wildlife, especially when the stream is fenced and planted. They also buffer the impact of **floods**.

Much of the remedial work associated with water and waterway enhancement involves the management of vegetation and can involve **significant tree planting**. With careful planning **vegetation** can be managed and trees and shrubs planted to perform **many functions** simultaneously including the **improvement of water quality and riparian habitat**.

## Intact Ecological Habitats

In pre-farming times, most small streams were heavily shaded (over 90% shade). The plant and animal life within the stream was specifically adapted to high shade, low temperature waters, and an array of organic matter (leaves and wood) delivered to the stream from the surrounding vegetation. Due to substantial vegetation cover there was considerably less soil and streambank erosion. The stream followed a natural meandering pattern that created some fast flowing areas and some slow eddies. The waters were clear, cool and almost free of pathogens. Forested upper catchments intercepted a significant portion of the rain, so that floods were less frequent than they are today.

Riparian zones were favoured habitat and dispersal areas for birds, insects, amphibians and other animals because of the easy topography and abundance of food and water. Plant diversity was readily maintained, thanks to seeds brought by animals (especially birds), winds, and waters.

## Ultimate Conditions for Native Flora

Natural, unmodified riparian zones typically extend from the stream edge, across the floodplain to

the base of the hills and, in steeper catchments, at least part way up the slopes. Prior to human settlement, much of this was forest covered and there was a wide diversity of plants. **Canopy tree species** such as *rimu, totara, miro, matai, kahikatea,* and *rewarewa* grew widely in these zones, and other tree species such as *cabbage tree, kowhai, ribbonwood, lacebark, putaputaweta* and several tree ferns were also characteristic.

Under these trees and around the edges a **rich subcanopy** of *Coprosma species, mahoe, pate, kamahi, tree fuchsia, five-finger, wineberry* and many other species abounded.

The associated **riparian wetlands and seepage zones** were often more open, with *flax, toetoe, sedges* and *rushes* predominant, as well as a scattering of cabbage trees and divaricating shrubs such as *mingimingi* and *twiggy tree daisy*.

The **margins of streams** flowing through unforested areas were dominated by *tussocks* and *sedges*.

**Plant assemblages similar to these can be restored over time in most modified riparian zones**. However, the order in which these are established will vary with the degree of modification and the proximity of healthy native forest.

## Establishing Conditions for Native Fauna

Our NZ waterways and riparian zones are used by a wide array of native fauna species including over 450 species of **insects, giant snails** and **worms, freshwater fish, frogs** and 88 **terrestrial bird species**. A large percentage are not found anywhere else in the world, and many are threatened.

For the restoration or re-establishment of an area of indigenous riparian habitat, the **zone needs to be of sufficient size** to attract native birds and insects and sufficiently wide for there to be a bush interior not exposed to the climatic extremes of the bush edge ("edge effect"). Later successional species of plant (including subcanopy species such as *tree ferns, kanono* and *pate,* and canopy tree species such as *totara and kahikatea*) prefer protected interior zones. They are less likely to regenerate naturally if a protected forest interior does not exist, nor will they arrive if birds are not attracted to the bush.

**River channels are natural corridors** for the movement of animals from one large area of bush to another. By their very nature riparian areas are long and narrow and so have a sizeable edge. This exposes each area to greater risk of weed invasion, its animal inhabitants to increased predator pressure, and its vegetation to increased risk of devastation by flood and wind. The greater the area of continuous bush cover, the lesser the risk to the flora and fauna.

The greatest benefit to indigenous biodiversity is likely to be gained where riparian bush restoration is focused on **restoring existing bush remnants** and on **joining existing fragments**.

As **dairy farms** occupy **2 million hectares** of NZ's land mass, their riparian zones provide an **essential ecological niche** as wildlife habitats and food sources. Many streams running through pasture have surprisingly high levels of shade (50–70%). This is largely provided by stream banks and by bank vegetation, but this is considerably less on farms than in forested streams (typically around 95%). The amount of shading has a significant impact on water.

**Water temperature** is an important determinant of habitat suitability for a wide range of aquatic flora and fauna. The **temperature of farm waterways** varies with climate, elevation, groundwater inputs, shade and flow, as well as from human activities such as farm discharges and water abstraction. Water temperature also varies from season to season and throughout the day. Small streams heat up and cool down more rapidly than larger streams and hence may be more responsive to changes in riparian shade. Pasture stream temperatures often exceed 20°C, which is too high for aquatic natives to thrive in. Shade levels of about 75 percent are sufficient to maintain water temperatures comfortably below 20°C. In the very smallest streams, the shade from stream banks, the surrounding land and overhanging plants may be sufficient to maintain acceptable water temperatures, whereas in larger streams tall riparian vegetation is necessary to lower water temperatures.

As well as influencing water temperature, **shade**, by reducing light levels, has a direct impact on **aquatic plant growth**. A reduction in stream lighting will produce an equivalent reduction in aquatic plant production. A major concern with open stream reaches is that algae and aquatic plants may grow to nuisance levels. This is more likely in **agricultural catchments** where **waters are enriched by nutrients**.

## Riparian Planting for Fauna

As is the case with native plant restoration on most land types, the establishment of a **diversity of plants** representing different species, plant sizes and forms and with different leaf shapes will improve the variety, continuity and abundance of food available to instream fauna. Exactly what plants are established when will depend on the conditions of the particular stream.

**Recommendations for inclusion** in the variety of natives for the enhancement of instream food supply are:

(a) a mixture of species with **soft leaves** (eg, wineberry, tree fuchsia, koromiko, mahoe and pate) which break down rapidly, and **hard leaves** (eg, *titoki, karamu, lemonwood, kohuhu, five-finger and kamahi*) which break down over longer periods

(b) a mixture of species with **larger leaves** (eg, *wineberry, karamu, tree ferns, five-finger and pate*) which are more likely to stay resident in a stretch of stream for longer, and small leaves (eg, koromiko, red matipo, and kohuhu) which are more inclined to be moved downstream

(c) a selection of **shorter lived species** (eg, *wineberry, karamu, koromiko, and kohuhu*) which are more likely to supply rapid sources of **woody debris** to the stream

(d) trees and shrubs with a **weeping habit over stream edges** (eg, *toetoe, Carex species, flax, kowhai, native brooms and tree ferns*) to supply a variety of **insects** and other invertebrates for **fish**.

## Native Freshwater Fish

**Thirty species** of native freshwater fish (as well as 20 introduced species) reside or spend a significant part of their life cycle in New Zealand's rivers and streams. **Fifteen species** have a marine phase in their life cycle so access to and from the sea is crucial if they are to survive.

Although your farm may seem a long way from the coast, the streams on your land could be a vital link to and from the sea for fish. About half of our native fish species are **migratory** and require access to or from the sea at some stage of their life. **Dams, weirs and elevated culverts** which create barriers to fish movement can prevent these species completing their lifecycle.

Native fish occur from sea level to elevations exceeding 1500 m but the greatest diversity can be found in **low-elevation streams** close to the sea. *Banded kokupu* and *koaro* prefer fast flowing, rocky bottom streams while inanga and *giant kokopu* live in swampy, lowland waterways. The young of all these species make up the whitebait catch. These species rely on **streamside cover** to provide cool, sheltered habitat. Water temperature and clarity, dissolved oxygen, toxic substances and nutrients all have an effect on the **feeding, spawning and health of fish**.

## Protecting Fish Habitat

Protecting fish habitat is important for the future of conservation and recreational fishing. A number of things can be done to enhance the value of streams for fish - and in the process, safeguard water quality for other users.

**Fencing streams** to restrict stock access.

**Providing cover and shade** by maintaining overhanging plants alongside the stream.

**Planting trees, shrubs or flax** along the northern, sunny side of the stream to shade the water. This keeps the water cool, slows down the growth of aquatic plants and in the process, acts as a filter for farm runoff for the betterment of water quality.

## Fish Survey on Go-Ahead Farm

A fish survey of the GoAhead tributaries was conducted in Jan 2019 as an assessment of the health of the stream. The presence of Caddisflies and Mayflies indicated good water quality. There was an abundance of koura, some eels and frogs. See the Appendix for the fish survey report.

## Water Ecology & Farm Drainage Ditches

It is increasingly recognised that drains and artificial waterways play important environmental and ecological roles. They are an important habitat for a range of key conservation, commercial and recreational animal and plant species and sources of mahinga kai for iwi. The draining of wetlands, as well as the clearing of riparian zones along streams and rivers, has resulted in the significant loss of fish and wildlife habitat. As a result, drains and smaller waterways may provide the **only alternative habitat within a region** for important native species, and through their linked to larger systems farm drains may provide refuge for native fish.

On the negative side, **drainage ditches** (as they accumulate nutrients, sediment, herbicides and pesticides) act as conduits for a range of agricultural chemicals and other contaminants from farmland where they merge with natural waterways flowing into larger aquatic systems such as streams, rivers and lakes. Diffuse pollution also occurs when nutrients or other contaminants are leached through the soil into groundwater.

Agricultural non-point sources account for 75 percent of the **total nitrogen loading** to New Zealand surface waters. Urine and dung from livestock and the application of nitrogenous fertiliser are the principal sources of high nitrogen levels on farmland. Nitrogen is lost from pastures and cultivated land as surface runoff, or leached through the soil to groundwaters in the form of soluble nitrate nitrogen, especially during winter.

Once nitrogen has found its way to groundwater, it can only then be treated where the groundwater reappears at the surface such as at springs, seepage zones and wet areas at the base of hills, and sometimes seepage zones along stream banks. The retention of these wet areas with the vegetation that typically grows in them is essential if nitrogen is to be removed from the emerging groundwater that flows through them. Provided there is plenty of suitable organic matter, anaerobic conditions exist, and hydraulic conditions are such that suitable retention times exist, in excess of 90 percent of the nitrates in the incoming water can be removed.

These drains play an important part in that. Whether they are natural streams or wetlands that have been substantially modified, or channels constructed specifically for drainage purposes, they link **physically and biologically to the wider catchment**. Upstream activities on surrounding land affect drains, which in turn affect downstream systems, which eventually flow into natural streams that connect to **larger aquatic systems** (eg, rivers, wetlands, lakes and estuaries).

# Steps to Restoring Go-Ahead Farm's Riparian Zone

## Go-Ahead Farm Riparian Landscape Description

This farm has many types of what can be broadly classified as Riparian Areas. The existing wetlands, and areas (including channels) which poorly perform wetland functions as they are not

protected or revegetated, are discussed separately in another section. The riparian area alongside the streams is the focus herein. This is a mixture of moist and dry banks along a waterless stony streambed which becomes swollen like a river in heavy rains. This huge volume of fast flowing surface water then disappears into the underground aquifer when the weather fines up.

Having a plan is the key to getting value for your money and doing it right the first time. These basic steps, which incorporate local environmental planner Meret Weiss's recommendations, can be applied to any farm riparian zone besides this farm. Your riparian plan should cover these stages: **fencing,** followed by **planting,** accompanied by **maintenance.**

## (A) Fencing

Livestock trample and graze plants. They also damage banks and defecate in water, adding sediment, nutrients and bacteria which reduce water quality. Well-constructed permanent fencing will guarantee stock exclusion.

Follow these tried and tested steps:

**(1) Mapping:** Map your waterways and create a fencing plan based on the points below. Work out fence lines and crossing points.

**(2) Past Flooding Experience**: To avoid losing plants in floods, determine how your waterway behaves in full flow. This will help you decide where to place fences and what to plant. Set fences back from the regular high flow height. This may be quite different from the low flow height.

**(3) Runoff Funnels**: Identify areas on your farm where runoff funnels water most frequently or erosion occurs. These areas have the greatest effect on water quality and include seeps, springs, swales, gullies, eroding banks, boggy areas and wet soils. These should be part of the fenced area and prioritised for planting. Bank reconstruction might be needed before planting.

**(4) Decide what is manageable**: Fencing can be completed reasonably quickly, whereas planting and follow-up maintenance takes longer. Set a realistic timeframe and budget for planting. For example, by planting 25% of the area per year, riparian zones will be complete in four years.

**(5) Choose a Fencing Setback Distance**

The aim of the setback is to slow runoff enough to ensure as much bacteria, nutrients and sediment as possible are filtered out before they enter your waterway. A setback distance for a healthy riparian zone should vary on-farm to reflect different soil types, slopes and flow.

A wider setback is needed on steeper paddocks, longer paddocks and heavier soils, because these all generate fast flowing runoff. On flat to undulating land, relatively small zones of 3-5 m are still capable of reducing nutrients, sediment and bacteria entering waterways.

When choosing the setback distance of your fence, keep in mind what you want to achieve by planting the zones. If you want to create shade for your stream to reduce weed growth and keep streams cool, you may need wider zones to allow more space for the trees. If you want to filter nutrients, sediment and bacteria from runoff, then smaller zones (3-5 m) with shrubs and grasses will still be effective.

A grass strip at least one metre wide should be left between all fences and waterways to help filter sediment, phosphorus and faecal bacteria from runoff before it reaches the water. The grass strip will also prevent plants from tripping electric wires or being grazed.

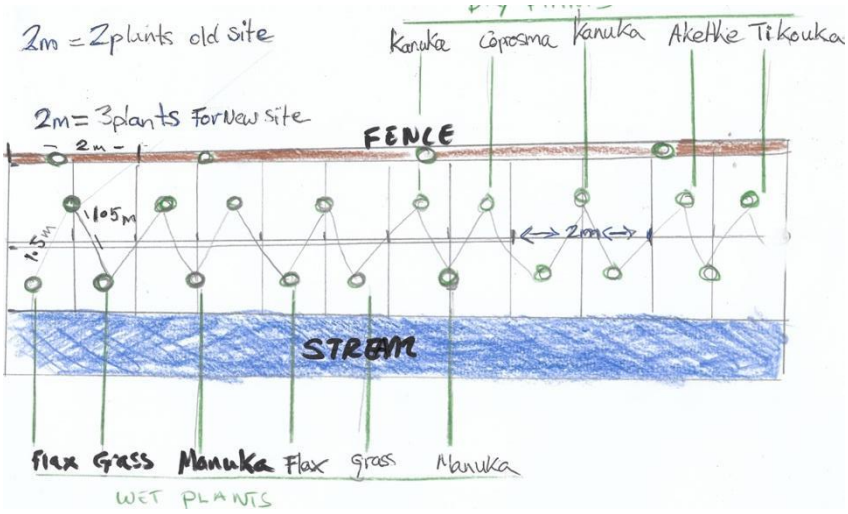
Fencing will be at least 4 metres from the stream giving us a two metre margin to plant in**.** If the distance between stream and fence is only two metres there is no point in planting as the overall beneficial effects will be completely lost.

## (B) Planting & Maintenance

### (1) Locations on Go-Ahead Farm

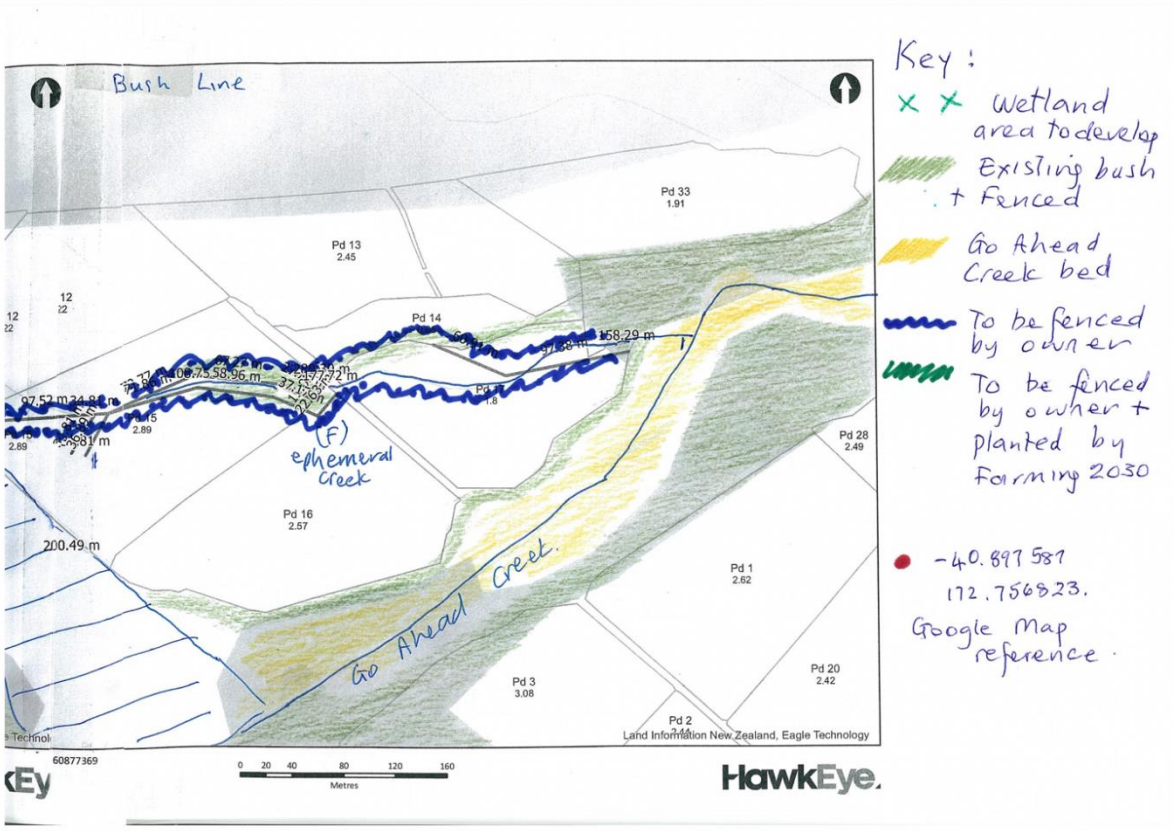
* Planting the upper and lower banks will improve water quality more than using a grass strip alone.

