

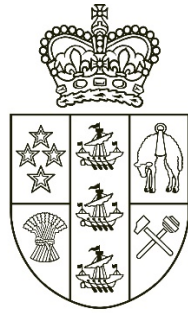


The Agricultural Dilemma

Sir Paul Callaghan Eureka!

Young Science Leaders Forum 2018

Report



*Government House
New Zealand*

Sir Paul Callaghan Eureka! Young Science Leaders Forum Report

Kia ora koutou

As Patron of the Eureka Trust, I was delighted to host the 2018 Sir Paul Callaghan Eureka! Young Science Leaders Forum at Government House in Wellington. As always, I was very impressed with the calibre of the participants and their robust and stimulating discussion.

This final report of the day affirms the vital role scientific inquiry plays in addressing economic and societal challenges of our times. My thanks and congratulations to all the young scientists for their thoughtful and informative contributions.

**Dame Patsy Reddy, GNZM, QSO
Governor-General of New Zealand**

Introduction

The Agricultural Dilemma

The Sir Paul Callaghan Eureka! Young Science Leaders Forum is a new initiative of the RCW Eureka! Trust.

The overarching objective of the Forum is to bring together future science leaders to consider how emerging science and technology may provide answers and future solutions to a public policy issue of major significance to New Zealand and elsewhere.

This year's topic was almost self-evident.

Agriculture is at the heart of New Zealand's economy. The production of food from use of our land and water provides a major proportion of the wealth generated by New Zealanders and New Zealand entities. New Zealand depends on a strong agricultural sector to be able to generate the capital and financial resources which provide us with the lifestyle we seek.

The demand for food in the world is increasing with population growth and expanding middle classes in developing countries. The United Nations predicts world food production will have to double by 2050 to meet demand.

The impacts of intensification of agricultural production on our land and water resources are a central topic of public discourse during this time of increasing awareness about the environmental impacts of human activities and climate change.

In a nutshell, this is the agricultural dilemma. How do we balance the needs of our economy, environment and the needs of people for food?

There are no easy answers. All decisions have consequences and trade-offs are implicit, inescapable and intergenerational.

Which is why, as a society, we must approach the issues at the core of our dilemma with the needs of future generations foremost in our minds.

Who better to provide input on those needs than the young people who have already shown they have the leadership and thought skills which will be needed to make the best decisions.

Therefore our Forum brought together members of the Eureka! Alumni group (previous Sir Paul Callaghan Eureka! Award winners, finalists, scholarship recipients), the 2018 Sir Paul Callaghan Eureka! Awards Finals cohort, senior secondary school science students from the Wellington region, teachers, sponsors representatives, and Rotary volunteers many of whom who have been involved with the Eureka! Programme for several years.

Process

Dr Russell Ballard, Chairman of the Eureka! Trust acted as MC and led off proceedings with an outline of the nature of the dilemma and the Challenge to the Forum participants.

Contextual contributions to the discussions were provided by:

- Professor Juliet Gerrard, The Prime Minister's Chief Science Advisor,
- Professor Stephen Goldson a science advocate from Agresearch and Lincoln University and,
- Dr William Rolleston a scientist and, as a former President of Federated Farmers, an industry advocate.

The presentation outlining the elements of the Challenge is included below.

The following report recording the outcomes of the Forum discussions and group work was prepared by science journalist Veronika Meduna, Editor of The Conversation.

