growingfutures

Case studies demonstrating the value of science and innovation in New Zealand's leading edge bio-science industries... and their significance to New Zealand

SUMMARY REPORT

May 2005

MARTECH Consulting Group

In association with

nzier
authoritative analysis

With support from:

HortResearch

New Zealand TRADE & ENTERPRISE

Zespri Kiwifruit

CROP & FOOD RESEARCH
Mana Kai Rangahau

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A series of case studies demonstrating the value of science and innovation in New Zealand's leading edge bio-science industries … and their significance to New Zealand

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Contents:

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ABSTRACT

This project is a case study series demonstrating the value of bioscience and innovation excellence that has transformed New Zealand's horticultural industries with world-leading products and technologies.

New Zealand's exports of horticultural products have increased from $150 million to over $2.2 billion in 25 years. Over that time, all of the many fruit, flowers and vegetables that are now exported to over 100 countries have changed in either the products themselves and/or in the systems by which they get to market. Importantly, all have moved significantly to meet market needs that also have changed.

With the objective of developing an integrated series of case studies, including robust economic assessments where practicable, the project team used a timeline technique to analyse progress from initiation through to commercialisation of the technology. and. The set comprises 21 case studies encompassing almost $1.9 billion of exports – and covering approximately 83% by value of total NZ horticulture exports.

In contrast to the perception held by some planners and decision makers, the analysis shows how New Zealand horticulture is at the cutting the edge in many aspects of innovation, production, quality maintenance, distribution and marketing as well as how, where and why science and innovation input creates value for the local and national economy. Most developments progressed through many stages to their present form. The work also outlines a number of examples where innovative foods have been developed and significant new advances are emerging.

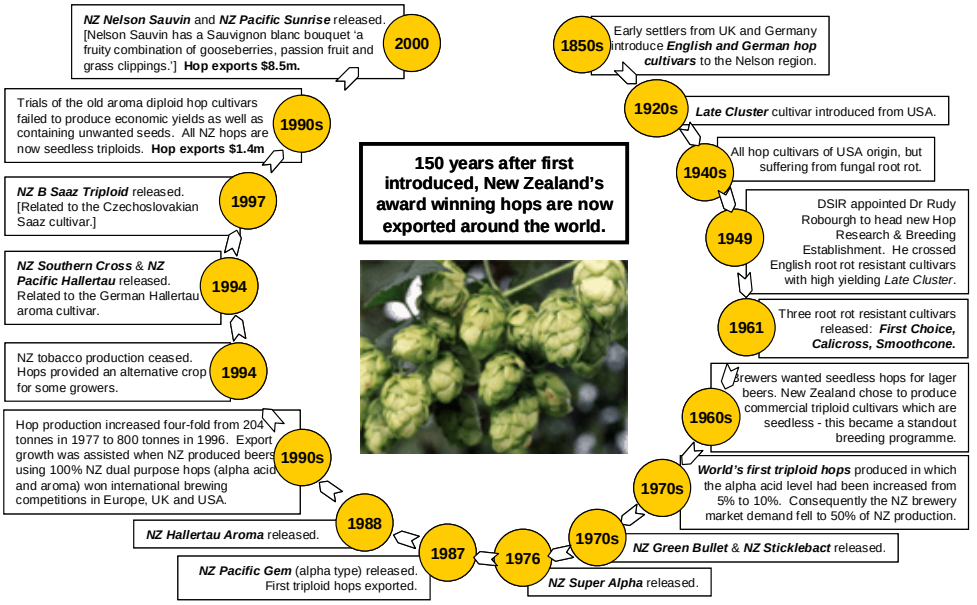
New Zealand can rightfully claim to be at the forefront of many 'remarkable and diverse innovations' in international horticulture as its systems and knowledge are used globally. As an example, hi-tech grading equipment, a by-product of New Zealand's striving for the highest possible quality outturn of produce in distant markets, is New Zealand horticulture's seventh most valuable export after kiwifruit, wine, apples, and onions, squash and processed vegetables.

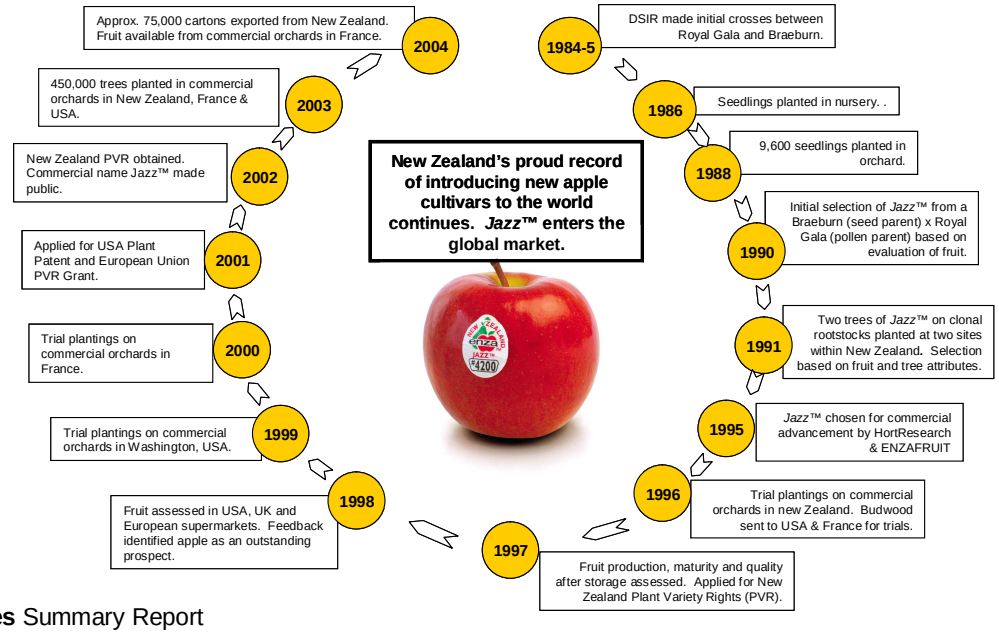
Science and innovation has been vital in maintaining New Zealand's global competitive position – but there is a need to have this basic premise more widely appreciated. These case studies show that funding science and innovation has been a good long-term investment. Like other technologies, our bio-science industries need continual advancement in areas such as new cultivars, imaginative novel products and processes, and advanced environmentally friendly systems. A strong commitment to effective and orderly marketing is also vital to gain the full benefit of the investments in science and innovation.

