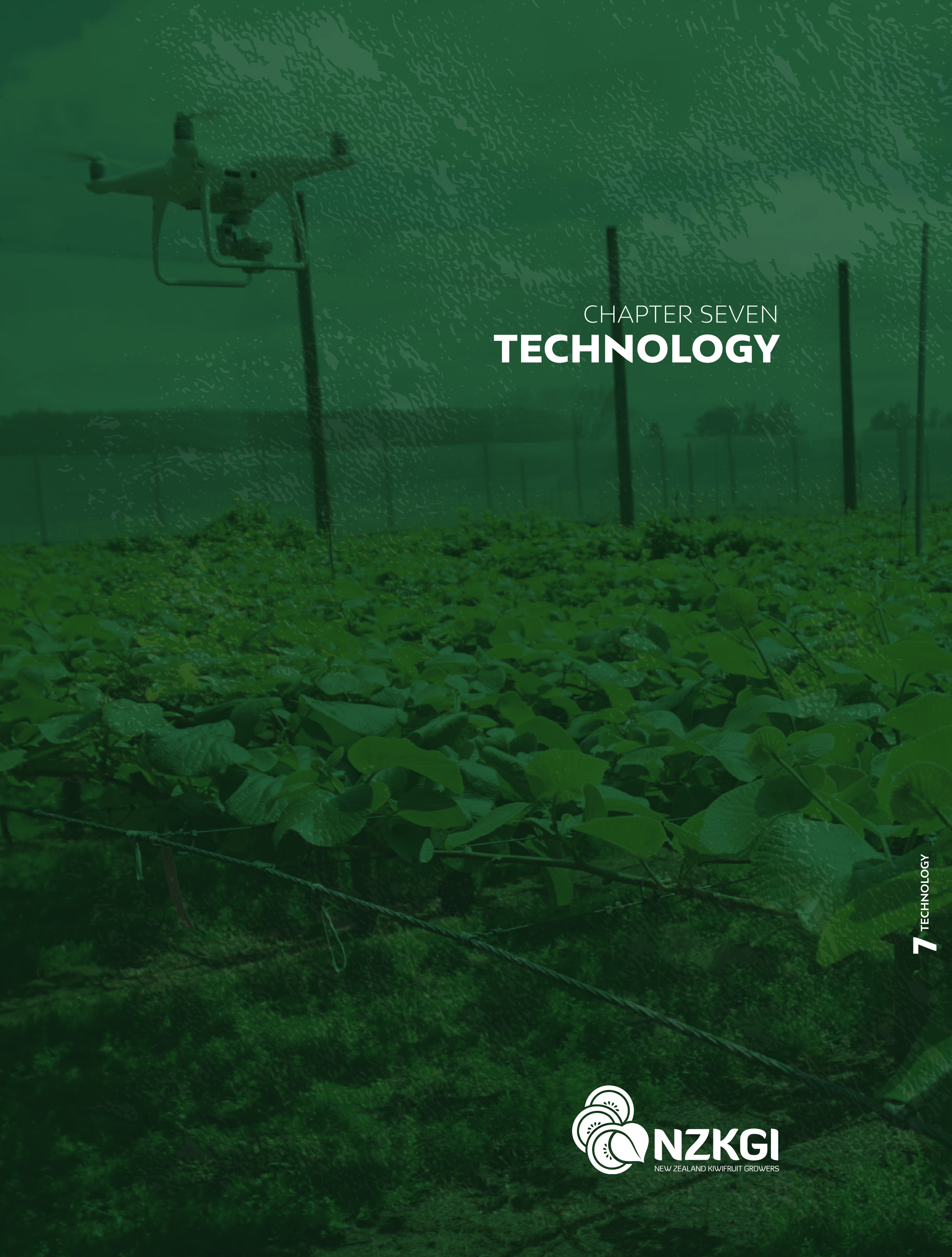


CHAPTER SEVEN

TECHNOLOGY

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

7

CHAPTER SEVEN

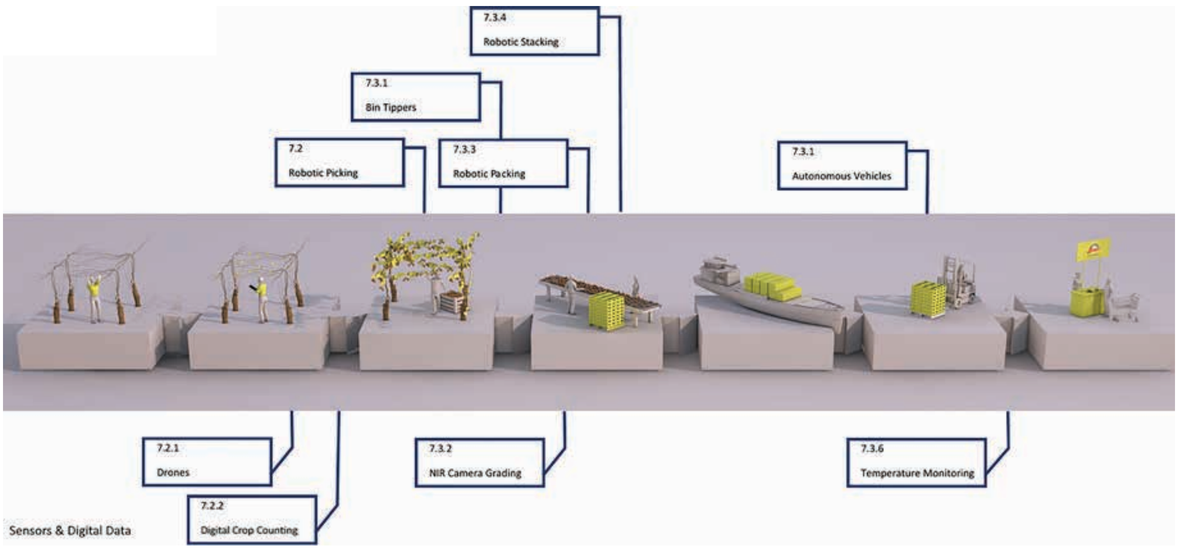
TECHNOLOGY

Technology is an incredibly exciting space in horticulture where the industry is working on a number of ideas to improve productivity, address labour constraints and increase output. This chapter will examine the key areas of the supply chain to understand where technology currently is and where it may take us in the future.

THE SECTION IS DIVIDED AS FOLLOWS

7.1 TECHNOLOGY

While technology has always been an important part of the horticulture industry, it is becoming increasingly so. Technology can come in several forms: Robotics and automation are usually introduced to drive efficiencies in tasks typically requiring human labour that are either dangerous, dull or dirty. A second form of technology is the increasing use of sensors to measure, monitor or analyse areas of the kiwifruit supply chain where more information, or more accurate information is required. There are several drivers to where technology will take the industry over the coming years, however the key immediate driver is the concern around labour scarcity. New Zealand currently has extremely low unemployment and if continued, will impact upon the ability to help with industry growth aspirations. The kiwifruit industry will require an additional 7,000 seasonal workers by 2026 in order to harvest and pack the predicted crop volumes based on the current operating systems in place. Ongoing adoption of technology within the industry, while addressing the immediate concerns around labour shortages, will also enable (and require) an entirely new job market. This market will be one of highly skilled/upskilled labour to build, service and maintain automation technologies, and equally skilled individuals to analyse, interpret and act on the sensor data to improve the efficiency of the kiwifruit supply chain.



Above:
A snapshot of the kiwifruit supply chain from production to consumer highlighting areas discussed further in this chapter 7

7.2 ON THE ORCHARD

Kiwifruit crops require a high labour input to maintain and grow successfully. Key activities include vine maintenance and harvest. Pruning is vital to ensuring a balance between vegetative growth and fruit production. Harvesting is a labour-intensive task that is particularly time critical.

Finding automated answers to these issues is both complex and expensive. Other crops in New Zealand have benefited from the development of technology in much larger growing areas with better access to capital investment overseas (e.g., apples, grapes). However, kiwifruit production worldwide is comparatively small and New Zealand is the world leader. The number of New Zealand based orchard operators of large enough scale to have access to the necessary capital for technology development is also very small.

While mechanical pruning has been developed in other crops, it always comes at a cost of quality. Similarly, robotic harvesting comes in many different forms but there are some unique aspects to growing kiwifruit that make it particularly challenging e.g., fruit that are susceptible to damage. Finding technological answers to allow the production of high volumes of quality fruit, and picking those crops in the appropriate window, with less reliance on seasonal labour, will be on ongoing challenge for the industry.

