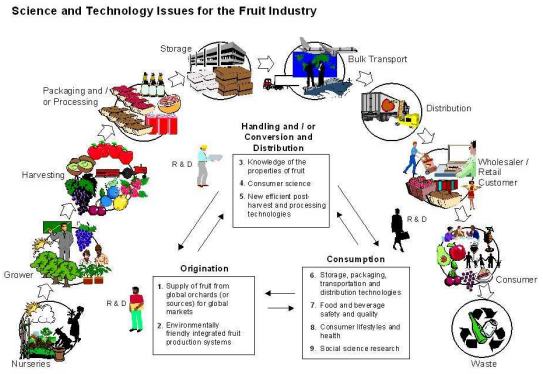
11. There is much more to New Zealand's fresh supply chains than just timely delivery to markets

Collaboration between science and industry, each with their unique global reach, has been a key to the development of robust New Zealand Supply Chains within the horticultural sector. Recognition that production and postharvest factors interact is of equal relevance as they determine the quality of the fresh fruit and vegetables and flowers offered to the end consumer.



Customer demand for New Zealand's fresh fruit and vegetables in international markets is built upon the unique *texture*, *taste, flavour, colour* and *safety* of our products that appeal to those discerning consumers who want a safe, nutritious and high quality food. To achieve this, New Zealand fresh fruit, vegetable and flower industries face challenges in moving these living products along a lengthy supply chain to distant world markets.

A measure of the effectiveness of the long supply chains for these fresh products from New Zealand is that we remain competitive in our key markets in Europe, USA and Japan – and often command a price premium. Essential to this success is industry innovation underpinned by science and supported by responsive industry infrastructures that recognise the market signals. Important science and industry innovations in our Supply Chains include:

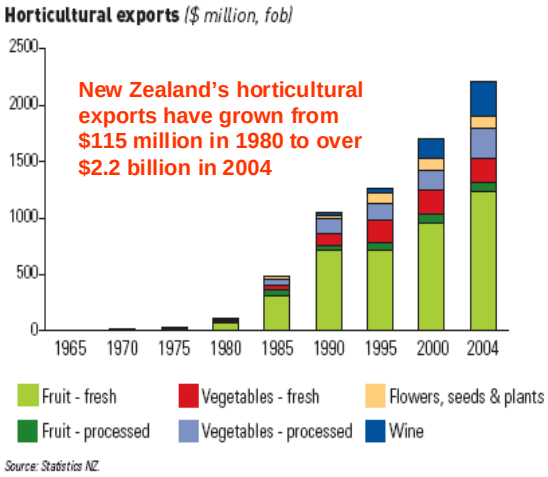
- Breeding and selection of fruit, vegetables and flowers that retain quality throughout an extended supply chain.
- Fertiliser management that minimises storage disorders and enhances storage life of fruit.
- Integrated fruit (IFP) and vegetable production systems that ensure quality products enter the supply chain.
- Innovative packaging that reduces physical damage to fresh fruit and vegetables during transit; and use of polymeric films to reduce moisture loss and to control concentration of the critical atmospheric gases.
- Determination of the optimum concentrations of atmospheric gases in controlled atmosphere (CA) storage of apples and kiwifruit.
- Discovery of the effect of ethylene (a natural ripening gas) on kiwifruit ripening.
- Establishment of kiwifruit maturity indices that indicate when fruit can be harvested so that loss of fruit flavour and taste does not occur when the fruit is later consumed.
- Development of protocols for rapid cooling of fruit and vegetables after harvest and the maintenance of optimum relative humidity.
- Development and use of fast, accurate, electronic fruit and vegetable sorting machines.
- Introduction of supply chain management systems that monitor the environmental conditions as the product moves along the chain with capacity to trace the product back to the supplier.

