

Plant & Food
RESEARCH
RANGAHAU AHUMĀRA KAI



Discover. Innovate. Grow.

“MA TE PATAI KA MOHIO,
MA TE MOHIO KA MATAU,
MA TE MATAU KA ORA.”

“Through questioning we discover,
through discovering we learn,
through learning we succeed.”

MORE THAN ANY OTHER NATION, NEW ZEALAND OWES ITS HEALTH AND WEALTH TO THE SOIL AND TO THE SEA. WE HAVE HARNESSSED BOTH THROUGH GENERATIONS OF HARD WORK AND CLEVER THINKING, AND HAVE SHARED OUR HARVEST WITH THE WORLD. THE QUALITY OF OUR FUTURE RELIES ON HONOURING THAT LEGACY AND CONTINUING TO DELIVER OUR PROMISE OF HEALTHY FOOD FROM A CLEAN ENVIRONMENT.

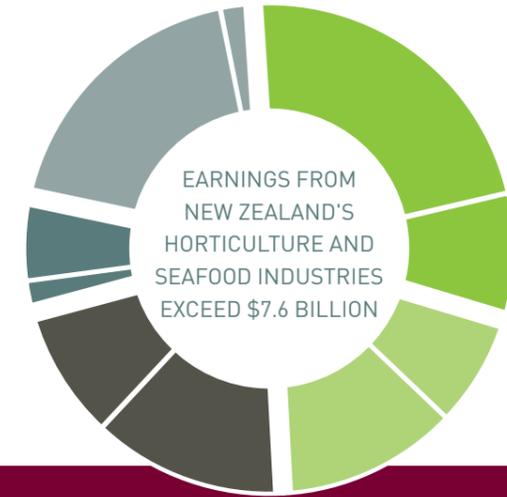


1980 to 2010: an explosion of food-based exports

SEAFOOD
Exports \$1.4bn
Domestic spend \$0.16bn

OTHER HORTICULTURE
Exports \$0.16bn
Domestic spend \$0.42bn

WINE
Exports \$0.98bn
Domestic spend \$0.67bn



FRUITS
Exports \$1.71bn
Domestic spend \$0.64bn

VEGETABLES
Exports \$0.56bn
Domestic spend \$0.91bn

OUR INDUSTRIES NOW GENERATE CLOSE TO \$5 BILLION OF EXPORTS, OVER 11% OF NEW ZEALAND'S TOTAL EXPORT VALUE.

MILESTONES:

HORTICULTURE → INDUSTRY

1982 First New Zealand wine tasting in London

1990 Horticultural exports exceed \$1 billion *

1997 ZESPRI International Ltd created to manage export and marketing of New Zealand kiwifruit

2001 Exports of vegetables (fresh and processed) exceed \$500 million

2003 Horticultural exports exceed \$2 billion

2005 Total horticultural production exceeds \$5 billion

2006 Wine exports exceed \$500 million

2009 Horticultural exports exceed \$3 billion, including \$1 billion of kiwifruit exports

SEAFOOD → INDUSTRY

1986 New Zealand introduces Quota Management System

1992 Seafood exports exceed \$1 billion

PLANT & FOOD RESEARCH →

1992 Crown Research Institutes formed, including HortResearch and Crop & Food Research

1997 ENZA releases Pacific Rose™ apples

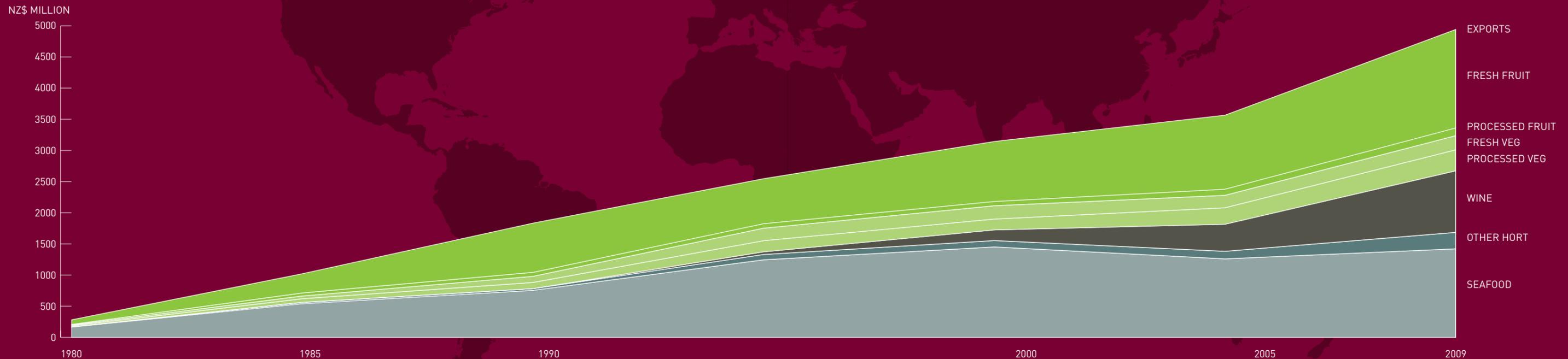
2000 ZESPRI® GOLD Kiwifruit released

2002 JAZZ™ apples released by ENZA

2004 Prevar™ formed to commercialise pipfruit cultivars

2005 Moonlight potatoes released

2008 HortResearch and Crop & Food Research merge to form Plant & Food Research



Seafood industry figures: Seafood Industry Council.
Horticulture industry figures: FreshFacts, except *Halsted, J. Orchardist of New Zealand 63(9).

Value from fresh ideas

Plant & Food Research has made a clear and public commitment to drive sustainable growth in New Zealand's plant and marine-based food industries. We stand alongside our industry partners as a trusted source of scientific discovery and innovation dedicated to delivering prosperity, health and sustainability from this nation's unique productive environments.

A very real sense of opportunity is emerging across New Zealand's horticulture, arable, seafood and processed food industries as global food and environmental imperatives shift into greater alignment with our established commitment to sustainably produced, high value premium products.

In turn, New Zealand has recognised that primary production remains at the heart of our economic wellbeing. It is our growers, farmers, fishermen and food producers who will generate much of our future wealth by sustainably producing and marketing fresh and processed foods based on flora and fauna unique to or owned by New Zealand.

Key groups within our plant and food production sectors have set their own ambitious goals for growth and have highlighted the need for knowledge, innovation and foresight to drive ongoing competitive advantage. Plant & Food Research exists to ensure the critical mass of research energy required to achieve those goals.

In meeting that core purpose, our Institute emphasises research that aligns with identified opportunities for growth,

profitability and sustainability. We then work closely with industry to ensure research is transferred successfully as new industry practices and protocols, tools, technologies or products, so that opportunities can be swiftly pursued and captured.

To ensure consistency of impact across all key sectors, our research direction is driven by awareness of issues that relate to the broader food sector as a whole, including market access, product innovation, biosecurity and environmental impact.