Right:
Robotics Plus prototype kiwifruit pollinating autonomous vehicle

Right:
Robotics Plus kiwifruit harvesting autonomous vehicle

7.2.1 Drones, GPS Units and GIS Software

There have been advancements in other areas contributing to crop production on the orchard. UAV (Unmanned Aerial Vehicles or Drones) can be used to monitor crop conditions, the impact of droughts or floods, and to assess requirements for fertilisation and irrigation. By compiling and digitally analysing records from multiple flights and multiple areas of the orchard over time, UAV technology can help the kiwifruit industry to gain new insights regarding climate change, water resource management and rates of soil erosion.

Under New Zealand's laws, commercial UAVs can be utilised as long as they operate in line of sight of the person controlling them and are flown beneath 120 metres. However, the technology is capable of much more than that: UAVs can be flown from anywhere or preprogrammed to follow a flight path and undertake functions using GPS.

Zespri contracts GPS-it, a farm and orchard mapping company who utilise UAV technology, for orchard mapping and audits of orchards growing licensed varieties. All orchards are subject to audit by Zespri when they have grafted or planted their new license allocation, and subsequent random audits are also carried out from time to time.

The three main technologies used are:

- High accuracy GPS units
- Drones (UAV) used to capture aerial imagery
- Geographic Information Systems (GIS) software to process and present the maps.

All three technologies have undergone significant advancement over the past 20 years. The accuracy and reliability of GPS units has improved along with an increased number of available satellites; UAV's have become more commercially popular; and GIS software has become much more accessible and user-friendly. Together they complement each other to produce high accuracy results that are essential for the audit programme, considering the high value of Gold3 orchards and licences. The data produced from this process can be used by Zespri and growers to assist with many important decisions such as PVR enforcement, crop estimation, biosecurity readiness, pest and disease management and more. Growers can also access this data and utilise it to generate precise plans that will help them make important decisions with confidence.

For more information see **www.gpsit.co.nz**

" UAV technology can help the kiwifruit industry to gain new insights regarding climate change, water resource management and rates of soil erosion. "

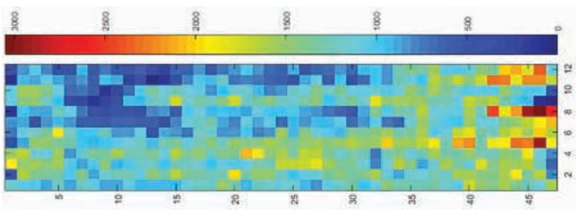
7.2.2 Digital Crop Counting Technology

Accurate crop estimates (of volume and size profile) are important for the grower to make crop management decisions; for postharvest for operational planning; and for Zespri to make decisions around logistics and market planning. Until recently, crop estimation has involved a combination of historical crop data and manual monitoring – taking fruit samples from different areas of the orchard and physically measuring and recording size and weight data. Sampling can be expensive, time-consuming, and of limited accuracy due to natural variation across orchards. With the advent of ground-based camera imaging systems, this information can be obtained faster, earlier, and more accurately. These systems need to be ground-based to count what is most important to the industry – flower buds, flowers, and fruit. These parts of the kiwifruit vine are hidden by leaves when viewed from above e.g., from a drone.

Camera units travel beneath the canopy and record digital images of the canopy from below. New software technology analyses these images, identifying individual fruit, estimating the dimensions (length, width, height) of each, taking the distance from the camera into account and using triangulation for accuracy, then utilising an algorithm determined from machine learning/AI modelling to estimate the density and size profile of the crop.

Using this technology, three hectares of orchard can be scanned per hour. Comparisons with pack out reports in the 2022 harvest have shown the density data produced has an average accuracy of 93.7%.

For more information see **https://fruitometry.com/**



Right:
A visualisation from part of a Gold3 orchard showing the total fruit counted. Each square is one management area within which orchard management decisions can be made. In this image, over 650,000 individual fruits have been tracked and counted.

7.3 POSTHARVEST

A large amount of labour is required to grade and pack the fruit into export pallets of product ready to ship around the world. Considerable investment has gone into technological advancements in the postharvest space. These have increased efficiencies and the capacity of operators to deal with increasing crop volumes. There has been a reduction in dependence on unskilled labour, with a number or roles redeployed within packhouse facilities, and a corresponding increase in roles for skilled people to help keep the technology running.

