



21 December 2023

Department of Agriculture, Fisheries and Forestry

**RE: Agriculture and Land Sectoral Plan Consultation**

Food Frontier thanks the Department of Agriculture, Fisheries and Forestry for the opportunity to provide a submission to this important consultation.

[Food Frontier](https://www.foodfrontier.org) is the independent think tank on alternative proteins in Australia and New Zealand. We are committed to growing our region's protein supply with new, sustainable, and nutritious options that create value for businesses, farmers and consumers.

Alternative proteins, including proteins that are plant-based, cell-cultivated or precision fermented, is an innovative, emerging domestic sector that has the potential to bolster food security and the sustainability of Australia's agrifood sectors, while also delivering significant economic, health and environmental benefits.

Recognising the Agriculture and Land Sectoral Plan is focused on reducing emissions that come directly from agriculture and on the land, as well as emissions associated with energy, fuel and electricity use by the sector, we appreciate this consultation is predominantly aimed at decarbonising existing industries.

We applaud the Federal Government for pursuing sectoral decarbonisation, as well as those in existing agriculture industries already undertaking their own decarbonisation efforts. Reducing emissions and environmental impact is critical to ensuring the future viability of Australia's agricultural production and food security.

Yet, in the combined context of climate change, growing global food security and nutrition-related public health concerns, and ongoing disruptions to supply chains, we urge the Federal Government to supplement decarbonisation efforts with a comprehensive national food systems transformation plan to address vulnerability points across the entire system and actively build complementary, low-emissions agrifood industries.

There is widespread international recognition that current food systems must evolve, contributing between one quarter and one third of all global greenhouse gas emissions<sup>1 2</sup> and trillions of dollars annually in hidden health, social and environment costs.<sup>3</sup> For Australia, as a world leading food producer and exporter, transforming our systems of food production, distribution and consumption is both a domestic challenge and a global opportunity.

For this reason, and that Food Frontier can only speak from its specialist remit of alternative proteins, we have instead submitted to this consultation a position paper detailing the need for Australia to adopt a food systems policy approach, inclusive of decarbonisation. It also outlines the critical role alternative proteins can play, alongside conventional animal protein industries, to support this critically needed transformation and sustainably meet the growing demand for nutritious foods as the world's population reaches between 9 and 10 billion by 2050.<sup>4</sup>

Food Frontier looks forward to future discussions on this topic and participating in any supplementary public stages of this consultation.

Your sincerely,



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# Australian Food Systems Transformation

**Global food systems are estimated to account for one quarter to one third of all greenhouse gas (GHG)<sup>i</sup> emissions.<sup>5 6</sup> This share is so significant that, even if fossil fuel emissions were stopped immediately, it alone could make it impossible to limit warming to 1.5°C and difficult to realise the 2°C Paris target.<sup>7</sup>**

Variances between emissions estimates are due in part to what different researchers determine constitutes a food system. Definitions like estimates also vary, but a 'food system' largely encompasses the production, processing, packaging, distribution, consumption and disposal of food and beverages.<sup>8</sup>

Larger estimates have included emissions related to land use change, such as land clearing or deforestation for use in agriculture, the production and application of synthetic fertilisers and other inputs, through to post-retail, including emissions associated with cooking, waste and even packaging.<sup>9</sup> Lower estimates have capped the system at land use at the one end and retail at the other.<sup>10</sup>

Despite these differences, experts agree the majority of global food systems' emissions come from agricultural production, with methane emissions from livestock the key contributor.<sup>11</sup> While methane's impact on climate change is different to carbon dioxide over time, the need to rapidly reduce emissions of all GHGs to keep warming to well below 2°C is equally critical.

Australia's agriculture sector has below-average emissions intensities for cattle and grains production in comparison to other developed nations of producers and exporters. Its recorded use of pesticides and fertilisers is also amongst the lowest in the world.<sup>12</sup> Nonetheless, agriculture as a whole contributed 17.7 per cent of Australia's GHG emissions in 2023, with more than three-quarters of this figure attributed to enteric methane emissions produced during the digestion process of ruminant livestock.<sup>13</sup>

There is already significant, genuine action being undertaken by Australian governments and across agrifood sectors to decarbonise existing industries' operations, with the goal of many to achieve carbon neutrality by 2030, if not by 2050. These efforts are to be applauded, not only for the reductions in emissions and environmental impact they will realise at the commercial scale if delivered in full, but also for Australia's farmers on the front-line of climate change working to ensure the future viability of their businesses.

And yet, in the combined global context of climate change, growing food security and nutrition-related public health concerns, and ongoing disruptions to supply chains, the future of our food systems is not guaranteed by sectoral decarbonisation alone.

## The need for a systems approach.

The world's population is expected to reach between 9 and 10 billion by the middle of the century, with the accompanying rise in demand for food expected to grow by 60 per cent.<sup>14</sup> Global protein demand, especially for animal meat, is also projected to increase considerably, with the greatest demand coming from Asia to meet its rising population, disposable incomes and adoption of Western dietary habits.<sup>15</sup>

In Australia, as abroad, this demand cannot be met sustainably by increasing livestock production alone.

### Environmental impact.

Even if global livestock and dairy farming achieve carbon, or climate, neutrality in the coming decades, global authorities have acknowledged there is not enough arable land available globally to meet the sheer scale of demand.<sup>16</sup> Livestock currently provides just 18 per cent of all calories consumed globally, yet existing agriculture already uses almost one half of the earth's habitable surface, of which 75 per cent is used for livestock grazing and feed production.<sup>17</sup>

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<sup>i</sup> For the purposes of this document, 'emissions' refers to greenhouse gas emissions, unless specified as a particular gas (methane, carbon dioxide, etc.).

Globally, poor industrial farming practices are also contributing to biodiversity loss through deforestation, overgrazing and monocropping, as well as the degradation of soil and contamination of waterways.<sup>18</sup> If not raised to the leading standards being set and continuously improved by farmers in many OECD countries, including in Australia, expanding global livestock production will continue to degrade the environment at an escalating pace.

Similarly, the world's ocean ecosystems are at risk of collapse, with 90 per cent of fish stocks already 'fully exploited or overfished'.<sup>19</sup> Global demand for proteins must therefore be supplemented with a diverse range of existing and emerging sustainable options, such as those from plants.