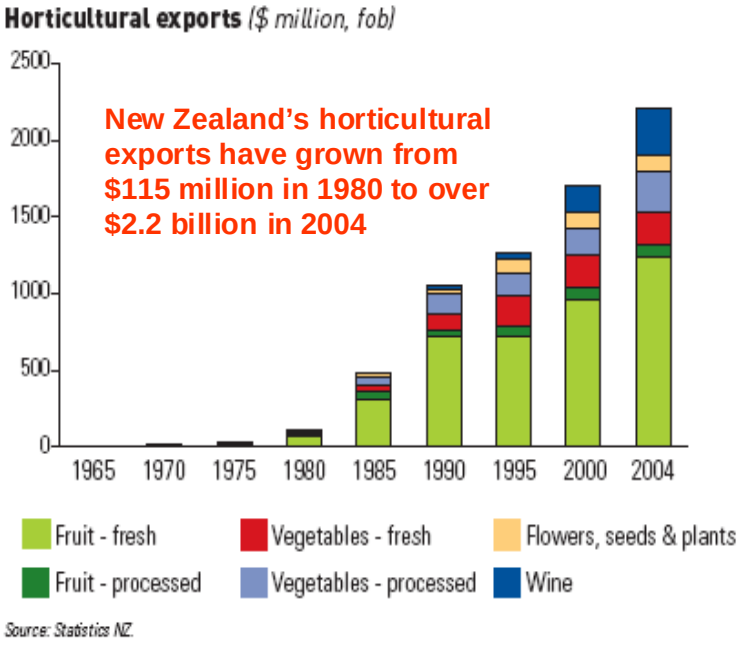
INTRODUCTION

Since competitive bidding for research dollars was introduced in New Zealand following the establishment of Crown Research Institutes (CRIs), the proportion of government funds available for horticultural research has remained almost constant. A combination of limited resources and constantly changing priority targets by the major funding agency (the Foundation for Research, Science and Technology, FRST) has created ongoing pressures for those agencies delivering research outputs.

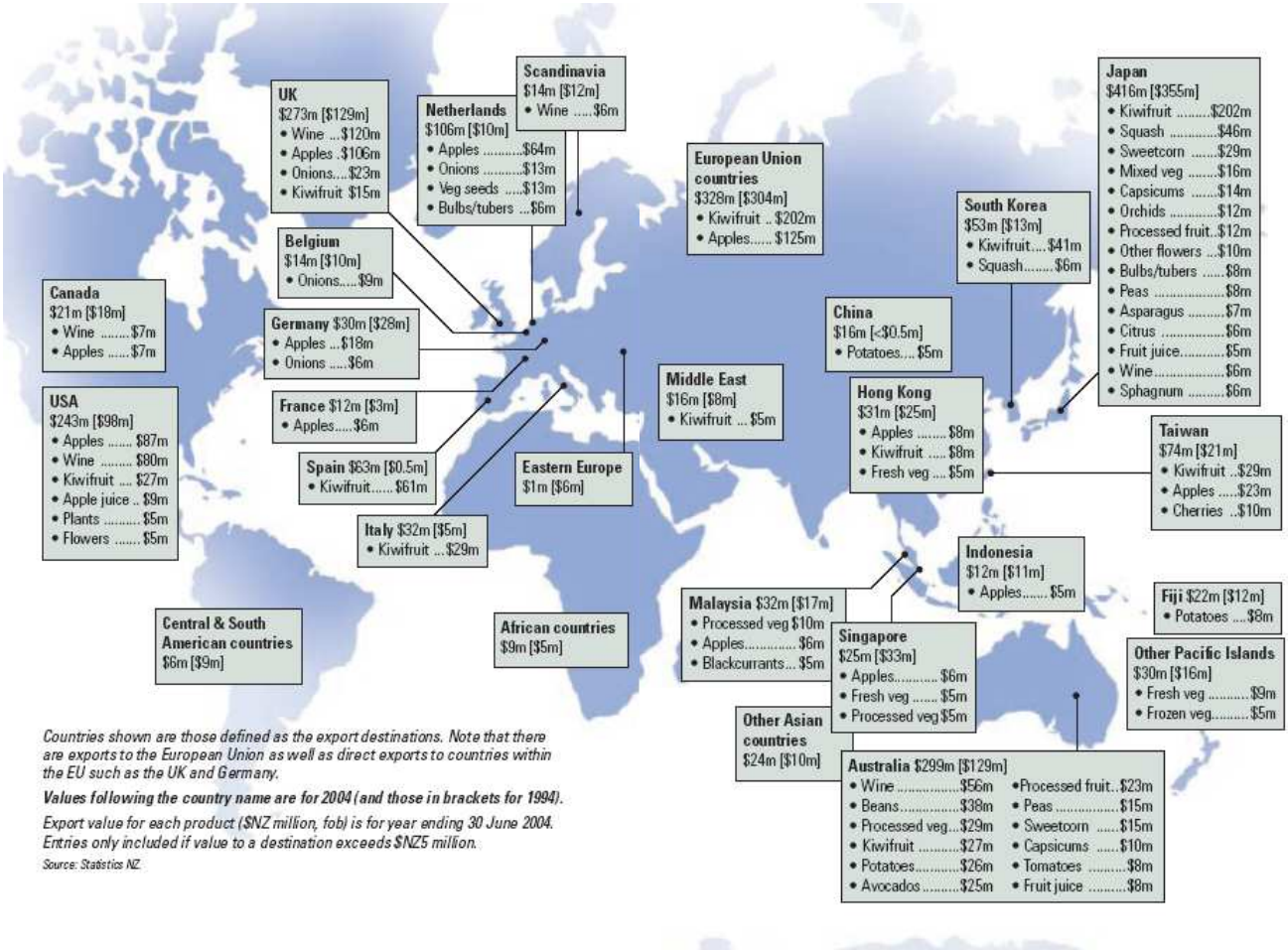
A few attempts have been made in New Zealand to quantify the benefits that accrue to an industry and the nation from investment in research and development in the primary sector. Dick et al (1967) conservatively estimated that the internal rate of return (IRR) for 4 disparate examples of research involving the primary sector was in the order of 20%, while Scobie and Eveleens (1986) indicated an IRR and a benefit/cost ratio (B/C) of 30% and nearly 3:1 respectively for selected examples in agricultural research in New Zealand. Typically the returns on agricultural and horticultural research are high overall, but characterised by long lag times of 10 to 25 years before full benefits are realised. The two time charts below are examples.







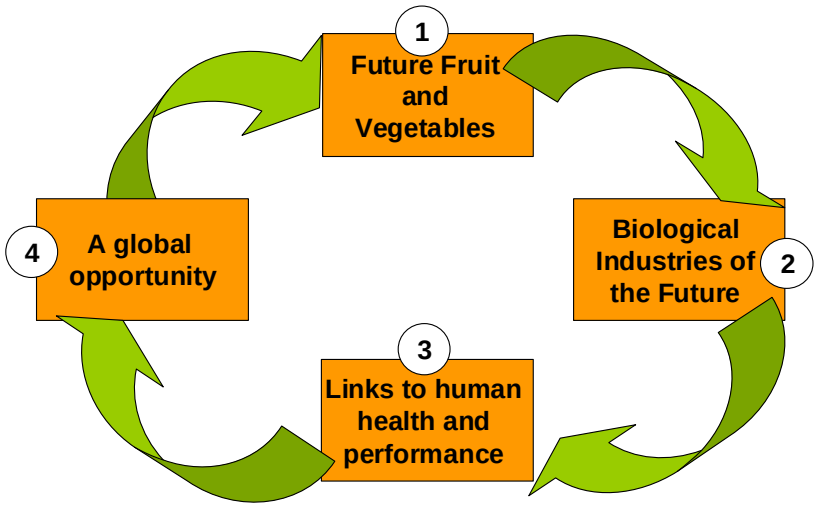
- Sixty-five percent of New Zealand's product exports are from its plant-based industries.
- Exports of horticultural crops exceeded $1 million to 41 countries, up from 15 in 1994.



- Major changes in cultivars grown and systems used have occurred in this time, a reflection of the innovation and expertise generated by R&D and rapidly adopted commercially.
- Scientific outputs and initiatives have enabled New Zealand to establish a high reputation for
  - producing a diverse range of new and desired food crops,
  - delivering high quality products to international consumers in a timely manner
  - being a preferred provider of many quality lines of fruits, vegetables and flowers.