7.3.1 Bin Tippers

When the bins of fruit arrive from the orchard at the packhouse, they must be emptied into the grading and packing line. The technology that assists with this activity is an automated bin tipper. These can handle the variety of bin sizes and types (wooden or plastic) used in the industry and allow continuous flow of up to 120 bins per hour depending on size. The bins are also sanitized on exit.

Right:
The Sorma bin tipper continuously empties bins autonomously onto the grading line

TECHNOLOGY | 132

7.3.2 Near Infrared and Camera Grading

Once on the grading line, camera grading is increasingly being used. The multiple high-speed cameras capture over 300 high-definition images of each piece of fruit as it travels across the grading line. These images are processed to identify external fruit defects, including blemishes, flat fruit, soft fruit, and sooty mould. Near Infrared (NIR) Technology can be used to assess internal quality of the fruit.

The grading machine then accepts or rejects the fruit and the ones that are accepted are then bumped off the line at the right time to be packed in trays with fruit of the same size and quality. This was all once undertaken by individuals handling every piece of fruit and the use of this technology has reduced the number of manual graders on an average shift from 20 down to 3.

Right:
NIR grading machine

How Does NIR Work?

NIR cameras pulse light into fruit and measure changes in wavelengths in rebounded light. From this, the NIR machine can measure the internal qualities of fruit including dry matter, brix, colour, and pressure.

One purpose of NIR technology is to recover fruit which is above dry matter thresholds, from size counts which have failed to meet dry matter requirements. For example, the Minimum Taste Standard (MTS) for Gold3 in 2022 was 70% of fruit sampled met a Dry Matter (DM) level of ≥16.1%. Small count sizes generally have lower dry matter, and it isn't uncommon for smaller size counts (36's and 39's) to fail MTS. Even though fruit has failed to meet the 70% DM threshold, a percentage of fruit in these size counts will be above 16.1%. Some of this fruit can be recovered as class 1 using NIR technology.

The flesh of gold fruit is green until it matures. Gold must meet colour requirements to achieve harvest clearance i.e., change from green to gold. Fruit is tested using a chronometer. Even when fruit achieves clearance, there will be a percentage which is green, and requires colour conditioning at ambient temperature before it can be accepted into inventory. NIR allows green fruit to be treated separately, making the colour conditioning process more efficient.

Another bonus with NIR technology is that it has the potential to make better decisions on how long the fruit will last e.g., should the fruit be sold quickly, or will it last the distance on a ship to Europe? The technology can optimize storage potential by segregating fruit within 'ideal' ranges. For example, a desirable brix range for long storing Hayward (Green) kiwifruit is 8°- 11° at harvest. Fruit outside of the ideal range can be segregated and shipped early, thereby improving the storage potential of fruit within the ideal range.

For more information see **www.compacsort.com**

7.3.3 Automated Packing

After each piece of fruit is labelled, the fruit is packed by size into bulk packs or layered trays depending on the orders received and the market it is destined for. This is often where a bottleneck occurs in the process if the packing is being done by hand. Various technological solutions are in use, with varying levels of automation, from tray/box prep, addition of plastic liners, through to automatic box and tray fillers.

