Levy oration – 2019
Musings on our sustainable agriculture journey

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It is indeed a great honour to have been invited to deliver the Sir Bruce Levy Oration. I have chosen as my topic "Musings on our sustainable agricultural journey", as topical now as it was when I started in the mid-1980s.

I arrived in New Zealand in 1982, fresh from a PhD on *Lotus pedunculatus* in Scottish hill country, to take up a Post Doc on *Lotus* in South Island high country and Sir Levy's book 'Grasslands of New Zealand' became a bible for me. I spent some time thinking on how best to frame the oration and decided that the way to tell the story was through a time line placing policies, publications and activities that I thought illustrated the drivers and responses that made up the sustainable agriculture journey. Following the time line, I outline some global trends that will impact on grassland-based livestock production; the future role of grasslands and finally some key insights from my journey.

My first degree was in ecology in 1972, it was only the second year that the degree had been in place. It has stood me in great stead as it taught me to take a systems approach, and the importance of relationships/interactions and feedbacks. I have applied these principles in such diverse topics as agriculture, water and social systems. What really inspired me was learning about the green revolution and the power of science to improve the food security of the world. It led me to a career in applied research. However, we now know that, along with the very positive gains in food security, the cumulative impact of these systems continues to be detrimental to the environment – particularly water and soil quality e.g. use of manufactured fertiliser, pesticides and intensive irrigation. The cumulative effect is something that I will come back to throughout this oration and the unintended consequences of systems designed with only one outcome in mind.

Sustainability in a global political sense was introduced through the Brundtland report in 1987. It provided a definition of sustainable development that is still used today: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

This was followed in 1992 by the earth summit in Rio de Janeiro named Agenda 21, followed by the Millennium Development Goals of 2000, and currently the world is focused on delivering the 17 Sustainable Development Goals introduced in 2015. As time has progressed, the goals have broadened from purely environmental and economic to include social and have placed people at the heart.

So, what was happening in NZ while the global politicians were growing in their understanding that we have limited resources and that people are central to the issues and the solutions? To answer that question, we must view agriculture as a form of social-ecological system with people at its core as the decision makers and designers of the system interacting with, and part of, the environment. As with any system, it is subject to its fair share of shocks including political, climate related and institutional that have impacted on sustainable and resilient farming systems.

When people ask why I came to New Zealand I jokingly say I was an economic refugee from Margaret Thatcher and within two years neo-liberalism arrived in New Zealand. This is an example of a financial shock that reverberated throughout the system. Virtually overnight, price support was abolished along with development grants for farmers and restructuring that included the floating of the NZ dollar. The pain to the farming sector was compounded by interest rates soaring to over 20% and the newly floated dollar, which experts thought would fall, but which rose sharply and stayed there, further eroding export returns. The reforms also led to the privatisation of extension services.

The unintended consequences of these reforms included the negative environmental impact on hill country where previous government policy had provided incentives to clear and develop; however, without fertiliser and grazing pressure, these lands reverted and increased the potential for further erosion.

A major climate shock in the form of Cyclone Bola hit the eastern regions of Hawke's Bay, Gisborne and the East Cape in March 1988 with associated record high rainfall totals with storm damage heaviest in Gisborne. A total of 1,765 farmers were affected by flooding with around $90M worth of crop damage. This focused local and national policy on the concept of resilience of both land and communities. One response from the Government was to create the East Coast Forestry Conservation scheme to protect forests and prevent erosion. Interestingly, the response to the 1984 financial reforms were compounded by the 1988-89 drought that hit the East Coast due to increased feed costs.

Systems are governed by institutional norms

ISSN 2463-2872 (Print) ISSN 2463-2880 (Online) https://doi.org/10.33584/jnzg.2020.82.3431

and rules and two changes in these occurred in the early 1990s. 1992 saw the formation of the Crown Research Institutes with the amalgamation of DSIR and MAF forming AgResearch. Related to this was the introduction of contestable funding for research and over the years an increased focus on outcomes and impact. This was a shock to the science community used to having resources allocated to programmes of their choosing. Over the years, we have learnt the importance of focus on impact and building the necessary trusted relationships with next and end users of the work to ensure relevancy and impact. Unintended consequences of a contestable system have been periodic realisations that certain core capabilities for New Zealand benefit e.g. soil science, are exposed.