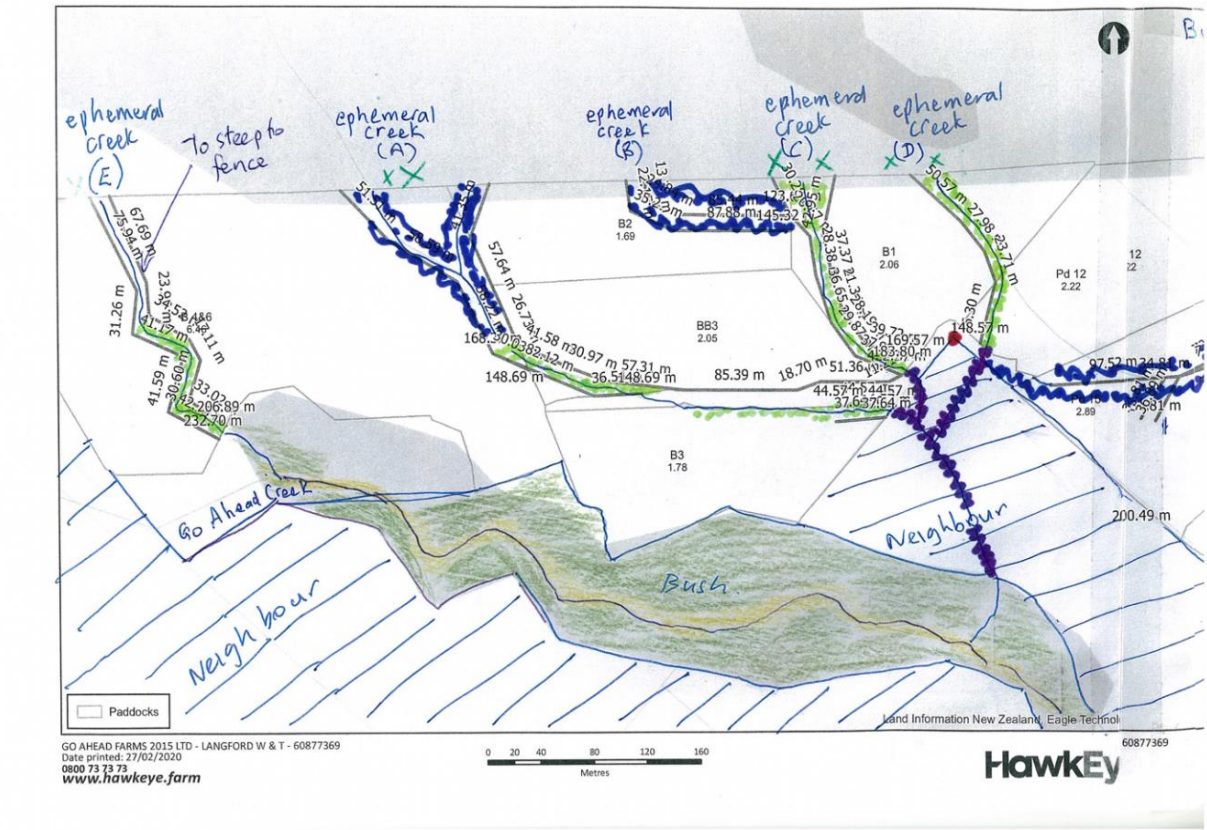
* The top steep banks A B C and D (*refer to map below*) of Go Ahead stream are to be fenced only and regenerate on their own. A and F to be replanted on the flatter sections only.




### (2) Preparation for Planting

The sites we will plant will be fenced and prepared by the farm owner ready for planting, free of large invasive weeds. Tall grasses trimmed back with scrub cutter. We will be planting on an open site that was grazed by stock prior to fencing. Plants will go in at 1.5 to 2 metre spacings diagonal. 2m = 3 plants


Bush Line
Key:
Wetland area to develop
Existing bush + Fenced
Go Ahead Creek bed
To be fenced by owner
To be fenced by owner + planted by Farming 2030
-40.897581
172.756823.
Google Map reference.
(F) ephemeral Creek
Go Ahead Creek.
Pd 33 1.91
Pd 13 2.45
Pd 14
Pd 16 2.57
Pd 28 2.49
Pd 1 2.62
Pd 3 3.08
Pd 20 2.42
Pd 2
200.49 m
158.29 m
97.52 m
34.84 m
60877369
Land Information New Zealand, Eagle Technology
HawkEye.


ephemeral creek (E)
To steep to fence
ephemeral creek (A)
ephemeral creek (B)
ephemeral creek (C)
ephemeral creek (D)
Go Ahead Creek
Neighbour
Bush
Neigh bour
200.49 m
B1 2.06
B2 1.69
B3 1.78
BB3 2.05
Pd 12 2.22
148.69 m
85.39 m
18.70 m
148.57 m
97.52 m
34.84 m
Paddocks
GO AHEAD FARMS 2015 LTD - LANGFORD W & T - 60877369
Date printed: 27/02/2020
0800 73 73 73
www.hawkeye.farm
60877369
HawkEye

**(3) Re-establish Native Plant Cover**

The first step is to plant hardy species for a revegetation approach re-establishing a cover of native plants. They are typically all '**survivors**' and should grow under more extreme fluctuating conditions, eventually to contain a much larger range of species found in the area.

**The 1st set of plants are:**

1. *Leptospermum scoparium* **Manuka**
2. *Kunzea ericoides* **Kanuka**
3. *Coprosma robusta* **Karamu**
4. *Cordyline australis* **Ti Kouka** (cabbage tree)
5. *Phormium tenax* **Harakeke** (NZ flax).
6. *Carex secta* **Pukio**

For this '**nurse crop'**, it is important to plant densely 1.5 metre apart, as the plants will then support each other and you will get a rapid canopy and avoid weed problems. The biggest reason for plant loss is in the early stages of the restoration projects is weed competition, particularly grasses! So getting onto weeds early throughout the site and keeping on top of them is the most critical part for success.

0-1 **RIPARIAN ZONE MAP OF 'G-H FARM' – MERET WEISS**

**(4) Manage Weeds**

Following this planting is ongoing **weed control** ('releasing') and monitoring to determine the degree of mulching required. This will need to be done every 2 to 3 months in the first two years so plants can establish themselves.

**(5) Order Shrub Trees**

600 shrubs need to be ordered to follow the first step planting, filling in the shrub forest trees planted amongst the nursery crop. This is a good time to order plants for any further wetland plantings or new sites.

**(6) Plant Shrub Trees**

Plant these with 600 shrub forest low canopy trees when the nurse crop is established enough. These understory trees (such as *Mahoe, pittosporum, lance wood, Makomako*) should ideally be planted in winter 2022 (or 2023), depending how well established nursery trees are.

**(7) Collect Wilding Seeds**

Do seed collection and scattering under initial plantings to encourage new seedlings.

**(8) Plant Additional Trees**

Next plant 1500 plants in the area marked on the map as F. Also identify any plants that have not survived from the previous planting and fill in with new plants in those spaces. These will be planted using the same arrangement in Step 1 above.

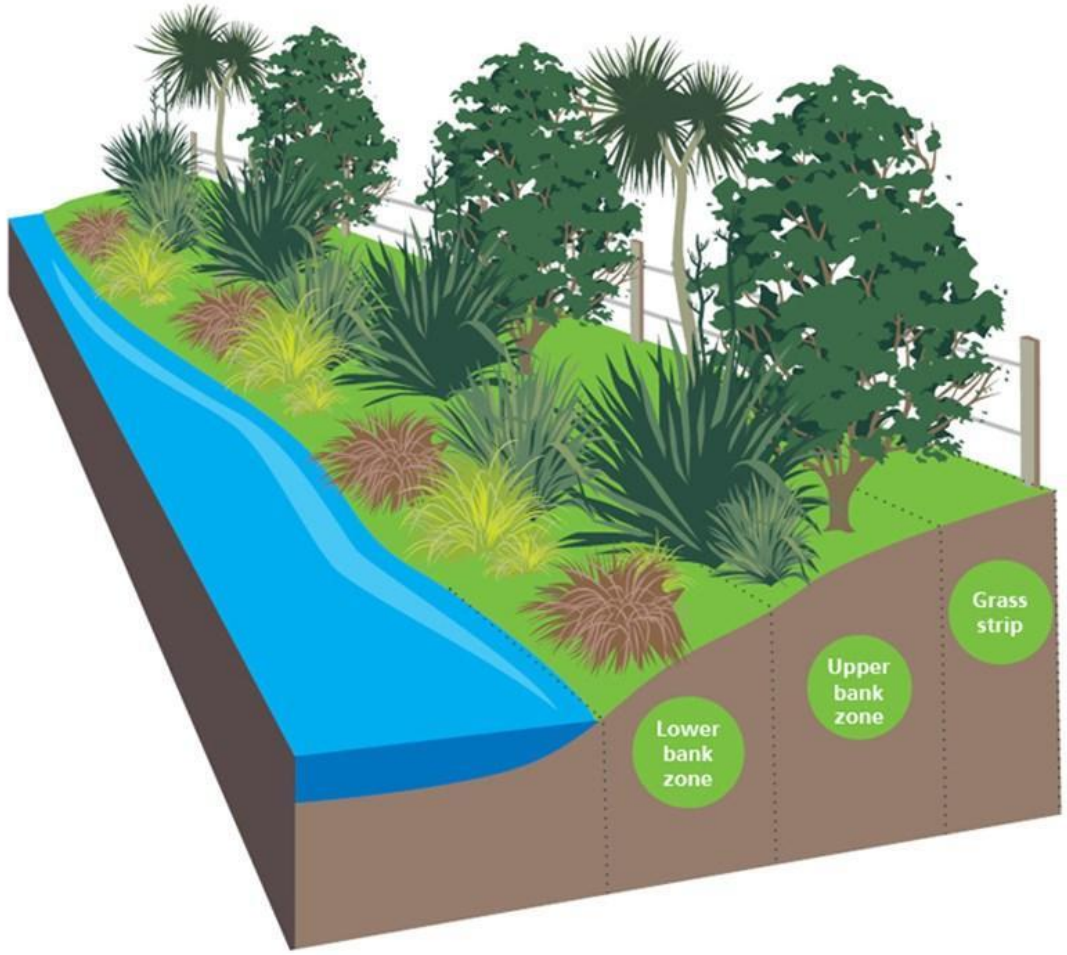
**(9) Do Infill / Enrichment Planting**

These are late stage plants required depending on the site, with especially selected sites to achieve natural mature forest canopy. Plant 25 to 50 large *Podocarp* canopy trees, such as *Rimu, Miro, Matai, Kahikatea*.

**(10) Follow up with Supplementary Plantings**

When the riparian zone is well established, supplement by planting trees under an existing or developing canopy. This can be safely done any time from autumn to spring, as the forest floor underneath a healthy canopy will generally be frost free.

## Riparian Planting Zones



In the riparian margin between the waterway and fence, there can be up to three zones of plant types:

**Grass strip:** A grass strip at least one metre wide should be left between all fences and waterways to help **filter sediment**, phosphorus and faecal bacteria from runoff before it reaches the water. The grass strip will also prevent plants from tripping electric wires or being grazed if the lower banks will be planted.

**Upper bank zone**: The upper bank zone is on higher ground but may still be **partially flooded** every couple of years. Use flaxes, grasses, shrubs or trees which provide shade and shelter.

**Lower bank zone**: The lower bank zone is prone to flooding so plants need to be **tolerant of waterlogging**. Use plants such as sedges and rushes, which are well rooted and can survive many days under water.

We will use the Plant Guard combos which include 4x50cm Bamboo 100% Biodegradable coir Matt and Guard. This is less labour intensive but comes at a greater initial cost. Surround each plant with at least a 30-40 cm diameter of biodegradable.

## Tree Planting Technique Guide

1. Remove grass and weeds.

2. Dig a hole that is big enough to accommodate plant roots without them being curled up or bent in the hole.

On drier soils, ensure the base of the stem is 1-2cm below the soil surface.

Mulch around plants will help keep soils damp, reduce weeds and provide nutrients.Good mulches include straw, staked down cardboard or wool.

3. Put a stake beside plants (unattached) so they can be easily seen when weeding and identified if they have died and need replacing.

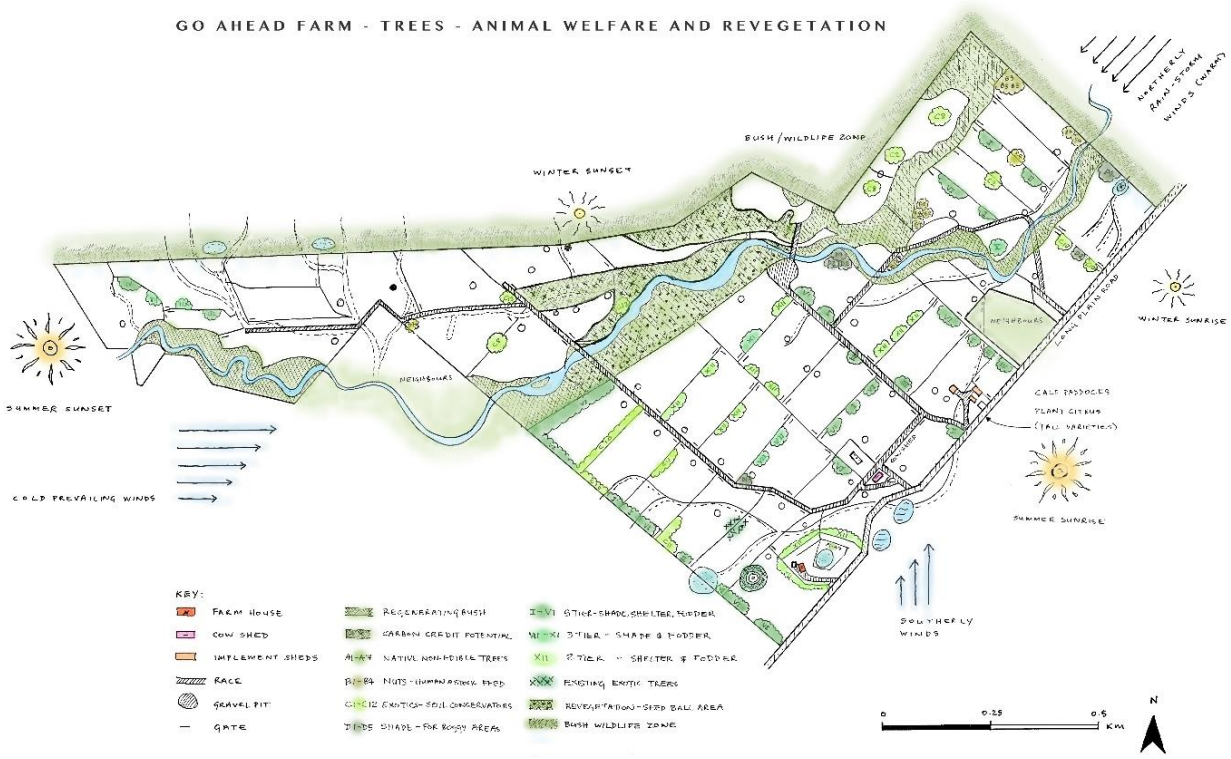
## Protective maintenance

Surround each plant with at least a 30-40cm diameter of biodegradable weed mat, mulch or old woollen carpet to suppress weed growth.

Avoid using plain wood chip around the plant as it will strip all the nitrogen out of the soil causing the plant to yellow off and die.

### Active maintenance

Stake each plant for easy location and brush cut, hand weed (strong preference) or carefully spray with a herbicide twice a year.




# Shade & Fodder Trees

## Shelter & Fodder Trees for Stock

### Advantages of Fodder Trees

- Provide shade and shelter, aiding comfort, wellbeing and production
- Increase the feed produced on an area of land by using vertical space
- Provide supplementary feed in times of drought or winter shortage (generally fodder trees should not exceed 5% of an animals dietary intake)
- Stabilise the soil and recycle nutrients back to the pasture through their roots
- Offer a range of healthy additives to an animal's diet and help to prevent intestinal worms. This is attributed to the protein content of trees, their provision of trace elements, and

secondary compounds such as tannins acting as anti-parasitics.

# Benefits of Trees on Farms

Trees can provide commercial and stock health benefits on your farm. They can provide cost effective shade and shelter - helping boost grass growth and livestock performance. They can enhance field drainage by improving the rate of water infiltration; reducing pugging damage and waterlogged pasture. Acting as buffers, trees can help trap pollutants before they enter watercourses. Trees and hedgerows can contribute to financial savings through providing you with wood fuel. And as well, they are aesthetic in the farm landscape.

## Selection Criteria for Shade Trees

Fast growing, can handle the wind, a mix of good wide spreading canopy with larger leaves and smaller leaves for a thicker canopy, varieties that are palatable to stock, a clean main trunk easy to trim the lower branches, have other uses such as timber or fibre.

## Planting Pattern & Spacing

Shelterbelts should be at right angles to your most harmful wind. The most important belt is the one preventing the wind from entering your property, as this is your most exposed boundary. For every metre of height, your shelterbelt will achieve 10 metres of wind redirection downwind. The width of your belt should match the mature width of the varieties you are planting unless you elect to side trim or prune. A triple row mixed species is usually the best option which requires an approx 8 metre wide belt.

An ideal pattern for combining the purpose of shelter and fodder is to have the canopy/tallest non-fodder tree (hence not pruned regularly for fodder) in the centre, with a tall fodder tree on both sides of it, and a short one in between and/or in front of that. Mix natives and exotics for diversity of function and appearance.

