Massey

definingnz

News from Massey University | Issue 27 | July 2014

www.definingnz.com

FUTURE FOOD

Higher quality, longer lasting, better for you

Plus

The virtues of roofwater

A layman's guide to the digestive system

New Zealand film culture

MASSEY UNIVERSITY
TE KUNENGA KI PUREHUROA
UNIVERSITY OF NEW ZEALAND

THE ENGINE OF THE NEW NEW ZEALAND

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definingnz is an occasional magazine from Massey University, Private Bag 11-222, Palmerston North 4442, New Zealand.

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DEPARTMENTS

Emeritus Professor Roger Morris, a world-leading epidemiologist, has been awarded a Massey medal – the university's highest academic honour. Professor Morris joined Massey as Professor of Animal Health in 1986, going on to found the Massey-based EpiCentre, the largest veterinary epidemiology training and research centre in Australasia. Morris played a key role in securing Massey a $15 million contract from the World Bank and European Union to develop and teach a 'One Health' Master's degree programme for health professionals across South Asia. The One Health programme is intended to build epidemiology and biosecurity capacity, anticipating and preventing pandemic disease outbreaks.

We want 'brand New Zealand' to be shorthand for the best of food and nutrition in the same way that 'brand Germany' is shorthand for the best of automotive engineering.

"Let food be thy medicine and medicine be thy food," is one of the sayings attributed to Hippocrates, the Greek physician referred to as the father of Western medicine. Living on the Greek island of Kos in the 5th century BCE, Hippocrates would probably have eaten a diet that included a mix of legumes, nuts, non-refined cereals and breads, olive oil and fish.

This is, we now know, in many ways an ideal diet, and one of the reasons why, many centuries later in 1961, desperately poor post-war Greece enjoyed the highest life expectancy (measured at the age of 45) of the national groups tracked by the World Health Organization.

When combined with an active lifestyle, the Mediterranean diet – as it has come to be called – turns out to be protective against coronary heart disease, cardiovascular disease, Alzheimer's disease and cancer. The epidemiological studies show that people who are on it live longer, healthier lives.

The Mediterranean diet is a vindication of Hippocrates' intuition: diet is one of the major determinants of health.

Of course, the post-war Greek population did not choose the Mediterranean diet over some other rival. They were locavores of necessity, eating what was to hand as it became seasonably available and, for times were hard, in moderation.

Today in the world's high-income countries, we are confronted by an all-you-can-eat super-abundance of choice, and again the epidemiological evidence is clear. As we become more and more sedentary and consume super-sized high-calorie diets rich in fat, salt and sugar but often deficient in nutrients, so our health is declining.

As I write, the New Zealand Medical Association has declared New Zealand's soaring obesity rate, with its associations with conditions such as diabetes, high blood pressure and cancer, to be a public health crisis – and the same phenomenon in some measure is happening worldwide.

This matters, both to the individual, who pays the price in what the health experts refer to as disability-adjusted life years, and to society, which picks up the health and social costs.

It is imperative that we make it easier for the consumer to make good choices. Hence the design of healthy foods, the promotion of well targeted public health initiatives and working alongside industry are emphases within Massey's College of Health.

But they are not the only ones, for food is a multidimensional issue. How, for example, do we ensure that our food is sustainably produced, manufactured and distributed? How do we make sure it is safe and traceable? What, significantly, can be done to ensure world food security?

The latter half of last century was shaped by the 'green revolution' – the vast increase in agricultural production ushered in by the introduction of new fertilisers, fungicides, pesticides, plant varieties and farming practices.

It was the green revolution that enabled the world to double its population during my adult lifetime while at the same time feeding people better and, in real terms, more cheaply. But the revolution is running out of puff.

In the 1960s the growth in crop yields was around 3 percent per year for staple crops. Today it sits at around 1 percent. And new challenges are arising. As climate change begins to bite we will see more and more severe weather events as well as large-scale climatic shifts.

In February 2011, the Food Price Index kept by the United Nations Food and Agriculture Organisation (FAO) since 1990, hit its all-time high, and while it fell somewhat subsequently, it is on the rise again.

Food security is a pressing issue. In 2050, in a more resource-constrained world, there will be two billion more mouths to feed – the population equivalent of two extra Indias. According to the FAO, 60 percent more food will be needed by 2050 if current food consumption trends continue.

China recognises this. China has 9 percent of the world's arable land and 21 percent of the world's population – a population that as it increasingly joins the urban middle class is hungry for what we have: a diet rich in meat, dairy and fats.

Hence, in recent years, we have seen Chinese firms snapping up food assets and farms, last year acquiring United States-based pork producer Smithfield Foods in a US$4.7 billion deal.

These are times of great challenge and, for food-exporting nations like New Zealand, of great opportunity. According

to the World Trade Organization, about 25 percent of global farm output is traded internationally. This figure can only increase – and as it does, part of that increase needs to be captured by New Zealand. Indeed, the Ministry of Business, Innovation and Employment wants New Zealand to raise annual food exports to 40 percent of GDP (or $60 billion) by 2025, requiring a compound annual growth rate of 7 percent.

For New Zealand, our ambition should be to staircase from basic commodity exports to ever more sophisticated, highly sought-after and profitable products. We need to shift away from skim milk powder towards the infant formula in which it is the principal ingredient. Away from green kiwifruit, to its lucrative licence-protected cultivar Zespri Gold. Away from undifferentiated chilled meat, towards premium grass-fed cuts traceable back to the pastures on which the individual animals were sustainably raised.

We need products that promote good health and that address issues such as obesity on the one hand and poor nutrition on the other.

We want 'brand New Zealand' to be shorthand for the best and most healthy food and nutrition in the same way that 'brand Germany' is shorthand for the best of automotive engineering.

And the most certain way of ensuring this happens is to have the strongest possible links between the food industry, key government agencies and our universities, key among them Massey, which is this year celebrating its 50th year of teaching food technology and numbers many of New Zealand's most prominent food industry leaders among its alumni.

In this issue of *definingnz* we meet a subset of the Massey scientists whose research and teaching are helping to create the food industry of tomorrow. We meet Professor Marlena Kruger, one of the leaders of the Government's High-Value Nutrition National Science Challenge; Associate Professor Marie Wong, whose work helped to establish the place of New Zealand avocado oil as an export commodity and who is now working with olive oil. We meet Professor John Bronlund and Andrew East, who are working with some of New Zealand's largest packaging manufacturers to design boxes that will help take New Zealand's products to market in optimum condition; Professor Julian Heyes, whose work with climate and atmospheric control is helping New Zealand fruit to stay fresh during storage; and Professor Roger Lentle, whose fundamental research into the physical processes of digestion may lead to new medical treatments and the design of foods with particular health benefits.

We explore the Massey microbrewery, where students learn the fundamentals of food process engineering.

Will New Zealand's food exports hit $60 billion by 2025? Can we ally foods engineered for their health benefits to enlightened public health policy? When I meet Massey's world-leading food researchers, I see no reason why not. The opportunities lie open. We must work together to seize them.

CELEBRATING 50 YEARS OF FOOD TECHNOLOGY

50

1964 - 2014

2014 marks the 50th anniversary of food technology at Massey and of the university's Bachelor of Food Technology, the first degree of its kind in the world. To celebrate, events are being held throughout the year.

For more information see **www.massey.ac.nz/2014**.

NZFOODAWARDS

IN ASSOCIATION WITH MASSEY UNIVERSITY

Entries are now open for the 2014 NZ Food Awards with two dedicated awards categories – one for small and one for large producers – along with a special category to include innovations by primary producers and ingredient supply companies. Entries close on 25 July, finalists will be announced on 4 September, and the Gala Dinner will be held on 25 September.

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

How many species of weta does New Zealand have? The current count is 70, but there could be many more, and, who knows, you may be able to add to the tally.

Massey's Ecology Group has just launched the 'Weta Geta' website, partly as a guide to identifying members of New Zealand's Orthoptera – an order of insects that includes grasshoppers, crickets and weta – and partly to solicit information that will help researchers to classify and catalogue new and existing species and map their distribution.

Associate Professor in Evolutionary Ecology Steve Trewick is asking people to shoot first and send later. "In the past we've had people send in some pretty grizzly packages, so we're advising people to send us a photo first and kill the insect by putting it in a jar and freezing it. We'll look at the photo and send out the appropriate packaging for the insect to be posted to us."

The group is particularly interested in cave weta, of which many are small and rarely seen.

There are five broad types of weta: the tree, ground, giant and tusked weta, which belong to one family, and the cave weta, which constitute a family in their own right. All are nocturnal. Their habitats include grassland, scrub, forests, caves and urban gardens.

The Weta Geta website has been funded by the Department of Conservation's Terrestrial and Freshwater Biodiversity Information Systems Programme.

wetageta.massey.ac.nz

Craig Shepherd, at right, the Managing Director of Harbour City Security, has donated $25,000 towards the expansion of the Wildbase wildlife hospital at Massey University's Manawatū campus. Shepherd – also known as Duckman for the sanctuary he provides for hundreds of ducks on his Ohariu Valley property – has a long association with Wildbase. In 2011 and 2012 he helped the Wildbase team to care for wildlife affected by the *Rena* oil spill. "I jumped at the opportunity to help out and raise money for their desperately needed new facilities."

Original Albany staff members cutting the cake to mark the campus's 21st birthday. Left to right: Gabrielle Graham, Dr Nitha Palakshappa, Professor Michael Belgrave, Dr Elanor Rimoldi and Associate Professor Grant Duncan.

TW Group funds retail chair

Massey has partnered with The Warehouse Group (TW Group), New Zealand's largest listed retailer, to fund a new chair – the Sir Stephen Tindall Chair in Retail Management. Based in the College of Business, the new professor will set up a Bachelor of Retail and Business Management, which is expected to take students from 2015.

The degree is expected to attract both people in the retail industry who want to upskill and school leavers contemplating a career.

"Retail is an exciting industry to work in and the new retail degree will combine general business knowledge with retail-specific content, meaning students will be set up for a wide array of career opportunities, ranging from logistics to supply chain management to running multi-million-dollar businesses," says TW Group Chief Executive Mark Powell.

Professor Ted Zorn with TW Group Chief Executive Mark Powell.

School of Aviation lecturer Savern Reweti has been designing low-cost desktop trainers customised for New Zealand pilots for as little as $15,000, a snap when compared to commercial simulators with $1 million to $20 million price tags. "The most expensive device I've developed was a motion-based research simulator for about $90,000 so, in simulator terms, it's a huge difference," says the newly graduated PhD in aviation. Dr Reweti is working with Massey's mechatronics (mechanical engineering) staff and students to improve the force feedback in his simulators.

John Kramer PhD

At the end of a successful career in culinary education, John Kramer (pictured with Chancellor Chris Kelly and Assistant Vice-Chancellor Professor Brigid Heywood) should have had a long and happy retirement with his wife Jan. There were many things he wanted to do, including walking across the stage to be capped with the PhD on which he had embarked as, he said, a joking gesture to "get up the noses" of the staff who had supervised his Masterate thesis. Unfortunately, it was not to be. At age 73 Kramer found himself confined to the Mary Potter Hospice with terminal bone cancer. But if Kramer could not come to the graduation ceremonies, the graduation ceremonies would come to him. In April 2014 John Kramer became John Kramer Phd in a ceremony held at the Mary Potter Hospice with family and Massey staff in attendance. Kramer emigrated from the Netherlands at age 18, began a career as a chef and cooked for the Queen and the Shah of Iran during their visits to New Zealand. Later he was a senior lecturer in catering at Wellington Polytechnic. His contribution to culinary education was recognised with a life membership of the New Zealand Chefs Association.

His PhD thesis addresses food safety in small and medium-sized New Zealand hospitality businesses.

Wellington film director Geoff Murphy has been awarded an honorary Doctorate in literature – although he thinks "rascal of the realm" would be a more fitting title. Murphy, 75, has directed 18 films and is best known for pioneering a renaissance in New Zealand cinema in the 1980s with three genre-challenging hits – *Goodbye Pork Pie*, *Utu* and *The Quiet Earth*.

NIne new graduates – three with Master of Veterinary Medicine (Biosecurity) degrees, four with Master of Public Health (Biosecurity) degrees, and two with Postgraduate Certificates in Science celebrate their graduation in Ulan Bator, Mongolia. The Mongolian graduates are the latest to complete the World Bank-funded One Health programme run by Massey. With its integration of veterinary and medical specialist topics in a single curriculum, the One Health programme is intended as a global safeguard against disease pandemics.

The institution that is the *Barely There* calendar has published its latest edition. Ten percent of the profits go towards Riding for the Disabled; the remainder fund the veterinary students Half-Way Day celebration, marking the midpoint of their five-year qualification.

www.vetcalendar.co.nz

Four-year-old Manasa, a red panda at Wellington zoo, is operated on by Massey surgeon, Richard Kuipers Von Lande assisted by veterinary science students. Manasa had broken his leg and dislocated his ankle in an awkward slip after being chased up a tree by his father. He is expected to make a full recovery.

Dame Suzie Moncrieff, creator of the World of WearableArt (WOW) Awards, has been awarded an honorary Doctorate for her contribution to art and design. She will receive a Doctor of Fine Arts at the Wellington graduation ceremony in May. Moncrieff has long been a friend and mentor to creative arts education at Massey, and WOW has sponsored an educational exchange for Massey fashion students with the San Francisco Academy of Art University. Moncrieff also created a WOW award to showcase design students, boosting their design industry visibility. Massey graduates who have won Supreme Awards are Nadine Jaggi in 2008 (whose work is pictured here), Luka Mues and Loren Shields in 2010 and Katie Collier and Sophie Littin in 2011. Rebecca Maxwell won the 2012 WOW Factor Award and was featured in the 2013 promotion campaign.

Improving plant resistance

Research by Massey University Research Fellow Dr Kee Sohn and his collaborators and published in the journal *Science* has revealed the structure of the paired immune receptors found in plant cells and the mechanisms by which these immune receptors confer disease resistance to important bacterial and fungal pathogens.

Sohn says a detailed understanding of the plant immune system is vital to the development of advanced strategies to engineer disease resistance in future crop breeding programmes.

The research may be of long-term assistance in such applications as breeding kiwifruit strains resistant to Psa-V, a disease first found in New Zealand orchards in November 2010. Psa-V has been estimated to cost New Zealand between $740 million and $885 million over a 15-year period.

Sohn is a Research Fellow in the Institute of Agriculture and Environment at Massey University, and is co-funded by Massey and the Bio-Protection Research Centre. His research team collaborates with Professor Jonathan Jones from The Sainsbury Laboratory and the John Innes Centre in the United Kingdom.

The **Charles Fleming Lecturer for 2014** is Massey's **Dr Mike Joy**. Joy will present the 2014 Charles Fleming Lecture, **The demise of New Zealand's freshwaters: politics and science**, for each of the 10 branches of the Royal Society of New Zealand during June and July 2014.

Nelson:	Thursday 10 July
Palmerston North:	Tuesday 15 July
Hawke's Bay:	Thursday 17 July

These lectures are not ticketed or bookable via the Royal Society of New Zealand. Please contact the individual society branches for details. More information is available via the Royal Society of New Zealand website:

www.royalsociety.org.nz

Of rats and robins

A programme of rat poisoning and trapping in small forest blocks in the King Country has hugely boosted populations of native species, a six-year study has found.

A research team, led by Massey University Professor of Conservation Biology Doug Armstrong, analysed the effects of rat control in 19 forest fragments (small blocks between five and 20 hectares) on the Rereahu Farms near Benneydale.

They found that small-scale rat control led to a rise in North Island robin populations of an average 50 percent each year, and that other species preyed on by rats also benefited.

"The results are magic," Armstrong says. "We saw a transformation from a few native North Island robins that could barely survive or breed, to forest fragments full of happy parents feeding begging young and an obvious increase in other species like whiteheads, rifleman and cave weta."

The research team developed a novel experimental and Bayesian modelling approach that allowed population growth to be estimated in individual fragments. They also developed a connectivity index used to predict the most effective pest-control strategies, as proximity to unmanaged forest prevents populations in fragments being built up. The research found that stock fencing improved breeding success, allaying fears that fenced fragments might be worse because they harbour more rats.

The research, funded by a Marsden grant worth $880,000, is published in the *Conservation Biology* journal.

On higher ground – 50 years at Fergusson Hall

Jennifer Little writes.

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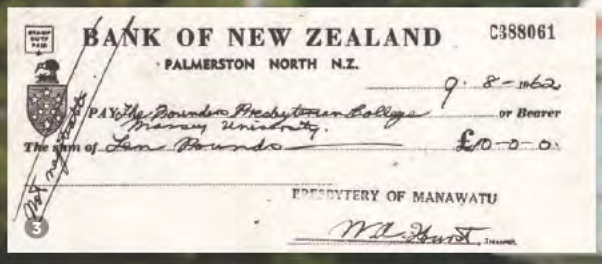

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A sea view in Palmerston North is a rarity. For social work student Maria Langenhoven, glimpsing the Tasman Sea from her second-floor balcony is one of the charms of living at 'Ferg' – Fergusson Hall. She can spot Mount Taranaki's silhouette on a clear day too. Life in the grand 106-year-old colonial homestead – built on an elevated outcrop in the suburb now called Summerhill – mostly revolves around fun and friendship. Humans versus zombies parties, water fights, volleyball, cooking contests – all permeated by a palpable sense of the past and embellished by the old-world elegance of stained-glass panels and huge bay windows.

First-year sports and exercise student Josh Bond likes that "you feel like you are a part of history. The house has a really good vibe". Both enjoy living close to the campus yet secluded and separate from it. A steep bush track links their higher-ground haven to the campus.

Sculleries, serveries, butteries and the 17 bedrooms of the original Atawhai House were reconstructed and converted to a modern 50-room hall of residence after the Keiller family sold it to the Presbyterian Education Purposes Trust in 1962. It was officially opened and renamed Fergusson Hall in 1964 by its namesake, the-then Governor-General of New Zealand Sir Bernard Fergusson.

50th Jubilee Reunion, 4-5 October 2014

Join other 'Fergies' for a special reunion weekend. The programme includes hall tours, a celebration service, time to socialise and a gala dinner on Saturday night.

Speakers will be former residents Dick Hubbard (founder of Hubbard Foods and former Mayor of Auckland) and Amy Thomson (Graduate Analyst at New Zealand Treasury).

See **definingnz.com/fergreunion** for more details and to register.

