June
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Productivity Commission 5 Pillars Inquiries

- **Creating a more dynamic and resilient economy**
- **Investing in cheaper, cleaner energy and the net zero transformation**

1 INTRODUCTION

CropLife Australia (CropLife) is the national peak industry organisation representing the agricultural chemical and plant biotechnology (plant science) sector in Australia. CropLife represents the innovators, developers, manufacturers, formulators and suppliers of crop protection products (organic, synthetic and biological based pesticides) and agricultural biotechnology innovations. CropLife's membership is made up of both large and small, patent holding and generic, Australian and international companies. Accordingly, CropLife advocates for policy positions that deliver whole of industry and national benefit. However, our focus is specifically on sustainable environmental land management and an Australian farming sector that is internationally competitive through globally leading productivity and sustainability practices. Both of which are achieved through access to world-class technological innovation and products of the plant science sector.

The plant science industry contributes to the nation's agricultural productivity, environmental sustainability and food security through innovation in plant breeding and pesticides that protect crops against pests, weeds and disease. More than $31 billion of the value of Australia's agricultural production is directly attributable to the responsible use of crop protection products, while the plant science industry itself directly employs thousands of people across the country.[1] CropLife Australia is a member of CropLife Asia and part of the CropLife International Federation of 91 CropLife national associations globally.

CropLife welcomes the Australian Government's commitment to prioritising reforms that will underpin ambitious productivity growth and support raising living standards across the Australian community. While Australian agriculture has demonstrated long term productivity growth that outstrips the market sector, creating resilient productivity growth in the industry must continue to be a focus of Government policy. This is necessary not only to protect and grow agriculture as an important source of export revenue but also to underpin the production of fresh produce necessary to curb cost of living pressures faced by Australian families.

Australian agriculture continues to be an important source of export revenue in the economy, contributing over ten per cent of exports of goods and services in 2023-24;[2] however, productivity growth across the sector faces headwinds created by climate change

[1] Deloitte Access Economics, 'Economic Contribution of Crop Protection Products in Australia', August 2023, https://www.croplife.org.au/resources/reports/economic-contribution-of-crop-protection-products-in-australia/.

[2] ABARES, "Snapshot of Australian Agriculture 2025" (ABARES Insights, Issue 1 February 2025) DOI: https://doi.org/10.25814/gs4g-ys39.

and restrictions on new technologies.[3] Price rises in fruit and vegetables as reported by the ABS has led food inflation for the ten months of FY2024-25.[4] This inflation, which reflects the tightness of supply and demand for fresh produce in Australia, erodes the purchasing power of real wages across the economy. Productivity growth across Australia's horticultural commodities is important to curbing the impact of food inflation on household budgets while returning fair reward to our nation's farmers.

CropLife appreciates the opportunity to comment on the Productivity Commission's inquiries to identify and report on priority reforms in each of the areas under the Government's five pillar productivity growth agenda. Specifically, CropLife seeks to make a submission in response to the following questions:

- Pillar 1 – Creating a dynamic and resilient economy:
    - Reduce the impact of regulation on business dynamism
- Pillar 5 – Investing in cheaper, cleaner energy and the net zero transformation:
    - Reduce the cost of meeting carbon targets

[3] W Chancellor and C Boult, "Australia's farm productivity slowdown – why it matters, and what it means for policy makers", (ABARES Insights, Issue 2, July 2024) DOI: https://doi.org/10.25814/dcvj-7934.

[4] ABS, "Monthly Consumer Price Index Indicator" https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/monthly-consumer-price-index-indicator.

2 PILLAR 1 - CREATING A MORE DYNAMIC AND RESILIENT ECONOMY

2.1 Reduce the impact of regulation on business dynamism

2.1.1 Regulation of Crop Protection Products and Gene Technology

Australia has established science-based regulatory frameworks that underpin the commercialisation and use of plant science innovations by the Australian agricultural sector.