Research has shown that:

- 15–20 year old eucalypts spaced 6 metres apart will create 70 % shade, and the maximum shading under any density of eucalypts is 80 %
- 15–20 year old pines at 7–14 metre spacings will create 70 % shade
- the pine trees spaced at 3.5–10 metres apart will create 90 %.

Extrapolating from this, any tree of similar height, with a relatively spreading form, at a similar spacing, will provide a similar amount of shade. All the shelter-fodder tree guilds being recommended for G-H Farm have a tall tree included, featuring at the centre of the guild.

## Selection Criteria for Fodder Trees

Produce leaves or pods that animals like to eat, withstand lopping, pruning, pollarding, and

coppicing, adapt easily to different sites and environments, withstand intense shade if planted with other species, withstand damage by pests, diseases and browsing animals.

## Feeding Options

Direct feed during summer by either controlled grazing or lopping off branches as required. Alternatively harvest it into silage, hay or make it into dry chaff. Crops with strong coppicing ability can be break-fed to stock. Use as security in times of drought. Deciduous trees let light into pasture in winter, so include them.

## Recommended Management Plan

(1) Plant pole/small tree and protect from stock by fencing

(2) Maintain protection and control weeds if necessary

(3) Light prune and initial feed use during late summer

(4) Keep trunk protected from stock

(5) Prune/pollard at 2.0–2.5 m above ground

Subsequent years prune every 2–3 years (regardless of drought), to keep trees at reasonable size.

**Pollarding** is cutting your tree down to a tall stump (about shoulder height) so the new growth is above grazing height. Cut in summer to supply fodder, so ensure your tree is mature and established enough to regrow the following spring. Fully pollard only every 2-6 years, or alternatively remove 50% of the branches each year. The best pollarding fodder species are mulberry, willow and poplar.

# Recommended Fodder Trees

All of the trees selected for Go-Ahead Farm can cope with heavy clay-type soils, which are characteristic of Go-Ahead Farm. Regardless, some of them prefer lighter quite well drained soils. All can tolerate light frosts, and some are fine in heavier frosts. Most are good bird attractants either by their berries or flowers, and also good bee attractants. This range of selected plants should provide year round food on the farm for birds and bees.

**(A) NATIVES**

(1) ***NZ flax*** (harakeke, *Phormium tenax*) Height: 2 – 3mtrs. Makes a maintenance-free shelter, plus it helps to prevent bloat and to remedy scouring. Cows, sheep, deer and goats will eat tips and strip the foliage of its tasty green parts.

(2) ***Broadleaf*** (kāpuka, *Griselinia littoralis*) 5 – 15 mtrs. Highly palatable to stock and deer, reasonably fast-growing and recovers quickly from browsing.

(3) ***Whiteywood*** (māhoe, *Melicytus ramiflorus)* - Approx 5 mtrs, but can grow up to 10 mtrs in very favourable conditions. Fast-growing tree that is so palatable that early farmers nicknamed it 'cow leaf'. It was considered a valuable source of fodder, especially in droughts. Cows, horses, sheep, deer and goats love it.

(4) ***Five-Finger*** (whauwhaupaku, *Pseudopanax arboreus*) – Approx 3 mtrs. Highly palatable to cattle (and deer, goats, possums and wallabies). Seven-finger (pate, *Schefflera digitata*) is similar.

**(5)** ***Toi Toi*** (*Cortaderia* spp) 1 – 3 mtrs. The 3 native species are fast growing and good for low shelter and animal fodder.

**(6)** ***Lacebark****(Hoheria populnea)* Height: 7 – 10 mtrs. Moderately palatable to browsing animals.

**(7)** ***Taupata*** (*Coprosma repens*) 2 – 8 mtrs & ***Karamu*** (*Coprosma robusta*) 2 4 mtrs. Fast growing evergreens, good low shelter (grow to 3 – 4 mtrs), handles poor soils well. Karamu is better suited to inland sites.

**(B) NUTS**

Nuts are also very long-lived trees and provide good shelter. They make excellent stock food, and cows, sheep and pigs will all learn to eat them.
General Timing: summer (leaves), autumn (nuts)

**Recommended Species:**

***(1) Walnuts*** – make a great shade canopy particularly on the far edges of the farm. They help to deter flies, lice and mites, however do inhibit grass growth underneath. However they like a dryish climate, with a high summer temperature and winter chilling (down to -10$^{o}$C).
Preferably, soil should be fertile and have a moderately high pH. The main diseases to affect walnuts are phytophthora (root rot), usually they have been planted in soils that are too wet, and can get walnut blight. So they are recommended with caution only to plant on the drier areas of the farm.

**Recommended Variety**: Persian/English Walnut (*Juglans regia*), as it has a thinner shell, suitable for grazing animals. Japanese Walnut is good for moist areas.

***(2) Hazelnuts*** (*Corylus avellana* ) – both nuts and leaves (in summer) offer good fodder. They make a great hedgerow shelter and can handle boggy areas. A moderately shade-tolerant fruit shrub, reaching 3–8 m tall but can reach 15m. Plant in clumps as they need several to pollinate each other.

***(3) Chestnuts*** - have a very prickly burr, but animals can stamp them open to get the nuts out. The leaves, bark, chestnut pellicle and skin are all anthelmintic. Recommended Varieties: European/Spanish Chestnut (*Castonia sativa*), Chinese Chestnut (*Castonia mollissima)*

***(4) Oaks*** *(Quercus spp)* – there are 19 edible varieties, all having half the nutrient value of maize. **Recommended variety***:* Holm oak *(Quercus ilex)* – suitable for single row windbreaks

**(C) <u>EXOTIC SOIL CONSERVATION TREES</u>**

**(1)** ***Tagasaste/Tree Lucerne*** *(Chamaecytisus palmensis)*

**Timing:** winter (foliage, branches)

**Benefits**:

- Fast growing evergreen (1 – 2 mtrs per yr) with an open spreading habit, so can be used as winter feed - cut and allow to regrow (natural height is 4 - 6 mtrs);
- Is lush with a high nutritional value and stock love it;
- Is a favourite of wood pigeons, if you want to attract these birds;
- Flowers in early spring for bees.
- Legume - fixes nitrogen in the soil
- Is frost tender when young (plant late spring, propagating from seed or cuttings) but acclimatises - it's happy in Golden Bay.

**(2)** ***Locust Species*** (*Gleditsia spp)*

Locusts are a large brown bean produced by trees and favoured by animals.

**Timing:** spring-summer (foliage, pods).

**Benefits**:

High in sugar and protein and beneficial nutrients. Pods contain 16% protein, carbohydrate 30.5% and fat 7.5%, and have 26% sugar content. Thornless varieties can be sourced, which is advisable. Honey locust (*Gleditsia triacanthos*, also known as *gleditsia*) will tolerate frosts and wetter climates and produces a high yield of pods. Known to yield up to 50 tonnes per hectare per year.

Fixes nitrogen in the soil. Propagated from seeds or from suckers.

(3) ***Tree Medic*** *(Medicago arborea)*

- Fixes nitrogen in the soil.

• Shortish tree which is great for bee forage as well as livestock fodder

(4) ***Wattle*** (*Acacia spp*)

- Hardy down to −5 °C but does not survive prolonged frost. Prefers a sheltered position in full sun, with well-drained, acidic or neutral soil. However fast growing on poor sites and generally tolerate heavier soils
- Fixes nitrogen in the soil.
- Evergreen, winter and spring flowering for bees
- Coppice well, plentiful foliage
- Foliage and green pods are fodder for stock animals, acacia seeds have a high nutritional value, and are good sources of protein, fat and carbohydrate.
- Good for use in regenerating areas to stabilize the soil, to provide wildlife habitats, and successively harvest for firewood.

**Recommended Species** (in order of priority for clayish soils): Silver Wattle (*Acacia dealbata*) – 10 – 20 mtrs; Sydney Golden Wattle (*Acacia longifolia)* 2 – 7 mtrs; Black Wattle (*Acacia mearnsii*) 5 – 15 mtrs; Tasmanian Blackwood *(Acacia melanoxyln) 15 – 30 mtrs* – best as a timber species in tall shelter belt rather than fodder.

**(5)** ***Albizia*** **-** *Paraserianthes lopantha* (formerly *Albizia lopantha*):

**Timing:** spring-summer (foliage, pods).

• Fast growing to 12m, but short lived evergreen tree

• Fix nitrogen into the soil

• Useful as a windbreak in a mixed planting.

• Flowers attract beneficial insects and the leaves can be used as soap.

**(6)** ***Plane*** *(Platanus spp)*

• Produces foliage to ground level and a good filler under taller trees. Palatable to browsing animals.

Recommended Varieties: London Plane (*Platanus acerifolia*) 20 – 30 mtrs, Oriental Plane (*Platanus orientalis*) 20 – 30 mtrs

**(7)** ***Mulberry*** (*Morus spp)*

- Are easily propagated and transplanted
- Hardy and drought resistant, with small to medium sized long lived deciduous trees.
- Heavy regular bearers of fruit. The tree and especially the fruit are used as a self harvested food

for pigs, poultry, sheep and cattle.
- Leaves are very nutritious with Crude Protein 15.1%, Crude Fibre 13.7%, Nitrogen free extract 50.3%, Calcium 1.95% and Phosphorous 0.4%.
- Coppices readily and the timber is good for tool handles and fence posts

**(8) *Paulownia*** (*Paulownia tomentosa*)

- Drought-resistant, super-fast growing deciduous tree to 12 - 15 m. Grow on higher ground, with lower water table
- Deep-rooting, and late-leafing, with sparse canopy and large, heart-shaped leaves
- Timber is used for fine furniture and the leaves as mulch or fodder

**(9) *Coral Tree*** *(Erythria x sykesii)*

- Deciduous nitrogen-fixing tree, 8 – 18 mtrs tall, flowers late winter & early spring, attracting nectar eating birds
- Tolerates acid low pH soils, and light frosts
- Good shade tree, young leaves good for browsing or lopping for fodder
- Thick tap root, good for erosion control (known in NZ as 'plough breaker') however wood has no timber value.

**(10) *Bamboo* (***Bambusa spp)***

- Quick, effective, low maintenance, cold tolerant shelter and stock fodder.
- Highly nutritious and stock love to get at them, so they must be allowed to establish to maturity before being grazed.
- Use clumping varieties only (eg *Bambuseae oldhami,* which grows to 9m. If you use running varieties, you will have an ongoing management problem on your hands.
- Very good for erosion control and shelter as it forms a dense clump that gradually expands outward; therefore suitable as a single-species shelterbelt.
- Do not plant in heavy clay or constantly waterlogged soils.

**(11) *Willow* (*Salix spp*)**

**Timing:** summer (foliage, branches)

**Benefits**:

- Drought tolerant and frost resistant. Ideal for soil stabilisation work.
- It likes wet areas and is good for stabilising stream banks.
- Willow bark contains many beneficial chemicals (including being the original source of aspirin).
- Deciduous, fresh leaves and small stems (less then 10mm) are superior to summer pasture. Once introduced to an animal, they can be fed in quite large amounts.
- It quickly grows a large amount of fodder which can be completely harvested every 2-3 years (ideal for pollarding), yielding 200 kgs per tree per year. The foliage contains 17% protein.
- Male trees provide pollen for bees in early spring when bee food is scarce.

- It's an anthelmintic for horses and all livestock and a decoction of the bark is efficacious against flukes (trematode parasites) and diarrhea in sheep.

**Propagation & Management**: Propagated from cuttings. Trees are kept low (or it can grow up to 15 m) and grazed directly. Willows coppice readily, even when cut right back.

However, willow is a contentious tree. Although is an excellent animal fodder with many other purposes and advantages, its suckering habit means it easily becomes rampant. If it's planted it needs to be carefully managed, by trees being kept low (or it can grow up to 15 m) and grazed directly. DOC and TDC are actively trying to eradicate wild willows across the country, so its merits vs demerits should be discussed to make a clear informed decision.

**Recommended Varieties** (from Soil Conservation Centre): *Salix babylonica*, and the hybrid *Salix matsudana x alba*. *Tangio, Hiwinui, Makara, Moutere, Salix triandra 'Semperflorens'*

**(12) *Poplar* (***Populus spp)***

**Timing:** summer (foliage, branches)

**Benefits**:

- Pioneer, columnar tree up to 30m.
- Fast growing on moist, fertile sites, and are easily grown from stem cuttings. Resistant to wind but sensitive to late winter frost.
- Leaves (particularly *Populus yunnanensis,* which is also rust-resistant and unpalatable to possums), are naturally high in zinc, which help prevent facial eczema.
- Shelter / windbreak, erosion control, animal fodder, valuable to butterflies
- Deciduous - falling leaves in autumn are eagerly consumed by sheep and cattle
- Fast growing, so branches can be cut and fed out
- Grows well on dry sites and stabilizes soil
- Yields of five to seven tonnes dry matter per hectare per year on first cutting, second browsing should double this. Can be grazed within their first two or three years.

**Propagation & Management**: Propagation from cuttings or suckers. Maximum yield if kept well grazed and small, but trees should be well spaced.

**(D) NON FODDER TREES FOR BOGGY AREAS**

These 'mop up' trees planted in a small grove format can replace willow. They are suitable for quite boggy areas:

**Some Exotics** (non fodder trees):

1. ***She-oak* (*Casurina* spp) –** evergreen, prefer moist soils
   Recommended varieties: Swamp She-oak (*Casurina glauca*) 10 – 14 m; Black She-oak (*Casurina*

*littoralis*) 8 – 12 m; Drooping She-oak (*Casurina stricta)*

2. ***Alder* (*Alnus* spp)** - non leguminous Nitrogen fixer, overall handles clayish and boggy soils, good for coppicing and firewood**.** Recommended varieties: Red Alder *(Alnus rubra)* 15 – 20 mtrs*;* Black Alder *(Alnus glutinosa* 15 – 20 mtrs*;* Italian *(Alnus cordata)* 15 – 20 mtrs*;* Grey Alder *(Alnus Incana*) 5 – 15 mtrs

**Natives**

- ***Titoki***
- ***Kahikatea***
- ***Te kouka/cabbage tree*** (grows up to 20 m)

**Further Selection of smaller (generally) Natives for inclusion in shelter belt**: varieties of olearia, coprosma, hebe (esp koromiko), pittosporum, kowhai, ribbonwood, mingimingi, red tussock

## Poplar and Willow: Management & Stock Feeding

Willows and poplars are the most suitable trees for supplementary fodder, as they are already planted on many farms for erosion control or as shelterbelts and shade trees. However, willow must be monitored carefully and prevented from spreading into fields by the animals grazing on their small arterial succour roots.

Poles/wands are usually planted during late winter and early spring.

- They can (and should) be pruned pollard style every other summer so that they regrow as bushy, low-growing trees bearing plenty of fine branches for feeding – but out of stock reach. It is relatively easy and much safer to prune these thinner branches when growing at this height. These trees will still act as "water pumps", helping to prevent erosion on unstable hill slopes.
- Browse blocks of willows and poplars planted close together is another way to grow and harvest tree fodder. The poles are grown closely together and these can be browsed by stock once well established. It then pays to trim the untidy remainder after browsing down nearly to ground level, to allow regrowth for the next summer.
- They can be grown on unimproved areas, preferably in swampy corners unsuited for good pasture growth – but a good pasture understorey will develop as the trees grow and will be grazed by the stock as they also browse the trees, as an additional benefit.
- Poplars react to summer and autumn drought by shedding their leaves, which are usually more palatable than most available pasture at this time. The livestock grazing under these trees will eat the available leaves as they fall, providing them with trace elements.
- Poplars and willows are similar in nutritive value. Their foliage contains valuable compounds called condensed tannins (CT) and phenolic glcosides (like aspirin)
- A 5-10 year-old tree can yield up to 22 kg per tree of edible forage.

# Shade & Fodder Trees for Go-Ahead Farm

## Recommended Species - Condensed (no description, with height only)

Here are the species just as a list, for the purpose of selecting from to create effective guilds, which are offered next. For description of the trees, refer to previous pages.

**Natives** (non edible to animals): varieties of olearia, coprosma, hebe (esp koromiko), pittosporum, kowhai, broadleaf, lacebark, ribbonwood, mingimingi, red tussock, toitoi, te kouka/cabbage tree (grows up to 20 mtrs)

**(A) NATIVES** (generally shorter height) – also serve as animal fodder

**(1) NZ FLAX** (harakeke, *Phormium tenax*) Height: 2 – 3mtrs.

**(2) BROADLEAF** (kāpuka, *Griselinia littoralis*) 5 – 15 mtrs.

**(3) WHITEYWOOD** (māhoe, *Melicytus ramiflorus)* - Approx 5 mtrs.

**(4) FIVE-FINGER** (whauwhaupaku, *Pseudopanax arboreus*) – Approx 3 mtrs.

(5) **TOI TOI** (*Cortaderia* spp) 1 – 3 mtrs.

**(6) LACEBARK** *(Hoheria populnea)* Height: 7 – 10 mtrs

(7) **TAUPATA** (*Coprosma repens*) 2 – 8 mtrs & **KARAMU** (*Coprosma robusta*) 2 4 mtrs. Superior to Taupata in this situation.

