T R A N S C R I P T

LEGISLATIVE ASSEMBLY ENVIRONMENT AND PLANNING COMMITTEE

Inquiry into Tackling Climate Change in Victorian Communities

Melbourne—Tuesday, 10 March 2020

MEMBERS

Mr Darren Cheeseman—Chair
Mr David Morris—Deputy Chair
Mr Will Fowles
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Mr Paul Hamer
Mr Tim McCurdy
Mr Tim Smith

WITNESSES

Professor German Spangenberg, Head, Agriculture Victoria Research, and

Mr Graeme Anderson, Climate Specialist, Agriculture Services Branch, Agriculture Victoria.

The CHAIR: Thank you for joining the Committee today for this public hearing for the Inquiry into Tackling Climate Change in Victorian Communities.

On behalf of the Committee I acknowledge the traditional Aboriginal owners of the land on which we are meeting. We pay our respects to them, their culture, their elders past, present and future, and elders from other communities who may be here today. I also extend a welcome to any members of the public and the media present today. This is one of a number of public hearings that the Environment and Planning Committee is conducting in Melbourne and around Victoria to inform itself about the issues relevant to the Inquiry.

Before we begin there are some important formalities that I must outline. All evidence taken today will be recorded by Hansard and is protected by parliamentary privilege. This means that you can speak freely without fear of legal action in relation to the evidence that you give. However, it is important to remember that parliamentary privilege does not apply to comments made outside the hearing even if you are restating what you have said during the hearing. You will receive a draft transcript of the evidence in the next week or so for you to check and approve. Corrected transcripts are published on the Committee's website and may be quoted from in our final report.

Thank you for making the time to meet the Committee today. Could each of you please state your full name and title before beginning your presentation.

Prof. SPANGENBERG: Professor German Spangenberg, Head of Agriculture Victoria Research, Agriculture Victoria.

Mr ANDERSON: Graeme Anderson, Climate Specialist with Agriculture Victoria.

The CHAIR: Fantastic. Over to you.

Video presentation.

Prof. SPANGENBERG: Thank you for the opportunity to make a presentation to the Inquiry into Tackling Climate Change in Victorian Communities. Our joint presentation today will introduce Agriculture Victoria's strategic priorities, we will provide a series of case studies on our research and innovation agenda on climate change adaptation and mitigation, and my colleague Graeme Anderson will then describe Victoria's changing climate and the impacts on-farm, emissions from agriculture in Victoria and the tools available to farmers to adapt to climate change and reduce emissions.

Supporting farmers respond to climate change is a priority for Agriculture Victoria. Agriculture Victoria's purpose is aligned with a sustainable and resilient agriculture sector, working in partnership with farmers, industries, communities and other government agencies. One of the strategic priorities for Agriculture Victoria is to prepare the agriculture sector for the challenges of climate change by working in coordination with the Climate Change in Industry Transition office that reports directly to the Department's Secretary. This office works to help Victorian industries and communities to take advantage of Victoria's shift to a carbon-neutral economy, and also build thriving places and regions well adapted to climate change.

Investment in research and innovation is a key way Agriculture Victoria is supporting the sector to prepare for a changing climate. The focus of my presentation is on research and innovation undertaken by Agriculture Victoria in partnership with agriculture industries and communities to deliver climate change adaptation and mitigation outcomes to the Victorian communities we serve.

The first example I would like to describe is our research and innovation on adaptation of dairy cows to climate change, specifically heat tolerance. For the dairy industry to remain productive and profitable in the face of climate change we need animals, and also pasture cultivars adapted to warmer, drier and more variable weather

conditions. In Victoria there are between 100 and 120 days when the temperature-humidity index exceeds 60 and dairy cows are under heat stress. The impact of a four-day heat event is a reduction of milk production of 40 per cent during the event and 10 per cent for the remainder of the lactation. So, a single four-day heat event in Victoria will cost the dairy industry approximately 40 million litres of milk, and this is worth an estimated $16 million. The identification of dairy cows that are genetically more heat tolerant is a very important strategy to mitigate the impact of heat stress.

Our scientists have thus developed and validated the world's first genomic breeding values for heat tolerance. This involved the analysis of very large data sets of millions of weather records and millions of milk production records provided by farmers from hundreds of thousands of cows, spanning one decade, together with the DNA profile of tens of thousands of cows and bulls. As a result, the heat tolerance breeding values were released in 2017 as a world-first through the Good Bulls Guide app, as you see in the image, of DataGene, which is the organisation responsible for driving herd improvement in the Australian dairy industry. This now enables our farmers to make a breeding decision as soon as a calf is born, accelerating genetic gain, with over 80 per cent of farmers accessing this technology. Heat-tolerant dairy cows drop their milk production significantly less during heat stress compared to those that are susceptible. The difference in milk is about $300 per cow per year.

This year in January in the Good Bulls Guide release there were over 300 bulls available in the Australian market with excellent heat tolerance genes, including the top two genetic merit heifers. This means that productivity and heat tolerance can be combined.

Australia—due to our research in Agriculture Victoria in partnership with industry and community—is the first country in the world to release this important tool to enable our farmers to breed for improved heat tolerance and thus also enhance animal welfare.

A second example is our research on the mitigation of methane emissions in the dairy industry. Methane production from enteric fermentation accounts for approximately 60 per cent of emissions on dairy farms. In 2019, Australia produced approximately 9.3 billion litres of milk, a level of production substantially higher than the 5.4 billion litres in 1980. This means that, due to improvements in milk production per cow through genetics and better feeding—enabled through our research—the carbon footprint of milk, as measured by methane intensity, has decreased from 33 grams of methane per litre of milk in 1980 to 20 grams in 2020—a reduction of 40 per cent. Genetic selection for cows with greater feed intake and milk production has directly led to improvements in methane intensity and a reduction in methane emissions.