Decision makers who influence funding decisions for R&D in horticultural science, such as investment funding and advisory groups, need to be fully aware of the essential underpinning of research in sustaining the future contributions of the bio-science industry in New Zealand. Agriculture and horticulture should not be perceived as 'sunset industries' now supplanted by electronics, biotechnology and new age high technology businesses. This series of case studies demonstrates the remarkable success of New Zealand's *Future Horticulture*. In each case study the authors found science and innovation developments that they could only describe as truly amazing.

There is a need to increase R&D funding (in real terms), and build strong horticulture science and technology programmes in the CRIs and Universities. Horticultural science must be presented as an attractive career for young people. There are many career opportunities to join the industry as growers, managers, scientists, marketers, technologists and consultants in a challenging industry that is based on high technology, that is innovative and progressive, and that adds value in amazing ways.

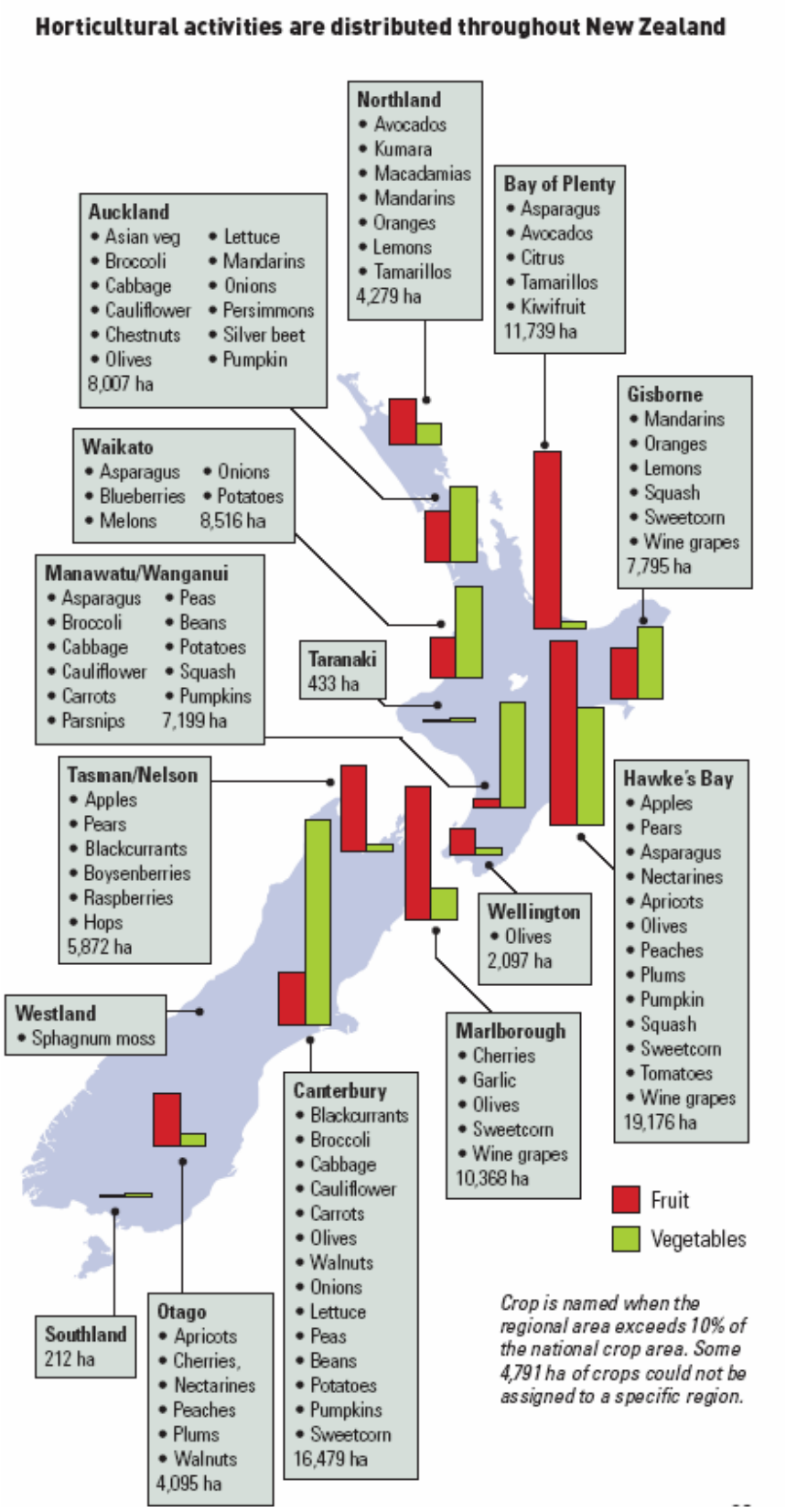


Our bio-science industries are a major opportunity for New Zealand to be a world leader and to capture significant value.

Benefits for such a focus would be expected to include:

- *Increased export earnings*: from (i) produce exports, (ii) Plant Variety Rights (PVR) and other income streams from produce grown outside New Zealand, and (iii) increased export earnings from high technology fruit sorting and other process and handling systems equipment

- *Increasing regional development:* New Zealand's horticulture base is spread across the whole country. So too are the supporting industries. We have world class technology businesses in locations such as Hamilton, Hastings, Te Puke, Dannevirke, and also in several locations in the South Island e.g. Marlborough with its dominant new world wines and leading-edge bulk handling continuous fermentation processes.



- *Improvements to land use and the environment:* Huge improvements have already been achieved through many export varieties using integrated pest management programmes and very few harmful organophosphate or 'hard' spays.
- *Increasing awareness of the value of fresh foods:* New Zealand's '*5 +a Day'* programme is cited by UN agencies as being the most effective in any country. Heightened awareness from leaders championing *Future Horticulture* should improve the health position of the whole community.
- *Education should also be a focus:* In recent years the number of graduates from horticulture programmes has fallen dramatically (by about 90%) in ten years. This does not appear to be aligned to the growth that the *Future Horticulture* industries have experienced and severe shortages of suitably skilled people currently exists even when further growth is projected. Not to be overlooked are the many skill areas the sector requires in other than horticulture. A few years ago, most could not have foreseen that, for example, graduates in pure maths would employed full time in the sector. High technology is here to stay in horticulture and the New Zealand industry relies upon it. *The Future Horticulture* case studies identified several areas where New Zealand is leading the world in high technology applications in horticulture – from development of cultivars through the many post harvest steps including high speed fruit sorting to advanced forms of presentation at retail.

This project therefore set out to address two questions:

> **"*What is the impact of a dollar spent on science and innovation in the horticulture sector?'***
>
> ***"What is the value of the horticulture sector to New Zealand?***

MATERIALS AND METHODS.

Selecting a framework A case study technique was used as a means of identifying and communicating science and innovation achievements. Each case study needed to: (i) educate, (ii) entertain, (iii) demonstrate a notable development or innovation, and (iv) be amenable to economic evaluation if possible. The outputs are expected to provide resource material for several future communication formats.

Methods. Invitations were sent to 100 selected individuals with special knowledge of horticulture asking them to suggest case study topics. Some 80 recommendations were received, and these were reduced 25 topics covering a range of innovations and produce types (Table 1). The project team interviewed key industry personnel and/or researchers involved in developing the innovations. Where possible data was collected for economic analysis.