Comparatively, plant protein sources have small GHG footprints,<sup>20</sup> and can simultaneously deliver environmental benefits in their production, including nitrogen fixing qualities to improve soil quality and a reduced reliance on synthetic fertilisers (the second largest source of GHG emissions in agriculture).<sup>21 22</sup> For instance, per kilo, rice, wheat and soymilk, the respective three highest average emitting plant proteins, still have lower emissions than the lowest average emitting farmed animal protein, farmed fish.<sup>23</sup>

There is a common misconception around the environmental impact of soy production that persists, given the vast amount of land globally that has been dedicated to its production.<sup>24</sup> It is worth noting, however, that only 7 per cent of the world's soy production is used for human food products, while 77 per cent is used for animal feed.<sup>25</sup>

At the extremes, beef's global average emissions profile is 60kg CO<sub>2</sub> equivalents (e) per kilogram of product, to pea's 0.9kg.<sup>26</sup> Averages do not perfectly reflect the significant variances between different global or regional production systems, however beef produced in Northern or Eastern Australian systems emits between 20-26kg CO<sub>2</sub>e emissions per kg of boneless beef in comparison.<sup>27 28 29</sup>

With this in mind, research has been undertaken to understand if it is what people eat, how it is produced or from where it is sourced that produces the biggest environmental impacts. A landmark 2018 study of 38,700 commercially viable farms and 1600 processors producing 40 different agricultural goods in 119 countries, including Australia, found that for most food products, transport only accounts for 6 per cent of the emissions profile, and processing 4 per cent.<sup>30</sup> Instead, it is the food product itself that has the highest impact on the environment and resulting emissions.<sup>31</sup>

This same data set analysed in 2023 against the recorded diets of 55,000 people in the UK, found that completely plant-based diets reduced emissions, water pollution and land use by 75 per cent compared to meat-rich diets. Even 'low-meat' diets (less than 50g a day) halved the impact of 'high-meat' diets, as did pescetarian and vegetarian diets.<sup>32</sup>

While opportunities exist for Australia to reduce enteric methane emissions inherent to livestock production over the medium to long term, including through emerging immunisation and feed supplement technologies, rapid decarbonisation would require the decreased consumption of red meat.<sup>33</sup> For these reasons and more, the Food and Agriculture Organisation (FAO) of the United Nations took to the 2023 COP28 Summit in Dubai its net zero agrifood systems roadmap,<sup>34</sup> along with a pledge for nations that over-consume meat to limit their intake and to developing nations to improve livestock farming.<sup>35</sup>

## Health and access to nutritious diets.

Seeking to address the globe's growing protein demands with conventional animal meat sources alone could also lead to unintended public health consequences.

There are many nutritional benefits associated with meat and dairy products; benefits Australian consumers and our trading partners have been able to enjoy thanks to Australia's high-quality domestic produce. For developing nations, especially those with high levels of malnutrition or reliance on subsistence farming, health experts recommend increased consumption rates of meat and or dairy products to improve health outcomes.<sup>36</sup>

However, health experts have also long recommended that Western nations – which consume meat at rates much higher than the global average – reduce consumption of red and processed meat in line with national dietary guidelines, due to 'strong evidence' of their association with or causation of the development of multiple non-communicable lifestyle-related diseases (NCDs), such as type 2 diabetes mellitus, many cancers, and cardiovascular diseases.<sup>37</sup>

Instead, experts recommend increasing the consumption of whole and plant-based foods to reduce the incidence of lifestyle related NCDs.<sup>38 39 40</sup> Greater dietary adoption of whole grains, fruits, vegetables, legumes, and nuts, for example, can also deliver other nutritional benefits including increased nutrient and fibre intake, to support healthy digestion and weight control, boost heart health and reduce blood sugar levels.<sup>41</sup>

In the domestic context, Australians consume nearly double the maximum amount of red meat advised by the Australian Dietary Guidelines (ADGs)<sup>42</sup> and more than double the global average consumption figure.<sup>43</sup> Of this meat consumption, the most recently published Australian Health Survey indicates that one-third of adults' average daily meat consumption is composed of non-lean or processed meats, the type of meat recommended to be limited by the Dietary Guidelines.<sup>44</sup>

The Survey also found that only 6 per cent of Australians meet the ADGs' recommended daily consumption targets for fruit and vegetables.<sup>45</sup> Though not exclusively diet related, just under half of Australians (47%) have one or more lifestyle related NCD. This number is expected to rise into the future, placing significant pressure and otherwise avoidable costs on Australia's health system.<sup>46 47</sup>

The FAO estimates that NCDs caused by 'poor diets' - typically low in fruits, vegetables, nuts, wholegrains, calcium, and protective fats, and high in sodium, sugar, saturated fats, and processed meats - costs the global economy US\$7.3tn a year.<sup>48</sup> Other estimates have calculated the total externalities linked to poor nutrition globally, including costs to human life, environmental sustainability and economic loss, at nearly US\$20tn, more than double the direct cost of global food consumption.<sup>49</sup>

These estimates demonstrate the fiscally undeniable need to transform global food systems to deliver healthy and environmentally sustainable diets to all.

Despite Australia having one of the most globally conservative approaches to the recorded use of antimicrobials in food producing animals,<sup>50</sup> there are also growing public health concerns over increasing over-use and misuse of antibiotics in global animal agriculture contributing to rising global antibiotic resistance, as well as the increasing risks of zoonotic disease outbreaks due to intensifying industrial animal agricultural practices and deforestation.<sup>51</sup>

The risk of these public health threats originating in Australia may be lower than elsewhere in the world; however, our interconnectedness with international supply chains exposes Australia to the consequences, as evidenced during the coronavirus pandemic.

## Food security.

While Australia is not currently considered food insecure, producing enough to feed itself three times over,<sup>52</sup> it is vulnerable.