Inspired by the Brundtland report, the Labour government of the day undertook the groundwork for reforming New Zealand's environmental and planning laws. Further work by the newly elected National Government resulted in the Resource Management Act (RMA) 1991, which replaced a plethora of laws related to town planning and resource management. Sustainable management is placed at the heart of the regulatory framework, devolving responsibility for resource management to local councils and communities guided by national policy statements. The new RMA was a catalyst for a different way of thinking and behaving and informed research and interactions with the pastoral sector.

I moved to Whatawhata hill country research station in 1985 and continued a focus on pasture ecology shifting from legumes to grasses. This allowed me to take the principles of ecology, ecosystems, interactions, relationships, feedbacks etc and apply these to the whole farm system and later to the catchment scale. In the early 1990s, having considered the global and national awareness in sustainable development, we linked social science with biological science to explore how farmers understood sustainable agriculture. We commenced the first study groups with farmers examining simultaneously the environment and economic performance of dairy and dry-stock farming. Those farmers involved in these groups were to take leadership positions in Federated Farmers and the Waikato Regional Council assisting with policy and enabling farmers to see that the challenges were societal not only for farmers to address. These initiatives and the conversations between conservationists and farmers led to the formation of the Farm Environment Trust in the Waikato, the precursor to the Ballance farm environment awards. At the time these groups were set up it was difficult to get organisations to release staff to assist as the focus on the environment was seen as a passing fad. For me this highlights the importance of science in taking a thought leadership position and to acknowledge the courage that it takes to step out of the 'business as usual' system to aspire to respond to future trends. It is important that we support less experienced researchers to think and behave in this way.

Pastoral farming and the environment came into strong focus in the early 2000s when the work by Environment Waikato (now Waikato Regional Council) on the Taupo variation took place. Monitoring of water quality in Lake Taupo detected a slow deterioration in clarity linked to excess nitrogen, which was promoting phytoplankton growth. There was real concern that an increase in intensification of existing farm systems and/or a change in land use to dairying would result in further deterioration. One of the important changes in behaviour to tackle this issue was increased interactions among scientists, regional policy and the affected community. There were many evening meetings involving all three parties where anger, fear, denial and lack of trust in science were aired. Research up to that point had focused on increasing on-farm production with a focus on strategic use of nitrogen, supplementary feed and efficient growth of animals. Now research was saying that nitrate leaching into water was causing problems. A solution for one issue at one scale created a problem at another scale at a distance from where the decisions and action on the ground were occurring. No wonder farmers were confused. Little research attention was directed at the cumulative impact and the larger catchment system that farms sit within. A failure to join up science at different scales occurred within different organisations.

So, what was concerning people? It was the observed negative impact on water quality at a time and place of intensification and expansion of dairying. Many people thought that the market was going to influence behaviour towards achieving improved environmental performance but, in fact, water quality was very much a local community issue e.g. the "dirty dairying" campaign that drove behaviour change. Farmers had to learn to farm within nutrient limits dictated by the vulnerability of the receiving catchment and the values that the community wanted from the water e.g. swimming, collecting kai, fishing etc. New Zealand grassland systems are complex as the animal/plant interactions and predominance of all-year outdoor grazing creates diffuse contamination, which is so much harder to manage than point source. Science had to focus on delivering effective and practical mitigations and scientists had to get used to informing policy and appearing as expert witnesses. The funding system at the time was helpful in awarding 6-year programmes of work to develop solutions. Technical solutions had to be developed within relevant policy approaches that saw the introduction of the terms "grandparenting" and "natural capital", with regional councils taking

different approaches to defining and meeting water-quality targets.

Morgan Williams, the Parliamentary Commissioner for the Environment, released his 'Growing for Good' report in 2004, which outlined the state and direction of environmental indicators related to land-based primary production and warned of the consequences of unregulated intensification. His emphasis was on acknowledging that natural resources are finite using the term "natural capital" and that system re-design was required in order to continue growing food within natural capital limits. Such re-design included shifting to a value-add model where NZ products would "tickle the palates of the world's rich". Over a ten-year period from 1990 to 2000, the expansion and intensification of dairying resulted in a 28% increase in milk production in the North Island and a 43% increase (up from the 1990 7% level) in the South Island.