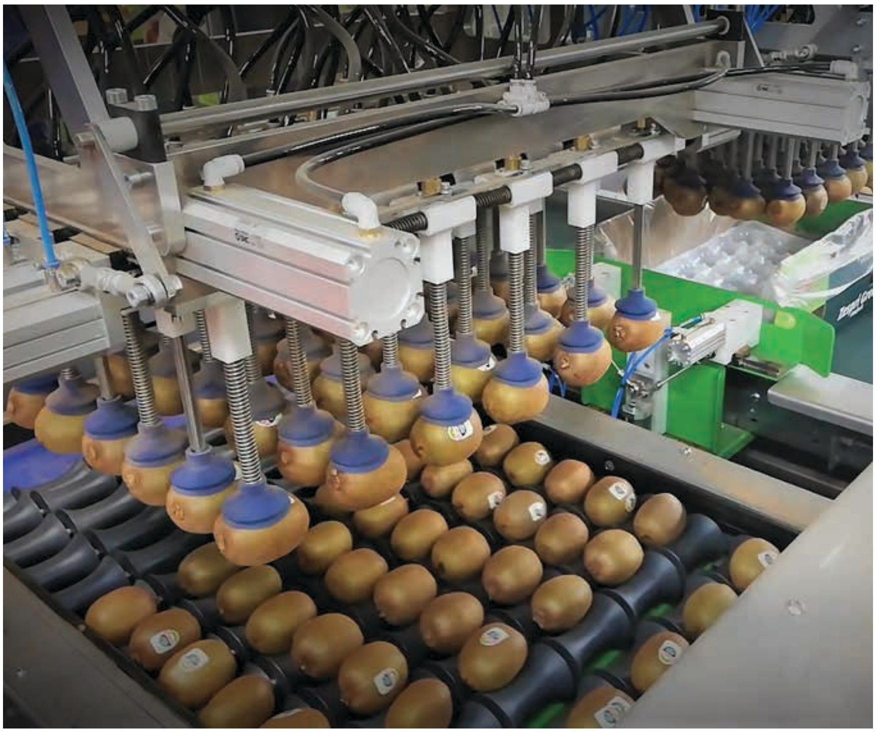
One of the first automated tray packing machines was The Pacmaster, developed in 2017/18 by Apata Group and MAF NZ, a local subsidiary of MAF RODA Agrobotic (France). As technology has progressed, companies like MAF RODA have applied sensor and robotic componentry to assist with presenting the fruit to the machine in a way where variability is managed. This means that the machine can consistently and accurately pick up the fruit, without dropping them, while also handling each fruit very gently so as to not damage or bruise the product.

Unique components of the Pacmaster include inclined conveyors with smart fruit sensing capability, multi-format heads that adapt to the different tray layout and individual suction cups that can lift the fruit and position them into the tray. The fruit size being packed can change quickly in any pack run, and the Pacmaster is able to quickly alter the number of suction cups used depending on the amount of kiwifruit required in the specific tray. Initial testing on site in the 2019 kiwifruit season showed that the Pacmaster could consistently pack 22 trays of kiwifruit per minute. This is a significant change compared to older tray packing versions at 15 trays per minute or the 3 trays per minute achieved on average by packing staff per outlet on a sizer. Newer technology now allows for a completely automated system from box lining, filling, closing, labelling, and distribution to the palletisers at a rate of 60 boxes per minute.

For more information see **www.mafnz.com**

Right:
The Pacmaster

MAF NZ AGRO ROBOTIC



7.3.4 Palletisation

After grading and being placed into their trays or boxes, the fruit then need to be assembled onto pallets and strapped down (palletisation), ready for shipping, before they can be put into cool storage. The technology may or may not include the use of robotic stackers taking the boxes directly off the packing line and placing them on the wooden pallet, stacking to the required height. Separate palletisers complete the corner board positioning and strapping. This removes the need for human input in this task, saving time, producing a more consistent pallet, and removing the risk of injury from heavy lifting.

Right:
Robotic arms placing full boxes of produce onto pallets ready for coolstorage

7.3.5 Autonomous Vehicles

Right:
A Skilled Group autonomous forklift that moves product without human interference

Forklifts require labour for operation, and operators need training to become proficient. Improving EV technology has led to the development of electric forklifts that are quieter, less polluting and remove the risk of carbon monoxide poisoning when used indoors. Completely autonomous vehicles are being deployed in great numbers globally in a large variety of production and warehousing environments including the horticulture sector. Millions of bins and pallets are moved across the same paths and into similar locations constantly in the packhouse environment which can also be undertaken via the automated fleet.

7.3.6 Lights-out Coolstore Automation

The first fully automated coolstore for the kiwifruit industry was opened in May 2019 by EastPack. An investment of $10m, the new coolstore is termed a 'lights-out' coolstore – it has no people inside it and works with a series of robotics and artificial intelligence to check, move and position pallets of fruit into two rooms, each with a tall tower of racking that reaches 14m or 5 levels high. The entire structure is 51m by 41m and 18.2m high. It has the capacity to store 1.2 million trays of fruit and was built in response to the huge growth of fruit volume anticipated in the next five years (see image on next page).

7.4 MANAGEMENT OF FRUIT TO MARKET

Much of the New Zealand grown fruit travels by sea to markets in the northern hemisphere. Travelling this distance requires careful temperature management, monitoring and adjustment to ensure the fruit arrives in peak condition, closer to eating ripeness to delight kiwifruit consumers.

Zespri's quality monitoring programmes include the use of temperature monitors in combination with fruit monitoring by technicians – a combination of sensor data and human judgement to make complicated decisions.