

Taste the Future

How are prosumers shaping the future of food and what it means for Australian farmers?



A report for:



Supported by:



By Lara Ladyman

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Cover Photo: Lara Ladyman, of Katanning, Western Australia, sets out on this CBH-supported Nuffield Australia Farming Scholarship, with an empty plate to discover what will be on tomorrow's menu. Source: Rob Ladyman



Figure 1: Chef Jozef Youssef's experimental restaurant in London, Kitchen Theory, is an enchanting and extraordinary food experience that challenges each of the senses. Source: Lara Ladyman

This dish, called 'Ryujin's Servant', incorporating jelly fish and seaweed, is eaten while wearing headphones listening to sounds of the sea - a 'sonic seasoning'. Underwater images swirling on the table create a sense of being surrounded by ocean. Why jellyfish? Chef Jozef explains the seas have been overfished and many people are seeking sustainable forms of seafood, and jellyfish may be one of these. The challenge is that beyond Asia, jellyfish are not a familiar food. The research behind the dish was conducted with Charles Spence, professor of experimental psychology at Oxford University. It explores how a multisensory experience can be used to introduce diners to this sustainable 'future food' that is unusually textured but essentially flavourless and one about which they may have preconceptions. As a diner, while the science is interesting, it was the whole experience: the exquisite food, the explanation of the dishes, and the immersive and magical atmosphere that made this dining journey one that the author will never forget. Chef Jozef is a master storyteller.



Figure 2: A burger grown from bovine stem cells in a laboratory, in the Netherlands, sparked this Nuffield adventure to explore the future of food. Source: Mosa Meat

Executive Summary

Taste the Future is about what, and how, people will be eating and producing food into the future, and what this means for Australian farmers.

This report aims to: Understand the essence of the critical ingredient of any future menu – tomorrow’s consumer; Highlight the trends and technologies shaping the future of food and farming, referred to within this paper as the 10 ‘P’s disrupting the future of food; and Discuss opportunities and threats for Aussie farmers in the brave new world of tomorrow.

The author chose to investigate the future of food to try to understand the churning and disruption occurring globally in the agrifood industry, and to be able to infuse that when charting a course for the family farm. More broadly, the author believes it is imperative for Australian agriculture, with its strong culture of innovation, to future gaze so it can continue to be at the forefront of change.

This journey was sparked by the world’s first burger grown in a laboratory; not a field or feedlot in sight. The \$US325,000 meat patty, set to change the narrative on where food comes from, was put to the taste test in 2013 by its creator Mark Post, food critic Hanni Ruetzler and author Josh Schonwald. When the author met with Dr Post in the Netherlands in 2018, he was optimistic his company, Mosa Meats, could be plating up cell-cultured burgers commercially by 2021.

Cell-cultured meat also dubbed slaughter-free or cultivated meat, is just one of the trends that will shape agrifood sectors in the next two decades and beyond.

The study is drawn from the author’s travels in 2017 and 2018 to Bhutan, Brazil, India, Denmark, Qatar, the United States, Singapore, Spain, the United Kingdom, the Netherlands, and Italy. Thrown into the mixing bowl are conversations and interviews with farmers and futurists, restaurateurs, retailers, chefs and consumers, solicitors, start-ups, social media influencers and innovators. It includes time immersed in a world of food-and ag-tech ecosystems, the latter being new to the author and proving to be inspiring and eye-opening.

This report does not seek to predict the future, rather, it aims to set a table for what tastes and technologies are possible – not all will make it out of the melting pot, but they will stir the discussion on the future of food and farming.

It will find that there will be many different plates put forward as part of any future eating experience, as food is part of one's identity and culture. Even so, future consumers, most likely urban dwelling, will want to know more about their food: where it comes from, how it is grown and whether it is good for them, the planet and for those who produce it, and this must include profit, as it is essential for sustainable production.

There will be greater scrutiny on farming practices and ever higher community expectations about the environment: chemical and fertiliser applications, animal welfare, use of land, energy and water resources, waste and sustainability of production. Farmers will also be equipped with more data, management decisions will be based on algorithms and carried out by autonomous machines. They will have new and real-time insights into every aspect of the business, and this will extend beyond the farm gate to the consumer.

A key finding of this study is that the Australian agriculture community must act now to nurture consumer trust, and to share the incredible story of agriculture with, our consumers, influencers and policymakers. This is not about commodity groups promoting chicken, beef or lettuce, this is about sharing how and why we farm, in a way that resonates with consumers' food values. As farmers and food producers, we also need to educate ourselves and really get to understand the consumer of tomorrow.

Food-and ag-tech communities are rewriting how research, products and foods get to market and how these ideas are funded. This is a relatively new but rapidly evolving space for Australian agriculture, and farmers need to have a genuine stake in this space. Many of these agrifood-technologies, including digital and other track-and-trace technologies, will play vital role not only in the story telling but in building consumer trust. There is also need for greater collaboration by all stakeholders if Australian agriculture wants to become a \$100+ billion industry by 2030 and a leading force on the global ag-and food-tech stage.

However, in order to realise these flavours foreshadowed by sci-fi, it will be crucial for rural Australia to have high-speed wireless internet connectivity and access to data insights afforded our counterparts in other parts of the globe. Without this, Australian agriculture will be left in the wake of its global competitors.

The future of food will be full of flavour and disruption, and it will provide huge challenges and mouth-watering opportunities for Australian farmers.

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Foreword

Twenty years ago, the idea of a food replicator or robots planting a crop in which every aspect was monitored by sensors and data communicated instantly with the farmer, agronomist and markets was the realm of science fiction. That future of autonomous vehicles, crops designed by silencing or boosting genes, and sensors that can monitor just about anything, is here today. But what will that look like in 20 or 30 years?

In 2013, the world's first hamburger cultured from stem cells was put to the taste test. Around this time, I headed back to the family farm in Katanning, Western Australia, after more than a decade in rural media and other roles in the agricultural industry.

I had seen how the print media had been caught napping by the digital world, unprepared and almost ostrich-like in its response, and the ensuing battle to play catch-up.

Even though, as an industry, Australian agriculture has a culture of innovation, I wanted to learn and understand what was happening on the global stage when it came to new and disruptive technologies and trends. Not only so we could make changes on our own farm, but because, as an industry, I believe it is imperative we know what may lie ahead so we can continue to be at the forefront of innovation and change.

I had plenty of questions: What would this future look like? What would we be growing? How would it be grown? What if food were compiled by a 3D printer? What would a convergence of technologies like artificial intelligence (AI), big data and robotics mean, not just for farmers, but across the agrifood value network?

The curtain-raiser to this new technology is a need to feed 9.8 billion people by 2050 (FAO, 2017). This is creating a paradigmatic shift about where food comes from, something about which I have always been passionate. More people will live in cities, and the gap in understanding between consumers and where their food comes from will only grow, in spite of the rise of urban agriculture and vertical farms.

So where does that leave the Aussie farmer? To understand what tomorrow's producer will be growing, I needed to understand tomorrow's consumer and the food we would be eating. Hence my Nuffield journey to gain a taste of the future.

Acknowledgments



Figure 3: The 2017 crop of Nuffield Farming Scholars, Nuffield executive members and hosts at the Combined Scholars Conference, Brazil. Source: Nuffield International.

To the Nuffield Australia and Nuffield International team, executive and board for their dedication and superb organisation in creating this once-in-a-lifetime programme.

To all who offered help at home and abroad with contacts, sent a follow-up email or provided feedback and challenged me. To those I met on the road and those who took the time to share their stories, show me around or offered a place to rest my head and do some washing. I have been inspired on every step on this journey, and it would not have been as amazing and insightful as it has without those conversations, chance meetings and catch-ups.

Thank you to our hosts, guest speakers, in-country programme co-ordinators and helpers who organised the briefings, the Combined Scholars Conference in Brazil, the UK Triennial and our Global Focus Program. My travels took me from the Amazon rainforest to the sand dunes of Qatar, from India's coffee-covered mountains to Christmas trees in Denmark and the cornfields of Iowa, United States, via a dairy and a bioreactor or two, and all in the midst of Brexit and Trump's triumphant, or tumultuous, reign.

I was thrown into the deep end of food-and ag-tech communities and want to say a big thank you to those I met at these events and beyond, as well as to the event organisers for their support of this Nuffield project. These included: The World Agri-Tech Innovation Summit 2017,

Future Food-Tech 2017, Silicon Valley Forum, Seeds of Our Future 2017, Speciality Food Association Summer Fancy Food 2017, New Harvest 2017, World Food Prize 2017, Y-Food London Food Tech Week 2017, World Retail Congress 2018, Seeds and Chips 2018 and F&A Next 2018. I learned to speak a new language, and was challenged by the disruption, the possibilities and the innovators and entrepreneurs following their dreams.

To the WA Nuffielders and those further afield, whose stories and friendship inspired me to want to have a go: thank you for the tips, the feedback and suggestions. To Rob and Jen Warburton, for all the times spent pondering the future of food from the entrée of this journey. To my mentor, Richard Heath: thank you for sharing your insights and wisdom – you always knew the right contact, at the right time.

To my sponsor, CBH, for your investment in growing the capabilities of the WA agricultural industry, through the support of the Nuffield Scholarship program. To the CBH board and team for help with contacts and information, as CBH too delves into the incredible opportunities big data, digital agriculture and agrifood-tech will open for Western Australian farmers.

Rabobank, through its FoodBytes event, set the scene for what was to come. While Chontell Giannini and her iTravel team were wonderful in assisting with my travel arrangements twice around the globe.

To my fellow Global Focus Program travellers Ed Payne, David Hichens, Felicity McLeod, Rebecca Hyde, Stuart Tait, Jaap Dunn, Matthew Fealy, Murilo Bettarello and Crispin Howitt: I treasure your friendship, your inquiring analysis and passionate discussion at day's end.

To my family, Tanya and Simon, and their daughters Gem and Lilly, who stepped in when needed while I was away, and my dad, Rob, who has supported and encouraged me to make the most of this delicious, inspiring opportunity.

Abbreviations

AI	Artificial Intelligence
AFI	Australian Farm Institute
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeat
IoT	Internet of Things
IoE	Internet of Everything
FAO	Food and Agriculture Organization of the United Nations
FDA	US Food and Drug Administration
GMO	Genetically Modified Organism
GRDC	Grains Research and Development Corporation
HFHa	Hands Free Hectare
LED	Light-Emitting Diode
MLA	Meat and Livestock Australia
NFF	National Farmers' Federation
P2D	Accelerating Precision Agriculture to Decision Agriculture report
RFID	Radio-Frequency Identification
USDA	US Department of Agriculture
UN	United Nations
UN DESA	United Nations Department of Economic and Social Affairs

Objectives

Taste the Future is about what and how people will be eating and producing food into the future and what this means for Australian farmers. This report aims to take a blue-sky look at tomorrow's consumer and some of the technologies or drivers of change – from the lab to the lips, or soil microbiome to gut microbiome – shaping the agrifood systems of tomorrow.

In doing so, the author hopes to challenge, and provide an insight for, Australian farmers to position themselves to capitalise on opportunities and to foresee major disruptors, as global agrifood systems are rapidly being redesigned and transformed.

The FAO (2017) estimates food production globally will need to increase by 50 per cent to feed 9.8 billion people in 2050. Although it is beyond the scope of this study to solve per se, the immense and critical challenges of zero hunger and related Sustainable Development Goals – the need to nutritiously and sustainably feed a growing global population with less available land, greater pressures on the environment and water resources, is affecting change in future food systems.

The study aims to:

- Understand the essence of the critical ingredient of any future menu – tomorrow's consumer;
- Highlight the trends and change-drivers shaping the future of food, referred to in this paper as the 10 'P's disrupting the future of food;
- Investigate the technologies transforming the future of farming and food; and
- Discuss opportunities and threats for Australian farmers in this brave new world.

Chapter 1: Back to the Future

Will it be crickets? Will it be 'bred' in a lab? Will it be grown by robots? Can it be ordered from a flying minimart? Is it good for one's own health, those who produced it and that of the planet?

