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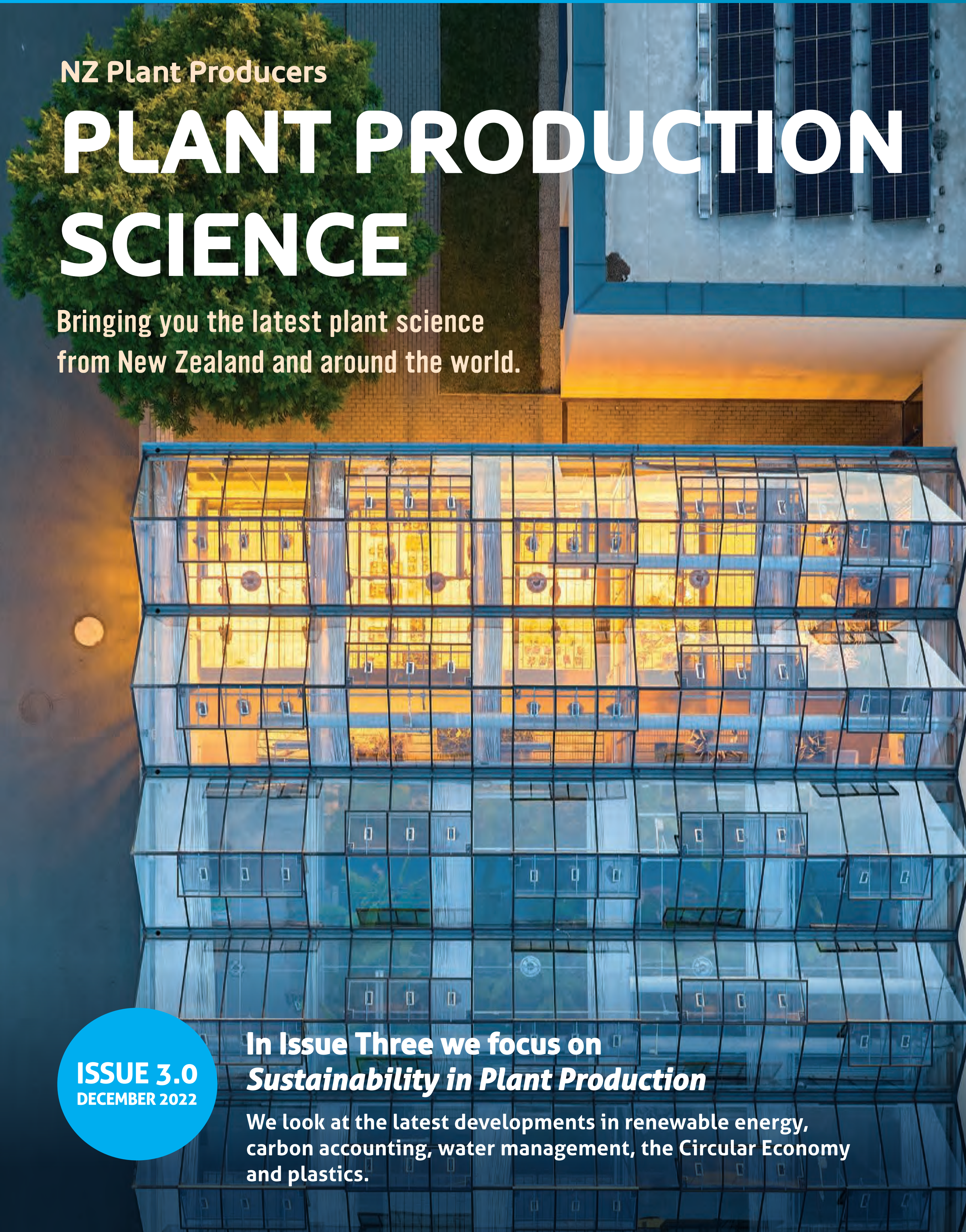
NEW ZEALAND PLANT PRODUCERS INCORPORATED



NZ Plant Producers

PLANT PRODUCTION SCIENCE

Bringing you the latest plant science from New Zealand and around the world.

ISSUE 3.0
DECEMBER 2022

In Issue Three we focus on *Sustainability in Plant Production*

We look at the latest developments in renewable energy, carbon accounting, water management, the Circular Economy and plastics.

Contents

Welcome to Plant Production Science, *in this issue we look at the latest developments in science and practice helping our sector to be sustainable now and into the future.*

Improving the sustainability of plant production has key importance in minimising negative environmental impacts. When it's done right, being more sustainable and efficient will lead to being more profitable. Like other sectors, the plant production sector has an opportunity to move away from a reliance on fossil fuels and to improve how we manage resources like water and material like plastics.

But we are also a significant part of the sustainability solution for New Zealand. From a lifecycle perspective, plants have a vastly positive carbon footprint which we need to tell our customers about. Plants produced for riparian zones, wetlands, restoration and erodible land, and afforestation have major benefits to water quality, biodiversity and create a significant source of renewable material.

The challenge going forward is how to build sector wide coordination – both ensuring production can meet the demands for sustainably produced plants, as well as measuring and improving the sustainability of our inputs.

There are many opportunities to improve our sustainability story. We can use technologies to better manage and mitigating clean water resources and help reduce our carbon and non-renewable footprints. We can choose to replace inputs into our businesses with more renewable resources, moving further up the waste hierarchy – rethinking, refusing and replacing waste.

Ngā mihi

Kathryn Hurr, Biosecurity & Technical Manager
NZ Plant Producers Inc.

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Using science and innovation in your plant production? Tell us about it! kathryn@nzppi.co.nz

The carbon footprint of trees and shrubs

Even though greenhouse gas emissions are created during tree and shrub production, this is more than offset by the amount of CO_2 they sequester during their life span.

Studies show that between 1.7 and 3.4 kg's of CO_2 are emitted during the production of a container grown tree seedling but that tree will go on to absorb almost a tonne of CO_2 in its lifetime.

Carbon footprint is a term used to describe the impact of greenhouse gas emissions associated with a product or activity. It relates to the emission and removal of greenhouse gases in the environment. Carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) are the main three greenhouse gases resulting from human and environmental processes.

Carbon dioxide is the most important GHG for plant production. The carbon footprint for plant production includes emission during the lifecycle of plant production, usually from burning fuel but this is followed by the removal of carbon from the atmosphere over time as the tree grows.

Carbon footprint of landscape plant production systems

Modelling research done in the USA has identified the carbon footprint for different types of plant production systems. The research used a Life Cycle Assessment of the inputs and processes to identify those that contribute the most to total carbon footprint and variable costs.

The research identified differences between field and containerised plant production. The greatest contributor to GHG for field-grown trees was due to equipment use (71 to 77%) and up to 89% of this use per plant occurred at harvest as shown in Figure 1. Input materials and equipment used in the harvesting process contributed an average of 26% of the total variable costs for field-grown tree models.

While equipment use was the primary contributor to the farm-gate CF of field-grown plants, the use of plastics was the primary contributor for container-grown woody plants, grown on outdoor beds with full sun or artificial shade provided by shade structures.

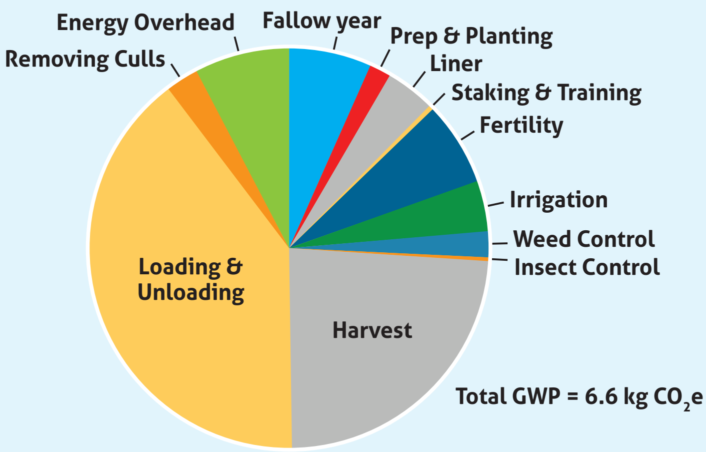


Figure 1. Relative carbon footprint (global warming potential [GWP], kilogram carbon dioxide equivalents [kg CO_2e /tree] of input materials and equipment use during 5cm calliper redbud (*Cercis canadensis*) field production phase (seed-to-gate).