In all cases we integrate science across production, manufacturing, distribution and marketing platforms, combining market insight with a deep and fundamental understanding of the biological potential of New Zealand's food resource base and the systems that ensure its value is realised.

Success in this ensures lower costs across the supply chain, greater efficiencies in resource allocation, innovation in food design and the ability to produce foods that grow New Zealand's share of existing markets while also successfully opening new opportunities in growth areas.

The knowledge we create allows industry to produce more and better food from less land, with reduced environmental impacts and fewer chemical, carbon and water inputs. This is complemented by innovation that supports the production, marketing and exporting of high value fresh and processed foods tailored to meet well-defined global food trends: health, sustainability, convenience, novelty and sensory appeal.



MICHAEL AHIE
CHAIRMAN



PETER LANDON-LANE
CHIEF EXECUTIVE OFFICER

Research that delivers:

→ Better cultivars faster

→ Residue-free pest and disease control

→ More sustainable and profitable systems

→ Proprietary foods with price premiums

Target:

New plant and seafood-based foods, beverages and ingredients from environmentally and economically sustainable production systems



OUR SCIENCE COMBINES MARKET INSIGHT WITH A FUNDAMENTAL UNDERSTANDING OF THE BIOLOGY OF OUR FOOD RESOURCES. WE SUPPORT OUR INDUSTRY PARTNERS IN MEETING THEIR TARGETS BY DEVELOPING RESEARCH PROGRAMMES THAT IDENTIFY OPPORTUNITIES AND ADDRESS ISSUES. TO ACHIEVE THIS, WE DRAW ON THE EXPERTISE OF 658 SCIENTISTS ACROSS THE INSTITUTE.

→ BETTER CULTIVARS FASTER

STRATEGY:

- New cultivars with identified consumer and producer traits
- Identified molecular mechanisms controlling key traits
- Breeding programmes using integrated genomics tools

MAIN RESEARCH THEMES:

- Identifying molecular mechanisms controlling key traits
- Developing molecular markers for key traits
- Genotyping and phenotyping of germplasm collections
- Developing new technologies to support breeding programmes
- Breeding of new cultivars with defined commercial traits

→ RESIDUE-FREE PEST AND DISEASE CONTROL

STRATEGY:

- New tools and systems for biologically based pest and disease control
- New disinfestation technologies
- Improved biosecurity risk assessment, detection and response
- New cultivars with intrinsic resistance to pests and disease

MAIN RESEARCH THEMES:

- Understanding interactions of plants with pests and diseases
- Identifying genes conferring resistance to pests and diseases
- Developing novel methods for detection and monitoring of pests and diseases
- Developing decision support and risk assessment tools
- Developing novel biological control and disinfestation methods

→ SUSTAINABLE AND PROFITABLE PRODUCTION SYSTEMS

STRATEGY:

- Whole systems modelling and prediction technologies
- Improved production, pre- and postharvest technologies
- New tools for ecoverification, footprinting and traceability
- New cultivars designed for future environmental conditions

MAIN RESEARCH THEMES:

- Developing land, water and crop management decision support tools
- Developing alternative fish harvesting and storage systems
- Investigating new species for aquaculture
- Developing intelligent packaging for fresh produce
- Developing sensor technologies for field and postharvest assessment
- Developing methods to ensure crop pollination
- Using system modelling to define plant types for the future

→ PROPRIETARY, PREMIUM FOODS AND BEVERAGES

STRATEGY:

- New cultivars with functional wellness benefits
- New ingredients from proprietary cultivars developed for specific wellness activity
- New food and beverage concepts based on proprietary cultivars

MAIN RESEARCH THEMES:

- Understanding consumer purchase decisions
- Identifying and isolating compounds conferring health and wellness benefits
- Developing food and beverage concepts based on horticultural and seafood products
- Understanding consumer selection based on odour
- Developing postharvest protocols based on understanding of senescence
- Identifying alternative uses of horticultural and seafood by-products

Keeping the kiwi flying

Innovation is the key to meeting the New Zealand kiwifruit industry's aim of \$3 billion in annual export earnings by 2025.



- In 2009, 1.8 million tonnes of kiwifruit were produced worldwide. New Zealand is one of the top three kiwifruit exporting countries, alongside Italy and Chile.
- New Zealand supplies 30% of globally traded volume yet captures over 70% of the value generated by the top three exporters.
- Kiwifruit is New Zealand's top horticultural export, worth over \$1 billion in export earnings.



The New Zealand kiwifruit industry is currently dominated by two cultivars. 'Hayward', which was introduced in the 1930s, accounts for over 90% of kiwifruit produced globally. 'Hort16A', marketed as ZESPRI®GOLD Kiwifruit, was launched commercially in 2000 and, although it accounts for only 22% of export volume, generates more than \$525 million in global revenues each year.

The industry has identified that extending New Zealand's kiwifruit product portfolio through the release of new cultivars, which demand a premium price via strong consumer appeal, is a key driver in meeting

the industry's target of \$3 billion of exports by 2025. These products must have excellent taste and flavour qualities, as well as demonstrated health and nutrition benefits and novelty characteristics such as colour and convenience. Storage potential and the ability to licence cultivars to growers close to key markets are vital in delivering products of high quality to New Zealand's distant consumers throughout the year. Improved productivity across the supply chain will also contribute through increased efficiency and improved product quality and yield.

INNOVATION AT WORK ...

LAUNCHED IN 2000, ZESPRI®GOLD KIWIFRUIT NOW GENERATES MORE THAN \$525 MILLION IN ANNUAL GLOBAL REVENUES.

RESEARCH TARGETS

NEW CULTIVARS WITH TASTE, FLAVOUR, NOVELTY, HEALTH, YIELD AND CONVENIENCE CHARACTERISTICS

→ MOLECULAR MARKERS FOR KEY PRODUCER AND CONSUMER TRAITS

→ ENHANCED STORAGE POTENTIAL

→ SUSTAINABLE PRODUCTION SYSTEMS THAT OPTIMISE INPUTS AND MAXIMISE YIELD, QUALITY AND MARKET ACCESS

Our kiwifruit research ensures the kiwifruit industry is sustainable long term through the development of new, novel cultivars, as well as tools and techniques that increase yield, optimise inputs and enhance market accessibility.

Building on the success of our 'Hort16A' cultivar, marketed as ZESPRI®GOLD Kiwifruit, we are developing new cultivars of superior quality that command a market premium, with a focus on taste, consumer health, novelty and convenience. Our sensory and consumer research identifies the qualities in kiwifruit

that appeal most to consumers, such as taste, texture, flavour, convenience and appearance, to inform our breeding programme. Modern molecular biology techniques allow us to identify the plant genes responsible for these characteristics, as well as for traits desired by the producer, such as pest and disease resistance and flower sex, and to select those seedlings with the genetic profiles most likely to confer commercial success.

We work with the industry to develop orchard management programmes that allow growers, both in New Zealand and overseas, to

produce kiwifruit of maximum yield and quality while reducing inputs and cost. These integrated programmes address the control of pests and diseases using biological agents as well as vine and canopy management techniques. We also develop protocols that optimise storage conditions and postharvest management to ensure fruit is delivered to the consumer in a premium condition.