Any failure to maintain high performance Supply Chains into our global markets will immediately place those markets at risk as consumers need assurance that the fresh fruit and vegetables we offer are safe and have been harvested from sustainable production systems. Audited production practices and accurate trace back systems are critical to the growth of our horticultural exports. An inability to access experienced science skills to maintain and extend these will also place these Supply Chains at risk.

1. Background:

1.1. Introduction

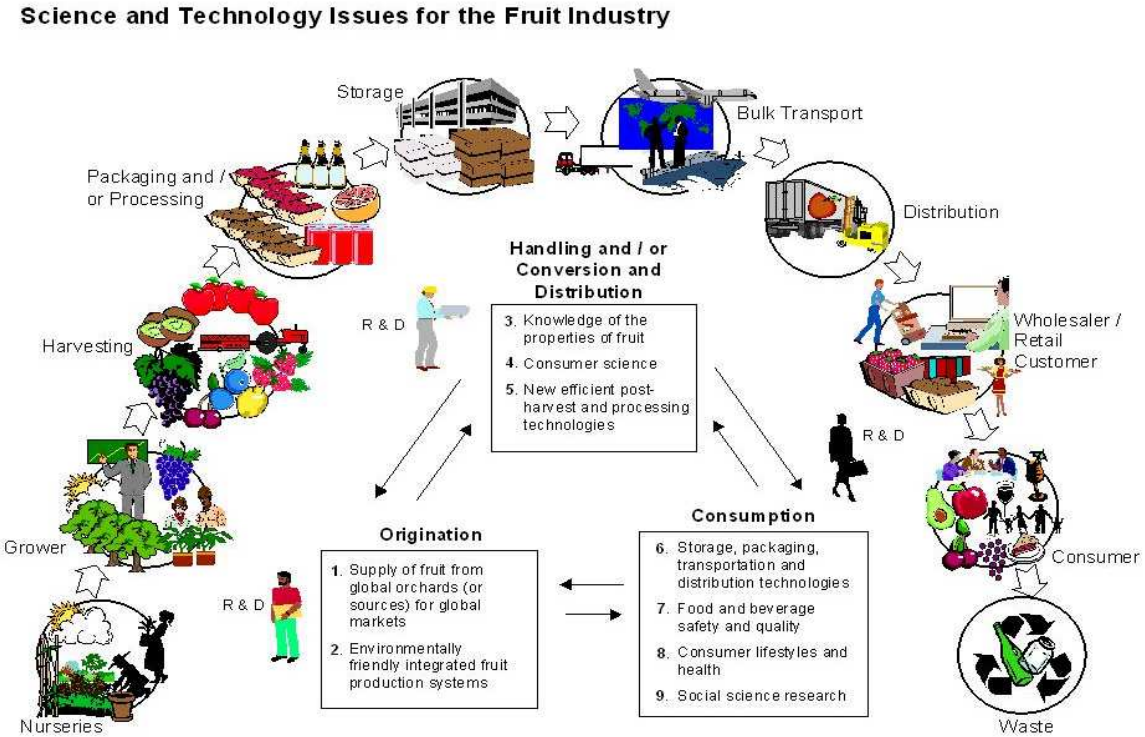
Horticultural exports from New Zealand have increased dramatically over the past 30 years from a value of $116 million in 1980, to $1 billion in 1990 to $2 billion in 2003. This represents an increasing proportion of the merchandisable export trade from this country, from 2.5% in 1980 to 6.8% today. A diverse range of fresh fruits, vegetables, flowers, plants and seeds, as well as processed products including wine, are marketed in at least 105 countries, with exports exceeding $1 million to 41 countries, (up from 27 in 1990), and exceeding $10 million in 21 countries (up from 5 in 1990).



Key markets include the European Union, Japan, USA and Australia, with horticultural products comprising more than 10% of total NZ exports to the United Kingdom and Japan. New Zealand is a major international trader in many products including kiwifruit, apples, onions and squash. In spite of being further from its major markets than any other fruit, vegetable or flower exporting country, New Zealand has achieved an enviable international reputation for providing premium quality products of high value to discerning consumers in major markets. It has done this by developing strong, efficient and robust supply chains from 'paddock to plate' or orchard to consumer for many of its important export crops.