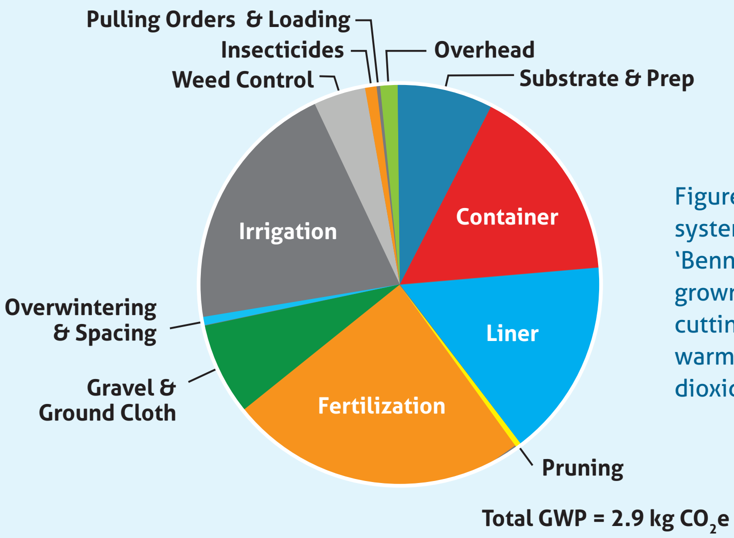


Figure 2. Relative impact of production systems components of *Ilex crenata* 'Bennett's Compacta' in an 11Litre container grown on the east coast of the U.S. on its cutting-to-gate carbon footprint (global warming potential [GWP], kilogram carbon dioxide equivalents [kg CO_2e /plant]).

The farm-to-gate CF of shrubs in 11L pots ranged from 1.72 to 3.36 kg CO_2e depending on the location and system protocols. Variable costs for these shrubs ranged from US$2.88 to US$5.73, influenced primarily by input materials and secondarily by labour, both of which varied by container size sequencing practices.

Carbon sequestration

CO_2 is sequestered from the air and stored in the wood of plants during production and their useful life in the landscape. Plants differ in terms of the density of their wood but approximately 50% of the dry weight of wood is carbon.

Greenhouse gases will be emitted when the tree is removed from the landscape at the end of its life, primarily from petrol and diesel com-bustion in chain saws, chippers, and trucks. GHG from take down and disposal were calculated to be 214 and 88 kg CO_2e for red maple and redbud, respectively. Take down and disposal of the shrubs studied would result in 1.25 kg CO_2e GHG.

When all production and take down costs are balanced by carbon removed from the atmosphere, the study showed there is a massive net positive balance of carbon during a tree's life in the landscape (see Figure 4.) This could be emphasized in marketing efforts as consumers increasingly consider the potential environmental impact of green industry products (e.g., carbon footprint) when making purchasing decisions.

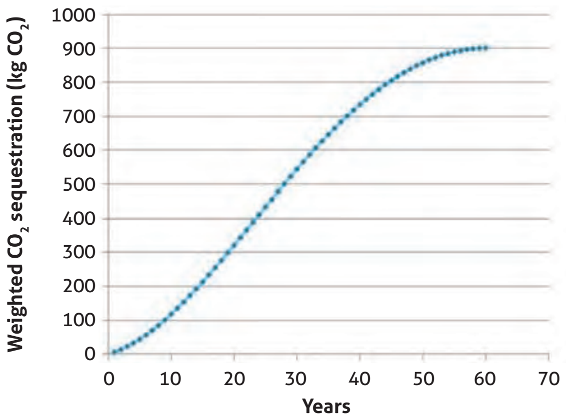


Figure 3. Carbon dioxide sequestration by a red maple tree during its 60-year life in the landscape weighted over a 100-year assessment period.

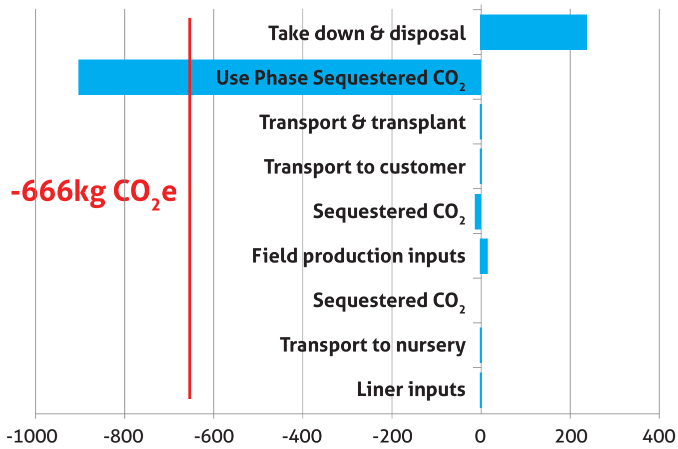


Figure 4. Life cycle impact of a red maple considering the carbon footprint (global warming potential [GWP], kilogram carbon dioxide equivalents [[kg CO_2e /tree]) of production, transport, and transplanting, and take down and disposal balanced by the carbon sequestered during a 60-year life in the landscape, weighted over 100-years.

Research by Dewayne Ingram and Joshua Knight, University of Kentucky, and Dr. Charlie Hall, Texas A&M University, 2019.

Renewable energy

The New Zealand Government has set an ambitious goal of reaching net zero emissions by 2050. What does this mean for our industry?

The Emissions Reduction Plan 2022 sets out a transition pathway from fossil fuels to a carbon-neutral or fossil-free economy by 2050. As part of this, the Government aims to produce a Gas Transition Plan by the end of 2023 and phase out coal boilers by 2037. Setbacks in natural gas supply are already causing some challenges for producers in our industry and the timelines are tight for a gradual energy transition.

New technology is required. Innovative approaches are being developed and tested all over the world, including new developments in electricity generation, heat storage, heat pumps, climate (humidity) control, greenhouse structures, and more.

The Energy Efficiency & Conservation Authority (ECCA) has been working with the covered crops (horticultural) sectors to develop a decarbonisation pathway through to 2050. A study commissioned by TomatoesNZ / Horticulture New Zealand has explored options for renewable energy sources and sustainable energy technology for greenhouse climate control.

While our industry does not have the same energy demands as the covered crops sector, the 5-step plan developed by EECA serves as a road-map for our sector. **https://www.eeca.govt.nz/**

Step 3 of the 5-step focuses on improving efficiency in current energy use. This involves looking at possible improvements in structures, buildings, design, and insulation with regard to efficient electricity flow. It could mean very simple things, like repairing holes in greenhouses, using screens to control temperature, and humidity control.

5 Step plan

1. Increase engagement and awareness
2. Measure emissions and set targets
3. Optimise equipment and improve processes
4. Reduce energy demand
5. Switching to renewable energy

Step 5 of the plan covers switching to renewable energy.

Potential alternative energy arrangements in greenhouses could include:

- Low-grade heat from external sources
- Low-grade heat harvested in own glasshouse in summer and stored underground
- High-grade heat from a geothermal or industrial source
- Green electricity from solar, wind, hydro or biomass, produced on-site or off-site
- Heat pumps possibly in combination with a low-grade heat source and (green) electricity
- Bio-energy including waste wood
- Hydrogen, a promising option for the future
- Combination of the above

In this article, we summarise evaluations of three of these fossil-fuel alternatives for controlling greenhouse temperature:

Heat-pumps

Heat pumps could be ideal for lower temperature users. Low-grade heat is a stream of water or air with a moderate temperature. In freezing conditions in winter, water of say 5-10°C is relatively warm.

This water can be fed into a heat pump, which extracts the heat from the incoming stream and transfers it to the outgoing stream. The outgoing stream has a cranked-up temperature of, for example, 35°C, which is high enough for greenhouse heating. The heat pump uses electricity for this process in an efficient way: every 1 kWh electricity that goes in produces 3 to 4 kWh heat that comes out.

The Biomass boiler at Zealandia Horticulture in Canterbury.