EXTENDING THE MARKET

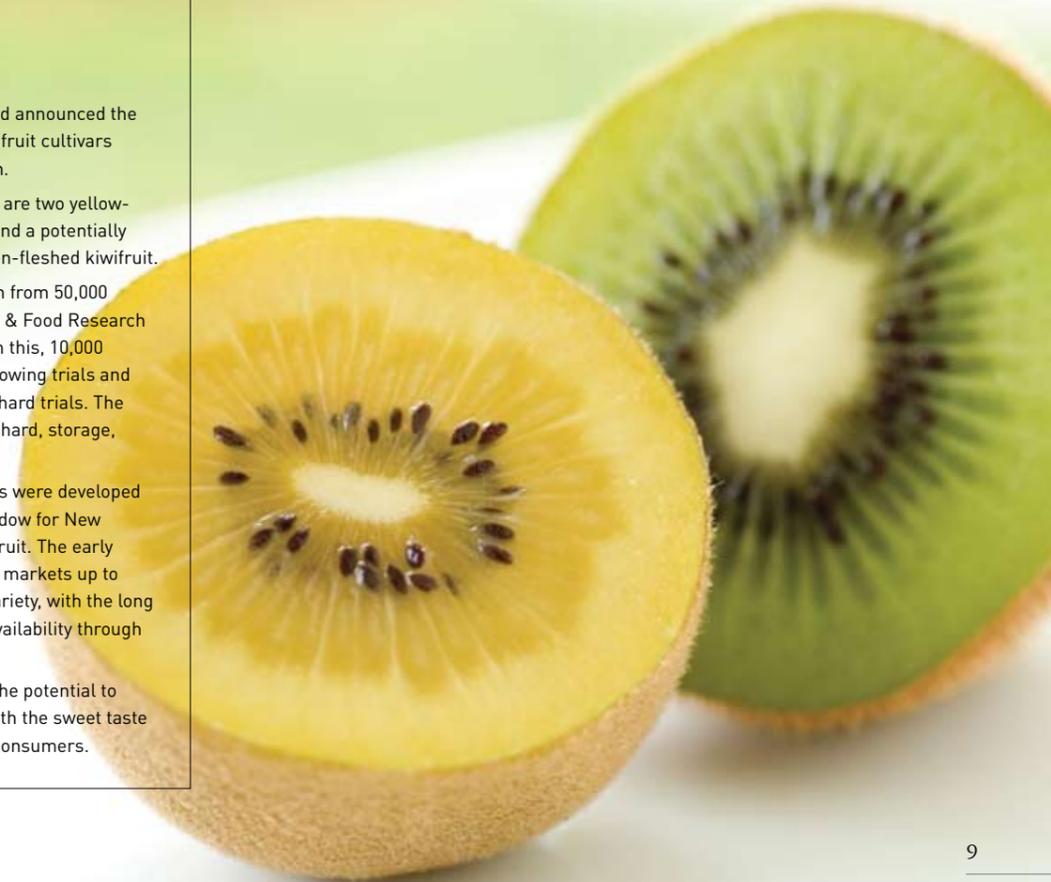
In June 2010, ZESPRI® Group Limited announced the commercialisation of three new kiwifruit cultivars developed by Plant & Food Research.

The three new commercial cultivars are two yellow-fleshed varieties - an early season and a potentially long-storing - and a new sweet green-fleshed kiwifruit.

The three new cultivars were chosen from 50,000 new varieties developed in the Plant & Food Research kiwifruit breeding programme. From this, 10,000 were initially selected, 40 went to growing trials and four were finally selected for on-orchard trials. The extensive screening included on-orchard, storage, shipping and taste tests.

The two new yellow-fleshed cultivars were developed specifically to widen the market window for New Zealand-grown ZESPRI®GOLD Kiwifruit. The early season cultivar is predicted to enter markets up to three weeks ahead of the existing variety, with the long storing variety expected to extend availability through the winter.

The new green-fleshed variety has the potential to establish a new market segment, with the sweet taste possibly appealing to new kiwifruit consumers.



100% pure apples from New Zealand

Controlling pests and diseases and reducing chemical residues keeps premium export markets accessible.

New Zealand has an excellent reputation as an apple exporter, based on both its production systems and the wide variety of products offered, including a history of innovative new cultivars such as 'Royal Gala', 'Braeburn', the Pacific™ series and the JAZZ™ and ENVY™ brands.

Meeting market access requirements is a key focus for the New Zealand pipfruit industry. Eliminating pests and diseases that can

close export borders whilst reducing use of chemical control agents provides an additional challenge in exporting to premium markets, where fruit with reduced or zero chemical residues have increasing appeal for many consumers. Integrated production systems that control pests and diseases with minimised chemical usage provide an opportunity for New Zealand to differentiate itself from other producers and remain competitive in premium markets.



- In 2008, global production of apples was close to 70 million tonnes and pear volume exceeded 20 million tonnes.
- New Zealand produces more than 430,000 tonnes of apples per year. 70% of these are exported, with a value of \$395 million.
- Apples account for 25% of New Zealand's fresh fruit exports and 12% of total horticultural exports.
- New Zealand apples are exported to 68 countries. 51% of apples exports go to the EU, 24% to Asia and 17% to North America.
- In 2009, New Zealand ranked third behind Chile and Italy among apple producing countries in overall competitiveness, based on criteria including production efficiency, infrastructure, financial and markets.



RESEARCH TARGETS

TARGETED CONTROL OF PESTS AND DISEASES USING BIOCONTROL AGENTS

→ PRODUCTION AND DISINFESTATION SYSTEMS WITH LOW CHEMICAL INPUTS

→ NEW CULTIVARS WITH BOTH SENSORY APPEAL AND INCREASED RESISTANCE TO PESTS AND DISEASES



APPLE FUTURES

New Zealand's apple sector is spread across a range of environments, each with their own pest and disease challenges.

To ensure that all apples meet the programme criteria, Apple Futures incorporates a range of tools which can be used in different combinations depending on the growing environment. Computer modelling, monitoring of beneficial organisms and targeted spraying allow growers to intervene with optimised control methods only when required.

Approximately 65% of New Zealand apples are produced under the Apple Futures programme, meeting the phytosanitary requirements of over 65 countries and being residue-free or with residues below 10% of EU regulatory tolerances.

The Apple Futures programme was developed with the support of three regional economic development agencies – Hawke's Bay Incorporated, the Nelson Regional Development Agency and Otago Forward – and New Zealand Trade & Enterprise.

Plant & Food Research works with the pipfruit industry to develop production systems that minimise the use of traditional chemical sprays to control pests and diseases. Spraying is targeted, using computer modelling, at specific pest or disease threats at appropriate times of the growing season. We are also investigating the use of biological controls – such as natural enemies of insect pests, microbial control agents and natural compounds – to minimise use of chemical control agents. Our chemosensory research is

identifying pest pheromones and developing synthetic semiochemicals for use in lures and traps and for mating disruption protocols.