1.2. Supply Chain Systems

The Supply Chain starts with the production of fresh fruit and vegetables; continues through the grading, packaging and storage of the products; and into transport, distribution and consumer market. Delivery of fresh horticultural products requires proactive management of the complete chain from field to consumer. This is critical for the success of New Zealand fresh exports where the time between harvest and entry to the consumer market is usually measured in weeks and months rather than days.



This development of Supply Chains has been particularly effective in sectors that are strongly organised and vertically integrated with effective communication and control throughout the whole chain. Examples include *ZESPRI™ System*, within the kiwifruit sector and the pip fruit sector prior to de-regulation when *ENZA* was the sole exporter. Other horticulture sectors have developed supply chains to suit their needs with varying degrees of success. Sectors with multiple exporters often have more difficulty in effectively managing and coordinating their Supply Chains than those with single or a limited number of exporters.

- *The ZESPRI™ System is an integrated production and delivery system from orchard to retail that is applied to all cultivars and classes of kiwifruit. It is focussed on environmental and social responsibility and long-term sustainability.*
- *Six major principles underpin the ZESPRI™ System:*
  - *total integration of processes from grower to consumer;*
  - *documented and verifiable traceability and transparency from grower to retail shelf;*
  - *ethical business practice;*
  - *sustainable development;*
  - *food safety; and*
  - *GE free.*
- *High quality, safe and nutritious fruit are produced from and eco-friendly system that is based on a unique orchard management system that keeps artificial inputs to a minimum through close monitoring and prudent practices; strict harvest deadlines that ensure ZESPRI™ fruit is always tasty; packaging that is recyclable or re-usable;*
- *A quality assurance system that can trace a tray of ZESPRI™ Kiwifruit right back to the orchard it came from and the people that grew it; a commitment to continual improvement and innovation to meet consumer and customer requirements for safe and delicious, health-giving food.*

*Extract from '*Celebrating 100 Years; The New Zealand Kiwifruit Industry 1904-2004', p. 207.

Supply Chains within New Zealand horticulture have the following characteristics:

- ***Strategic alliances*** with firms which have specialised skills;
- ***Organisational structures*** that facilitate communication, information sharing and transparency between partners;
- ***Human resource partnerships*** with all levels of staff within all organisations in the chain such that the people have a common vision and commitment to excellence;
- Use advanced ***information technology*** systems to monitor products traveling along the chain and with good trace back systems and timely feedback to key decision makers.
- ***Vertically integrated structures*** that have the ability to control key operations in the supply chain.

New Zealand horticulture sectors have made the necessary paradigm shift away from the traditional and fragmented practices of the past, and benefits have flowed from this changed behaviour.

- A loyal customer base that is confident of receiving timely delivery of a quality product has developed.
- Innovative uses of information technology have been introduced to the supply chain.
- Strategic long-term alliances have developed with collaborative partners – on packaging, storage and transport to market as examples.

- Systems have been developed to rapidly share information among partners within the supply chain.
- Smart outsourcing of non-essential core businesses has assisted in reducing costs and improving services.
- Partner businesses have been re-engineered to optimise customer service and build profitability.

This technical success of the Supply Chains is underpinned by a science resource that embraces all components of the chain from producer through to overseas consumer. These resources are easily accessed by industry, reside within both public and private sector research agencies and tertiary education institutions and have very good networks into the global science and technology community. A stand out feature is that the New Zealand horticulture sector moves quickly to take up and implement new technologies in the fresh fruit and vegetable supply chains.