In cold climates, the input for a heat pump must be luke-warm water, because a heat pump cannot efficiently extract heat from freezing cold air. In milder climates, the input for a heat pump can be (lukewarm) outside air. Hence four types of heat pumps can be distinguished: air-to-air, air-to-water, water-to-air, and water-to-water. Lukewarm water can come from many sources, such as a (milk) factory, cooling water from a data centre, water treatment plant, aquifer (underground water bubble) or surface water (canals, ponds).

Heat-pumps are the most efficient generation of heat, with 1 unit in and 4 -5 units out, but they can be expensive to install and may necessitate an upgrade of the lines on site.

Bio-energy

Bio-energy is being trialled by greenhouse growers worldwide. The obvious bio-fuel in New Zealand is waste wood from forestry, but it is a matter of securing sufficient supply and reliable transport for future years. More than 9 percent of New Zealand’s energy already comes from bioenergy (Bioenergy Association, 2022).

Multi-hectare greenhouse operations will struggle with the sheer volume of waste wood needed. The use of other types of biomass, and innovative ways of pre-processing it, are being investigated.

More than 9% of New Zealand’s energy already comes from bioenergy.

(Bioenergy Association, 2022).

Geothermal

Soil and water below the ground contain reservoirs of thermal energy. Geothermal heating systems recover this energy and convert it to heat that can be used in greenhouses and other buildings. Geothermal heating is an important area of focus for greenhouses in the Netherlands, with around 17 geothermal sources in operation and plans to develop two new systems each year until 2040. They are the 2nd biggest food producers in the work and have mastered innovation in food production for decades. They are now focussing efforts on switching from fossil fuels to geothermal energy to reduce carbon emissions and increase

Geothermal activity. Rotorua, New Zealand. *Credit: Pexels.com*

Geothermal areas for Direct Heat Use

Figure shows known areas of warm water systems

energy security.

Low-temperature heating can be used in various ways, such as pumped directly into the heating system, stored in a buffer for use overnight, or fed into a heat pump to increase temperature. It is particularly well-suited for greenhouses and nurseries (among others), for example. There are several examples of greenhouses using the geothermal heating located near Rotorua (Plenty Flora (Gerbera growers) and Taupo (Gourmet Mokai).

GNS Science scientists are investigating the potential for warm water extraction as a potential energy/heat source for low to medium temperature users in New Zealand. Low-temperature geothermal resources are found across New Zealand and typically provide temperatures of 60 to 80°C at a few hundred metres depth. Suggested case study areas include the wider Tauranga region and the Hauraki plains, but are not limited to there. Warm water systems exist throughout NZ.

GNS are interested in partnering with local plant producers on feasibility studies for use across our sector.

Dr. Anya Seward, Geothermal Geophysicist, GNS Science | Te Pū Ao

Water management

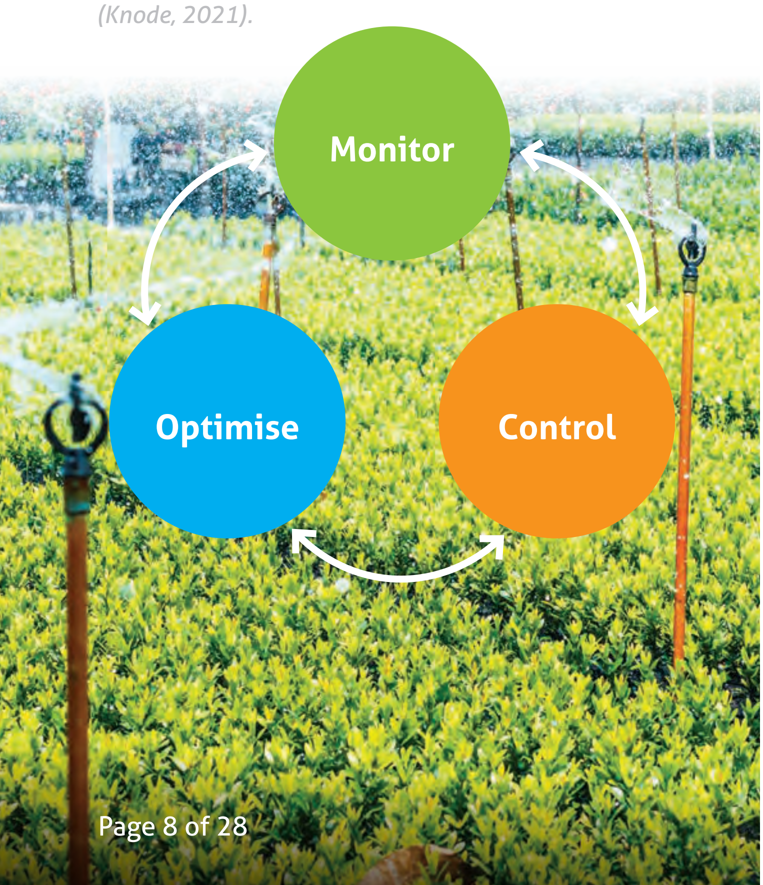
Water is a crucial resource in plant production. We each have a role to ensure our water use is effective, efficient, and sustainable for current and future generations.

With climate change and increases in severe weather events like drought, water scarcity and management are ever-increasing problems. Reducing water wastage through monitoring and system efficiency is key.

Technology – Smart water usage

Technology can help improve efficiency, accuracy and insights by managing 3 key areas:

(Knode, 2021).



Sustainable water management

...the ability to meet the water needs of the present without compromising the ability of future generations to do the same.

Monitoring

Monitoring improves understanding of water usage throughout the business/nursery, both in the supply of water and understanding the storage and distribution (irrigation).

- Available technology: Flow meters, pressure transducers, level sensors, nodes - accessing the cloud to analyse, present data and provide insights

Control

Improving control can streamline management, reduce costs and improve efficiency.

- Available technology: a single system that controls irrigation across the whole plant production area.
- Automation and remote access to reduce labour needs and costs
- Data can be digitally logged to provide insights, visualisation and influence future decision making.

Optimising

With greater control and understanding of water use in the business/nursery, insights can be used to optimise plant growth and efficiency of water use. Several different types of external data can be used depending on the needs/desired outcomes including:

Soil data

Soil probes can be used to measure several different environmental/atmospheric conditions.

Soil Temperature probes – Monitoring changes in soil temperature can provide insights into seasonal changes and the influence on plant water needs. It can also be used for other data like growing or dormancy/ chill days.

Volumetric Water Content Probes – Balancing the fine line between providing enough water while maintaining sufficient root aeration and avoiding leaching/excessive water runoff. Data from volumetric water content probes can be used to influence irrigation scheduling to help maintain optimal conditions in this difficult balance.

- The aim is to maintain Field Capacity (Optimal) and avoid Saturation (Overwatering) and Permanent Wilt Point (Stress). This is also important for nutrient management.

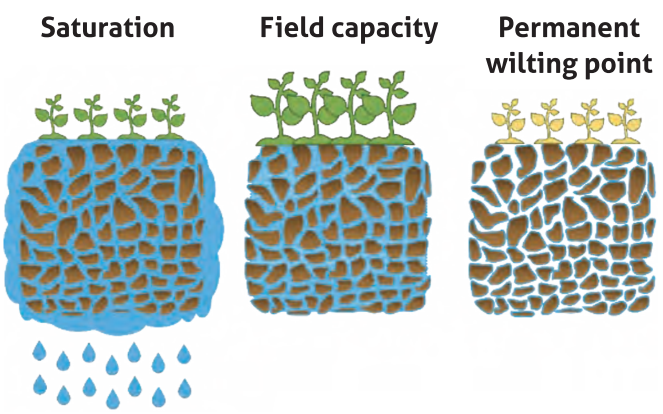


Figure 1. Volumetric Water Content (UGA Extension, 2022).

Weather data

Utilise local or onsite weather data for location specific needs, such as rainfall data to adjust sprinklers and temperature for frost risk.

ETO & VPD

- Evapotranspiration (ETO): Understanding plant water demand hourly or daily
- Vapour Pressure Deficit (VPD): Maintain certain VPD with humidity/mister manipulation so the plants put their energy into growth

These technologies help the producer consider plant need variations on a daily basis, not just changing schedules monthly.