We are also investigating alternative methods of postharvest disinfestation which leave no residues and may reduce agrichemical residues applied preharvest. These include physical treatments, such as temperature, controlled atmosphere and waterblasting, as well as chemical treatments and irradiation protocols.

Our pipfruit breeding programme is targeted at producing new apple and pear varieties

with both characteristics of high consumer appeal – firmness, crispness, juiciness, good appearance and novel flesh and skin colours – and resistance to a range of pests and diseases, including scab, fireblight, powdery mildew, woolly apple aphid and leafroller. Our genomics research allows us to identify promising parents, and to screen subsequent offspring, based on the genetic profile most likely to confer these desired characteristics.

Berry boost for health

Exploring health properties unique to New Zealand cultivars is helping to add value to a fast growing sector.



New Zealand blackcurrants, blueberries and Boysenberries have high concentrations of natural compounds known to be good for health.

The New Zealand blackcurrant sector aims to establish products from New Zealand as uniquely differentiated, and to encourage ingredients derived from its cultivars to be used in functional foods and beverages worldwide. The blackcurrant industry also seeks to improve production, yields and quality of blackcurrants through breeding of new and novel cultivars tailored to New Zealand conditions.

Identifying new health benefits from blueberries for marketing is the focus of New Zealand's blueberry industry as it builds sustainable growth from fresh and processed product.

Consistent supply of high quality product and development of new products that promote the unique flavour of New Zealand Boysenberries will allow the sector to increase grower returns through sustainable growth in export earnings. In addition, crop management programmes for high yields of healthy berries will improve production efficiency and reduce costs.



- Close to 6 million tonnes of berries are produced globally each year, at a value of around US\$2.5billion.
- Outside Europe, New Zealand is the largest supplier of blackcurrants, with 3% of global production.
- New Zealand's berry industry is worth over \$85 million with returns from fresh, frozen, juice and processed markets.

RESEARCH TARGETS

IDENTIFY COMPOUNDS PROVIDING HEALTH BENEFITS AND PROVE EFFICACY



FOOD INGREDIENTS AND PRODUCT CONCEPTS TO DELIVER OPTIMAL BENEFITS FROM HEALTH COMPOUNDS



NEW CULTIVARS WITH HEALTH COMPOUNDS

Plant & Food Research is assessing the natural phytochemical compounds from berries to identify those that deliver additional benefits for health beyond basic nutrition. We use cellular, chemical, receptor and organ-based bioassay screening to identify compounds that minimise muscle damage, modulate oxidative stress and inflammation, and have a beneficial effect on the immune system. We are also investigating the bioactivity of these compounds to optimise their delivery for increased efficacy. Using this knowledge, we develop ingredients and new product concepts that deliver optimal benefits from these compounds.

Our berry breeding programme is developing new cultivars with agronomic characteristics - such as pest and disease resistance, yield and chill requirements - and consumer characteristics - colour, acidity and size - as well as high concentrations of health compounds, including Vitamin C.

BLACKCURRANT COMPOUND PROVIDES WELLNESS BENEFITS

There is growing evidence dark-coloured berryfruit can provide additional health benefits beyond basic nutrition. Much of this research is based around studies of the antioxidant anthocyanins, responsible for the dark blue/red colouring of many fruits.

Through work with the blackcurrant industry identifying specific benefits available from New Zealand blackcurrants, Plant & Food Research scientists have discovered that other natural chemicals in the berries may also play a role in their unique health offering. Trials have shown that an extract derived from New Zealand-grown blackcurrants - taken in capsule form before and after exercise - offers three potential beneficial effects for consumers: minimising muscle damage by modulating oxidative stress, modulating inflammation and potentially enhancing the body's natural defences against disease. Ongoing research will determine exactly what compounds are responsible for the benefits.

Helping summerfruit taste success

Filling gaps in supply is key to the growth of the summerfruit industry.

New Zealand is uniquely placed in the world with a late Southern Hemisphere harvest season, particularly for apricots. This presents the New Zealand industry with a strong competitive position in providing Northern Hemisphere consumers with fresh fruit as supply from other producers begins to tail off.

The New Zealand summerfruit industry aims to fill this Northern Hemisphere supply window through the development of unique cultivars with excellent storage qualities and high consumer appeal. The industry also wants to develop new peach and nectarine cultivars

with the super-sweet flavours that appeal to consumers in Asia, as well as new apricot, plum, peach and nectarine cultivars that appeal to the domestic market.

Improving crop management processes to produce good yields of cherries, apricots, peaches and nectarines at optimum quality with minimal chemical residues is another industry focus. Better crop management will provide long-term sustainability for the industry by optimising inputs and efficiency while maintaining access to export markets.



- New Zealand's summerfruit industry is worth over \$70 million, with nearly half its revenue coming from niche export markets, primarily of cherries and apricots.
- New Zealand's summerfruit industry aims to earn \$24 million pa by 2018 from apricot exports.
- Export volumes of apricots increased by over 40% in 2009 to 3500 tonnes.

RESEARCH TARGETS

NEW LATE-MATURING APRICOT CULTIVARS WITH DESIRED FLAVOUR AND TEXTURE FOR EXPORT

→ OPTIMISED ORCHARD MANAGEMENT PROCESSES

→ FRESHER FRUIT FOR LONGER

Plant & Food Research is working with the New Zealand summerfruit industry to improve rootstock and tree management processes to optimise plant nutrition, enhance water use, optimise pollination, minimise pests and diseases and improve frost protection. This work focuses on efficient production of cherries, apricots, peaches and nectarines of the size, colour, texture and taste desired by consumers.

Our summerfruit breeding programme is supported by our consumer and sensory

science research investigating the qualities in apricots and peaches that appeal most to consumers, as well as our knowledge of fruit storage. We use modern molecular biology techniques to explore our extensive germplasm collections and identify plant genes responsible for desired qualities. Molecular markers are developed to speed up the breeding process by screening seedlings for key characteristics – such as taste, texture and storage potential.

Our primary target is new, novel cultivars with high consumer appeal, particularly apricots to

fill the spring market window in the northern hemisphere.

We also develop harvest and storage protocols that allow growers to pick their fruit at optimum times and store them appropriately, to ensure fruit delivered to the consumer is of the highest quality and taste.