1.3. Preharvest production determines product quality entering the supply chains

Quality of fresh fruit and vegetables is determined before the time of harvest. *Crop variety*, the *soil and climatic environment*, and *crop management* together determine the quality of the product that enters the supply chain. Innovation by science and industry within the New Zealand horticulture industry uses several strategic approaches towards raising the quality of the fresh fruit and vegetables that are harvested. These include:

- ***Choice of crop varieties***
  For over 100 years crop varieties have been bred and selected for New Zealand soils, climate and horticultural production systems. Initial selection criteria included the productivity of the variety under New Zealand environmental conditions, resistance to local pests and diseases, and the product quantity and quality for the local market. During the last 40 years, the export potential of New Zealand's horticultural industry has been recognised by horticulturalists who now add post harvest qualities and novelty value to their selection criteria. This is seen as the first step in placing quality fresh fruit and vegetables onto distant overseas markets. Examples include apples, squash, kiwifruit, onions, blueberries, apricots, Calla lilies and carrots.
- ***Fertiliser management***
  Post harvest quality of fruit and vegetables is influenced by the fertiliser management of the crop. During the past 30 years, scientists have worked to provide decision support tools for fertiliser management of horticultural crops. The need for this innovation has been periodically highlighted when particular fertiliser nutrient deficiencies resulted in quality problems such as 'corky pit' due to boron deficiency in apples, manganese, zinc, boron and magnesium shortages in summerfruit, calcium and bitter pit in apples. Research has established guidelines for the fertiliser requirements of a range of horticultural crops and identified the optimum leaf and fruit concentrations of essential mineral elements.
- ***Water management***
  Too much and/or too little water will affect the yield and post harvest quality of fruit and vegetables. Scientists have established the water requirements of many crops and provided guidelines to manage the water available to the crop. Leading edge work in this continues as water increasingly becomes a limited resource in some production areas, e.g. wine grapes in Marlborough.
- ***Pest and disease management***
  Pests and diseases impact on the yield and post harvest quality of fruit and vegetables. New Zealand has been very innovative in developing and implementing pest and disease management programmes that add value to fruit and vegetables destined for both the local and export markets. These include *KiwiGreen* (kiwifruit), *AvoGreen*

(avocados), *SummerGreen* (summerfruit), *Integrated Wine Production* (grapes), *Integrated Fruit Production* (pipfruit), *Integrated Greenhouse Management* (tomatoes and capsicum) and *Integrated Pest Management* (outdoor vegetables). All significant export crops now have integrated pest management programmes.

- ***Tree and vine architecture***
  Uniform post harvest fruit quality is more attainable when all fruit on a tree or vine enjoy a light similar environment. Optimum light penetration into canopies leads to increased carbohydrate accumulation within fruit and enhanced flavour and taste. Modern tree architecture and vine training systems are designed to meet these objectives. Growers carefully monitor the growth of trees and vines and their fruit to manage the factors that contribute to quality fruit production.
- ***Fruit maturity determines harvest dates***
  Post harvest quality of fruit and vegetables is best when the product is harvested at the optimum stage of maturity. Scientists have studied development of fruit and vegetables and identified criteria that can be used to determine the optimum harvest time best suited to the specific market requirements.
- ***Geographic Information Systems (GIS) aids crop management***
  In future GIS systems may be used to identify areas of a property with specific plant performance or fruit quality attributes that may benefit from dedicated management practices. Product from different areas of the property may be harvested to meet different market specifications.

1.4. Postharvest management determines product quality exiting the supply chains

Postharvest management is designed to delay the ripening process while the fresh fruit and vegetables move along the supply chain to local domestic markets and/or distant export markets overseas. A challenge is to retain the fresh quality that will encourage the consumer to repurchase after their first taste experience.

Plants use fruit to produce offspring from their seeds that mature and become dispersed in some manner. As fruit ripen they release ethylene, which is a naturally occurring ripening gas. Ethylene accelerates both the rate of sugar accumulation that increases sweetness and the breakdown of cell walls that induces fruit softening. These changes are associated with colour changes of fruit from green to yellow, or green to red depending on species and variety. Commercial fruits are usually brightly coloured with high concentrations of sugars so that they attract birds that eat the fruit and spread the seeds far and wide.