The author's Taste of the Future set out to explore some of these questions to take a blue-sky look at the disruption and technologies that will shape farming and food – from the lab to the lips, or growth-medium microbiome to gut microbiome – and consider this from the setting of Australian agriculture. It was a \$60 billion industry in 2017/18 (<https://www.agriculture.gov.au/abares/research-topics/agricultural-commodities>) NFF target (now adopted by Federal Government) for \$100 billion by 2030.

It is a taste that included time immersed in a world of food-and ag-tech which attracted \$US16.9 billion in investment globally in 2018, an increase of \$6.9 billion from the previous year (AgFunder, 2019).

But first, a look back at the future:

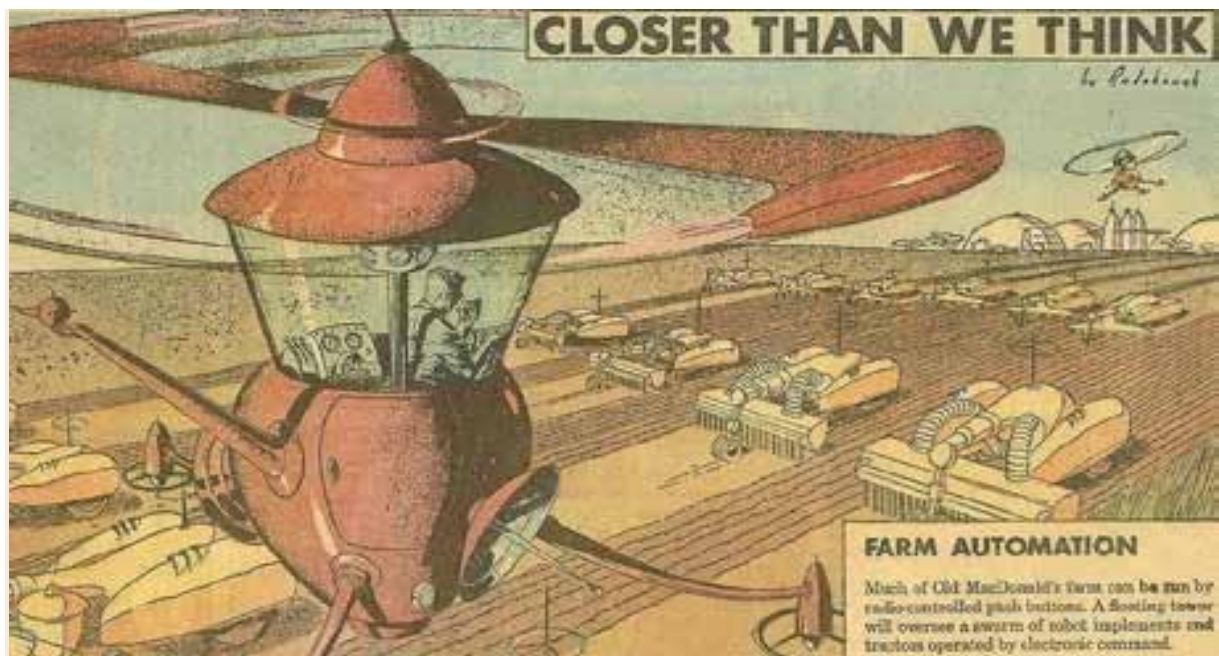


Figure 4:: Farm Automation. "A floating tower will oversee a swarm of robot implements and tractors operated by electronic command." Source: Closer Than We Think!, 1958.

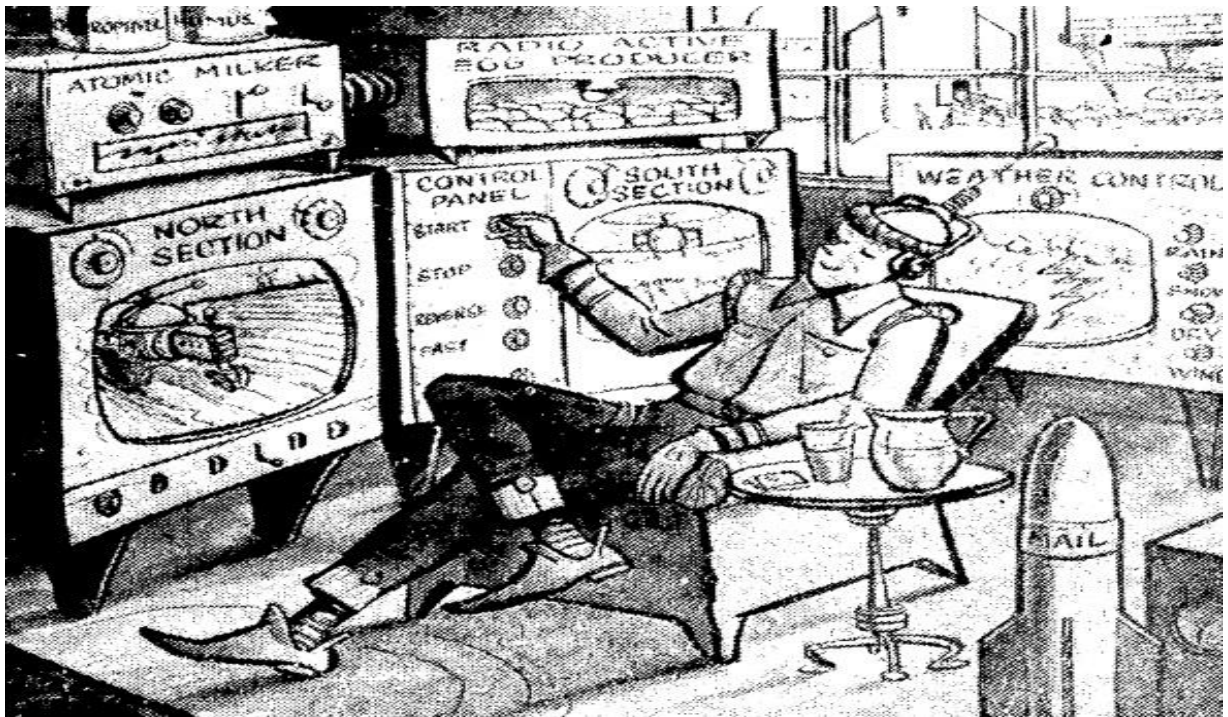


Figure 5: "Push-button farm of the Year 2000." Source: K-State, December 1958

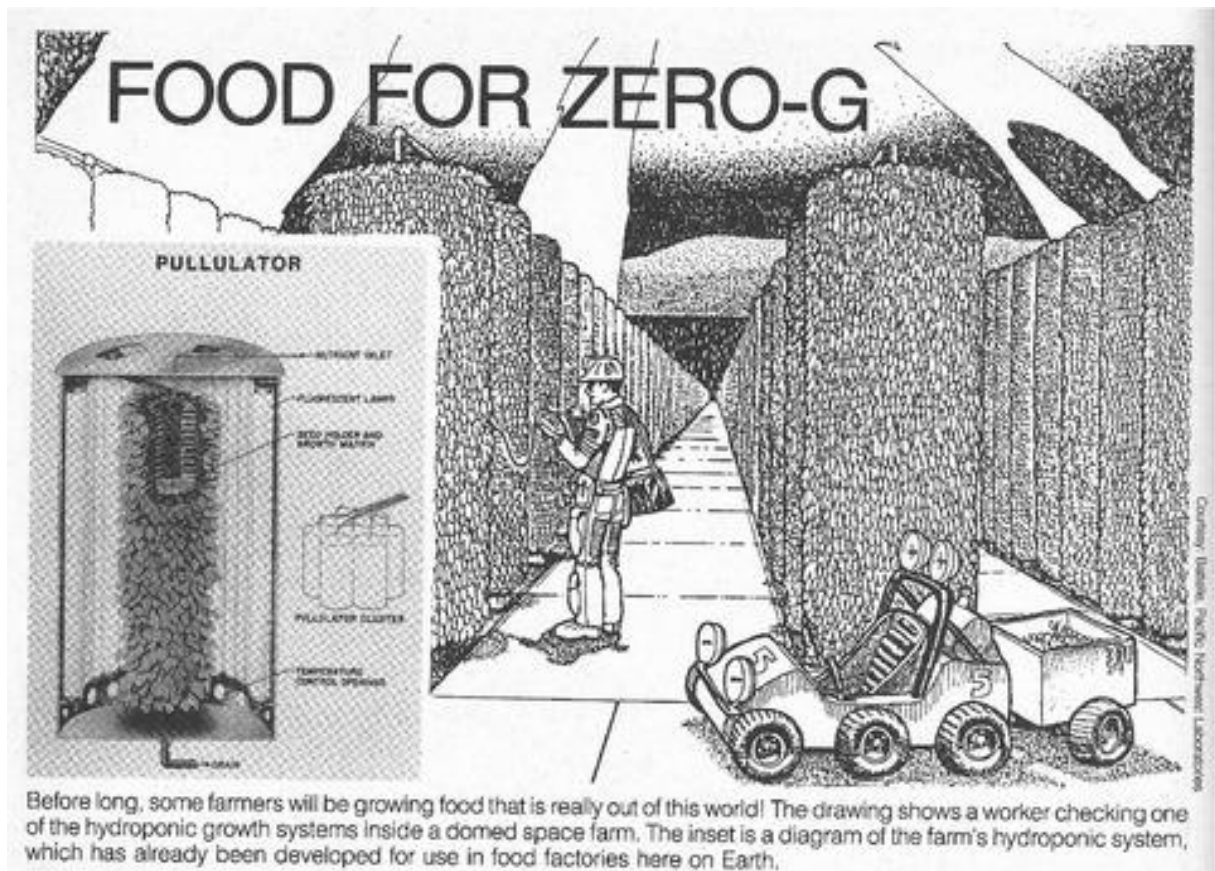


Figure 6 An imagined interview with a space farmer of 2012. Source: Kids' Whole Food Catalogue, 1982.

Drivers of change

The terminology may vary – with some authors citing megatrends or mega shocks, others transformative or disruptive technologies – but there is little argument there will be immense and rapid change in agrifood systems globally by 2050.

Trends of non-science (consumer activism) and choosier/health-conscious consumers are among those noted by Robert Saik (2016), of Agri-Trend Canada, and CSIRO as being change agents for agriculture production into the next decade.

As well as consumer-led drivers, Mr Saik (2016) cited bioengineering, 3D printing, robotics; water; precision agriculture; artificial intelligence and data, while CSIRO (July 2017) suggests, a less predictable planet faced with limited and decreasing quality of natural resources; an aging population; one world with increasingly connected global value chains; and smarter food chains will mould food and agriculture production into the future.

In addition, the STT Netherlands Study Centre for Technology Trends (2016) lists smart materials, autonomous micro-robots, information technology and its infrastructure, bioinformatics, smart farming, renewable energy, biorefinery and biofuels, protein transition, food design, vertical agriculture, aquaculture, conservation technology, transport technology and weather modification as among those that may have an impact on Dutch food and agriculture in the lead up to 2050. It is the author's view that the impact of these trends is not limited to the Netherlands and will have a global reach.

Chapter 2: The 10 'P's disrupting the future of food



istock.com/Gremlin

Figure 7: THE 10 'P's disrupting the future of food.

Drawn from this Nuffield journey, the author highlights several big 'P's as being instrumental in transforming the future of food, and most relevant in the context of Australian food and agriculture. The interactions and relationships between the 10 'P's are incredibly intricate and interlinked, however at the centre of these is tomorrow's consumer or prosumer. Who this future eater is and how this is shaping the agrifood value chain from the plate to the paddock, or the lab, will be explored in following chapters.

The Planet

By 2030, it is projected the world population will reach 8.6 billion people, increasing to 9.8 billion by 2050, with two-thirds living in cities and the gap between consumers and producers continuing to have widened. This is also about the pressures on land, water and energy resources and the challenges of climate change.