Irrigation scheduling from space?

Using high-resolution satellite imagery to estimate plant growth and cover is nothing new. NASA has been using it since the early 1980's to track forest biomass and the effect of droughts on crops. However, this technology is gaining momentum and use in the primary industries to measure plant growth, canopy cover, and even estimate dry matter of pasture.

Cindy Lowe *(Our Land and Water)* has used this satellite data to help calculate crop coefficients, water needs and therefore irrigation scheduling in arable crops. The hope is to integrate this satellite data with interpreting software to calculate irrigation scheduling recommendations.

There is huge potential with this technology for future use in the plant production sector – How can we scale this technology to suit/be integrated with our production systems?

Jacinta Harrop, NZPPI.

Greenhouse Control – Technology

Maintaining optimum year-round plant growth in the greenhouse and propagation house involves monitoring and controlling many factors, including temperature, humidity, lighting, CO^2, irrigation and fertilisation.

Control systems running independently of one another can lead to an imbalance of environmental controls, resulting in systems fighting against each other causing inefficiencies.

Integrated control systems ensure that all installed systems work together to achieve the best outcome for growers and crops. Every aspect from temperature, humidity and lighting to radiation, CO^2 and irrigation can be controlled autonomously using integrated controller technology.

Priva controllers, an easy user-interface showing all data at the growers fingertips.

Temperature and humidity

Temperature and humidity in the propagation house or greenhouse affects a wide range of crop qualities including strike rate, growth rate, development and production. Often these areas can be heated or cooled with external equipment that require power or energy sources such as gas or waste oil. Ensuring temperature sensors and equipment are well maintained and accurate improves crop quality and production and can also reduce operation costs.

Lighting

There are several different lighting systems available for growers to utilise in their nursery or greenhouse. Good control systems can control photoperiod, supplemental, or top-up lighting depending on the fixture or application. Daylight extension or photoperiod control influence the length of light plants experience to maintain a vegetative growing phase or trigger a flowering response. If lighting is required to add growth to the crop, top up or supplemental lighting can be useful. A top up lighting programme adds light at the end of the day, whereas supplemental lighting is delivered throughout the day to meet a minimum light level for maintaining growth. Some controllers and light fixtures also have available options to adjust spectrum and intensity, allowing fine tuning for lighting control, energy costs and maintaining year round production.

Irrigation

While hand watering is important for top-up irrigation, best results come from a well-designed, integrated, and automated system. Irrigation can be incorporated into the integrated control system and allow growers to use weather or climate influences to trigger their operation. It can maximise water use, reduce pumping costs and water wastage and nutrient losses.

Online solutions

Cloud or internet connections are the latest way of staying connected with what is happening in the nursery or greenhouse and can be set up with alerts and alarms to notify if a set of parameters are not met. Perhaps the temperature in the greenhouse is too hot due to a failed vent motor or fan, or the irrigation pump flow is too high due to a burst pipe. Alarms keep you informed and paired with an online connection, can allow you to adjust settings remotely.

Maintenance

To ensure that you are getting the most out of your control system, it is critical to ensure regular maintenance including preventative maintenance as part of your scheduled six-monthly and annual schedules. It also acts as a reminder to check the things that may be forgotten about during a busy growing season. Time invested in maintenance increases the life expectancy of valuable equipment and makes breakdowns during the season less likely.

Integrated controls and scheduled maintenance can lead to increased efficiencies, better ROI's, less down time, and better overall control of your crop and environment. It allows you to control every influence on you crops growth and to be able to react quickly if something goes wrong, minimising losses.

5 top tips

With the change of season just around the corner bringing colder weather and shorter days, now is the time to review what you are doing as it can have a marked impact on production. Nathan Hewson shares his top 5 tips for greenhouse climate control during the cooler seasons:

1. **Scheduled maintenance** – preventative maintenance is going to pay dividends throughout the busy growing season, with fewer break downs and less down time, allowing you to focus where your time is needed or better spent.
2. **Optimise your settings for the change in season** – close the greenhouse down earlier to retain heat and energy from the sun saves on power and reduces energy bills. Be sure to watch the humidity and set up your controller for purging the excess humidity that may build up from plants transpiring towards the later part of the day. Any free energy captured from the sun will reduce expenses of keeping the greenhouse warm.
3. **Use thermal screens** – save energy by creating a thermal buffer between the crop and the cold outside, reducing energy bills and enabling better control of the growing climate.
4. **Install LED Lighting to supplement growth** – with shorter days and lower sunlight you can add LEDs to drive growth and improve plant health, reduce disease and increase production. If adding light, you also need to optimise irrigation, temperature and humidity to create the best growing environment.
5. **Upskilling or training** – autumn and winter are the best times to learn about how to use your systems better in the future to allow optimisation of your climate and irrigation strategy to achieve better outcomes. Review data or settings on your controller and results from previous seasons to help come up with a strategy and plan.

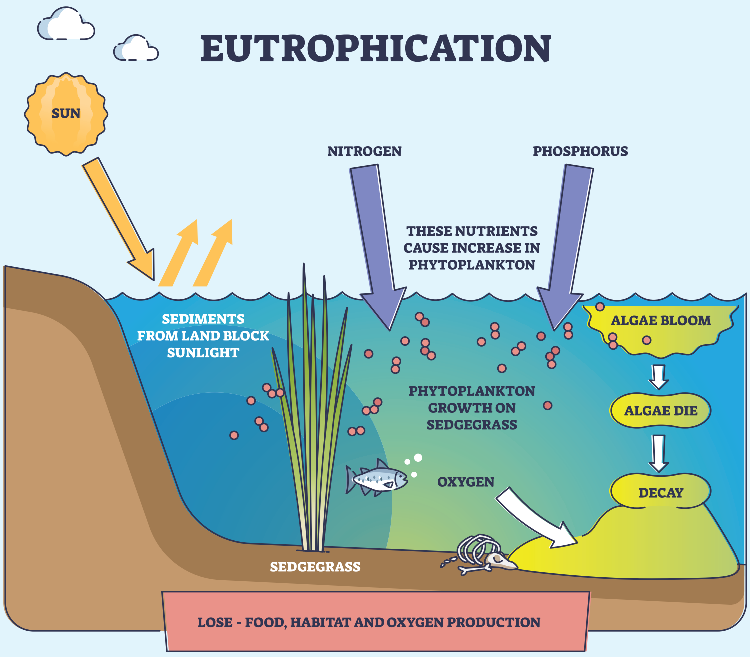
An integrated control system that is well-maintained and supported by in-house system knowledge and early alarm notifications greatly assists plant producers to increase plant growth and health and reduce losses.

Nathan Hewson, Advanced Hort.