Science and industry work together to understand the factors that influence the postharvest physiological behaviour of fresh fruit and vegetables. The present postharvest technologies used within the supply chain are designed to maintain product at a high level for as long as possible after harvest.

Several critical factors must be optimised to ensure that the postharvest sector of the supply chain is operating effectively:

- ***Harvest Maturity Indices:***
  The decision as to when to harvest a crop is usually made by the grower. Harvest maturity indices have been identified for most crops and these are designed to indicate the harvest date that is most likely to ensure that optimum quality product is available to the consumer.

  With most vegetables, and fruit crops such as cherries, strawberries and citrus, the quality is best at harvest and will gradually deteriorate following harvest. Postharvest

technology aims to maintain acceptable quality by managing the product temperature along the supply chain.

With fruits such as apples, kiwifruit, summerfruit, bananas, and avocados, and some fruit vegetables such as tomatoes, the product can be harvested before it is ripe for eating because the ripening process will continue after harvest. With these fruits the harvest time is critical because the fruit must be sufficiently mature to ripen, and with sufficient carbohydrates to ensure that the fruit have the desired taste, texture, juiciness and flavour when consumed. Scientists have determined the criteria for optimum harvest maturity indices for apples and kiwifruit and other crops. These criteria have changed as we have built our understanding of the fruit's physiology.

- ***Temperature management:***
  The rate of postharvest deterioration of fruit and vegetables can be reduced by lowering the temperature along the supply chain. Postharvest storage life is directly related to product temperature. Temperate fruit such as apples, kiwifruit and summerfruit and most vegetables are best stored at zero degrees (0^{O}C) after harvest. Subtropical fruits and vegetables, such as citrus, avocados, beans and tomatoes, are best stored at 5 to13^{o}C in order to prevent chilling injury. These temperature management protocols have been developed by scientists and technologists for many horticultural crops.

  Over 30 years ago science established that storage temperatures of 0^{0}C were suitable for the then existing apple and kiwifruit varieties. Subsequently, temperatures slightly above 0^{o}C have been recommended for both fruits in order to minimise physiological chilling injury and other cold related disorders.

  Scientists and technologists have worked with industry to develop forced air cooling and other systems that remove field heat from fruits such as kiwifruit, apples, summerfruit and vegetables immediately after harvest.

  Research has shown how kumara, kiwifruit and some summerfruit can be 'cured' by a period of warm temperatures followed by storage at recommended temperatures. This treatment allows minor physical damage to the product that occurs during harvesting and handling, to 'heal' and form scar tissue reducing the risk of postharvest rots.

  Technology has improved the airflow and minimised temperature and humidity variation within coolstores.

  Many perishable crops such as strawberries, asparagus and flowers must be exported by airfreight because the product's postharvest life is too short to be transported by sea. The introduction of new postharvest technologies now allows the shipment of cherries to Taiwan and avocados to USA by sea rather than air with much reduced transport costs.

- ***Atmosphere modification:***
  The composition of the atmosphere in which fruit are stored also determines the rate of deterioration of fresh fruit and vegetables. Reduced oxygen and/or increased carbon dioxide concentrations will reduce respiration and the level of ethylene. Modified atmospheric storage systems (known as controlled (CA) or modified (MA) atmosphere storage) are used to maintain product quality and extend its storage and shelf life and this technology is used for the export of fruit from New Zealand. Padfield initiated the pioneering work on CA storage for apples and pears in New Zealand during the 1960s and 1970s. Although adopted by a few progressive orchardists for local market sales, the technology was not adopted on a large scale for export fruit until the late 1980s and 1990s.