The Sir Paul Callaghan Eureka!
Young Science Leaders Forum

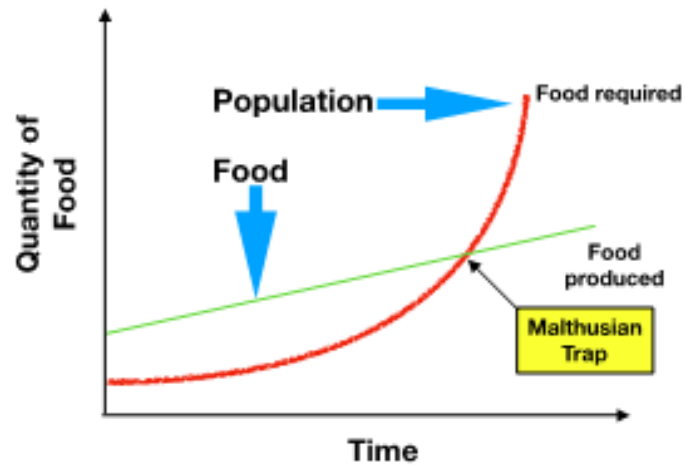
The Agricultural Dilemma

Malthusian Theory

Malthusian theory:

Population increases geometrically

Food increases arithmetically



UN Forecasts- “food production will have to Double by 2050”