Prosumer

Prosumers actively demonstrate their beliefs and aspirations through their purchases, and will influence the consumption behaviours of others, or become involved with designing or customising products for their own needs. These future consumers, or ‘eaters’, want to know more about where food comes from, how it is grown and whether it is good for themselves and the planet. Aided by social and immersive media, and information at the click of a button or on voice command, prosumers will play a growing role in shaping agrifood policy, and how we farm.

Policy

This refers to the rules, regulations and assurance standards that describe food and govern agrifood supply networks. This ‘P’ is also about the evolution of technology. Technology generally precedes policy, which usually has to play catch-up, as is the case at present with CRISPR foods, cell-cultured meat, drone and autonomous vehicle use.

The Palace

The home of the future is going to be buzzing with technology, from digital assistants ordering more Kernza® chips, or duckweed burgers (with or without extra zinc), to bench-top bioreactors brewing a lab-grown steak and a 3D printer producing pizzas ready to eat. Some technology will be in communal areas, such as vending machines that grow greens.

The Pitch

The food-and ag-tech start-up scene is fundamentally changing the way research and investment is driven, and new ideas are being developed and brought to market. Food will no longer be the domain of those traditionally considered farmers, food processors and supermarkets; rather, these arenas will be shared with venture capitalists and angel investors, technologists, data companies and the consumer with a good idea to disrupt food and farming.

Precision/Planet Farming 4.0/5.0

One of the several names given to the next phase of farming that will use not only precision tools, but also digital technologies, autonomous vehicles, AI and gene editing, all of which promise to deliver step-change in farm innovation, productivity, profitability and sustainability. High speed wireless internet connectivity and data insights afforded to our

counterparts in the agricultural sector in other parts of the globe are crucial to delivering this change. This 'P' includes pre-and-post farm-gate technologies like plant breeding.

Plate to Paddock

The traditional linear food supply chain model of farm to distributor to processor to marketplace/retailer to consumer is being dramatically disrupted by agrifood start-ups. This 'P' is no longer linear. It encompasses supply chain technologies, food safety and traceability, bricks and mortar, as well as online eateries and retail, meal kits, delivery platforms, "grab-and-go", along with integrated shopping and entertainment experiences (retailment), including those via social media and live streaming.

Pods

Pressure on resources, the opportunity to control increasingly unpredictable climatic conditions, decreasing costs of technologies like LEDs, and the promise of traceable, pesticide-free produce, deliverable to the customer within hours (if not minutes) has attracted significant venture capital into controlled growing environments. These pods which are attracting new breeds of farmers, include: vertical, underground and even desktop versions, and encompass aquaculture, algae, cannabis, nutraceutical, plant and insect production.

Pipette and Print

Prototype novel foods, including cell-cultured foods, aim to reproduce everything from milk to tuna, without the slaughter of animals. 3D or 4D printers may print out and even cook – depending on what food ink is in stock - whatever meal they are programmed for. Protein which could be used for food or animal feed has even been created using electricity, water, carbon dioxide, and microbes (VTT, 2017).

Big Picture Technologies

The convergence of these big picture technologies is not only driving the frontiers of food production but will have far-reaching impacts and affect every aspect of our day-to-day lives.

These big 'P' technologies include:

- Sensors and big data;
- Machine learning, deep learning and artificial intelligence;
- Biotech and gene editing including CRISPR;
- Robotics and automation;

- Communications, social media and immersive media (augmented, virtual and mixed reality and extreme reality enabling human-machine interfaces);
- Digital connectivity, 5G and IoT;
- Nanotech and new materials;
- Quantum computing;
- Energy, battery and transport efficiencies and smart supply chains;
- Satellites and space;
- Digital to physical transfer (3D and 4D printing); and
- Mobile Fintech (mobile commerce).

Singularity University chairman Peter Diamandis (2015) estimates that by 2020, there will be 40 billion connected devices, generating more than 600 zettabytes of information.

He said this global network of connectivity, drones and satellites is connecting people as well as things, in the form of devices and sensors, forming the IoT and the Internet of Everything (IoE). Self-driving cars and augmented reality headsets will add exponentially to the data generated from people's surroundings.

“The bottom line is, we are heading towards a future where you can know anything you want, any time you want, anywhere you want. In this future, it's not ‘what you know’, but rather ‘the quality of the questions you ask’ that will be most important.” Dr Diamandis also contends that with so much data, “privacy may truly be a thing of the past”.

Chapter 3: The Prosumer



Figure 8: The Future Consumer

WHO

Increasingly, the prosumer, or so-called 'eater', most likely urban dwelling, will want to know more about their food. Prosumers are proactive in "exhibiting their beliefs, ethics, standards and aspirations through their purchases" (Lyons, 2017) and "influence the brand choices and consumption behaviours of others" (Havas Global Comms, 2014).

Food Futures Lab research director Sarah Smith, who predicts the term “consumer” will be “dead” within 10 years, believes the future consumer will view food as a reflection of identity, while personal food production will be seen as an empowering experience.

According to Ms Smith, “eaters are more than just consumers at the end of the supply chain. They have agency, they are co-creators, they take a more active role in what is being produced and how”.

Prosumers are inextricably linked to the planet. Their food choices and advocacy/voice reflect a desire for: sustainable, ethical and responsible food production, to combat climate change and to feed the world.

The power of prosumers is illustrated by the rise of activist investors and people-led campaigns effecting change, in the belief they are doing the right thing by the planet, animals or whatever the cause may be. The market power of prosumers is also motivating start-ups/investors to find solutions to tackle these concerns.



Figure 9: UK start-up Toast is using bread, that would otherwise have been thrown out, in the beer making process. Toast is one of many start-ups tapping into consumer sentiment about food waste and concern for the planet’s wellbeing. Source: Lara Ladyman

In a 2017 report AgFunder noted that a high proportion of AgTech investments were in start-ups seeking to solve the challenges of: food waste, greenhouse gas emissions, chemical residues and run-off, drought, labour shortages, health and sugar consumption, opaque supply chains and distribution inefficiencies, food safety and traceability, farm efficiency and profitability and unsustainable meat production (AgFunder, 2018).

The sector is certainly “flavour of the month”. In 2018, \$US16.9 billion was infused into ag- and food-tech globally, of which \$US29 million was invested in Australia (AgFunder, 2019). This global investment is further broken down by category. The Mixing Bowl’s ‘Food Tech & Media Landscape’ (2018), and ‘AgTech Landscape 2017’ identifies some of the start-ups playing in this crowded space.

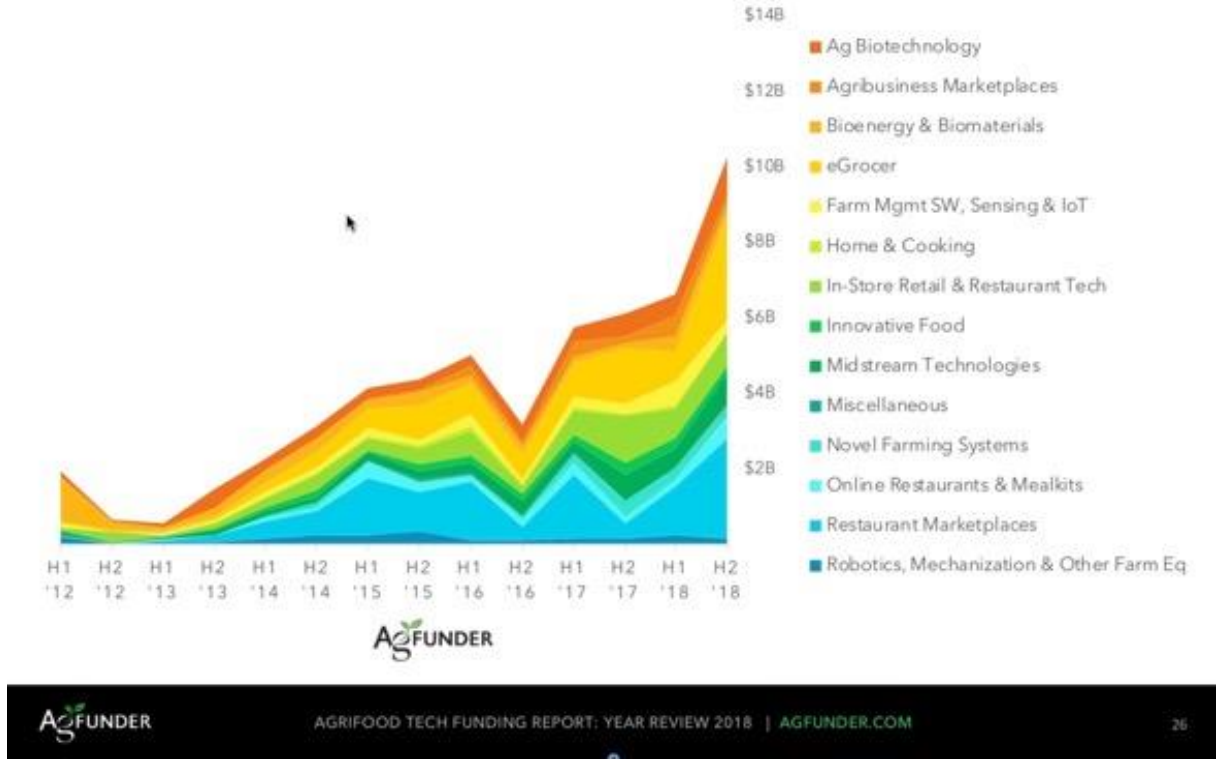


Figure 10: Global investment in agrifood tech, deals by category 2012-2018. Source: AgFunder, 2019.

FOOD TECH & MEDIA LANDSCAPE 2018



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Figure 11: Food-Tech and Media Landscape 2018/Ag-Tech Landscape 2017 Source: The Mixing Bowl

AGTECH LANDSCAPE 2017



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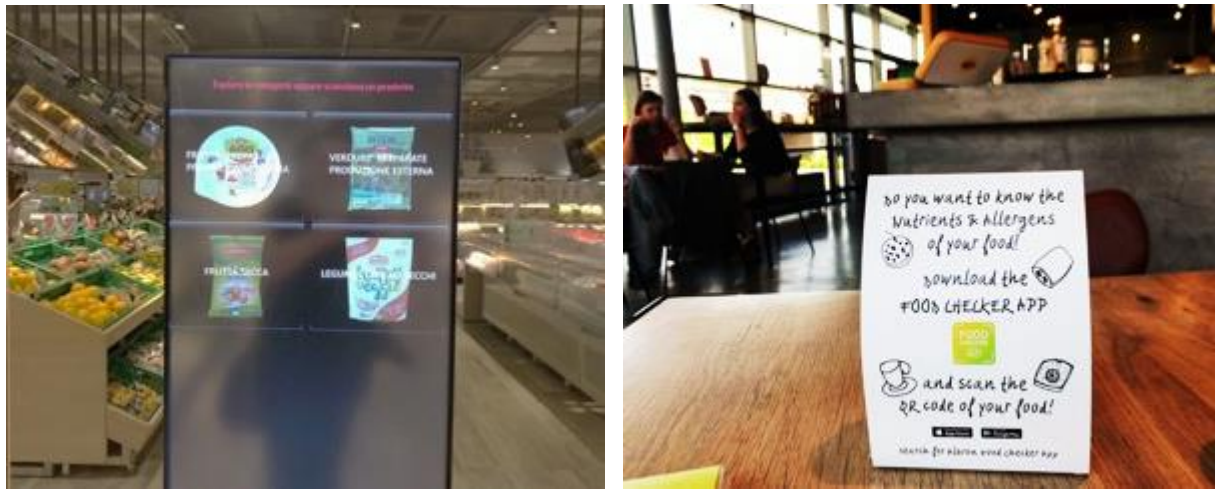


Figure 12: Digital technologies are providing greater transparency in the supply network. a) At the Co-op's Supermarket of the Future in Milan, customers can scan products to learn more about where they came from. The store is also fitted with smart shelves, while b) at this café on the Wageningen University in the Netherlands, patrons can download a food checker app to get information on a food's ingredients. Source: Lara Ladyman

How will tomorrow's consumers want their food served?