Here, as in many places, increasing extreme climatic events are impacting the ability of local farmers to produce food and other agricultural goods.<sup>53</sup> According to the Intergovernmental Panel for Climate Change (IPCC), climate change has already slowed the growth of agricultural productivity globally over the past 50 years, with further warming projected to increase global food insecurity and supply instability into the future.<sup>54</sup>

Domestic modelling shows that recent seasonal conditions (2001 to 2020) have already reduced the profitability of Australian broadacre farms by an average of 23 per cent.<sup>55</sup>

As the domestic impacts of climate change increase, including more frequent and severe natural disasters, localised changes to growing regions, and heightened biosecurity risks, there is a genuine risk that, even with advances in innovation, Australia's agricultural productivity and growth could be severely hampered.<sup>56 57</sup>

Supply chain disruptions, including droughts, fires and floods impacting Australian farming operations, are felt hardest by Australian producers and communities already at heightened risk of food insecurity, particularly those in remote and low socioeconomic communities.<sup>58</sup> Australia's reliance on globally interconnected and complex supply chains also increases its vulnerability to external shocks, as evidenced by ongoing global geopolitical tensions and the consequential restriction of access to, and the increased costs of, imported inputs such as fuel and fertilisers.<sup>59</sup>

These impacts result in heightened costs along the supply chain for producers and consumers. It also increases the risk of food insecurity, which is already being exacerbated in the current cost-of-living crisis.<sup>60</sup> Foodbank, an Australian hunger relief charity, estimates that, in 2023, 36 per cent of the Australian population is either moderately (13%) or severely (23%) food insecure, with an additional 12 per cent being only marginally food secure. This is a 3 per cent decrease in Australia's food security levels in just one year.<sup>61</sup>

## Pursuing domestic transformation.

With the United Nation's 2023 Emissions Gap report stating **the world is on track to warm by nearly 3°C this century**, increasing the likelihood several catastrophic and irreversible climate tipping points are passed, it is more critical than ever that the world earnestly tackles sustainable food systems transformation.

For Australia, as a world leading food producer and exporter, transforming our systems of food production, distribution and consumption is both **a domestic challenge and a global opportunity**.

No one protein, existing or emerging, or agrifood tech innovation, is a silver bullet solution to Australia's complex food systems challenges. Vulnerability points across the entire system must be addressed, and the approach across sectors and governments coordinated through considered, holistic policy.

Australia's endorsement of the Emirates Declaration on Sustainable Agriculture, Resilient Food Systems and Climate action at the 2023 UN Climate Change Conference, COP28,<sup>62</sup> is a welcome and critical step forward that must now be backed with coordinated action.

Australia must continue to invest in enabling current agricultural production to become more sustainable and resilient in the face of climate change, and work closely with health and nutrition sectors to build a common impetus to adopt more plant-centric diets. This includes updating the 2013 ADGs<sup>63</sup> to reflect the latest evidence base and include sustainability as a guiding principle of how Australians eat.

To safeguard against future domestic and global shocks and ensure the economic outlook of our agrifood sectors, Australia must also scale-up investments into onshore food manufacturing capability and market diversification. This includes diversifying not only where and how foods are produced, but also what foods.

As noted by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), the growing global demand for protein is vast and can only be met through a combination of animal, plant, and novel protein production systems.<sup>64</sup> Australia has the potential to be a world leading and sustainable producer of them all.

## The Case for Alternative Proteins

Alternative, or complementary, proteins have an essential role to play in Australia's food systems transformation.

There are varying definitions of alternative proteins and what foods and technologies make up this category. Food Frontier primarily works on plant-based meats, and the cellular agriculture<sup>ii</sup> technologies of cell cultivation and precision fermentation, while other organisations and academics also consider algal, insect, molecular farming, and biomass fermentation, among other types of proteins and production technologies as core to the alternative proteins sector. Some also include the broader applications of cellular agriculture technologies beyond producing alternatives to conventional animal products, such as alternative fuels and fibre.

For the purposes of this document, alternative proteins are proteins that are plant-based, cell-cultivated or precision fermented.

Alongside conventional animal proteins, alternative proteins present a tremendous opportunity to help secure Australia's long-term food security and the economic outlook of the domestic agriculture and food sectors in the face of climate change and growing global demand for protein.

Food Frontier's 2019 State of the Industry report projected that plant-based meats alone could generate nearly AU\$3B in Australian sales and provide 6000 full-time jobs by 2030.<sup>65</sup> CSIRO projected the broader plant protein sector, including dairy milk alternatives, bakery ingredients and protein products used in sports nutrition, could deliver an additional AU\$3B (totalling AU\$6B), and that precision fermentation presents an AU\$1.45B domestic opportunity by 2030.<sup>66</sup> While there is no Australia specific projection at this stage, McKinsey & Company estimate the global cultivated meat market to be worth US\$25 billion by 2030.<sup>67</sup>

Alternative proteins are already bringing economic and employment benefits to Australia, and ongoing investment into the growth of the sector will not only place Australia at the forefront of meeting rising global demand for these innovative food products, but also help to address many of the challenges Australia's food system faces.

According to Alternative Proteins Global data, Australia ranks eighth globally for total alternative protein investment from 2022 to the first half of 2023.<sup>68</sup> The number of alternative proteins companies in Australia has risen from less than five in 2017, to more than 30 in 2023, and, of the 300 products now available on our supermarket shelves, 56 per cent are made by Australian plant-based meat manufacturers.

Recognising the scale of the broader plant protein opportunity, the number of plant protein ingredient manufacturers in Australia has increased to at least six and growing. Made from Australian grown grains and

<sup>ii</sup> 'Cellular agriculture' is a commonly used umbrella term referring to both cell cultivation and precision fermentation (among other novel food technologies like molecular farming).



pulses, these value-added products are now being used by domestic and international companies across more than 23 different food and beverage categories to deliver increased protein and fibre content.

Australia's cellular agriculture industry, while still young and addressing challenges, is on track for substantial growth.<sup>69</sup> There are now nine domestic cellular agriculture companies, and Australia is on the verge of having its first cell-cultivated meat product approved for domestic sale, with Vow Foods' novel foods application for cell-cultured Japanese quail currently before Food Standards Australia New Zealand.<sup>70</sup> Only Singapore and the United States (US) have so far approved the sale of select cultivated meat products,<sup>71</sup> giving Australia the potential to become the third. Singapore, the US and Israel are the only countries to have approved the sale of precision fermented dairy products.<sup>72</sup>

As has been witnessed in Singapore<sup>73</sup> and is now happening in the United States,<sup>74</sup> a defined regulatory pathway to market could catalyse Australia becoming the next global hub and market for cellular agriculture product development and innovative food experiences. Food Frontier understands US regulators have seen an influx of cellular agriculture food product applications since the US approvals in June 2023. If Australia positions itself correctly, not only will global companies seek out Australia as its next market, but they may also look to set up domestic production, bringing with them significant investment and employment opportunities.