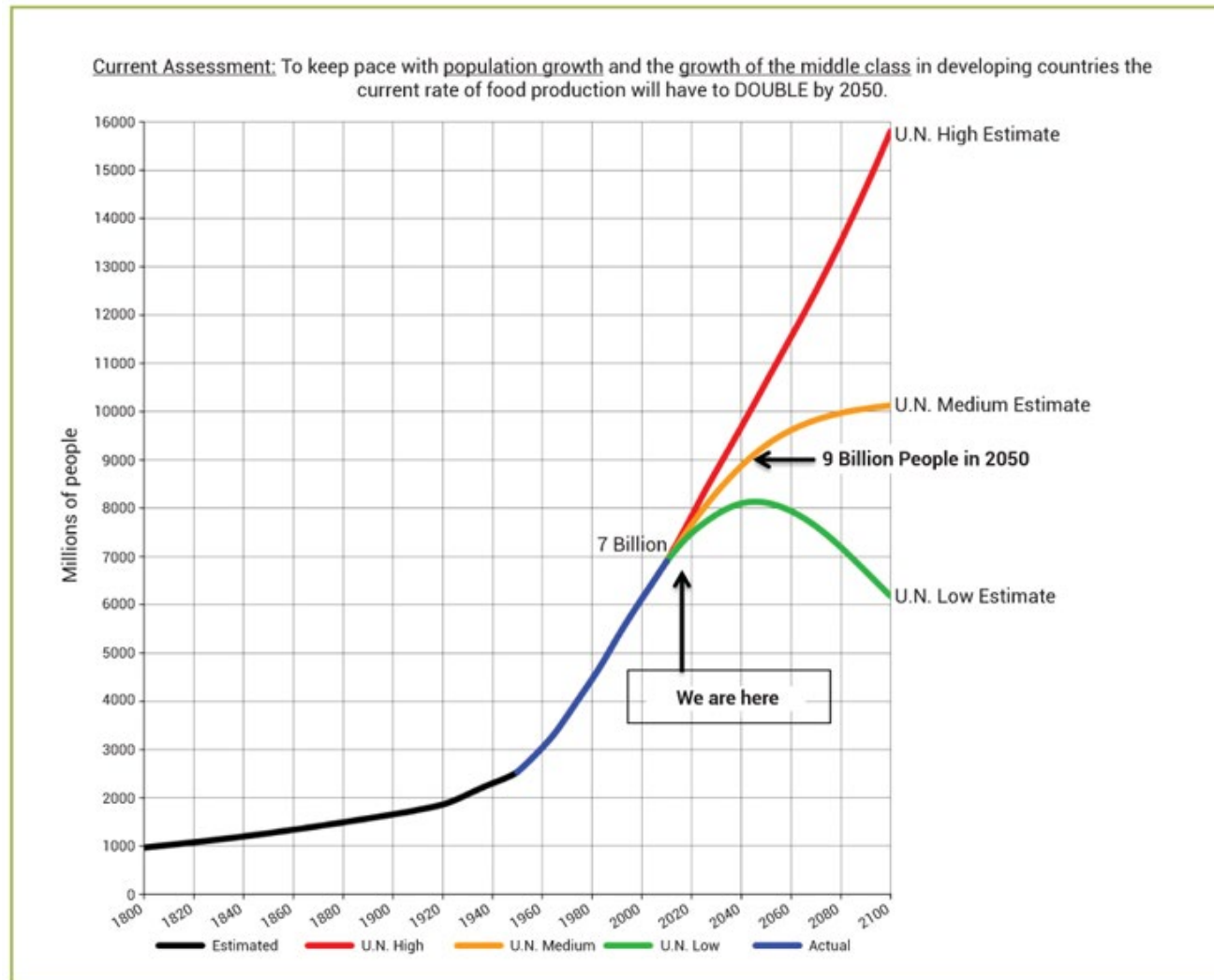


Figure 11. U.N. projections of human population growth to 2100.