We have developed the world's first "Feed Saved" breeding value, which was released in 2015 by DataGene, with ongoing improvements made since. Research in improved lifetime health and efficiency, such as genetic improvements in survival, feed utilisation and reproductive performance will also help reduce methane emissions per cow and per unit of product. Genetic selection alone could result in a 34 per cent reduction in methane yield and a 46 per cent reduction in methane intensity.

This transformational research is part of the DairyBio initiative funded by the Victorian Government jointly with industry via Dairy Australia and the Gardiner Foundation. Importantly, it has a well-established route to impact via DataGene, thus ensuring the delivery of outcomes for Victorian dairy farmers and the Victorian communities from our research efforts.

Our research has also quantified the effects of dietary fat supplementation—using by-products from other industries—on methane production by dairy cows, and we can reduce it by approximately 3 per cent for every 1 per cent increase in the dietary concentration of fat.

Mr FOWLES: Can I just clarify there, Professor Spangenberg, when you are talking about the dietary fat, you are talking about the input into the animal?

Prof. SPANGENBERG: Yes.

Mr FOWLES: In a pure grass diet there is very little dietary fat anyway, is there not? It is mainly when they roll on the grains that the fats are introduced?

Prof. SPANGENBERG: Exactly. It is in the form of a supplement provided in the dairy with the grain.

Mr FOWLES: So there would be seasonality to that too, wouldn't there?

Prof. SPANGENBERG: Well, it could be controlled. It is basically adding cottonseed meal, for example, or canola meal or grape marc, so it is by-products from other industries that are fed in the—

Mr FOWLES: Sure, but they would only be fed in the months when there is no grass on the ground?

Prof. SPANGENBERG: They could potentially be fed also—

Mr FOWLES: So is your study a year-long study?

Prof. SPANGENBERG: Yes, this is research that we have done year-long.

Mr FOWLES: Okay, thank you.

The CHAIR: Thanks, Professor.

Prof. SPANGENBERG: There are also other emerging nutritional strategies that have the potential for further substantially reducing methane emissions from ruminants. One of those is a new additive that is called 3-nitrooxypropanol, which is the formula that you see there—or 3-NOP for short. Our research has shown that through using in-vitro techniques that when we add 3-NOP we could reduce methane production by up to 60 per cent.

In summary, the key message that I want to convey to the panel is that the mitigation of methane emissions from the dairy industry will involve a combination of existing as well as novel technologies. Our research in Agriculture Victoria has been at the forefront and remains fundamental to achieving this outcome for the dairy industry and Victorian communities.

The CHAIR: Can I just ask, and it is probably a little bit more related to the previous slide on heat stress really, but a lot of dairy farms that I have visited often do not have a lot of shade. Obviously at this stage you have done a lot of research in terms of the genetics of animals to increase their tolerance of heat, but it occurs to me that on a hot day if you are under the shade of a tree, it is substantially more comfortable—certainly from a human perspective—than it is in the heat of the sun. Is the department doing any research in terms of how farmers might utilise the uptake of trees to provide shade, which would also perhaps assist those dairy animals in dealing with heat more appropriately or more comfortably?

Prof. SPANGENBERG: We have established interventions in the form of either the use of sprinklers in the dairy or trees for shade. Genetics is in-building a solution in a form that gives us cumulative benefits over time. In a sense, the simplest way of taking innovation on farm is actually through seed and semen—it is through genetics—which delivers cumulative effects. These are complementary approaches; and the focus of our research is on genetic innovation via an established route to impact through DataGene.

A further example that I want to provide is the one on research and innovation on improving the flexibility and also water use efficiency of forage systems in adapting to climate change. In Victoria, the profitability of pasture-based livestock systems is intimately linked to the amount of home-grown feed converted into animal product. Our research, in this particular case, was focused on northern Victoria and has centred on two main themes relating to, on the one side, changes in water availability and how to improve water productivity—it means the amount of forage production per unit of water—and also how to develop more flexible forage systems. In doing so we have been able to identify forage systems with 40 per cent higher water productivity, and that has benefited farmers in making decisions on changes to the forages grown on farm.

Further, studies using information from commercial dairy farms have allowed us to identify grazing management options resulting in a 35 per cent increase in the amount of pasture utilised by grazing when compared to the current industry "best practice".

Research undertaken by Agriculture Victoria through two major innovation initiatives, DairyBio and Dairy-Feedbase, in partnership with Dairy Australia and the Gardiner Foundation, has also led to the development of the world's first experimental hybrid varieties in ryegrasses, perennial and short term to

enhance yield; and to quality all fescue; and of novel pasture measurement technologies to optimise pasture utilisation.

A further example refers to our helping the grains industry adapt to climate change through a landmark research program that we completed recently on the effects of elevated carbon dioxide—or CO_2—on grains performance and quality under field conditions, and we simulated that in a horizon of 2050. This was an 11-year program referred to as the Australian Grains Free-Air Carbon Dioxide Enrichment—or AGFACE for short—which provided, I think, vital knowledge to help equip the Victorian grains industry to adapt for future climate conditions. It permitted basically the study of future climate impacts now, thereby allowing us time to adapt to future environmental conditions.

It is well established that atmospheric levels of CO_2 are rising. Actually during the 11-year life of the AGFACE program atmospheric CO_2 concentration rose from 383 to 407 parts per million, so—a 6 per cent increase, and the concentration is predicted to increase to 550 parts per million by 2050, which was the target concentration that we studied in AGFACE.

In AGFACE, the impacts of current and future climate variables and their interactions were tested in over 60 crop varieties covering wheat, field peas, lentils, canola and barley—with a variety of environments including drought, heat extremes, soil types and fertiliser inputs included with elevated CO_2 to capture a broad range of climate and production variables that are important to understanding climate impacts to agriculture.