**(B) NUTS**

**Recommended Species:**

***(1) Walnuts***. **Recommended Variety**: Persian/English Walnut (*Juglans regia*)

***(2) Hazelnuts*** (*Corylus avellana* ) 3–8 m tall but can reach 15m.

***(3) Chestnuts*** - Recommended Varieties: European/Spanish Chestnut (*Castonia sativa*), Chinese Chestnut (*Castonia mollissima)*

***(4) Oaks*** *(Quercus spp* **Recommended variety***:* Holm oak *(Quercus ilex)*

**(C) EXOTIC SOIL CONSERVATION TREES**

**(1) TAGASASTE/TREE LUCERNE** *(Chamaecytisus palmensis)* 4 - 6 m

**(2) LOCUST SPECIES** (*Gleditsia spp)*

(3) **TREE MEDIC** *(Medicago arborea) 2 m*

(4) **WATTLE** (*Acacia spp*)

**Recommended Species** (in order of priority for clayish soils): Silver Wattle (*Acacia dealbata*) – 10 – 20 m; Sydney Golden Wattle (*Acacia longifolia)* 2 – 7 mtrs; Black Wattle (*Acacia mearnsii*) 5 – 15 m; Tasmanian Blackwood *(Acacia melanoxyln) 15 – 30 m* – best as a timber species in tall shelter belt rather than fodder.

**(5) ALBIZIA** - *Paraserianthes lopantha* (formerly *Albizia lopantha*): Fast growing to 12m, but short lived evergreen tree

**(6) PLANE** *(Platanus spp)* Recommended Varieties: London Plane (*Platanus acerifolia*) 20 – 30 m, Oriental Plane (*Platanus orientalis*) 20 – 30 m

**(7) MULBERRY** (*Morus spp)*

**(8) PAULOWNIA** (*Paulownia tomentosa*) 12 - 15 m.

**(9) CORAL TREE** *(Erythria x sykesii)* 8 – 18 m

**(10) BAMBOO (***Bambusa spp)* *Bambuseae oldhami,* grows to 9m.

**(11) WILLOW (*Salix spp*)** Trees are kept low (or it can grow up to 15 m) and grazed directly. **Recommended Varieties** (from Soil Conservation Centre): *Salix babylonica*, and the hybrid *Salix matsudana x alba*. *Tangio, Hiwinui, Makara, Moutere, Salix triandra 'Semperflorens'*

(12) **POPLAR (***Populus spp)* Columnar tree up to 30m.

**(D) NON-FODDER SHADE TREES for Boggy Areas**

**Exotics**

(1) She-oak (*Casurina* spp) – 8 – 12 mtrs ; (2) Alder (*Alnus* spp) - 15 – 20 mtrs

**Natives**

(1) Titoki

(2) Kahikatea

(3) Te kouka/cabbage tree (grows up to 20 mtrs)

## Location Considerations

Wind direction, light and shade needs, soil type, pasture moisture content, size of paddock (as tree guilds compromise pasture area), stocking intensity, fodder trees gaps staggered with those on the edge of adjoining paddocks. Single species eg bamboo, are located in close-by areas for common management efficiency.

## Recommended Guilds

**5-TIER** – position of tree from outside to inside (however this combination can go either way from wind side to leeward)

**I**. 1 (A1)Flax 2 (A3)Whiteywood 3 (C4)Wattle 4 (C3)Tree Medic 5 (A1)Flax

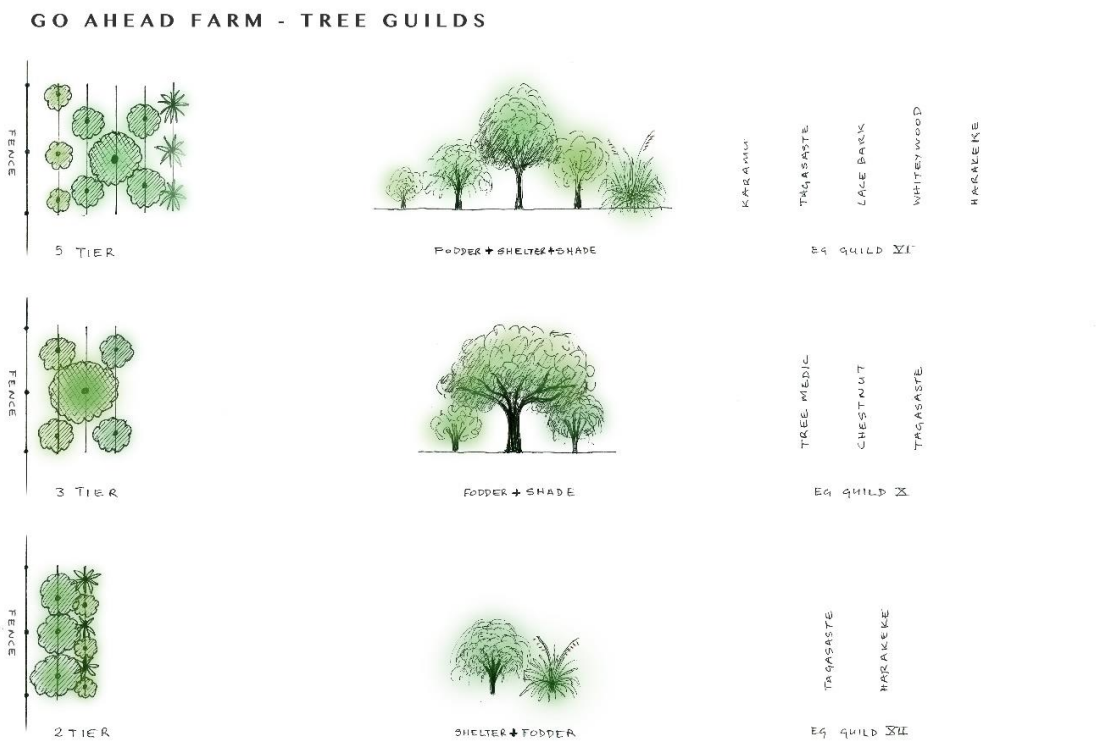
**II**. 1 (A5)Toi Toi 2 (A6)Lacebark 3 (C5)Albizia 4 (A5)Toi Toi 5 (A1) Flax

**III**. 1 (A7)Karamu 2 (A3)Whiteywood 3 (C6)Plane 4 (A4)Five-Finger 5 (A1)Flax

**IV**. 1 (A1)Flax 2 (A2)Broadleaf 3 (C12) Poplar 4 (C1)Tagasaste 5 (A1)Flax

**V**. 1 (A5)Toi Toi 2 (B2)Hazelnut 3 (C7)Mulberry 4 (B2)Hazelnut 5(C3)Tree Medic

**VI**. 1 (A7)Karamu 2 (C1)Tagasaste 3 (A6)Lacebark 4 (A3)Whiteywood 5 (A1)Flax




**3-**

**TIER** – the selected central tree is quite slow growing and very tall with wide canopy spread when mature, and plan is that at around 8 years old, trees on either side are either progressively coppiced/pollarded (if suitable) or progressively cut down completely with the fodder fed out to the cows. All exterior trees selected are nitrogen fixing as well as being very palatable to stock.

| | | | |
|---|---|---|---|
| **VII**. | 1-2 (C4)Golden Wattle | 3 (C12)Poplar | 4-5 (B2)Hazelnut |
| **IIX**. | 1-2 (C1)Tagasaste | 3 (C8)Paulownia | 4-5 (C4)Black Wattle |
| **IX**. | 1-2 (B2)Hazelnut | 3 (C9)Coral Tree | 4-5 (C2)Locust |
| **X**. | 1-2 (C3)Tree Medic | 3 (B3)Chestnut | 4-5 (C1)Tagasaste |
| **XI**. | 1-2 (C4) Silver Wattle | 3 (B4)Oak | 4-5 (C2) Locust |

**2-TIER** – recommended in two types of situations on this farm:

(a) Where there is no 'back to back' adjoining paddock which animals have access to eg in orchard shelter belt. In this situation the width of the shelter belt is 3 – 4 mtrs and the height should not overall jeopardise the fruit trees' sun accessibility for warmth and light. In this configuration, there is one major tree and one minor tree planted between the major trees and in the front paddock-facing row, with this pattern repeated. The minor tree is for animal browse (can be after coppicing/pollarding) and the major tree is for shade and/or shelter as well as being palatable, hence

foliage able to be lopped and fed out from time to time, with height management considerations if applicable.

(b) At the edge of the lucerne paddocks, as that nitrogen-fixing high-nutrient monocrop is quality fodder for the animals, and used as a 'top-up/treat' for in their diets. Utilising a 2-tier lower fodder shelter minimises taking up grazing land space with trees as well as enabling the paddock to have more sun for its herbal growth. Provision of taller and more abundant shade and shelter from extreme conditions is compensated for by the more substantial tree guilds in adjoining paddocks.

XII. **2-TIER recommendations –** stagger these combinations along the fodder shelterbelt

(C1)Tagasaste + (A7)Karamu

(C5)Albizia + (A2)Broadleaf

(C4)Wattle + (A1)Flax

However, use any combinations of the following within your edible shelter belt: **Minor Trees**: **Natives: Flax, Broadleaf, Five-Finger,** Karamu **Minor Exotics:** Tagasaste/Tree Lucerne, Tree Medic. **Major Trees** (all Exotics): Locust Species (Non Thorny Varieties), Wattle (*other than Tasmanian Blackwood*), Albizia.

NB: If non-fodder or taller trees are decided to be included, then the number of species and varieties can increase considerably.

**1-TIER FODDER TREES**

(B) **NUTS –** As nut trees become very large, it's wise to plant them as a small grove (eg 3 trees in a triangle in the corner of a paddock) of their own species independent of other tree guilds – mostly for pollination and nut-fall timing considerations. The best management strategy is to seal off the corner of their area, locking it up until the opportune time comes to let animals in to feast on the nuts which have fallen onto the ground. Once the trees are mature enough to withstand trunk damage, the electric fencing around them can be temporarily removed for the feast.

**Recommended Nut Species:**

(B1) ***Walnut*** - Recommended Variety: Persian/English Walnut (*Juglans regia*)

* (B2) ***Hazelnut*** is included instead in the multi-tier guilds, as it is a much smaller tree.

(B3) ***Chestnut*** - Recommended Varieties: European/Spanish Chestnut (*Castonia sativa*), Chinese Chestnut (*Castonia mollissima)*

(B4) ***Oak*** *(Quercus spp* Recommended variety*:* Holm oak *(Quercus ilex)*

***** (C10) **WILLOW** (*Salix spp*) is a contentiously debated tree. We are only recommending it sparsely for this farm, managed using a pollarding approach on the edges of grazed paddocks, so young suckers are eaten by stock to prevent rampancy. If decided to include willow and manage it well, recommended varieties are: *Salix babylonica*, and the hybrid *Salix matsudana x alba*. *Tangio, Hiwinui, Makara, Moutere, Salix triandra 'Semperflorens'*

** Poplar is included in some of the 5-tier fodder-shelter guild mixes due to its fast growth rate, tall stature, mid-level foliage, and non-rampancy nature. The central location it occupies is a superior position than having it as a single species shelter tree.

*** BAMBOO (***Bambusa spp)* - Clumping varieties only (so does not run, has naturally contained spread) Recommended variety for this area and purpose: *Bambuseae oldhami (*grows to 9m). Planting several in a row for management is the easiest for harvesting and management. Makes a wonderful windbreak.

**1-TIER NON-FODDER TREES** - a few (preferably of same species for pollination and compatible root and branch form structure) non fodder trees planted in a small grove to replace the 'out-of-control' Willow as well as to be planted in quite boggy areas:

(D1) Casuarina (non-native)

(D2) Alder (non-native)

(D3) Titoki (native)

(D4) Kahikatea (native)

(D5) Te kouka/cabbage tree

# Orchard & Vegetable Garden

## Heritage Orchard Motivation & Benefits

The scion wood of 30 heritage/heirloom fruit trees from 'old family' farms in Golden Bay, was grafted onto rootstock, in July 2019 during a 'Farming 2030' workshop led by Meret Weiss. The collection consists mostly of apples and pears. Each variety has a story behind it, which links it to the family and the farm it came from.

These trees are now growing up in PB Bags by the house. When they are mature enough, they will be planted out in one of the designated orchard areas, based on the planting plan portrayed in the accompanying maps. They will be accompanied by other fruit trees which are still to be propagated or purchased.

Casual fruit harvesting was part of Wayne's upbringing. The family farm featured a range of fruit trees, which he and his siblings free-range browsed on as they moved about helping with farm responsibilities. Wayne wants his own children, as well as visitors, to experience that delight.

His motivation is also to preserve and popularise these selected local heirloom varieties, which are adapted to Golden Bay conditions, as it is these qualities which are the most likely to withstand climate change fluctuations. Heritage fruit trees are renowned not to need chemical sprays to protect them from pests and diseases, as they have inbuilt hardiness.

## Three Orchard Concepts:

### Intensive Orchard, Home Orchard, Farmwide Treecrop Spots

In each of these options, the spacing of the fruit trees is carefully taken into account, with consideration for mature tree height, width and habit, as well as harvesting ease. Sun, soil, moisture, protection (wind and frost) and pollination needs of each species has also been considered. For all options it is recommended to especially plant understory insectary flora, particularly perennials, for natural pest management. Examples are Fennel, Yarrow, Comfrey, Phacelia, Golden Rod, Alexanders and Cow Parsley.

The aim is to have a diversity of fruit year-round, including early, middle and late varieties of a species. Varieties which have proven to perform well in Golden Bay will be selected, with attention to Go-Ahead Farm's microclimates and other particular conditions.

It is possible to have all three designs and locations as part of family and community fruit production, or subtracting just some parts of the orchard design, with consideration for their part in the integrated management. Refer to maps when reading comparisons below. The distance

between all trees and their proximity to fences and potential new shelter belts has been measured, so positions can be determined with reference to the scale of the map.

## Zoning

Recommendations are referenced to the Permaculture land zoning concept for the purposes of management, efficiency and flow. There are 5 zones, which simply described, can be seen as progressively radiating areas oriented from the centre of human activity, which is usually the family home. Examples given from the perspective of food production.

*Zone 1*: Closest to the house, elements and functions requiring daily attention and regular harvest eg kitchen garden.

*Zone 2*: The next zone out, requiring less regular attention - commonly particular kinds of management needing seasonal attention eg orchard, staple crops garden.

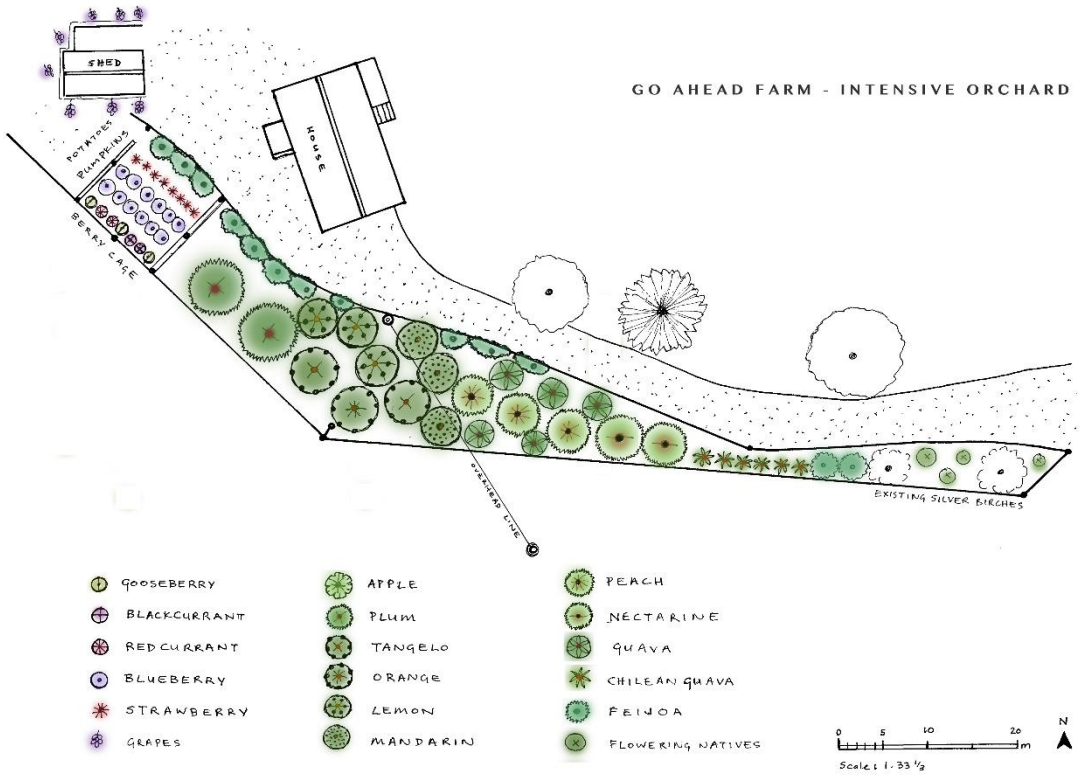
*Zone 3*: Scaled production with larger area needed with field use rotating annually or perennially eg grains, sheep, field peas.

*Zone 4:* Longer-term management with larger creatures and slow growing treecrops eg nut trees, beef cattle, timber trees.

*Zone 5:* The wilderness zone for wildlife habitat and food foraging, minimised from the dangers from human encroachment eg riparian strip. This zone is a dedicated space for native plant

reseeding, bird population flourishing and water bodies managed by nature. It enables ecological restoration for the wellbeing of the whole farm ecosystem

## Features & Comparison: Intensive Orchard




**Location**: This orchard, berry area and staple crops garden is intentionally located close to the house, on the upper area following the driveway taking the opportunity of the high-up strip of land for sun exposure and observation ease.

**Description**: This orchard is based on the Food Forest/Forest Garden Concept, where the proximity of fruit trees are relatively close, minimising the need for groundcover management and optimising the use of understory insectary plants to prevent insect damage.

A Food Forest has several tiers (usually five), however this orchard has only two (sometimes one - where the strip narrows). The varying of widths within the strip has a bearing on tree location, as do the overhead power and phone wires.

A 5-row berry area is situated within this orchard, enclosed within a walk-in cage structure, because of bird competition. Contained within this berry area are blackcurrants, redcurrants, gooseberries, blueberries and strawberries.