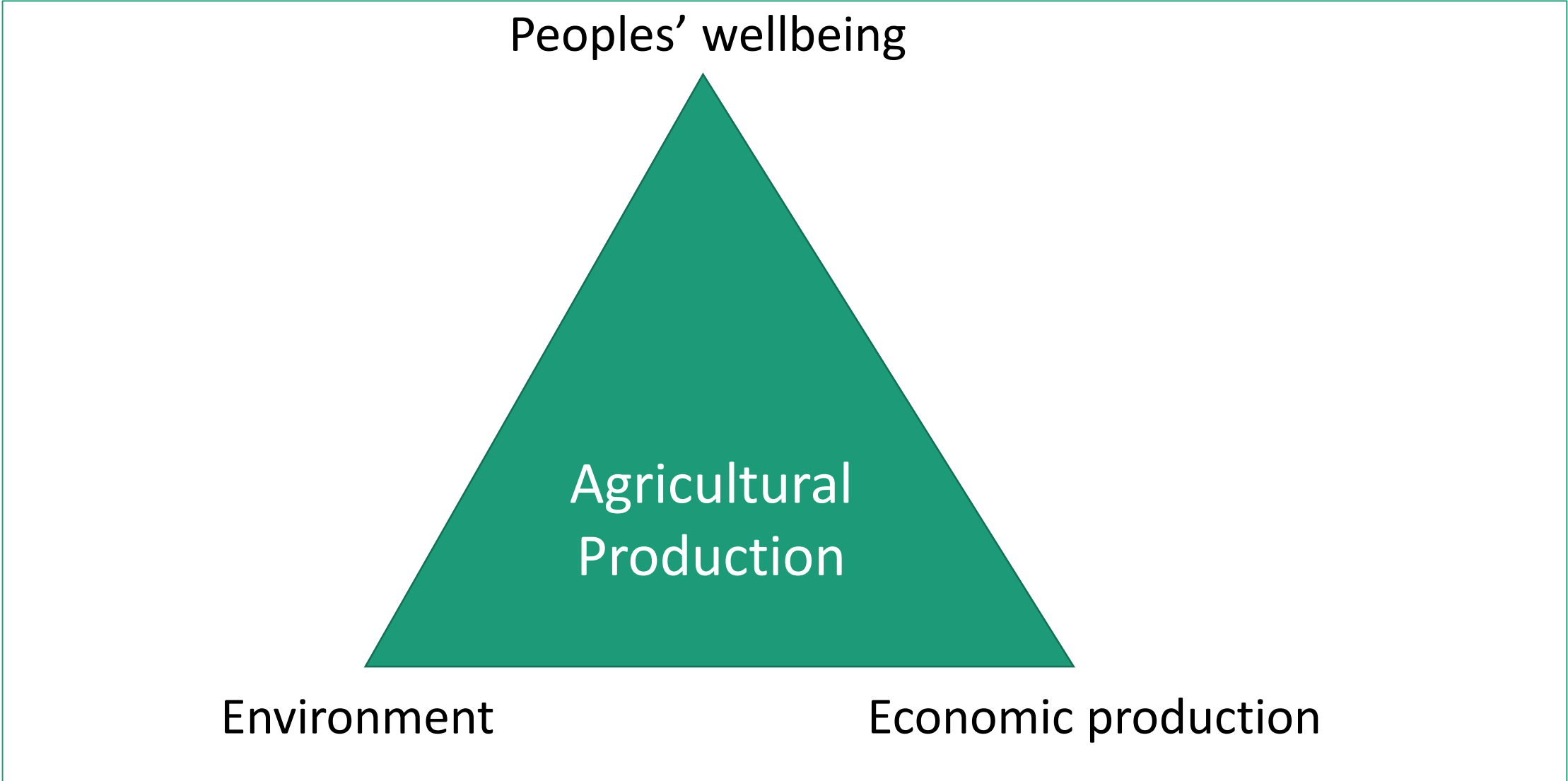
NZ Agricultural Statistics

- Agricultural Production and Processing:
 - 9% of GDP
 - 10% of employment
- Agricultural Exports:
 - ca. 60% of merchandising exports
- Global trade in Foods and Beverage:
 - 2.5% share

Agricultural Intensification

- Science and innovation has enabled intensification of Agricultural Production, delaying the Malthusian 'trap'
- However, while providing substantial benefits it has not come without issues:
 - loss of natural environments and habitats
 - water pollution
 - greenhouse gases
 - animal welfare
 - genetic diversity, etc