The key findings from AGFACE into the effects of elevated levels of CO_2 on semi-arid rainfed cropping systems show that traits selected to improve water use efficiency will become even more beneficial under future climate scenarios. The reductions in plant nitrogen and concentrations of other nutrients due to the direct effects of elevated CO_2 are expected to decrease grain and bread quality, as well as increase pest and disease impacts on yield, unless new traits can be selected to reduce these negative impacts. On the other side, elevated levels of CO_2 were shown to increase nitrogen fixation and growth in grain legumes—pulses. These findings from this work fundamentally informed our current research to drive genetic gain to address the negative impacts, particularly in cereals, through a technology that we developed in Agriculture Victoria that we call "genomic selection", which we now routinely apply to breeding in cereals, oilseeds, pulses and forages.

This brings me to describing now a key national innovation asset that Agriculture Victoria hosts and operates, and this is the Australian Grains Genebank. One cannot possibly imagine agricultural systems that are productive and profitable in the context of climate change without there being crop varieties that are adapted to climate change. And crop diversity—more specifically, genetic diversity underpinning traits—constitutes the fundamental biological basis for adaptation.

Access to genetic diversity is an essential prerequisite, regardless of whether the selection and breeding is undertaken by farmers or breeders, and the striking fact about crop diversity and access to genetic diversity is the level of interdependence that we have, that exists amongst countries. Plant genetic resources for food and agriculture are the quintessential global public good. No country is self-reliant, and least so Australia.

The Australian Grains Genebank is a national centre for preserving and distributing grain crop genetic resources for Australia and is a result of a partnership between Agriculture Victoria and the Grains Research and Development Corporation on behalf of grain growers. It houses more than 159 000 accessions representing 300 million seeds from over 150 countries that are currently held at -20 degrees Celsius—that allow us to maintain them viable for 50 years or more—and we distribute—on an annual basis—tens of thousands of accessions, both nationally and internationally.

Grain genetic resources are essential for global food security. They house the global diversity of crop traits and genes for their use in accelerated procession breeding, traits such as disease resistance, drought tolerance, water use efficiency, nutrient use efficiency, grain quality and many others that the AGFACE program highlighted.

Worldwide, coming now to the last example I would like to describe, there is an increased demand for plant-based protein foods. Pulses are an attractive source of plant-based protein as they have a protein content of between 20 and 30 per cent. They are thus in high demand to complement animal-derived sources of protein and also to cater for evolving dietary patterns. Our research and innovation in pulses over the years has enabled

and underpins this growth opportunity of the plant-based protein sector, including new regional employment, new industries, new products and new markets.

Our field pea variety, Kaspa, for example, commercially released in 2002, was quickly adopted by industry and represented over 90 per cent of production in the years following the release. And, since, we have released multiple varieties of field peas. In 2018 we released a variety called Butler with improved tolerance to bacterial blight—this is a disease that is particularly triggered through damage by frost. And next year, we will release the first field pea variety with multiple virus resistance and excellent yield potential across all growing areas in Australia.

In relation to lentils, the area sown to lentils was negligible in 1994, and it exceeded 350 000 hectares in the 2017–18 season, with the lentil variety Nugget bred by Agriculture Victoria now widely being considered as the industry standard. Since, again, we have bred and released multiple lentil varieties, including recently the herbicide-tolerant variety PBA Hurricane XT that made up 63 per cent of total pulse varieties sown in 2017. And last year, the variety Highland XT—targeting the drier regions of growing districts—was released by Agriculture Victoria. Next year we will release a first herbicide-tolerant large-sized red lentil variety that will give growers better marketing options and improving also grower resilience.

Agriculture Victoria has been the foundation that built the Australian lentils, chickpeas and field peas industries, cementing our role as a national leader in pulses genetic improvement, quality and agronomy.

Pulses, in particular lentils, are a high-value crop contributing to the profitability of grain growers. The adoption of lentils has also attracted new lentil processing industries—dehullers and splitters—also a freight distribution hub and transport companies, all of these contributing to regional employment, to new jobs in regional Victoria.

Pulses are also an important rotational crop for cereals; they reduce soil-borne pathogens, increase nitrogen fertility of soil and decrease—in that manner—growers' dependence on chemicals and fertilisers that are associated with nitrous oxide emissions, enhancing the diversity and resilience of agricultural production systems.

Pulses also will attract price premiums across different export markets, including in India, Bangladesh, the Middle East and China.

We are currently also investigating viable alternative legumes that can be grown as both winter and summer crops to provide diversification of crop choice, disease break options, nitrogen benefits and maximise resource capture across the farming system.

Thank you for your time and for the opportunity to present.

The CHAIR: Terrific. Thank you. There is one additional slide. I am not sure if you wish to speak to it.

Mr ANDERSON: Yes.

The CHAIR: Okay, Graeme, you are going to take us through that?

Mr ANDERSON: Yes.

The CHAIR: We might hear your presentation and then we will open up to questions.

Mr ANDERSON: Very good. Thanks for the opportunity to present to you today. I lead our climate extension engagement, so we do a lot of work with farmers, so we are just running through some of that engagement work we do.

Farmers are noticing a lot of increase in variability and extremes. We do a lot of engagement with them to talk through understanding good old-fashioned variability, also recent trends, but also the science behind what is changing. One of the key things a lot of farmers have noticed that in the 1980s if you watched a cold front off the coast of Perth, it would mean rain three days later; now more often than not they watch it slip to the south. So explaining that science to them is a key bit because that is what sets them up for what are they planning for.

There is great interest and a lot of discussions around what drives their variability. I guess one of the things is the example of a product that we put out a couple of months ago, which is temperature decile maps for the last 100 years. So while a lot of farms have long-term rainfall records and rainfall variability will continue, farms do not have records of temperature. Many remember a hot day as a kid, but this particular decile map shows that changing pattern. So we are at the start of what is a longer journey of these increasing temperatures. Farmers have noticed a lot of those changes. There is a lot of great work happening to adapt to that. There is also a range of views on climate change, and I guess part of it is around framing it so that people are preparing and doing things that prepare them well for the future.

Victoria is predicted to get hotter, so you can see those trends there—those temperature trends from south-east Australia. Those trends are as predicted. While there is some variability there, that is what will continue, and how far they continue is to do with the amount of greenhouse emissions that are put in the atmosphere. One of the key things for agriculture is that if you just repeat the last 100 years of variability but you do that 1 to 2 degrees warmer, you do not get the same result, so dealing with a bigger summer, extended summer, is part of it. Some summers will be okay, but if they are drier summers that extra heat plays out differently for us.