However, co-investments from Australian governments into the domestic sector and a comprehensive food systems transformation policy that sends clear direction to private investors are required to deliver on the full scale of economic, health, security, and environmental benefits.

## Supporting food systems transformation.

Building the domestic alternative proteins sector could be one of the greatest actions Australian governments take to achieve their net zero 2050 targets.

A 2022 report from Boston Consulting Group found that globally, **investments in plant-based meat alternatives alone lead to far greater reductions in emissions than from other green investments**. The report states that dollar for dollar, **investing in improving and scaling meat alternatives drives three times more emissions reductions than investing in green cement technology; seven times more reductions than green buildings; and 11 times more reductions than zero-emissions cars.**<sup>75</sup>

The report also found that if alternative proteins reach a predicted 11 per cent global share of the meat, egg, and dairy sector, it will lead to a **reduction of 0.85 gigatons of CO<sub>2</sub>e worldwide by 2030 – equal to decarbonising 95 per cent of the aviation industry within the same timeframe.**<sup>76</sup>

Beyond decarbonisation, there are a number of critical ways alternative proteins, and the growth of a world-leading domestic sector could support Australian food systems transformation, while also positioning Australia as a future foods leader and global supplier. While not exhaustive, these are detailed below.

### Diversified, sustainable proteins.

For a food system to be truly resilient, a diversity of nutritious produce and production systems is critical.<sup>77</sup> In the case of protein, increasing extreme weather events and climatic variability are threatening the long-term viability of Australia's conventional animal protein industries through droughts, fires, floods, and global supply chain shocks.<sup>78</sup>

Continued efforts must therefore be directed to both fortifying conventional animal proteins' ability to withstand pressures and reducing environmental impact, as well as to diversifying Australia's sustainable protein options to ensure ongoing access to sufficient and healthy food. This includes plant-based, precision fermented and cell-cultivated proteins.

As previously detailed, plant protein crops have inherently low emission profiles, and, if used as the leading protein source in products such as plant-based meats, milks, and other protein-supplemented foods and drinks, offer businesses and consumers alike the ability to reduce their environmental footprint. For example, figures from CSIRO and carbon auditor and certifier, NoCO<sup>2</sup>, analysing the emissions impact of plant-based meat alternatives produced in Australia found they range between 2.2 - 2.72kg CO<sub>2</sub>e emissions per kg of product.<sup>79</sup> In comparison to beef produced in Northern or Eastern Australian systems, which emits between 20 - 26kg CO<sub>2</sub>e emissions per kg of boneless beef, this is a 9x reduction.

In recognition of this vast potential to reduce emissions, some suppliers (such as Compass Group) to institutional food providers like hospitals and workplaces are already investigating their ability to offer plant-based alternatives to customers as a convenient way to not only cater for a diverse range of dietary (i.e., vegan, vegetarian and halal) and nutritional needs (i.e., increased protein and fibre content for aged care), but also meet impending scope 3 emissions reporting requirements.<sup>80</sup>

Common dietary adoption of more plant-based meats as a centre-of-plate alternative, as well as broader plant protein products, could also help to curb global demand for new agricultural land and the consequential deforestation.<sup>81</sup> Research has demonstrated that if just half of all animal-based meat and dairy products were replaced with plant-based alternatives by 2050, the swap would allow for a complete cessation of land clearing from forested areas, and a global reduction of agricultural land requirements by 12 per cent.<sup>82</sup>

However, while plant proteins, like animal ones, continue to be grown via traditional agricultural production methods, these farms too are exposed to changing weather patterns and increasing extreme climactic events. Acknowledging the important work already being done to identify, develop and produce crop cultivars that are resilient to hotter and drier climates, as well as a more carbon-rich atmosphere,<sup>83</sup> continued investment in climate resilience in agriculture is required.

Diversification of protein sources will also be crucial to ensure against overreliance on any one option. Investment into novel production systems, like precision fermentation and cell cultivation technologies, which have the potential to produce large quantities of protein in biofactories, is required to safeguard and supplement total protein production. These production facilities, which could be placed in disparate locations around the country wherever there is sufficient access to the required feedstocks, production inputs, and renewable energy sources, would also enable geographical decentralisation of our protein producing regions.

Given cellular agriculture's nascent stage, there is currently a limited, though growing, amount of environmental or life-cycle analysis (LCA) data available, with multiple studies aiming to quantify environmental impacts underway and ongoing. Cell cultivation and precision fermentation technologies still have scalability challenges to overcome as well before the true commercial emissions profile and environmental proposition can be quantified, however, of the data that is available:

- The most comprehensive environmental impact analysis thus far, a 2023 LCA of projected cultivated meat production in 2030, has found that on average, cultivated meat will be nearly three times more efficient at turning crops into meat than even the "most efficient" livestock animal, chicken, and six to 13 times more efficient than beef cattle.<sup>84</sup>

In terms of reduced GHG emissions, the study found that cultivated meat offers an 85 to 92 per cent reduction compared to beef, a 52 per cent reduction compared to pork and a 17 per cent reduction compared to chicken. In addition, the study found that cultivated meat reduces land use by 63 to 95 per cent and reduces water use compared to all forms of conventional animal production. This is the first LCA to use primary data from 15 different companies working in the cultivated meat supply chain.<sup>85</sup>

- An LCA of US company Perfect Day's precision fermentation-produced whey protein made using agriculturally derived feedstocks found that when compared to protein from bovine milk, the precision fermented whey produced 91 to 97 per cent fewer CO<sub>2</sub>e emissions, required 29 to 60 per cent less energy demand and reduced blue water (fresh water) consumption by 96 to 99 per cent.<sup>86</sup>
- Some precision fermentation technologies require no agricultural feedstocks at all, instead using hydrogen or methanol, and are being used by companies like Finnish Solar Foods to turn air into protein ingredients. One paper calculates that precision fermentation using methanol needs 1,700 times less land than the most efficient agricultural means of producing protein: soy grown in the US,<sup>87</sup> suggesting it would use 138,000 times less than the least efficient means, beef.
- Another example is from the Austrian company Arkeon, turning CO<sub>2</sub> into protein ingredients. In comparison to 'conventional agriculture', Arkeon estimates their fermentation technology uses 99 per cent less land and only 0.01 per cent of the amount of water, while also being carbon negative.<sup>88</sup>