The Staple Crops garden (eg potatoes, kumara) is situated nearest to the garage and closest to the house. There is plenty of scope for pumpkins to be spot-planted within that area, and right along the driveway edge.

**Infrastructure Modifications:** Take down the fence just alongside the driveway. Leave in the posts where the berry area is located – those markers are the posts for either end of the berry cage. If grazing is necessary in the home wetland surrounds area, put across an electric fence for that duration to keep the cows in there and therefore away from the intensive orchard. There would be a gate put in between the deer fence and the back of the shed for access into the pastures beyond.

**Irrigation**: The most suitable is low-level networked dripper irrigation on short risers, gravity fed from the house-shed area.

**Shelter:** As this area would be partially exposed to the southerly winds, planting appropriate shelter in the paddock immediately behind the deer fence to the south is the best way to offer the fruit trees protection. To double-up in purpose, the trees selected are also animal fodder trees, accessible in that paddock just behind this orchard area. They can also act as a 'suntrap', aiding in the ripening of fruit.

**Groundcover & Animal Management**: Typically this scale of orchard uses poultry for pest management. Chickens are the most suitable species. However they are not suitable for grass management, so as soon as the trees are planted, cows should be kept out and this area managed using a weedeater or scythe.

**Pluses**: From the zoning perspective, this area is in full view of the family as they walk or drive down the road, which happens several times a day, particularly with the quad bike. So they can notice anything untoward, such as animal encroachment or tree damage. They can also notice when the fruit tree starts to blossom or fruit is getting just ripe enough to pick. Some fenceposts can be reused in situ for berry cage structure.

**Minuses**: It removes a small area of cow grazing land. However this strip is reasonably narrow and a tiny part of the overall farm.

## Features & Comparison: Home Orchard

**Location**: The Home Orchard is positioned in Zone 2, broadly surrounding the wetland nearest the house.

**Description**: As this area features a wide range of conditions, so species and varieties need to fit accordingly. Due to this, the diversity of fruit trees is less than in the Intensive Orchard. Some of the more challenging conditions are damp soils, more acidic soil,

oscillating groundwater table, shady areas, exposed areas. However overall, the gentle slopes above the wetland are fine growing spots for many fruit trees. The damper area just above the wetland itself has excellent conditions for growing hazelnuts, so a hazelnut semicircle hugs the wetland. When selecting species heights and positions, thought has been given to northerly views and sun aspect with regard to the house.

Cane berries (blackberry, boysenberry, raspberry) kept contained with horizontal wires, are situated by the back fence close to the house, in what will be a protected area which gets good morning and early afternoon sun.

For map referencing convenience, one of two optional areas for the Intensive Vegetable Garden has also been positioned on this map. This is located between the house and the area currently utilised by the family as a small sports field. This is a 3-tier, 10 m long terrace garden, consisting of 1.8 m divided by pathways. This could instead be a 2-tier garden in the flatter higher area as shown on the map. Together with the staple crops garden, this should provide sufficient vegetables to support the family's needs, given their labour allocation.

**Infrastructure Modifications:**

Due to providing a windbreak from the westerly winds, doubling up as 'lop and drop', animal fodder, a fixed new fence will be created in the northern area (connected to the main road fence along Long Plain Rd) going around to the western sector, and that current one will be removed.

**Irrigation**: Late winter planting is best, to capture the typical spring rains. Spot watering can temporarily happen by hose in times of drought. This orchard location offers a good opportunity to create swales (especially shaped ditches on contour) due to its generally sloping terrain. They would capture rainwater, then spread it out and sink it down, resulting in a higher water table for tree roots to access during dry periods. As the water table is high anyhow it's worthwhile doing some structured observation.

**Shelter:** Animal fodder hedges at the edge of this area, double up as shelter belts. They are 4.5 m wide and 2-tier, to minimise the area of pasture taken up.

**Groundcover & Animal Management**: A mixed species insectary and herbal groundcover would accompany the orchard trees, as with the Intensive Orchard. However, these fruit trees will be wider apart so require more groundcover management. Since this is a reasonable amount of area (though not prime pasture) to take out of production, animals should be kept in until trees become larger to take off protection shields (44-gallon drums recommended - but there may be better protection such as electric systems, which works better for large animals). At this stage the introduction of ducks for grazing is suggested. Depending upon the quantity and management, this regime may need to be complimented by weed eating or mowing. The trees (apart from the hazelnuts) should be far enough apart to get tractor with mower between.

**Pluses**: This broader area is suitable for species which require more space, especially the heritage fruit trees. It has been selected due to its closeness to the house for community hosting, but being far enough away not to encroach on family privacy. Its diversity of terrain and 360 degree aspect, demonstrates the possibilities of a farm orchard, especially if groundcover management strategies can work successfully. It demonstrates an atypical unusual relationship between a wetland and an orchard.

**Minuses**: Groundcover management is not straightforward. Lank grass of the species currently predominant is not the best for accelerating soil quality, nor is it attractive. The amount of land taken out of grazing needs to be weighed up with a community orchard in that location.


## Features and Comparison: Farmwide Treecrop Spots

**Location**: Situated in Zone 3 and 4, at various protected focused spots located around the whole farm, with respect to the soils and orientation to suit a species needs. The angled corner of any paddock where gates are not nearby, and which creates a natural triangle, is a spot worth considering, as it is more easily fenced. There is no map which advises on these locations, however a few of them already have nut trees recommended.

**Description**: Fruit trees which are family favourites, such as plums, apples and oranges/tangelos, will be chosen for these locations. Soils may need to be modified somewhat to meet classically free draining loamy textures that most trees require to grow and bear well. The term 'orchard' doesn't really fit for this approach, as they are spots of mostly 3 - 7 same-species, different variety trees, clustered together, engendering elements of surprise, delight and adventure.

**Infrastructure Modifications:** New fixed fencing which joins to existing fencing on either side.

**Irrigation**: None, unless supported by people with buckets, to bring water to the plants. If there is a structure nearby which already has water connected (eg milking shed) this spot could tap into that according to needs.

**Shelter:** None specifically. If the fruit trees are lucky distance-wise, they would 'borrow' the shelter of the closest trees strategically planted for animal fodder and shade.

**Groundcover & Animal Management**: Minimal. Occasional weed-eating would be beneficial.

**Pluses**: Heirloom trees are ideal in these situations, as they need to really 'fend for themselves' and 'prove their worth' as candidates for adverse conditions. Farmwide Treecrop Spots may be an enticement for people coming to the farm for education and recreation, to explore its 'far reaches' in search of that tantalising taste!

**Minuses**: Trees may struggle due to minimal management and zero irrigation, in comparison with in a purpose-designed Zone 1 or Zone 2 orchard. Shelter, feeding, thinning and pruning are likely to become low priority, unless they are integrated within farm-wide animal movement and general management planning.

## Poultry for Orchard Management

Chooks, geese and ducks are handy in mowing and manuring the orchard and cleaning up fallen fruit. They search in mulch and under plants for tasty grubs and worms. They control the breeding cycles of pest insects, cut the grass for just a few bucks of food a week, and deliver high nitrogen fertiliser to each fruit tree, manuring the ground with virtually every step they take!

Ducks like to eat grass, so they will enjoy grazing on the lawn and keeping the weeds down. Ducks will trample down the grass and keep it down that way, but they actually don't each much grass. However they are great for orchard hygiene. They eat flies, grubs, slugs and moths. They are good egg layers but need supplementary feed. Like geese, they need water to swim and bath in.

Geese are the best grazers of these three types of poultry. It is best to start out with a young pair of well-bred geese from parents selected for their temperament. Untrained unruly geese can bite, fly and ringbark small trees. They are best kept in with sheep netting however if they are determined

to get out they may squeeze through this. 2 – 3 geese will keep 500m of grass under control, so stock accordingly.

# Supplementary Income

There is scope for by utilising areas of the farm for additional income, without diminishing the dairy herd or jeopardising income from milk production.

## Rejected Considerations

These ideas have been considered, but dismissed for the following reasons:

* **Field Crops:** Species most suited to Kotinga area conditions, such as barley and old varieties of wheat: The farm's stony soils which can have winter-spring drainage issues are not a good fit for cropping. However the latter should improve considerably with a more intensified Regen Ag system and the implementation of water issue solutions recommended herein. Two crops which are the most suitable are maize (for people or animals) and industrial hemp. Maize is a 'heavy feeder' requiring additional soil inputs to bear well.

* **Hemp** is a reasonable candidate, however to bring in a good return, processing equipment (such as a decorticator and oil press) would need to be available and accessible locally, and this is not the case. If a co-operative of farmers would choose go into production at the same time and purchase this equipment, hemp should be worthwhile, as there is a worldwide demand for it. This topic is worthy of discussion amongst Golden Bay Farmers, and dialoguing with other farmers around NZ who grow and sell it.

Most hemp is grown for its seeds, which yield a highly nutritious and valuable food oil, which is sold throughout New Zealand, used as a base for bodycare products, and exported around the world. It is also used in the textile industry for clothing, in the building industry for housing insulation and wall panels, and also for rope and heavy-grade paper. Hemp farmers must apply to the Ministry of Health for a permit to cultivate, deal, breed, import or sell viable seed, and must pay a fee of NZ$511 per license, but no longer need to call their crop an experiment. Licences are issued for one year. A research and breeding licence, obtainable after the first year, allows hemp farmers to grow and breed unapproved cultivars and register new cultivars.

* **Timber Trees:** Although planting up several areas into forestry woodlots would be a good additional land use option, Wayne and Tyler are not interested in investing in the annual management labour required, nor taking a worthwhile chunk of land out of pasture production, considering the 25+ years return on outlay.

* **Firewood**: If a forestry project was undertaken, as the trees mature, interim income could be made from pruned branches sold for firewood, or thinned trees for use as posts if ground-durable

timber species were chosen. Otherwise selected species could be grown especially for firewood and harvested much earlier, or thick ranches of coppicing species utilised.

**A Firewood Harvesting Option**: Shade/shelterbelts which have been designed only with animal fodder species, could also double-up for firewood harvesting, either by replacing up to 35% of the species with trees grown especially with 'firewood trees'. As these are removed, their gaps naturally filled by the surrounding trees through time. Note that some of the species selected as animal fodder are also good firewood trees, so the similar removal principle could apply. If Wayne and Tyler are willing to invest in the labour required, as well as the management complexity, this income source could be worth considering once the sums are done .

## Additional Income Recommendations

Using unproductive or minimally productive spaces and existing resources of the farm, the following are possibilities for increasing economic inflow:

### (1) Education & Demonstration Venue for Sustainable Farming

After five years, with finance, labour and national external factors permitting, this farm should have most, if not all, of these farm-wide design recommendations in place. Whilst significant development steps are in progress, offering hands-on experiences together with specific educational sessions, is also a worthwhile option to bring in money. During this time, these adult students could be accommodated in the local area, or housed in caravans and/or tents on-site by the woolshed (retrofitted with ablutions and simple cooking facilities) during warm summer months. This would be the time to seriously consider adding a **purpose-built farm-stay cottage/s** to enable guests to be accommodated on-site, and take time to familiarise themselves with the farm's features and daily activities. For this purpose, as well as larger non-residential educational events, the currently inadequately used woolshed could have its upper level turned into a classroom eg with whiteboard, projector screen and comfortable seating. This would be useful even now, as Wayne is increasing his role as a speaker on farm management and human wellbeing.

### (2) Farm Plant-Guilds Nursery

Once sufficient trees have been raised for all the farm's needs then this same operation can become a specialist commercial production nursery. For background, refer to the section in this document entitled '*Go-Ahead Farm Development Implementation Steps: Implementation Stages on the Farm, Step 1: Establish a Plant Nursery, 1st Choice*'.

This nursery, by now having plenty of experience, would specialise in propagating, advising and selling trees, using the concept of functional farm guilds (a) for animal fodder, shelter and shade,

(b) for riparian and wetland restoration, (c) for mixed firewood lots, (d) packages of containing a mix of insectary plant seeds for orchard understory (collected from your own orchard area). Besides bringing in profits through being owned by the farm (or the Kotinga Farmers Collective), this nursery should provide employment for a few locals. As far as we are aware, there is no other nursery in New Zealand doing this.

## (3) Poultry

As recommended, chickens are a valuable addition to the Intensive Orchard, and ducks and geese for the Wetland Surrounds Home Orchard. In addition to being 'orchard managers' these animals would provide additional income through eggs and meat.

## (4) Trees for Offsetting Carbon

Besides growing trees for timber, animal fodder, shelter, shade, soil conservation and biodiversity, you can add capital value to your farm through earning carbon credits under the Emissions Trading Scheme (ETS), or Permanent Forest Sink Initiative for forests.

Planting trees, or fencing an area intentionally for regeneration, can help 'offset' emissions from your farm business, because as trees grow, they store carbon in trunks, branches, leaves, and roots. When trees are cut down, the saving is'undone' when the carbon is 'unlocked', being released back into the atmosphere when the wood becomes processed. Soils are excellent carbon sincs but are not included in the ETS equation.

**ETS credits are a viable longer term income for Go-Ahead Farm**. An area at the top area of the farm towards back has been identified for this purpose (see Trees map). It can be fenced off to **regenerate without any human planting assistance** and still qualify, or a choice can be made to do some planting there.

Measuring carbon in your forests: Different species accrue carbon at different rates. Exotic species tend to grow quickly so accrue carbon faster. Indigenous forest tends to grow slowly so accrues carbon slowly. For forests 100 hectares and under MPI has default ETS look up tables to calculate the carbon stock per hectare for different species and regions. The look up tables are available on MPI's website.

The Field Measurement Approach is used to calculate the carbon sequestered from forests which are over 100 hectares. Information on the Field Measurement Approach is available on MPI's website.

The New Zealand Emissions Trading Scheme (ETS): to reduce emissions domestically to meet international obligations, the ETS puts a price on greenhouse gas emissions in the form of New Zealand units (NZU). An NZU is equal to 1 tonne of carbon dioxide equivalent. Sectors that absorb greenhouse gases, such as forestry, can earn and trade NZUs, while sectors that emit greenhouse gases must purchase and surrender NZUs to the Government.

The transport, energy, industrial processing, waste, and forestry sectors are fully included in the ETS and are obligated to surrender units for emissions. The agriculture sector reports emissions in the ETS, but is not obligated to surrender units.

Earning and trading New Zealand Units: Dairy farmers who own exotic or indigenous forests first established after 31 December 1989 can voluntarily register their forests in the ETS to earn NZUs as the forest grows. To find out how to register a post-1989 forest in the ETS visit the Ministry for Primary Industry's website.

Participants in the ETS earn units by submitting an Emissions Return that states the amount of carbon the forest has stored or lost over time (see 'Measuring carbon in your forests'). Submission can happen every year or as a 5 year summary. A carbon increase allocates NZUs to the farm-forester, a decrease requires surrender of NZUs to the Government. NZUs earned in the ETS can be traded on a carbon trading platform and provide a source of income. It's important to explore all options and gain an understanding of the financial implications of offsetting programmes before initiating. To find out more, check out 0800 CLIMATE, on the Ministry for Primary Industries website.

# Implementation Steps: Go-Ahead Farm

**For Integrated Landuse Design**

## Timing Considerations

The following considerations need to been taken into account for deciding the staging of these recommendations – it's all about timing!

Seasonal, growing and planting factors have been fully considered when determining implementation stages. However the farming family knows best about animal management, financial and labour timing, so there may need to be some adjustments when that information is added in.

### Seasonal time

Consider the impact (positive or negative) of seasonal climate. Spring is Golden Bay's strongest winds and highest rainfall time, July is the most frequent frost time, mid-summer is typically hot and dry (with the consequence of drought in recent years). In winter when heavy rainfall happens, the sunshine isn't strong enough or long enough to dry out the ground, resulting in water pooling and mucky ground, not great for driving tractors or moving animals through.

### Growing Time

Grass and other groundcover seed takes time to establish to the height and level of vigour ready for grazing, and to grow taller again ready for the next grazing round. Cuttings of trees take a couple of years to grow to the size ready to plant out in the field, so these should be started at the onset of the implementation.

### Planting Time

Late autumn and winter is the best time for planting tree seedlings so that establishment energy is concentrated in the roots rather than the leaves or buds. Also particular species have their most appropriate season for planting and tending.

### Farm Animal Management Time

**Annual:** Cow conception, gestation and calving, the latter being a demanding time for the farmer.

**Daily:** Milking and shifting cows from paddock to paddock.

## Financial Time

Repayment of bank loan instalments need to happen at specific intervals, so profit over expenditure needs to balance out, determining when money can be made available for new developments. Grant money is pivotal to being able to implement this plan, as financial outlay of its components is beyond the means of Wayne and Tyler. Fortunately several grants are available for the farming sector, particularly for riparian restoration, so successful applications mean being able to move forward with implementation. Fortunately every application to date has come through.

## Labour Time

Through the engagement of Farming 2030, local labour has been forthcoming to help out with some farm project development (eg riparian zone tree planting). This will hopefully continue into the future. Autumn and winter when cultural and tourism activities are at a low ebb and people's own properties require the least management, are the best times to access local labour.

## Global Impact Time

At this time on Planet Earth, it is impossible to predict what impacts will be detrimental or favourable to farming operations. One thing is for certain – the only constant is change! We are in a time of economic instability, particularly regarding exports, imports, and currency value. The procuring of farm machinery or parts for the machinery we currently depend on, isn't guaranteed. Climate change is in full force, with higher than usual winds/cyclones, rainfall/floods, drought/fires etc. The global Covid19 pandemic has no foreseeable end, with an ultimate consequence of NZ being a lone island nation.