Certainly farmers are noticing water security and reliability has been affected in both our dryland catchments and also our irrigation areas, and that has been played out with a lot of discussion on water reliability. That is not just in the drier areas but often in some of our higher rainfall areas, which traditionally have quite reliable run-off. Farmers are noticing a bit more variability in that, so there is a lot of effort to go to how we improve our water security.

Also, what we have noticed is volatility between seasons. We have always had great variability, but supply chains and farmers are experiencing greater production fluctuation. When everything goes right, we can produce more than ever. But the next year, if it is a very dry year, we can have very low production levels. That coping from one to the next puts a lot of pressure not only on individual farms and businesses and their management but also on supply chains. An example was our 2015 dry season where a lot of input suppliers would not have sold a lot of stock and farmers tightened their belts because it was a low production year. The next year we had a one-in-20-year high rainfall year. Farmers were keen to put all of the great innovations forward and then they find it difficult getting hold of fungicides or inputs or what have you. Some of these issues and that volatility go right across the supply chain.

Another observation is around extreme events and poor seasons, which can disrupt farm business incomes. Even speaking to farmers recently in East Gippsland, the amount of money that some of them have spent on fodder puts back their business plans by five years. A common theme is, 'We just want five relatively normal years that we can get to where we want to'. But if you suffer a great disruption, you are spending all of that money on something that you perhaps would not have had to 30 years ago. So there is a lot of work there on dealing with that volatility that is taking the edge off some of that profitability. But also from a productivity point of view, with a lot of the great gains we have made in agricultural productivity, increasingly volatile weather can take a slice off some of those productivity improvements. If we indeed had 30 years of average rainfall, we would see higher benefits coming from all of that, so there is a challenge there in how we meet that challenge and increase that rate of productivity improvement.

We know that the risks to climate change are greater the higher the global emissions. The challenge before us—and there is a lot of discussion happening globally, nationally and at a state level and at an individual business levels—is around how we tackle emissions. The graph on the top right is agricultural emissions in Victoria. About two-thirds of that is from enteric methane from livestock. Second to that is agricultural soils with nitrous oxide. You are probably aware of this, but in the accounting of the emissions, 'agricultural emissions' is just referring to methane and nitrous oxide.

If you look at the graph on the top left [slide 12], you can see agriculture is at the top there as a proportion [13.5%] of all of Victoria's emissions, but down the bottom you will see land use and land use change and forestry, so agricultural lands in terms of the carbon that is in soils or taken up in trees and forests also play quite a key role. In the broader production of food and fibre there are emissions that actually come across a whole range of those sectors, whether it is transport or electricity.

The image at the bottom is really just showing some of these areas which are on farms and what sets us up for making progress on tackling emissions on farm. On the right you can see trees and soils, so our landscape has a great ability to hold carbon. I guess we often refer to it as the role of carbon stewardship and sequestration. I mention stewardship because there is a great deal of carbon in our landscape and if we warm up another degree some of that carbon is at risk of being released. It is not just automatically about adding sequestration in, we have actually got quite a task to ensure we understand our carbon assets and they are still there in 2050.

There is great opportunity for adding carbon through more trees on farms and farm forestry, shelter belts and all of that, as you say. Often a lot of those benefits from becoming more efficient and having a better farm play out well for emissions as well. And it is not just forestry. I did bring a sample here today; this is an example of a straw panel product that is made Bendigo. That actually takes carbon out of the atmosphere, and that straw goes into building product that is basically the same as forestry as a way of taking carbon out of the atmosphere and putting it into housing stock and creating jobs along the way. There are those solutions out there when you start looking at the world and 'How do you turn this into something that is of value?', so that is happening.

Soils is a really big area. German has looked at all of the terrific innovations coming for livestock and around also the nitrogen management on farms, so there are a lot of gains there. All farmers we meet are really keen on how they actually become more efficient at these things, so all of these things have a natural benefit to the actual business and production. So that is good.

The supply chain: I know one thing that resonates a lot with farmers is that the supply chains are responding in terms of the need or drive for lower emissions products. In providing food and fibre for a world of 8 billion, there are great opportunities there by actually being leaders in lower emissions products. And energy—so there are certainly the other opportunities around how agriculture participates in the energy transition.

Speaking on that, the department has had the Agriculture Energy Investment Plan, which has been a $30 million investment. It has basically been spearheaded about growing that capability of being able to become more literate around energy on farms and where to invest. So there are a lot of assessments on farms and grants to help with applying improvements. And quite a lot of that is around, you know, reducing energy costs by about 20 per cent—to actually apply those innovations on farms. So it is a good example of being able to do things better. It reduces emissions but saves money.

I am fairly comfortable with this sort of space, with our engagement with growers. There has been a lot of work on climate literacy—understanding variability and climate change. We have got products like *The Break* newsletter, that puts out monthly commentary to farmers on seasonal forecasts, because climate change will turn up one year at a time and understanding how the oceans and seasons are primed for wetter or drier is important.

Deep soil moisture probes are an example of new technologies which are buried under paddocks that keep farmers up to date on how much rain is stored in the top 1 metre of the profile, and that can be really important for farmers as part of trying to make the most of it when we have seasons when the soil profile is full; and then when there is actually limited stored soil moisture, that is a warning sign for managing risks better. So there have been a lot of great decisions based on that, and there is a lot more development of that as an example of a [climate risk] technology.