The findings of the project will initially be presented to two target groups:

- Politicians, planners and decision makers who influence Science and Innovation priorities and spend.

- The industry itself. The premise for this being that if growers don't truly understand that they are part of an innovative, dynamic and emerging biological industry, then more distant people won't either. Growers can change mindsets.

FINDINGS

1. Horticultural champions

New Zealand horticulture is built upon innovative, visionary, risk takers who lead the industry. These 'champions' are drawn from both the industry and science communities. They are supported by many growers who take calculated risks in adopting new and sometimes unproven technologies. Their vision, motivation, dedication and often downright stubbornness is a feature of New Zealand's innovative horticulture.

2. Novel crops plant breeding and selection

New Zealand has an international reputation for innovation in introducing new fruits (e.g. kiwifruit *ZESPRI™ GREEN* and *ZESPRI™ GOLD),* new fruit cultivars (e.g. Gala, Braeburn and Jazz™ apples) and new plants (Zantedeschia or calla lilies) to international trade. The original genetic material has been introduced from many countries including:

- tamarillos from Ecuador;
- apricots from Afghanistan;
- kiwifruit from China;
- potatoes from Peru.
- calla lilies from South Africa

Other genetic material has been sourced from off-shore breeding programmes and adapted by breeding and selection to meet local conditions including:

- hops from Germany
- nectarines, peaches and plums from the USA
- blueberries from USA

Sourcing of seeds and plants from other countries is a well established New Zealand practice. In fact practically all New Zealand's exports are produced from introduced plants.

The global kiwifruit industry has been based on the Hayward cultivar, (originated from a seed selection from China in 1904). This is a selection from *Actinidia deliciosa* which is only one nearly 70 species of this genera known to exist. Diversification of the kiwifruit crop has been achieved with the introduction of Hort 16A (marketed as ZESPRI™ GOLD which is another species *A. chinensis.* The original cross was made in 1987. The decision to grow the selection commercially was made in 1992 and the first fruit were harvested in the late 1990s. The new cultivar was launched commercially in markets in 2000. This cultivar is protected by international plant variety patents (PVR), which allows Zespri International to enter into reciprocal ventures to grow the cultivar in the northern hemisphere (Italy, France, Japan and USA). Zespri can supply fruit to supermarkets throughout the year. ZESPRI and HortResearch receive direct commercial return from these plantings.

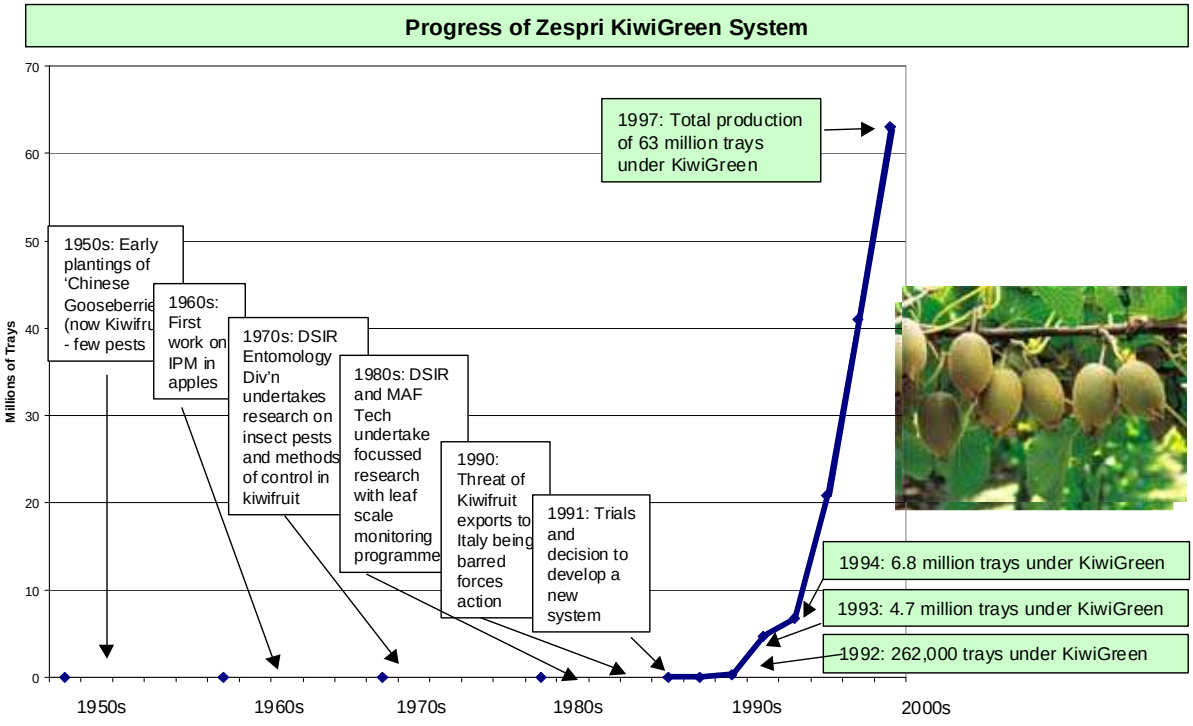
3. Green Horticulture

The major New Zealand fruit industries have adopted integrated fruit production (IFP) systems for their crops. Thus *KiwiGreen*, *AvoGreen*, *SummerGreen*, *IFP* for apples, and *Integrated Wine Production* systems are practised throughout New Zealand horticulture.

These technologies are characterised by the use of pest and disease monitoring systems to determine spraying interval, use of "soft sprays' such as *Bacillus thuringiensis* (BT) and refined mineral oils, and a minimal use of organophosphate sprays (sometimes referred to as 'hard' sprays).

Development and implementation of the *KiwiGreen System* in New Zealand is a remarkable and successful story (Campbell et al 1997). During the mid 1990s the Italian market for New Zealand kiwifruit was at risk because of possible unacceptable spray residues on the fruit. The NZ Kiwifruit Industry decided to worked with HortResearch and develop a pest management programme to reduce the use of sprays. They quickly developed and implemented a pest and disease management system based on previous research on the ecology of actual and potential pests, on monitoring pest and disease populations and establishing threshold levels. They compiled a user-friendly operations manual for growers, and funded an extensive technology transfer programme. In 1992 less than 8% of growers were involved; but within 5 years 100% of the export crop, was produced under the *KiwiGreen* system, now renamed the Zespri™ system. This amazing adoption of this new technology was achieved without Government subsidy. The markets were retained and new standards of orchard management reached.

Harris (1998) estimated that the return on research investment by the *KiwiGreen* programme exceeded the 10% discount rate used in the analysis. In the analysis undertaken in the current Future Horticulture project, the internal rate of return on the $50 million invested over 20 years exceeded 30%.



4. Decision Support Systems

A relatively new development has been the emergence of intelligent Decision Support Tools (DSP) that significantly improve the information basis upon which producers can make improved decisions.

Three examples are:

- Aphid Watch is a system of high level suction traps that monitor aphid populations well above immediate crop influence and provide a reliable additional source of data. Knowing the overall incidence of population levels of aphids allows producers to regulate remedies aligned to need. This reduces cost and increases quality. In squash pumpkin, an export crop of over $50m export value, fruit quality can be reduced by up to 85% if impacted by viruses carried by aphids and other pests.
- Pesticides are important tools used to grow high quality fruit and vegetables, but Horticultural managers needed a decision support tool that would help them determine which pesticides are best suited to their crops, without downgrading the soil and water environment. What happens to any applied chemical depends upon its properties, but is also determined by the crop cover, climate and soil characteristics, and the amount and timing of the applications.