- The Australian Pesticides and Veterinary Medicines Authority (APVMA) regulates agricultural and veterinary chemicals under the National Registration Scheme established by the *Agricultural and Veterinary Chemicals Code Act 1994* (Agvet Code).
- The Gene Technology Regulator, with the assistance of the Office of the Gene Technology Regulator (OGTR), regulates Genetically Modified Organisms, including GM crops under the *Gene Technology Act 2000.*

The science-based regulatory schemes Australia has implemented for these technologies has created frameworks that facilitate the benefits they provide to the Australian agricultural sector while preventing harm and promoting community trust. In doing so, the regulatory arrangements have created pathways that support the commercial investment required to bring new technologies and innovation to Australian farmers.

While the use of these products in the Australian farming system have undeniably contributed towards enhancing the dynamic and resilient nature of our agricultural industry, structural impediments impede the full technological opportunity they offer to our farmers. Specifically, because the Australian market for these products is relatively small, innovator companies face a greater risk of being unable to recoup a return commensurate with their substantial, lengthy investment in R&D and commercialisation.[5] These factors lead to delays in bringing new products to the Australian market compared to other jurisdictions and/or a limited commercialisation of the technology's full potential (eg a partial registration of a crop protection product that does not provide access to minor commodities).

As such, it is imperative that the necessary high standards of scientific risk-based protection these regulatory systems provide is delivered in a cost-effective, efficient, predictable and

[5] Mandala, "An Australian patent credit system: Boosting investment and innovation in agriculture" (report, 30 June 2023). See also AgbioInvestor, "Time and Cost of New Agrochemical Product Discovery, Development and Registration (report, February 2024) and AgbioInvestor, "Time and Cost to Develop a New GM Trait (report, April 2022).

responsive manner.[6] This is necessary to enable global and domestic businesses to confidently assess the commercial feasibility of investments required for regulatory approval and commercialisation in the Australian market. Reforms to Australia's intellectual property settings that compensate innovators for time lost in market while undergoing mandatory pre-market assessment will further support the commercial feasibility of bringing new technology to Australian farmers.

Crop protection products

Agricultural chemicals (commonly known as pesticides or crop protection products) play an important role in driving on-farm productivity in Australian agriculture. Deloitte Access Economics identified that $31 billion of the value of Australia's agricultural production, or 73 per cent of the total value of crop production in 2020-21, was directly attributable to the use of crop protection products.[7]

Importantly, the technologies embedded within these crop protection products have also enabled farmers to implement practice change innovation; most observable in the broadscale adoption of no-tillage and minimum-tillage farming across the Australian broadacre cropping sector.[8] This farming practice, which is enabled by the use of herbicide weed control over summer fallow periods, has increased the productivity of Australian farmers in the face of climate change by improving water use efficiency and declining yield sensitivity to drought conditions.[9] The Grains Research and Development Corporation's Water Use Efficiency Initiative identified the use of herbicides during summer fallow resulted in an average 60 per cent increase in seasonal water use efficiency and returned farmers on average $5.60 for every dollar they invested in weed control.[10]

[6] Agricultural and Veterinary Chemicals Code Act 1994, Schedule – Agricultural and Veterinary Chemicals Code, s.1A.

[7] Deloitte Access Economics, 'Economic Contribution of Crop Protection Products in Australia', August 2023, https://www.croplife.org.au/resources/reports/economic-contribution-of-crop-protection-products-in-australia/.

[8] A Read, J Rollan, C Creed and James Fell, 'Environmental Sustainability and Agri-Environmental Indicators – International Comparisons', (ABARES Insights, Issue 2, July 2023), DOI: https://doi.org/10.25814/zzdq-4t23.

[9] Neal Hughes, Kenton Lawson, and Haydn Valle, 'Farm Performance and Climate: Climate-Adjusted Productivity for Broadacre Cropping Farms' (Department of Agriculture and Water Resources, ABARES, May 2017), https://www.agriculture.gov.au/abares/research-topics/climate/farm-performance-climate.

[10] Grains Research & Development Corporation, 'Water Use Efficiency Research Is Transforming the Productivity Potential of Australian Farming Systems, Demonstrating That Efficiency Gains of 20-40 per Cent Are Possible with Optimal Pre-Crop and in-Crop Management Practices', n.d., https://grdc.com.au/about/rde-investment-strategy/delivering-impact/investing-in-water-use-efficiency-yields-results.