Since then it's been home to more than 3500 Massey students from all over the world. Many are returning to the scene of their youthful antics for a jubilee celebration in October, which coincides with Massey's jubilee year. Founding Fergusson Hall inmate and food technology graduate Dick Hubbard, former Auckland Mayor and founder of Hubbard Foods, will be among them.

Simon Cayzer, who has run day-to-day operations as Head of Hall for 14 years, and Professor Andrew Brodie, Chairman of the Presbyterian Educational Purposes Trust, brim with historical anecdotes and are seeking more through Facebook connections with alumni.

The house was built in 1908 on the 12-hectare estate by Scottish migrant Edwin Keiller and his two brothers, of the Dundee marmalade-making-family fame. At the time there was no road access, so all the materials had to be hauled up the bluff, says Cayzer.

Designed by architect Charles Natusch (who also designed Wharerata), the house was built of Australian jarrah, heart rimu and kauri. The family developed three hectares in lawn and gardens, with a sunken rose garden, stables, gardener's cottage, workshop, greenhouse and small orchard. (The rose garden is gone, but this year's students are building a summerhouse.) At the jubilee event, the house will be renamed Keiller House in honour of its original owners.

One of the property's best-kept secrets is a bomb shelter hidden in the surrounding bush, built in 1942 in anticipation of a possible World War II invasion by the Japanese, but only ever invaded by students with ghetto blasters in the 1980s.

Descendant Patricia Keiller, granddaughter of Edwin, still lives in Palmerston North and recalls hearing kiwi at night from the home's large, open upstairs balcony where she would sometimes sleep. She would have seen the mountain and ocean in the distance too. Some things don't change.

1. Governor-General Sir Bernard Fergusson and his wife arriving for the official opening of the hostel. Facing is Reverend Ian Purdie, first Chair of the Fergusson Trust. Shaking hands with Fergusson is the Very Reverend Stan Murray, Moderator of the Presbyterian Church. 2. The sweeping staircase leading from the front door. 3. A £10 deposit secured the purchase of the property by the Presbyterian Church. 4. The secret of Ferguson Hall: a World War II bomb shelter.

Below: House residents Josh Bond and Maria Langenhoven.

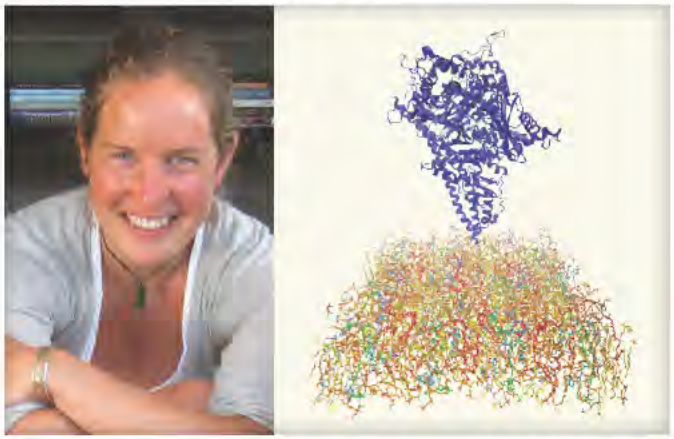
Making proteins dance

The same kind of computer power used in Weta Workshop's CGI is being harnessed by Albany-based Dr Jane Allison to make movies of how protein molecules move inside cells.

"We tend to think of proteins as solid and something we should eat, but inside cells they dance around like little robots doing the work that keeps us alive," she says.

While modelling the movement of isolated proteins is now a relatively well established technique, studying proteins – the lumbering molecular giants of biology – in their cellular working environment is more challenging.

Funded by a recent Marsden Fast-Start grant, Allison is investigating why some proteins tend to clump – a phenomenon linked to diseases like Parkinson's, Alzheimer's and type 2 diabetes – and how this might be prevented.



Dr Jane Allison with a modelled protein. Blue helices represent the protein PI3Kalpha, which binds to the cell membrane (coloured) and sends signals related to cell growth that can lead to cancer. Allison's work to understand the interaction may lead to new anti-cancer drugs.

"Lowering the purchase age for alcohol was associated with a long-term impact on alcohol-involved crashes among drivers aged 18 to 19 years. Raising the minimum purchase age for alcohol would be appropriate."

The conclusion of a study conducted by Taisia Huckle and Karl Parker of Massey's Social and Health Outcomes Research and Evaluation (SHORE) centre. Prior to the drinking age being lowered from 20 to 18 in 1999, teen drivers in New Zealand had about the same odds as motorists aged 20 to 24 of being in an injury-causing accident while over their respective legal alcohol limits. They are now 21 percent more likely to be in such a crash.

"It is really busy around here and like someone is crossing and the cars just speeding and they are like texting on the phone and doing something else they are not supposed to be doing and like they don't see the person crossing..."

"Someone can like, do something to me... like violence to me"

Suburban children talk in interviews about why they can't play on the street or walk to school without supervision. The interviews formed part of the Kids in the City study led by Professor Karen Witten of the College of Health.

Where do the children play?

In Auckland, increasing numbers of children are living in the CBD: how can their needs best be met? This is the issue central to the Kids in the City study. The study, which published a summary of its results in April 2014, assessed the levels of physical activity and independent mobility of 253 inner-city and suburban children aged nine to 12 in Auckland and explored their experiences and perceptions. The good news is that despite the children spending an average of 6.8 hours per day sedentary (ranging from 6.3 to 7.8 hours per day), the vast majority (96 percent) accumulated a daily average of at least 60 minutes of moderate-to-vigorous physical activity every day – the minimum level recommended for optimal health. The bad news: many children relied on the supervision of adults for opportunities for outdoor play and movement. Parents or caretakers accompanied children on 59 percent of trips to and from school, 77 percent of shopping excursions and 92 percent of travel to organised sports. Witten advocates that any residential development make proper provision for communal indoor and outdoor spaces where children can play safely and independently. Ministry of Transport figures show that in the 20 years to 2012 the average time children spent on "active travel" such as walking and cycling fell from 130 to 72 minutes a week. The Kids in the City study was conducted by researchers from SHORE and Whāriki and the University of Auckland. It was funded by the Marsden Fund.

Professor of Nutritional Physiology Marlena Kruger of the Institute of Food, Nutrition and Human Health takes a bone scan of a patient.

Leading the challenge

New foods that address the Western world's growing public health problems – such as arthritis, heart disease, type 2 diabetes and Alzheimer's – are the goal of the High-Value Nutrition National Science Challenge, to which the Government has committed up to $180 million over 10 years.

The foods will be tailored to the needs of particular population segments, such as mothers, infants and older adults, and will generate export income, says Professor Marlena Kruger.

In particular, changing demographics have created a lucrative niche for foods that ameliorate or prevent age-related chronic conditions.

Kruger, an expert in bone and joint health, is Massey's representative on the challenge's cross-disciplinary science leadership team, which also includes Distinguished Professor Hardjinder Singh of Massey's Riddet Institute and representatives from the Universities of Auckland and Otago, AgResearch and Plant & Food Research. So far the team has identified five areas of health research: cognitive function, mobility, infant and maternal health, gut and immune, and metabolic health.

The research itself is expected to be broken into three stages: the laboratory development of foods with specific benefits; rigorous clinical testing; and finally, in close collaboration with the food industry, the development of prototype foods leading to commercial products.

One of the key benefits expected of the initiative will be the validation provided by clinical trials. From 2016 marketers will be legally permitted to claim particular health benefits for foods, provided they have sufficient evidence. These might be existing nutritional claims ('calcium reduces the risk of osteoporosis') or new, unique claims substantiated by a dossier of evidence that demonstrates a causal relationship between the food component and the health effect.

This is familiar territory for Kruger, who is closely involved in commercial work designing and running bone health clinical trials in Asia and Africa.

"We use biomarkers – measurable indicators in the blood or urine that point to a physiological condition – to tell us, for example, if bone is being broken down. As part of the challenge research covering the various health areas, we will need to develop new biomarkers to assess changes in health and wellbeing."

The High-Value Nutrition National Science Challenge is one of 10 National Science Challenges launched in 2013 to enable new cross-disciplinary teams to work on New Zealand's most complex and pressing issues.

All the right ingredients

food HQ New Zealand's Food Innovation Gateway

A conversation with Mark Ward, the Programme Director of Palmerston North-based FoodHQ, New Zealand's international centre for collaborative food research. New Zealand's goal is to increase annual food exports to $60 billion by 2025.

Can you tell us a bit about how Food HQ came into being and how you happened to become its head?

FoodHQ has been on the drawing board for some time, and recently its members decided it was time to create the start-up and implement their collaborative vision. They needed someone to set up the partnership formally in terms of a strategic plan, brand, launch, website, joint work streams and stakeholder relations. I was fortunate to be selected to lead that work together with close colleagues from across the 10 partner organisations. It is hard to see boundaries to what can be achieved when you bring together the very best food research and education organisations with international food/ food assurance businesses, visionary local government, and market-savvy commercialisers.

Is there anything like this overseas?

Yes, we have formidable competition overseas, in particular in the countries investing heavily in food and agriculture research, development and extension. We collaborate with many universities and research institutes in these countries, in particular with Wageningen UR in the Netherlands, where it established an analogous organisation some time ago called Food Valley.

How many collaborators does FoodHQ have so far?

In terms of individual scientist-to-scientist collaborations,we are currently mapping them in a project led by Brennon Wood. These interactions will number in the thousands, with the Riddet Institute alone having well over 700.

What are the challenges?

All active participants in the FoodHQ work streams have their busy day-jobs working for our individual organisations, and sometimes that has to take priority over a joint piece of work, but we always get there in the end. We have at least eight major initiatives on the boil now, the most recent being joint work on a FoodHQ-led proposal to establish a New Zealand Centre for Food Safety Science and Research. More than 20 research and technology leaders are involved in developing a joint bid to the Ministry of Business, Innovation and Employment. This activity is a sure sign that New Zealand works best when it works together on big opportunities and challenges. FoodHQ personifies this belief.

What do you think FoodHQ will look like in 2030?

I hope FoodHQ will exemplify all that is best about innovative, healthy, safe food, developed and produced in the most sustainable nation on Earth. It's only 2014 and we have already stepped up a gear in rising to big global opportunities; so I repeat, I see no boundaries to what we can achieve – together!

Food, fads and the power of flexibility

Every day we're bombarded with food fads and opinions, but Massey's **Professor Bernhard Breier** is among researchers making real advances in our understanding of how nutrition and lifestyle affect health. He talks to **Bevan Rapson**.

The noise around food has never been louder. From wall-to-wall cooking programmes on television to the promotion of supposed wonder diets on the internet, spin about products and sensational headlines about new theories in newspapers and magazines, it's a daily barrage of information.

For individuals with health and weight concerns, the promises of quick-fix solutions are especially seductive. Add societal concern about increasing obesity and rising health costs for the taxpayer, and the ready market for the hype is obvious.

Professor Bernhard Breier, the chair in human nutrition at Massey University's new College of Health at Albany,

understands very well the clamour around his specialist subject. "Everything to do with food is very trendy and very fashionable," he says. "It happens because we all eat, we are all experts, we all have opinions. What is important is to have an informed debate."

That means rigorous research, although new nutrition-related findings often won't be relevant to all population groups. "There are so many shades of grey," says Breier. "Some of the things portrayed by the media sound like, 'Eureka! We've found the holy grail of this or that'. It's not like that really."

Breier is internationally recognised for his work on metabolic health and the long-term consequences of maternal nutrition during pregnancy. Locally, he has been a principal investigator for the Gravida National Centre for Growth and Development (a government-funded Centre of Research Excellence) for more than 10 years. His career has been driven by his interest in how enhanced nutrition and other lifestyle factors can make for more productive and happier lives.

It's important work. The benefits go beyond the wellbeing of an individual, with economic studies proving the increased productivity of a healthier population. An intervention in childhood or even before birth can change an individual's health 'trajectory', leading to a greater chance of a higher income later in life.

When someone who is 'metabolically flexible' exercises in the morning while their blood sugar is low, they will burn energy stored as fat. Someone who has type 2 diabetes and is overweight will not access that energy efficiently.

The demand for 'answers' is high, but Breier is reluctant to recommend or warn against particular foods that won't affect everyone in the same way. And the 'hot' topic of obesity is one he'd rather discuss in other terms entirely. "Of course it is an important topic; a large number of people are affected," he says. Everybody talks about it, "because it is something you can see, we have ideas about it. But that's only the surface. What's really behind that is to do with metabolic health, or the ability to utilise energy".

While much of his work over the years might be described as obesity research, he prefers not to call it that, "because it's not about what we can see, it's about the functioning". People become obese for different reasons and experience different outcomes. Some pathways to obesity are genetic, others 'epigenetic', meaning that environmental influences, such as diet in early life, have changed how genes express themselves. Then a range of social and socio-economic factors comes into play. "So the concept of obesity from a health perspective is often not helpful in terms of the underlying ill health."

The different ways of becoming overweight or obese call for different solutions, but Breier identifies the underlying issue as one of metabolic 'flexibility', a topic that he and his Massey colleagues have studied and published on at length. "It is really defined as the ability to use and switch from one body fuel source to another, and the body's ability to alter its utilisation of stored energy."

When someone who is 'metabolically flexible' exercises in the morning while their blood sugar is low, they will burn energy stored as fat. Someone who has type 2 diabetes and is overweight will not access that energy efficiently. On eating, a 'metabolically inflexible' person cannot use sugar in the bloodstream efficiently and it is instead turned into fat.

"That's the vicious cycle," says Breier. "And why the concept of metabolic flexibility is so helpful."

Happily, there are ways to improve that metabolic performance, sometimes by increasing the consumption of protein or by adopting a 'low-GI' (glycaemic index) diet and eating more vegetables. Regular physical activity and cardiovascular fitness can be a huge help; increased muscle mass means that even when someone is sleeping they are burning more calories. "You can train yourself to be more metabolically flexible," Breier says. "The powerful thing about that approach is that the individual is in charge of their own destiny. It is a matter of having a concept that gives people something to work with rather than being helplessly caught by something that is called our 'obesogenic environment'."

Breier is also excited by novel Massey research into sweet-taste perception and its relation to food choices and eating behaviour that influence metabolic health. He points to emerging evidence that "taste perception is thought to be the strongest driver of food selection". Different people detect sugar at different thresholds and researchers are also looking at the relationship between 'hedonic preference' – the sugar concentration

people prefer – and metabolic health. The concept reaches back to the beginning of life, with evidence that babies may develop taste preferences even in the womb, where some are exposed to higher levels of sugar in mothers' amniotic fluid, a common finding in gestational diabetes.

Another important field of study is the role of nutrition and exercise in supporting cognitive function later in life. Maintaining metabolic flexibility has been proven to help slow the rate of cognitive decline in ageing. Breier: "If you go to a gym to lose bit of belly fat, that's one thing, but keeping your brain sharp? That's a big motivation." Similarly, a healthy diet, eating low-GI foods, more vegetables and omega-3 fatty acids, can contribute to maintaining brain function. "It's an area in which we have got a very strong interest," says Breier. "What are the active ingredients in plants and food that have positive effects on brain function?" Polyphenols, found in many fruits and vegetables as well as red wine and green tea, are one fertile area for study among scientists aiming to support cognitive function.

A diet rich in omega-3 – found in oily fish such as tuna and sardines and in marine algae – has been proven by just-completed research at Massey to improve how blood sugar is used in the body. Breier uses an engine analogy to describe the effects: "It's like using the right fuel and having a good tune-up".

Breier predicts that the next couple of decades will bring sharply increasing numbers of new food products with enhanced nutritional qualities. "Work is going on worldwide. That kind of research has got the potential to make a very big contribution to improving our health," he says. With Massey celebrating 50 years of work in food science, Breier acknowledges the unique partnerships that have developed between different disciplines within the university, with nutritionists and food engineers having the opportunity to devise foods for different needs. "We can use the knowledge of food engineering to generate food that is healthier and very acceptable to distinct population groups worldwide, and it doesn't need to be expensive." In an example to which any cereal-lover can relate to, he cites work on reducing the amount of sugar used in breakfast products to add crunch. Helpfully, "there are other ways of generating crunchiness".

Research such as that on sweetness sensation can feed into health, dietetic and food engineering projects, to everyone's benefit. "This is the multidisciplinary nature

of work in our college, which makes it so fascinating and so powerful," Breier says. "That's the beauty of Massey University. I can just walk next door and say 'What do you think about this?'."

Locally and more immediately, he's similarly enthusiastic about the College of Health's new involvement in a school-lunch programme in South Auckland, run by the Feed the Need charity. Not only are university experts able to offer nutritional analysis and advice, the programme also offers them the opportunity to educate children, teachers and parents, and to study outcomes. "This programme will bring not only food but also nutrition knowledge," he says. "The impact will be far bigger than just delivering food to school." At least one dietetics student will study the programme as their Masterate research project.

... babies may develop taste preferences even in the womb, where some are exposed to higher levels of sugar in a mother's amniotic fluid, a common finding in gestational diabetes.

"It's a very good example of what the essence of the College of Health is all about," says Breier. "Going into the community, having an impact, and engaging in such a way that disease is prevented and health enhanced."

The good oil

Catherine Masters talks to **Associate Professor Marie Wong**.

In Mediterranean Europe and the Levant the tradition of growing olives stretches back thousands of years. In New Zealand our industry is a few decades old. Even so, it is doing respectably well: in 2013 olive oil was worth $2.3 million in domestic sales and $400,000 in exports.

But the intricacies of producing olive oil in New Zealand's climate have not been well understood. So, wanting to know when to harvest to get the best yield and taste profile, New Zealand's growers turned to Associate Professor Marie Wong at Massey and Dr Allan Woolf at Plant and Food Research.

"Olives have been grown for thousands of years in Mediterranean countries and are harvested according to a changing colour gradient," explains Wong. "This method doesn't work for New Zealand's diverse growing regions because colour change is dependent on sunshine and climate – and some olives here don't change colour before they are harvested."

In a collaboration with Plant & Food Research, Wong and her colleagues tested cold-pressed oils from three olive varieties – Italy's 'Leccino' and 'Frantoio' and Greece's 'Koroneiki' – harvested at intervals during the picking season.

The results? Olives harvested early in the season produce a more peppery and pungent oil, with the flavour profile shifting towards more buttery, nutty, vanilla and toffee notes as the harvest date is delayed.