It is important to note that renewable energy is critical to realising the full sustainability potential of alternative proteins. For comparison, one study has shown that when using current carbonised energy systems, cultivated meat has five times lower cumulative environmental impact than average beef cattle production, but when using renewable energy, the impact increases to 18 times lower than beef cattle production.<sup>89</sup>

Following the lead of conventional animal protein industries to reduce emissions, many alternative protein companies have committed themselves to achieving carbon neutrality and using only renewables as they scale operations.<sup>90 91</sup>

## Accessible, nutritious diets.

In the global context, alternative proteins offer nutritional sources to supplement the future global protein demand that cannot be met with conventional animal proteins alone.<sup>92</sup> In the domestic context, where Australians are generally not protein deficient,<sup>93</sup> alternative proteins will enable consumers to access more options that meet their diverse health, fiscal and environmental demands.

As previously noted, nations like Australia with high rates of meat consumption, especially red and processed meats, are advised to adopt more whole food and plant-based diets. Food Frontier supports the view commonly held by health and nutrition experts and authorities that the ideal diet for good health consists of mostly whole foods, preferencing a rich variety of fruits, vegetables, and wholegrains.<sup>94 95 96</sup>

However, the reality of current dietary habits and preferences of Australians, as well as the limitations of time, effort and cost required by both consumers and health authorities to engage in behaviour change, is making the widespread adoption of healthier dietary habits difficult and slow. Despite decades and millions of dollars spent on public health campaigns to increase dietary fibre and vegetable consumption, we can determine from the recent boom in alcohol-free beer and spirits, that consumers are more likely to change their behaviour and habits when they can swap in a product that is familiar, convenient and tastes good.

This convenient swap is what plant-based meats offer consumers – a nutritious, familiar taste and format that can be easily substituted into routines and cuisines.

Understandable questions have been raised regarding the nutritional qualities of plant-based meats, and that according to the NOVA classification system proposed by Brazilian academic Carlos Monteiro, plant-based meats are considered ultra-processed foods (UPFs).<sup>97</sup> With more than 300 plant-based meat products currently available in Australian supermarkets utilising a wide range of processing methods, ingredients, and formulations, as with any food category, there are wide variances in nutritional profiles and health star ratings, often depending on the brand's intended market – from health conscious consumers to those who prioritise taste.

Many plant-based meats also have been designed to replicate their conventional processed animal meat equivalents such as schnitzels and nuggets, sausages and hamburgers, and other utility foods which typically do not offer the same nutritional benefits as an unprocessed chicken breast or whole fish fillet.<sup>98</sup> A 2023 Australian study by the George Institute for Global Health comparing these counterparts found that the plant-based meat products were on average lower in sodium and saturated fat than animal-based products and had equivalent protein and energy values. Uniquely, they also offered high levels of fibre, which is not found in animal meat.<sup>99</sup>

Where diets contain inadequate amounts of fruit and vegetables to meet recommended fibre intake, plant-based meats can provide a useful supplement to ensure that consumers are getting enough fibre with their protein.<sup>100</sup>

The nutritional profiles of Australian plant-based meats have generally improved over the last five years as manufacturers have undertaken product and process development in recognition of consumer demands. The previously mentioned George Institute Study identified a reduction in average sodium content across the category from 2019 to 2022.<sup>101</sup> Industry is also increasingly looking at micro-nutrient fortification to ensure the nutritional benefits of animal meat products can be sourced in plant-based meats too, with 12 per cent of products now fortified with iron, vitamin B12 and or zinc.<sup>102</sup>

Noting some consumers' concerns around processed foods, existing and emerging manufacturers are also actively working to simplify their ingredient lists, including by using higher-quality domestic ingredients.

A recently published 2023 study has also demonstrated that not all UPFs are alike regarding associated health outcomes. The large prospective cohort study of more than 260,000 participants assessed dietary intake by analysing participants consumption of total UPFs - in addition to categorising total UPFs consumed into nine smaller subgroups - and the associated risk of developing multimorbidity of either cancers, cardiovascular diseases or type 2 diabetes.<sup>103</sup> It found that while higher UPF consumption as a whole was associated with an increased risk of multimorbidity not all subgroups had the same level of associated risk. Whereas the associated risk was highest for animal-based products and artificially and sugar-sweetened beverages, no associated risk of multimorbidity was found for plant-based alternatives.<sup>104</sup>



Though one of the first studies of its kind investigating health outcomes associated with UPF subgroups rather than as a whole, this research demonstrates the importance of considering the nutritional composition of processed foods to help understand their varying impact on health. In fact, many agrifood experts recognise the critical importance of food processing to enable access to nutritional, safe, and sustainable foods,<sup>105</sup> particularly in the context of global food security concerns, where equitable access to a whole food diet is not guaranteed and could be made even more challenging as population levels rise and climate shocks increase.<sup>106</sup>

As precision fermented and cell-cultivated proteins become commercially available over coming decades, they too are expected to play a critical role in enabling global access to sufficient amounts of nutritious foods.<sup>107</sup>

While research is ongoing, as well as regulatory approvals, companies working in the cellular agriculture industry believe that cell-cultivated meats and precision fermented dairy will be able to offer consumers the same nutritional qualities as the conventional meat and dairy counterparts they are replicating. The biggest hurdle for these products in achieving widespread consumer adoption will be achieving (and then surpassing) price parity with animal meat and dairy products; something the plant-based sector in Australia has been able to make progress on as production has scaled, with further improvement still required to ensure equitable access.<sup>108</sup>

### **Value-added agrifood industries.**

In support of becoming an AU\$100B food and fibre sector by 2030, alternative proteins also present existing Australia agrifood industries with a substantial economic opportunity to value-add to existing operations and diversify into new, innovative fields. With the future of domestic agrifood industries under threat from climate change and at risk from global supply chain shocks, it is critical Australia builds up sovereign downstream capabilities and provides greater economic certainty across the domestic supply chain.