Within this, there is a relative urgency to move as swiftly as possible in making the changes recommended in this report, together with the advised Regenerative Agriculture regime. In particular, the suggested water management measures, shelter tree guilds and food production systems, will provide a resilient climate change buffer.

# Implementation Staging on the Farm

## Step 1: Establish a Plant Nursery

Hundreds or thousands of trees are needed for the farm for different functions. Not having to buy in trees, or get them at reduced cost, makes for huge savings. An early-on action would be to establish a plant nursery ready for propagating in next autumn. This nursery should propagate plants for wetland and streamside riparian area restoration as well as animal fodder/shelter plants. Grants should be available for such. Recommendation is that propagation start in Autumn 2021

from cuttings or seeds, be potted up into progressively bigger PB bags (likely 2 - 3 times) over two years, and ready to plant out in Spring 2023.

***1st Choice:*** The most ideal would be for your **Kotinga area catchment** to have its own nursery, located on your farm (since it's going to be a demo farm), but operated by the Kotinga farming community. This distributes labour and strengthens local community – plant propagation is easy and fun to do with kids too. These trees are also available for other farms in the area, so it's a win-win.

***2nd Choice***: A centrally located nursery, preferably in Takaka, is established and managed by the Farming 2030 group, intentionally operated through Golden Bay wide casual **voluntary work and working bees**. This site could be the Golden Bay Community Gardens.

***3rd Choice***: To collaborate with someone who already has a **commercial nursery** within Golden Bay, and place orders for the trees you want them to propagate for you.

## Step 2: Soil Improvement & Pasture Management

Follow the **Regen Ag steps** to changing over **pasture grasses** to mixed ley sward species as well as balancing out the **mineral component** in the soils. This would happen in several stages so that there is always enough grass to sustain this size of herd. See Regen Ag consultant's advice.

There are three options of practice in **preparing current pasture** for this change: (a) glyphosate spray grass to kill it, then plant, (b) use the 'old fashioned' method of discing, ploughing and harrowing several times to break up grass clods, then sow the new species. (c) direct sowing into existing pasture. The less the pasture is disturbed, the more the micro-organisms which maintain soil health, flourish.

Regen Ag has other interim steps in this transition process, which involve annual green manure crops to improve soil structure and function, and natural stimulants which multiply micro-organism populations.

## Step 3: Water Management (1st Priority stages)

Start addressing the most **extreme issues** by taking the least costly do-able measures. Suggested steps are:

(a) Get Trevor James out again to complete his **assessments** of natural wetland boundaries, fish passages, and stock crossings impact. Also to make his recommendations about Constructed Wetland design, including materials. Also to take nitrate samples if this is within the jurisdiction of his work with TDC.

(b) By early Spring, use sawdust from a local mill or small-sized bark from a treefelling woodchipping operation, to put on **races** to '**mop up'** the standing water and faeces, and when

substantial enough, scoop up with a front-end loader tractor, to stockpile and sell as orchard or garden compost. Continue to do this year by year.

(c) Put up electric or fixed **fences** to **protect** the most vulnerable natural channels, farm ditches and potential wetland areas currently accessible to cows and vulnerable to **waterlogging** - where water can scour and/or pond up after a decent-volume rainfall.

(d) **Plant up** the **internal zone** (Zone 1 with reference to Wetlands map) of fenced off **water courses** and **wetlands**, using locally eco-sourced plants, which Farming 2030 volunteers can harvest together with appropriate permission, from natural wetland areas or established wetlands on other farms.

(e) Identify a 'setback distance' for any paddocks requiring it and create filter strips, wet seepage zones and **riparian margins**. Use '**sponge functioning plants'** in these areas. See species list.

(f) Change the '**standoff paddock'** to a different one, which is as flat as possible and on high ground. Firstly prepare this paddock by dumping and spreading a mix of sand and rough gravel in any low-lying areas to help with drainage, and plant with tough pasture grasses such as NZ native grasses. Another alternative is a paddock on a slight slope draining into a planted up wetland or substantial waterway (plantings in that need to be established first).

(g) Make limestone or rock platforms under and around **water troughs** to provide a sturdy support base.

## Step 4: Establishing Shelter/Shade/Fodder Trees (1st Priority Stages)

**Background Consideration**: If these trees are being specifically raised in a community orchard (as outlined in Step 1) for Go-Ahead farm, they won't be ready to be planted until 3 years away from now, even though most species selected are quite fast growing, as it is recommended they become a reasonable size before planting out to give them the best chance of becoming established, as they will be exposed to a range of weather conditions, and be without irrigation.

However, if some of these trees are purchased from a commercial nursery (recommended) they will be big enough to plant out in Autumn 2021

(a) Just to get the shelter system going, it's advisable to **purchase** around 30% of the total amount of trees, selecting and planting all guilds along one fence area at one time, for the purpose of making it worthwhile to fence off. To spread the early plantings throughout the farm, select every third paddock in sequence which has a shelterbelt designed in.

(b) Also **fence off and plant** out 30% of the nut grove areas, as nuts are very slow growers, and you will be purchasing those trees rather than propagating them.

(c) At the same time as this is happening, **fence** off the **Carbon Credit** revegetation area.

## Step 5: Water Management (2nd Priority Stages)

(a) Create a **Constructed Wetland** in the Hump & Hollow paddock (see Trevor James recommendations)

(b) Put up electric or fixed fences to **protec**t the **remainder of the natural channels, farm ditches and potential wetland areas** currently accessible to cows and vulnerable to waterlogging. Include all ephemeral stream areas (see Riparian Zone Map by Meret Weiss).

(c) **Plant** up these areas, following the steps outlined by Meret's planting recommendations. Here they are in brief:

- In late winter of 2020, plant hardy species for a revegetation approach (this happened!), to re-establishing a cover of native plants.

Follow this up for a couple of years with ongoing 'releasing'/weed control.

- In winter 2021 plant remaining riparian strips with another 1500 plants of hardy species as per the markings on the map.

- In winter 2022 (or 2023), plant shrub forest low canopy trees into this nurse crop area of hardy species, given that it is sufficiently established. Do seed collection and scattering under initial plantings to encourage new seedlings.

- In a couple of years time, infill/ enrich with late stage plants depending on the needs of the site, to achieve natural mature forest canopy.

(d) Complete all wetland plantings with recommended species - placements as shown in the designs.

## Step 6: Establishing Shelter/Shade/Fodder Trees (2nd Priority Stages)

(a) By now, if you have been involved in raising such **trees in a dedicated nursery** for the farm, they should be ready to **plant out** (it will have been around 3 years). The previously planted ones should have been managed for grass growth impingement and be well established. Any that didn't make it can be replaced at this stage. Obviously get all fencing in place, and 'scalp' the grass before planting.

(b) Plant the rest of the **nut trees** and all the **soil stabilisation trees** in higher up areas.

# Implementation Staging for Home Area Food Production

## (A) Preparing for your Wetland-Surrounds Home Orchard

(1) **Raise Some Poultry**

Before planting any fruit trees, get some **ducks and geese** and keep them (containment?) for a year to see if you enjoy their company and their management. You will then only need to address one aspect of orchard management at a time.

If this doesn't work out for you, then you can sell them, or fatten them further to sell for their meat. Based on this, you will then **confirm or eliminate** that way of **managing** the wetland-surrounds home area orchard, and decide to go ahead with mechanical management instead, and if not then continue grazing that area rather than have it become an orchard.

(2) If you choose to go ahead, start putting in the **boundary fence** just behind the area allocated for the **orchard shelter trees**. Permanent fixed fence is best. Also take away the back fence (some can be used for new fence) behind the family sports field as this will no longer be necessary.

(3) **Plant shelter/fodder trees** species as indicated in the design.

The internal side of this belt can be fenced off using electric fencing, to protect these trees from the cows for a couple of years, to get established.

(4) **Order your fruit trees** now, as nurseries often have a 1 - 2 year wait.

(5) By observing this area during a couple of hot summers, assess the need for on-**contour swales** for the water nourishment of the trees in dry periods, and create if necessary. As the water table in this area is high, swales are likely not to be needed, and may be detrimental.

(6) When it's time to take the cows out all together and **plant your fruit trees**. This would likely be 3 years after you had started out with your ducks and geese. The purpose of staging this orchard establishment like this is to stretch out the **cow grazing duration** in this area.

(7) If you decided not to go ahead with this orchard, **around-the-farm fruit trees** can conveniently be planted out at the same time as some the 1st of nut tree planting, and some at the 2nd stage of nut tree planting, and fenced accordingly.

## (B) Creating your Intensive Orchard & Staple Crops Garden

(1) Preferably this Spring (2020), start preparing the land for your Intensive Orchard (if you decide to go ahead with that) by changing the pasture grass into a **mixed herbal ley** (same as in our Regen Ag fields), first by using a low-set rotary hoe to loosen up and turn over the existing grass.

(2) At the same time, **prepare and plant up** the area behind the deer fence for the **animal fodder trees/shelterbelt** designed to protect that orchard from southerly **winds**.

(3) At the same time mark out the **staple crops garden** and plant '**green manure' seeds** into it to start bringing natural nitrogen into the soil.

Order your fruit trees now, as nurseries often have a 1 - 2 year wait.

(4) Since the cows will no longer be grazing in there, you can **take out the fence** bordering the driveway, leaving in the berry cage posts (of course this action is accompanied by using electric fencing for the cows if you graze them in the wetland surrounds area).

(5) In late autumn (2021), when the ley is established, **plant your fruit trees**, staked, and protected by tree guards. At a similar time, build the **berry cage**, and prepare the **berry beds**.

(6) **Dig in the green manure crop** into your staple crops garden and make its protective wooden slab **borders**. Add in more **topsoil** and your farm's broken-down **sawdust-manure mix** to build up the soil fertility, to be incorporated into the soil by the earthworms over winter.

(7) In Winter (2021) **plant your berries**.

That Spring (2021) your **vege garden** will be super-ready to be **planted** in seed potatoes, kumara, pumpkins etc. That Spring (2021), put in **natural pest management plants** or seeds surrounding the fruit trees.

(8) The following Autumn (2022), **introduce chickens** into the area for manuring and insect control.

NB: If you have the **available labour**, you can prepare your **Intensive Vege Garden** in a similar way to the Staple Crops Garden, at the same time. There is the encouragement to do so, since it's a repeat process, requiring similar boundary materials, but with a terrace garden approach. It's a great advantage to have both gardens functioning at the same time.

# References

## Section 1. Introduction & Overview

* **'***Farming 2030 – Summary Doc for Dairy NZ'* by Debbie Pearson (Précis and adapted by Robina)

* NB: Much of this material is based on information arising through client interviews and land use observation

## Section 2. Permaculture Design Approach

* Earthcare Education Aotearoa papers on: *Permaculture Design Steps, Client Interview Questions, Site & Sector Survey Guide*.

## Section 3. Soils & Pastures

**Regenerative Agriculture**

* *'Insight into Regenerative Agriculture in New Zealand: The Good, the Bad and the Opportunity'*

https://pureadvantage.org/news/2020/04/30/insight-into-regenerative-agriculture-in-new-zealand-the-good-the-bad-and-the-opportunity/

* Pure Advantage's 14-part article series *on Our Regenerative Future* (30 April 2020), including*: The Science of Regenerative Agriculture with Dr Gwen Grelet*

* *Calm the Farm investors to help accelerate New Zealand's transition to regenerative farming* (10 March 2020, Stuff)

* *What is Regen Ag and why is it big for NZ?* (4 May 2020, Newsroom)

* *An Analysis and Overview of Regenerative Agriculture* by Dr Charles N Merfield, August 2019 (Report number 2-2019, BHU Future Farming Centre, Lincoln, New Zealand)

* *What is Regenerative Agriculture*? Greenpeace NZ https://www.greenpeace.org/new-zealand/story/what-is-regenerative-agriculture/?

**Animal Health & Field Medicines**

* '*Treatment of Organic Livestock with Medicinal Plants: A Systematic Review of European Ethnoveterinary Research*' - Mayer M.a, d · Vogl C.R.b · Amorena M.a · Hamburger M.c · Walkenhorst M.d

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* SOLID participatory research from Denmark:

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* *Healthy herbs for healthy cows*

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* The BHU Future Farming Centre *Rongoa Pastures Heathy Animals Resilient Farms* A report prepared for Ngā Pae o te Māramatanga 30 November 2015

- for a structured format of pasture herbs, go to Table 3: *'European pasture herbs for healthy animals'* adapted from Chris Day Herbs for *Pastureland 2007*.

* Latin names for species come from: The Royal Horticultural Society Encyclopaedia of Herbs 2014 reprint(Brown, 2002)

and New Zealand Plant conservation Network ( www.nzpcn.org.nz)

* https://thisnzlife.co.nz/the-most-beneficial-trees-for-livestock/

## Section 4. Water Management

**Waterways Generally**

* *Environmental Considerations for the Farm of Wayne and Tyler Langford* - Trevor James 18 Dec 2018

* '*Managing Waterways on Farms: A guide to sustainable water and riparian management in rural New Zealand*

https://www.mfe.govt.nz/sites/default/files/managing-waterways-jul01.pdf

* *Keeping our Waters Clean: Silt Traps Fact Sheet* 2010 - NZ Landcare Trust

**Riparian Zone**

* *Riparian Area Planting Plan for Go-Ahead Farm 2030* – a paper by Merrit Weiss

* *Environment Topics: Land Management – The Importance of Riparian Connection*. Leaflet by Hawkes Bay Regional Council

**Wetlands & Wetland Plant Species**

* NIWA 'Guidelines: *New Zealand Constructed Wetland Treatment of Tile Drainage*' (54 pgs)

* NIWA 'Guidelines: *New Zealand Constructed Wetland Planting Guidelines'* (26 pgs)

* NIWA *'Guidelines for Constructed Wetland Treatment of Farm Dairy Wastewaters in New Zealand'* (68 pgs)

* *Wetland Restoration: A Handbook for New Zealand Freshwater Systems*. Edited by Monica Peters & Beverley Clarkson Landcare Research – Manaaki Whenua, Lincoln, N.Z. : Manaaki Whenua Press, 2010.

* *Wetland Factsheet 3 – Planting Guide*. Waikato Regional Council

* Dairy Australia: *Hump and Hollow Drainage* (leaflet)

* Farmfact 5.1: *Benefits of Managing Waterways*

* Farmfact 5.3: *Fencing*

* *Guidance Manual for Constructed Wetlands* - Urban Pollution Research Centre Middlesex University, London

* https://www.doc.govt.nz/get-involved/run-a-project/restoration-advice/native-plant-restoration/local-planting-guides/ecological-restoration-in-nelson-marlborough/

## Section 5. Shade & Fodder Trees

**Books**:

* *Tree Farms in the New Zealand Landscape* – George Stockley

Pub: Northern Southland Farm Forestry Assn (3rd edition) 1982

* *Plant Materials Handbook for Soil Conservation*

*Vol 1: Principles & Practices* (Water & Soil Miscellaneous Publications No 98)

*Vol 2: Introduced Plants* (Water & Soil Miscellaneous Publications No 94)

National Water & Conservation Authority

**Web Info**:

* *The Most Beneficial Trees for Livestock*

https://thisnzlife.co.nz/the-most-beneficial-trees-for-livestock/

* *A Guide to Tree Forage Crops* – New Zealand Treecrops Assn

https://treecrops.org.nz/crops/fodder-and-forage/forage/

* *Trees for Animal Fodder*

https://www.blockhill.co.nz/trees_for_animal_fodder

* *Trees for Fodder* – Farm Forestry of New Zealand

https://www.nzffa.org.nz/farm-forestry-model/why-farm-forestry/trees-for-fodder/

* *Hill Country Heros: The benefits from pollarding poplars and willows to provide fodder*

https://beeflambnz.com/knowledge-hub/PDF/poplars-and-willows-fodder

## Section 6. Orchard & Vege Garden

* *Treecrops Compendium* – a booklet compiled by Earthcare Education Aotearoa

* All other material all self-generated by Robina McCurdy

## Section 7. Supplementary Income

**Emissions Trading Scheme**

* https://www.dairynz.co.nz/environment/land-management/planting-trees/

* https://www.nzffa.org.nz/farm-forestry-model/why-farm-forestry/trees-for-carbon/