This puts a palette of flavours at the disposal of the growers. "They can harvest an early batch and a late batch if they want to and keep the flavours distinct or blend to give a balanced flavour," Wong explains.

Wong, whose work helped to establish the New Zealand avocado oil industry, advocates choosing freshly harvested New Zealand olive oils over their often more mature imported competitors.

When it comes to olive oil, freshness matters, she says. One reason for consuming olive oil is its association with various health benefits, such as protection against heart disease. As the oil ages – and imported oils may be upwards of a year old before they arrive on our shelves – many of the beneficial compounds, such as vitamin E and phenolics (antioxidants), are diminished.

Ripening prospects

The science of postharvest storage is allowing New Zealand to ship fresh fruit and vegetables worldwide, bringing in export revenue of $1 billion-plus from kiwifruit alone. And this may be just the beginning. **Malcolm Wood** talks to postharvest scientist **Professor Julian Heyes**.

In Tokyo a schoolgirl eats a kiwifruit from the Bay of Plenty as a lunch-time snack. In Seoul, crisp, sweet Nelson-grown Fuji apples are a family dessert treat. In a British pub lunch, a patron tucks into a steak and – Waikato-grown – onion pie. And none of them thinks anything more of it than any of us might when dicing bananas onto our muesli.

"We live in an age when we can access global food resources in a way that we never have before in history. Why should you reject that?" asks Professor Julian Heyes.

But he would say that. It is his discipline, postharvest storage, that makes this all possible and underpins the success of New Zealand's fresh fruit and vegetable export industry.

We are, after all, an agricultural nation a very, very long way from anywhere "and trucking is not an option".

By his estimation, New Zealand has a higher ratio of postharvest scientists than any other nation on Earth, "which isn't surprising".

Heyes began his academic career with a BSc (Hons) in botany from Victoria University of Wellington, graduating in 1979, then moved to Oxford to take up a Rhodes Scholarship, with his Doctoral research addressing boron deficiency in

"They said, 'Your New Zealand peonies are so unreliable. Some arrive half open; some arrive with a tight bud and take one to two weeks before they open.'"

roots. It was, he says, very subtle work, "plant physiology for the sake of plant physiology", and quite unlike his next career move. Moved by a desire to do good in the world, he and his wife headed to Zimbabwe, where he embarked on a "wild ride", serving an apprenticeship as a university lecturer and learning how to teach every aspect of plant physiology at every level. They were there for four formative years, before Heyes took that "real job" as a post-harvest technologist back in New Zealand at what was then the Levin Horticultural Research Centre.

Here some of the work was of Oxford-like abstraction – he and his colleagues showed how the curvature of an opening flower petal arose from cell mechanisms that led the inner face of the petal to grow more quickly than the outer – but he also soon found himself working with industry. "For me that was a big transition to say okay, what I do has to make sense to business people."

One of the first practical problems on which he worked was the case of the unreliable peonies. In New York, stems of peonies could fetch US$8 a stem, but the florists of New York were not happy, remembers Heyes. "They said, 'Your New Zealand peonies are so unreliable. Some arrive half open; some arrive with a tight bud and take one to two weeks to open.' "It's a nightmare. Can't you deliver all these peonies so that three days later they are fully open?'"

Heyes and his colleagues thought the problem "doable". "So we took a series of peony varieties, harvested them at a series of closed-bud through to open-bud stages, and put them through simulated

The tyranny of distance

New Zealand is a long way from anywhere.

Adapted from *Fresh Facts 2012*, published by New Zealand Institute for Plant & Food Research Ltd. See freshfacts.co.nz. Sea distances from sea-distances.org.

Export value 2011	
Kiwiberries	$1.5m
Tamarillo	$0.2m
Feijoa	$0.2m

Looking for the next kiwifruit

If the furry, brown-skinned, unprepossessing fruit we once knew as Chinese gooseberry can, when rebadged as kiwifruit and heavily marketed, achieve global stardom, can we perform the feat again?

There are candidates in the wings. Tamarillos, feijoas and – a recent arrival – kiwiberries, grow well here and are little known to the rest of the world.

Who knows what some industry scale and some well pitched marketing might do? But before all else comes the hurdle of storage. Tamarillos and feijoas store for about four weeks, kiwiberries for about six. To cater for seafreight to the Japanese market – allowing for loading, unloading, shipping, warehousing, distribution and unforeseen contingencies – four to six weeks are needed; for the European market, eight to twelve weeks.

Which fruit has the best prospects? In the short term, driven by supply, perhaps kiwiberries and tamarillos. In the wake of the damage caused by the PSA virus, many kiwifruit growers have diversified into kiwiberries to sustain cash flow, and the tamarillo crop is about to rebound as growers recover from the 2006 arrival of the North American psyllid insect pest.

But in the longer term, Professor Julian Heyes' nominee is that New Zealand home favourite, the luscious, fragrant – but highly perishable – feijoa. "Feijoas grow widely in New Zealand, and it's three or four years from planting to fruiting. We could have a big industry."

Once a day he visits the feijoa trays in his laboratory. Here various fruit varieties are stored to see when it is that the afflictions of age – mould, browning, softening – strike. (On the day I visit, the trays hold globular, glossy green fruit marred by medallion-shaped outcrops of mould.)

"The breeders tend to select for size and flavour and appearance, and we keep saying to them that unless you include storage life you are going to get a beautiful product that is only suited to New Zealand."

In recent times a series of PhD students has begun to address the problem of feijoa storage, and a Masterate student is using a reflectance spectrometer, the intention being to distinguish, using nearly imperceptible colour gradations, the keeping qualities of individual batches of fruit.

"We want to select a particular colour and say that, without cutting it open, a piece of fruit will give you four to six weeks of storage and still have four days of good-quality life at the end."

In Heyes' vision, New Zealand's feijoa industry will become far more postharvest oriented. We will grow feijoa varieties that have been selected for their keeping quality, sort the individual fruit according to their storage characteristics, and store and ship them in customised storage environments.

This would be a sea change in the industry. At the moment, New Zealand's growers are focused on the domestic market, generally picking the fruit when it is ready to eat. This is good for the consumer, but means a short shelf life.

"No other industry that is trying to get storage life picks at the ready-to-eat stage. They always compromise, go a little bit firmer and a little bit less mature, as you do for apples and tomatoes.

"If you pick a week early, and segregate the fruit by skin colour – they are all green, but we've got our lovely reflectance spectrometer that can measure colour to a very narrow band – you may be able to select just those fruit with the longest storage lives for export."

The other chicken-and-egg problem facing the industry is scale. The kiwifruit industry is successful because, after years of consolidation at every level, it is big enough to invest in marketing and research. "Zespri can afford to do beautiful, very detailed work. It's a billion-dollar industry."

How will the overseas consumer react to the six-week-old feijoa? There is only one way to find out, says Heyes.

"If you are selling into Singapore, where nobody knows what a feijoa tastes like, maybe they will be okay with something that is just a little less aromatic, a little less sweet. We won't know until we try." ■

Waste not

In New Zealand, postharvest storage means better products and greater returns. In the developing world, it transforms lives.

In green, fertile, sparsely populated New Zealand, it may not look like it, but the world faces a food crisis. According to the World Food Programme, as things stand, 842 million people in the world do not have enough to eat, and by mid-century the world will probably have another two billion mouths to feed. Factoring in the demand for protein-rich diets in newly prosperous nations, it has been estimated that crop production will need to double.

But there is another way of making more food available: reduce waste. Between 30 and 50 percent of all food that is grown globally is wasted, but the waste happens at different points along the supply chain depending on where you are.

In rich nations, such as New Zealand, a lot of food is left behind or thrown out because it is out of specification, says Heyes. A piece of fruit, for example, might be deemed too large, small, misshapen or blemished to sell and so be left unharvested or tossed out when it reaches the supermarket. Or, all too often, the consumer sends food to the landfill.

"People like to buy fruit and vegetables because they look pretty in the fruitbowl, and then they start to rot and they throw them away. They are very perishable ornaments for the home.

"In the developed world you just shake your head and say that's the way we live in this affluent world. That's people's choice."

In the developing world – although, bizarrely, says Heyes, that figure of 30 to 50 percent of food wasted is the same – the loss happens elsewhere. "The type of waste that happens in the developing world is true rot – it's picked but it never gets to a marketplace: it rots along the way."

Here Heyes and his colleagues could make a real difference. Since the early 1980s and his years teaching plant physiology in Zimbabwe, Heyes has been fascinated by the question of why some countries succeed while others fail. In 2004 he graduated with a Postgraduate Diploma in Development Studies, and over the years he has become more and more involved with international aid and development.

Over the decades, he says, most of the world's agricultural aid and development budget has been spent on ways that "help people grow stuff", while a paltry amount has been spent in addressing the questions about what happens afterwards. Where will it be sold? How will it get there? And will it fetch a competitive price?

Heyes is active in the international Postharvest Action lobby group (which helped to instigate the international Linking Farmers to Markets initiative), has been sought out by Volunteer Service Abroad (VSA) to help with science-based placements, and is a member of the Ministry of Foreign Affairs and Trade's (MFAT's) Agricultural Services Advisory Panel.

VSA first contacted Heyes in connection with the Vanuatu Agricultural Research and Training Centre, which Heyes went on to visit in 2013. "Three young Ni-Vanuatu staff were hired as young scientists in the 1990s, and they are now in charge of this research centre with 50 staff. One has an honours degree, one has a Masterate and the other has a PhD, and they are doing a great job, but what a responsibility.

"So I went for a couple of weeks last year, met the people, talked to the staff, looked at the opportunities in their very big research centre site, and recommended three different placements, which have now been advertised."

Recently Heyes learned that a proposal he and Massey soil chemist Chris Anderson put to MFAT for community development and agricultural aid in east Indonesia has had funding approved for a six-month scoping study.

If the conclusions are positive, the study, led by Anderson, could lead to a multi-year programme conducted with the University of Mataram in Lombok.

"We will be taking a long-term, hard-nosed, 'What's your opportunity?', 'What's your market niche?' approach," says Heyes. "And we'll be asking the right questions. Instead of saying what we think they should do, we'll be asking 'What do you aspire to do? What would be resonant with your culture?'."

Above: Professor Heyes during a visit to Vanuatu.

storage and transport at different temperatures and times."

Soon afterwards, stems of peonies, their opening times perfectly calibrated, were winging their way to the United States.

But air cargo space is limited and the sorts of boutique commodity with value-to-weight ratios that justify air travel are rare, says Heyes (who joined Massey in 2009). On occasion, he says, a New Zealand fruit grower might use personal contacts to despatch a few boxes of produce overseas to a spot market where they will fetch a few thousand dollars. "It works, but it is totally random."

This is one of the reasons for the worth of the cut flower industry hardly budging since the late 1980s, while the kiwifruit industry, which was then of equivalent worth, is now a behemoth worth $1 billion-plus in export receipts. Flowers fly; kiwifruit travel steerage.

Shipping by sea is also vastly more environmentally friendly; Heyes has done the sums.

"I provided a briefing paper to [Prime Minister] Helen Clark when she was facing criticism about food miles to Europe. We showed that the energy invested in shipping a kilogram of apples from New Zealand to Europe was roughly the same as the energy invested in the average British shopping trip of 6.2 kilometres from the home to the shops and back."

New Zealand's problem is the time it takes to get our products to market.

Even Japan, one of the closest of New Zealand's major markets, presents problems, says Heyes. "Getting to Japan may take as little as 12 days on the water. But you have to load and unload a container and get it through a supply chain. That's four to six weeks if you include loading, unloading, shipping, warehousing and distribution. Anything less than that and you are going to lose a proportion of your crop, because inevitably there will be hold-ups in the chain. If you are going to Europe you have six weeks on a ship if it travels direct. But there is a big risk of trans-shipment somewhere in Asia, so you need at least eight or 10 weeks of storage life.."

For some exports this hardly matters. Onions can travel as unrefrigerated deck cargo all the way to Europe. "As they travel through the tropics they might lose a bit of quality in the heat, but when they get to the other end they are still okay."

Fresh fruit are another matter.

Blame evolution, says Heyes. Fruit evolved as a way for plants to distribute their seeds

Persimmons are placed in a vacuum chamber to investigate induction of disease resistance through the application of a mild hypobaric stress. In 2011 persimmons were worth $7 million in annual export value to New Zealand. They can be stored for three or four months.

The surface characteristics of a persimmon are measured using a reflectance spectrometer.

– complete with a package of fertiliser – via the droppings of the animals attracted to consume them at peak ripeness.

"There is a precise stage of ripening when the fruit is aromatic, it has a lovely texture, a good sweetness, and that is the stage at which I can guarantee that if you cut it open the seeds will have turned mature. It's biology; it knows what it is doing."

And that ripening process is part of an ageing continuum leading through to senescence: the loss of texture, browning and, eventually, rot.

Fortunately, there are strategies the exporter can adopt. So-called climacteric fruit – such as kiwifruit and tomatoes – can be picked at the point were they are short of being quite ripe and will continue to ripen while in storage. (Non-climacteric fruit such as lemons will only lose condition from the moment they are picked.) And while the metabolic cost of time cannot be stopped, it can be slowed.

Heyes lists some postharvest storage methods that can be used separately or in combination. The fruit can be chilled; it can be held in a controlled atmosphere with regulated amounts of oxygen and carbon dioxide and, to prevent water loss, a high relative humidity (which is why he recommends that you keep fruit and vegetables in your fridge in perforated plastic bags); absorbent materials can be used to remove the volatile plant hormone ethylene (released by the fruit to hasten and synchronise ripening) from the atmosphere; or ethylene can be released in controlled amounts to ripen the fruit as it nears the marketplace.

Different fruit suit different regimes, says Heyes. Consider kiwifruit. Green kiwifruit are best stored at close to zero degrees Celsius; the gold varieties are best stored at 2° C.

Kiwifruit are extraordinarily sensitive to ethylene, responding to concentrations of parts per trillion, says Heyes.

"We are collaborating in the development of sensor systems that detect 'hotspots' of elevated ethylene at locations within pallets in a cool store or ship's hold, and that may be a signal of localised rot development or over-ripening. This would allow much more targeted repacking, where only a few pallets need to be broken down and checked for condition during long-term storage."

This level of detailed understanding is typical of the kiwifruit industry, which understands its markets and the mechanics of postharvest storage in a way smaller exporters can only envy.

The Japanese consumer, who is willing to pay premium prices for kiwifruit, likes 'high flavour' says Heyes. "That's the terminology they use, and that means we have to pick high dry matter at harvest." High dry matter equates to a higher load of sugars and starches that will be converted to sugars as the fruit ripens.

So Zespri rewards growers for delivering high dry matter fruit. "And the growers will girdle their crop, do crop load adjustments by picking off excess flowers, and pluck leaves to try to get more light in, all with the goal of high dry matter."

The European market is different. "They want fruit to be ready to eat when they pick it up from the supermarket. They don't get the idea that you can stick a hard brown kiwifruit in a bag with a banana, or whatever. So Zespri said, okay, we can do that. So now they manage storage systems for kiwifruit so that even the earliest-season fruit is ready to eat on arrival in Europe."

Even so, further advances are possible. As part of a Ministry for Primary Industries Primary Growth Partnership, Heyes and his immediate office neighbour, Dr Andrew East, are working on how to assess non-destructively the keeping qualities of individual fruit. For despite

A persimmon is placed in a texture analyser. Various methods can be used to assess the texture of fruit, each with its own merits.

the industry's sophistication, some things remain mysterious.

"You can have two adjacent farmers with their kiwifruit blocks separated by a hedge, and the fruit from one block will store until July and the fruit from the other will store until November," says Heyes.

Although the fruit may look identical, clearly they are not. If a non-destructive way can be found to distinguish when a batch of fruit is likely to fail, this will open up the industry to the application of inventory management, which in the fresh product sector, says Heyes, is something extremely rare.

"With fresh products, we generally say these are perishable products, first in, first out. The oldest crop gets sold."

But the oldest crop may not be the first to expire. From the point of view of avoiding having to throw out stock, the best strategy, says Heyes, would be some variation of FEFO (First to Expire, First Out). "FEFO inventory management for kiwifruit based on non-destructive testing, that's the big goal."

Using a combination of destructive and non-destructive methods, one of Heyes' and East's PhD students has been able to predict the order – but not the exact time – in which batches of kiwifruit will fail, and more postdoctoral researchers and PhD students are tackling the problem.

"We have some cool non-destructive technologies," says Heyes. One technology, optical coherence tomography, uses the scattering of laser light to measure cell qualities at the fruit surface. Another, fringe detection, which employs slivers of light to measure surface relief, is based on software developed to measure skin wrinkles for the cosmetics industry.

The software is used to reconstruct curved surfaces as flat planes. "So the software takes a round kiwifruit and zuuu...p, here's a flat kiwifruit, and now we can measure the pore size and the spacing or minute surface defects, and if there is something in there that correlates with storage time we will be away laughing."

The final element in Heyes' research is the health benefits of the food and how they are affected by storage. The greater the benefits, the better for both consumer and supplier.

"Consumers buy products based on appearance, and repurchase based on taste, but in their minds they think they are buying nutritional quality as well, they have that association."

At Massey, recent studies have looked at how kiwifruit consumption might promote bone health and how blueberries might be good for muscle recovery.

"We are working with experts in nutrition and physiology to identify bioactive compounds that address particular conditions at particular stages," says Heyes. "It is very careful, very meticulous work, and it's a breath of fresh air for me.

"It's not just saying, this is still a saleable, product, it's saying this is a saleable product that will benefit your health.

"Down the way it will become essential for us to be able to say that New Zealand products don't just look and taste good, they are good for you."

"It's not just saying this is still a saleable, product, it's saying this is a saleable product that will benefit your health."

Boxing clever

Professor John Bronlund and **Dr Andrew East** are setting out to reinvent the cardboard carton. They talk to **Malcolm Wood**.

If you lose 3 percent of the weight of your fruit, you lose 3 percent of your sale price

What is New Zealand's largest export product? Is it milk powder? Wine? Kiwifruit? Ask Professor John Bronlund of the School of Engineering and Advanced Technology and he may offer you a contender you haven't thought of: cardboard. Be it apples, kiwifruit, meat, cheese, butter or wine, most of the goods on which New Zealand's export income depends travel in cardboard boxes, many millions of them.

These 'C-flute corrugated paperboard cartons' have been around for a while. Corrugated paper 'cardboard' is a product of the 1850s, the pre-creased-and-cut carton was devised in the 1870s, and from about 1910, corrugated paperboard cartons began to replace wooden crates and boxes.