Cropping currently accounts for more than half (53.2 percent) – or AU\$35B – of the value of Australia's agricultural production<sup>109</sup> with most of Australia's grains and pulse crops sold on volatile global commodity markets to be processed offshore.<sup>110</sup> Once processed into plant-protein ingredients, including isolates and concentrates potentially made from the same Australian-grown crop, domestic manufacturers must then import them back at a higher cost for product manufacturing.

Other companies are forced to purchase internationally grown and processed plant-protein ingredients where Australian options are not available in the required formats, quantity or at an affordable price point. Access to cheap, offshore, and highly specialised manufacturing capabilities in Asia also sees white label final products imported for domestic sale by Australian companies.

Despite large volumes of domestic production of many of the grains and pulses used in plant protein products, Australia is missing out on key value addition opportunities as a result of limited domestic processing (e.g., fractionation) capacity and food manufacturing (e.g., extrusion) capability.

At present, Australia only has three commercial-scale plant-protein fractionation facilities, with industry sources indicating that at least ten facilities are required to meet current demand. They suggest Australia could host up to 20 of these facilities given the expected future domestic and global demand for plant protein ingredients, made from the grains and pulses Australia already grows.

From 2018-19 to 2019-20, the volume of plant-based meat manufactured in Australia increased 70 per cent, with leading companies indicating their strong desire to use more Australian ingredients in their products.<sup>111</sup> The demand for Australian grown ingredients is rising among other food categories too, from baked goods to sports nutrition products and more, demonstrating significant need for local processing as well as advanced food manufacturing capabilities.

The plant-based meat industry alone is projected to produce 169,000 tonnes of finished product by 2030, however the lack of domestic capacity is already causing shortfalls in ingredient availability.

This bottleneck not only increases the price of protein ingredients for food manufacturers and, consequently, consumers, it also entrenches our reliance on imports and further exposes Australia to international supply chain shocks. Critically, the potential economic and jobs value-addition for the domestic agrifood supply chain is forfeited and efforts to reduce emissions and establish local, scalable, and sustainable operations are undercut.

Co-investments from government and industry into the necessary infrastructure and research and development (R&D), as well as incentives for farmers to grow more pulses and grains for the plant protein supply chain and for manufacturers to undertake the required product development to source locally are required to catalyse this domestic value-addition opportunity.

While the plant-based meat sector currently uses soy, wheat, and pea as its predominant protein ingredients, as product and technology development continue, opportunities to leverage high-protein crops widely grown domestically, such as faba, navy and mung beans, lupins, lentils, and chickpeas, will increase. Additionally, growers have a potentially lucrative opportunity in the long-term to grow and supply new optimised crops, including grains and oil crops, as well as vegetables such as mushrooms and beetroot, capitalising on manufacturers' demands for nutritionally, texturally, and taste-optimised produce, and consumer's preference for locally grown ingredients.

Similarly, the growth of a domestic precision fermentation industry can provide established agrifood industries, including sugar, wine and beer industries, the opportunity to value-add to their waste streams. Precision fermentation requires sources of sugar – such as glucose, starch and or other waste streams as a feedstock for production. Given the levels of waste produced in sugar processing and in beer and winemaking, many are already investigating this potentially lucrative (and circular) opportunity to valorise waste streams through dedicated R&D.

Complementary fermentation processes and spare capacity also has many operators in the wine and beer industries exploring the potential to contract existing facilities and manufacturing equipment for use by precision fermentation companies.

## **Regional development and jobs.**

The critical first step for building a value-added plant protein industry is more processing infrastructure. More broadly, there is a significant opportunity in the construction of co-access and contract manufacturing facilities, with some estimating there are more than 1000 food companies around the world looking for somewhere to manufacture their products.<sup>112</sup> Regional Australia could be a major beneficiary of this development.

The additional processing facilities required could logically be located in regional growing hubs to process locally grown crops and provide the economic and jobs benefits to the surrounding growers and communities. While farmers will always seek the greatest value, domestically or internationally, for their produce, the growth of a domestic plant protein processing industry will offer growers a 'backstop' price and a guaranteed market where they can command a premium for otherwise traditionally rotational crops sold as just animal feed.

For example, Horsham, a major Victorian pulse growing region, is home to Australian Plant Proteins' (APP) fractionation facility specialising in protein isolate ingredients made from locally sourced faba and mung beans, lentils, and field peas. The local growers supplying APP are already receiving greater economic value as a result of the development of this processing capability, as will the growers in South Australia that supply APP when the company's next fractionation facility becomes operational in coming years.<sup>113</sup>

The fermentation facilities required for precision fermentation could also be placed in regional areas with direct access to the required agrifood feedstocks. This means they could be co-located with existing sugar growing industries, commercial scale wineries or breweries across Australia, creating entirely new, complementary, and innovative agrifood regional industries. Given the byproduct produced during plant protein fractionation is a starch, these two alternative protein industries could also be located in plant protein growing regions.

For example, Cauldron Molecules, an Australian start-up based in Orange, NSW, is working to build Asia Pacific's largest network of contract precision fermentation facilities across regional Australia to manufacture food (as well as fibre and fuel) ingredients for customers including established livestock companies, food and dairy companies, and start-ups.<sup>114</sup> The company has already partnered with the Queensland Government to develop a business case for a large-scale AU\$300m facility in the sugar growing region of Mackay, utilising locally grown sugarcane waste streams as a feedstock.<sup>115</sup>

Food Frontier is also aware of several international cultivated meat companies investigating the viability of establishing Australian production hubs given the expansive land availabilities and potential to generate significant solar energy.

## **Exports to secure long-term economic outlook.**

As an export-oriented sector, Australian agrifood industries can play an important role as a low emissions protein supplier, meeting growing global food demand while contributing to global emissions goals. On the doorstep of Asia, where demand for alternative proteins is highest and the meat substitutes market (mock meat and plant-based meat) is already worth US\$4.32B in 2023, with expected growth annually by 33.27 percent to reach US\$13.63B in 2026,<sup>116</sup> Australia is optimally placed to capitalise on this significant export opportunity.