There will be many different plates put forward as part of any future taste testing or eating experience, as food is part of one's identity and culture. Even so, the future of food looks to be personalised (from a nutrition/health and wellbeing and experience point-of-view), data-driven and served with an authentic story, a splash of social media and a dollop of convenience.

A tempting story

When it comes to food and prosumers, the story of where food comes from and how it is grown matters, as does the telling of the story and the language used.

The storytelling is the reason prosumers will go back again for a food experience or product; it's about the emotion it provokes – because with a click of a button, there will be multiples of whatever they are looking for elsewhere, and probably at a lower cost.

Authenticity is a basic ingredient of the story. It is spelled out in the 4'T's – trust, transparency, truth and trace. In this time of fake news and fake food, distrust in the food system is significant.

Track-and-trace technologies which make it easier for food to be fully traceable and provide transparency, for example, about ingredients or provenance, help to instil consumers' trust in

food. Such technologies include Blockchain, DNA-testing, isotope analysis, sensors, smart packaging, radio-frequency identification, barcodes and image recognition.

Walmart and IBM, for example, have teamed up on Blockchain. This has enabled Walmart to trace the origin of its lettuce in a matter of seconds, rather than the seven days it took previously. This instantaneous traceability is paramount when it comes to food safety, and as of the start of 2019, Walmart's grocery chain suppliers of leafy green vegetables will be required to upload data to the Blockchain through its IBM Food Trust Network (Rossow, 2018).

Furthermore, Walmart, in 2018, applied for six patents focussing on ag-tech and moved its supply chain closer to the paddock. According to CB Insights (March 2018): "By taking more control over how its produce is grown, Walmart could a) potentially save on costs, by vertically integrating its food processing chain, b) manage crop yields more effectively, and c) increase its emphasis on transparency and sustainability to attract shoppers." The patents include a robot bee and use of drones to monitor crop damage and identify and control pests. In 2018, Walmart also started processing its own milk and in 2019 announced plans for an end-to-end supply chain for its Angus beef products to ensure "visibility in every step in the supply chain", to be able to answer customer demands about where their food is coming from (Walmart, 2019).

SafeTraces™, another example of track-and-trace technology, is based on DNA sequences drawn from seaweed. Company chief executive officer Anthony Zografos (2017) describes it is an edible, odourless, tasteless, invisible 'barcode' that can be applied to food, enabling each grape, apple or spinach leaf to carry a complete source of information such as producer ID, lot number, production date etc to enable it to be traced along the supply chain. The end user collects the product sample which is analysed in 15 minutes using a smartphone.

Another new tool – ProductDNA, developed by barcode standards organisation GS1 UK – aims to standardise the language and make it easier for subscribers to access supplier information about products, including calories, nutritional content and sustainability claims. The likes of Nestle, PepsiCo, Sainsburys, Ocado and Tesco have signed up (Farrell, 2018).

Rob Ward (2018), co-founder and director of the UK-based Grocery Accelerator and Nuffield Scholar added that retailers were using nutritional technology to help consumers personalise

choice, and the same systems would enable provenance tracking. On this front, Tesco has partnered with the app Spoon Guru, as has Asda with Food Maestro.

“With these technologies, the main focus is traceability and nutrition, and no doubt more will come forward and ultimately crystallise into something that connects farming to eating, using technology that’s personalised to our own preferences,” he said.



Figure 13: UK retailer Marks & Spencer uses DNA technology to trace its beef. Its website includes an interactive map enabling consumers to learn more about the farms where the product is grown. Their catch cry is: “We trace it, so you can trust it.” Source: Lara Ladyman

With a splash of immersive media

As well as track and trace technologies, the telling of this story will be aided by agrifood tech, social media and immersive media. These tools in conjunction with digital commerce platforms expand the marketplace – from the roadside stall to the world. At the same time, they will enable the relationship between the farmer and the eater to become more direct, immediate and intimate.

Social media and influencers also play a significant role in how consumers make food purchasing decisions. In Australia, research by online reservation platform Open Table (The New Daily, 2017) suggests that about 65 per cent of diners take photos of their food to share on social media, while 31 per cent admitted to dining at a restaurant to order a particular dish

they had seen online. In the US, 22 per cent of people said they visited a particular restaurant because of 'food porn' or atmosphere they had seen posted online (Locker,2018).

Immersive media too will increasingly change the storytelling of food – for example, it may enable an eater to be transported to the field where the grapes for their wine were grown. Kabaq is one company using augmented reality to bring restaurant menus to life. It enables the diner or on-line buyer to see virtual 3D images of the food. London restaurant City Social had theatrical augmented reality cocktails on its menu for a limited time, Los Angeles-based Project Nourished uses a combination of virtual reality, augmented reality and other sensory tools to redefine the eating experience, while agbiotech company KeyGene is using virtual reality as a plant breeding tool.

That said, a real-life, fun experience on a farm, and a personal connection with a farmer will create unforgettable stories.

A dollop of convenience: On the go and on mobile

Convenience is the apartments being built in London and New York without individual kitchens, as there are numerous easier alternatives to cooking at home; it is the rise of online grocery and meal deliveries like Uber Eats, FarmDrop and Hello Fresh; it's being able to buy a 'ready to cook at home' meal, complete with the bottle of wine and the glasses all packaged together as one bustles through St Pancras Station, London, on the daily commute. It is also about being on the go and on mobile and having everything accessible from a mobile device with the tap of a button or a voice command.

Generation Z has no experience of a world without smart devices or the internet. In the US, this generation accounts for 26 per cent of the US population, with an annual purchasing power of \$US44 billion (Hasen, 2018). Mobile marketing strategist, Jeff Hasen, notes that two out of three of these teens make purchases online and, of these, more than half are making purchases on their phones.

Facebook head of global Retail and eCommerce Strategy Martin Barthel, speaking at the 2018 World Retail Congress, Milan, said the "world is mobile."

By the numbers: 2.13 billion people use facebook, more than 90 per cent on mobile.

When it comes to buying groceries online and on mobile, consumers from China are leading the way. In the US, according to Mintel research, just one in 10 turn to the internet for fresh produce purchases. Sixty-nine per cent of those surveyed said they were hesitant

to buy an item they could not see or touch, nearly 80 per cent were concerned about freshness and 63 per cent had safety concerns (Mintel, 2018).

However, Amazon’s purchase of Whole Foods in 2017, combining food and digital worlds, and providing the online retail giant a bricks and mortar footprint which doubles as a mini warehouse, as well as the \$US944 million joint venture between UK retailer Marks & Spencer and online grocer Ocado to form an online delivery company further indicates where the market thinks the future of food is heading. In addition, Walmart, in 2018, filed a patent on a system that would allow customers to see in 3D fresh items they were ordering.



Figure 14: The Whole Foods promise on the window of a store in New York. Source: Lara Ladyman





Figure 15: How technology is transforming dinner! a) Gordon is the only barista at Café X in the Metreon, San Francisco. He can serve 200 coffees a day. Source: Lara Ladyman b) Vending machines and AI food-stocked robots, that drive themselves to a desk near you and c) palm identification technology (linked to a customer's bank account), from Chinese AI company DeepBlue Technology, Source: DeepBlue Technology. d) Uber is planning to test its flying taxis in Australia in 2020 and has its sights on starting commercial flights in 2023. Uber Eats is also planning to take to the air. Source: Uber

Let's get personal



Figure 16 Personal insights a) DNA test kit, developed by Italian-based start-up Allelica. Their DNA tests start from around €100. Users can also opt for a package that includes nutrition consultations and personalised diet planning. Source: Lara Ladyman b) Edible electronics being developed by the Italian Institute of Technology as future tools for real-time monitoring of human health. Source: Italian Institute of Technology.

Personalization of food is driven by health and wellbeing. The future eater will increasingly want to avoid particular foods for health/diet reasons including food intolerances and allergies. There are several start-ups offering testing services, not only of DNA but also of gut bugs. Others factor in the results from Fitbits, which will, in the future, include data from sensors embedded in clothes or one's person.

Personalization is also about a unique product offering or experience. It is the M&Ms with a picture of your face on them, it's the server in Starbucks calling your name, a matter more of facial recognition technology from a previous visit than from friendly conversation, and it's the use of data to select the perfect wine for you as start-up Vinhood is doing. Behind all of these personalization offerings are proprietary databases on food flavors, nutrition and you.

The ultimate in delicious data and personalization is edible electronics. Imagine real-time reporting of the body's response to food and medicine.

The Italian Institute of Technology is developing just that. According to the institute's Mario Caironi (2018), these edible, biocompatible, electronic devices will enable active monitoring of patients' health from inside the body and act as a tool to track and monitor food, this includes monitoring of therapeutic applications like controlled drug release.

The Prosumer and the Farmer

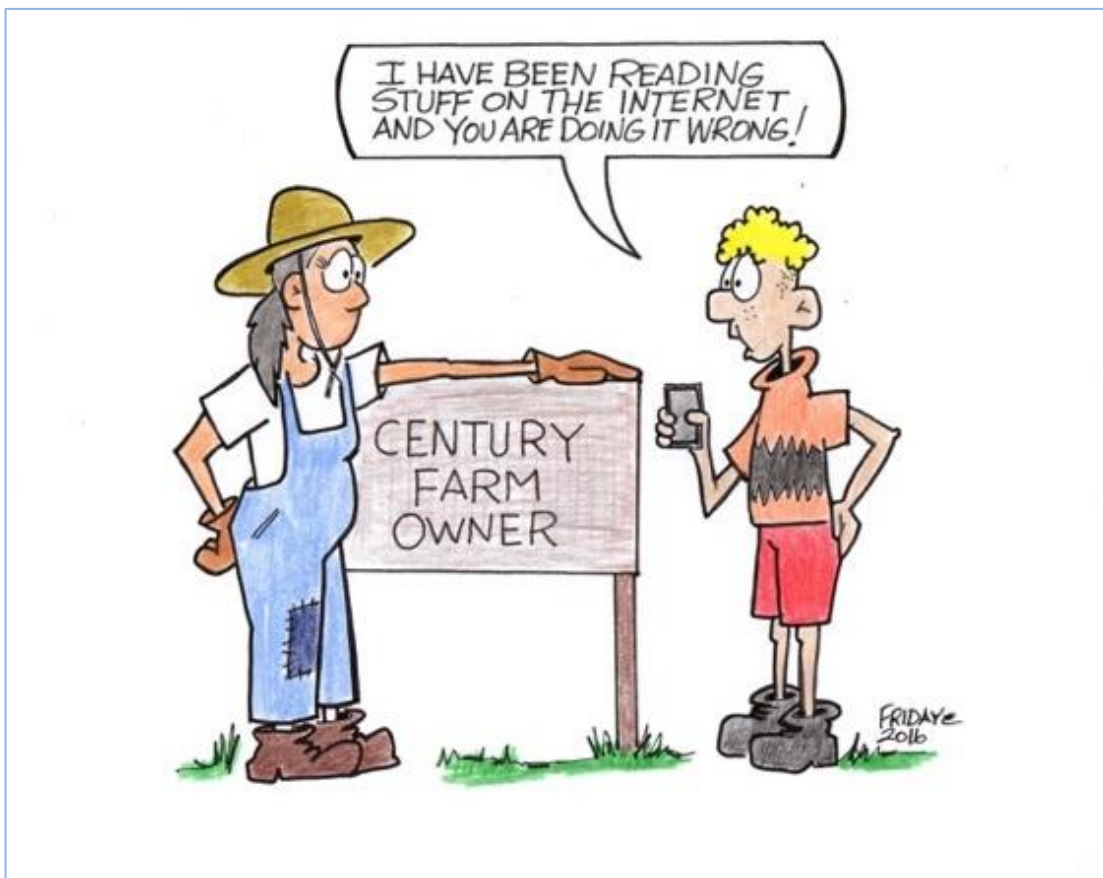


Figure 17: *The tech-savvy Millennial*. Image credit: Friday © 2019 Cartoons

The future consumer will play an increasingly prominent role in shaping our food and farming systems (Lusk and McCluskey, 2018) or, as Julie Borlaug (2017), granddaughter of Norman Borlaug, the 'Father of the Green Revolution', said at the World Food Prize, Des Moines, in 2017: "We have a new boss in agriculture: Moms, bloggers, foodies and yoga instructors who have an online certification in nutrition. They speak louder than we do, and they are full of inaccurate information, but they are powerful when they speak."