The design of the early cardboard boxes would have been by guess and by God, says Bronlund. Manufacturers learned as they went along, making incremental improvements. The cardboard box of today is the product of descent with modification.

Is the design of current boxes optimal? These days there is a body of science to back up experience. Fed variables such as the height and circumference of a box and the thickness of the cardboard, the McKee formula devised in 1963 can be used to estimate the compression strength of a box, and from time to time, says Bronlund, a PhD student might choose some particular design of box for their research topic.

"Generally what they get after three years is a fairly complex model that tells them how that one box design performs. Maybe the model will tell them how to tweak the design slightly, or tell them why it fails or behaves the way it does. But no-one ever asks how you would approach things if you could start afresh. Everything is just a slight modification of what's already there. It could be that evolution is the ultimate way of getting a great solution, but no-one really knows." Bronlund and Senior Post-harvest Scientist Andrew East are setting out to change all that.

Funded by a $5.1 million Ministry of Business, Innovation and Employment grant and working in close partnership with industry, the two are developing computer-based modelling tools to assist in the design of 'better packaging solutions'. Set the properties of the product to be carried, be it fruit, meat or cheese, and the tools will optimise a box design to fit the purpose.

How hard can designing that perfect cardboard box be? Harder than you might think. Consider the export apple industry, a product that earned New Zealand $340 million in 2012, in part because New Zealand apples command a reputational premium.

The apples inside the cardboard box, sitting on what are known in the trade, as 'Friday trays' are still very much alive. They are taking up oxygen, converting sugars and starches to water, carbon dioxide and heat. They are transpiring water – water that cannot be replaced – into the surrounding atmosphere.

Once the apple has been picked, says East, the first thing to do is chill the fruit, slowing its metabolism, enabling storage for long periods and transport to export markets. Cooling can be done after the fruit has been packed, in which case the packaging needs to promote the dissipation of heat.

At the same time, the exporter wants packaging that will help the apple to retain its moisture content. "Losing moisture leads to the fruit shrivelling and it cuts the yield as well. If you lose 3 percent of the weight of your fruit, you lose 3 percent of your sale revenue," says East.

Ideally, the conditions at the centre of a pallet of apples should be the same as those at the outer edges, otherwise there is a risk of delivering a pallet of product of mixed quality.

Then there is the matter of how to fit as much fruit as possible into a shipping container or ship's hold. The more the fruit, the lower the costs, the greater the profit.

There is the matter of structural strength. The box at the bottom of a pallet has to support its own contents and the weight of the entire pallet above it.

To complicate matters, most cartons are now required to double as retail-ready packaging – packaging perforated and printed in such a way that it can be turned into an attractive retail display with no need for the fruit to be handled again.

Finally there is the question of balancing the performance of the packaging against its cost.

Bronlund and East's modelling tools will allow hundreds of designs be tested and appraised, the process taking days rather than, as at present, years. They will identify optimal designs.

A formal alliance with the packaging industry will then let them put together short runs of the proposed packaging to see if the boxes perform as predicted.

Does a cardboard box even have to be box-like in aspect? For some applications, says Bronlund, asymmetrical packaging may make sense, promoting airflow between the cartons.

Such is the scale of the packaging industry that comparatively tiny innovations could lead to major cost savings, and Bronlund foresees a potential profit stream from the export of intellectual property.

Not to mention that other, less tangible benefit, that someone, somewhere – perhaps in Europe, Japan or China – is enjoying the best of New Zealand produce. A tender cut of meat. A juicy kiwifruit. A sweet, crisp apple.

Tank commander

Sarah Wilcox takes a trip to the Roof Water Research Centre to talk to senior lecturer **Stan Abbott**.

Stan Abbott is distracted. "Do you know what's happening?" the ardent sports fan asks, waving his arms. "New Zealand is playing India at cricket, and doing quite well." From the roof of the four-storey Block 4, beyond the line-up of tanks, tiny white figures can be seen at play on the green of the Basin Reserve.

But it is the 1000-litre tanks – the hub of the Roof Water Research Centre – that we are here for. Each is set up to collect Massey's rainwater using a different system. "This one has a floating exit valve to take water from the top of the tank and this one has a calmed inlet pipe to stop any sediment at the bottom being disturbed as rainwater enters the tank," explains Abbott as we make our way along the line.

"All these tanks are fed simultaneously by the same roof water, but they are trialling different filters, diverters and tank entry and exit systems for product manufacturers and the Ministry of Health. That way we can see how well they work compared with each other."

Around 10 percent of New Zealanders rely on roof water. They live on farms, lifestyle blocks and islands and in a host of other slightly out-of-the-way places.

Most of them swear by the quality of the water from their taps. But roof water, says Abbott, is very easily contaminated. Bird, possum and rodent droppings, soil and leaf litter; many things other than water are deposited on roofs and in gutters.

"People have this idea that rainwater is always pure and safe to drink, even when it's not."

A 1997 study found that consumers of roof-collected rainwater were three times more likely than people on mains water to contract campylobacteriosis – a severe form of diarrhoea – and a five-year national study conducted by Abbott was just as disquieting. Of the 560 samples he collected from kitchen taps fed by tank water, more than half failed to meet acceptable standards and 40 percent-plus had faecal contamination.

"Lots of people say they never get sick, but they do, it's just not reported or they've been drinking it for so long that they've become immune to the pathogens."

Some of these represent serious health risks, particularly for anyone whose health is otherwise compromised. Campylobacteriosis symptoms include fever, headache, abdominal pain and bloody, watery bowel movements. *Giardia,* another pathogen that crops up in contaminated roof water (and to which children are particularly susceptible) brings on sulphurous burps, explosive diarrhoea, stomach cramps and nausea. Both are highly transmissible.

Abbott and his students do their best to overwhelm the systems they are testing. "We want the birds to come and poop here, so we attract them with seeds and bread. From time to time we put known amounts of bacteria onto the roof as well."

Then, when it rains, Abbott tracks changes in temperature, pH, salinity, dissolved oxygen and turbidity via sensors in the tanks. He also has a sophisticated weather station on the roof.

"I can check all the water quality parameters and data from the weather station on my office computer. If it rains suddenly, I can see if, say, the turbidity has gone up in some tanks but not others, and therefore which systems are performing best and collecting the cleanest water."

A surge of distant cheering stops Abbott mid-sentence. Over at the Basin Reserve the crowd are on their feet and a cricketer waves a bat above his head. Brendon McCullum has just clocked up 300 runs and made New Zealand sporting history.

Abbott is jubilant. "He's done it! What a moment – and we were here. Isn't that great?" ■

Left: Stan Abbott alongside the tanks of the Roof Water Research Centre. The centre dates back to 2005 when it was set up using seed funding from the Ministry of Health. Its main purpose is to investigate cost-effective physical and chemical methods to protect roof water from contamination.

Environmental monitoring students prepare water samples for testing.

A 97-well tray filled with a roof water sample and test reagent after incubation. Forty-seven large wells and 24 small wells fluoresce under UV light and result in an *Escherichia coli* count of 270 organisms per 100 millilitres.

Retaining water

Cities are thirsty. The Te Marua treatment plant at the southern end of the Tararua Range treats 60 million litres of water every day, most of it destined for the residents of Wellington city. What would happen if the capital's water supply were disrupted?

When the 6.3-magnitude earthquake of February 2011 struck Christchurch it caused chaos, damaging seven of the eight water reservoirs and water pipes city wide. In the days following, hundreds of people queued for up to five hours for water brought in by milk tankers, and although more than 80 percent of the supply was restored in two weeks, tap water had to be boiled until April.

And that was in flat, easily accessed Christchurch, not Wellington, where the bulk water main crosses a major fault six times, and the main road in and out of the city runs along a fault line.

It is estimated that in a magnitude 7.6 earthquake it would take 65-90 days to restore water to Wellington. Hence 60 25,000-litre emergency tanks have been installed by Porirua and Wellington City Councils at schools, marae, churches, community halls and fire stations. Kept sealed until an emergency, the tanks would provide water for fire fighting or – after treatment – for drinking. Even so, 1.5 million litres of water would not go far among the 250,000 or so people living in Wellington city and Porirua.

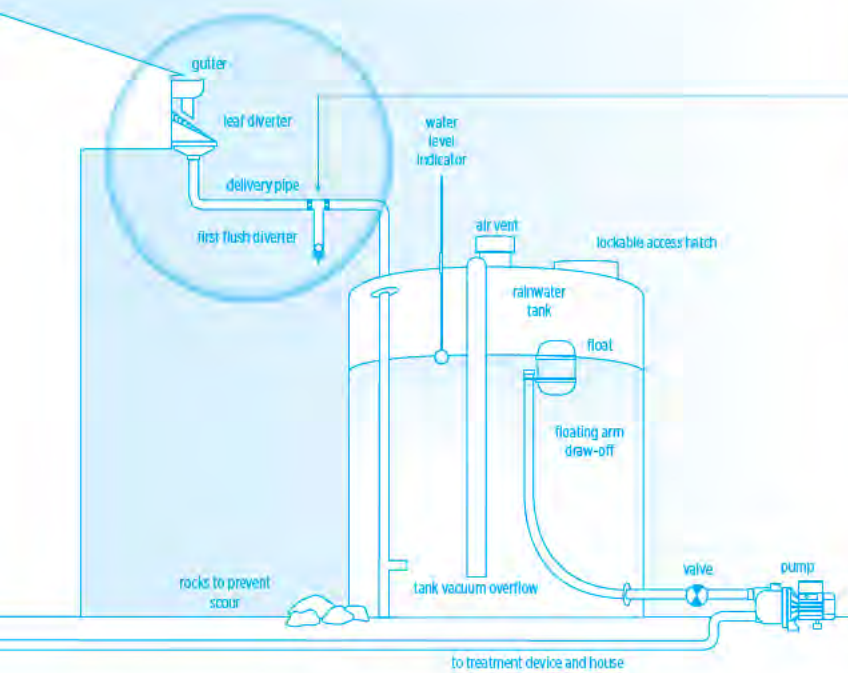
Public campaigns have urged residents to put aside a store of nine litres of water per person as a three-day supply – a bare minimum as Abbott points out.

"It may be enough for your drinking water, but you would need much more for washing, cooking and general hygiene."

Better by far would be to have widely distributed roof water supplies as a back-up. So the Wellington Region Emergency Management Office has partnered with a tank supplier to offer 200-litre rainwater barrels for $105 – half their normal retail cost. The tanks collect roof water until full and the excess flows into the stormwater drain as normal.

"Everyone should be putting in a rainwater tank – even just a small barrel," says Abbott. "After the Wellington earthquake in July 2013, most of the supermarkets sold out of bottled water as people ran to buy it! We don't want that to happen after a serious earthquake. With your own barrel, you don't have to worry about having enough."

Roof water can also relieve the pressure on water supplies more generally, reducing or delaying the need to build new reservoirs.



If there is a piece of kit that Abbott particularly loves, it is the first-flush diverter. This simple device sends the first few millimetres of rain to waste (and the road dirt, bird faeces or rotten vegetation that is flushed off the roof with it), and collects the rest of the rain in the tank.

"Everyone with a rainwater tank should have one, it's so effective. Simple methods like this, as well as regular maintenance – installing gutter mesh to keep leaves out and trimming branches that overhang the roof – really improve the quality of roof water and reduce gastrointestinal disease."

By law, when roof water supplies more than 25 people for at least 60 days a year, it has to be certified and tested for compliance by the Ministry of Health. For small individual house supplies, it is up to homeowners and landlords to make sure the water is safe to drink.

Senior Lecturer in Microbiology and Communicable Diseases at the Institute of Food, Nutrition and Human Health, Stan Abbott takes a special interest in the environmental microbiology of drinking and recreational water. He is recognised internationally as an expert in many aspects of rainwater harvesting.

In Kāpiti, Waitakere, North Shore and Rodney districts, householders are offered rates rebates to install rainwater tanks. These can be drawn on for the activities that account for an estimated 65 percent of domestic water use: running washing machines, flushing toilets, filling swimming pools, watering gardens and washing cars. (For public health reasons, the use of roof water for drinking is usually prohibited where mains water is available.)

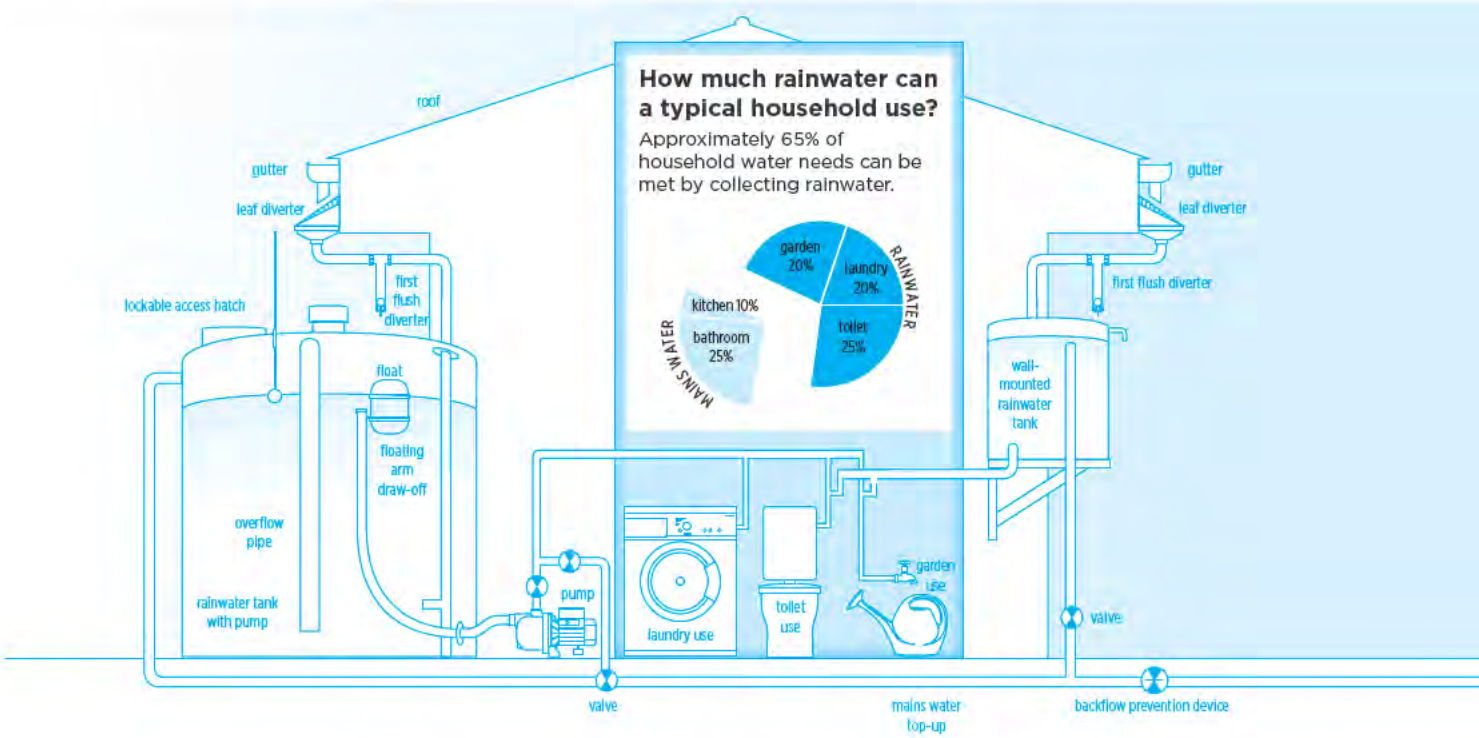
Commercial buildings such as supermarkets, warehouses and factories have even larger surface areas that are ideal for collecting water.

"At Eden Park, roof water is used to flush the toilets during a game. That's a massive 60,000 litres when the ground is at capacity, which doesn't have to come out of the town supply."

Conservation House in Wellington, Landcare Research in Auckland, Meridian Energy in Wellington and the Waikato Mail Centre also use roof water systems for part of their water supply.

"We are working with BRANZ to develop standards so that every new large building is required to use its roof water. In New Zealand we don't respect water. It falls from the sky but we don't care – it's a precious resource going down the drain." ■

One of the places people are likely to be exposed to untested and untreated roof water is in one of the Department of Conservation's 970 backcountry tramping huts. Abbott sees this as an anomaly. "If tramping huts weren't so hard to get to, their water supplies would have to be tested to check that they comply with the Ministry of Health's drinking water standards [because of the number of people who use the water]." Instead, users are warned to boil or otherwise treat the tank water should they have concerns about its quality, and to alert Department of Conservation staff to any contamination. "People are probably going tramping and getting infected without realising it. If the incubation period for a gastro bug is two weeks, they are likely to be back home before getting sick and think they've got food poisoning from a takeaway, when it was actually the hut water supply."



"an extremely attractive by-product"

Malcolm Wood talks to the movers and shakers of the **Massey microbrewery community**.

Life as we know it started with beer. It is a plausible assertion, says Professor Richard Archer. When civilisation began in the Middle East's fertile crescent, with the settled farming enabled by grain-based agriculture, the principal grain was probably barley, and barley would have inevitably led to brewing. Or it may have been, in fact – as several authorities have contended – that it was the very wish to brew beer that persuaded prehistoric man to settle and farm. Either way, beer (probably more of a porridgy concoction than a sparkling lager) was there from the beginning.

A home brewer himself – his favoured beers are dark, heavy, as malty as possible and home-brewer tolerant – Archer, who heads the Institute of Food, Nutrition and Human Health, likes this idea.

However, having a taste for beer and an appreciation for ancient history is not why Archer initiated building a microbrewery on Massey's Manawatū campus. The microbrewery is a teaching tool: a small but perfectly formed food processing plant, "with an extremely attractive by-product". "It has everything you might want to teach process engineering," says Archer, "pipes, valves, heat exchangers, steam-heated vessels, a computerised control and logging system and a complex set of variables that you can manipulate as you like."

The microbrewery is very micro – each of its 10 fermentation tanks holds just 200 litres of beer, whereas small craft breweries seldom brew less than 1000 litres at a time – and very functionalist. This is an unashamed piece of industrial plant. Little in the way of polished wood. No gleaming copper. Just well engineered, gleaming stainless steel tucked away in the corner of a concrete-floored laboratory.