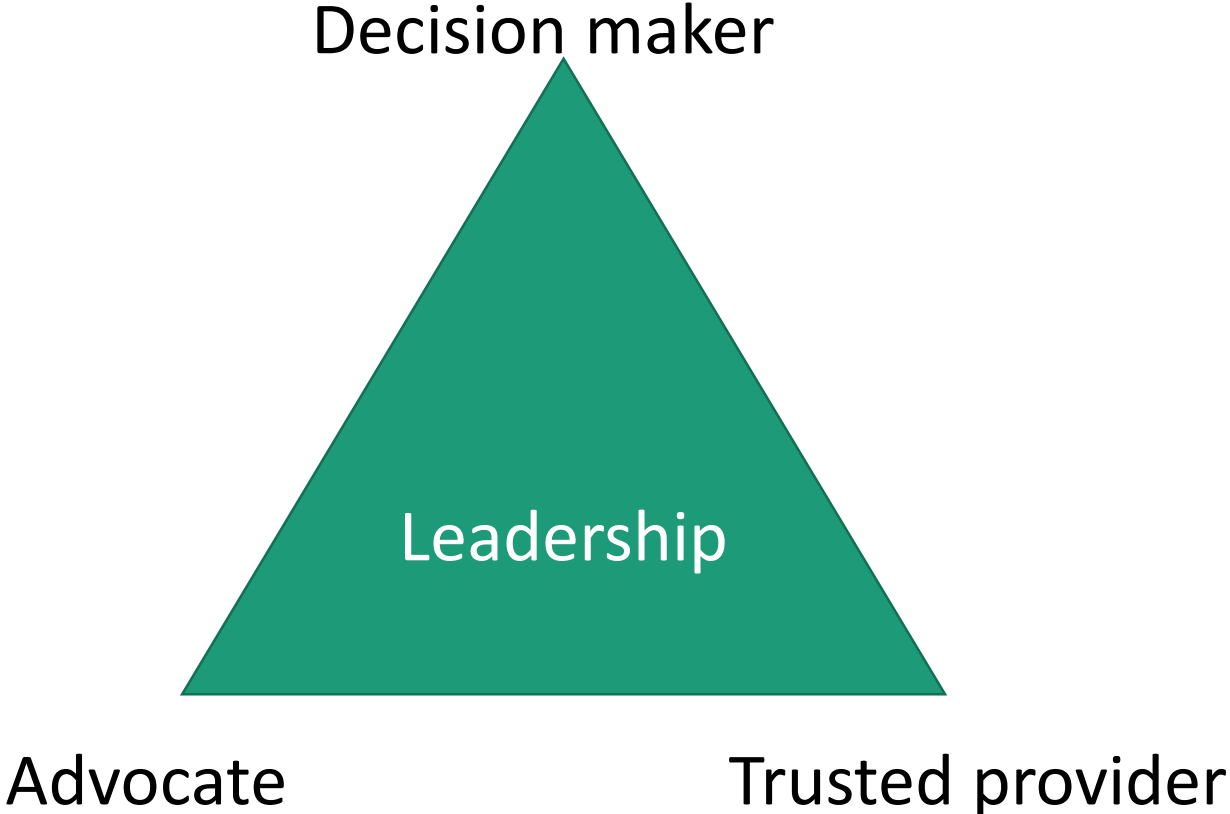
The Agricultural Dilemma



Your Challenge

- Has New Zealand got the balance just right and if not what do we need to do to get the balance right in the future?
- Consider:
 1. The impact of your recommendations
 2. What is necessary to ensure successful implementation

The implementation Challenge - Trusted information



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Sir Paul Callaghan Eureka! Young Science Leaders Forum

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The challenge

The challenge for participants was to consider the future of agriculture and whether we have the balance right at the moment. If not, participants were asked to consider what steps we need to take to optimise it in the future?

General feedback

Among the group that reported back, there was agreement that agriculture is not currently in balance, and therefore its future is a major challenge. There was a sense that the forces acting on farmers are largely economic, and that the way agriculture is practiced currently is dominated by profitability and productivity, while environmental and social factors don't yet carry equivalent weight.

However, participants also agreed that primary production is part of New Zealand's cultural identity and that it should remain so. Most specific suggestions were about how to make a shift towards more sustainable agriculture – or other uses of land and marine resources – for the people who draw their livelihood from it as well as all of us, as we depend on the primary production sector in one way or another.

With primary production (including fisheries) making a significant contribution to GDP, participants saw the main challenge in increasing production while at the same time decreasing environmental impacts.

Overall, participants thought that the primary sector will need to adopt science more than it already does, diversify and embrace social change. They saw the government's role in translating societal change, funding innovation and implementing regulation and oversight.

Summary of recommendations

Economy

Many recommendations focused on how farmers could either increase their yields without causing more damage to the environment, shift production to higher-value products to sell to elite markets, or transition to other types of landuse without losing out financially.

- New Zealand's meat producing industry could turn into a supplier of premium markets;
- Emerging markets – honey, seafood, insect—based proteins, plant-based proteins;
- Clean meat – meat produced with reduced emissions and environmental impacts;
- Restoring agricultural land to native bush and diversifying income sources, i.e. tourism;
- Further diversification to include alternative products from the land, e.g. honey;
- Is New Zealand at risk of losing its export markets?
- Focus on niche markets instead of bulk selling in order to retain economic benefits without ecological damage;
- Should economics dictate what people are able to consume (i.e. free range is more expensive)?
- Optimisation and diversification aided by science might enable a gradual, sustainable shift to a future of sufficient production and sufficient protection of the environment;
- Even if, say, the dairy industry does its best, will that be environmentally sustainable?
- Issues of large vs small scale production – can small afford to be good?
- Do we need to change attitudes to the land – not simply a resource to exploit.

Technology

There was agreement that science, technology and innovation will be required for making current agricultural methods more sustainable as well as to explore new types of landuse or marine resources.

- Adoption of new technologies should be encouraged and farmers should have better channels to receive new information; they are more likely to accept new technologies if they come through their own communication channels;
- Encourage innovation through agriculture-specific fellowships and grants;
- Seafood (through aquaculture and fisheries) could provide more protein if done sustainably.

Greenhouse gas emissions:

- Added probiotics to shift rumen microbiome towards lower methane emissions; however, only short-term solution because of microbial resistance;
- Long-term solution in genetics – improving livestock;
- Use pasture grasses that have lower emissions, e.g. forage rape;
- Changing landuse, less reliance on dairy, move to horticulture;
- Methanogen inhibitors.

Alternative sources of protein:

- Insect-based proteins (increased food production, uses less land and fertiliser, lower greenhouse gas emissions);
- Synthetic meats;
- Plant-based proteins.