## Section 8. Recommended Implementation Steps

* All material all self-generated by Robina McCurdy

# Appendix

## Benchmark Soil tests: June 2020

### PROFESSIONAL SOIL REPORT

**Account of** SOLLYS CONTRACTING **Address** TAKAKA, NZ,

**Service Representative** "Kinsey Ag Service" **Date** 06/24/2020

5736833880

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Farm | ROSS_WRIGHT | W_LANGFORD | W_LANGFORD | W_LANGFORD | W_LANGFORD | |
| | Field | | EFFLUENT | LUCERNE | HOME | BURNELLS | |
| | Sample | | REGEN | REGEN | | | |
| | Lab No. | | C0004 | C0005 | C0006 | C0007 | |
| | Total Exchange Capacity (M. E.) | | 8.87 | 8.02 | 14.64 | 13.64 | |
| | pH of Soil Sample | | 5.90 | 5.96 | 5.81 | 5.53 | |
| | Organic Matter, Percent | | 4.00 | 3.30 | 5.80 | 6.10 | |
| ANIONS | NITROGEN: | lbs / acre | 90 | 83 | 104 | 106 | |
| ANIONS | SULFATE - S: | p.p.m. | 9 | 19 | 14 | 10 | |
| ANIONS | P1 or (Olsen) PHOSPHATES: as (P2 O5) lbs / acre | Desired Value | 237 | 237 | 243 | 242 | |
| | | Value Found | 316 | 351 | 468 | 472 | |
| | | Deficit | | | | | |
| EXCHANGEABLE CATIONS | CALCIUM: lbs / acre | Desired Value | 2413 | 2182 | 3981 | 3710 | |
| | | Value Found | 2141 | 2135 | 3404 | 3148 | |
| | | Deficit | -271 | -47 | -577 | -562 | |
| EXCHANGEABLE CATIONS | MAGNESIUM: lbs / acre | Desired Value | 255 | 231 | 421 | 392 | |
| | | Value Found | 275 | 162 | 450 | 170 | |
| | | Deficit | | -69 | | -222 | |
| EXCHANGEABLE CATIONS | POTASSIUM: lbs / acre | Desired Value | 315 | 312 | 437 | 415 | |
| | | Value Found | 160 | 150 | 238 | 142 | |
| | | Deficit | -154 | -161 | -199 | -273 | |
| EXCHANGEABLE CATIONS | SODIUM: | lbs / acre | 31 | 36 | 31 | 21 | |
| | BASE SATURATION PERCENT | | | | | | |
| | Calcium (60 to 70%) | } 80% | 60.34 | 66.52 | 58.14 | 57.69 | |
| | Magnesium (10 to 20%) | | 12.96 | 8.42 | 12.82 | 5.19 | |
| | Potassium (2 to 5%) | | 2.33 | 2.40 | 2.09 | 1.34 | |
| | Sodium (.5 to 3%) | | 0.77 | 0.99 | 0.48 | 0.34 | |
| | Other Bases (Variable) | | 5.60 | 5.48 | 5.78 | 6.34 | |
| | EXCHANGEABLE HYDROGEN (10 to 15%) | | 18.00 | 16.20 | 20.70 | 29.10 | |
| | Cobalt (p.p.m.) | | | | | | |
| | Salinity 1:2 EC (dS/M) | | | | | | |
| | Chlorides (p.p.m.) | | | | | | |
| | Boron (p.p.m.) | | 1.15 | 1.25 | 1.04 | 1.19 | |
| | Iron (p.p.m.) | | 1570.03 | 1680.51 | 678.33 | 674.00 | |
| | Manganese (p.p.m.) | | 57.87 | 61.52 | 20.02 | 10.92 | |
| | Copper (p.p.m.) | | 2.76 | 2.31 | 0.96 | 9.35 | |
| | Zinc (p.p.m.) | | 11.91 | 10.33 | 12.73 | 4.84 | |
| | Molybdenum (p.p.m.) | | | | | | |

Control 45570

# PROFESSIONAL SOIL REPORT

**Account of** SOLLYS CONTRACTING **Address** TAKAKA, NZ,

**Service Representative** "Kinsey Ag Service" **Date** 06/24/2020

5736833880

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Farm | ROSS_WRIGHT | W_LANGFORD | | W_LANGFORD | | W_LANGFORD |
| | Field | | LUCERNE | | OLD_LUCERNE | | NEW_LUCERN |
| | Sample | | COMBO | | | | |
| | Lab No. | | C0013 | | C0014 | | C0015 |
| | Total Exchange Capacity (M. E.) | | 11.39 | | 9.89 | | 10.20 |
| | pH of Soil Sample | | 5.86 | | 5.80 | | 6.06 |
| | Organic Matter, Percent | | 4.80 | | 4.10 | | 4.20 |
| ANIONS | NITROGEN: | lbs / acre | 98 | | 91 | | 92 |
| | SULFATE - S: | p.p.m. | 21 | | 16 | | 17 |
| | P1 or (Olsen) PHOSPHATES: as (P2 O5) lbs / acre | Desired Value<br>Value Found<br>Deficit | 240<br>547 | | 238<br>519 | | 239<br>469 |
| EXCHANGEABLE CATIONS | CALCIUM: lbs / acre | Desired Value<br>Value Found<br>Deficit | 3097<br>2713<br>-384 | | 2689<br>2413<br>-275 | | 2775<br>2642<br>-132 |
| | MAGNESIUM: lbs / acre | Desired Value<br>Value Found<br>Deficit | 327<br>319<br>-8 | | 284<br>212<br>-72 | | 293<br>274<br>-19 |
| | POTASSIUM: lbs / acre | Desired Value<br>Value Found<br>Deficit | 361<br>285<br>-75 | | 312<br>193<br>-119 | | 330<br>328<br>-1 |
| | SODIUM: | lbs / acre | 33 | | 32 | | 24 |
| | BASE SATURATION PERCENT | | | | | | |
| | Calcium (60 to 70%)<br>Magnesium (10 to 20%) } 80%<br>Potassium (2 to 5%)<br>Sodium (.5 to 3%)<br>Other Bases (Variable)<br>EXCHANGEABLE HYDROGEN (10 to 15%) | | 59.57<br>11.70<br>3.22<br>0.64<br>5.68<br>19.20 | | 61.03<br>8.95<br>2.50<br>0.72<br>5.80<br>21.00 | | 64.76<br>11.21<br>4.13<br>0.52<br>5.28<br>14.10 |
| | Cobalt (p.p.m.)<br>Salinity 1:2 EC (dS/M) | | | | | | |
| | Chlorides (p.p.m.) | | | | | | |
| | Boron (p.p.m.) | | 1.47 | | 1.61 | | 2.51 |
| | Iron (p.p.m.) | | 1669.69 | | 1781.38 | | 1747.36 |
| | Manganese (p.p.m.) | | 32.60 | | 31.71 | | 27.38 |
| | Copper (p.p.m.) | | 1.89 | | 1.88 | | 2.06 |
| | Zinc (p.p.m.) | | 10.42 | | 8.91 | | 10.42 |
| | Molybdenum (p.p.m.) | | | | | | |

Control 45572



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PERRY AGRICULTURAL LABORATORY, INC.

# PROFESSIONAL SOIL REPORT

**Account of** SOLLYS CONTRACTING **Address** TAKAKA, NZ,

**Service Representative** "Kinsey Ag Service" **Date** 06/24/2020

5736833880

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Farm | | ROSS_WRIGHT | W_LANGFORD | W_LANGFORD | W_LANGFORD | W_LANGFORD | W_LANGFORD |
| Field | | | MEADS | MEADS | PAKAHI | PAKAHI | EFFLUENT |
| Sample | | | REGEN | | | REGEN | |
| Lab No. | | | C0008 | C0009 | C0010 | C0011 | C0012 |
| Total Exchange Capacity (M. E.) | | | 19.40 | 7.29 | 14.23 | 15.69 | 11.66 |
| pH of Soil Sample | | | 5.98 | 5.27 | 5.31 | 5.51 | 5.72 |
| Organic Matter, Percent | | | 6.39 | 3.90 | 6.03 | 6.06 | 4.70 |
| ANIONS | NITROGEN: | lbs / acre | 107 | 89 | 105 | 105 | 97 |
| | SULFATE - S: | p.p.m. | 9 | 16 | 11 | 10 | 15 |
| | P1 or (Olsen) PHOSPHATES: as (P2 O5) lbs / acre | Desired Value | 248 | 236 | 243 | 244 | 240 |
| | | Value Found | 237 | 352 | 158 | 182 | 651 |
| | | Deficit | -11 | | -84 | -62 | |
| EXCHANGEABLE CATIONS | CALCIUM: lbs / acre | Desired Value | 5276 | 1983 | 3870 | 4268 | 3172 |
| | | Value Found | 4852 | 1191 | 2694 | 3316 | 2525 |
| | | Deficit | -424 | -792 | -1176 | -952 | -647 |
| | MAGNESIUM: lbs / acre | Desired Value | 558 | 210 | 409 | 451 | 335 |
| | | Value Found | 724 | 182 | 288 | 354 | 339 |
| | | Deficit | | -28 | -121 | -97 | |
| | POTASSIUM: lbs / acre | Desired Value | 527 | 304 | 428 | 459 | 368 |
| | | Value Found | 87 | 233 | 149 | 167 | 348 |
| | | Deficit | -439 | -70 | -279 | -292 | -20 |
| | SODIUM: | lbs / acre | 25 | 30 | 25 | 22 | 30 |
| BASE SATURATION PERCENT | | | | | | | |
| Calcium (60 to 70%) } 80% | | | 62.53 | 40.83 | 47.33 | 52.83 | 54.13 |
| Magnesium (10 to 20%) | | | 15.56 | 10.40 | 8.45 | 9.41 | 12.12 |
| Potassium (2 to 5%) | | | 0.58 | 4.11 | 1.34 | 1.37 | 3.83 |
| Sodium (.5 to 3%) | | | 0.29 | 0.91 | 0.39 | 0.31 | 0.56 |
| Other Bases (Variable) | | | 5.44 | 6.86 | 6.78 | 6.38 | 5.96 |
| EXCHANGEABLE HYDROGEN (10 to 15%) | | | 15.60 | 36.90 | 35.70 | 29.70 | 23.40 |
| Cobalt (p.p.m.) | | | | | | | |
| Salinity 1:2 EC (dS/M) | | | | | | | |
| Chlorides (p.p.m.) | | | | | | | |
| Boron (p.p.m.) | | | 1.70 | 1.51 | 1.02 | 1.43 | 1.50 |
| Iron (p.p.m.) | | | 87.29 | 1772.23 | 471.41 | 165.32 | 1422.27 |
| Manganese (p.p.m.) | | | 12.14 | 85.11 | 11.62 | 10.19 | 23.85 |
| Copper (p.p.m.) | | | 0.43 | 2.90 | 0.92 | 0.34 | 1.48 |
| Zinc (p.p.m.) | | | 9.46 | 11.26 | 15.76 | 13.49 | 10.54 |
| Molybdenum (p.p.m.) | | | | | | | |

Control 45571

Page 1 of 1

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PERRY AGRICULTURAL LABORATORY, INC.

# SOIL BIOLOGY REPORT

Report prepared for:
Tasman Environmental Trust
Debbie Pearson
Kathryn Brownlie
Takaka, 7142

**For interpretation of this report please contact your local Soil Steward or the lab.**

Report Sent: 30 Jun 2020
Sample #: 05-7426
Unique ID: Home Block
Plant: Pasture
Season: winter
Invoice Number: 6318
Sample Recieved: 19 Jun 2020

Soil Foodweb New Zealand
12 Smith Street
Waihi, 3610 New Zealand
07 863 8556
info@soilfoodweb.co.nz
http://www.soilfoodweb.co.nz

| Assay Name | Result | Units | Desired Level | Commentary |
|---|---|---|---|---|
| **Organism Biomass Data** | | | | |
| Dry Weight | 0.67 | N/A | 0.45 to 0.85 | Within normal moisture levels indicating organic matter at reasonable levels, however organic matter must come in contact with active microbes to be converted into valuable, stable humus. |
| Active Fungi | **8.01** | µg/g | > 30.00 | Fungal activity low. Soil's fungal food resources probably too low. Additions of fungal foods with other inputs should help to lift levels ie good quality humates, fish hydrolysate etc. - |
| Total Fungi | 349.77 | µg/g | > 300.00 | Total fungal biomass in good range - Fungal diversity appears at reasonable levels with adequate hyphal formation. A few damaged and no longer viable groups also evidient. |
| Active Bacteria | 30.31 | µg/g | > 30.00 | Bacterial activity within normal levels. |
| Total Bacteria | 313.57 | µg/g | > 300.00 | Good total bacterial biomass. - |
| Actinobacteria | 0.00 | µg/g | < 20.00 | |
| **Organism Biomass Ratios** | | | | |
| TF:TB | 1.12 | | 0.80 to 1.45 | Correctly balanced fungal and bacterial biomass for pasture. A good result. The fungal biomass helps build soil structure, reduces disease and cycles nutrients especially calcium and the bacterial biomass helps with soil structure plus provides foods for the predators ie worms, beneficial nematodes and protozoa, thus cycling nutrients. |
| AF:TF | **0.02** | | > 0.10 | The overall percentage of active fungal biomass is too low. |
| AB:TB | 0.10 | | > 0.10 | The overall percentage of active bacteria is in good range. |
| AF:AB | **0.26** | | 1.00 to 2.00 | Fungal dominated soil, becoming more bacterial with time. |
| **Protozoa (Protists)** | | | | |
| Flagellates | 6,843.00 | number/g | > 5,000.00 | Protozoa barely in range. Nutrient cycling by the actions of these bacterial-eating predators is low. ie 56-84 kg/ha of N per 3 month period. |
| Amoebae | 6,843.00 | number/g | > 5,000.00 | |
| Ciliates | 68.34 | number/g | < 137.00 | |
| Nitrogen Cycling Potential | 56-84 | kg/ha | | Nitrogen levels dependent on plant needs. Estimated availability over a 3 month period |
| **Nematodes** | | | | |
| Nematodes | Not Ordered | number/g | > 10.00 | |
| Bacterial | Not Ordered | number/g | > 4.00 | |
| Fungal | Not Ordered | number/g | > 4.00 | |
| Fungal/Root | Not Ordered | number/g | < 1.00 | |
| Predatory | Not Ordered | number/g | > 2.00 | |
| Root | Not Ordered | number/g | < 1.00 | |
| **Mycorrhizal Fungi** | | | | |
| ENDO | 69.00 | % | > 10 | Normal colonization. However low fungal activity may suggest mycorrhiza is not functioning at optimum levels. - |
| ECTO | | % | > 10 | not used |
| Ericoid | | % | > 10 | not used |
| **Miscellaneous Testing** | | | | |
| E.coli | Not Ordered | CFU/g | < 800.00 | For most areas, the maximum E.coli CFU/g is 800 - 1000. Please check your local regulations for more information. - |
| pH | Not Ordered | | | |
| Organic Matter | Not Ordered | | | |
| Electrical Conductivity | Not Ordered | µS/cm | < 1000.00 | |

# SOIL BIOLOGY REPORT

Report prepared for:
Tasman Environmental Trust
Debbie Pearson
Kathryn Brownlie
Takaka, 7142

**For interpretation of this report please contact your local Soil Steward or the lab.**

Report Sent: 30 Jun 2020
Sample #: 05-7427
Unique ID: Lucerne Regen.
Plant: Lucerne
Season: winter
Invoice Number: 6318
Sample Recieved: 19 Jun 2020

Soil Foodweb New Zealand
12 Smith Street
Waihi, 3610 New Zealand
07 863 8556
info@soilfoodweb.co.nz
http://www.soilfoodweb.co.nz

| Assay Name | Result | Units | Desired Level | Commentary |
|---|---|---|---|---|
| **Organism Biomass Data** | | | | |
| Dry Weight | 0.75 | N/A | 0.45 to 0.85 | Within normal moisture levels indicating organic matter at reasonable levels, however organic matter must come in contact with active microbes to be converted into valuable, stable humus. |
| Active Fungi | **4.47** | µg/g | > 30.00 | Fungal activity low. Soil's fungal food resources probably too low. Additions of fungal foods with other inputs should help to lift levels ie good quality humates, fish hydrolysate etc. - |
| Total Fungi | **142.37** | µg/g | > 300.00 | Low total fungal biomass. Apply foods as mentioned above. Fungal play an important role in the opening of soil structure, disease and pest suppression and the cycling of nutrients ie calcium. - Fungal diversity appears at adequate levels with some larger healthy looking hyphal formations. Others small with some damaged and no longer viable groups also evident. |
| Active Bacteria | **23.21** | µg/g | > 30.00 | Bacterial activity slightly low. Soil's bacterial food resources probably low. Additions of seaweed applied with other inputs should be beneficial to both bacteria and other organisms. |
| Total Bacteria | 314.16 | µg/g | > 300.00 | Good total bacterial biomass. - |
| Actinobacteria | 0.00 | µg/g | < 20.00 | |
| **Organism Biomass Ratios** | | | | |
| TF:TB | **0.45** | | 0.80 to 1.45 | Too bacterial for pasture production. Build fungal biomass to create a balanced ratio with bacterial biomass for healthy production. |
| AF:TF | **0.03** | | > 0.10 | The overall percentage of active fungal biomass is too low. |
| AB:TB | **0.07** | | > 0.10 | The overall percentage of active bacteria is too low |
| AF:AB | **0.19** | | 1.00 to 2.00 | Bacterial dominated soil, becoming more bacterial with time. Not desirable in this instance. |
| **Protozoa (Protists)** | | | | |
| Flagellates | **1,836.71** | number/g | > 5,000.00 | Low protozoa numbers, low nutrient cycling by the actions of these bacterial-eating predators. High ciliate numbers indicate possible anaerobic conditions. |
| Amoebae | 6,103.32 | number/g | > 5,000.00 | |
| Ciliates | **184.20** | number/g | < 79.00 | |
| Nitrogen Cycling Potential | 28-56 | kg/ha | | Nitrogen levels dependent on plant needs. Estimated availability over a 3 month period |
| **Nematodes** | | | | |
| Nematodes | Not Ordered | number/g | > 10.00 | |
| Bacterial | Not Ordered | number/g | > 4.00 | |
| Fungal | Not Ordered | number/g | > 4.00 | |
| Fungal/Root | Not Ordered | number/g | < 1.00 | |
| Predatory | Not Ordered | number/g | > 2.00 | |
| Root | Not Ordered | number/g | < 1.00 | |
| **Mycorrhizal Fungi** | | | | |
| ENDO | 50.00 | % | > 10 | Normal colonization. However low fungal activity suggests mycorrhiza is not functioning at optimum levels. - |
| ECTO | | % | > 10 | |
| Ericoid | | % | > 10 | |
| **Miscellaneous Testing** | | | | |
| E.coli | Not Ordered | CFU/g | < 800.00 | For most areas, the maximum E.coli CFU/g is 800 - 1000. Please check your local regulations for more information. - |
| pH | Not Ordered | | | |
| Organic Matter | Not Ordered | | | |
| Electrical | | | | |

# SOIL BIOLOGY REPORT

Report prepared for:
Tasman Environmental Trust
Debbie Pearson
Kathryn Brownlie
Takaka, 7142