For farmers, there will be greater scrutiny on farming practices and ever higher community expectations about the environment, applications of chemicals and fertilisers, animal welfare, use of land and water resources, waste and sustainability of production. Look no further than the current consumer concern being played out over glyphosate and neonicotinoids.

This is exacerbated by the growing disconnect between paddock and plate (an NFF (2017) survey found 83 per cent of Aussies describe their connection with farming as 'distant' or 'non-existent'), declining numbers of farmers and those employed in the agricultural industry, fragmented representation and a loss of political voice.

According to Purdue University Agriculture Economics department head Jayson Lusk (2018), how the agricultural sector communicates its message will be vital. He said: "How does one communicate about food and agriculture in a way that continues to increase agricultural productivity but in a way that is acceptable to higher income consumers? It's more than just getting your message out. You need to communicate value of science and technology in a way that appeals to urban values."

Dr Lusk said influencers cared less about food prices and more about quality, nutrition, naturalness and environment, and innovations that addressed these concerns were needed. "We certainly need to feed the world, but it's going to be hard for people in richer countries to feel the urgency, and when they do, people may react in ways that reduce farm incomes," he said.

Identifying messages that appeal to insiders as well as outsiders is important. There is also a need to better articulate that "productivity growth is more than just about prices".

According to Dr Lusk, while the media today is more fragmented than in the past, the terms of the debate about the future of food and agriculture would be defined by those with ability to wield power and access to political might, major media outlets and Hollywood.

“These influencers are young, higher income and urban and more likely to be persuaded by the food movement,” he said.

The Happiest Pigs in the World!

One of the stories that shows how farmers are really connecting with consumers was that of Nuffield scholar, Erik Stegnik, and wife Paula, and their pig farm in the Netherlands. ‘Piggy’s Palace’ is not just any pig farm: it is famous as being home to the world’s happiest pigs. When you visit, you see pigs, a mudhole and a slide in the fresh air. So, to a pig, it is a palace.



The Piggy’s Palace concept is just one part of the farm business. They also run 500 sows conventionally, 3000 porkers between the Netherlands and Germany, plus 100 organic sows and 800 organic porkers. Each year in media - social and traditional – there is a competition seeking new ideas from the public for Piggy’s Palace. A slide for the pigs was one such winning idea. A piglet swing and even a trampoline have been some of the others. Erik said the competition creates a lot of interest from, and engagement with, the public. One of the ideas that went viral was pig milk cheese – a world first. Being Dutch, making the cheese was the easy part – learning how to milk a pig – more difficult.

Annually, more than 7500 visitors head to see Piggy’s Palace, where they can enjoy a BBQ, pat-a-piglet (great for social media posts) and even adopt a pig. Erik says that the idea of adopting a pig has been taken up by people who wanted to show their children where their food comes from. Families can visit their pig and get sent update photos through the whole process. They get their pig as sausages at the end.

Erik, with the help of researchers, is also working to identify and verify feed ingredients and other factors like low stress handling to make the pork tastier. Their pork products are sold on farm, as well as through local retail and restaurants. He adds that it’s

important to have a good relationship with the chefs, and the butchers, serving their product because they are also the storyteller when it comes to sharing the fantastic tale of Piggy's Palace and the World's happiest pigs, with the consumer.

Chapter 3: Plate to Paddock



Figure 18: *Growing to order. Indoor farm, Farm One, started by Australian Rob Laing, supplies some of the New York's top restaurants with chemical-free herbs, microgreens and edible flowers. This includes the two Michelin star restaurant, Atera, which is located in the same building as Farm One in Tribeca, NY. Source: Lara Ladyman*

Propelled by a convergence of new, and lower cost technologies, the future of food is transforming the supply network whereby the traditional and for the most part linear food supply chain model from the farm to the distributor/processor, marketplace, to the consumer, is no longer linear, and the paddock may be a 'vending machine' growing greens located in a supermarket or restaurant. It is also creating new relationships between the consumer and farmer.

Berlin-based Infarm, for example, which pitched at "F&A Next, 2018", is placing such "farms" inside supermarkets, enabling the customer to see the food growing. InFarm CFO Martin Webber sees instore farming as "the future of retail". The start-up also has farms inside distribution centres and restaurants – harvesting sometimes "minutes before the food goes on the plate". As of May 2018, they had 20 farms in Berlin and were aiming to have 200 by the end of 2018, and to be in 10,000 supermarkets by 2022 (Atomico, 2019). "We are the new farmers, and the city is our farm. We are going to eliminate food waste, cut down on transport networks and the carbon footprint at the same time." Martin explains that Infarm is selling living plants together with the roots, which provides for a superior taste, aroma and nutritional value. Their business model is not the selling of farms. "We rent farms, so the customer/supermarket is paying a monthly fee, and together with the farm, the customer/supermarket also rents the services (to look after the farm). The supermarket never touches the farm, we send our farmers out to harvest and put the plants on the shelf and to check if everything is alright". Among other retailers, Infarm has partnered with Amazon Fresh in Germany, France and Switzerland (Atomico, 2019). In 2019, Infarm raised \$US100m in a Series B round.

"Accelerator-come-farm" in a box – Square Roots in Brooklyn – co-founded by Kimbal Musk and Tobais Peggs, also delivers directly to the user. Here a "new breed of farmer" is growing greens in 40-foot shipping containers. The 320 square feet of growing space is said to produce a similar amount of food as two acres of farmland (Levy, 2017). This type of production is seen as a way of cutting food miles and producing year-round, while the farmers also learn entrepreneurial skills.

Direct-to-the-end-user models are enabling not only disruption of distribution, but also of the actual varieties of food that will be grown. Chief executive officer of California-based vertical farm "Plenty", Matt Barnard (2017), said that the company's growing and distribution model, where plants could be picked and delivered the same day, paves the way for varieties to be

selected for taste, rather than also a need to withstand often lengthy distribution process. Plenty, which uses machine learning to perfect its growing recipes, made headlines in 2017 when it raised \$US200 million in a Series B funding round led by tech-investor SoftBank. A fund that invests on behalf of Amazon founder Jeff Bezos, is another of its investors.

Meanwhile, Sonia Lo, CEO of Crop One Holdings, (parent company for FreshBox Farms, a vertical, modular farm in Massachusetts) predicts that by 2030, 50 per cent of leafy greens in the US will move indoors, just as the tomato industry did from 2000-2015.

Other investments in this sphere include online UK retailer Ocado's £17 million investment in two vertical farming ventures announced June 2019 (Askew, 2019), while Crop One Holdings, in partnership with Emirates Flight Catering, in 2018 announced a \$US40 million investment to build the "world's biggest" vertical farm (130,000 square feet, capable of producing three tonnes of leafy greens a day). It is to be located adjacent to the Dubai airport, so plants can go from the farm to departing planes in less than 24 hours.

These closed environment chambers are being designed for space agriculture and long duration missions to the moon, Mars and back, explains Gary Stutte (2017) scientist and consultant for Synrge. He sees this controlled environment – intensive horticulture – as pushing the limits of productivity, whereby potato yields of twice that of the world record field yields (in two thirds the time), and wheat yields four times greater than field yields, have been achieved. The University of Queensland and the John Inness Centre have also shown it is possible to grow wheat (from seed to seed) in eight weeks. Their research builds upon work by NASA and utilises LED lighting and day-long regimes (up to 22 hours) to optimise photosynthesis (John Innes Centre, 2018). In addition, Dr Stutte says that changing the colour of light to which a plant is exposed can dramatically change a plant's appearance, nutritional quality and health benefits without increasing power, water, labour, or nutritional inputs.

Chapter 4: Pipette and Print

In spite of a projected rise in meat consumption globally and a boost in beef consumption in China, as we head towards 2025 - whether it is riding the wave of the flexitarian, reducetarian, vegetarian or vegan diets or a desire for healthier eating - insects, algae and other protein alternatives are capturing millions in both investment dollars and the taste buds of consumers.

In 2017, US food and drink start-ups attracted \$US1.08 billion (Food+Tech Connect, 2018). The biggest slice of that pie – US\$179.5 million – went to alternative proteins, for everything from milk to meat. The Food+Tech Connect (2018) report claimed that both consumer demand for plant-based food and investor activism were driving growth in this sector. Other categories such as e-commerce and Ready to Drink coffee also took a slice of the cake. In 2018, more than \$US1.45 billion was invested in 247 deals. According to the 2018 US Food and Beverage Startup Investment Report (Food+Tech Connect, 2019), plant-based meat and dairy alternatives accounted for a third of the total investment.

Soon, this space will be further crowded with cell-cultured alternatives. The Rabobank (2017) report, “Watch Out... Or They Will Steal Your Growth”, shows that, rather than current market size of alternative proteins, ‘growth’ is of most significance.

“Three of the strongest demand drivers for alternative protein products are essentially those that are ‘pushing’ consumers away from regular animal protein consumption, namely concerns around health, animal welfare and sustainability,” said report author, Justin Sherrard, Rabobank global sector strategist for animal protein. “That said, there are also a number of ‘pull drivers’, such as curiosity to try new products, convenience and personal nutrition”, he added.

Richard Allen, account manager, Kantar, said sales of plant-based home meals was also being driven by price-point. Per portion he said these were 35 pence cheaper compared to meals with meat. Mr Allen also told the audience at Kantar Talks, London, 2019 that Health is a bigger driver behind plant-based options, ahead of environmental or animal welfare (Morrison, 2019).



Figure 19: Protein alternatives are being developed across the food chain for everything from milk to fish. Source: Lara Ladyman

a) Plant-based proteins from soy and lupine beans being developed at Wageningen University. b) A Silkworm snack and Cricket Pasta from Thailand-based start-up Bugsolutely. c) French company, Algama, under the brand name The Good Spoon, is developing food and drinks made from microalgae. The company is dedicated to plant-based foods, as it sees these as being better for the planet. d) Good Hemp, one of the many dairy-free milk alternatives, on sale in London. e) Quorn, made from mycoprotein, a product of the fermentation of the fungus *fusarium venenatum*

26th April 2018

Meat-free madness

By Gordon Davidson



QMS chairman Jim McLaren



'MEAT FREE Mondays' have been introduced to Edinburgh's council-run primary schools, to the outrage of the Scottish red meat sector, which described the decision as 'ill informed and ill-judged'.

The move makes the capital the first local authority in Scotland to adopt the idea, which was first instigated by celebrity vegetarian

Figure 20: Meat-free Madness. Source: *The Scottish Farmer*, April 26, 2018.



Figure 21: Plant-based burgers sizzle.

a) The Impossible™ burger, being put to the taste test at a trendy burger joint KronnerBurger in Oakland, California. One of three locations in the San Francisco Bay area that the revolutionary burger was available in April 2017. The plant-based burger contains genetically modified soy leghemoglobin, made from genetically engineered yeast. b) Beyond Meat released its first plant-based patty in 2016, selling in the meat section of the grocery store. In 2019 it's burger was launched in McDonalds. Source: Lara Ladyman

2018 marked five years since the first, very expensive (\$US325,000), laboratory-grown burger was put to the taste test. A growing number of start-ups are aiming to create everything from tuna to turkey without an animal in sight. Cell-cultured and alternative proteins are taking on a swag of products derived from animal production – milk, eggs, chicken, turkey, fish, prawns, duck and even lab-grown mouse meat for the pet food industry.

As Rabobank senior analyst consumer foods, Nick Fereday, (2018) said: “Just 5 per cent of the US market could make (lab-grown meat) a viable product.”