Precision agriculture:

- Technologies that reduce fertiliser use;
- Vertical agriculture.

Waste treatment:

- Algae could be grown on ponds of effluent to produce feed pellets and biofuels (closed-loop system, reduced waste, less reliant on fertiliser, lower emissions, higher economic benefits; but issues of public perception, impact on farmers, potential toxicity).

Education

Participants stressed that education and communication are crucial tools for a transition to a more sustainable agriculture.

- Need to listen to a much wider community and to bring different groups together – from farmers to private sector to citizen science groups and matauranga Māori;
- Build better relationships between a wider range of groups;
- Need for scientists to earn their social licence or political capital;
- STEM assessments should be more focused on problem-solving skills and analytical thinking;
- Schools are already running research projects into insect-based foods, should be encouraged;
- Agriculture should be taught in schools so people understand the challenge;
- Connecting population centres better with rural food producers;
- Use celebrities to promote products and farm management practices;
- Target values and beliefs in communications.

Societal change

Participants felt that changes in consumer behaviour will drive some of the necessary changes in agriculture.

- Demand-led change through raised awareness of long-term consequences of some agriculture-related outcomes (e.g. greenhouse gas emissions from livestock, increased fertiliser use, river pollution);
- Society putting more effort into anticipating problems rather than responding to problems (precautionary principle);
- Shift towards a circular approach to agricultural production and the economy in general;
- Higher awareness of food waste, willingness to consume/waste less;
- Shifting attitudes towards genetic engineering (first to get public buy-in likely GE wasp control); gene editing can lead to precision breeding;
- Some of the most productive land is being lost to urban development;
- Trends in vegetarian diets; what impact will that have on meat industry; viewed as a “western” trend;

- Higher awareness of animal welfare issues;
- To keep pace with population growth, food production will need to double by 2050;
- Changing perception of taste and willingness to try new sources of protein;
- Definition of “expert” is changing;
- Technology can innovate faster than economic change; opportunity to leap-frog technologies;
- Disruption plays out in every industry, agriculture is no exception;
- Consumers care about the origin of foods and sustainability across the entire supply chain;
- Should farmers be in charge of how land is used?

Impact of recommendations

Participants were asked to consider how any of their recommendations would impact on the primary production sector. Some of the suggested changes went beyond adjusting current practice and called for a more radical reset.

- Recognition that the primary sector is very different from other industries;
- Individual farms operate within specific conditions, but their product is marketed and sold by corporate organisations;
- Difficult to develop policy that works across all levels;
- Agriculture is an export business and any change needs to happen in a global context;
- Consumers are international, whatever NZ produces has to remain attractive to international markets.

Implementation

Participants came up with a range of initiatives for what the government and the industry itself could do to implement change.

- Regulatory reform – to be more accessible, more willing to take experimental risks in contained environments, test things out rather than shutting the door;
- Increased funding support for innovation as well as subsidies for transition;
- Develop national strategy to coordinate government support;
- Develop sugar tax equivalent for meat;

- Emissions trading scheme to act as an incentive to reduce emissions from agriculture;
- Reward farmers who reduce environmental impacts, penalise those who don't;
- Develop auditable farm systems and a certification process (e.g. for clean meat) to give consumer choice;
- Any farm pilots for new technologies (e.g. algae grown on effluent) will have to be subsidised to prove concept, viability, economics;
- Protect IP in green tech;
- Set target for 100% renewable energy, electric road transport;
- Increase number of agricultural sustainability awards (e.g. Ballance awards);
- Support mental health of farmers;
- Formulate a golden standard of agricultural practice and use blockchain technology to test, measure and verify;
- Have policing in place to stop supermarkets and other food producers from wasting food;
- Critical to fund more research into new ways of optimising production while protecting the environment;
- Incentivise environmental stewardship, i.e. a direct financial benefit to producers;
- Legislate for environmental stewardship;
- Invest in training, upskilling;
- Allow more migrants in for specific jobs;
- Establish national competition to encourage people to innovate in agriculture.