At present, eight Australian plant-based meat companies are currently exporting their products to at least 14 different countries, with several others actively working towards exporting. This figure does not include ingredient producers such as APP which has signed distribution deals with major agri-business Bunge to export its locally produced protein isolate to North America and Europe,<sup>117</sup> or Wide Open Agriculture (WOA), who has signed a non-binding agreement with UK food ingredient company Ingå Group, including to exclusively market and sell WOA's lupin-based protein products, including Buntine Protein, across Europe.<sup>118</sup>

For plant protein, the export opportunity is not just in final plant-based products, like meat and milk alternatives and protein-fortified and functional foods, but also in the processed ingredients and the plant protein crops themselves. The benefits of public trust in 'Brand Australia' are highly appealing to international consumers and businesses,<sup>119</sup> including manufacturers interested in Australia's potential to produce higher quality, better performing protein ingredients and products using the latest innovations in plant breeding and processing techniques.

The future export market for precision fermentation and cultivated meat is also projected to be considerable. As previously noted, the global cultivated meat market is tipped to reach US\$25B by 2030<sup>120</sup> and precision fermentation US\$36.3B,<sup>121</sup> with the largest growth predicted in the Asia Pacific region. Again, Australia is well placed to capitalise on this opportunity in the long-term and direct significant economic growth to the domestic agrifood sector as a result.

Current export opportunities are limited, however, with only three countries, Singapore, the US and Israel, having approved the sale of certain cellular agriculture products by a small handful of companies. The present technical novelty of these foods requires each product be approved for sale by food safety regulators in each jurisdiction in which the companies wish to sell their product, the majority of which have not yet received an application to trigger official investigations into the safety of these advanced manufacturing processes.

For an Australian company to be able to export, they must first receive approval to sell into the desired international market(s), and to manufacture domestically. A streamlined regulatory process domestically as well as in international markets is still some years away and requires many more applications be made globally, as well as for shared standards to be formed and adopted by global authorities such as Codex Alimentarius.

World-leading progress is being made domestically, nonetheless. Vow Foods is expected to launch its first product in Singapore in early 2024,<sup>122</sup> potentially making it only the third company approved globally to sell a cultivated-meat product. We understand a number of other Australian cell-cultivated and precision fermentation companies are also seeking to submit applications for approvals in the near-term, with a long-term view to exporting.

Across all alternative protein industries, opportunities also exist for Australian companies to export their intellectual property, with many international companies looking to adopt cutting edge technologies and production processes, including those being developed now in Australia's world-leading universities and incubators.

## Waste and circularity.

Though not mentioned earlier, Australia has a considerable food waste problem negatively impacting domestic emission and food security levels alike. Approximately 3 per cent of Australia's annual GHG emissions come from food waste, with more than 7.7 million tonnes of food loss and waste generated each year from across the agrifood supply chain.<sup>123</sup>

Waste reduction and reuse is inherent to many alternative protein production systems, presenting innovative and lucrative opportunities for Australian food systems circularity. Emerging technology is already demonstrating the sector's ability to capitalise on existing agrifood sector's waste streams, as with precision fermentation, as well as to commoditise their own byproducts.

Many domestic plant protein processing companies are pursuing circular and low-waste ingredient production, seeking to utilise the entire grain or pulse to produce high-protein ingredients. APP for instance, uses whole pulses to produce an isolate protein powder. The remaining carbohydrate pulp byproduct leftover at the end of the fractionation process is then repurposed as animal feed and sent to a nearby beef feedlot twice a day.

Other existing grain industries are also heavily investing in R&D to find innovative ways to value add their own waste streams, such as canola meal, into human-grade plant-protein products.<sup>124</sup> Greater investment in domestic R&D into alternative protein processing and manufacturing technology is still required to further unlock opportunities to reduce waste production in the sector itself as well as repurpose other sector's waste streams. This in turn would support Australia's future food security and food systems circularity, potentially directly producing more food products for consumption.

# Global food systems policy approaches.

To quote CSIRO again, there is widespread international recognition that food systems must evolve to meet the challenges of a changing climate, increasing demand, supply chain and workforce disruptions, rising input costs, and nutrition-related public health concerns.<sup>125</sup> Australia's signature on the 2023 COP28 Emirates Declaration, alongside more than 150 other countries,<sup>126</sup> is evidence of this.

Forward thinking governments, particularly those at greater risk of food insecurity due to their geographical location, natural resource availability, population or climate, are already working to address how they will sustainability source, produce and consume food into the future. Governments that have recognised this challenge as an economic opportunity are also engaging heavily with alternative proteins with first mover advantages.

Singapore, with limited landmass and a high dependency on food imports, commenced an ambitious '30 by 30' food resilience strategy in 2019 to produce 30 per cent of its nutritional needs by the year 2030.<sup>127</sup> Capitalising on its existing strengths in innovation, technology and R&D, Singapore has since become a global leader in alternative proteins. Not only was it the first country to approve the sale of a cultivated meat product, but it has also led global investment in alternative protein companies and partnered repeatedly with industry to build the required manufacturing and R&D infrastructure.<sup>128</sup>

China and the US' leaders both committed their countries to undertake food security and innovation strategies. Chinese President Xi Jinping used the 2022 "Two Sessions," China's most important political conference, to urge agricultural officials to pursue protein diversification, explicitly calling out alternative proteins as critical to securing the country's future food supply. Xi's speech followed the inclusion of a section on "creating future foods," including cultivated meats and plant-based eggs as examples, for the first time ever in China's Five-Year Agricultural Plan, released in January 2022.<sup>129</sup>

US President Joe Biden issued an Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe and Secure American Bioeconomy in September 2022.<sup>130</sup> This included US\$2B and joint participation by the US Departments of Agriculture and Defence to develop the bio-manufacturing industry to lower food prices, create jobs, strengthen supply chain resilience, improve health outcomes and reduce emissions.<sup>131</sup>

Canada, with a pulse industry comparable to Australia's,<sup>132</sup> has set its sights on becoming a plant protein global leader in recognition of the scale of the agrifood value-addition opportunities available to the country. Through the government-backed, industry-run innovation supercluster, Protein Industries Canada, the country is pursuing a CA\$25B by 2035 plant-based roadmap to become a sovereign food, feed and ingredients manufacturing powerhouse, backed by world leading crop, process, and product R&D.<sup>133</sup> Canada also updated its national dietary guidelines in 2019 to recommend that, among protein foods, plant-based options are consumed the most often.<sup>134</sup>

Since December 2022, three additional countries have announced national strategies to transform their domestic food systems. Germany released its future food strategy to ensure everyone in the country can eat healthily and sustainably, while protecting the environment, climate and species diversity and future food security.<sup>135</sup> Announced within weeks of each other in October 2023, Denmark will make domestic food production completely climate neutral by 2050,<sup>136</sup> and South Korea will bolster local plant-based food production and consumption.<sup>137</sup>

All three countries have put fostering domestic alternative protein industries at the heart of their strategies and have recognised the importance of shifting diets to become plant centric. Like Canada, Denmark updated its Official Dietary Guidelines in 2021 to prioritise consumption of protein-rich plant foods over meat and to teach climate-friendly eating.<sup>138</sup>

It is now Australia's turn.