  Working collaboratively with TransFresh (a USA company that pioneered land and sea container CA shipment of perishable horticultural crops, especially lettuce and cherries). New Zealand scientists and engineers developed the technology that allowed modified atmospheres to be controlled during transit for periods of up to 4

weeks, rather than relying on an initial 'charge' of appropriate gas mixture and a passive maintenance (and decline) of atmosphere en route to the destination. This technology was adopted worldwide by TransFresh, and used for summerfruit and avocado shipments from South Africa to Europe, and cherries from USA to Asia.

New Zealand scientists developed recommendations for CA storage of kiwifruit during the 1970s and such information has been used widely in NZ, Italy and USA. The New Zealand industry did not adopt CA for kiwifruit until the late 1980s when senior industry personnel saw how the technology was being used in Italy to maintain kiwifruit quality over extended periods. They then became strong advocates of CA storage on their return to New Zealand. CA storage systems for both kiwifruit and apples predominantly use equipment imported from Italy.

- ***Ethylene:***
  Ethylene is produced by all fruits, flowers and vegetables but they all vary in their response to ethylene, whether it is produced internally, or supplied from external sources. Ethylene is a key factor in determining the post harvest behaviour of most fruits. It can induce colour changes from green to yellow (used commercially for de-greening citrus), and it induces ripening that involves fruit softening, production of aroma and flavour as well as conversion of starch reserves to sweet sugars. Ethylene is used commercially for ripening of banana, tomato, avocado and kiwifruit. On the downside, ethylene can induce senescence leading to rapid and premature deterioration of the product; and quality problems such as midrib browning of lettuce.

  Scientists found that kiwifruit are very sensitive to external ethylene and softened prematurely if exposed to concentrations in excess of 0.03 ppm. Consequently industry devised protocols to ensure that packhouse and coolstore facilities remained free-of-ethylene so as to avoid premature quality deterioration of fruit.

  With the objective of pre-ripening fruit so it is 'ready to eat' when it arrives in the supermarket, industry is developing the technology that will allow both temperature and ethylene concentrations to be manipulated in containers on ships en route to overseas markets.

- ***Packaging to meet customer requirements***
  Packaging is a critical component of any successful supply chain, especially where markets are a long way from the production base.

  The New Zealand horticultural industry has worked closely with industry to design a range of innovative, pack types that are characterised by flair and functionality. These include corrugated cardboard cartons and a pulp tray for apples designed so that energy is spread and absorbed if the carton is slightly over full or is dropped. Pocket pack trays for kiwifruit are used to market and brand the fruit.

  High speed labelling of individual fruit (at 10 to15 fruit per second) was introduced by the New Zealand fruit industry in collaboration with private companies.

  The NZ kiwifruit industry was a world leader in developing systems to track fruit from orchard to market. Buyers can identify the orchard that produced the fruit, the packhouse, the packing date and subsequent history of the fruit to the market. These systems are also used for quality control within the supply chain.

  Recent collaboration between HortResearch and a commercial company has resulted in a world leading novel package. Using innovative science and technology the partners have produced a label that changes colour in response to the volatile compounds that fruit produce naturally as they ripen. In this packaging, consumers can purchase fruit at a particular stage of ripeness ('crisp and not ready to eat', 'juicy and ready to eat') depending on the colour of the label on the *ripeSense*™ package.

HortResearch has also designed an innovative pocket pack that contains an ethylene release capsule; that can be activated on demand to release ethylene gas that will cause the fruit to ripen when planned.

- ***Fruit sorting:***
  For packaging and marketing fresh food products need to be sorted into quality categories. Fruit and vegetables are variable in size, quality and appearance but consumers seek uniformity in *size* and *appearance* as well as consistency in *taste* and *texture*.

  World leading fruit sorting machines have been developed in New Zealand by companies such as *Compac Sorting Equipment*, *Lynx Horticultural Systems* and *BBC Technologies*. These machines are able to sort and monitor fruit at rates of 10-15 fruit per second, segregating on the basis of size, volume (density), colour, internal sugar concentration and recognisable defects. New Zealand fruit grading machines have been sold in overseas fruit producing countries such as USA, Canada, Italy, France, Australia and Japan. Designers and manufacturers of these machines attribute their incentive to develop their technologies to the high quality demands of growers and exporters, especially Zespri International, who must have perfect fruit of optimum quality to continue to succeed in overseas markets.