  The development of the *GROWSAFE® Calculator* involved a partnership of science, industry and regional authorities working together over a two year period, covers 34 crop types and ranks all pesticides available in New Zealand for their environmental friendliness across 13 regional authorities. The model handles more than 28,000 combinations of crop, region, soil type and agrichemicals.

  Global customers for New Zealand's fresh and processed fruit and vegetables need assurance that all food products are safe for human consumption. However, there is also a growing interest among the global consumers in ensuring that food production systems used by producers, both in their home country and New Zealand, are sustainable. The *GROWSAFE® Calculator* is a valuable tool to assist horticultural producers in making management decisions which minimise the impact of pesticides on the environment.
- Another example is the *Aspire* programme for asparagus, a crop management and decision support technology developed by Crop & Food Research that has a greater acreage under the system in the USA than in New Zealand and is currently being taken up by growers in the UK and the European Community.

5. In Horticulture, New Zealand's science and innovation achievements have gone far beyond the orchard or paddock.

5.1 Post Harvest Systems

What we found in the collection of case studies is that not only has New Zealand excelled in areas such as the development of new and better performing cultivars (*ZESPRI™ GOLD* and ENZA Jazz® apples and developed greatly improved management systems: *Zespri™ System* for kiwifruit, but also it has developed a postharvest supply chain system incorporating handling, storage and packing systems that are linked to distribution and tracking systems believed by many to be the best example of global distribution of any fresh produce

Horticulture complemented these achievements by targeting more distant horizons

5.2 New ways of presenting fruit and vegetables

Recognised by TIME magazine (29 Nov. 2004) as being one *of the world's most amazing inventions in 2004*, ***ripeSense™*** is the world's first intelligent ripeness indicator label. This development is but one of many innovations New Zealand organisations are pursuing to meet three trends.

ripeSense™ evolved from the simple idea of making a fruit label that is capable of more than just branding product and this has lead to the next revolution in fresh produce marketing.

Once fruit is picked from orchards, the challenge to present fruit in top condition increases with distance from markets, more sophisticated consumer demands and the need for year-round supply. In the past, loose fruit, often unripe, was sold from bins where it was easily bruised, squeezed and prodded to determine its ripeness. Then came 'ready to eat' fruit, bundled and pre-packaged, but in a manner whereby it is still difficult to determine its ripeness.

Not knowing if, or when, the fruit has reached their preferred state of ripeness frustrates consumers and becomes a barrier to purchase. *ripeSense*™ eliminates this problem by using a sensor label that reacts to the aromas released by fruit as it ripens. The sensor is initially red and graduates to orange and finally yellow. By viewing the colour of the sensor, consumers choose fruit which is at their preferred ripeness.

***ripeSense™* packaging on display at Fruit Logistica, Berlin; the world's largest fruit fair.**

Damage and shrinkage are reduced as *ripeSense*™ significantly reduces damage by consumers as they inspect fruit before purchase; and the recyclable *ripeSense*™ pack provides improved hygiene security. Extra handling can lead to high levels of shrinkage in store.

ripeSense™ for pears is already on the market and developments are well advanced on *ripeSense*™ indicator labels for kiwfruit, melon, mango, avocado and stone fruit.

The *ripeSense*™ is the world's first intelligent ripeness indicator label system was developed in New Zealand by HortResearch, a New Zealand Crown Research Institute. The commercial production and marketing is undertaken in partnership with Jenkins Group, a supplier to New Zealand's horticultural labelling industry.

5.3 Designer Foods.

In food types, work is underway to develop new forms of fruit and vegetables that will meet the specific dietary needs of consumers.

In the case studies we discuss a range of emerging developments that show much promise for the future.

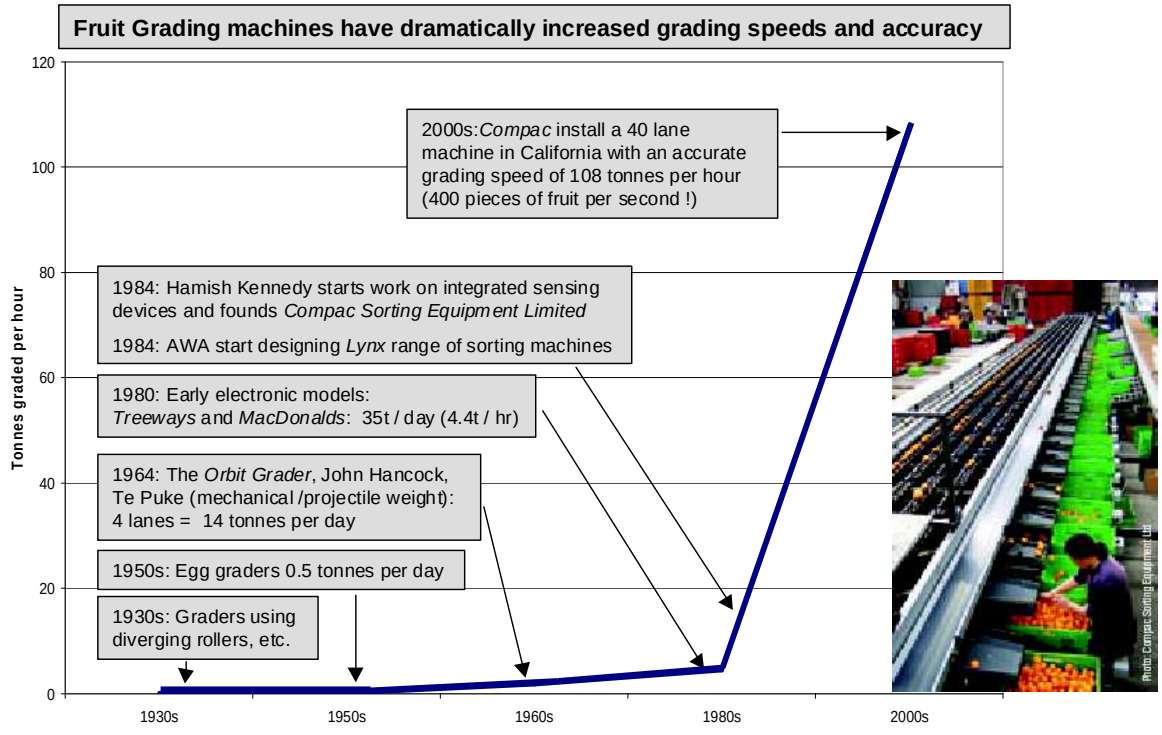
5.4 Production in target and third countries.

Processes have been developed for New Zealand horticulture to find ways to offset the limitations of seasonal supply from the Southern Hemisphere. Through a range of arrangements, marketers are now sourcing product from other countries that help ensure the shelf space in supermarkets are continually stocked by top quality produce controlled by New Zealand marketers. These arrangements include retaining plant variety rights (now possible with DNA tracing of fruit outputs that can identify the plant type from which the produce was grown), provision of technical advice to suppliers in order to meet New Zealand industry quality standards, and increasingly investment in growing, packing and storage of product produced.