We do over 140 forums a year, working with agriculture stakeholders or advisers or Landcare groups, where we are invited to come and speak and share information on climate. We have a climate webinar series—there is one tomorrow—which is just trying to make this information more accessible, and people can watch recordings at a time that suits. The Climatedogs animations—I am not sure if you have seen them. We have done them for Victoria, explaining the science of climate and what is behind our big drivers of variability, and they have been taken nationally. There are farm sessions on farm water supply, soil erosion, maintaining ground cover and farm planning. There are dairy and irrigation workshops that are happening at the moment around climate risk. We have livestock network programs like BetterBeef and BestWool/BestLamb and a key element of all of those is setting farms up to deal with greater variability within livestock systems. The Horticulture Industry Network have a number of meetings where they focus on climate. We have dry season support infrastructure grants. It is largely about, as we go through each dry season, learning from that and building back better.

So a key focus is around supporting industry and community climate risk projects. So our role is really to be supportive. There are a lot of service providers out there supporting farmers and agribusinesses, and we often get used to come in and help explain some of the climate change, because it can be a bit of a conflicted topic for some of them to talk about. And a lot of partnership projects that we have nationally are with the Bureau of Meteorology and RDCs [research and development corporations].

So I guess this is sort of a bit of an overview of some of the activities that support Victorian farmers to manage climate impacts. As German has gone through, you know, modern technologies, research innovations, genetics innovations—all of those things hold us in good stead, and they have got to be captured and tested and applied in a Victorian context.

Improved on-farm and regional infrastructure, especially around storage of water—we have seen a lot of that, but that is the sort of stuff that holds us in really good stead. And improved communications, transport and social—these are the things that farmers are saying, 'This makes for good communities to live in'. That is what we are trying to create.

Working across jurisdictions has been a really important one, and getting that national coordination. So Victoria, and our policy team, has been pulling together a national collaboration via the Ag Min. There are also great opportunities in meeting local market demand, but we have got to ensure we are still good at maintaining A-plus biosecurity. That keeps our markets open, so that is really important, and also looking at how we make the most of having lower emissions, food and fibre for markets and we have got the evidence base to demonstrate that.

Business management: this is a key thing that is popping out even more so, to deal with that volatility is around who is better prepared to manage the business impacts of that, financially. Farm planning, there is a lot of that—which helps making a landscape better prepared for the changes in climate. And the people bit is around networks, knowledge channels, basically all communities and farms are after access to how they maintain good connections that are bringing in good knowledge so that they can invest and grow. And practice change is the focus, I guess. While there is a lot of talk about what people might believe on climate change, whenever we talk about the 'practices which make farms better off, improve their efficiency or save them money', everyone is fully on board with that.

So that is our summary. The climate is changing. Expect it to become hotter and drier with more extreme weather events, but higher global emissions bring with them higher risks. So we have a great self-interest to be reducing emissions. Increasing variability and extremes are already having an impact on farms. There is terrific science research and innovation to help farmers be prepared for the future. We have got tools and information to help farmers discuss, understand, manage and seize opportunities. Often a lot of this is framed as 'There are obvious risks', but there are also a lot of opportunities for those who have solutions and can do this well. And it is a priority for Agriculture Victoria at the moment.

The CHAIR: Terrific. Well, thank you for your presentation. I certainly have a number of questions, as I am sure my colleagues do.

So Landcare obviously over the last 30 years has been a real innovation and has, I think, led to a lot of low-cost but great quality outcomes, for fencing off water courses and all of those things. It occurs to me that it is a really robust model because it is farming communities effectively working together with a shared common vision. Agroforestry and soil carbon and some of these other innovative farming techniques I think are relatively poorly known amongst the Victorian farming community. There are certainly some hotspots where it is happening really well—the Otways would be a good example of that.

It occurs to me that agroforestry obviously provides a number of benefits. Firstly, it is a cash crop that is available to that farmer in 30 or 40 years time. But there seem to be some barriers in place: (a) it is poorly understood, and (b) often there are impediments to farmers in 20 or 30 years time in removing that agroforestry crop because it gets caught up in other public policy challenges. But it occurs to me that there are a huge number of benefits around putting additional carbon into the soil, into providing great shade and shelter for livestock, and ultimately if it is done well there will be a fantastic crop. How might ultimately the department better support farmers wishing to take up agroforestry, and what are from your perspective and observation some of the impediments to that being taken up to a greater extent?

Mr ANDERSON: I might have to take that question on notice. I used to manage a Plantations for Greenhouse Project. The Otway Agroforestry Network—they are great examples of what can be achieved. We do know, like with Jigsaw Farms, there are great examples of farms that have really happened throughout the Landcare era where farmers have revegetated a proportion of their farms and the extra shelter benefits. The farms look fantastic, and they have got a great carbon story to sell. A key part of that too has been not just the revegetation activities but really increasing the agricultural production of the agriculture component of land. Those two are always there, even with the Otway Agroforestry Network. That is a key element of improving the agricultural bit, by having more integrated trees.

The CHAIR: Certainly one of the observations that was made to us was—I assume the proportion might be slightly different depending on the landscape—that you can potentially put aside 20 per cent of your farm and it will still lead to increased agricultural gain because you are not losing lambs. There are a whole lot of benefits. Even though you have reduced the footprint of your farm in terms of what you are actually farming in a traditional sense, there are productivity gains that offset that if it is done well and thought through in a clever way.

Mr ANDERSON: That is the story for Jigsaw Farms, where they have doubled production on 80 per cent of their best land agriculturally using really good science in fertility and pastures, livestock and feedlot systems there. The less productive soils are what they have put to farm forestry on quite a scale. That works very well for the lamb industry, but perhaps 20 per cent would not translate as well if it was a dryland cropping situation, so the different farming systems probably have a difference in what is the right percentage that matches the local landscape. But a key challenge for those that are wanting to do more revegetation is usually going to be the up-front cost, and there are fencing requirements as well. It is just a longer term journey in terms of that investment. So that is often a challenge that is brought up.