In 2006, the market did start to exert pressure around environmental performance related to carbon emissions (C footprint) in the form of food miles. Images of apples having oil spilled over them with the quote "that this was the true cost of an apple from NZ" were aired on UK television. New Zealand responded at a national government level by obtaining scientific evidence to refute the claims. This approach resulted in the development and use of Life Cycle Assessment (LCA) for New Zealand circumstances. LCA enables the undertaking of comparisons between the C footprint of New Zealand versus international products. For example, New Zealand dairy and sheep are amongst the lowest globally, traditional beef is towards the lower end and there is variation among farms, systems and types of feed input. As a methodology, LCA is also helpful in identifying the hot spots throughout the value chain (e.g. brought-in feed must consider the energy used in production and transportation; use of air compared to sea transportation etc) in order to target mitigation and it will continue to be an aid to designing low C systems.

International pressure on the impact of livestock on the environment increased in 2010 with the Food and Agriculture Organisation publication of 'Livestock's Long Shadow'. The publication of this comprehensive analysis had unintended consequences including: the reluctance of donors to invest in livestock systems; a call for a reduction in livestock consumption; and the ongoing vilification in social media of livestock production. With greater public awareness of the negative impacts on the environment of livestock production the market along with local community pressure continues to exert pressure on producers to demonstrate sustainable practices. Global initiatives such as the Global Agenda for Sustainable Livestock uses multi-stakeholder partnerships to develop science-based, analysis and mitigations, and documents the contribution that livestock systems make to delivering to nine of the 17 Sustainable Development Goals, taking a more balanced approach.

In 2014, as a first step to improve freshwater management at a national level, the government introduced the National Policy Statement for fresh water management (NPSFM), Te Mana o te Wai. The NPSFM, set a national direction and a platform for community discussion through a National Objectives Framework to assist regional councils and communities to more consistently and transparently plan for freshwater objectives. The NPSFM set out objectives and policies that direct local government to manage water in an integrated and sustainable way, while providing for economic growth within set water quantity and quality limits. I was privileged to be part of the Technical Leaders Group for the 2015 Waikato Healthy River plan change. This was the NPSFM in action with the Waikato Regional Council in a co-governance partnership with the Waikato and Waipa river iwi, adopting an innovative collaborative means of working, establishing a Collaborative Stakeholder Group (CSG) in 2014, with industry, community and sectors putting forward their own delegates to sit on the group. The role of the CSG was to intensively review and synthesise technical and community material and to form recommendations to inform and guide policy development but the final decisions remained with the council and co-governance with iwi. The CSG developed draft recommended water-quality limits and targets, issues, objectives and policy methods (including timeframes) for the Waikato and Waipa River Catchments, and to work out how to manage within those limits given the values that are present. I was particularly involved in the undertaking of an integrated assessment of the impact of the proposed land-use change on social, cultural, economic and environmental outcomes. What remains clear for the undertaking of integrated assessments is the lack of sound social data. Most of the assessment had to be done with small groups of knowledgeable people using, where available, past impact assessments for communities where such things as closure of industry (e.g. closing freezing works) had occurred. The types of information the community was interested in understanding the impact on included: schools, health services, retention of youth, community institutions etc. Without relevant and rigorous data, it is difficult to understand the full impact and to design transition paths that compensate for negative consequences.

New Zealand has been a signatory to both the Kyoto Protocol and the Paris Agreement 2015. A point of importance to grassland farming that is not regularly referred to is the recognition of the fundamental priority of safeguarding food security and ending hunger, and

within Article 2b, "foster climate resilience and low GHG emission development in a manner that does not threaten food production". Agriculture only became part of the United Nations Framework Convention (UNFCCC) on Climate Change in 2011 (19 years since UNFCCC formation). The Koronivia joint work on agriculture is the process looking at issues related to agriculture associated with climate change taking into consideration vulnerabilities of agriculture to climate change and approaches to address food security. New Zealand has a clear part to play in helping define and develop practices that mitigate GHG emissions from grassland-fed livestock while contributing to global food security, and futureproofing grassland-based systems to adapt to climate change.