5.5 Sorting and grading technologies

The speed and accuracy of todays high tech graders is truly amazing. Imagine a machine that can take 20 to 30 images of each fruit and stitch them together as an integrated image, covering the full 100% of the surface area, and from those images recognise each piece of fruit as to whether a small blemish is the same or different from a previous one, and also recognising both stem and calyx as not being blemishes – all at the rate of 10 per second. What has been described here already happens on single lane of a grading machine widely used in New Zealand and that is also being exported. Not surprisingly, it has a major market share. In case you thought that was fast, the company, *Compac Sorting Equipment* has supplied a 40 lane installation is the USA that processes 400-600 pieces per second depending on initial quality of the line of fruit.

The development of sorting and grading technologies demonstrates innovation, ingenuity and adaptability within New Zealand horticulture. New machines can rapidly sort on the basis of weight, size, colour, maturity, sweetness, firmness and defects with high accuracy, consistency and speed. The significant increase in volume of fruit handled per hour is illustrated below.



We were intrigued by this success and found that there are several companies that also have leading edge equipment with significant export growth. In one of our case studies we cite seven such companies. The following are two examples.

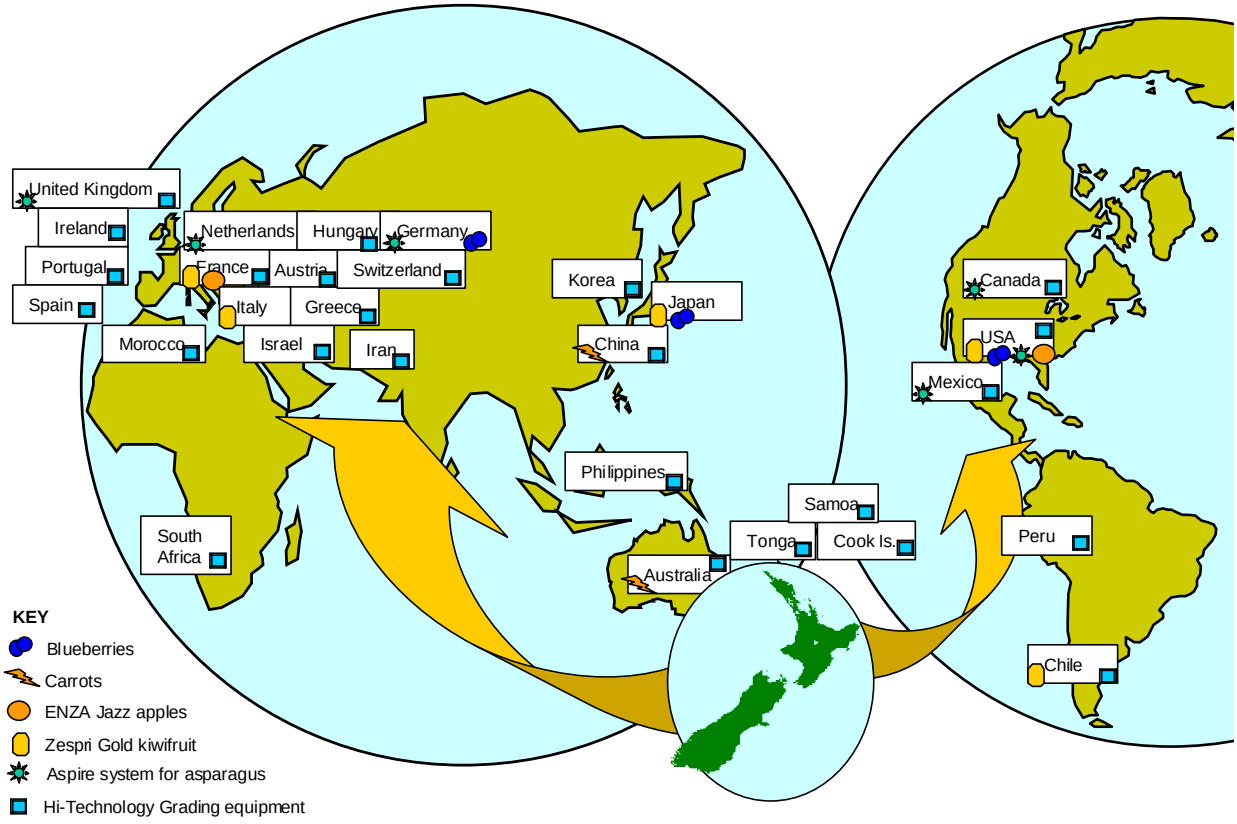
- *Compac Sorting Equipment* have developed commercial electronic fruit grading machines for New Zealand and now export to 17 countries. Early machines sorted only by size or weight. These new machines segregate for weight, colour, internal quality (^{O}Brix) and defects at the rate of 10-15 fruit per second, positioning them as world leaders in optical sorting technology.

  Compac have more than 50% market share of new grading machine sales in California, sorting citrus, tomatoes and summerfruit and similar market share with apples in Washington State, USA. (a market three times the size of New Zealand's total apple production).

- *BBC Technologies:* the main market focus of this company is large-scale high speed packing operations in North America where they have a large market share for berryfruit sorting machines. These machines sort a wide variety of soft fruits and nuts, including blueberries, cranberries, olives, strawberries, cherries, cherry and grape tomatoes, peanuts, almonds and pistachios. A machine for sorting soft berry fruits has been a dream for many packers. Fruit firmness is measured as fruit fall onto a small sensor and soft fruit are removed using air jets. Medium to large sized blueberries can be sorted at a rate of 100 kg fruit per hour. BBC Technologies believe they now sell 80% of all new berryfruit graders in the USA

Currently these manufacturers export equipment to the value of $25 million or more per year, a significant spin off for New Zealand's horticultural export sector.

New Zealand *Future Horticulture* industries supply systems, or sell high-technology equipment to, or grow produce in many other countries that all add to our export revenues.



In many ways it could be said that New Zealand primary industry (a term that is sometimes applied to land based products) has a secondary industry within it. The map below will be enlightening to many – as it was to the authors.

Projections are that the exports of high technology fruit and vegetable graders from New Zealand could reach $100 million by year 2010.

6. Why this level of global achievement?

We asked some designers and manufacturers to guide us as to why New Zealand has been able to achieve dominance in several overseas markets for this equipment. The following are some of the answers we received – and are in our view indicative of the high standard of what we are describing as *the 'silicon valley of horticultural expertise'*.

- James Flocchini, Marketing Manager, Compac on 'our original business driver'

> *"we needed to have a step up in order for New Zealand's fruit to travel all that way (to Northern Hemisphere markets) with higher transport costs to be competitive in the market – and among the things we could do was a more consistent job in sizing, a more consistent job in colour sorting – so that the product was more consistent and more easy to sell"*

20 Years ago, Red Delicious apples were colour graded into two colour bands. Later one colour standard was set, with a minimum level. *[Compac optical sorting machines can grade fruit to 16 different user-defined colours.]*

Subsequently, single desk Producer Boards were able to require higher quality standards e.g. where accuracy in weight needed a standard deviation of less than one gram. A greater accuracy in meeting set weights per carton unit, allowed growers using Compac sorting machines to increase returns by up to 5% through not having to overfill cartons with fruit they would not be paid for. *[With the Compac system, the weight of each fruit is recorded 250 times and analysed to 0.1 grams - all in less than 1/10th of a second.]*

- Hayden Borrie, Designer, WYMA Engineering, Christchurch, exporters of produce handling machinery:

> *"In Canada we have a client where we have replaced equipment that is only about three years old, but technology that NZ would regard as 20 years out of date."*

- Des Langdon, Managing Director of Langdon Engineering fruit handling equipment since 1985 under the LENZ brand, located at Te Puke:

> *"Hort 16a (ZESPRI™ GOLD kiwifruit) required fruit handling to be so gentle, and that knowledge has now gone to 'green kiwifruit' also. Any of the European companies don't compete with us (New Zealand) in this area. The fruit is handled with kid gloves, and the speed has got faster and faster. That is the trick of the game."*

- Warren Evans, Director, Lynx Horticultural Systems,

  "New Zealand leads the way in what we do. We do in New Zealand what others have not even thought of. We are thinking about what to do next – up to five years ahead of where other countries have got to."