Mark Post (2018), the creator of that first burger, anticipates that his company, Mosa Meat, will have lab-grown meat – although his preferred term is ‘cultured meat’ – on barbecues by 2021. The company’s mission, like others’ within the industry, is to “produce ‘real meat’ for the world’s growing population that is delicious, healthier, better for the environment and kind to animals”. After early investment from Google co-founder Sergey Brin, in July 2018, Mosa Meat announced it had raised €7.5 million from a number of investors, including M Ventures (Merck’s venture capital arm) and the biggest meat company in Switzerland, the Bell Food Group. “Meat demand is soaring and in future won’t be met by livestock agriculture alone,” said Bell Food Group chief executive officer, Lorenz Wyss (Mosa Meat, 2018). “We believe this technology can become a true alternative for environment-conscious consumers, and we are delighted to bring our know-how and expertise of the meat business into this strategic partnership with Mosa Meat.” This ‘real meat’ is claimed to: “generate an estimated 96 per cent less greenhouse gas emissions, use 99 per cent less land and 96 per cent less water than livestock meat” (Mosa Meat, 2019).

The likes of Tyson Foods - with an annual revenue of \$US41 billion, the US’ biggest meat processor - and the agribusiness giant Cargill are also betting on alternative proteins.

In 2016 and 2017, through its investment arm, Tyson acquired a 6.5 per cent stake in plant-based protein company Beyond Meat, which it sold in 2019 ahead of Beyond Meat’s listing on the Nasdaq (IPO price of \$US25 per share). In 2019, Tyson launched its own plant-based protein patties and nuggets. Its interest is not only in plant-based proteins: through its venture capital arm, Tyson has also invested in cell-based meat company Memphis Meats, as have Cargill and other high-profile backers, including Bill Gates and Richard Branson.

In May 2018, Tyson also became a seed investor in Future Meat Technologies Ltd, an Israeli start-up developing cultured meats.

Daan Luining, chief technology officer for Meatable, in his pitch at F&A Next, 2018, at Wageningen University, said they would be able to create a cell-cultured burger in three weeks or less. He says Meatable is developing what he refers to as the second generation of cultured meat: “Our cells can grow indefinitely inside a bioreactor...and wouldn’t need a single drop of foetal bovine serum. Our cells can also turn into fat cells next to muscle cells so we can re-create the product people associate with eating meat. Through our technology and a flick of a switch the stem cells all turn into muscle or fat cells.”



Figure 22: What’s in a name? Alternative names for meat produced from cell culture, suggested at the 2018 New Harvest conference.

Suggestions include: clean meat, craft meat, lab farmed, enhanced meat, future meat, bio-meat and motherless. In 2019, Washington-based pro-plant-based and cell-cultured protein lobby group the Good Food Institute announced, based on consumer research, that it would be adopting the term cultivated meat, in preference to terminology like cell-based meat Source: Twitter.

When will we put a lab-grown ribeye on the barbie?

An interview with Mark Post (2018), creator of the first burger made of stem cells from cows, and Professor of Physiology at Maastricht University, the Netherlands.



Figure 23: Mark Post serves up a cultured burger. Source: Mosa Meat.

What is your vision for the future of animal protein?

Realising this is a very expensive, resource-intensive part of our diet, but also a very cherished part of our diet, I think animal protein will be produced mostly from cell cultures and tissue cultures, so in a more resource-efficient way with less greenhouse gas production and fewer animals.

What is the timeframe for commercial release of your burger?

Technically, we can bring this to market in a few years (2021). It will still be somewhat expensive – maybe \$US10 for a hamburger – so more in restaurants and specialty stores, initially. Eventually it will hit price parity with regular meat. Exactly when that will happen, I don't know. It may take a couple of years, it may be sooner than that, but it will take more time.

When will we be able to put a lab-grown steak on the barbie?

Eventually, we will have to make a lab-grown steak – a ribeye or filet mignon, for example – and the technology to do that is basically there, to some degree, in the medical field, but it still needs to be applied to large-scale food production, so it is difficult to predict. It is safe to say it is not going to happen in the next five years. Is it between five and 10 years or 10 and 15 years? – I don't know.

Why is cell-cultured meat so transformative?

It's transformative in many different ways. It's transformative because we'll use fewer resources to produce food for nine billion or 10 billion people in 2050, with lower greenhouse gas emissions and fewer animals. It will also be transformative because it will change the job market – feed production and farming will change; it will change, to some degree, the meat industry – slaughterhouses, for example – and it will also change our culture because we will have to look at meat in a different way. It will no longer be something that comes from animals directly, but is made in a lab or factory, or in a microbrewery, or some system, so it will culturally change the value of meat.

Will meat from other livestock be grown using cell-culture technology?

I think eventually that is true for every part of the livestock industry. For every animal that has stem cells, muscle cells, you can make this happen. For most of these species, the reasons for doing it are different. For cows in particular, it's the resource-inefficiency of a cow and the greenhouse gas/methane emission. For sheep, also methane. For fish, it's mostly biodiversity, because they are already very efficient at converting vegetable proteins into animal proteins. For chicken, which is a pretty efficient animal for feed conversion, it's mostly animal welfare, as there are so many animals involved. For pigs, it is probably a mix of those reasons.

What do you think cell-culture of animal protein means for farmers?

It's an important issue, particularly for livestock farmers – the cell-culture technology will change the business. It will make it smaller, much less intense; it may mean they may need to go into crop farming to produce, for instance, the feed for these cells.

In my mind, farmers are basically entrepreneurs extracting value from land, and if we really need much less land to produce food for nine billion people, then some of that land will be freed up for nature or recreational activities, and that will be another way for extracting value from your land. The other part of that is food production, and here I am thinking primarily of

producing crops like sugar cane or sugar beets, or high-protein crops like soybeans or peas, to eventually feed the cells.

Will there be animal farming in the future?

Absolutely there will be animal farming in the future, if only for having animals as stem cell donors to create the meat. If you do the maths, there will be a lot fewer animals. Theoretically, we could go from 1.5 billion cows to 30,000 or 50,000, so there will be far, far fewer. I don't know if there will still be some artisanal meat production through livestock.

There are areas of course - in Africa, for instance - where there are small holder farms with only a couple of animals that just roam the area for the little food there is and that nothing else can eat. There, cows make sense as an investment and security for future disaster, and there are probably areas in Australia where cows make sense, because you can't do a lot else with the land; but I don't think there are that many other areas (where the land can't be used to grow something else).

I don't know how long it will take, but it is going to take at least 30 years. A couple of things need to happen for that transformation to take place entirely. For one, the public at large needs to accept it – not only a few front-runners in cities – but everybody will need to accept this is the future and this is the way we are going to consume meat. Typically, it takes a long time for people to adjust. Secondly, of course, it is a huge production system. Since this is a completely new technology and a completely new industry, it will take a long time to develop that type of scale.

I understand this is a radical vision and it is radical innovation, and it may not seem to be very romantic or appealing in the beginning. But in all honesty, I do believe we have few alternatives. The only other real alternative is to all become vegetarians, or at least consume much less meat, and in my mind, a future with still-decent meat-eating consumption without the negative externalities is a better future than one where we have to restrict ourselves too much in our consumption pattern.

What will be in a Mars burger?

The Mars burger will be exactly the same as the Earth burger. It will be locally produced, with cells grown in a bioreactor or tissue production system, but on Mars, using a completely recyclable system.

Not just cell-cultured meat

Plant cell cultures are used to produce industrial and cosmetic compounds, so why not fresh food? That was the question asked by Lauri Reuter (2017), of the VTT Technical Research Centre, Finland, who shared his studies, at New Harvest 2017.

He said that while growing animal cells was complicated, growing plant cells was “very easy”. Using plant cell-culture technology, VTT researchers have been examining the nutritional and sensory properties of dried and fresh cells grown from cloudberry, lingonberry, stone bramble and the Arctic bramble.

But it is early days for brewing plants. Dr Reuter reported that a jam made from processing the lingonberry culture tasted like lingonberries. “It was quite delicious,” he said. “The problem is, when we made it out of strawberry cells, it tasted exactly the same. The good news is that, when you make it out of green strawberries, it tastes like lettuce – it kind of doesn’t add up. We are really at the beginning of engineering the flavours of the cell cultures themselves, as, for the 20 years we have been using it for industrial application, we have not been focussed on food and how to process them into something that tastes good.”

Dr Reuter does not foresee plant cell culture being used to provide bulk food to solve the hunger problem. “But they can provide many phenolic compounds we need for our health,” he said. In his view, plant cell cultures may open the door for new foods from plants which, like the Arctic Bramble (that has one berry per plant), had not so far been possible to domesticate or cultivate traditionally (VTT, 2018).

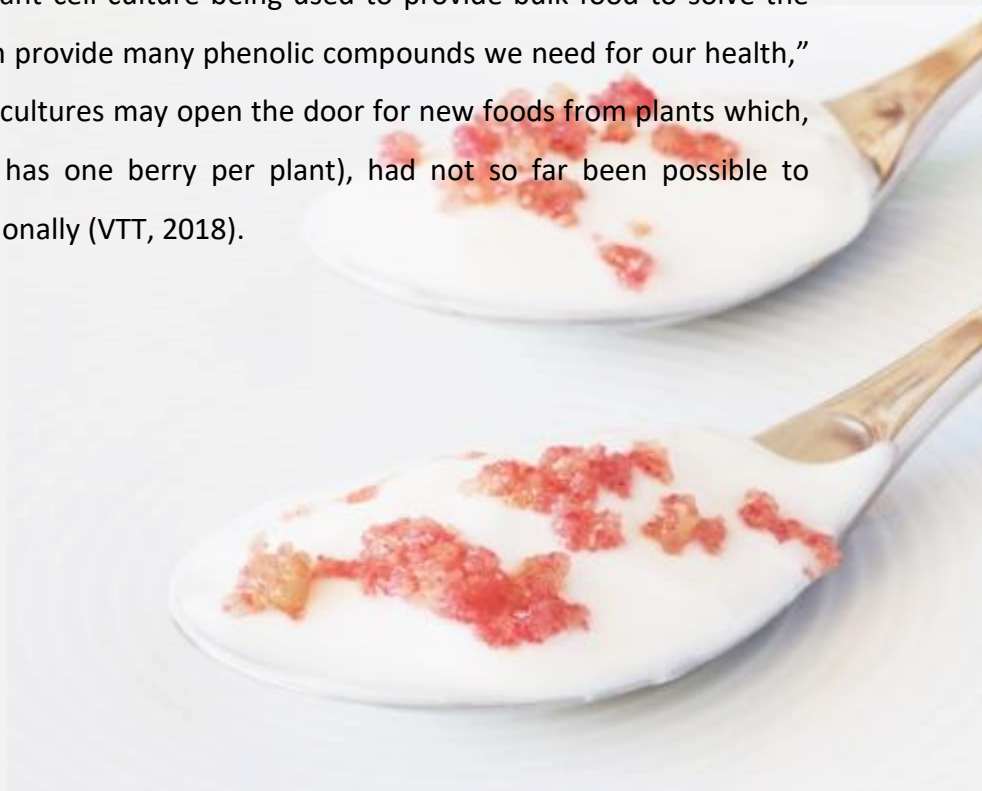


Figure 24: *Plant cells cultured at VTT. Source: Heiko Rischer, VTT, 2018*

Designer babies, livestock and crops

CRISPR is a gene editing tool “poised to upend natural genomes and erase inherited diseases” (Fan, 2019).

The world’s first gene-edited babies were born in China in 2018, sparking a furore about the use of the technology on human embryos. Soon afterwards, Chinese officials declared the experiment illegal.

The first commercial food product from a gene-edited crop was consumed in the US in 2019. The oil, being used in restaurants, is produced from soybeans gene-edited to have reduced saturated fats. Calyxt, which developed the gene-edited soybean (using a technique called TALENs (transcription activator-like effector nucleases), touted it as non-GMO and also noted that the high oleic soybean meal was a “premium non-GMO feed ingredient with added benefit for livestock” (Calyxt, 2019).

The world and the legislation may not be ready for designer babies. However, within the medical world, gene-editing technology is being embraced for its potential to cure diseases. The question remains: Are prosumers ready for gene-edited food? And will they allow new genetic breeding tools which will be developed into the future to be utilised in tomorrow’s menus.