  Producers in other countries have been known to buy NZ produce at retail, specifically *ZESPRI™ Kiwifruit,* to demonstrate to their own staff that high quality can be achieved through a Supply Chain that is seen as the benchmark of best practice.

  Clusters of engineering and technology companies design, build and install partial and complete systems for product handling, grading and packaging. The larger suppliers have more than half of their production exported to countries from Spain to Peru, and in crops as diverse as asparagus, blueberries kiwifruit, citrus, pomegranates and washed potatoes.

2. Science and Innovation features

New Zealand is a net exporter of fruits and vegetables being one of the few countries in the world that exports more than it consumes domestically. For this reason the New Zealand horticulture automatically assesses most developments that impact on the export business and especially the time needed to get the products to market. The close linkage between science and industry has led to findings from scientists being quickly applied by industry and integrated into the supply chain. This culture has given New Zealand a competitive advantage in Northern Hemisphere markets over other Southern Hemisphere competitors.

Scientists discovered that calcium reduced bitter pit, a storage disorder in apples and developed a calcium spray programme for orchard use with susceptible varieties. Fruit sampling protocols were developed to determine which apple crops had low calcium and were at risk. Meanwhile the dynamics of calcium uptake, distribution and accumulation in fruit became better understood and that information was used to improve tree management practises.

Technologists developed an innovative vacuum infiltration process for increasing calcium concentrations in fruit after harvest. The process was adopted by the New Zealand Apple & Pear Marketing Board (NZAPMB) and used to retain the Cox's Orange Pippin apple trade to Europe during the 1980s. Currently orchard sprays, postharvest dips and/or drenches are used to enhance calcium concentrations in apples.

Up to 1988 kiwifruit were harvested on 1 May without regard for the season's impact on fruit maturity. Scientists found that when fruit attained a soluble solids level of 6.2% it could be harvested with the confidence that it would move along the supply chain without significant quality loss and be of acceptable eating quality when it reached the consumer. In 1989 the kiwifruit industry adopted this criterion as a harvest maturity index.

Since 2000 the industry has been developing and refining a protocol for using dry matter as a basis for harvesting fruit with maximum taste when eaten by the consumer. It was recognised that maximum consumer acceptability would be achieved when the percentage of soluble solids at harvest was 7% to 8% and at eating ripe it was greater than 14.5%. Inclusion of dry matter as a quality attribute should result in consumers receiving fruit that is high in dry matter and consistently tastier, sweeter and more acceptable than fruit with lower dry matter.

A number of different attributes have been developed for assessing harvest maturity of apples including

- days from full bloom,
- fruit background colour,
- amount of starch remaining in fruit as determined by a starch/iodine test,
- fruit firmness

all with the intent to harvest fruit destined for long-term air or CA storage to be harvested prior to the natural increase of ethylene production.

During the 1980s the NZAPMB adopted a very innovative programme developing airtight aircraft containers with suitable gas atmospheres to transport high value Cox's Orange Pippin apples to the United Kingdom at the very beginning of the fruit season to achieve top prices. These containers were designed to fit into the hold of Jumbo Jets (Boeing 747 aircraft). The containers were packed with fruit, flown to the UK, unloaded, and then returned to NZ empty within days to be re-used on another flight. This was most successful, but eventually became uneconomic, especially with the introduction of ships with the capability of transporting CA containers.

3. Benefits

The New Zealand horticultural industry has increased its exports from less than $120 million in 1980 to more than $2 billion today with domestic market value being estimated also at about $2 billion making horticulture a $4 billion industry.