Nutrient management

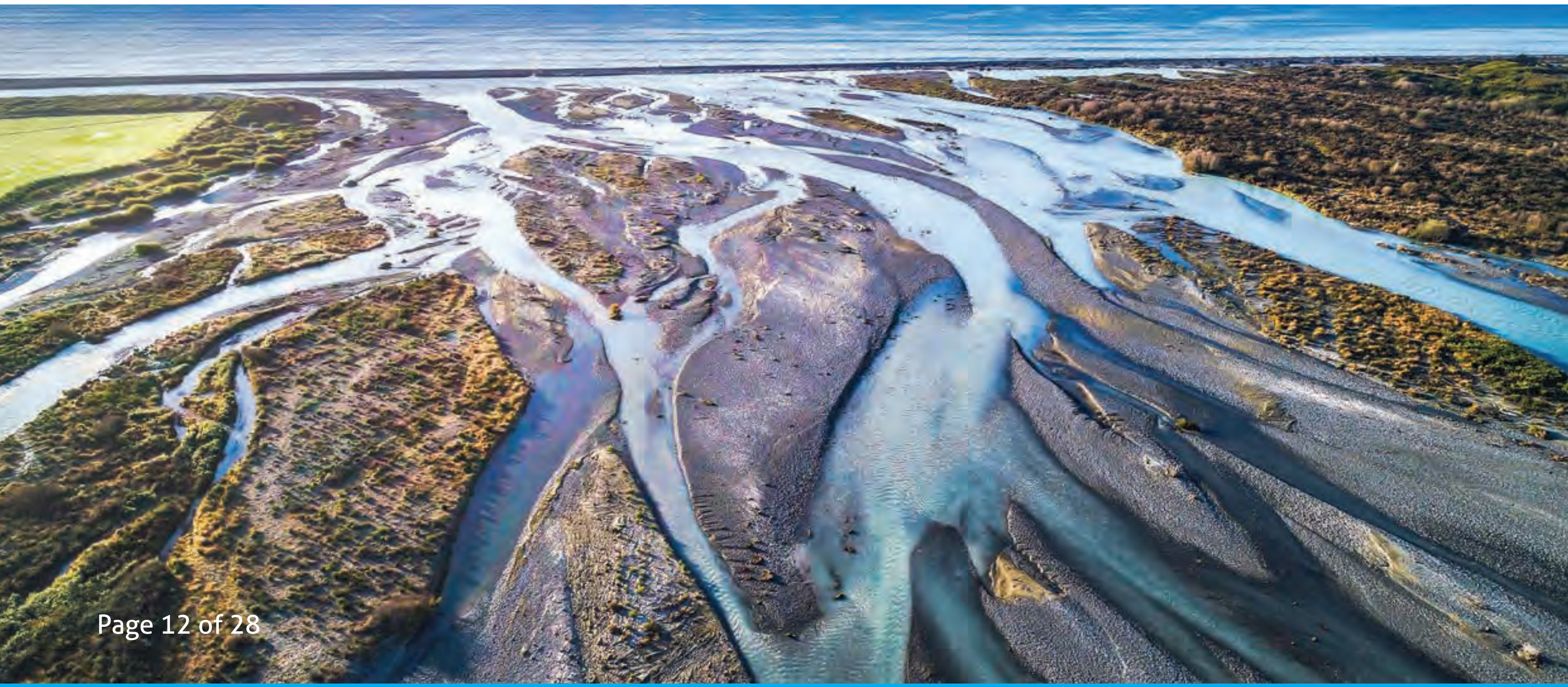
Managing nutrient leaching and loss in soil and run-off is regulated in the dairy and market garden sectors. Our industry must also consider its own impacts and the mitigation options.

If not actively managed, nitrogen and phosphorous leaching can lead to eutrophication of waterways. Soil type, structure and fertiliser applications play vital roles in the potential for leaching of both these nutrients. Our industry produces a huge range of plant species, each with their own nutrient needs, adding complexity to the timing and management of fertilisation and irrigation. A unique advantage for our sector is the concentration of growing areas with a high potential to collect and capture rainwater and irrigation run-off. We can also control the properties of growing media we use.



Eutrophication

Excessive richness of nutrients (primarily nitrogen and phosphorus) in a body of water, which causes an increase in dense growth of plants and algae.



The Nitrogen problem

Nitrogen is accessible to plants in two forms, nitrate (NO_3^-) and ammonium (NH_4^+). It is provided to plants through the additions of fertiliser and the breakdown of soil organic matter. Available nitrogen in the nitrate form (NO_3^-) is soluble in water and is particularly mobile in the soil profile. If more nitrogen is provided than plants can utilise, the excess can be lost through leaching.

Excessive nitrogen in waterways can contaminate sources of drinking water, deplete dissolved oxygen and lead to eutrophication in waterways, and encourage the growth of algal blooms and weeds.

The Phosphorus problem

Phosphorus is primarily available to plants as orthophosphate ions ($H_2PO_4^-$, HPO_4^{2-}). However, it exists in soils in several mineral or organic forms. It's not as mobile as nitrate, but it can be lost from the production system and enter waterways via suspended sediment in surface water run-off.

Other primary industries are at greater risk from this, losing valuable topsoil as suspended sediment in run-off compared to brought in media use in plant production. However, the loss of sediment in surface run-off is still a concern for sustainability and waterway eutrophication.

What can we do to manage nutrient loss?

In our sector with high ground coverage and drainage managed production areas, run-off capture and re-application is a feasible option. It provides another opportunity for nitrogen to be utilised by plants that would otherwise be 'lost' from the system, reducing fertiliser requirements. However, potential pathogen load/issues in run-off need to be understood and managed.

Sediment traps can be utilised to temporarily collect surface run-off water and allow time for suspended sediment to drop out of solution before draining away. This provides an opportunity to reduce phosphorus loss.

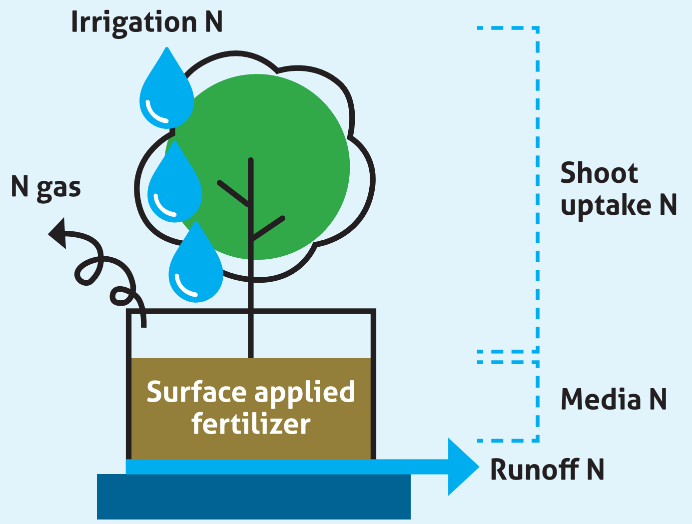


Diagram of nitrogen inputs and outputs measured to develop the nursery system nitrogen balance. Inputs include media nitrogen (fertilizer, roots, and media), surface-applied fertilizer, and irrigation water nitrogen. Outputs include nitrogen in runoff water, shoot uptake, remaining in media, and gas from media.

Managing fertilisers and irrigation activities can also help:

- Avoid overwatering/excessive irrigation causing runoff
- Avoid heavy applications of fertiliser
- Avoid fertilising ahead of excessive wet periods (heavy rainfall)
- Time fertiliser applications to periods of high plant growth and ability to utilise available nutrients
- Avoid applying fertiliser when soil temperatures are low and consider plant size/needs
- Use controlled or slow-release fertilisers

Aim for optimal

Although inadequate fertiliser application can reduce plant growth and crop profitability, excessive fertiliser application is also costly and increases the risk of nutrient loss. Aim for the optimal i.e. good plant nutrient uptake and growth without excessive production costs.

Jacinta Harrop, NZPPI.

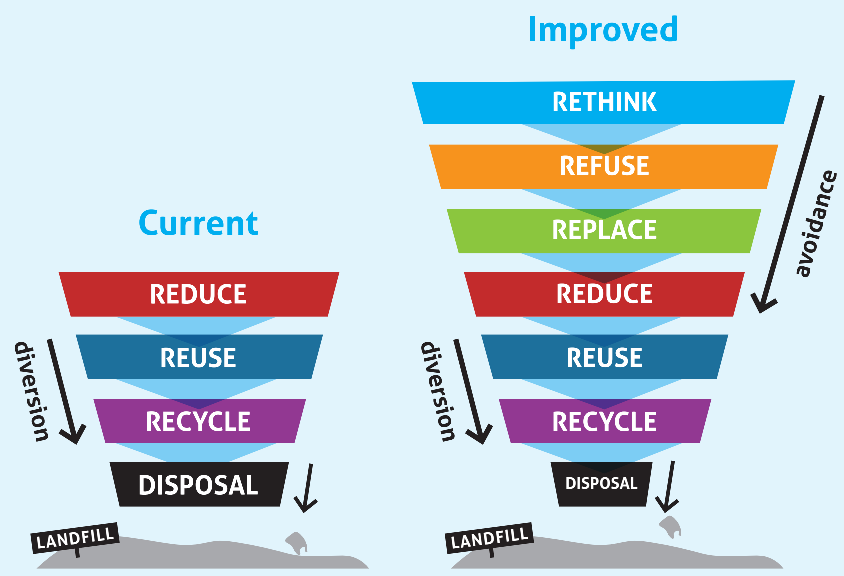
The Circular Economy

At the heart of the circular economy is ensuring that everything that we make, we can unmake. It's a shift in perception from our current Take-Make-Use-Waste mindset (where products and packaging are landfilled often after a single use) to a mindset where used materials are seen as resources that have value and can be used again. In practice, it implies rethinking the product you're making to design waste out of the equation as well as thinking about how to design to extend the life of a product.