A sample of the gene-edited plants and animals in the pipeline includes: a gene-edited canola tolerant to sulfonylurea herbicides, developed by gene-editing company Cibus, Flax with higher omega-3 content (Yield10 Bioscience), hemp with high-cannabidiol (CBD), low-tetrahydrocannabinol (THC) being developed by the California Hemp Corporation and Benson Hill Biosystems, tilapia with improved fillet yield, growth and feed conversion efficiency (AquaBounty Technologies and Intrexon) and pigs that don’t need castrating (Recombinetics/Acceligen and Hendrix Genetics).

In 2018, the Court of Justice of the European Union placed CRISPR technology for the EU, in crops in the same box as genetically modified organisms.

Meanwhile, the US has indicated that gene-edited crops will not be considered GMOs and, unlike GMOs, will not require labelling. In spite of this announcement, However, a US-based start-up using CRISPR for plant breeding said there remained significant uncertainty as to how the US would regulate CRISPR. In October 2018, the FDA announced its Plant and Animal

Biotechnology Innovation Action Plan, at the same time promising to finalise its guidance on genome-edited animals that will be used as food (Ledford, 2019).

In April 2019, the Australian Government announced that a form of gene-editing, called SDN-1 (or site-directed nuclease) techniques, will not be regulated, as these “pose no different risks and cannot be distinguished from conventional methods” Other forms of gene-editing, and those that introduce foreign DNA into a genome, will be regulated by the Office of the Gene Technology Regulator. As of April 2019, the Australian and NZ food standards regulator, FSANZ was still to report on how food from gene-edited plants and animals would be regulated.

US to label “bio-engineered” food

The US is introducing new labelling rules for genetically modified organisms or GMOs, to come into force by 2022. The legislation, announced in 2018, refers to GMOs – a term already familiar to consumers – as “bio-engineered”, and requires food manufacturers, importers, and certain retailers to disclose information about whether food offered for retail sale is bio-engineered (BE) or uses BE food ingredients; restaurants are exempt. Disclosure can be made by way of text, a symbol, electronic or digital link, or text message.



Figure 25: US labelling laws requiring identification of genetically modified foods, and ingredients referred to as ‘Bio-engineered’, will come into force by 2022. Source: USDA

Chapter 5: Into the Future

Hands Free Farming?



Figure 26: Jonathan Gill of Harper Adams and Martin Abell of Precision Decisions, on the edge of the Hands-Free Hectare at Harper Adams University, UK. The first HFHa crop, spring barley, was harvested in September 2017. Source: Lara Ladyman

“The future of food in the food service sector will be about personalisation; food as fuel, which is the convenience story, or food as an experience. Food security – provenance and food safety – will be important. Meanwhile, healthy eating and people choosing to eat less meat will prove to be trends rather than fads. It is a future where data and technology are the enablers of the wholesale changes – already under way – in how food is grown, sold and consumed.”

“We will be better at remembering customers - through data and, maybe, facial recognition. As has already been achieved with the Wagamama app, the “pain points” - the idea of waiting for 20 minutes, with your hand up, for the bill - will all go.”

“In the future, we will have ‘gastronomic’ passports. These will be a simple, secure way of communicating your needs, dietary requirements, allergies and preferences – either ahead of time, or automatically when you walk into a restaurant - so that what is being delivered is tailored to suit you.”

“I don’t think robots serving people in full-service restaurants will become the norm. Given that we are living in a more automated world, that human connection of people serving people will become even more important. Rather than the front of house, robots may be in the back of house.”

Mr Hacon says delivery platforms are having a huge impact on the restaurant sector. “Across ten of our restaurant sites, takeaway sales have gone from zero to nearly £2 million a year.” “The disruption is causing big problems. Restaurants have been built with kitchens designed, for example, to service 150 people seated at tables, not to serve 300 people at home as well. Going forward, we will see distinct changes in restaurant design. Restaurants will have bigger kitchens, separate doors for delivery/takeaway and separate menus to support takeaways.”

“As we become more urbanised and space becomes tighter, we will see smaller neighbourhood-type venues, with people wanting more individualised experiences. The kitchen and living areas in the home will become smaller or non-existent, so, increasingly, people will use restaurants as a ‘third space’ – somewhere to lounge, sit and converse and socialise, rather than just as a place to eat.”

“Convenience is crazy! We will see the places that are more about running in and grabbing food becoming more about that, so you will pre-order and pick up from a cabinet, without human interaction.”

“We will probably see 3D food printers at home for convenience, and we may see them in canteens and workplaces, but I would like to think that that will be the extent to which we see them; but watch this space.”

What will the future food service sector mean for the farmer?

“As for the farmer, when it comes to the future of food service - at the high end, the positive is that people want to know the provenance and where food comes from. However, in the

day-to-day dining environment, I worry about how little interest there is in the supply chain and where food comes from. As that becomes more homogenised, I worry about what that means for farmers.”

“In the retail sector, I think we are going to see an increase in direct farmer-customer transactions. We are already seeing this, but it is on an individualised basis. As yet, for someone running a group of restaurants, there is no infrastructure in place which allows that to happen. Given that restaurant groups in the UK are becoming bigger and expanding nationally, there is a need for technology providers who can deliver that link and the ability to transact directly with farmers.”

“Restaurants themselves are now investing further along the supply chain, to mitigate risk and create a story. One burger provider has become its own butcher as a way of ensuring quality as well as product integrity, while another restaurant group, ‘Flat Iron Steak’, has its own herd of cattle and can tie the provenance story back to the farm. ‘Flat Iron Steak’ also offers master classes with their in-house butcher.

The Future Market



Figure 27: *The Future Market offers a uniquely personalised shopping experience, enabling the eater to purchase concept foods of the future – based on one’s food personality. Source: Lara Ladyman*

Mike Lee, founder of 'The Future Market' – where you can shop for an array of concept foods as if it were 2042 – shares his views on the future of food:

To me, the future of food means that food products, and the way we consume them, will be better for people, planet and profit. Obviously, people and planet, but also profit, because we need sustainable businesses which can actually run, as well as supply us with the world's best food.

What the threats for the future of food?

The biggest threat is not technology, it's the public's ignorance of the food system. The biggest threat we could have is people not caring enough about their food and where it comes from. We have seen that change a lot over the past ten years, but there is more to do. If we can prevent mainstream public ignorance about the food system, that should insulate us from a lot of the problems we will face. I think people, not corporations, will have power over the food system.

What excites you about the future of food?

Today, as a food entrepreneur, it is so much easier to come up with an idea and turn it into reality very quickly, because the barriers to entry into the food industry have become fewer. There are more incubator kitchens, there are more accelerators, and more resources for young food entrepreneurs to get their product going.

Why did you open the Future Market?

This concept market of the future gives eaters an insight into products they may be purchasing up to 25 years into the future. It's a timeframe chosen for being distant enough to dream of what could exist, yet close enough, if people start now, to enable them to put something big in play for the future. The hope is that the Future Market's concept products will inspire the food industry to think more about changing the food paradigm. We hope people take these ideas and concept products and amplify them into real products.

What's on the shopping list?

Perhaps some home-brew that takes on a flavour of its own. 'Nanobrew', one of the concept products, is a home-brewing kit that uses the wild, airborne yeast around you – it will reflect your personal 'terroir' and taste distinct from the beer brewed by your mate who lives across town.

Alga Marina is a seaweed-based pasta, high in protein and very sustainable. Another product – Offal Good – is a pre-seasoned offal dish. Whole animal utilisation is a very big theme for us, and I think eating offal is part of that experience. Cannabis cuisine is also on the ‘shelves’.

As for cultured meat, Mike believes that, as with any new product, once this early-stage technology matures, it will be just another choice. I don’t think it will replace traditional farming, especially where the animals are well-raised, pasture-fed and antibiotic free, he says.

For those wanting to track exactly what they are eating, there is ‘Sensum’ - a premium dinnerware set with built-in visual capture and near infra-red mass spectrometer sensors to scan, analyse and record the food that hits your plate, fork and mouth.

More than microgreens

In the future, tomatoes will be seen not simply as a red, orange, yellow, green or purple fruit; consumers will pick different varieties based on their nutritional value – maybe for its lycopene (an antioxidant) or its Vitamin C levels.

Tara Vester (2018), partner co-ordinator for Dutch-based microgreens specialist, Koppert Cress, believes health will be more important in the future: “We are going to look at food in a different way. We are going to eat more vegetables, and the role of vegetables is also going to change. We are going to look at nutrition; instead of a tomato, we are going to look at what is really *in* the tomato.”

Ms Vester said it remained to be seen how consumers would determine that nutritional value. However, one option may be a scanner that analyses nutrition. Big data will also play a central role. From A to Z, everything is going to be mapped, so customers will be able to make choices based on accurate, reliable and scientific information, not just on what their senses (i.e., sight, smell, touch) can discern.

As well as microgreens, Koppert Cress’ highly automated greenhouses, located in the greenhouse dense area of Westland, grow edible leaves and flowers that are distributed to high-end restaurants and top chefs across Europe and further afield. Although tomatoes are not on its current grow list, Koppert Cress’ research and development is looking at nutritional content of its crops, as well as new varieties.

Ms Vester said Koppert Cress is about more than microgreens: “We grow microgreens, but what we really do is to try to make the world a little bit healthier by eating lots of vegetables. Everything we do is based around the concept of health and we are not just talking about food, but also air quality and sustainability. Everything we do is based on the question: is it good for us and for our planet?”

Koppert Cress’ plant-filled company restaurant, which provides its employees with meals that feature seasonal vegetables - and, of course, microgreens - is aiming to be the Netherlands’ first carbon-neutral restaurant.

The greenhouses use geothermal energy for heating in winter, and every aspect of the greenhouse is designed to be water-and energy-efficient; even heat from the LED lighting is harvested and used.

The final stop on a Koppert Cress tour - which includes a demonstration kitchen for chefs to experiment with, and learn about, the microgreens - is its indoor garden, created for school children to wander through and taste the produce grown within.

Ms Vester said she understands the challenge in feeding a growing population and, with that, the need to grow more plants per square metre. To that end, while not being utilised currently, the greenhouse has been designed with the capacity to grow vertically.

She said that a vital part of meeting this challenge was sharing innovative technologies and know-how: “There is so much innovation, not only in our greenhouse, but in other greenhouses in the vicinity, that can be such a help to growers all over the world. If you look at technology and innovation, I think we can play a huge role in tackling this problem all over the globe.”



Figure 28: Nutrition Facts. In the future, tomatoes will be bought not for their colour or ripeness, but for their nutritional content instead. Source: istockphoto.com/Alxpin

Food printed to precise order

3D printing in a variety of materials, from plastic to metal, is revolutionizing many fields – aerospace and medicine, for example – and it is also set to re-program the food story. That is the view of Jerson Mezquita, Jonathan Bluntinger and others from Hod Lipson’s team from Columbia University’s Creative Machines Lab, NY.

The 3D printer on which they are working is not the off-the-shelf variety that simply prints edible materials, layer by layer. “The key difference is, our machine is going to be able to cook as well, so when you lay down a layer then you can cook that layer,” Mr Mezquita explains. “We are using a low-power laser, and the laser can draw whatever shape you want, so you have infinite control over whatever it cooked”.

They believe that 3D printing can potentially re-write the personalization of food. “If you have a particular vitamin deficiency, it is hard to go to the supermarket and say, ‘I need five more grams of protein today or I need five milligrams of Vitamin C,’ but using a 3D printing machine you can actually portion out whatever it is you need and make a balanced, healthy snack,” Mr Mezquita said. It could also assist people who have to take a lot of pills and find them hard to swallow; the medicine, for example, could be printed into something easier to eat.

The team is also working on ways to make the machine consumer friendly, by creating a new way to make 3D models. “Imagine an intelligent machine – kind of like Alexa – where you say, “Alexa, make me a muffin” and it will pull down a recipe for muffins and then you speak to the machine and tell it to add blueberries or add less sugar,” he said.



Figure 29:3D food printer prototype from Creative Machines Lab, Columbia University, NY.
Source: Creative Machines Lab

Conclusion

“Dear future, I am ready,” reads a sign on the wall at the STT Netherlands Study Centre for Technology Trends in The Hague.