The CHAIR: And that just leads in to one further question. So historically the department of agriculture in its various guises in the past provided a lot of extension to farmers, and I think perhaps public policy over the last 30 years has seen a lot less extension provided to farmers. It seems to me that with some of the challenges around climate change adaption—educating farmers, assisting farmers in understanding what the productivity of their farms and the climate of their farms might look like in 10 or 20 or 30 years time—it might be of benefit that there is that opportunity for farmers to access support, advice and guidance. It seems to me that it is a bit piecemeal at the moment—often that resource was available to farmers in the past, but it is no longer available, and farmers often do not know where to go to get it. What is the current thinking from the department's perspective about how we might best engage with our farmers, literally farm by farm, to help them understand some of the practices they might wish to implement over the next period of time to enable their farms to continue to remain viable and productive and those kinds of things?

Mr ANDERSON: I have to take the question on notice in terms of the department's response, but with the overview of the development of extension resources across Australia you are quite right. Perhaps in the 1960s there was a much greater emphasis on departments of agriculture as the key extender of science information. Since that time there has been a really large growth of other providers who deliver services to farmers, so farmers get advice now from the retail sector where they are buying all their plumbing equipment and that sort of thing.

The CHAIR: Fertilisers.

Mr ANDERSON: There are also paid agronomists and livestock advisers. There are various levels of use of those, but if we go to our cropping areas it is very common that farmers have employed agronomists. So in a lot of ways, for some of those areas, they are getting better service than they would have in the past, and I guess the challenge is just around some of the public policy issues. Where are some of those private services not delivering? Often we will be involved in projects where there is a public policy reason for us to be involved and there is investment for that, and then with that service there is a discussion about who is best to deliver that service to have the greatest amount of engagement with farmers, whether it may be with us with regard to currently climate change and our climate communication stuff—that is where we do that.

The CHAIR: But if you are an agronomist working for a fertiliser company, surely you have a vested interest in selling as much fertiliser as you can. That is your livelihood. Are we comfortable with that advice

being the appropriate advice to the farmer, or is it motivated by the individual wishing to sell as much product as possible?

Mr ANDERSON: I guess that driver would be there, but an example would be the federal Carbon Farming Initiative a few years ago. They had an extension and outreach scheme. We teamed up with Fertilizer Australia, and they have a Fertcare accredited training program. We packaged up the science and worked with them on that, and so that was put into all of their training and accreditation programs for fertiliser advisers—who are Fertcare approved—and their fert spreaders on understanding nitrous oxide emissions and soil carbon. So it is an example of that partnership, and all of those farmers who use Fertcare-approved providers are getting that advice with the greenhouse stuff embedded in. So there are ways of doing it, and that is our challenge of 'How do we do it in a partnership?', because there is that [potential] conflict there. I guess we see that point is about looking at what is the best way of getting this in the hands of farmers. And that scheme, the federal carbon farming and extension outreach scheme, it actually put it out there—'So, okay, this is a public policy issue, but we'll invest in getting this R and D [research and development] through whoever is dealing with farmers'. There was an incredible array of networks and advisory groups and consultants and dairy supply businesses that all came and said, 'Yep, we want to work with our clients to improve how they do this'. So I guess that is sort of the transition from the 60s when it was primarily just an ag department's domain, but now there are a lot of other potential partners that we can work through to make sure that it is getting in the hands of farmers. I hope that makes sense.

Prof. SPANGENBERG: There are also new channels for delivering information. For example, what I have tried to illustrate is how digital technologies assist, and industry is then fully empowered to access relevant information. As an example, all the animal genetic innovation that we do for the dairy industry is basically delivered through an app, that every farmer will have access, to via an industry-owned non-for-profit data company. So in a sense there are now more channels and more technologies that facilitate tailored delivery of information to growers.

The CHAIR: The last question before I hand over to my colleagues. That obviously just shows Australia-wide what is happening with our climate. If I was a farmer, wherever it might be in Victoria, I would like to drill down into the data to see what that means for 10 or 20 or 30 or 40 years for my farm or at least farming district and what are some of the things that I might wish to do to change my farming practice even if I am remaining in the same industry sector. It seems to me that is often where the gap is, and often, yes, you can access information potentially through an app or whatever it may happen to be, but actually sitting down with someone and having a tour of the farm and having a conversation about some of the things that might be done to increase the resilience of that farm to climate change and increase the variability and those things, that is where a really practical use of extension might be really beneficial. I am comfortable I think in saying this now, that in the evidence the Committee has heard over the last six months there seems to be a gap in that bit, if that makes sense.

Mr ANDERSON: Yes, that does.

Mr MORRIS: Just on that chart, is there any chance of getting one that I can actually read without having to go to a large screen to do it?

Mr ANDERSON: Yes, I can get you one. Do you want posters or do you want it on a slide?

Mr MORRIS: A slide is probably the best.

Mr ANDERSON: We have got that [posters] for rainfall and temperature. People are familiar with posters that have Australia's variability of rainfall, which the Long Paddock in Queensland's department has had for a long time. They are fascinating, and you can see the big drought periods and wet periods, but it is interesting that no-one has put the temperature one up beside it and said primarily this issue is around the increase in temperature—we will have wetter and drier years in future but this is the bit that is not well understood.

Mr MORRIS: Yes, exactly. Can I go off on a bit of a tangent that sort of comes out of the bushfires, which are likely to be a more frequent presence in the landscape. I am from the Mornington Peninsula, so I am obviously interested in the grape industry, but as we have travelled around we have talked to quite a few wine growers and there has been a discussion about smoke taint in grapes. It may be outside your respective fields,

but I am wondering if there is any indication yet on the extent of the problem we are likely to have this year after the fires, or whether it is too early to tell.

Prof. SPANGENBERG: Agriculture Victoria has facilitated analytical services from different service providers, both in Victoria, and also by the Australian Wine Research Institute in South Australia. It seems from the results of that analysis that we have a patchy type of response. We know that there are significant differences from the point of developmental stages of the grapes, varieties and so on, so in a sense it is a bit too early to tell, but we will see how that develops, and we can expect variable results. The critical intervention though, is one of increasing the analytics to be undertaken so that growers can make the decisions as to whether to pick or not to pick the grapes. That is the reason why we want to do very targeted efforts—in the short term—to further reduce the cost of analyses through improvement in the analytics and by having analytical systems that are more predictive, as well as ultimately also reducing costs of testing so that these are more broadly applied.