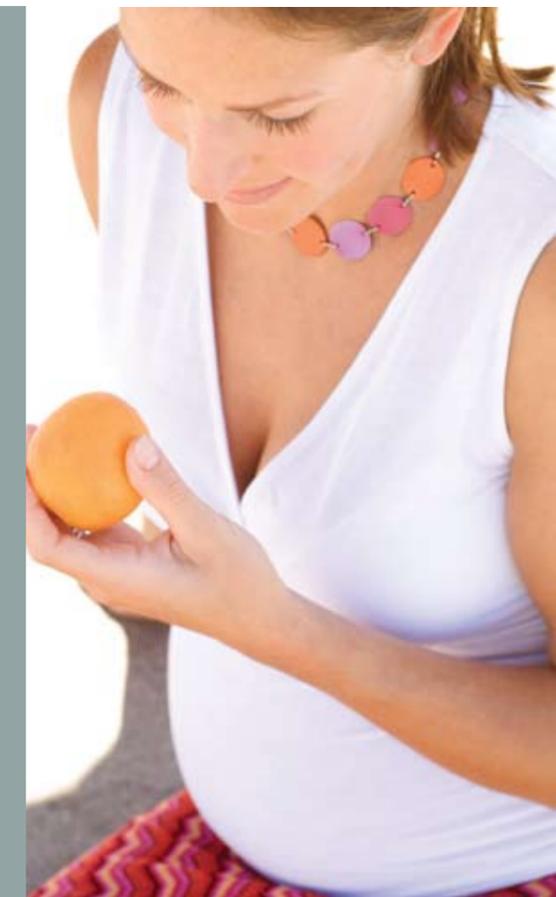
EARLY SEASON APRICOTS

Consumer anticipation of fresh apricots at the start of the summer harvest season poses a challenge for growers to meet demand, as fruit picked too early may lack sweetness from natural sugars that develop as they ripen on the tree.

Plant & Food Research has produced a new apricot that ripens in early to mid January and is sweet, juicy and firm to bite. In addition to its taste characteristics, its large size and bright red blush also add consumer appeal. This new cultivar has a high chill requirement and large-scale grower trials are underway in Central Otago.

Propagation continues for commercial volumes of trees and the first of these new apricots are due to reach supermarket shelves in New Zealand in the summer of 2013.

The new cultivar is a product of Plant & Food Research's breeding programme for Summerfruit New Zealand and its superior eating is anticipated to appeal to both apricot lovers and new consumers.



NEW ZEALAND IS UNIQUELY PLACED IN THE WORLD TO PROVIDE NORTHERN HEMISPHERE CONSUMERS WITH FRESH SUMMERFRUIT AS SUPPLY FROM OTHER PRODUCERS BEGINS TO TAIL OFF.

Making the most of five a day

New cultivars for fresh consumption with added consumer appeal are key to doubling vegetable industry production by 2020.

RESEARCH TARGETS

NEW CULTIVARS WITH GOOD NUTRITION, TASTE, NOVELTY AND PROCESSING CHARACTERISTICS

→ FRESH VEGETABLES FOR LONGER

→ PRODUCTION SYSTEMS THAT OPTIMISE INPUTS AND MAXIMISE QUALITY AND YIELD

→ EFFECTIVE PEST AND DISEASE MANAGEMENT SYSTEMS WITH REDUCED CHEMICAL INPUTS



- New Zealand produces over 1.3 million tonnes of vegetables each year worth \$1.5 billion in export and domestic trade.
- Potato is New Zealand's primary vegetable crop, predominantly for domestic supply.
- 80% of New Zealand's fresh vegetable export value comes from onions, squash and capsicums.
- More than half of New Zealand's \$336 million processed vegetable export value comes from peas, potatoes and sweetcorn.



New fresh vegetable varieties and products are recognised by New Zealand's vegetable industry as essential to future growth. To achieve their target of doubling production over the next decade, the industry is investing in the development of new cultivars and products with the qualities desired by consumers - taste, freshness, nutrition and convenience.

The long-term sustainability of the industry is also a major focus. The industry is developing new systems that best use available resources and ensure the environment is protected for the future. New technologies that retain quality during transport of vegetables to

offshore markets will also allow the industry to increase value through exports.

Specific sectors of the industry have additional defined needs. The potato sector, currently dominated by the domestic market, is focused on developing high value products for export. In addition, new technologies that protect crops from pests and diseases are highly sought.

The value of processed vegetable exports is expected to more than double by 2020. To meet this target, the sector is looking to extend its product offering to meet increasing demand from offshore markets, particularly in Asia.

INNOVATION AT WORK ...

SINCE ITS LAUNCH IN 2005, MOONLIGHT HAS BECOME NEW ZEALAND'S NUMBER ONE POTATO CULTIVAR, WITH MORE THAN FIVE MILLION EATEN EACH YEAR.

Plant & Food Research works with the vegetable industry to develop fresh vegetables, both familiar and novel forms, containing natural compounds known to provide good nutrition. Our genomics research allows us to quickly identify parents for the breeding programme and to screen subsequent offspring based on the genetic profile linked to the desired characteristics – such as taste, colour and high amounts of nutritional compounds. We explore the bioavailability of target compounds to ensure they are delivered to consumers in a beneficial form.

We use our understanding of plant firmness, crispness, colour and appearance to develop systems and technologies that retain vegetable quality and texture after harvest and during transportation. This ensures consumers are delivered products with high appeal, freshness and quality.

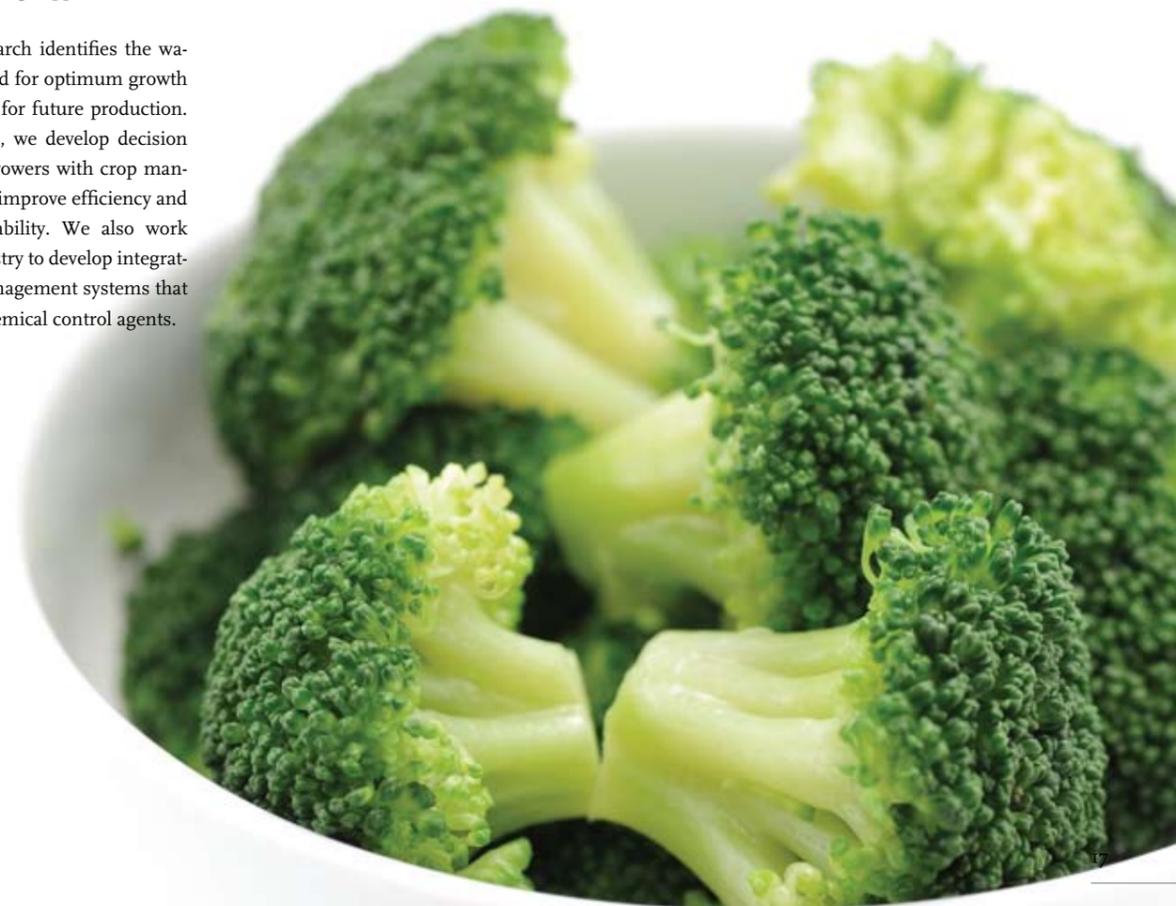
Our production research identifies the water and fertilisers needed for optimum growth and to protect the soils for future production. Using this information, we develop decision support tools to help growers with crop management decisions that improve efficiency and environmental sustainability. We also work with the vegetable industry to develop integrated pest and disease management systems that minimise the use of chemical control agents.