**For interpretation of this report please contact your local Soil Steward or the lab.**

Report Sent: 30 Jun 2020
Sample #: 05-7428
Unique ID: Pakahi
Plant: Pasture
Season: winter
Invoice Number: 6318
Sample Recieved: 19 Jun 2020

Soil Foodweb New Zealand
12 Smith Street
Waihi, 3610 New Zealand
07 863 8556
info@soilfoodweb.co.nz
http://www.soilfoodweb.co.nz

| Assay Name | Result | Units | Desired Level | Commentary |
|---|---|---|---|---|
| **Organism Biomass Data** | | | | |
| Dry Weight | 0.69 | N/A | 0.45 to 0.85 | Within normal moisture levels indicating organic matter at reasonable levels, however organic matter must come in contact with active microbes to be converted into valuable, stable humus. |
| Active Fungi | **0.54** | µg/g | > 30.00 | Fungal activity very low. Soil's fungal food resources probably too low. Fungal foods will help lift levels ie good quality humates and fish hydrolysate. - |
| Total Fungi | 389.86 | µg/g | > 300.00 | Total fungal biomass in excellent range, however it is out-competing bacterial biomass. This suggest fungal growth has been quite expansive in the past. - Fungal diversity at quite good levels with some large healthy looking hyphal formations. However a few damaged and no longer viable groups also evident. |
| Active Bacteria | **17.31** | µg/g | > 30.00 | Bacterial activity low. Soil's bacterial food resources probably low. Applications of seaweed type products plus judicious applications of sugar/molasses should help to lift active bacterial levels. |
| Total Bacteria | **210.58** | µg/g | > 300.00 | Low total bacterial biomass. Feed as suggested above. Bacteria form the food source for worms, beneficial nematodes and protozoa thus cycling nutrients. - |
| Actinobacteria | 7.18 | µg/g | < 20.00 | |
| **Organism Biomass Ratios** | | | | |
| TF:TB | **1.85** | | 0.80 to 1.45 | Too fungal for healthy growth of pasture. Need to lift bacterial numbers to balance with fungal biomass. This will help ensure nutrient cycling takes place. |
| AF:TF | **0.00** | | > 0.10 | The overall percentage of active fungal biomass is too low. |
| AB:TB | **0.08** | | > 0.10 | The overall percentage of active bacteria is low. |
| AF:AB | **0.03** | | 1.00 to 2.00 | Fungal dominated soil, becoming more bacterial with time. Desirable trend in this instance. |
| **Protozoa (Protists)** | | | | |
| Flagellates | 20,194.86 | number/g | > 5,000.00 | Good flagellate numbers but amoebae low. Low diversity. Some nutrients being cycled by the actions of these bacterial-eating predators. ie 81-112 kg.ha of N in a 3 month period. |
| Amoebae | **4,039.56** | number/g | > 5,000.00 | |
| Ciliates | 52.44 | number/g | < 242.00 | |
| Nitrogen Cycling Potential | 84-112 | kg/ha | | Nitrogen levels dependent on plant needs. Estimated availability over a 3 month period |
| **Nematodes** | | | | |
| Nematodes | Not Ordered | number/g | > 10.00 | |
| Bacterial | Not Ordered | number/g | > 4.00 | |
| Fungal | Not Ordered | number/g | > 4.00 | |
| Fungal/Root | Not Ordered | number/g | < 1.00 | |
| Predatory | Not Ordered | number/g | > 2.00 | |
| Root | Not Ordered | number/g | < 1.00 | |
| **Mycorrhizal Fungi** | | | | |
| ENDO | 36.00 | % | > 10 | Adequate colonization, although it is usual for mycorrhizal colonisation levels to be closer to 70% in healthy grass systems. - |
| ECTO | | % | > 10 | |
| Ericoid | | % | > 10 | |
| **Miscellaneous Testing** | | | | |
| E.coli | Not Ordered | CFU/g | < 800.00 | For most areas, the maximum E.coli CFU/g is 800 - 1000. Please check your local regulations for more information. - |
| pH | Not Ordered | | | |
| Organic Matter | Not Ordered | | | |
| Electrical | | | | |

# SOIL BIOLOGY REPORT

Report prepared for:
Tasman Environmental Trust
Debbie Pearson
Kathryn Brownlie
Takaka, 7142

**For interpretation of this report please contact your local Soil Steward or the lab.**

Report Sent: 30 Jun 2020
Sample #: 05-7429
Unique ID: Meads Regen
Plant: Pasture
Season: winter
Invoice Number: 6318
Sample Recieved: 19 Jun 2020

Soil Foodweb New Zealand
12 Smith Street
Waihi, 3610 New Zealand
07 863 8556
info@soilfoodweb.co.nz
http://www.soilfoodweb.co.nz

| Assay Name | Result | Units | Desired Level | Commentary |
|---|---|---|---|---|
| **Organism Biomass Data** | | | | |
| Dry Weight | 0.64 | N/A | 0.45 to 0.85 | Within normal moisture levels indicating organic matter at reasonable levels, however organic matter must come in contact with active microbes to be converted into valuable, stable humus. |
| Active Fungi | 16.77 | µg/g | > 30.00 | Fungal activity slightly low. Soil's fungal food resources probably too low. Additions of fungal foods with other inputs should help to lift levels ie good quality humates, fish hydrolysate etc. - Active fungal sporulation evident. |
| Total Fungi | 495.10 | µg/g | > 300.00 | Total fungal biomass in good range, however it is out-competing bacterial biomass. - Fungal diversity at good levels with large healthy hyphal formations. |
| Active Bacteria | 27.47 | µg/g | > 30.00 | Bacterial activity slightly low for winter season. Soil's bacterial food resources probably low. Additions of seaweed applied with other inputs should be beneficial to both bacteria and other organisms. |
| Total Bacteria | 312.93 | µg/g | > 300.00 | Good total bacterial biomass. - |
| Actinobacteria | 0.00 | µg/g | < 20.00 | |
| **Organism Biomass Ratios** | | | | |
| TF:TB | 1.58 | | 0.80 to 1.45 | Slightly too fungal for pasture production. Need to build bacteria to create a better balance with fungi thus ensure better nutrient cycling. |
| AF:TF | 0.03 | | > 0.10 | The overall percentage of active fungal biomass is too low. |
| AB:TB | 0.09 | | > 0.10 | The overall percentage of active bacteria is slightly too low. |
| AF:AB | 0.61 | | 1.00 to 2.00 | Fungal dominated soil, becoming more bacterial with time. Desirable. |
| **Protozoa (Protists)** | | | | |
| Flagellates | 896.94 | number/g | > 5,000.00 | Low diversity. Low nutrient cycling by actions of these bacterial-eating predators ie 28-56 kg/ha of N per 3 month period. High ciliate numbers indicate possible anaerobic conditions. |
| Amoebae | 4,325.58 | number/g | > 5,000.00 | |
| Ciliates | 131.03 | number/g | < 52.00 | |
| Nitrogen Cycling Potential | 28-56 | kg/ha | | Nitrogen levels dependent on plant needs. Estimated availability over a 3 month period |
| **Nematodes** | | | | |
| Nematodes | Not Ordered | number/g | > 10.00 | |
| Bacterial | Not Ordered | number/g | > 4.00 | |
| Fungal | Not Ordered | number/g | > 4.00 | |
| Fungal/Root | Not Ordered | number/g | < 1.00 | |
| Predatory | Not Ordered | number/g | > 2.00 | |
| Root | Not Ordered | number/g | < 1.00 | |
| **Mycorrhizal Fungi** | | | | |
| ENDO | 59.00 | % | > 10 | Normal colonization. However low active fungal biomass suggests mycorrhiza may not be functioning at optimum levels. - |
| ECTO | | % | > 10 | |
| Ericoid | | % | > 10 | |
| **Miscellaneous Testing** | | | | |
| E.coli | Not Ordered | CFU/g | < 800.00 | For most areas, the maximum E.coli CFU/g is 800 - 1000. Please check your local regulations for more information. - |
| pH | Not Ordered | | | |
| Organic Matter | Not Ordered | | | |
| Electrical Conductivity | Not Ordered | µS/cm | < 1000.00 | |

# SOIL BIOLOGY REPORT

Report prepared for:
Tasman Environmental Trust
Debbie Pearson
Kathryn Brownlie
Takaka, 7142

**For interpretation of this report please contact your local Soil Steward or the lab.**

Report Sent: 30 Jun 2020
Sample #: 05-7430
Unique ID: Meads
Plant: Pasture
Season: winter
Invoice Number: 6318
Sample Recieved: 19 Jun 2020

Soil Foodweb New Zealand
12 Smith Street
Waihi, 3610 New Zealand
07 863 8556
info@soilfoodweb.co.nz
http://www.soilfoodweb.co.nz

| Assay Name | Result | Units | Desired Level | Commentary |
|---|---|---|---|---|
| **Organism Biomass Data** | | | | |
| Dry Weight | 0.78 | N/A | 0.45 to 0.85 | Within normal moisture levels indicating organic matter at reasonable levels, however organic matter must come in contact with active microbes to be converted into valuable, stable humus. |
| Active Fungi | **1.94** | µg/g | > 30.00 | Fungal activity very low. Soil's fungal food resources probably too low. Additions of fungal foods with other inputs should help to lift levels ie good quality humates, fish hydrolysate etc. - |
| Total Fungi | **266.59** | µg/g | > 300.00 | Low total fungal biomass. Apply foods as mentioned above. Fungal play an important role in the opening of soil structure, disease and pest suppression and the cycling of nutrients ie calcium. - Fungal diversity at quite good levels with healthy looking hyphal formations. |
| Active Bacteria | 36.76 | µg/g | > 30.00 | Bacterial activity at good levels. . |
| Total Bacteria | 362.49 | µg/g | > 300.00 | Good total bacterial biomass. However bacteria are slightly out-competing fungal biomass. - |
| Actinobacteria | 0.00 | µg/g | < 20.00 | |
| **Organism Biomass Ratios** | | | | |
| TF:TB | **0.74** | | 0.80 to 1.45 | Slightly too bacterial for best pasture growth. Need to build fungal biomass to create the balanced ratio required for healthy pasture production. |
| AF:TF | **0.01** | | > 0.10 | The overall percentage of active fungal biomass is too low. |
| AB:TB | 0.10 | | > 0.10 | The overall percentage of active bacteria is in good range |
| AF:AB | **0.05** | | 1.00 to 2.00 | Bacterial dominated soil, becoming more bacterial with time. Not desirable in this instance. |
| **Protozoa (Protists)** | | | | |
| Flagellates | **1,786.62** | number/g | > 5,000.00 | Low diversity. Low nutrient cycling by actions of these bacterial-eating predators ie 28-56 kg/ha of N per 3 month period. High ciliate numbers indicate possible anaerobic conditions. |
| Amoebae | **3,574.54** | number/g | > 5,000.00 | |
| Ciliates | **197.22** | number/g | < 54.00 | |
| Nitrogen Cycling Potential | 28-56 | kg/ha | | Nitrogen levels dependent on plant needs. Estimated availability over a 3 month period |
| **Nematodes** | | | | |
| Nematodes | Not Ordered | number/g | > 10.00 | |
| Bacterial | Not Ordered | number/g | > 4.00 | |
| Fungal | Not Ordered | number/g | > 4.00 | |
| Fungal/Root | Not Ordered | number/g | < 1.00 | |
| Predatory | Not Ordered | number/g | > 2.00 | |
| Root | Not Ordered | number/g | < 1.00 | |
| **Mycorrhizal Fungi** | | | | |
| ENDO | 53.00 | % | > 10 | Normal colonization. However low active fungal biomass suggests mycorrhiza may not be functioning at optimum levels. - |
| ECTO | | % | > 10 | |
| Ericoid | | % | > 10 | |
| **Miscellaneous Testing** | | | | |
| E.coli | Not Ordered | CFU/g | < 800.00 | For most areas, the maximum E.coli CFU/g is 800 - 1000. Please check your local regulations for more information. - |
| pH | Not Ordered | | | |
| Organic Matter | Not Ordered | | | |
| Electrical Conductivity | Not Ordered | µS/cm | < 1000.00 | |

# Fish Survey – Go Ahead Creek tributaries,

4.4km upstream McCallum Rd

Jan 2019


A survey was conducted 29/1/19 on Go Ahead Tributary 1 at E1579242 N5472533.
The creek had a cobble/gravel substrate and a water temperature of 24.3 degrees in sunlight and 21.0 degrees in shade. There were a series of pools, the deepest of which was around 400mm. Caddisflies and mayflies were present which is a indication of good water quality. At E1579123 N5472679 which was just outside of the bush line the bank was 3 metres incised.

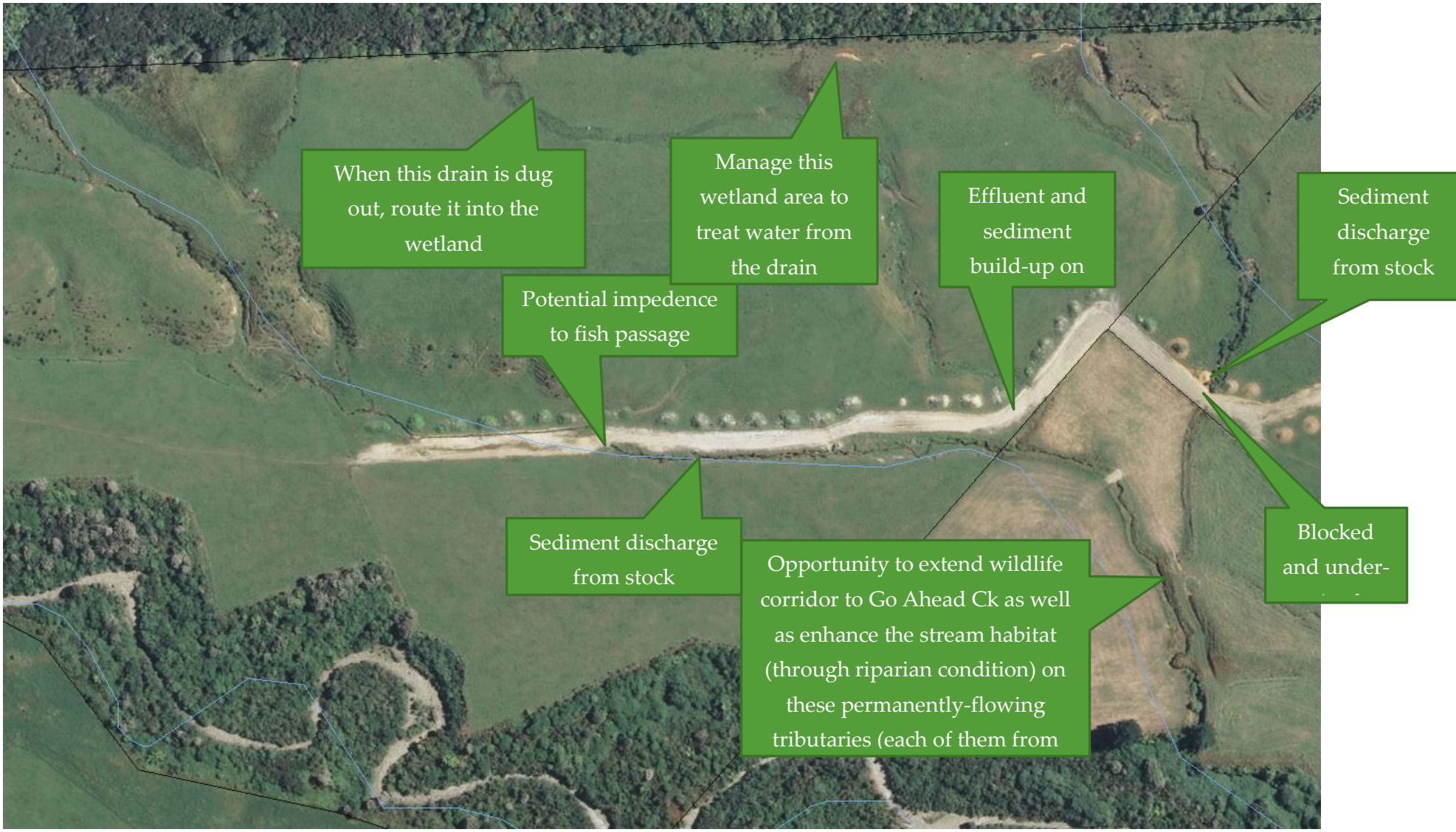
Go Ahead Tributary 2, E1579562 N5472553
A cobble/gravel substrate and a water temperature of 19.9 degrees in sunlight and 18.7 degrees in shade. The average width of the creek was 0.5 metres and the deepest pool was 300 mm. Although the creek was fenced on the true left, stock have access on the true right bank.

A spotlight survey was also conducted on 29/1/19. Tributary 1 had Longfin eels measuring 300, 320mm as well as an unidentified eel measuring 180mm.
There was an abundance of Koura; we observed 30 individuals measuring between 30-50mm.
Tributary 2 had Longfin eels measuring 230, 240mm as well as 74 Koura measuring between 30-50mm. We also observed 2 Golden Bell frogs in this habitat. =

# Water Management Maps – Trevor James

Map 1: Overview. Red box indicates inset map on Map 2

Map 2:


When this drain is dug out, route it into the wetland
Manage this wetland area to treat water from the drain
Effluent and sediment build-up on
Sediment discharge from stock
Potential impedence to fish passage
Sediment discharge from stock
Opportunity to extend wildlife corridor to Go Ahead Ck as well as enhance the stream habitat (through riparian condition) on these permanently-flowing tributaries (each of them from
Blocked and under-

Map 3: Homestead area and major sinkholes.

Map 4:

Map 5: "Middle Paddocks"

Map 6: Natural wetlands identified on the property from remote sensing