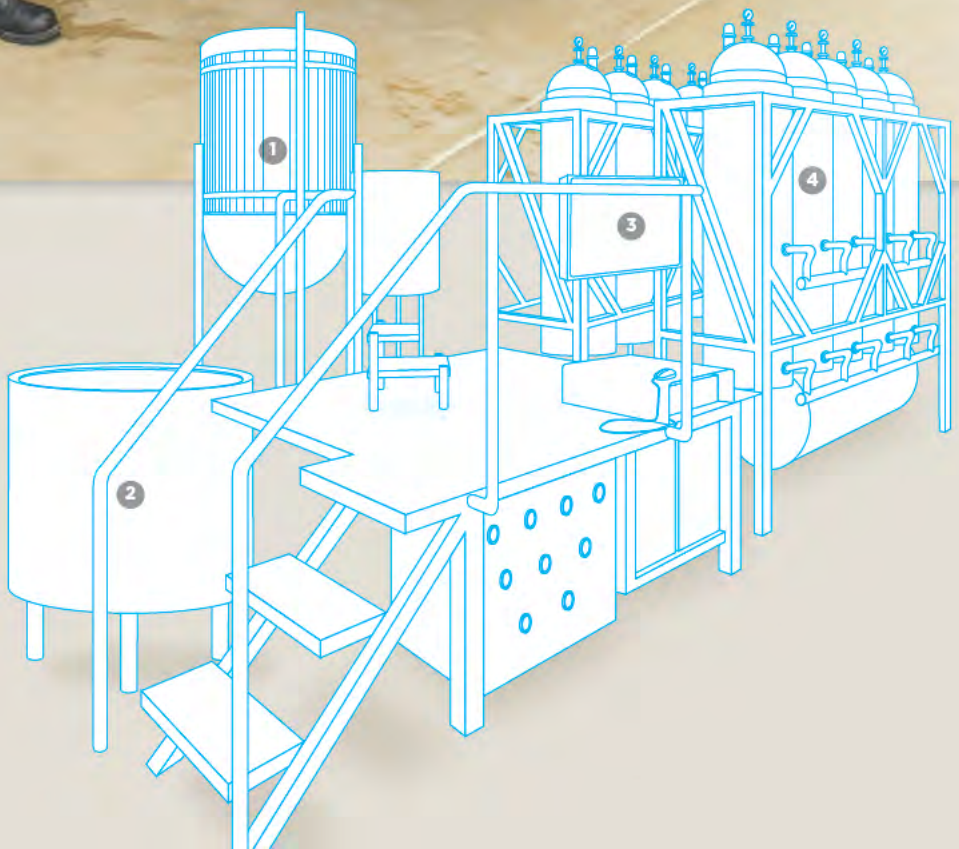
Much of the brewery, says Senior Lecturer Richard Love, was designed and built by engineering students on

"It has everything you might want to teach process engineering..."

Professor Richard Archer

"Most of the people who go in to engineering are there because they like to do things, they like to solve problems. They want this sort of real-world experience."

Tony Paterson, Professor of Bioprocess Engineering



Above: Chris Van Tiel, David Brown, Cameron Jamieson, Eruera Tait-Jamieson, Richard Love, Allan Hardacre, Michelle Tamehana, Michael Ryder, Camilla Riddiford.

Left: 1. The wooden-jacketed, steam-heated mash tun is also used as the microbrewery's 'kettle' or 'copper. 2. The lautering tun is also used as a whirlpool to separate out solids. 3. The workings of the microbrewery are controlled from a central computer console. 4. Each of the 10 tanks holds 200 litres. Out of view beneath the tanks is a water-and-glycol-cooled heat exchanger.

Taste test

For student Cameron Jamieson, the moment of truth was a first-year laboratory session in the microbrewery.

"I spent the day here from 8am to 5pm and after that I was hooked. Three and a bit years later and I am still here." Jamieson, who went on to become a stalwart of the Massey University Brewing Society, is shortly to take on an internship with Tui Brewery.

For student David Brown, it was a pilsener from Rotorua's Croucher Breweries. He began brewing beer at home during his final year at school – "I am not sure why," he says – and that first mouthful of beer was such an eye-opener that he felt compelled to write a mash note to its makers.

In answer Croucher invited him to Rotorua to participate in laying down a brew and he has since worked his summers there. Four years later – despite finding that good brewing is reliant on a regime of never-ending cleaning – the idea of setting up his own brewery, if not top of mind, is still lurking. "The costs are quite high and the market is, well, not saturated but quite crowded. I am sort of thinking of working for 10 years, getting a bit of money, and then re-evaluating."

Both in their 20s, Jamieson and Brown come of age in a fortunate time. Craft beer makers and craft beer drinkers have never had it so good. A creative renaissance is underway. As proof of this Michelle Tamehana – who helps to supervise the microbrewery and is a beer aficionado herself – brings forth some New Zealand beers to be tasted and several treasures to be admired.

The treasures – 'extreme beers' – are the products of Boston's Samuel Adams Brewery, one of the pioneer breweries that helped to define the modern craft brewing movement. One, a mid-1990s' Triple Bock in a tiny, wax-sealed, cobalt-blue bottle, is a collector's item. The others are Utopias, 10-year-old 20-something-percent alcohol beers more redolent of sherry or cognac than anything sparkling served from a tap, and with prices to match. A Utopias beer, in its copper brew kettle bottle, retails for hundreds of dollars and will fetch still more on the collectors' market.

Among the beers to be tasted are an Oh Lordy pale ale from Funk Estate; a Pot Kettle Black, an international award-winning malty black beer from Yeastie Boys; a Hopwired India Pale Ale (IPA) made with New Zealand hops from Blenheim's 8 Wired, and a Citra, a double IPA produced by Auckland's Liberty Brewing using American hops of the same name. There is even a Grand Cru, also from 8 Wired, a sour beer (fermented with Brettanomyces yeasts and Pediococcus bacteria, both normally to be avoided at all costs) aged in Pinot Noir barrels. The Oh Lordy pale ale by Funk Estate features a suitably psychedelic label – the craft beer industry has a nicely self-mocking hipster sense of humour.

What does the panel think? No-one wants to lapse into winespeak. There is joking talk of a 'yum-yuck scale', but one man's yuck is another man's yum. Jamieson likes Nelson's Sauvin hops, whereas Brown employs terms like kerosene and burnt rubber, "though some people only get fruit". The Grand Cru, though it draws one or two admiring gasps at first sip, is agreed to be best consumed in small quantities. The Citra is praised, though the to-and-fro consensus is that this is a beer better consumed fresh and on tap, while that heady taste of fresh hops is still vibrant.

From top of page: An impromptu tasting panel with, from left, fourth-year student Cameron Jamieson, microbrewery manager Michelle Tamehana, fourth-year student David Brown, and Professor of Bioprocess Engineering Tony Paterson. A NZ$200-plus Samuel Adams Utopias beer. An assortment of New Zealand craft beers. The Massey University Brewing Society Facebook page.

summer employment. Robert Stone Stainless of Hawera manufactured the domed brewing vessels at near cost. The list of credits that led to the brewery opening in 2008 and to its ongoing upgrading and refurbishment is a long one.

In recent times, a number of Massey's degrees have been reorganised to be much more project based, an approach that turns the usual paradigm of talk and chalk followed by laboratory demonstration on its head and dovetails nicely with the microbrewery.

Professor of Bioprocess Engineering Tony Paterson, who helped pioneer the shift to project-based learning, says the approach leads to highly engaged students. "Most of the people who go in to engineering and food technology are there because they like to do things, they like to solve problems. They want this sort of real-world experience."

Hence, in the course of laying down a batch of beer as a class project, the students will conduct practical exercises, such as calculating mass and energy balances or measuring the specific gravity of the wort – the unfermented liquid extracted from the mash –and using it to work out the potential alcohol content of the beer.

Love's consumer verdict on the beers that result: "They are usually quite drinkable. Some of them are a bit *strange*, but they are drinkable".

Other brews are laid down by student organisations: Techensoc (the technology and engineering student society) puts down brews in anticipation of events; the College of Creative Arts has created branded runs for its end-of-year student exhibition.

Sometimes a craft brewery will visit the microbrewery to experiment with a new idea (the microbrewery is available for hire) or even to turn out a tiny batch of boutique beer for sale.

An annual highlight is the five-day intensive short course held every November, featuring a guest lecturer from the University of Ballarat. "We have people who are already in the brewing industry and people who have mad ideas about creating their own breweries," says Love.

Richard Archer is pleased that the microbrewery has proven itself as a teaching tool – and that, in some small way, it is contributing to a cultural shift.

As a baby boomer, he remembers the days when the brewing business was a duopoly, dominated by Lion Breweries and Dominion Breweries, and the local beer was generally bland and characterless, intended to be consumed at speed and in quantity.

These days, although Lion and DB breweries (owned by Japanese firm Kirin and Singapore-based Asia Pacific Breweries respectively) still dominate the market, they do not have the field to themselves, and there are beers to suit every taste.

A 2012 Brewers Guild of New Zealand survey found that the number of breweries had increased from 48 in 2008 to 68 by the end of 2011, with most of the increase coming from craft breweries producing less than 40,000 litres. According to Statistics New Zealand, in 2012 sales of craft beer climbed by 20 million litres even as total beer production fell by 20 million litres. We are drinking less, but with greater discrimination.

Richard Love compares the state of the New Zealand boutique brewing industry to that of the wine industry in earlier decades: the best has yet to come. ■

Massey University will hold its fifth short course in brewing at the Manawatū (Palmerston North) campus in November 2014. The live-in course will be run by the University of Ballarat's Dr Peter Aldred and staff from Massey's Institute of Food, Nutrition and Human Health.

For more information go to **definingnz.com/brewingcourse**

Four craft beers to sample

Recommending any individual beer is a risky business, and Michelle Tamehana tries not to. "You should choose the beer to match the season or the occasion or the meal it is going accompany," she says. That said, here are a few panel favourites.

Michelle Tamehana

Three Boys Oyster Stout

"A strong roasted malt base with notes of chocolate and coffee."

David Brown

Croucher Pilsener

"It's the one that opened my eyes to it all."

Epic Pale Ale

"A go-to for any craft beer drinker, it's superb."

Cameron Jamieson

Hopwired by 8 Wired

"Sweet up front with a hoppy finish. Like most IPAs, a good match for a spicy Thai or Indian curry."

Reading the entrails

Malcolm Wood talks to **Professor Roger Lentle** who heads Massey's delicately named digesta group.

A version of this article ran in Massey Research *in 2008.*

Professor Roger Lentle has been described to me as Massey's David Bellamy, and it's true, there are similarities. Both are born communicators and the accents – bar Bellamy's tendency to swallow his 'r's – are much the same.

But unlike Bellamy's botany, Lentle's speciality is not a subject made for media. His interest is in the processes of digestion and the physical qualities of what passes through the digestive tract. He is an expert in 'digesta'.

If you think about your digestion in terms of the science you learned in school, it is probably in biochemical terms: the enzymes in saliva that break down starches, the mix of hydrochloric acid and the enzyme pepsin in the stomach, the bile and pancreatic juices in the small intestine. The chemistry that transforms the toast and jam you had for breakfast into the stuff of energy and body maintenance is wondrous, but there are other ways of framing the process.

Consider the mechanical and physical problems. Somehow your well chewed toast and cup-of-tea chaser must be shifted from mouth to oesophagus to stomach and then through the 10 metres of convoluted tubing that is first the small and then the large intestine, until you feel the call of nature and flush away something that is neither tea- nor toast-like in nature.

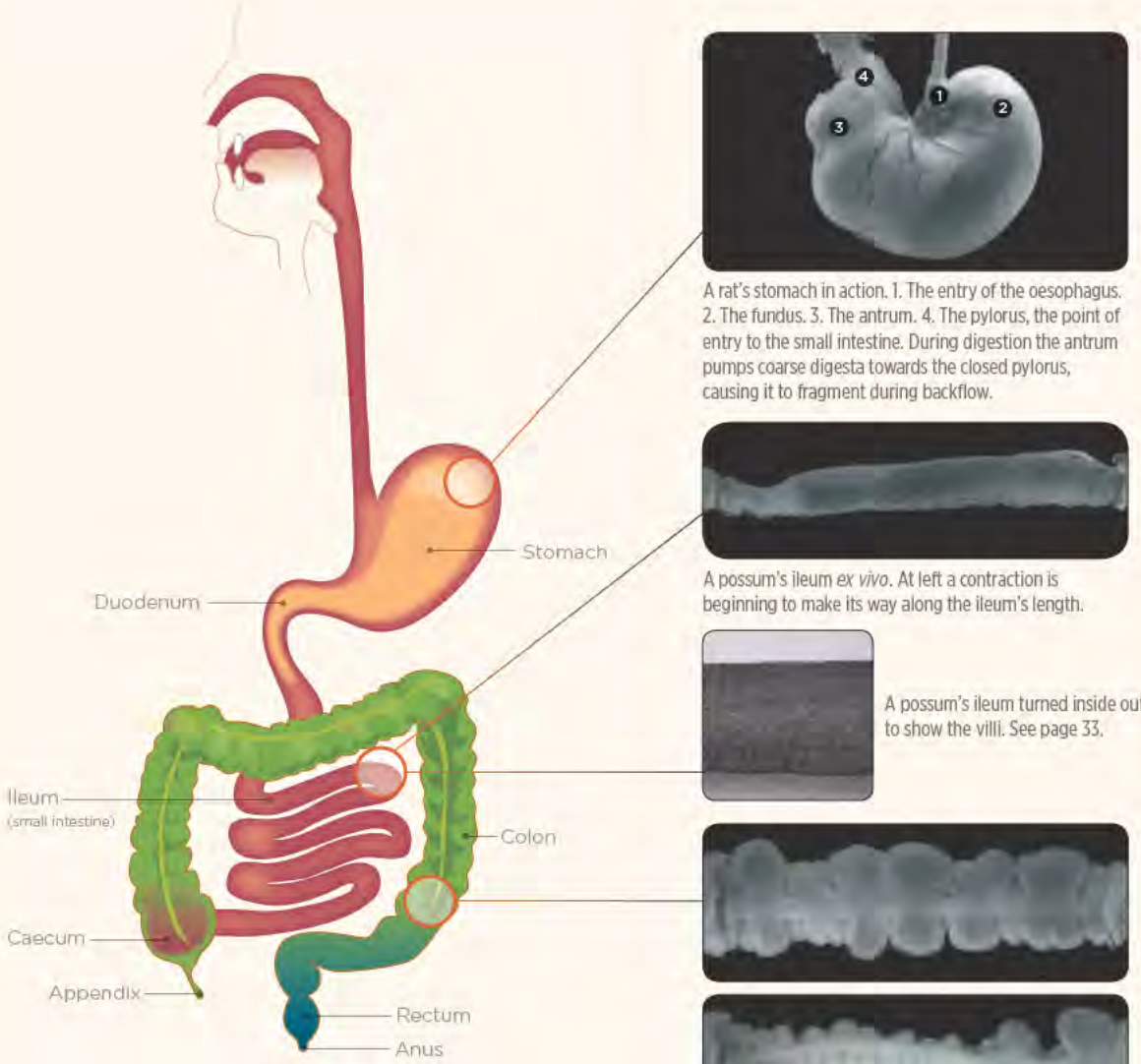
And that is not all, for along the course of this transmutation the digesta has to have been mixed in such a way that nutrients are transferred to the wall of the intestine and into your being, at the least energetic cost.

Why Lentle's interest in digesta? It is not something that might have been easily predicted. In a way, it could have been almost anything. The former senior lecturer in general practice at the University of Otago is something of a polymath. He likes diversions and digressions.

"I've got all sorts of backgrounds," he says, chuckling. "I have degrees in medicine – in fact I have been a practising clinician for 20-odd years. I have a degree in biochemistry. I have a Masterate in ecology and a PhD in digestive physiology – or ecophysiology if you want to be precise."

As it happens, what caught Lentle's interest was a 1986 paper by Deborah Penry and Peter Jumars. Penry and Jumars proposed modelling digestion processes by looking at the types of industrial reactor designed by chemical engineers.

These can be broken up into various theoretical models: batch reactors, where the ingredients are added to the reactor and completely removed when the reaction is complete (think home brewing) and continuous



A rat's stomach in action. 1. The entry of the oesophagus. 2. The fundus. 3. The antrum. 4. The pylorus, the point of entry to the small intestine. During digestion the antrum pumps coarse digesta towards the closed pylorus, causing it to fragment during backflow.

A possum's ileum *ex vivo*. At left a contraction is beginning to make its way along the ileum's length.

A possum's ileum turned inside out to show the villi. See page 33.

A rabbit's sacculated colon radially distended (at top) and contracted (below). The sacs, or external pouches, are known as haustrae.

flow reactors, which can either be plug-flow reactors or continuous-flow stirred tank reactors.

Penry and Jumars suggested, for example, that the ruminant gut was best thought of as a continuously stirred reactor – in the form of the stomach – followed by a plug flow reactor, conceptualised as the flow down a sequence of pipes.

Lentle was intrigued. He wanted to explore the model. Where should he begin? He decided to turn to the kangaroo as a model system. This was because, unlike placental ruminants such as cattle and deer, which have four-chambered stomachs and chew their cud (regurgitate and rechew their food), the kangaroo has a relatively simple digestive system: it chews its food well and only once, giving it a relatively homogenous consistency, and it has but a single stomach.

It was the consistency and characteristics of the mix of fluid and vegetation clippings in that stomach that interested Lentle.

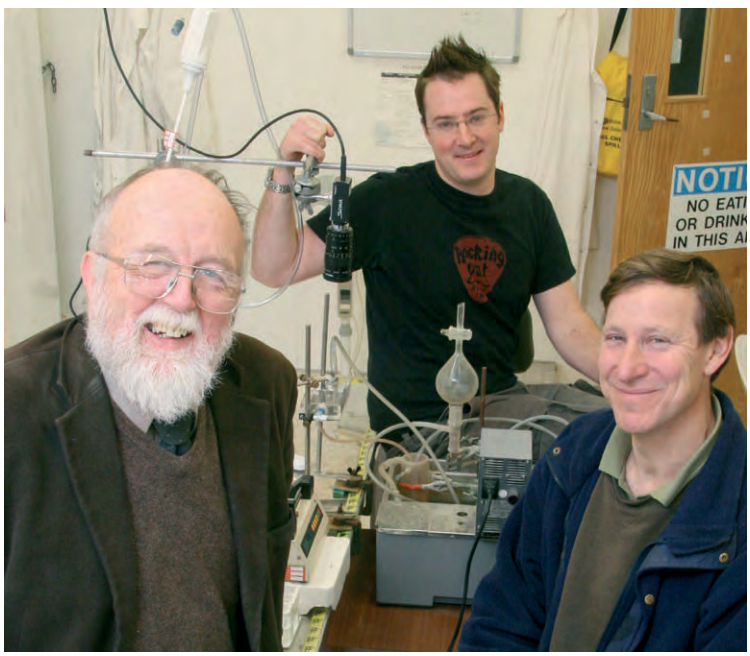
He sampled the mix, took measurements, and published. "That was really the first paper to evaluate properly the physical properties of digesta and how

they would mix, in terms of the theories of chemical engineering."