FINDING A SOLUTION FOR TOMATO POTATO PSYLLID

The tomato potato psyllid arrived in New Zealand in 2006 and can carry the disease-causing *Liberibacter* bacterium. The disease is associated with reduced yields and quality in tomato, potato and capsicum, crops worth more than \$800 million pa to New Zealand growers.

Plant & Food Research is working with the New Zealand vegetable industry to develop methods of monitoring and controlling the pest and the associated disease, including the use of potential biological control agents - such as natural predators like the brown lacewing. The information is contributing to the development of a pest management system specifically tailored to individual growing regions and information updates are released regularly to the vegetable industry.

The research is funded by vegetable growers, through Horticulture New Zealand, and the New Zealand government through the Ministry of Research Science & Technology and the Ministry of Agriculture and Forestry.



High performance arable foods and feeds

The sustainability and growth of New Zealand's arable food industry is underpinned by research and development of new products and technologies.

The New Zealand arable industry is predominantly a domestic market, producing cereal grains for use by the food industry and feed for livestock. The industry has two key targets for the future – adding value through new products targeted for specific uses, and innovative farming practices that improve environmental and economic sustainability.

There is increasing demand from premium consumers for foods tailored to their lifestyle and personal preferences. Cereal grains with novel characteristics – such as low gluten or high protein – allow the New Zealand food

industry to develop new, innovative products with increased consumer appeal for export markets.

The industry also recognises a requirement for efficient production systems that optimise the use of chemical inputs – including carbon, water, nitrogen and pesticides – and maximise soil health. New cultivars with increased agronomic performance, resulting in higher yields and reduced input requirements, also contribute to the long-term sustainability of the arable industry.

- Global barley, oat, triticale and wheat production totals over 9 billion tonnes each year.
- New Zealand's arable industry harvests over 1 million tonnes of grain each year, primarily wheat, barley and maize.
- The wider New Zealand arable foods industry generates \$5 billion pa of revenue.



RESEARCH TARGETS

NEW CULTIVARS WITH NOVEL AGRONOMIC, CONVENIENCE AND NUTRITIONAL CHARACTERISTICS

→ INTEGRATED PRODUCTION SYSTEMS THAT OPTIMISE INPUTS, CONTROL PESTS AND DISEASES AND MANAGE SOIL HEALTH

→ NEW LIFESTYLE FOOD AND INGREDIENT CONCEPTS BASED ON CEREAL GRAINS



IRRIGATING THE ARABLE FARM

Crops require adequate water for maximum yield and quality. Poorly timed irrigation can result in leaching of nutrients and reduced yield potential through water stress. Optimum use of water resources achieves both economic and environmental benefits.

Plant & Food Research has developed a whole-farm irrigation model to optimise irrigation scheduling in arable farm systems. This model has been incorporated into a decision support tool for farmers, distributed through the Foundation for Arable Research as the Aquatrac® irrigation calculator. The irrigation calculator uses soil, crop and weather information to determine when a crop's available water will drop below a critical point, allowing farmers to irrigate before this time to maintain crop health and yield. The calculator can be used for a wide range of arable crops in varying soil types across New Zealand.

Optimum irrigation scheduling generally aims to achieve 80% of soil water capacity, thus ensuring adequate water for crop growth but also providing capacity for rainfall. Optimum water in the soil eliminates leaching of nutrients where excess water drains away. Measures of crop yield loss can also be calculated where insufficient water is applied and can be used to prioritise which crops to irrigate to maximise returns.

Plant & Food Research is working with the arable industry to ensure sustainability through the development of new cultivars with increased agronomic performance and production systems that optimise inputs. Our breeding programme develops new wheat, barley, triticale and oat cultivars with increased resistance to pests and diseases and higher yields, as well as root systems that maximise

water and nutrient input efficiencies. We also develop feed and forage cultivars with increased nutritional value for livestock. Our integrated production systems allow growers to monitor soil concentrations and schedule nitrogen and water applications to optimise benefits and minimise environmental footprints.

Our research into gut health and satiety allows us to develop new concepts for foods with

added value for both consumers and the industry. Using our knowledge of food digestion, we identify specific characteristics of the grain that result in increased nutrition in processed foods. Combining this with our knowledge of grain processing and food concept development, our breeders develop new, novel cultivars for use in foods with added convenience for consumers.

Sustaining success from berry to bottle

Distinctive flavours and sustainable practices will retain New Zealand's premium wine reputation.

Wine is New Zealand's second largest horticultural export, with more than \$1 billion in export earnings in 2009. The growth potential of the wine industry depends on its ability to establish and capitalise on its reputation as a leading producer and marketer of highly distinctive, premium quality wines. In order to achieve strong value growth and create a platform for the industry's vision of \$2 billion exports by 2019, New Zealand Winegrowers (NZW) has identified three major science areas on which to focus – wine quality, sustainability and the appropriate management of supply and demand – to inform their global marketing strategy.

Understanding consumer preferences, as well as how vineyard and winemaking activities

influence taste profiles of grapes and wine, will allow the industry to develop wine flavours targeted to premium consumers in both existing and new markets. Tools that assist growers in vineyard decision making – including yield and canopy management, water and energy optimisation, and pest and disease management with nil residues – will maximise grape quality and ensure the industry is economically and environmentally sustainable. In addition, control measures designed to monitor and control grape yields can reduce the potential for oversupply that may affect the reputation of the industry and its premium position in world markets.



- More than 21 billion litres of wine is produced globally each year, with a market value of around USD\$260 billion.
- Export value from New Zealand's wine industry has grown at 23.8% pa for the past 20 years, to more than \$1 billion.
- New Zealand produces less than 1% of the world's wine, but is recognised as the premier producer of Sauvignon blanc.