The traditional view of the waste hierarchy was the three R's: Reduce, Reuse, Recycle. Today, the waste hierarchy has expanded to include more thinking around avoidance: Rethink, Refuse, Replace, Reduce, Reuse, Recycle.

Many assume that when a product or packaging is recyclable, the issue of Take-Make-Use-Waste is solved. Recycling is important, and it needs to be included in the waste hierarchy, but it's at the bottom of the hierarchy. When thinking about new initiatives that we might pursue, we need to think as high up the hierarchy as we can.

Rethinking the waste hierachy



Source: Prime Minister's Chief Science Advisor Report, "Rethinking Plastics in Aotearoa New Zealand" December 2019.

Aotearoa NZ has one of the highest rates of waste per capita in the OECD.

Research from the Ellen MacArthur Foundation suggests that

80% of waste

can be designed out in the design phase of a product or packaging.

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How we might we rethink what we're making? How might we use less materials in the products or packaging we make? How might we ensure what we're making is able to be reused? How might we make products that can be repaired? How might we think about different ownership models around products (e.g. leasing rather than owning)?

Keeping materials in circulation for as long as possible and making sure that the products that we're producing have as long a life as they can are key shifts to embrace as part of the circular economy.

The Ellen MacArthur Foundation promotes three principles of the circular economy are driven by design:

- Eliminate waste and pollution
- Circulate products and materials (at their highest possible value)
- Regenerate nature

Every type of material has a scrap value associated to it, including plastics. Some have a negative scrap value (which is typically the landfill disposal costs associated to a material).

A large portion of plant pots used in New Zealand are made from polypropylene (PP#5), which has a scrap value between $400-$500 per tonne for unprocessed scrap material. Clear PET has a scrap value around $200 per tonne, whereas coloured PET has a negative value. Clear HDPE has a scrap value around $900 per tonne, whereas coloured HDPE is valued between $400-$500 per tonne. When you're thinking about the choice of materials that you're using, choose one that has a positive scrap value (i.e. #5 PP, #2 HDPE). If you do, there's a greater likelihood this material will be recovered and made into a new product or packaging.

In Aotearoa NZ, there is a range of plastic plant pots made from coloured PET as well as polystyrene, both of which have a negative value and aren't recyclable at scale in the New Zealand context. Steer clear of these two!

It would be ideal if ALL plant pots were made from #5 PP, to allow us to develop a system and infrastructure to recover this material; a system wide, scalable way of getting all of that material back and be able to recycle it.

Plant pots are not accepted by councils in kerbside recycling, they will go to landfill. There are two reasons for this: (1) biosecurity reasons (if there is any soil residue left in a pot); (2) optical sorting machines at material recycling facilities are unable to identify black/dark coloured materials.

Product stewardship is coming our way, fast. The producer of a product or packaging will need to take responsibility for that material through to its end of life, including the costs associated to this. Plant pots will be captured within one of the product stewardship organisations (plastic packaging or farm plastics). The NZPPI Plastics Advisory Committee is doing work in that space. There's a lot of interest in compostable plastic pots, but it's important to note that they would still be captured under one of the product stewardship schemes. The Ministry for the Environment recently released guidance on compostables which is worth referring to: **https://environment.govt.nz/publications/compostable-products-ministry-for-the-environment-position-statement/**

MfE will shortly be consulting on standardization of curbside recycling so that we have all councils or local authorities doing the same thing, composting (particularly around food waste), and container deposit schemes.

Sandy Botterill,
Head of Corporate Social Responsibility,
Foodstuffs Marketing & CX

Recycling plastic waste

Plastic pots and labels are a significant contributor to our sectors' waste problem. Around 252,000 tonnes of plastic waste go into landfills annually according to recycle.co.nz, and both Government and kiwi's want solutions.

There are two main types of plastic used in pots in New Zealand: polypropylene (PP) #5 and polyethylene terephthalate (PET) #1.

Theoretically these plastics are an infinitely recyclable resource, if they can be cleaned and recovered for re-processing. However, New Zealand doesn't have the ability to recycle coloured PET, so even though it's recyclable, it has a negative scrap value and will go to landfill.

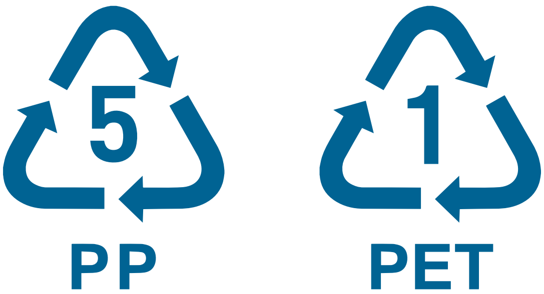
97%

of New Zealand's population do have access to PPE at curbside.

Many councils around New Zealand have now started taking household PP in curbside recycling, but plant pots are still a problematic waste stream and typically go to landfill. 97% of New Zealand's population do have access to PPE at curbside.

We need to have the system and infrastructure to recover those materials. The first is the shift to single materials. This will mean we will be able to create a system wide scalable way of getting all of that material back, and at the very least, being able to recycle it.

Various stewardship schemes have emerged where consumers return used pots back to the original store for recycling. Pot Recycle is a collaboration between Zealandia Horticulture and Mitre 10, supported by recycling partners that process the returned pots ready for remoulding at Zealandia's Auckland nursery. The Mitre 10 Pot Recycle initiative has recycled 1 million plant and seedling pots since launching in May 2021, equating to about 19 tonnes of plastic diverted from landfills around the country.



Bunnings have a similar scheme in place for pots. Other plant retailers keep a bin outside their store where people can drop off used, washed pots and in many cases, these are picked up by members of the public for their own use, propagating plants for school fairs etc.

Plastic stations at retail stores are catering to consumer demand for recycling.

Daltons are a member of the Soft Plastic Recycling Scheme which allows New Zealanders to recycle their soft plastic bags and wrappers. Consumers can drop their washed, clean and dry soft plastic bags into the Soft Plastics Recycling Bins at supermarket and retail premises.

Alternatives to plastic

Degradable pots offer another choice for plant production.

Paper pots

Paper pot propagation systems, such as Ellepot and FibreCell (previously known as Lanam) are well-established in commercial plant production. Ellepots are made from a degradable paper and can be produced with many types of growing media. A range of different perforated papers are available in different sizes and grades, for seedlings and cuttings through to larger grades for trees and shrubs. Papers are machine-made into long tubes, filled with potting media and sliced into the desired length. A range of nursery equipment is available as well as various automation options for dibbing, seeding, watering and transplanting.

Adopters of the system have found there is a need to adjust watering and use a different potting mix than in trays, tailored to the species, production system, and infrastructure.

Trials in New Zealand nurseries have found many species have faster growth rates in paper pots, including native trees. At Titoki Nursery in Nelson, plantable grades of matai (*Prumnopitys taxiifolia*) seedlings can be produced in just one season. Southern Woods Nursery in Christchurch halved the growing time of *Sophora* from seed, traditionally taking 18-20 months in tray systems down to 8-10 months in paper pots. Native grasses previously took 3-4 months to grow and can now be ready after only 1 month in paper pots. The faster growth is thought to be due to increased air flow around the roots, and natural air pruning of plant roots results in a more complex root system.

Lynwood Avocado Nursery in Whangārei have been trialling Ellebags as a replacement for plastic Planter Bags (PBs) in their avocado tree production. The entire pot can be planted in the ground with the tree, with minimal disturbance to the roots. Paper pots do not have the same ability to retain water as plastic, so experimentation was needed to adjust the watering and fertilising programmes. Their small-scale trial has now expanded to a trial of approximately 1500 trees, which will be field planted in the coming season and tracked during tree establishment phase.

Ellepot bag trial at Lynwood Avocado Nursery Ltd, 2022.