Could the stomach be acting as a stirred reactor? Not, he found, if it relied, as does an industrial stirred reactor, on producing turbulent flow.

"In order to induce turbulence in the stomach of the kangaroo [I found that] the muscle would have to contract at the speed of light."

Lentle now began measuring the qualities of the digesta as it travelled through the gut.



The members of the digesta team. Left to right: Professor Roger Lentle, technician Corrin Hulls and senior lecturer Dr Pat Janssen. Absent is anaesthetist Dr Paul Chambers of the Institute of Veterinary and Animal Biomedical Sciences.

Lentle's particular interest is in the changing rheology of the digesta – its characteristics of deformation and flow. For most of its life, your digesta is a non-Newtonian fluid. This means that unlike water, its major constituent, its viscosity does not remain constant.

"From a physics point of view you are dealing with a suspension of particles," explains Lentle, "and that brings problems with pumping, as any chemical engineer will tell you.

"Some suspensions of particles will lock up when you pump them – they shear thicken. The more you apply shear to them, the thicker they get and bang, they block up solid."

'Shear' is the sideways force you apply when you, say, run two surfaces across one another.

In fact, he says, fortunately for our digestive health, our digesta is pseudoplastic: instead of thickening it shears thin; alongside the gut wall the particles seem to line up under shear stress and they slip more easily.

But there is another problem: once the digesta starts to thicken – to become more of a particulate aggregate, as Lentle puts it – how does the gut circulate it in a fashion that allows it to add enzymes and fluids and take up the remaining nutrients?

"You look at the digesta in the terminal ileums of most animals and it is the consistency of treacle."

The answer, he has found, is that it does not. Instead, the gut compresses the springy mat of the digesta, forcing the nutrient-rich liquid to the sides of the gut, and then, as the gut relaxes and expands, the nutrient-depleted but now secretion-rich liquid is taken back in; a process rather like squeezing and releasing a kitchen sponge. "From the literature I have a fair idea of the pressures that are developed inside the bowel, so you can work out whether there would be significant extrusion of the liquid during compression."

The extruded liquid in turn lubricates the movement of the digesta.

Lentle goes hunting through his computer files and brings up a video of a long windsock of gossamer-like tissue against a jet black background. This is part of a possum's small intestine, the ileum. Suspended in a mix of nutrients, it is still living and – as a waft of motion along its length shows – still functioning, pumping through the guar gum mix it has been fed.

This was the next stage in Lentle's journey. Having established the properties of digesta, and in the process having shown that the mechanisms put forward by others could not work, he would try to find out what was happening.

Normally the processes of digestion are investigated by introducing a dye tracer into the digestive system, either with food or, using various processes, into different parts of the gut. But these methods have limitations: you cannot see what is going on where.

The method Lentle has chosen has been analysing the workings of actual organs *ex vivo*, maintained living within the laboratory. All at once the hidden is made visible, and there is another advantage: removing an organ from the body also removes the noise that comes from sympathetic and parasympathetic nervous systems. No longer is the organ responding to diurnal or nocturnal rhythms. No longer is it reacting to stress. And because

Magic fingers

Why is the lining of the human small intestine covered in the small protrusions known as villi? Recent work by Massey's digesta group shows that the conventional explanation is wrong.

Just because an explanation is appealing, that doesn't make it right. Under the microscope, the human small intestine is revealed to be lined with tens of thousands of protrusions called, collectively, villi. Each villus is about 0.5-1.6 millimetres long. Their purpose? To increase the effective diameter of the gut available to absorb nutrients. So says Wikipedia. So says many a textbook. Killer factoid: without the villi, the small intestine has the surface area of a cylinder; with the villi, it assumes the dimensions of a tennis court. Case closed. Or maybe not.

Since the 1990s there have been doubters. One problem, they point out, is that the gaps between the villi, at around 0.04mm, are simply too small to allow much liquid to circulate or nutrients to diffuse.

And Lentle's group has found more evidence against the 'tennis court' contention. "It turns out that the cells of the villi are renewed from the base, making their way up the side of the villi to the tip, where they briefly absorb nutrients before dropping off. The baby cells making their way up the conveyor are inactive." Most of the tennis court, it turns out, is out of play.

Why then do we have villi? There is some evidence for the villi moving. Might the individual villus have some role in stirring the liquid around the edges of the digesta? Lentle is dismissive: at this scale the villi move far too slowly to have much effect.

On the other hand, the small intestine does undergo various larger-scale movements, and one category of these, pendular movements, may hold the answer.

A pendular movement takes the form of a side-to-side wriggle of a portion of intestine. Until now, the function of the pendular movements has been generally assumed to lie in mixing the entire contents of the intestine.

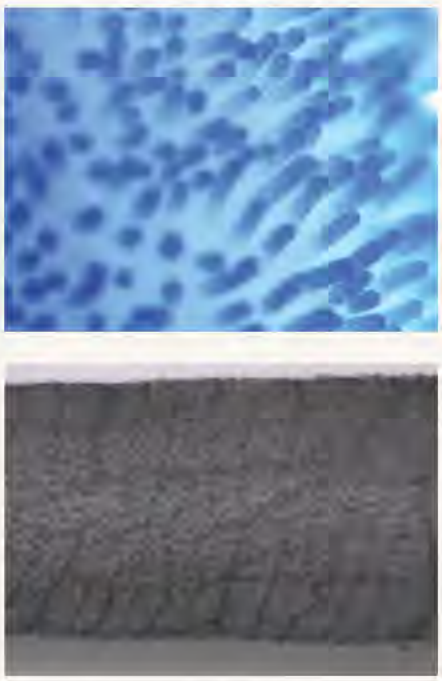
Again, this is not an explanation that bears scrutiny, says Lentle. By the time the digesta reaches the small intestine it is of a motor oil consistency and is not easily mixed – and indeed when the pendular movement was computer modelled (by a Frenchman who was formerly a postgraduate researcher in Lentle's group) little mixing was found.

What is the function of the villi and what is the role of pendular motion? With a kind of conspiratorial glee, Lentle opens another video. This is one of what looks like a roll of shag pile carpet. This is a living portion of bowel 'everted', turned inside out like a sock, the 'pile' being the tightly packed mass of villi, their tips stained blue with a harmless dye.

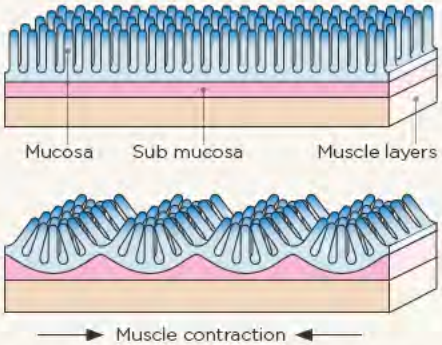
As Lentle speaks, the bowel sways violently from side to side in a pendular movement, and as it does something interesting happens to the sheet of villi: tiny ravines and clefts pulse along the length of the tips. The villi are acting like a thin sponge, squeegeeing up and expelling the thinner fluid that lies at the edges of the digesta.

"It's a fantastic sight," says Lentle. "So this is why you have pendular movement. When you do the modelling for pendular movement and incorporate the villi, you get beautiful mixing around their tips, where those newly formed cells can do their job.

"Nobody has described this before."



A possum's ileum turned inside out displays the villi, protrusions on the gut surface.



The villi sponge up and release fluid when the ileum is in motion.

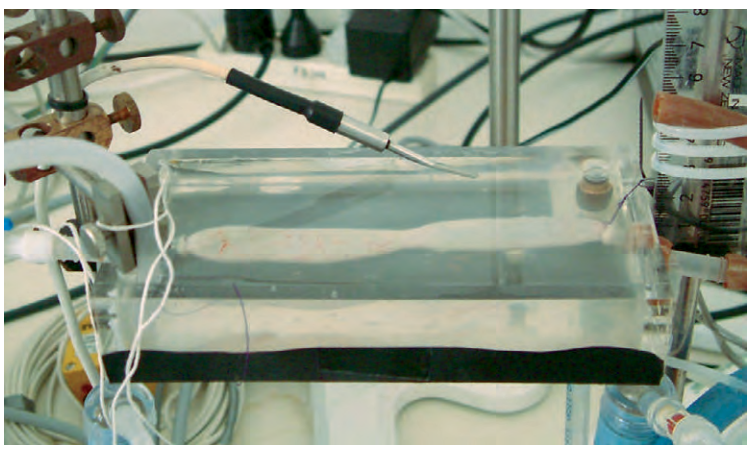
Lentle RG, Janssen PWM, DeLoubens C, Lim YF, Hulls C, Chambers P, Mucosal microfolds augment mixing at the wall of the distal ileum of the brushtail possum. *Neurogastroenterology & Motility* 2013, Vol. 25, Issue 11, 881–e700.

the guar gum mixes that are 'fed' to it are devoid of nutrients, another feedback mechanism is eliminated. In Lentle's words, this is the engine idling smoothly.

Because no one animal has a digestive system equivalent to our own, Lentle has picked and mixed. The possum ileum is the nearest practicable analogue he could find to the human equivalent in the small intestine. In place of a human stomach he has chosen rat, and in place of the human colon or large intestine, rabbit. "You get as near as you can."

How does the digestive system move digesta? Although it may look inert – an inelegant assemblage of bags and tubes – the digestive system is highly muscular. The stomach, for example, far from being a hold-all is better, in functional terms, viewed as three organs, each of which exerts a particular physical effect: breaking up solids, pumping digesta and constricting flow.

The more pipe-like lengths of the short and long intestines are also muscular. Here the muscle comes in two layers: radial muscles running around the diameter of the intestinal wall and longitudinal muscles



A section of living possum intestine is being directly observed in a tank simulating normal conditions in the body.

running along its length. The two layers work in rippling concert, the radial muscles opening and closing the diameter of the intestine and the longitudinal muscles shortening and then relaxing to propel their contents onwards. This rhythmically choreographed flow of extension and contraction is called peristalsis.

Lentle is not the first researcher to have observed digestive organs at work outside the body. But he is among the few to have monitored what happens when these organs are fed solutions that approximate real digesta in their viscosity.

Many physiologists have, for example, used a solution of salts and glucose when investigating the workings of the stomach. "That's fluid water; not at all like what you see on the pavement on a Saturday night," he says.

His approach to analysing what he sees is also novel. "The way we do the looking is frontier stuff."

High-definition video records the organs in action, the individual video frames are computer analysed and the results are compiled into a time sequence.

When analysing the action of the possum ileum, for example, one analysis measures the pixel distance between the walls of the ileum, while another measures the pixel distance between the vertical lines of feeder blood vessels – the vascular arcades – that intersperse the ileum. These two sets of measurements taken along the length and breadth of a section of ileum are then visually represented by shaded pixels: white for the maximum extension, black for the minimum, and intermediate shades for the measurements in between. Chemical engineer Dr Pat Janssen wrote the computer algorithms used for the spatiotemporal mapping system.

Lentle's work (the spatiotemporal mapping) shows that even in the absence of peristalsis, the muscles of the intestinal wall are in constant movement, see-sawing between the action of the radial and longitudinal muscles, exerting shear stress to liquefy the sides of the digesta where it meets the mucus boundary of the gut.

This 'fast phasic activity' has never been observed before.

Of what practical use is all of this? How can the rheometric qualities of what we eat be used to our advantage? Lentle gives the example of guar gum, the same soluble fibre he uses to feed his *ex vivo* organs. Guar gum has almost eight times the water-thickening potency of corn starch and is poorly digestible.

"A guar gum tablet has no nutrient content and yet it can be used to affect the glycaemic index [GI] of food quite profoundly. If you take a guar gum tablet after having consumed a sugary drink, your body's sugar uptake will be slowed," he explains.

"So the USDA [United States Drug Administration] allows the prescribing of guar gum for the treatment of diabetes.

"If you tinker with the physics, you can manipulate how much sugar, how much fat or how much cholesterol you soak up. Our understanding allows you to tinker intelligently."

How so? Say you want to thicken the digesta in the small intestine. Normally the stomach – the guardian of rheology as he terms it – will hold back thick material until it has been heavily diluted. But by understanding the way the system functions, you can set about fooling it.

"You can take something like guar gum and add another polymer to it, perhaps maltodextrin. When the viscous solution of guar gum mixes with the maltodextrin, the two polymer strands interact and the solution becomes a watery drink.

"The stomach interprets this as a liquid and pumps it into your small intestine, where an enzyme, pancreatic amylase, chops up the maltodextrin molecule leaving a thick, treacly, undiluted solution of guar gum."

A number of diseases can afflict the small and large intestines. Ulcerative colitis, for example, is a chronic digestive disease characterised by inflammation of the colon.

One ulcerative colitis treatment is the drug Pentasa (mesalamine), but in order for Pentasa to make it to the colon it must first avoid being absorbed in the small intestine. Lentle's understanding of the physics of digestion may allow more of the drug to reach its target.

Another disease that may lend itself to treatments that employ the physical properties of digesta is diverticulitis, a common disease of the large intestine.

Here the digesta has become much thicker, and, unlike in the small intestine, where peristalsis is more continuous, periodic mass movements help propel the contents from the large intestine through the colon to the rectum.

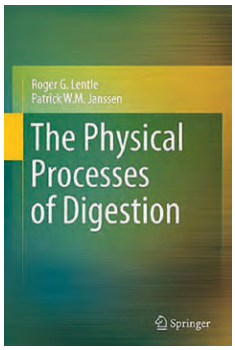
"Diverticulitis is generally seen as a problem where the pressure inside the cavity of the colon gets so high that it causes these little blowouts, rather like the blowouts through the wall of a tyre," explains Lentle.

"We know that in some way this is related to the character of the material. If you add inert fibre you can introduce changes to consistency. We know that people with high levels of fibre in their diets are less prone to diverticulitis."

The fibre causes 'intestinal hurry'. "When you get intestinal hurry the colon doesn't have as much time to absorb the water, so the stool becomes more liquid."

The equation seems to be more liquid stool means less pressure means less risk of diverticulitis, he says.

And it is the physical form of the fibre that seems to matter. Lentle cites a study in which volunteers were fed quantities of inert plastic, either in the form of tiny spheres or as milled flakes. The milled flakes reduced the transit time of digesta; the spheres made no difference.



The Physical Processes of Digestion
Roger Lentle & Patrick Janssen, Springer, 2011

Back in the hard times of evolutionary history, humanity acquired certain tastes. Although they may not be good for us in our now more sedentary existence, rich, sweet, fatty, processed foods are what we like. Little wonder that many of our modern-day afflictions have a dietary connection: obesity, diabetes, heart disease.

Lentle proposes that once you understand the physiological processes of digestion and intestinal function, you should be able to use nutritionally inert ingredients to engineer so-called functional foods that produce desirable effects.

> "If you tinker with the physics, you can manipulate how much sugar, how much fat or how much cholesterol you soak up. Our understanding allows you to tinker intelligently."

These include everyday foods that manage the difficult trick of both pleasing the palate and being good for us, and specialist products that address particular medical conditions or cater to the needs of particular populations, such as sports people, infants or the elderly.

Science writers are fond of rhapsodising about the miraculous workings of many other organs of the body: the 100 billion neurons in the brain, the 2.5 billion times the heart beats in an average lifetime, the immense biochemical complexity of the work of the liver, but relegate the stomach and intestines to the supporting cast. It is time to reassess. ■

Contains sweeteners

Work by the digesta group could lead to better,

It began unexpectedly. Sarah had always had a sensitive stomach. But in her 20s, while she and her partner were shifting house, she began suffering occasional debilitating abdominal pain for no apparent reason. Perpetually tired, losing weight, scared and sick, she was prescribed a battery of tests. A colonoscopy and endoscopy showed a digestive tract cratered with sores and a blood test confirmed the diagnosis. Crohn's disease.

Sarah is not alone. Around 15,000 New Zealanders suffer from one or other form of inflammatory bowel disease (IBD), with ulcerative colitis (which affects the large colon) and Crohn's disease (which can affect any part of the intestinal system) the most common conditions.

Sarah is the victim of her own immune system, which, perhaps prompted by an unknown environmental trigger, has turned against her.

For most of us, inflammation is a healthy response to a foreign substance or pathogen; when the substance is gone, so is the response. But in Sarah's digestive tract the inflammation lingers. Eventually, left untreated, Crohn's disease will damage the delicate walls of the intestinal tract.

As yet there is no known cure. The aim of treatment is to keep the patient in perpetual remission, says Professor Lentle, who before choosing a career in research practised as a clinician. "You end up treating the person with drugs like Salazopyrin or sometimes even steroids, the sorts of thing that damp down the immune response. What the clinician wants to know is, have I got it under control? Has the permeability of the gut returned to normal?"

But how do you pick up the signs of a flare-up in the making? Colonoscopies are awkward. X-rays are cumulatively hazardous. But there is a relatively simple and pain-free diagnostic test. It relies on the gut's permeability to sugars.

For a long time it has been known that inflammation makes the bowel lining more permeable to larger molecules and that this permeability can be used as an index of inflammation. But most of the molecules that make their way across the bowel lining into the blood-stream do not stay there for long and are difficult to measure: they are swiftly metabolised or stored by organs like the liver.

There are, however, exceptions. Some sugars, such as mannitol (technically a sugar alcohol) and lactulose, a

Sequeira IR, Lentle RG, Kruger MC, Hurst RD, Differential trafficking of saccharidic probes following aspirin in clinical tests of intestinal permeability in young healthy women. *Clinical and Experimental Pharmacology and Physiology* 2014; 41: 107-117.