Mr MORRIS: Thank you. If I may, Chair, just one other one: under the *Climate Change Act* there is a responsibility for the department to prepare an adaptation action plan. Where is Ag Vic at with that process?

Prof. SPANGENBERG: Well, the Minister for Energy, Environment and Climate Change is the responsible Minister for Victoria's *Climate Change Act 2017*, and I understand that the Department of Environment, Land, Water and Planning are presenting later today, so maybe that question can be more specifically addressed to them as to the role for Agriculture Victoria. The Minister for Agriculture has a role in the development of policies to reduce emissions from agriculture's activities, and also to help the agriculture sector to contribute to, I would say, a net-zero-emissions economy by 2050. And due to the nature of the emissions on farm, the Minister for Agriculture would also contribute to policies that relate to energy and land use, land use change and forestry activities.

Mr MORRIS: But you cannot give us an indication of when we are likely to see the actual plan?

Prof. SPANGENBERG: I think that would be a question better placed to the Department of Environment, Land, Water and Planning. The sector plans—

Mr MORRIS: My understanding is that there are nominated ministers, and your Minister is one of those nominated ministers. Is that not correct?

Mr ANDERSON: There is a primary industries sector plan, which is being developed. So we can take that on notice about the dates and timing of when that is going to be available, but we are having input into that at the minute, that primary sector adaptation plan. There are a range of statewide sector plans. The primary industries one has agriculture and forestry and fisheries included in that.

Mr MORRIS: Right, so it is not just the agriculture sector; it is the three.

Mr ANDERSON: Yes, that is right.

Mr MORRIS: Okay.

Mr ANDERSON: There is also a regional—

Mr FOWLES: So do you know who the coordinating minister is on that?

Mr ANDERSON: Sorry?

Mr FOWLES: Who coordinates that? Given that there are three separate areas there, who actually submits it? Is it through DELWP? Are they the coordinating agency?

Mr ANDERSON: They are the coordinating agency, but the primary industries sector is led through DJPR, and AgVic inputs into that.

Mr FOWLES: Thank you both for your presentation. I just wanted to reflect a bit on some of the evidence we have heard. I think it is fair to say—and I will say this in my capacity as the son of a farmer—that they are a

pretty stubborn lot. There is definitely a cohort who are really interested in the science and are really responsive to the uptake of new methods, new science, new findings, but there is a cohort who are probably pretty resistant. We have certainly had conversations with a number of them over the course of this Inquiry who are disbelievers in various aspects of the climate science. So my question is: how do you get the message out, what is the best way of communicating particularly with a cohort that might not be that receptive to a different way of farming, and what have been the most effective channels for ag to reach farmers, where you have actually seen an uptake in behavioural change?

Mr ANDERSON: Well, you are exactly right, and I deal with that most weeks. There is quite a bit of discussion and debate, and there are a lot of reasons for where people have sat themselves on this issue. So we communicate the science, but we know there is a segment there where the science does not matter, and we know that it is not just for this issue; it is for other issues as well.

What brings it all together is that they all have aspirations for the future. They want to have their lifestyles improved in future, and they want to make decisions today that leave them better off in the future. So while people can be having a debate about climate change, the role of leadership really is when someone then frames that discussion as, 'Well, how about we team up here for how we improve our water efficiency?', and then suddenly everyone in the room is focused on that—or 'How do we reduce our energy costs?' or 'How can we improve our lambing percentage?' or 'How do we get hold of that pasture that is going to get through hotter summers?'. So those are the sorts of things that bring everyone back to saying, 'Yes, these are solutions. I'm really happy, and this is about making my business and farm better set up for whatever happens'. That is what gets people in a much more enthusiastic setting and feeling like they are contributing. It is—

Mr FOWLES: And if I could ask: functionally, how does that happen? Is it town hall meetings? Is it one-on-ones? Is it just via email newsletters? How are you actually engaging with that cohort?

Mr ANDERSON: Well, there are a range of different things there. There are regional workshops that are happening, climate forums and what have you, but there are a lot of farm discussion groups. Groups like Birchip Cropping Group and Southern Farming Systems do a great job. But the discussion is at that level—there are great discussions around, 'Well, what do we do?'.

Farmers are very practical people, and they start to get more interested when they can see some things here that are actually going to help set them up better. So there is a real importance in the framing. You can have a discussion session on climate change, and the ones that are really interested will go and the ones that are not will not. But if you have it around 'We're having this session on how to halve our energy bills' or better set up for increasing variability and better forage systems to handle that fluctuation you will have a lot more people there.

So that framing and people coming to help people navigate that is what is really important. And that is what gets a lot more interest. Also the—

Mr FOWLES: Sorry, can I ask: do you think that you are adequately resourced to be able to meaningfully influence behavioural change amongst the farming cohort generally in Victoria?

Mr MORRIS: That is not an ideal question for these gentlemen.

Mr FOWLES: Well, do you have the tools in the toolbox to be able to really move needle on this? I mean, I think it is fantastic that you have this body of scientific work, but the challenge is making sure that it is actually adapted.

Mr ANDERSON: Yes, that is right.

Mr FOWLES: You have got all this terrific research. We can sit in this room in the CBD and say, 'Wouldn't it be great if farmers did X, Y and Z?', but it is all moot unless there is actually behavioural change—and I will use this pun intentionally—in the field.

Mr ANDERSON: That is exactly right, and the real opportunity as we wrestle with where we go to on climate change is about what we do that puts in place people actually changing practices and doing things that

have a good evidence base that actually are things that are reducing emissions, because there is quite a bit of well-intended desire at the minute that will not actually lead to reducing emissions. So that is where the evidence base comes in. I think, nationally and across all of our industries, there is room for a lot more focused effort on this issue and how we get better at engaging and adapting and reducing emissions as we go, so you are exactly right—and especially on a pragmatic footing. We will get to most agriculture if it is coming through and working through those stakeholders that are already working with farmers. And there is already quite an audience there that are happy to; they are just looking at how they get into that.