Promising results have also been found in the forestry sector. Dr. Craig Ford worked on trials at Scion and found paper pots could reduce radiata rooted cutting production time to about 6 months and not have any impact on field survival in growth. It could pave the way for double cropping, but the idea needs testing more broadly. Craig also found the plants held up well in mechanized planting and survival and growth was promising.

Habbag™ Biodegradable Bags

Peat pots

Peat pots were first marketed in the 1950s as a sustainable alternative to plastic, and are popular for home gardeners. They have a good ability to retain moisture, can help minimise transplant shock and decompose, usually within a growing season. However they can rip when handled and are not compatible in many commercial plant production potting systems.

Hemp and wool biodegradable bags

Retted hemp is one of the most environmentally friendly fabrics currently available and is one of the strongest and most durable of all-natural textile fibres.

Several versions of hemp and wool biodegradable bags are available in the market, e.g. The Wool Pot, with more in development.

Habbag™ Biodegradable Nursery Systems is being developed by Sis (Sarah) Johnston, owner of the Gorge Nursery in Oxford, and Jean-Michel Libeau of Lincspun Textile Group. It is a blend of hemp and wool which allow the roots to be air pruned as they grow through the wall of the bag, encouraging a more fibrous root system. The tree or shrub can be planted in the ground, and the roots can grow quite freely through the bag as it rots down in the soil. Saving on hand-weeding in production, HEMWOO™ geotex mats have been developed using the same materials for placement inside the bags as a weed suppressant. The geotex mats help regulate the surface temperature of the bag/pot, allow penetration of water and nutrients, and good circulation of air, and have natural nutrients, which get released into the plant: nitrogen, sulphur, sodium, potassium, and magnesium.

The Wool Pot™

The mats last up to two years so can be re-used and speed up dispatch as the weed mat can be removed prior to dispatch.

Scion scientists Maxime Barbier and Gerty Gielen with their biopolymer pot.

Bioplastic pots

Moving towards renewable sources of materials is an essential element of New Zealand establishing a circular bioeconomy. Plastics are associated with environmental impact across their life cycle, from the extraction of fossil fuels as a feedstock to the generation of microplastics. The environmental impact is a significant challenge for plant pots, as most of the 350 million pots used in New Zealand every year are frequently made from oil-derived polypropylene and are typically unsuitable for kerbside recycling due to soil contamination.

One approach to tackling this problem is to create plastics from renewable resources (bioplastics) and ensure that they naturally break down or compost (biodegradable). Bioplastics are plastic materials produced by directly processing natural biopolymers (starch, cellulose, proteins) or biologically through a fermentation process utilising microbes. The advantages of using bioplastics include the utilisation of waste, the reduction of energy, and the reduction of greenhouse gas emissions. Tree-based cellulose products, for example, have the benefit of carbon-sequestration of the growing tree up to the point of harvest. The challenge is ensuring physical performance characteristics and cost.

Addressing this problem, PolBionix working with Scion has developed a plant pot made from biopolymers (sugarcane, cassava and corn) and a unique bio-filler. These pots, which are set to be commercially available in New Zealand for the 2023 planting season, do not produce microplastics and have been designed to break down immediately after planting to release carbon dioxide. By fine-tuning the formulation using extrusion and composite fillers, the product properties have been tailored to the product application and provide cost advantages of the pot acting as a fertiliser for the plant as it composts. Confidence in the green credentials comes from extensive analysis performed at Scion's accredited biodegradation testing facility. The pots have been tested with three commercial nurseries, and Auckland Council are currently trialling them in some planting locations.

Alec Foster,
Portfolio Leader –
Bioproducts and Packaging, Scion.

Kaitiakitanga and sustainable plant production

Initiatives that approach sustainability through the Te Ao Māori lens have made considerable progress in recent years and created numerous opportunities for local communities.

Kaitiakitanga and other traditional Māori values have found a place in modern business practices, especially for those organisations working towards sustainability and conservation.

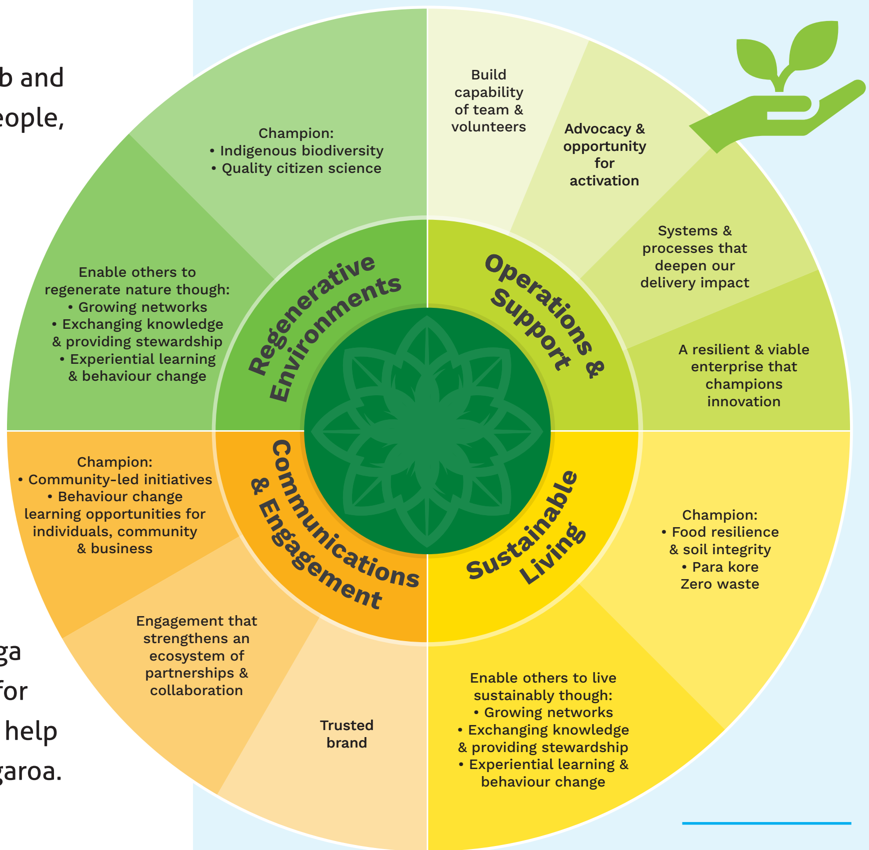
Kaipātiki Project draws on mātauranga 'Māori' in their native plant nursery operations at Birkdale and Hobsonville Point, as well as their wider activities with the community. Their native plant nurseries produce 89 different plant species for restoration and biodiversity, all eco-sourced from the Tāmaki Ecological District, and grew over 42,000 plants in 2022.

Kaipātiki Project is a volunteer-based Eco-Hub and organises a range of activities to empower people, inspire connection with nature and enable sustainable living. They are a Zero Waste hub (para kore) and run a composting collective, sustainability workshops and organise bush, stream and harbour restoration and biodiversity monitoring. They also facilitate the Auckland Iwi, Hapū & Community Nurseries network - supporting, enabling and upskilling 58 nurseries in the network across Tāmaki Makaurau.

Embracing Te Ao Māori, the team engages with mana whenua and mātāwaka Māori where possible to understand how mātauranga Māori can improve environmental outcomes for the area and incorporate this into its work, to help restore the taiao whenua, awa, puna and tangaroa.

Kaitiakitanga

In one interpretation it means guardianship and protection. It is a way of managing the environment, based on the Māori world view.



Jacinta Harrop, NZPPI.

The profit side of sustainability

Sustainability, as a worldwide movement, is starting to bring benefits and opportunities to the plant production sector, especially since the Covid pandemic. However, production costs are rising steadily so producers will need to improve efficiencies to maintain profitability.

The cost of containers, substrate media, propagation materials, fertiliser and labour all increased between 10 to 20% in 2021, and a further 8% in 2022 due to rising shipping costs, supply shortages and inflation. Another 4% increase in input costs is forecasted for 2023.

However, there is a correlation between being more efficient and being more sustainable. So an answer to absorbing these new costs is to embrace sustainable cultural practices.

Firstly, though, nursery and greenhouse crop growers need to know the input products and activities that contribute the most towards their costs and carbon footprint so they can explore lower cost sustainable alternatives.