Horticulture is technology intensive, with growers demanding and using high tech systems and solutions to obtain sustainable production of high quality, high value products that are sought after in more than 100 countries around the world.

Horticulture provides permanent and part time employment for thousands of people throughout many horticultural regions throughout the country, thereby creating wealth and a sustainable fabric to rural New Zealand. A study by Hughes (2004) indicated that the kiwifruit industry created wealth to the value of $2 billion (1.5%) towards NZ's GDP of over $133 billion for the March 2004 year. Hughes indicated that the Kiwifruit industry alone, directly and indirectly, supports a national workforce of 26,318 full-time equivalent (FTE) persons. The Kiwifruit Sector comprising *Zespri*, the growers and the post-harvest operations of packing and cool-stores account for 19% of the Bay of Plenty (BOP) regional economy. Regionally in the BOP, the Kiwifruit Sectors directly and indirectly account for $3.8 billion of regional output (26.3%), $456 million of net household income (16.4%), $1.5 billion of regional GDP (19.2%) and 18,426 full-time equivalent workers (19.0%).

Similar levels of impact are expected to apply in areas such as Hawkes Bay, Nelson, Marlborough and Central Otago where pipfruit, summerfruit and grape production is prominent.

This growth and economic importance that has developed over the past 25 years can be attributed to the horticultural industries that have commercialised many innovations by having the drive and entrepreneurial skills of growers in the rapid uptake and adoption of innovative research findings developed by scientists, and very innovative market interpretation and development.

4. Return on R&D Investment

Because of the diversity of R&D projects over many years it has not been possible to isolate and identify the costs or the specific monetary benefits resulting from research funding. However as seen above, science and industry have made remarkable discoveries that in turn have been implemented throughout the entire Supply Chain with the result that New Zealand is recognised for its

- quality of science,
- quality of service and
- quality of horticultural products

in markets around the world.

5. Quotes

Adoption of modern supply chain management concepts (quotes below from Zespri Group Ltd. Annual Report 2002):

- *"The ZESPRI™ System integrates innovation, technology transfer, quality, orchard, postharvest distribution, sales, promotions, category management and branding to leverage value from our unique fruit knowledge"*.
- *"The ZESPRI™ System: for ZESPRI™ and the industry to succeed into the future, consumers, and customers in the marketplace, and growers and suppliers must perceive and realise a mutual advantage. Achievement of that advantage will only come through strengthened integration."*

"*Imagine a system where a consumer in Europe could pick up a fresh New Zealand apple and at a push of a button on a display panel could see not just the orchard from which it came, but the particular orchard block – and see the orchardist who grew that same apple. Amazing? New Zealand has the technology to do this right now – and New Zealand is one of the few countries with data systems able to do this."* AgriQuality.

6. Information sources

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7. Observations by the authors

- *NZ growers and marketers in horticultural industries are well aware the critical importance of attaining quality at harvest. They are also aware of the need to maintain quality after harvest to ensure that product consistency is achieved to the high standard demanded by discerning customers in export markets.*
- *Postharvest research and subsequent uptake of results by industry into strong, efficient, integrated supply chains, has been a key factor in the successful growth of horticultural exports over the past 30 to 40 years.*
- *NZ postharvest research has been at the leading edge of international research in many areas for many years, including*
  - *the generation of new fundamental knowledge relating to product deterioration and quality,*
  - *the development of innovative postharvest technologies per se,*
  - *the modification and adoption of overseas research and development for use in New Zealand supply chains.*

This case study is one of a 21-part case study series aimed at demonstrating the value of science and innovation in New Zealand's leading edge bio-science industries... and their significance to New Zealand.

Martech Consulting Group is a strategic consultancy based in New Zealand. The growing**futures** case study series was in part based upon Martech's extensive work with sector representative groups, science providers and organisations that interact with science providers to achieve consensus on co-ordinated actions, improve governance, develop sector-based strategies and improve innovation processes.

The growing**futures** case study series was developed by:

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