It is the hope of the author that the insights gained from this report, into the prosumer or future eater and some of the technologies and tastes transforming food production, will stir the debate around what this future will mean for Australian farmers, so that they, too, can be ‘ready’, and be the ones setting the menu for change rather than being disrupted by what is a revolution of not only the agriculture and food value chain, but also of how we will eat, live, work and play.

In only three decades, the global population will approach 10 billion. I have no doubt that – enabled by rapidly-changing technologies – we will have the ability to produce enough food to feed the world, adequately, nutritiously and sustainably, in 2050. However, just as is the case today, it will depend on whether food can be grown, afforded by and transported to where it is needed to overcome starvation and malnutrition. Our ability to achieve the Sustainable Development Goals will be a crucial factor. It will also hinge on our future eaters and their version of ‘sustainable’ farming systems and whether farmers will be allowed to access a full pantry of best practice innovative existing and future technologies.

There are numerous movements – such as regenerative agriculture, conservation agriculture and others incorporating perennial/organic/more biodiversity/carbon neutral/chemical-free and even the emerging concept of circular agriculture – that tout benefits for the environment. There will be opportunities for some farmers to tap into these. However, a key challenge for Australian agriculture will be to define what it means by sustainable, ensure this meets expectations of a reasonable consumer and share with them how we are achieving this.

This “Taste of the Future”, which enabled me to experience a slice of the exploding food-and ag-tech revolution occurring across the globe, found many of these innovations, digital or otherwise, for example, track-and-trace technologies, can play critical role to help instil consumer trust in food and agriculture.

That future consumer is most likely to be urban dwelling, will want to know more about their food: where it comes from, how it is grown and whether it is good not only for them, but also for those who produced it, for the livestock and for the planet. All the while, the gap between the farmer and where their food comes will continue to have widened. By 2046 Australia’s

total population is expected to grow to 36.8 million, 75 per cent of whom will live in Sydney, Melbourne, Brisbane and Perth. These growth projections will take Sydney and Melbourne to around the size of Hong Kong or New York as they stand today (Infrastructure Australia, 2018). Meanwhile Brisbane and Perth are expected to see an almost doubling of population at just under 4 million and around 4.3 million respectively by 2046.

In a time where global connectedness, aided by social and immersive media, will give voice to a social conscience as never before, there will be increased scrutiny of farming practices. This includes ever-higher community expectations about the environment, applications of chemicals, fertilisers and antibiotics, animal welfare, use of land, energy and water resources, waste and sustainability of production.

A key finding of this report is that nurturing trust of our eaters will be one of the most critical issues that needs to be tackled by the agricultural industry for its future. As Charlie Arnot (2018), from the US Centre for Food Integrity, said: “If people trust you, the science doesn’t matter. If people don’t trust you, the science doesn’t matter.”

One in four Australian children doesn’t know where milk comes from, and 55 per cent don’t think farming is innovative (Hillman and Buckley, 2011). These are tomorrow’s consumers, policy makers and influencers, so it is of the essence that they have the opportunity to learn about and experience where their food comes from. Equally, if our children don’t think farming is innovative, how is the industry going to attract the data analysts, robotic engineers, coders and geneticists who will be essential for the future?

Beth Ford, chief executive officer, of US-based agricultural cooperative Land O’Lakes told the 2019 Thrive Innovation Summit that farmers were trusted, such that when images of farmers are put on their packaging, sales increase. However, more and more, questions were being asked about the practices used by farmers.

Throughout this Nuffield journey, it became evident that community expectation, government policy and the voices of NGOs, as well as activists, impacting on farming, were significantly louder in many of the countries the author travelled, including the Netherlands, Denmark and the UK - than in Australia.

So now is the time to change the conversation and the way we share the incredible story of Australian agriculture and growing food. We cannot afford just to continue to trade on the good will afforded the Australian farmer and hope for the best. A new approach is needed.

One which is centered around building trust and engaging with the future prosumer. It will need to be transformed.

An organisation or group and an across-industry strategy that has a specific charter of engaging with the consumer and bridging the gap between farm and fork is needed. The task must be tackled by the wider agrifood industry; it must go beyond commodity-specific activities where, for example, egg producers promote eggs, wool producers, wool, or red-meat producers promote red meat. This is about the agrifood sector building on and earning the trust of today's consumers and tomorrow's eaters, influencers, media and policy makers.

Our 'food tribe' is becoming part of how we define ourselves and so there will be a great diversity of plates (and other sensory tableware) put forward as part of the future menu.

Stepping into the not-too-distant future, food will be highly personalised, and data-driven. It will also need to be fast (convenient), or an unforgettable experience.

The golden ticket for each of the segments from Plate to Paddock is data, and the insights to be gained from this. Farmers and food producers must ensure systems are in place to readily capture not only on-farm data to drive efficiencies and profitability but also customer data and use this to enhance the prosumer experience.

The rise of the flexitarian or reducetarian is a trend that presents both a significant opportunity and a challenge for Australian agriculture. But for farmers to truly capitalise on this plant-based revolution it will require more research into the protein components of our existing and future crops, as well as market development.

Producers also need to heed the message being sent by eaters who are embracing alternative proteins – soon to include cell cultured meats and other products – that they have concerns around health, animal welfare, sustainability and climate change. Price is also a factor. Technology will play a role in enabling farmers to address these. For example, the CSIRO has developed a seaweed feed additive, called FutureFeed, found to reduce enteric methane production by more than 80 per cent while also increasing livestock productivity (CSIRO, 2019).

It is also about the conversations we have as an agrifood community, that we are setting an agenda for proactive change – part of this is ensuring we educate ourselves to really understand the consumer of tomorrow. And if we don't share our story of continuous

innovation with the supply chain, our prosumers and policy makers, it will be a moot point. It is also important not to let incorrect information go unchallenged.

In a bid to resolve some of these challenges, food-and ag-tech communities are disrupting the way research, products and foods get to market, and how these ideas are funded. These ecosystems are a new, and rapidly evolving, space for Australian agriculture, and we need to do more now to value-add Australian ag-and food-tech by opening the gate for farmer-led innovation.

In order to realise this 'digital future' whereby the Internet of Everything enables farmers to have real-time insights into every aspect of the business, extending beyond the farm gate to the consumer, *it will be pivotal for rural Australia to have high-speed wireless internet connectivity*, not only so there isn't a digital divide between city and country but so Australian agriculture is leading this charge and is not left behind its global competitors.

Many of the dishes being served up for the future menu and encountered by the author during her travels, including the one that started it all – the lab-grown burger – related to policy and legislation. Change is occurring rapidly, so this is new ground. No-one even knew which US agency should regulate cell-cultured meat, or what it should be called. Questions were raised about whether autonomous tractors could be operated in paddocks, let alone on public roads, and whether drones could operate beyond line-of-sight for agricultural purposes. In the UK until recently, drones had to land at the same weight as they took flight, limiting their potential as a spray vehicle or even one that could deliver pizza. There remains uncertainty across the globe as to how – and even if – gene-edited plants and animals will be regulated, and there were many questions on the future use of a range of agricultural chemicals. These issues, and others surrounding data and privacy, water, greenhouse-gas emissions, connectivity and the right to farm – as prosumers take more of an interest in how this happens – to mention just a few - are too important for Australian agriculture not to be designing the menu.

The pace of change, especially in the ag-and food-tech ecosystems and bringing new foods and products to market, witnessed during the authors travels was even faster than anticipated. Given this, both as growers and as part of the agrifood industry, we should take a lead from Richard Liu (2018) founder of China's biggest online retailer JD.com, and "think about tomorrow every day and innovate every day".

Today in Western Australia, for example, there is around 4000 grain growing entities, 20 per cent of which produce 80 per cent of the crop. This is down from 7500 in 2004. How many will there be in 2030 or 2050?

As the agriculture landscape is changing and the population becoming more urbanised, we need to interrogate and challenge our industry and representative structures and every aspect of the way we do business today, so we can add the ingredients needed for the Australian agrifood to head full speed into the future.

I have been so inspired by every mouthful (even of the insect burger) of this Taste of the Future, and the amazing people who helped along the way, who were so generous with their time, insights and friendship.

With this entree, I know the future for Australian agriculture will be full of flavour and disruption. It will also provide huge challenges and mouth-watering opportunities for Australian farmers.



Figure 30: Taste Tomorrow. Lara Ladyman bites into high protein noodle made from fish at the 2017 Speciality Food Association Fancy Food Show in New York. The surimi noodle, from the Oregon State University Food Innovation Centre is made from a low value fish called Pacific whiting, which is often the bycatch of going after a high value fish like salmon.

Recommendations

- Deliver and support technologies enabling rural and regional Australia to access to highspeed, wireless connectivity, it is critical for the future of food and farming.
- Brand the Australian agrifood sector and create opportunities to share the story of Australian agriculture in a way that captures the hearts of the future eater, the future robotics engineer and the future farmer. This includes expanding programs like the Rabobank/CQ University Teacher Farm Experience programme.
- Create a *consumer-facing* group or organisation/strategy that has across industry support. One (it can be an existing one) which is centered around building trust and engaging with the future prosumer, influencer and policy maker.
- Educate ourselves, and intimately get to know the future eater. As part of this it will be essential to capture and analyze consumer data. Use this data to drive and implement innovation.
- Embrace digital and other innovative technologies to instill consumer trust. It is essential that full product traceability from farm is part of this.
- Look for the opportunities in the rise of the flexitarian and personalised nutrition. Invest industry research dollars into new crops, new ingredients and protein components.
- Heed the messages from eaters in the rise of alternative proteins and alternative animal products whether it be gelatine, milk, meat, eggs or fish.
- Do not repeat the mistakes made when taking gene editing technology to consumers, that were made with GMOs – i.e., a failure to recognise consumers might have concerns.
- As an industry, set an agenda for proactive change and also ensure our own house is in order when it comes to meeting consumer expectations.
- Australian farmers must take a seat at the Future Food table, to shape the future menu not only in Australia, but also in the UN/FAO/Brussels etc., where voices of social movements and NGOs are loud and unrelenting and where decisions that will impact the future of food and farming are being made.

Plain English Compendium Summary

Project Title:	Taste the future: How prosumers are shaping the future of food and what it means for Australian farmers?
Nuffield Australia Project No.:	1718
Scholar:	Lara Ladyman
Organisation:	Tennisdale Katanning, Western Australia, 6317
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Objectives	Understand the essence of the critical ingredient of any future menu – tomorrow’s consumer; Delve into the trends and technologies shaping the future of food and farming; Investigate strategies food businesses are adopting to either disrupt or combat disruption and discuss opportunities and threats for Australian farmers in this brave new world of tomorrow.
Background	This report comes almost two decades after that of 2000 Nuffield Scholar John Foss, titled: Future trends in the global agrifood industry and strategies for Australia to remain competitive. Much has changed in that time, for example, the creation of lab-grown milk and meat, the rise of ag-tech and food tech start-up investment platforms and omnichannel commerce. Other issues highlighted in John’s 2002 report, surrounding the new consumer and their focus on health and wellbeing, and traceability will only continue to become more imperative for food producers to deliver.
Research	The study was undertaken during 2017 and 2018, touching down in Bhutan, Brazil, India, Denmark, Qatar, the United States, Singapore, the United Kingdom, Spain, Italy and the Netherlands. Interviews and insights were gathered from farmers, futurists and food-and ag-tech innovators.
Outcomes	This report provides insights into the future consumer and rapidly evolving ag-and food-tech space, in the hope that Australian agriculture can better position itself for a rapidly changing, digital, mobile and global future.
Implications	Agrifood industries are undergoing and embarking on rapid, eater-led, technology enabled transformation, where data and the ability to interpret it will provide the cream – albeit may be created in a lab. It is imperative Australian farmers and their global counterparts, take a seat at the future food table and help shape the menu, rather than be disrupted by it.
Publications	Presentation at Nuffield Australia Conference, Melbourne, Australia, September 2018.