Life cycle assessments of various US productions – redbud field production (seed-to-gate), red maple (pot-in-pot production) and Bennett's Compacta (Japanese Holly cutting-to-gate) – showed that just a few production inputs and processes accounted for most of the carbon footprint and variable costs:

- **Redbud production** – loading and unloading and harvest
- **Red maple production** – substrate, potting, system installation
- **Bennett's Compacta** – irrigation, container & liner, fertilisation.

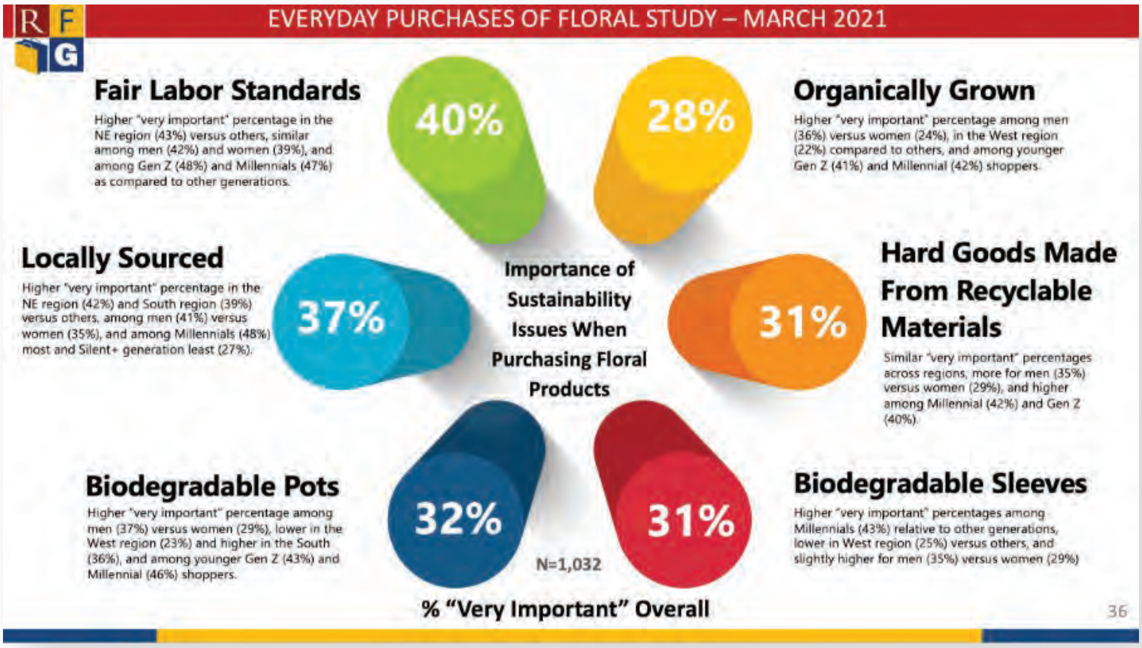
Lower cost sustainable alternatives to these production inputs include natural compost media, solar energy, integrated pest management, biofuels, water conservation, biopots, pot reuse and recycling.

Cities of the Future: 70% of the World's population is predicted to live in cities by 2050.

The research into the production carbon footprint also showed that the carbon sequestered by plants greatly out-weighs any greenhouse emissions created during production. This offers an opportunity to the industry to market its products' life cycle impact and its success in minimising production carbon footprint to end buyers – whether they are government agencies, city planners, landscapers or home consumers.

From a city planning point of view, we as an industry need to talk about the benefits of landscape systems as a whole. Green infrastructure assists with erosion prevention, air pollution and urban heat reduction, and stormwater mitigation. Environments without green infrastructure, for example, are more prone to flooding.

Plant producers also need to demonstrate to their buyers that their plants are produced more sustainably and ethically.



Sustainability information is important to the home consumers. A recent survey in the USA found that, as part of their purchasing decision the following was important to customers:

- organically produced plants – **28%**
- biodegradable sleeves – **31%**
- hard good made from recyclable materials – **31%**
- grown in biodegradable pots – **32%**
- locally sourced – **37%**
- fair labour standards – **40%**

Five years ago, these figures were all in single digits.

If plants are labeled as carbon saving, people are willing to pay US17 cents more. Plants that are advertised as being 'pollinator friendly' can claim a higher premium too in terms of what people are willing to pay for those plants. Indoor plants that are 'air purifying', removing Volatile Organic Compounds from the air, also command a premium.

Garden performance also influences garden consumption, so if people are successful with growing their plants, they buy more plants.

Cultivation information that enhances the knowledge base of the end consumer makes them more successful, and there are a range of smartphone apps that can help provide detailed growing information.

Understanding the economic and environmental life cycle benefits of plants in the landscape can also help in the promotion of landscape plants to environmentally conscious consumers. From an entire life cycle perspective, shrub and tree production has a vastly positive carbon footprint which we need to tell our customers about.

We need to let everyone know that our industry is part of the answer to climate change, not just through the creation of large carbon sink forests, but through regional, metropolitan and backyard plantings. If we don't champion plant production as the solution, no-one else will.

Dr. Charlie Hall is a Professor in the Department of Horticultural Sciences at the Texas A&M University and a Lifetime Member of the Texas Nursery and Landscape Association. Dr Hall presented on this topic at the NZPPI Conference 2022 via Zoom.

Lean methods and sustainability

Reducing waste improves sustainability and profitability. We look at how 'Lean' methods can help you to tackle 8 types of waste in plant production.

Waste can be defined as any expense or effort spent that doesn't contribute to converting energy and inputs into plants for sale. This can be wasted labour, time, energy and materials. Better planning and utilising the skills in your team can help you find opportunities to minimise waste across your operation.

Tackling waste requires a deep understanding of your processes. Walk through all operations within your nursery and document the inputs and processes, share these with your team to make sure it's accurate and create a value stream map so you can understand where your operations create value and what could be improved.

Continuously improve your processes and outcomes. Include your team to help make process improvement part of your company culture, and measure what makes sense so you can track improvements over time. Communicate your successes so your team can learn from them.

Finding Opportunity for Improvement

Understanding what waste looks like

Defects
Waste from inferior quality, rework or incorrect information.

Overproduction
Production that is more than needed or before it is needed.

Waiting
Wasted time waiting for the next step in a process.

Non-Utilised Talent
Underutilising people's talents, skills & knowledge.

Transportation
Unnecessary movements of products & materials.

Inventory
Excess products and materials not being processed.

Motion
Unnecessary movements by people (e.g. walking).

Extra-Processing
More work or higher quality than is required by the customer.

Here we take a closer look at the 5 key areas that can help you improve the sustainability of your business operations:

1. Defects

This type of waste is associated with the additional time, money, and resources dedicated to fixing problems. Waste can include damaged seedlings, poor plant health or shape that reduces the value or saleability of seedlings. While the elimination of all waste is not possible, employing stricter quality control measures can help reduce it.

2. Overproduction

Producing an excessive amount of seedlings typically occurs when they are produced before they are required. It can lead to interrupted workflow, increased storage costs, increased expenditure, and excessive lead times. This type of waste can be minimised by implementing better planning and work coordination procedures.

5. Transportation

Transportation is necessary to move goods or materials from one point to another, but the process itself adds no value to the final product. Petrol and diesel consumption is a primary contributor to the carbon footprint of plants in the retail chain. Transportation waste can be reduced in the growing environment by reorganising physical layouts and minimising the distances travelled between processes. Utilising more efficient transportation methods can also help reduce transportation waste.

7. Motion

The unnecessary movement or actions of people, machinery, and equipment. It can involve walking, reaching for materials, searching for files, sifting through inventory, and other repetitive actions that do not add value to the product or customer. Excessive motion, whether by a person or machine, can be minimised by readjusting or redesigning everyday tasks.

8. Excess Processing

Excess processing involves doing more than the required amount of work for a completed product or service: adding more components, performing additional steps, or duplicating tasks during the production process. Process mapping can be used to optimise workflow and eliminate over-processing.

Sarah Watson, People Mad.

New Zealand Plant Producers is the industry body for plant nurseries and related businesses.

Our members produce the plants growing the food that Kiwis eat and export, regenerating New Zealand's forests, beautifying our urban landscapes and being planted by millions of Kiwis in their backyards.

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