  Q. Why is this so?

  "Because we are an export country. Groups like Zespri have done us all a great favour. Their insistence of quality in the market place is the benchmark. Customers (competitors in other countries) buy Zespri product in some instances just to see the quality and consistency for themselves.

  By focussing on quality, this has pulled manufacturers into chasing that... our premium products are the benchmark.

  We have been working to tolerances within 1 % weight variation for 15 years. By contrast, up to a couple of years ago, Canada were still using metals rings for sizing and picked fruit into baskets – both practices New Zealand did away with 25 years ago. The concept of 'count sizes' (fruit graded to a uniform size to fit a defined number snugly into a single tray carton) was new to producers in other countries.

  When we went to sell our machines in South Africa in 2002, they did not know what colour recognition machines were, whereas in New Zealand these had been accepted as the norm and the most economic way to go."

7. Return on R&D investment

The return on R&D investment was assessed by comparing the industry performance with the innovation in place to that of a counterfactual[1] situation which identifies a possible industry performance, had the innovation not happened.

Definitions Used

The working definitions used in this assessment are as follows:

[1]***Counterfactual:*** *Counterfactuals are used to offset the value of what might have happened in the absence of the innovation or discovery. A highly probable single alternative is selected to calculate what the resource (e.g. land) might otherwise have produced.*

[2]***Net Present Value (NPV)*****:** *Net Present Value represents the benefits, less the costs, converted into equivalent values today. In the case of R&D, we have summed the benefits of an identified R&D advance, taken away the costs and used a 7% discount rate to calculate the NPV.*

[3]***Internal Rate of Return (IRR):*** *The Internal Rate of Return calculates the interest rate received from an investment over a specific period. By examining the costs, and when they occur, compared to the benefits (income) over time, the IRR calculation is the rate of interest at which the present value of future cash flows become exactly equal to the initial capital investment.*

[1] *Refer Appendix*

Case 1. ZESPRI™ GOLD

Because exports of ZESPRI™ GOLD Kiwifruit have only been underway in any volumes since the international launch in 2000, calculations of the Internal Rates of Return[2] (IRR) of R&D investment, and of Net Present Value[3] (NPV) will have little meaning. However, by 2009 both are expected to be significant and to have reached an IRR of 10% and the NPV is calculated to be $28.8 million.

Case 2. ZESPRI™ System (the KiwiGreen system).

- The Internal Rate of Return[2] (IRR) figures are directly dependent upon the assumptions indicated in the counterfactuals (details in main report). As there will be varying opinions on this level, we have provided a range of calculations:

World prices depressed by	5%	10%	20%
Internal Rate of Return (IRR)	31%	47%	79%

Net Present Value[3] (NPV) calculation = $196,500,000

Case 3. New apples cultivars - Jazz apples

- *Jazz*™ was first planted on New Zealand commercial orchards in 1996, on commercial orchards in Washington State, USA in 1999, and on commercial orchards in France in 2000. By 2003, some 450,000 trees had been planted on commercial orchards worldwide.
- At present *Jazz*™ returns a significant premium over other varieties. This premium is expected to continue for the medium term.
- Assessment results:

	as at 2004	as at 2009
Internal Rate of Return		13%
Net Present Value		$2.8 million

Case 6. Pests on export apples

- Assessment results:

	as at 2004	as at 2009
Internal Rate of Return	43%	44%
Net Present Value	$16.6 million	$22.3 million

- The 2009 assessments are based on the assumptions that:
  - Apple exports to USA will continue at present levels until 2009.
  - Present prices for export apples will continue until 2009.

Case 7. Hops

Assessment results:

	as at 2004	as at 2009
Internal Rate of Return	8%	13%
Net Present Value	$4.8 million	$16.5 million

- The 2009 assessments are based on the assumptions that:
  - Hop production continues to be 8000 tonnes/year.
  - Domestic consumption of hops continues to be 15% of total production.
  - The present swing towards growing aroma varieties continues at the rate of a 3% reduction in alpha acid varieties each year.
  - Export prices continue at current levels.

Case 13: Blueberries

- The area of the blueberry crop is about 430 ha in 2004, having expanded from 300 ha in the early 1990s.
- Exports of fresh fruit have expanded from $680,000 in 1983 to $2.1 million in 1990 and $7.5 million in 2003.
- The sale of NZ bred cultivars in Europe, USA and Japan returns a significant royalty payment to HortResearch as the breeder.
- It takes about 10 years to breed and select a new blueberry cultivar.

Assessment results:

	as at 2004	as at 2009
Internal Rate of Return	19%	21%
Net Present Value	$0.5 million	$2.7 million

- The 2009 assessments are based on the assumptions that:
  - Crop area will not increase between 2004 and 2009
  - Fresh export will increase at 4% per year with same profile of early, mid and late season sales.
  - HortResearch's forward projections of royalty income will be met.
  - Processed exports and domestic sales will continue at present levels.

Case 15: Asparagus (development of the *AspireNZ* decision support system)

Assessment results:

	as at 2004	as at 2009
Internal Rate of Return	53%	61%
Net Present Value	$2.1 million	$5.4 million

- The 2009 assessments are based on the assumptions that:
  - Crop area declines from 1900 ha in 2004 to 1800 ha in 2009.
  - Average yields will increase from 3 tonnes/ha in 2004 to 4 tonnes/ha in 2009. This result is expected as a result of industry rationalisation and Vegfed's concerted drive to double yields by 2010.
  - The profile of asparagus use and prices will not change after 2004.
  - Overseas fees for *AspireUS* and others will double between 2004 and 2009, while the portion of New Zealand crop under *AspireNZ* management will increase from 33% to 50% over the same period.

8. International Trends

In case study #21 we cite nine important trends that scientists, producers and exporters must consider if New Zealand is to maintain its very successful level of fruit and vegetable exports. We repeat them here because we considered that meeting these factors is fundamental to New Zealand's continued success.

1. **Consumer Power:** consumers are served by the global food and beverage industry who must provide products and services demanded by consumers or they will go out of business. Predicting these needs and desires is an inexact science, but increasing complexity and fragmentation food commodities will occur, and smart companies will develop techniques and marketing approaches to capture and retain a loyal customer base.
2. **Convenience Rules:** to a large degree snacks and meals have become interchangeable and where 'convenience food' is associated with eating while moving and also quick home cooking. Increasingly there are concerns that convenience foods should also be healthier. Real household incomes are growing and the percentage of income spent on eating food away from home is increasing and this trend will be especially important in many developing countries over the next decade as a growing middle class population emerges.
3. **Increasing Customisation of Food:** the need for 'customisation' comes from people increasingly expecting to be use food to suit time, energy and health or leisure needs. Ethnic and cultural changes will impact on food availability and choice as will changing demographics related to population ageing. Customisation is driving the development innovations such as indicator labels for shelf-life and product composition as consumer requirements become increasingly dynamic. Status and pleasure create demand for new flavours and tastes and indulgence food will be sought after.
4. **Health and Wellbeing as Drivers of Food Consumption:** there is increasing demand for food and food products that enhance human health, wellness and body shape on a global scale as public health legislation shifts to the individual taking more health responsibility and health foods considered the most important instrument. Fresh fruit have been relatively "under-consumed" compared with snack foods. Food safety issues will become even important in purchase decisions. Consumers are likely to demand more 'natural' foods, take alternative medicines, and demand functional foods with specific health providing ingredients.