Genuine, though siloed, efforts are being made by Australian governments to, for instance, decarbonise Australia's agriculture and food industries,<sup>139</sup> to promote healthy eating and preventative public health strategies,<sup>140</sup> to bolster sovereign innovation and manufacturing capability and skills, and reduce Australia's reliance on international supply chains.<sup>141</sup> Australia's food security is also receiving greater scrutiny as a result of the coronavirus pandemic related supply chain shocks and the current cost-of-living crisis.<sup>142</sup>

Given the impact, and critical importance, of Australia's food systems, this work must now be brought together under a coordinated approach, led at the federal level, that sees all Australian governments work in considered partnership with industry to transform how Australia produces, consumes, and distributes food.

## Domestic policy recommendations.

True transformation of Australia's food systems to become more sustainable and resilient, as well as more productive to support equitable access to enough nutritious foods globally, will take vast action across the entire system. Given Food Frontiers' remit and expertise, our recommendations are specific to enabling the growth of the domestic alternative proteins in support of this transformation.

We note CSIRO's 2023 Reshaping Australian Food Systems report, which was informed by in-depth consultation across Australia's agriculture and food industries, already offers the country a detailed roadmap with options on how it could comprehensively accomplish this transformation.<sup>143</sup> The opportunities presented by alternative proteins are featured throughout the roadmap.

We would also note the recommendations released in December 2023 by the Federal House Standing Committee on Agriculture (the Committee) following its Inquiry into Food Security in Australia. The key recommendation is that the Federal Government develops and executes a comprehensive National Food Plan (the Plan), in consultation and cooperation with State and Territory Governments, that would engage the entire food system "from paddock to plate and beyond."<sup>144</sup>

Critically, the Plan would encompass the domestic production and distribution of food, supply chain resilience, access to food, good nutrition and the implications of the food system on health, and the management of food waste and other waste products. It would also address the national security implications of food security, identifying and addressing vulnerabilities across the supply chain, including infrastructure and inputs.<sup>145</sup>

Food Frontier urges the Federal Government to adopt this recommendation, as well as the recommendation to appoint a Minister for Food, residing within the portfolio of Prime Minister and Cabinet, that would oversee the Plan with the support of a National Food Council made up of industry and community experts.<sup>146</sup>

We believe this must be bolstered with a cross-departmental taskforce that unites the various branches within the different departments with carriage of food and food systems-related portfolios. Such a taskforce would ensure coordinated activity and alignment in delivery of the Plan across the various departments responsible. Arguably, this same taskforce would be established for each of Australia's governments, ensuring they work in tandem to pursue the delivery of the Plan in each jurisdiction.

We also urge the Federal Government to adopt the recommendations to develop a specific strategy dedicated to expanding innovation and value-adding in food production and develop mechanisms to promote this innovation.<sup>147</sup>

As the Committee details in its report, innovative industries including alternative proteins have the capacity to improve, and in some cases revolutionise, Australia's food production, providing value-addition within the food supply chain, and increasing food security and economic development. The Committee recommends that all Australian governments work to support the growth of industries like alternative proteins, recognising their potential alongside existing agrifood industries to secure Australia's food systems.<sup>148</sup>

Food Frontier believes the significant opportunity alternative proteins presents Australia should be met with active support and collaboration from governments to ensure the country can capitalise on the full scope of economic, health, sustainability, and food security benefits. Policymakers should seek to facilitate the growth of this sector in recognition of its complementary nature to conventional animal protein industries, noting that all are critical to meet the exponential growth in global protein demand as the global population reaches up to 10 billion by 2050.<sup>149</sup>

Indeed, if Australia does not act quickly to back alternative proteins, it is at risk of missing out on the early mover economic advantage it currently has before it. Foreign governments and consumers are driving global demand for a diversification of protein offerings, and nations with comparable agrifood, R&D and innovation strengths to Australia have already begun capitalising on this demand. Australia can still capture this opportunity.



## List of recommendations:

- I. Adopt the following Food Security Inquiry recommendations:**
  - i. Recommendation 1: Develop and execute and National Food Plan;
  - ii. Recommendation 2: Appoint a Minister for Food to oversee the design, implementation and delivery of the Plan;
  - iii. Recommendation 3: Establish a National Food Council made up of industry and community experts that would inform the development and execution of the Plan; and,
  - iv. Recommendations 7 and 8: Develop a dedicated strategy to grow domestic food innovation and value-adding industries (including the alternative sector) and develop mechanisms to promote innovation in food production.
- II. Establish a whole-of-government National Food Taskforce charged with coordinating departmental delivery of the Plan and work closely with state and territory governments to align jurisdictional priorities and action.**
- III. Demonstrate support for alternative proteins through thought leadership and proactive sectoral engagement to foster positive sentiment for protein diversification and to engender investor and consumer confidence.**
- IV. Co-invest with industry in enabling, scale-up infrastructure, including into onshore processing capacity and contract / co-access manufacturing facilities that can be leveraged by the sector to provide domestic value-addition, economic and employment benefits.**
- V. Co-invest in dedicated innovation hubs and R&D programs aimed at scaling the sector and addressing its critical research needs.**
- VI. Proactively build Australia's alternative proteins skilled workforce through subsidised studies, industry placements and targeted, skilled migration programs.**
- VII. Pursue health strategies that encourage the adoption of plant-centric diets.**
- VIII. Utilise government procurement to incorporate plant protein in institutional settings, such as in aged care, to address diet-related health concerns.**
- IX. Generate investor attraction reports detailing the domestic and export opportunities for new protein industries through detailed market analysis (e.g., for lupins, field peas, etc.).**



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