INNOVATION AT WORK ...

SUSTAINABLE WINEGROWING NEW ZEALAND (SWNZ) IS A WORLD-LEADING PROGRAMME FOSTERING SUSTAINABLE PRACTICES ON 93% OF VINEYARD AREA AND IS ON TARGET TO MEET ITS GOAL OF 100% BY 2012.

RESEARCH TARGETS

TOOLS AND PROTOCOLS TO DIRECT WINE FLAVOUR

→ LOW IMPACT CONTROLS FOR VITICULTURAL PESTS AND DISEASES

→ DECISION SUPPORT TOOLS FOR SUSTAINABLE VINE AND VINEYARD MANAGEMENT

Our wine research spans the full spectrum of the industry, supporting industry goals by addressing key issues and delivering applied science and innovation to support its growth.

Our research, as part of the New Zealand Winegrowers Sustainable Winegrowing programme, improves the sustainability of vineyards through the development of tools that optimise nutrient, irrigation and agrichemical use. We also address pest and disease issues – such as mealy bugs and botrytis – through the

development of decision support models, risk management tools and cultural and biological controls.

We are the lead partner of the Sauvignon blanc Programme - the world's most comprehensive research programme for this variety. Through this programme, we have developed key tools, such as the Grape Yield Model, to assist growers in their vineyard management decisions. We are also investigating the influence of vineyard practices on wine quality and classifying the key aroma compounds that

produce the distinct New Zealand Sauvignon blanc style.

We undertake sensory and consumer research to better understand flavour and aroma perception as well as consumer purchase behaviour. This research supports the New Zealand wine industry in understanding consumer decisions and in developing wine styles best suited to both existing and emerging markets such as China.



THE GRAPE YIELD MODEL

Managing grape yield and crop load is vital to delivering high quality grapes at harvest. Excess crop load risks both under-ripe berries and a dilution of the components necessary to produce high quality wine. Late season thinning is an expensive, labour-intensive and time-consuming practice. Early prediction of grape yields to guide vine management decisions is therefore far better for growers.

As part of the FRST-funded Sauvignon Blanc Programme, research was carried out to determine whether climate data, principally the temperature during December and January, could be used to predict the yield of upcoming harvests. Results of the research demonstrated that temperature data from this flowering period correlated well with upcoming harvest yield. The number of degree flowering days, based on temperature data, is now being successfully used to predict bunch numbers developing some 18 months later, with figures from the following year used to refine the prediction based on estimated bunch weight.

High value sustainable seafoods

Innovative products and new species for aquaculture will enable export growth in the seafood industry.

New Zealand controls the world's fourth largest Exclusive Economic Zone (EEZ), more than 15 times the size of the country's land mass, and produces about one percent of the world's 67 million tonne fish catch.

New Zealand's aquaculture industry is worth about \$360 million annually. Estimates are that the sector will rapidly grow to match fisheries earnings within the next twenty years. To achieve its target of \$1 billion sales by 2025, the aquaculture sector is focused on innovation

to develop new species, products and markets for export. Partnerships between industry and government, communities, iwi, regions, research organisations and education providers are expected to play a key role in future growth of the sector.

The fresh capture sector is also poised for further growth, with the aim to be the preferred supplier of high quality seafood products to discerning world markets. New Zealand's strong international reputation for high quality

seafood products, reliable food safety and, of growing importance with consumers, for sustainable management of fisheries resources will support the industry in meeting its targets. Enhancing the industry's reputation for consistent high quality and supply, continued investment in new technologies, and capitalising on niche marketing opportunities are also expected to enable growth in the world's high value, premium markets.

TOP 5 EXPORT SPECIES 2009

MUSSELS	\$202m
ROCK LOBSTER	\$184m
HOKI	\$152m
SQUID	\$75m
SALMON	\$61m



- 130 species are commercially fished in New Zealand, 97 of which are managed by the Quota Management System.
- NZ marine fisheries waters (Exclusive Economic Zone & territorial sea) are 430 million ha, 15 times the area of its landmass.
- Seafood is New Zealand's fourth largest export product, worth \$1.4 billion in export revenue.

RESEARCH TARGETS

LOW IMPACT HARVESTING SYSTEMS FOR SUSTAINABLE WILD FISHERIES

→ POSTHARVEST STORAGE AND PRESERVATION SYSTEMS FOR OPTIMISED QUALITY AND SAFETY

→ NEW SPECIES EVALUATION FOR INCREASED PRODUCTION FROM AQUACULTURE

→ HIGH-VALUE INGREDIENTS FROM SEAFOOD BY-PRODUCTS

Plant & Food Research is part of Seafood Innovations Ltd, a joint venture research consortium company established with The New Zealand Seafood Industry Council Limited to drive research to benefit the New Zealand seafood industry. The goal of the company is to support the growth of the seafood export industry by increasing returns from the current seafood harvest through developing and commercialising innovative, consumer-appelling, value-added seafood and marine products.

We undertake live capture, harvesting and postharvest research for the seafood sector to ensure seafood products retain quality from capture to consumer and deliver premium returns in global markets. We also develop new, novel capture methods that have improved species selectivity, further enhancing New Zealand's reputation as a sustainable producer of first-class seafood products.

With the aquaculture sector, we are developing new species for aquaculture farming. We are also developing new packaging technologies for aquaculture products, such as Green-shell™ Mussels, reducing shell damage during transportation and optimising the quality of shellfish meat.

Plant & Food Research is also investigating new technologies to deliver high-value ingredients from fish by-products. We develop extraction and modification technologies for high value molecules found in fish, such as functional proteins and nutritionally important lipids. We work with industry partners to scale up these technologies and support manufacturers looking to commercialise new export products based on these molecules.

THE FARM POTENTIAL OF BUTTERFISH

Aquaculture is the fastest growing sector of the seafood industry. New Zealand Greenshell™ mussels, king salmon and Pacific oysters are already successful exports, but new species research is thought to be the key for delivering the growth and innovation required for the industry to reach its goal of \$1 billion exports by 2025.

Plant & Food Research, in a joint venture with New Zealand marine finfish producers, is working to establish butterfish as a viable species for aquaculture. Trials began at our Nelson-based Seafood Research Unit in September 2008 with wild-captured butterfish. Results have been very positive, with the fish proving a hardy and resilient species and demonstrating a voracious appetite, eating a wide range of foods, an important trait for any species to be farmed commercially.

After successful feasibility testing, plans are now underway to initiate commercial-scale evaluations and develop industry-ready guidelines.

Fresh thinking in food

New products and improved productivity are vital in growing New Zealand's food and beverage industry.



→ New Zealand's food and beverage industry leads the nation's economy, returning more than \$21 billion a year, over half our export earnings.

→ All its sectors - dairy, meat, aquaculture, wine and specialty foods - are growing and have contributed to a trebling of size since 1990.

→ In the specialty food and beverage sector there are 2000 manufacturers in New Zealand earning over \$8 billion from major export markets.