   The trends towards health-related products, convenience products and value-added products represent a significant growth potential for new and novel fruit varieties meeting these demands.

5. **Environmental Sustainability:** Current horticulture programmes are combining economic performance criteria such as the yield or gross margin and quality-based research (is it safe to eat?) with sustainability research (how the product is produced), which by its very nature involves economic, environmental and social aspects in an inter-related whole.

   In agriculture new micro diagnostic kits will give growers the ability to monitor plant health status at the cellular level, in the same way that they now use meteorological data and gross measures of pathogen load, for plant health management.

   Semi-closed systems, low chemical usage, IPM, etc are occurring, but the major trend is perhaps more in the organics pathway than organics itself and may be a greater trend than organics alone. The issue of 'food miles', nationally and internationally, will become more important in export market as environmental and resource issues surrounding food production, packaging, storage and transport are targeted by special interest groups.

6. **Food Safety:** consumers want to know that their food is safe, and proof of claims is becoming a key requirement, especially in the health benefit area. Certification and tracking of food production for safety reasons is increasing. There is a growing desire for "safe" and "natural" foods. Growth in the organic food sector is a consequence of this desire. Traceability techniques using state of the art, virtual real time monitoring will become the norm for horticultural food crops.

7. **Increasing Competition:** traditional international trade barriers are being lowered, resulting in an increasing amount of international global competition. A major consequence may be the necessity for reducing costs as a way of staying competitive. However fewer major supermarket chains will dominate sales globally, gaining increased power over producers, and marketing under their own brands to high quality standards.

8. **BioDigital:** the exponential increase in the power of IT combined with new technologies is fast creating a world where the monitoring and management of biological systems is available for real-time decision making. The reducing cost and increasing power of computer-based analysis will make current new technologies the preferred tool of regulation and monitoring internationally.

9. **Convergence of Sectors:** convergence of food, health and biotech areas is resulting in new products (value-added) and companies moving into new areas such as functional or fortified foods/ nutraceuticals; vaccines through food products, and where plants and microbes are starting to be used as factories in the production of biomaterials, plastics, fuels etc in plants (plants as factories).

In the case study series we have identified examples where all of the points cited below are being met to a major extent. In some instances the best examples are given in the most recent initiatives cited in three Case Studies:

#18 Health enhancing products

#19 Convenience foods

#20 Novel and gourmet foods.

SUMMARY

- Export is the driving force for the New Zealand's bio-technology industries that make up our horticulture sector. Growth in horticulture is primarily customer driven and takes place to meet export demand not to satisfy local needs. Export industries have established strong supply chain management systems that allow control to be maintained from orchard to market. The use of modern electronic technologies has enabled adoption of state of the art traceability systems. The high quality of export fruit and vegetables has delivered significant price premiums relative to many Southern Hemisphere competitors.

- Innovative new ways of presenting product at retail are being developed. *RipeSense* labels developed by HortResearch indicate fruit ripeness by reacting to ethylene levels, are now being commercialised. This innovation has been recognised by TIME magazine (29 Nov. 2004) as being one *of the world's most amazing inventions in 2004.*

- Many New Zealand products have unique attributes that are internationally recognised and preferred. 'New world' tastes and flavours, undoubtedly conferred by climate and soils, are augmented by smart growers and sophisticated supply chain systems. Wines from Sauvignon Blanc and Pinot Noir grapes are in demand in Europe and USA. Gala and Braeburn apples have been very successful in Northern Hemisphere markets. Kiwifruit is one of four new horticultural crops introduced to world trade in the 20th century. Blueberries selected and bred in NZ are being planted in Germany, Japan and USA because of their size, flavour and recognised health benefits.

- New Zealand horticultural scientists have international recognition for their innovative research achievements that have been adopted locally and offshore. These include
  (i) apple tree training systems;
  (ii) postharvest technologies;
  (iii) optimising quality through nutrition and crop load management
  (iv) development and implementation of integrated fruit and vegetable production systems,
  (v) development of fruit sorting machines,
  (vi) establishment of new industries with potential for success including avocado oil production, saffron production, manuka oil processing, kumara (sweet potato) processing and
  (vii) soil and water management.

  Growers and scientists travel widely developing key international networks that provide access to diverse product information and provide many intangible benefits.

- Close and seamless linkages usually exist between growers, scientists, technologists, consultants and marketing companies, all of whom network locally and globally. Constructive sharing of information takes place and is recognised as contributing to export success.

- New Zealand has a strong biosecurity policy to prevent entry of pests and diseases that threaten the horticultural, agricultural and forestry industries. It also has systems to ensure that fruit and vegetable exports meet the phytosanitary requirements of importing countries.

CONCLUSION

New Zealand has a very successful horticultural industry demonstrated by an exponential increase in exports since the 1980s. It has a reputation for providing premium quality and innovative products to discerning consumers, worldwide. It has been responsible for new fruit and flower introductions. Science and technology plays key underpinning roles in this development. Critical features are the visionary and motivated growers and their capacity to network into the science and technology community.

Internal rates of return will vary considerably among the case studies projects. However, of particular note is the IRR of more than 30% estimated to accrue from the *KiwiGreen* programme based on research over a 25 year period. It is anticipated that other case studies will have IRR values of between 10-30%.

New Zealand's performance suggests that it could have an exciting future at the forefront of many, if not most, remarkable innovations' that are the growingfutures in global horticulture.

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List of case studies in the growingfutures series:

1. ZESPRI™ Gold kiwifruit lights up the fruit world
2. ZESPRI™ *KiwiGreen* programme - world firsts in this vital crop management system
3. *Jazz*™ - a new New Zealand apple variety enters the global market
4. Advanced orchard systems lead to top yields for New Zealand apples
5. Integrated fruit production – quality apples for discerning consumers
6. DNA used to identify pests on export apples - a world first in biosecurity
7. New Zealand's award winning hops produce exceptional beers
8. New technology helps horticulturalists in sustainable management of land & water
9. Smart technologies used to control pests on outdoor vegetables
10. New Zealand's drive for premium quality fruit and vegetables has led to high technology grading systems that lead the world.
11. There is much more to New Zealand's fresh supply chains than just timely delivery to markets
12. NZ Sauvignon Blanc - right place - right time: a highly distinctive product on the world stage
13. Blueberries – a 20th Century fruit is part of New Zealand's expanding horticulture industry
14. Calla lilies (Zantedeschia) – a novel export flower crop with a global impact
15. *AspireNZ* decision support system for asparagus has global demand
16. New Zealand Kobocha – worth millions in Japan and elsewhere; our Squash Pumpkin exports use many innovations
17. Fresh Onions: a 5,000 year history – and New Zealand exports 200,000 tonnes each year
18. Health enhancing products from New Zealand plants
19. Convenience Foods and the revolution in produce marketing
20. Novel & Gourmet Foods
21. Trends that impact New Zealand's horticultural food exports