Mr FOWLES: Can I just turn my last question around and say: in an ideal world what would the Victorian Government be doing to assist in actually getting that behavioural change out there?

Mr ANDERSON: I think the second-last slide [slide 15] probably had that broader wish list. These are all of those sorts of things in the mix. You know, if you are looking forwards, what are most people after? These are the bits that all feed into that, I guess. And when we talk about adaptation it is interesting; there is adaptation at an individual farm business level. So part of it is farmers trying to ask, 'What are we trying to adapt to here?'. Because there are bigger risks in the climate projections. We know about the temperature stuff, but there is certainly an opportunity for greater variability, and we have seen with things like frost and what have you some of those parameters have not quite followed what was projected. But also what are the things that we can actually do on our farms that actually set us up for whatever happens in the next 20 years or 30 years? That is the stuff that helps make their business more reliable. And what makes us more efficient? How can they participate in renewable energy opportunities and that type of thing? The adoption of pulses in the Mallee is a terrific story in the last 30 years—there is a crop there that was not available 30 years ago—so they have got that as an option there now. And we know for farmers, when they grow their pulse crop, it adds some natural nitrogen in the soil, but then it actually leaves over some moisture because it does not have as deep roots so it has actually got an adaptation there; it leaves moisture there for the crop the year after.

So these are all things that feed into having us better set up in future. So that is probably what I would point to. Farmers remind us that we are actually adapting to changes in markets and trends in technology and everything else as well. So a common thing is them saying, 'Listen, I know you're concerned about climate change, but I am dealing with a lot of other change here, and we are really needing support for how we navigate our way through this'.

The CHAIR: Can I just ask a follow-up, really, from Will's question? The department has approximately 1000-odd staff. What sort of percentage of that staff would actually have some form of extension as a part of their job? And how might that have changed from the heyday of the extension programs from the 60s? It is back-of-the-envelope sort of stuff here, but I am just trying to get a bit of a sense of how many of those 1000 employees do have an element of extension somehow in their jobs. Would it be half or a third?

Prof. SPANGENBERG: The primary responsibility, if we go back to slide number three, is with the biosecurity and agricultural services function within Agriculture Victoria, and we need to take the question on notice and provide you with the details of staff members who would have a significant capability in relation to extension support.

The CHAIR: I would be interested to sort of get an understanding of that over the last, you know, 20 or 30 years. As I say it would be back-of-the-envelope kind of calculations, but it would be interesting to see the shift away from extension that has occurred.

Prof. SPANGENBERG: Concurrently, you have also seen other players providing extension services through other channels—

The CHAIR: No, I completely understand that. I am interested though in terms of the shift in extension from the public sector to the private sector and what that has meant from a DPI perspective.

Mr ANDERSON: It is a good question. It is interesting, that carbon farming extension outreach scheme, which was a federal initiative a number of years ago, recognised that public policy imperative to get this information out. But it then opened up to all extension providers—private, not-for-profit, everyone—to participate in. And the key was: tell us how many farmers you are regularly dealing with and tell us your ability

to package up this science and get it to farmers in a meaningful way. It is sort of part of understanding the modern landscape for how we make sure farmers have got some people that are well advised on this.

We do a lot of sessions which are with agronomists and advisers on helping them understand the climate issue, because they are really key to this. And they are having the same debates as most farmers amongst them too. Just because you are really good at ag science, it does not mean you understand what is happening in the atmosphere or what to do about it.

The CHAIR: Thank you.

Mr HAMER: At the start of your presentation you talked about a lot of the work that you are doing, particularly in the genetic and research space, to adapt to the current environment. Now, some of the research that we have heard is particularly in northern Victoria about the long-term viability of certain crops or certain farming. Have you done any research in that, particularly looking at maybe the 20- to 30-year time frame, about whether certain cropping or farming that currently goes on basically would not be viable in that area and might have to be in other areas of the state?

Prof. SPANGENBERG: Thank you for the question. Yes, we have research in two dimensions, and I have chosen one example, namely the AGFACE to illustrate this. We really look decades ahead so that we understand the path forward, informing the science that underpins the solution for the future. We have also done modelling—for example, in how different pasture species would be better performing in different parts of the state through to 2090. So almost—

Mr HAMER: 2090?

Prof. SPANGENBERG: Yes, it is really almost intergenerational. Equally, in the example of AGFACE, which concluded in 2018 and was an 11-year program, so started pretty early in looking at scenarios of what would be the impact of the concentration of the atmospheric CO_2 in a 2050 horizon, and that program informed the activities that we are doing now tailored to the grains industry. Equally, we are doing all the modelling relating to shifts in the feedbase, for example, in northern Victoria from, say, perennial ryegrass into other pasture species, including warm season grasses. One of the examples that I mentioned related to more flexible forage systems—was exactly about that, yes. So, we have done a significant amount of work on this, and we continue doing so, on future modelling not only on the variables that we will find into the future, but also importantly on their interactions. That is what informs our current research programs.

Mr HAMER: And has that been done on crops as well, not just pastures?

Prof. SPANGENBERG: We have done it in crops and pastures, yes.

Mr ANDERSON: It is also across some of the national industries. As you head further north it gets hotter, so there are a lot of varieties and work that is done from different climate zones. Farmers are very good at saying that there is successful agriculture happening across all the climate zones in Australia, but there are really different systems as to how they have set that up to deal with that climate, and our challenge for Victoria is the transition of reliable wet seasons to a warming up and having a bit more summer rain occasionally, but it is not reliable. So part of it is: what are those varieties and crops and systems that might translate that we apply here? It is back to the challenge of how people build that into the business—that transition over time.

The CHAIR: Terrific. Thank you so much. You have obviously given some undertakings there to provide some further responses on some of those questions, and I am sure the secretariat will chase you up in due course on those things. Thank you for your time.

Prof. SPANGENBERG: Thank you for the opportunity.

Mr ANDERSON: Thank you for the opportunity.

Witnesses withdrew.