Taking a historical perspective, it is time to look forward. There are at least five mega trends that will shape our future when they interact. A hungrier world: it is anticipated that there will be a 2-billion increase in the world's population to 9.8 by 2050 driving global demand for products; a wealthier world where a new middle class principally in Asia will increase demand for protein; a bumpier ride: increased volatility in climate, pressure on natural resources, geo-political movements will contribute to a reshape of the risk profile for agriculture; transformative technologies such as advances in digital technology, genetic science and synthetics will change the way that food and bio-based products are made and transported; choosy customers i.e. information-empowered consumers will have expectations around ethics, environment, personalised health and food safety. Linked with transformative technologies, there will also be a greater demand for transparency and authenticity. Couple this with media attention around the negative environmental impacts of livestock and recent articles outlining the combined negative impacts of red meat on the environment and human nutrition, and you have a perfect storm raining down on New Zealand pastoral farmers. It's a complex challenging world. Change is necessary to thrive. How do we give confidence to our farming community to make that change? Change is not just about technological fixes, we need change in our social, economic, institutional and environment and when it interacts it's called innovation. To understand change, we need to take a greater systems approach. Where you have a relatively simple problem a linear approach of passing on a technology fix has worked well e.g. the requirement for trace elements in the pumice country to make it viable to grow animals. As we move along the continuum of simple to complex the linear push from research does not fix the problem. The more complex the problem the more people are involved in the solution and therefore different ways of defining the issue and exploring solutions are required. A co-design approach where the system is explored to fully understand where the key points of intervention might yield the best results is helpful. It allows a variety of world views and diverse knowledge systems to be applied to the problem and for different players in the innovation system to understand their role and the role of others. Collectively this approach is known as co-innovation, however it should not be applied to every issue. There is a portfolio of approaches to aid adoption and the key to designing the best approach is through framing the right question. Thus, the importance of how you think not what you think. There has been success with a variety of farmer groups that are guided using a facilitator who has the role of questioning, listening, encouraging options and acting as a broker across networks of experts. The group is supported therefore by a network of subject matter experts with an emphasis on building the capacity and capability within the group to gain that confidence to change. A key issue that is prevalent throughout the world is how to successfully scale up from small groups to the larger community of farmers. Mapping the social network that those individuals within a group have assists with identifying those trusted individuals who have the potential to act as innovation brokers to share information throughout the network. It also identifies where there are gaps and is a tool for monitoring the performance of the group over time. Usually the network surrounding the group extends over time as they become introduced to a range of subject-matter specialists, visit other farms and demonstrations etc. Placing an emphasis on the building of a network's capability assists in reaching beyond the existing group.

To end on a positive note – grassland-based livestock grazing systems are the nexus of food security and human, environmental and societal development. They contribute to nine sustainable development goals with a focus on four domains: Food and Nutrition Security; Livelihoods and Economic Growth; Animal Health and Welfare; and Climate and Natural Resource Use. These systems need to be described in their whole not just an emphasis on the negative. We need to be able to develop a realistic view of the benefits of New Zealand grass-fed products balanced by the environmental issues and the mitigations and approaches we are taking to address these of which there are many. Grasslands of the world should unite to gain acknowledgement of the power of sunlight conversion to grass to protein that can be eaten by humans, it is really a miracle.

I offer the following insights as a personal reflection as indeed the whole of this oration has been:

- We have been attempting to address these issues with many initiatives for the last twenty years, but we have spent little time evaluating what has worked or not and why

- Excellent relevant science only informs the decisions that are social and political and is not value free
- Social science is core to understanding decision making across the innovation system
- We need to increase our capability in systems economic, environment, social, cultural approaches
- Multiple goals will mean trade-offs, shifting priorities and finding equitable transitions
- Respect other knowledge systems and utilise diversity.

Passion, energy, and tenacity have helped me with addressing the issues in my career around sustainable agriculture and now I would add one last one, **urgency**.