The food and beverage industry is critical to New Zealand's economic wellbeing. Securing sustainable future growth in this sector requires productivity improvements and innovation. The major sub-sectors of the industry cover a range from commodity to premium markets and encompass a large number of industry organisations and companies. As a whole, the New Zealand food and beverage industry recognises improved productivity, new products and new markets are essential to growth.

Primary production sectors – such as agriculture, horticulture, aquaculture and viticulture – are focused on the development of new technologies that ensure environmental and economic sustainability in the production of raw materials. These raw materials must have

qualities desired by processors, retailers and consumers.

In both the fresh and the processed food and beverage sectors the demand is strong for products in the nutrition and health areas. Foods offering health and lifestyle benefits are a rapidly growing segment of the global market and the efficacy of these products require scientific proof for maximum consumer appeal.

An understanding of country-specific differences and what appeals to 'local' consumers will provide the industry with a unique opportunity in new and existing export markets. Increasing the knowledge of New Zealand's food industry of consumer preferences and behaviour will allow the industry to better deliver the foods and beverages desired by discerning consumers.

FOODS OFFERING SCIENTIFICALLY-VALIDATED HEALTH AND LIFESTYLE BENEFITS ARE A RAPIDLY GROWING SEGMENT OF THE GLOBAL MARKET.

RESEARCH TARGETS

NEW PLANT AND SEAFOOD-BASED PRODUCTS WITH SUBSTANTIATED HEALTH AND LIFESTYLE CLAIMS BASED ON PROPRIETARY IP

→ NEW GENERATION OF FUNCTIONAL FOODS BASED ON HOLISTIC HUMAN PHYSIOLOGY MODELS

→ UNDERSTANDING CONSUMER PURCHASE DECISIONS AND THEIR APPLICATION IN PREMIUM PRODUCT DEVELOPMENT

Plant & Food Research works with the horticulture, viticulture and seafood industries to develop technologies and products across the food value chain, from grower to supermarket.

Our consumer and sensory science identifies consumer preferences in different market segments to inform our breeding and food innovation programmes. We breed new and novel

cultivars with the qualities desired by the consumer – such as taste, texture, convenience and nutrition - for the fresh and process markets.

Our integrated production systems allow growers to deliver produce that is environmentally and economically sustainable. This is combined with an understanding of pests and diseases, allowing us to protect our borders and ensure access to our offshore markets.

Our food innovation research identifies food components, their structure and how they interact in our diet. We also create delivery systems for valued components, develop new ingredients and concept products and provide the scientific validation that assures foods and drinks are beneficial for our health and wellness.

UNDERSTANDING CONSUMER PREFERENCES

While the science of human genetics is relatively new, it is a fast-growing field of interest to many food and beverage companies. Many global food companies are exploring the development and delivery of personalised foods to consumers seeking to meet their individual needs and preferences.

Understanding the differences in people's food choices and preferences will reduce much of the risk associated with new product development. Many factors affect food choices and one of them is the ability to smell specific compounds that define distinct flavours.

Plant & Food Research is investigating how personal genetic differences influence food perceptions. So far, we have identified a group of genes that may be involved in the detection of green leaf smell characteristics found in many fruits, vegetables and wines. We continue to identify odour detection thresholds for key compounds and explore individual genotypes to assess the influence of genetics on what people choose to eat.



Te Raranga Ahumara

Sustainable management of Maori-owned resources will significantly impact New Zealand's economic growth.



- Maori land development activities account for 7.4% of New Zealand's total agricultural output.
- Maori have a land base of 1.5 million hectares used for pastoral farming, horticulture and forestry.
- Maori-owned companies control about 40% of New Zealand's seafood catch.

Primary industries in New Zealand, key to the country's economic growth, have a strong Maori presence. Research and innovation have the potential to add value to existing Maori assets, particularly in agriculture, horticulture, forestry and aquaculture, growing not only the contribution of Maori activities to the New Zealand economy but also growing the national economy overall.

Maori enterprises are investing in scientific research and development to promote

innovation and success. One key element for ensuring economic growth is the sustainable use of resources owned by Maori, Iwi or Maori organisations, including research that allows better management of these resources, such as sustainable land use practices or products based on indigenous flora and fauna. New technologies and products that extend participation in and value of Maori activities are expected to contribute greatly to New Zealand's success and growth.

RANGAHAU AHUMARA KAI:

"THE SEARCHING OUT OF KNOWLEDGE TO TEND TO PAPATUANUKU AND TO GROW FOOD AND SUSTENANCE FOR THE WELLBEING OF HUMANKIND".

OUR MAORI NAME, RANGAHAU AHUMARA KAI, IS MORE THAN A MERE TRANSLATION OF PLANT & FOOD RESEARCH; IT EMBODIES MANY IMPORTANT PHILOSOPHIES THAT ARE CULTURAL TAONGA TO MAORI.

RESEARCH TARGETS

FOODS AND INGREDIENTS BASED ON INDIGENOUS FLORA AND FAUNA

→ SUSTAINABLE CROP AND SEAFOOD PRODUCTION SYSTEMS

→ NATIVE PLANTS FOR HORTICULTURE

Plant & Food Research works with Maori organisations to develop new products and technologies in the fields of horticulture, aquaculture, food and flavours and sustainable land use. We work with Maori organisations to identify opportunities for research and innovation that combine indigenous knowledge and modern techniques to support the economic aspirations of Iwi and Maori business of New Zealand.

Our Maori Business Unit, Te Raranga Ahumara was established in 2009 to ensure research is undertaken with an understanding of the social, environmental, economic and cultural aspirations of our Maori partners.

We are working with Maori partners to develop new foods and ingredients based on indigenous flora and fauna, particularly traditional food plants and seafood, as well as new technologies and techniques to manage

the production of native plants. We are also developing new tools for the control of pests and diseases and techniques for sustainable production of traditional crops, such as wine grapes, pipfruit, vegetables and arable crops, that recognise Maori tradition and culture.

FINDING THE FLAVOUR OF NEW ZEALAND

Indigenous New Zealand flora produce unique flavours that can be used in the development of new, novel foods and ingredients with significant export potential.

The FRST-funded Flavours of New Zealand project uses Maori knowledge of indigenous plants, such as kawakawa, horopito and manuka, to identify and extract flavours that can be incorporated into new ingredients and food concepts with a distinctive New Zealand taste.

The research screens native plants for unique flavours, as well as variations caused by geographical source and growing conditions; uses chemistry techniques to identify the aroma and flavour compounds present; sensory evaluation to determine the key combinations of compounds that provide the best flavour; and develops extraction methods that can be scaled up for industrial use. The research will also establish optimal cropping conditions for the plants and inform breeding programmes focused on producing cultivars with high concentrations of the desired compounds.

The research, supported by the Federation of Maori Authorities, will provide economic benefits across the supply chain, from Maori-owned forests and nurseries that can provide native plants to food and ingredient manufacturers and exporters.





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From well managed forests

Published September 2010



www.plantandfood.co.nz