Far left: Study leader, postgraduate student Ivana Sequeira.

less intrusive tests for inflammatory bowel disease.

synthetic sugar, cannot be digested or metabolised and, if they make their way across the lining, are soon expelled in the urine. Mannitol is a monosaccharide, a sugar small enough to transit, like glucose, directly through cells in the gut wall. Lactulose, on the other hand, is a disaccharide (a pair of linked monosaccharides), making it a sugar that is too large to transit the cells directly and must instead make its way through the pores situated in the tight junctions between cells – pores that enlarge in an inflamed gut.

In the standard sugar absorption test, the patient is given an oral dose of a set ratio of lactulose and mannitol and a urine sample taken after a standard period of time is analysed for its concentrations of the two sugars. "There is an index called the lactulose/mannitol ratio," explains Lentle. "The proportion of mannitol in the urine sample would be taken as telling you something about the size of the internal surface area of the intestine, and the proportion of lactulose would tell you about the degree of inflammation."

In a normal gut mannitol should diffuse easily from the gut to the bloodstream, while lactulose should be largely excluded by the narrow pores. In a healthy subject, the ratio of lactulose to mannitol might be anywhere from 1/50 to 1/100. Hence for diagnostic purposes, an elevated ratio of the normally poorly absorbed lactulose to the readily absorbed mannitol is an indication of an inflamed bowel. Low levels of both sugars might be taken to mean that the gut is performing poorly at absorbing nutrients. Elevated levels of both sugars would support a diagnosis of 'leaky gut' syndrome.

But although the test is useful, much of the fundamental science behind how the test relates to the physiology of the gut has, until now, been unclear. How do the results of the test vary with the interval between ingestion and urination? And in a related question, where in the intestine are the two sugars being absorbed? Are there different sites for different sugars? How precisely does inflammation affect the uptake?

In 2013 Lentle's group conducted a double-blind study, led by postgraduate student Ivana Sequeira. Twenty healthy young women were given a 600-milligram dose of aspirin, which is known to induce gut inflammation, followed by a dose of the sugars mannitol, rhamnose (another small monosaccharide that has widely been regarded as interchangeable with mannitol) and lactulose, and urine samples were taken every half hour.

The group found that the time distribution of the peaks of the different sugars in the samples show that various segments of the gut are more or less permeable to different sugars; that rhamnose and mannitol have, in fact, quite different absorption profiles; and that one of the standard assumptions – that a decrease in the absorption of monosaccharide sugars in IBD sufferers is due to the destruction of delicate infoldings called villi lining the gut wall – is not necessarily right. Healthy volunteers dosed with aspirin display exactly the same effect.

The resulting paper has been lauded by the journal editor as "a good example of how solid clinical physiology studies should be planned, paving the way for valuable improvements of existing methods to benefit both patients and clinicians".

Beyond the 15,000 New Zealanders who have IBD, the group's work on the absorption of sugars could have much wider implications for the 225,000-and-counting New Zealanders who suffer from diabetes and the million-plus-and-counting who are obese.

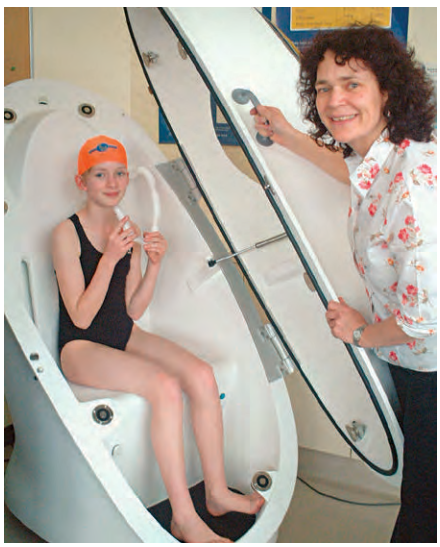
Check the food labels on many of the food products on your supermarket shelves and you will find the GI given as a guide to planning a healthy diet. This is a measure of the rate at which the carbohydrates in the food are broken down into glucose and absorbed from the gut into the blood. In high-GI foods this happens swiftly, causing your blood glucose level to rise rapidly. In low-GI foods, the carbohydrate is digested slowly, resulting in a more gradual rise in blood glucose. Low-GI foods will give a longer-lasting feeling of satiety and they avoid the insulin spikes and troughs that may predispose people to diseases such as type 2 diabetes. Using the GI you might choose to breakfast on porridge with a GI of 55, rather than cornflakes with a GI of 93. (Pure glucose has a GI of 100.)

To arrive at a food's GI measure, 10 test subjects fast for 12 hours before eating 50 grams of the food in question, and their two-hour blood glucose response is assessed. But like the sugar absorption test, the GI test lacks nuance. Where in the gut is the glucose absorption happening? Given that excess glucose is constantly being mopped up by the liver, is blood glucose the best measure?

The work of Lentle's group could lead to better, more precise tests and the design of healthier foods.

The POD squad

Why are some of us fat and some lean? Using the BOD POD and the PEA POD, Massey's Institute of Food, Nutrition and Human Health seeks answers.



From top: Associate Professor Jane Coad with full-size POD. Researcher Louise Brough with her son Barney test the PEA POD in preparation for the Little Peas: Mother and Baby Study.

Looking, for all the world like the suspended animation capsules in one of the *Alien* movies, the BOD POD and its smaller cousin the PEA POD are two of Associate Professor Jane Coad's workaday tools.

The PODs use the displacement of air to measure the body volumes of the people who sit or lie inside them. From the weight and volume measurements the PODs calculate percentage body fat. According to the annual New Zealand Health Survey, in 2012 almost one in three New Zealanders was obese. But what does 'obese' mean? For epidemiological purposes, the measure is Body Mass Index (BMI), which is arrived at by dividing an individual's body mass by the square of their height. The threshold for obesity is set at 30 kilograms per square metre.

But when it comes to the individual, BMI is a famously flawed measure. Many All Blacks would register as obese using BMI as the measure, when in fact their physiques are dominated by muscle, not fat, while many individuals who sit within the normal BMI range have a high fat mass. TOFI – thin on the outside, fat on the inside – to use the joking acronym. The PODs, on the other hand, do not lie.

At Massey, the PODs have been used to further a number of studies. One such study looked at how the composition of women's bodies changes in the wake of pregnancy. Evolution, says Coad, has provided for women to accumulate a store of fat during pregnancy that can be drawn on during breastfeeding in times of scarcity. (Lactation is more nutritionally demanding than pregnancy.) But most well-fed western women, she says, can breast feed without drawing on these reserves and the fat tends to linger unless a conscious decision is made to get rid of it, perhaps through diet or exercise.

If another pregnancy follows soon after the birth – and in recent times many women have chosen to delay childbearing and to then have children in close succession – losing that weight becomes still more difficult.

Coad has found that sometimes the BOD POD and her research subjects tell quite different stories. When she and her collaborators asked women about how active they were, many said they were highly inactive: they had other small children and no time for the gym. But those other small children in fact meant constant activity, and this was visible in body composition.

In another study the PODs are being used to look at the links between bone health and body composition. Here the general supposition is that being heavier has its benefits, cushioning the body against falls and, by providing a certain amount of helpful stress, building stronger bones. But, militating against this, abdominal fat is associated with the production of the small proteins called cytokines, creating a constant low-grade inflammation that has the potential to damage cardiovascular, metabolic and musculoskeletal health.

For an upcoming 'Little Peas: Mother and Baby Study', Coad is recruiting 100 women in the later stages of pregnancy in order to look at the relationship

How you can help

The Little Peas: Mother and Baby Study is looking for women in the Manawatū region who are 16 and over and in the late stages of pregnancy to take part in an investigation into the links between maternal and infant body composition after birth. In the course of four visits to Massey's Human Nutrition Unit, the women and their infants will have measurements taken of their body composition. There will also be a series of questions about diet and activity and the infants' feeding and temperaments. The visits are timed at seven to 28 days after birth, four weeks, six months and 12 months.

Call Chris Booth on 0800 0800 28 or Jane Coad on 06 350 5962.

between the body composition of the mother and the infant and how these values change in the first six months of the infant's life. To determine explanatory factors, the study will note the type (breast or bottle) and pattern (timing, frequency and intervals) of feeding and, using accelerometers, the levels of activity of both mother and child.

There are, says Coad, a number of ideas they would like to put to the test. Do children who have larger stores of body fat grow into adults who have similar body compositions? Do the pattern and type of feeding play a role?

"One of the thoughts that is floating around is that breastfeeding is protective against obesity, because it allows the appetite regulation mechanisms to be stronger."

Mothers who breastfeed will feed until the children stop suckling, she explains. "As long as the baby is growing you know that the baby is consuming the right amount." Mothers who bottle feed may be more inclined to persist with feeding until the bottle is emptied. "You look at it and say there is a little bit left, nearly finished. You are overriding the infant's appetite regulation. You can't do that if you breastfeed."

Does this incline bottle-fed infants towards later obesity? The child subjects of the 12-month study will be followed up at set intervals during their childhoods.

Other key collaborators in these research are Louise Brough, Jasmine Thomson and Janet Weber.

Iron rations

Feeling constantly tired? You may have an iron deficiency.

26
Fe
Iron

It is one of the most ubiquitous elements on Earth – the fourth most common element in the Earth's crust – and we need very little to get by. The average human body contains around three to four grams – about a teaspoonful – and requires a miniscule top-up daily.

Yet iron deficiency is the world's most common nutritional disorder, affecting about 20 to 25 percent of the world's population, predominantly children and women, and assessing and addressing iron deficiency is one of Associate Professor Jane Coad's abiding interests.

"It's fascinating. I find iron..." she pauses, searching for a word, "elusive."

It is iron's propensity for exchanging electrons with other elements that makes it essential. This propensity makes it key to oxygen transport and metabolism. Two-thirds of the body's stores of iron are embodied in the iron-containing protein haemoglobin, which transports oxygen in the blood.

(On the other hand, in oversupply iron can be dangerous, pillaging the electrons from other atoms and creating free radicals – a short-lived family of compounds that damage cells and DNA. So the body has developed mechanisms for regulating iron uptake and for storing any excess out of harm's way.)

Someone deficient in iron will produce fewer red blood cells or have lower levels of haemoglobin. The symptoms of this iron anaemia include fatigue and slow cognitive and social development during childhood.

And even relatively mild deficiencies may still exert effects, says Coad. "There is a hierarchy. If you've not got enough iron for everything, you will have enough iron for red blood cell production, so the level of haemoglobin won't fall, but some other functions will be compromised. People do not function or feel at their best."

Athletes, adolescents, children, reproductive-age women and blood donors – who should be careful to allow an adequate interval between donations – are groups who should pay particular attention to their iron status.

Iron deficiency ought to be an easy enough problem to fix, one might think. Consume more iron. But it isn't quite that simple. The form in which it is consumed matters. The iron in breast milk, for example, is much easier to take up than the iron in dairy-based formula milk, and the haem iron (haem as in haemoglobin) in meat (which contains both haem and non-haem iron) is easier to absorb than the non-haem iron in vegetables. Vitamin C improves the uptake of non-haem iron as does an unknown factor in meat, while calcium (another essential element) and some proteins inhibit it. These associations are well documented.

Yet when various studies have attempted to improve iron status by, say, increasing the intake of vitamin C, the results have generally been disappointing. On Massey's Albany campus, dietitian Kathryn Beck favours a whole-diet approach. "We don't eat individual foods in isolation, but in combination. We need to look at the sum of the foods people eat."

A study conducted by Beck and her Massey colleagues Rozanne Kruger and Cathryn Conlon looking at the association between iron status and diet in 404 Auckland women found that a meat and vegetable diet (beef, chicken, broccoli, carrots, capsicum and lettuce) reduced the odds of a suboptimal iron status, while a milk and yoghurt diet (milk as a drink, milk in food and yoghurt) raised them, and that it may be better to consume milk and milk products between meals. ■

Some signs of iron deficiency anaemia

feeling tired and weak
poor work or school performance
slow cognitive and social development in children
difficulty maintaining body temperature
greater susceptibility to infection
glossitis (an inflamed tongue)

Recommended dietary allowances for iron for infants (7 to 12 months), children and adults

Age	Males	Females	Pregnancy	Lactation
7 to 12 months	11mg	11mg		
1 to 3 years	7mg	7mg		
4 to 8 years	10mg	10mg		
9 to 13 years	8mg	8mg		
14 to 18 years	11mg	15mg	27mg	10mg
19 to 50 years	8mg	18mg	27mg	9mg
51+ years	8mg	8mg		

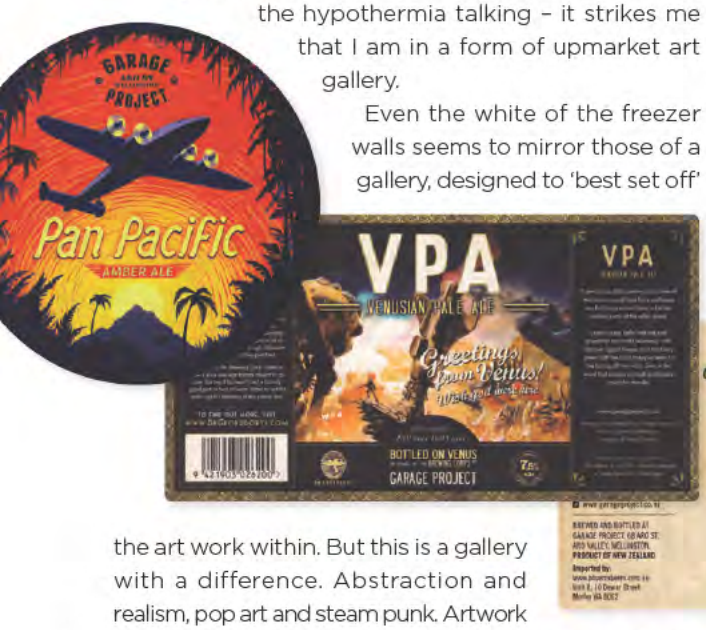
Source: United States National Institutes of Health

The art of beer

In the line of duty, design lecturer **Donald Preston** goes shopping.

These are the trials of research. Here I am in the Regional Wines and Spirits beer fridge choosing a selection of beers on the basis of their labels. At least the research materials will not go to waste. But after a while – and this may be the hypothermia talking – it strikes me that I am in a form of upmarket art gallery.

Even the white of the freezer walls seems to mirror those of a gallery, designed to 'best set off' the art work within. But this is a gallery with a difference. Abstraction and realism, pop art and steam punk. Artwork referencing the Arts and Crafts movement. Artwork referencing B-grade horror movies. Everywhere labels vying for my attention. This gallery is about appealing to all tastes, and above all about fun and not taking itself too seriously – witness Tuatara's 'Double Trouble' 3D label and attached 3D glasses.



It doesn't seem too long ago that most craft beer labels looked like 'home craft' design. Sometimes this was deliberate. Looking 'amateur' – in the sense of something done for love rather than money – was a useful distinction.

But times have moved on. These days the small breweries' design aesthetic is all about personality. These craft brewers strive to create craft labels that convey fun, experimentation, creativity, identity and belonging.

It is now understood that a 'craft' or small-run beer can be very sophisticated, so the labels do not need to suggest a brew made in the backyard. These breweries seem to be saying "If I have produced a quality craft beer it should be presented with a quality craft label". And it's not just about the brewery – the brewery logo is often obscured – it's all about communicating the philosophy and vibe of the company and making a connection. As design guru Milton Glaser once said, "Design in general is the creation of affection".

Who has not been swayed in the purchase of a bottle of wine by the label – especially if the bottle is likely to be seen in a social setting? The same now applies to craft beer. These are beers to take to a restaurant and place proudly on the table. But what sort of statement do you, as a consumer, want to make? To my eye, modern New Zealand beer labels seem to fall roughly into three categories: those that follow or reference traditional beer labelling; those that appear to be repositioning beer as a serious, premium product, visually more in line with high-end wines than workaday beers; and those that seem to be totally rejecting any historical and traditional connections, employing an approach more akin to poster design than packaging.

The traditional and the not-quite

For the historical referencing I chose Yeastie Boys' Golden Perch. Golden Perch is a visual mash-up – using traditional iconography of a barmaid in Bavarian dress who, on a closer look, has the head of a fish – perhaps a perch? – coupled with an unintelligible quote from Robbie Burns on the back of the label. Together with the black letter/Gothic text and the gold foiling, the connotation is that this is a traditional brew with German connections, but with something subversive ('fishy'?) going on.

The collage of barmaid and fish seems to reference the work of German artists, Dadaist John Heartfield and surrealist Max Ernst.

It is only when I go to the website that I discover I have missed the most obvious reference. The Golden Perch inn appears in Tolkien's *The Hobbit*, reputedly serving "the best beer in the Eastfarthing".

The Golden Perch is a subversive re-imagining: a beer label for insiders.

The other two beers in my 'traditional' label category – the bucolic Emerson's Pilsner and the Arts and Crafts-influenced Voyager IPA – are just that, traditional.

The new champagne

Moa's 'Imperial Stout' sees itself sharing a shelf with expensive bottles of bubbly. The elegant design, uniquely shaped and branded bottle, Champagne-style cork, label copy with an emphasis on traditional production processes – "aged in oak Pinot Noir barrels" – and limited availability all clearly identify this as a beer positioned as a serious, premium product. The beer style is clearly identified 'front and centre' on the label and is the first thing you register. As a piece of simple, pure communication, this works well.

New-school labels including Tuatara's 'Double Trouble' 3D label and attached 3D glasses.

Playfully sophisticated

For the final category I've gone for Wellington's Garage Project, arguably the leader in the label game, and its 'Death from Above' beer. With high-quality illustration and a bold colour palette, this label makes multiple references. The image of helicopters against a giant sunset makes reference to the Vietnam war and more directly to the movie poster for *Apocalypse Now*. The image also suggests a more contemporary 'war on drugs'. Hops were described as a "wicked and pernicious weed" when they were first introduced to England in the 1500s, and here we see a devil's face, formed from the plant, looming above a cultivated 'crop'. (The Garage Project also produces a beer called Pernicious Weed.)

The label copy is in a similar vein. "Inspired by the heat and freshness of Indochine flavours and the high citrus intensity of American hops, Death from Above combines mango, Vietnamese mint, lime and chilli with Centennial, Amarillo and Citra hops. The result is intense, but the name is misleading. This is a beer of balance rather than conflict with bitter-sweet, heat and citrus character. I love the smell of myrcene in the morning." This is very sophisticated labelling. It says that this is not a beer to be chugged. The Garage Project wants the consumer to turn the bottle around, read the label, understand the linkages and references and, sometimes, go to the internet to get the backstory.

Timeline

1750ca Labels are in use on various forms of bottled alcohol, such as port wine, but beer is generally decanted into the customers' own containers. The nearest thing to a beer label is the use of stamped wax seals.

1773 Captain Cook brews beer for his crew while visiting New Zealand. "We at first made our beer of a decoction of the spruce leaves; but, finding that this alone made it too astringent, we afterwards mixed with it an equal quantity of the tea plant..."

1834 With the repeal of the Duty and Drawback on Flint Glass, glass bottles come into greater use. Until this time very little bottled beer has been produced in the United Kingdom.

1835 New Zealand's first brewery is established by Joel Samuel Polack in the Bay of Islands.

1855 Labelled bottles are now in general use in the United Kingdom as, with improvements in transport infrastructure, brewers expand production to exploit urban population growth.

1872 The screw stopper is patented by Henry Barrett of England. Until now beers have been stoppered with cork.

1880s The production of bottled beer expands vastly owing to the introduction of specialist machinery.

1892 Crown caps are invented by William Painter.

1917 In New Zealand, 6pm closing for pubs is introduced as a 'temporary' wartime measure, leading to the 'six-o'clock swill' as patrons get their fill before closing time.

1956 New Zealander Morton Coutts, the foundation head brewer of Dominion Breweries Ltd, patents a system of continuous fermentation. This gives greater beer consistency and product control.

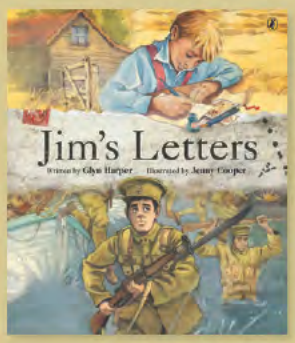
1960s The cork lining of the crown caps is replaced by plastic and in the mid '60s twist-off crown caps arrive.

1967 Pubs return to 10 o'clock closing.

1970s After a series of amalgamations, New Zealand brewing is effectively a duopoly, dominated by Lion Breweries and Dominion Breweries.

1981 Mac's Brewery is founded in Nelson, breaking the duopoly. It is the first of the new craft breweries.

2011 The number of breweries in New Zealand hits 68 by the end of 2011.



Jim's Letters

Story by Glyn Harper, illustration by Jenny Cooper, Puffin Books

Jim's Letters is the story of fictional 18-year-old soldier Jim Duncan's travels and experiences during World War I in Egypt and Gallipoli as related in his letters to his younger brother, Thomas, who lives on the family sheep station in the South Island.

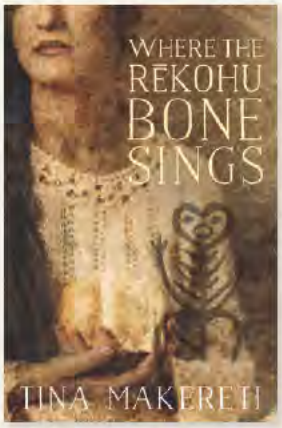
In creating Jim's experience, Professor of War Studies Glyn Harper drew on his editorial research for *Letters from Gallipoli: New Zealand Soldiers Write Home* (Auckland University Press, 2011), a collection of 190 previously unpublished letters collected from archives, newspapers and family collections.

Jim's first letters home are full of anticipation and bravado. He experiences the exotic sights and sounds of Cairo, undergoes military training and finds camaraderie with his fellow soldiers as they approach the battle zones of Europe and Turkey.

Jim's final letter to his family from the trenches of Gallipoli describes the intense heat, the terrible food and the burying of dead soldiers, while conveying his mixed feelings. He writes: "War is certainly not the great adventure I thought it would be", but concludes on a cheery note with, "Please tell Mum not to worry about me. I would not have missed this experience for the world".

Harper says he balked initially at the idea of ending the book with Jim's death, but it was an honest conclusion. By the time the Gallipoli campaign ended, nine months after it began, nearly 3000 New Zealand soldiers were dead.

Beautifully illustrated by graphic artist Jenny Cooper and with the folded letters contained as inserts, *Jim's Letters* is recommended for children five to eight.



Where the Rēkohu Bone Sings
Tina Makereti, RHNZ Vintage

Where the Rēkohu Bone Sings, Tina Dahlberg's first novel, reflects, she says, her "obsession with identity and having multiple ethnic origins". The obsession is understandable, for Dahlberg's own ancestry embraces Ngāti Tūwharetoa, Te Ātiawa, Ngāti Rangatahi, Pākehā and – the indigenous people of the Chatham Islands – Moriori.

Rēkohu is the Moriori name of the Chathams' largest island (literally 'misty rain') and the ambit of the novel ranges geographically from the Chatham Islands to London and across time from 1835 to the 21st century.

Launched in March, *Where the Rēkohu Bone Sings* has garnered good reviews in *The New Zealand Herald* and *New Zealand Listener* and on Radio New Zealand. In mid-May it stood at number five on the Booksellers New Zealand weekly bestsellers list.

Tina Dahlberg is, among other things, a Senior Tutor at Massey's School of English and Media Studies.

A fantasy career

For a Master of Science graduate with his major in ecology, Stephen Minchin has arrived at an unusual career destination as the principal of Steam Press, a publisher of fantasy and science fiction.

Minchin studied on the Manawatūcampus, following his Wellington-based family's injunction that anyone studying had to be at least 100 kilometres distant. He graduated with his MSc in 2002, along the way having a great time. "I would definitely do that again."

Since then he has taught English in Japan, worked for a horticultural consultancy and studied (and tutored in) publishing at Whitireia Polytechnic, where visiting publishers, who proclaimed that there was no market for science fiction and fantasy, gave him the perverse incentive to prove them wrong.

"There are a hell of a lot of people who read science fiction and fantasy. When [*Game of Thrones* author] George RR Martin was here he had huge numbers at his Lambton Quay book signing."

In its three-year existence, Steam Press has established something of a name for itself. *The Prince of Soul and the Lighthouse* by Fredrik Brounéus, the first novel Minchin accepted for publication, was the subject of glowing reviews and is to be published in Germany by the same firm that picked up Eleanor Catton's *The Luminaries*. *Mansfield with Monsters* by "Katherine Mansfield with Matt and Debbie Cowans", a Gothic re-rendering of Katherine Mansfield's short stories with bonus vampires, ghouls and alien monsters, won the 2013 Sir Julius Vogel Award (the New Zealand science fiction awards) for best collected work. And Michael Morrissey's *Tropic of Skorpeo* also generated some buzz, Michael Larsen of *New Zealand Listener* writing that it reminded him "of Jasper Fforde's books, and also of Lewis Carroll and Thomas Pynchon as if seen on a Hunter S Thompson acid trip. Hilarious, often very sexual, occasionally puerile, undoubtedly clever".

Along the way Minchin has learned about book distribution, the sale of overseas rights, making e-books and the art of assessing manuscripts, the good, the not so good and the outright strange. Oddly enough, some of the best manuscripts he has read have arrived unsolicited.

In October Minchin and Steam Press head to the Frankfurt Book Fair. "In New Zealand we sell around 2000 copies; in the German market we might be able to sell 20,000."

Cinéphile

Prompted by his experience of living in France, **Simon Sigley** has investigated the changing relationship between New Zealanders and minority cinema. The result is his book *Transnational Film Culture in New Zealand*. He speaks to **Malcolm Wood**.

Image by Solène Sigley

"In France I found there were ways of talking about the cinema that were enlightening, instructive, entertaining and in a variety of media: radio, television, magazines, weekly reviews. I could just plug in and feel myself connected."

Academic publishing is not, generally, a road to fame or riches, but it has its moments. When I call him, Simon Sigley has just had one: a royalty cheque awaiting him on his desk. Not a large one, but then neither is his market. *Transnational Film Culture in New Zealand* is a niche publication, written because its author loves film.

Film was the most important medium of the 20th century, he says, "a protean cultural phenomenon with huge industrial and aesthetic ramifications", and he is fascinated by its changing cultural status in his native New Zealand, the more so because for around a decade he lived in a country where film has always been given its intellectual due: France.

Sigley went to France in 1985, a fresh graduate in political studies, funding himself by driving taxis part time. He was attracted by the French film and literary culture he had met while a student, determined to learn a second language, and, with the United Kingdom being the accepted OE destination, he wanted to be that bit different. "France was a way of marking myself out from the rest I suppose. Also the French education system didn't ask for a lot of money." The idea was to undertake a Masterate in political studies.

But the reality of life in metropolitan Paris quickly brought him up short. "Desire gave me wings, but the reality on the ground was sobering. I knew no-one, I had a weak understanding of the French language, and going from Auckland to Paris was alienating and unsettling."

Aspirations recalibrated, he headed inland to the university town of Nancy, where summer courses in French language and literature were on offer. Here he settled in, made friends, found work, and, in time, embarked on – and later completed – a Masterate in film studies.

"I decided I was going to become a filmmaker, so I went back to Paris, enrolled in a film school and found a freelance position teaching English." And he became a serious watcher of films. "I didn't know many people, and being a student and working part time I had a reasonable amount of time." Picking and choosing from among the many cinemas scattered around the arrondissements of Paris, he regularly went to several films a week.

While this might be viewed as slightly odd behaviour here, in Paris it was not. In France, cinema has always been treated as a legitimate art form, "a very serious way of engaging with reality" and not, as in New Zealand, a poor cousin to literature, theatre and music.

"In France I found there were ways of talking about the cinema that were enlightening, instructive, entertaining and in a variety of media: radio, television, magazines, weekly reviews. I could just plug in and feel myself connected."

But Sigley's decade in France also had its frustrations. He hated the bureaucracy; he missed New Zealand's natural environment. One of his film school projects was a video he called *Pourquoi j'haime la France*, or *Lov 'ate France*. "It was a series of video postcards describing the trials and tribulations of a New Zealander living in Paris."

The tug of home was strong, and Sigley's French wife had not been to New Zealand or met his family. They flew back in 1994 to test the waters.

It felt like a different country. The New Zealand Sigley had left was still a closed economy, 1981's *Goodbye Pork Pie* was New Zealand film's one break-out success, and film studies was only taught at postgraduate level.

The post-Rogernomics New Zealand to which he came home was far more open, cosmopolitan and commercially oriented: three New Zealand films – *The Piano* (1993), *Heavenly Creatures* (1994) and *Once Were Warriors* (1994) – were wowing audiences worldwide; and film studies had come of age as an accepted subject for undergraduate study.

Sigley and his wife settled in, deciding they both liked the lifestyle, and in the late 1990s he began casting around for a PhD topic. A study of a Taiwanese filmmaker became an exploration of the influence of French film culture on New Zealand film culture, "but that turned out to be a little bit narrow" and finally national film culture: the topic that would become *Transnational Film Culture in New Zealand*. The project became, he says, a way of reconnecting with a country from which he had grown estranged during his years in France. "I had changed, and so had the country."

His thesis (heavily abridged and updated to be the basis for the book) would take him into uncharted territory. While the phenomenon of New Zealand film had received attention, as had some individual

filmmakers, the societal and cultural backdrop was unexplored.

New Zealanders have long loved the movies. In 1917, 550,000 New Zealanders went to the pictures each week, and in 1960 the average New Zealander went to the movies 17 times a year. But the cultural relationship with film has been a complicated one, an interplay of national identity (for many decades New Zealanders viewed themselves as better Britons), morality, politics and snobbery – both the conventional and the inverse kind.

Let a letter to the *Otago Daily Times* in 1921 give the flavour.

> Sir, On more than one occasion I have written to you condemning immoral, debasing kinema (sic) shows in our town. Two or three months ago I went to the American dramatisation of Dr Jekyll and Mr Hyde and came away with the intention of writing to you again, but could not find decent English words to express my feelings. Such an abominable travesty of the story by our beloved Stevenson, introducing long drawn out sensuous music-hall scenes that have no part in the original at all.

Had sound arrived – as it would in 1928-29 – the writer would have had something to say about American accents as well.

But there was also, from early on, a small minority who were willing to treat film as an art form in its own right. An Auckland Film Society was in existence in 1929, although the number of members it had is unknown, and in 1933 film societies came into existence in Dunedin, Christchurch, Wellington and a number of smaller centres. The Wellington Film Society held its inaugural screening in April 1933, only shortly thereafter to find itself prosecuted for showing the uncensored Soviet film, *The Road to Life*.

An examination of the problems of rehabilitating delinquent and unemployed orphans in the wake of the civil war, *The Road to Life* was hardly salacious fare and Soviet cinema, says Sigley, had particular merits for film aficionados, as a result of its pioneering use of editing techniques. Moreover, as a private society, the society did not believe it was subject to the relevant section of the Cinematograph Films Act (1928).

Above, clockwise from top: The cover of the Wellington Film Society's 1972 season brochure; a view of the censor in the Auckland University literary journal *Phoenix*, 1933; logo created for the Lido Cinema in 1962.

But among the establishment, the fear of communism was strong, and, as Sigley writes, "This government of farmers was unlikely to appreciate the cultural pretensions of a film society who seemed to think they could thumb their noses at the common man by claiming to be exempt from censorship standards that applied to everyone else."

The Wellington Film Society was successfully prosecuted, and, writes Sigley, "the nascent film society movement brought to a limping halt".

Perhaps the decision to prosecute also tells us something about New Zealand's self-image. Even in the 1930s, New Zealanders were an urban people – the tipping point came in 1910 – but this was not the way we saw ourselves. We were hardy folk living on the natural frontier.

And this self-view remained in place for decades. Witness the 1975 coffee table book, *The New Zealanders*, says Sigley, with its cover image of Colin Meads with a lamb tucked under each arm. Or take *This is New Zealand*, a film made by the National Film Unit for Expo '70 in Osaka, Japan and remastered in 2007, which was built around a sweeping series of aerial panoramas set to the music of Sibelius.

"We do have this really powerful identification with the land," says Sigley. Partly, he says, this is because we have magnificent natural landscapes that touch on the sublime, but it is also because we lack the sorts of densely layered experience to be found in the older cities of Europe.

"When I lived in France I didn't want to go into what they called the wilderness. I wanted to be in Paris all the time. I remember some friends prevailing on me to go – because Parisians are forever wanting to leave for the countryside – to Normandy, for the wilderness experience, and I was totally disappointed. The signs of human habitation were everywhere – and I just wasn't getting the experience of something primal that I get even when I go into the Waitakeres, 40 minutes from my back door. For me their real jungle was the urban one, not their tame countryside, not their landscapes that have had people living in them for 20-something thousand years."

Fortunately, these days we need not content ourselves with landscape alone. Despite its faltering beginnings, the New Zealand film festival movement eventually prospered. Led by Bill Gosden – one of the many

remarkable individuals who have made New Zealand film culture what it is – the New Zealand International Film Festival (NZIFF) now runs screenings in 14 towns and cities around New Zealand, as well as holding the annual stand-alone Autumn Events (formerly known as the World Cinema Showcase).

Sigley, who recently watched a restored version of Carol Reed's noir classic *The Third Man* (1949) courtesy of the Autumn Events, describes the annual festival, which is largely funded by box office sales, as "a fantastic omnibus... it is remarkable what they are able to offer".

Is the annual NZIFF, supplemented with the fare available through arthouse cinemas, enough? Sigley wants something more, a cinémathèque, a film library devoted to screening classic, overlooked, neglected and forgotten films. This, says Sigley, is a case of market failure that ought to be addressed. Melbourne and Brisbane have cinémathèques. Why not us?

"Here in Auckland we have middle-browish arthouse cinemas – the Rialto, the Lido, the Academy, the Bridgeway – but they don't bring in the most challenging films. They don't bring in a lot of non-European cinema. So there are great swathes of world cinema that we do not get to see, and to a huge degree our impression of what film can be is based on Hollywood."

Don't get him wrong. He likes Hollywood and Wellywood. A well made genre movie has its pleasures. "Sometimes I just want to go and chill out with my daughters watching the latest Peter Jackson Tolkien saga instalment."

But he also wants challenge. "I want films that have you scratching your head because of the novel ways in which they arrange sights and sounds. That have you thinking 'What's going on here? How do I engage with this?'."

Recently he has developed an enthusiasm for the work of Harvard University's sensory ethnography lab, best known for *Leviathan*, an immersive – in many senses – and entirely wordless 'documentary' about a fishing crew off the coast of New Bedford.

It is the sort of thing that could only ever work in the cinema proper. And it is to the silver screen, the darkened theatre, and the all-encompassing sound system that Sigley owes his allegiance.

True, the demarcations in quality between film and television and between the varieties of digital media are dissolving. Television series like *The Sopranos*, *Top of the Lake* (directed by New Zealand's Jane Campion) and *Game of Thrones* have the production values of cinema and the luxury of being able to craft extended "intricate multinarrative shows that are clearly of interest to filmmakers", and Sigley's daughters are screen agnostic: they watch their chosen media on iPods or smartphones or computers or a flat screen in the living room.

But a film viewed in the cinema, the environment for which it was crafted? That is special. Nothing, says Sigley, compares with that visceral, embodied experience of cinema, that moment when lights dim, the chatter stops, the sound swells and the movie begins. ■

Transnational Film Culture in New Zealand
Simon Sigley, Intellect Books

Sigley's current research interest – expressed in academic papers and book chapters – centres on the work of the National Film Unit (1941-90) and how it articulated the nature and values of New Zealand's national life. Generations of New Zealanders will remember seeing the National Film Unit's work at their local cinemas, whether in the form of *Weekly Reviews* (1941-50), *Pictorial Parades* (1952-71) or in-depth documentaries, such as *Journey for Three* (1950), *The First Two Years at School* (1950) and *Pumicelands* (1954). Shown here is a still from *Journey for Three*, a docudrama created to attract British immigrants to New Zealand. Directed by Michael Forlong and scored by Douglas Lilburn, this was in many ways a landmark film, says Sigley, drawing on influences as wide ranging as Hollywood, Italian neorealism and German alpine cinema. "It is a really rich amalgam and Forlong is a significant filmmaker who is still unsung. Many people suppose that only three feature-length films were made in New Zealand before Roger Donaldson's *Sleeping Dogs* came out in '77, but they overlook that at 52 minutes *Journey for Three* was considered to be of feature length, and it was released in the United Kingdom as part of a double feature." *Journey for Three* can be viewed on the NZ On Screen website: www.nzonscreen.com/title/journey-for-three-1950.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