Cost shifting public good activities onto the private sector

The APVMA is the only pesticide regulator in the OECD entirely funded by industry fees and levies. This full cost recovery model, combined with Australia's relatively small market, discourages global innovators from registering new, productivity-enhancing technologies for Australian farmers. The result is an undermining of the agricultural sector's international competitiveness.

This funding structure limits the National Registration Scheme's ability to deliver on the public policy objectives set out in Section 1A of the Agvet Code, which prioritise farmer access to safe and effective agricultural innovations through an efficient regulatory system.

Moreover, full cost recovery has led to misplaced public concerns that the APVMA lacks independence from industry. While the system provides no actual scope for undue influence, introducing a public funding component—aligned with other regulators—would strengthen public confidence in the APVMA's integrity.

CropLife recommends that the Government fund the APVMA's public benefit functions in line with its own cost recovery guidelines. According to the Department of Agriculture, Fisheries and Forestry, an additional $8.4 million annually would fully support the APVMA's public good functions, including compliance, enforcement, and chemical reconsideration.

Other regulators already receive public funding:

- The Office of the Gene Technology Regulator (OGTR) receives over $8 million annually via appropriation.
- The Therapeutic Goods Administration (TGA) receives $15 million annually to support its public good activities.

Comprehensive public funding would also reduce barriers for smaller registrants, support innovation for minor crops and niche industries, and help meet the broader public objectives of the regulatory framework.

Changes to the assessment of the Agvet Code's Efficacy Criteria

The Efficacy Criteria, established under section 5B of the Agvet Code, is the most subjective of the statutory criteria for registration of crop protection products. Guidance produced by the APVMA focuses on the binary question of whether a chemical product can, to a reasonable degree, achieve one of the effects listed in paragraphs 4(2)(a) to (e) of the Agvet Code. This assessment is not intended to serve as a guarantee of commercial performance but plays a critical role in setting use rates and patterns, underpinning the assessments required under the safety and trade criteria.

The efficacy criteria need not duplicate obligations registrants hold to farmers and other users under the Australian Consumer Law that a product will perform in accordance with the manufacturer's description.

Registrants of crop protection products have identified an increasing tendency by the APVMA to treat efficacy as a matter of internal scientific certainty or statistical purity, disconnected from its role in a broader regulatory decision. This is misguided. Field conditions are inherently variable; product performance will always depend on the user's judgment, agronomic practices, and local conditions. Therefore, the regulator's role is not to guarantee consistent effectiveness under all conditions, but to determine whether the exposures approved (via label instructions) are justified by a scientifically credible likelihood of benefit under reasonable use.

This escalating and unpredictable situation has affected the registration of fungicides, insecticides and herbicides. Among CropLife Australia members alone, **at least 50 applications have gone overtime or have had to be withdrawn** in the past year as a result of these new and completely unwarranted demands for efficacy data. Delays of three to four months are common (reported for over 20 applications), with a few even exceeding one year and at least one application experiencing a 16-month delay.

The current state of overdue and delayed applications not only poses a serious threat to Australia's farming productivity but also impedes our nation's ability to properly prepare and respond to a range of potentially catastrophic biosecurity threats. As such, it is our view that this matter be escalated substantially to ensure it is addressed as a matter of urgency.

These changes have occurred despite there has been no change to the regulation or to guidance material to have caused these delays or led to the current level of unnecessary bureaucratic requests and decisions being made by officers of the APVMA.

<u>Intellectual property (IP) – Patent extension and data protection enhancements</u>

A patent system that recognises the specific commercial realities of Australia's plant science sector is essential. Patent term extensions and enhanced data protection are practical, internationally validated mechanisms to address market thinness and regulatory-induced delays.[11]

[11] OECD (2014), Guidance Document on Regulatory Incentives for the Registration of Pesticide Minor Uses, Series on Pesticides and Biocides, No. 63, OECD Publishing, Paris, https://doi.org/10.1787/9789264221710-en.

Australia's agricultural innovation ecosystem depends on timely access to new technologies that improve productivity, sustainability, and resilience in food and fibre production. However, the structure of Australia's intellectual property (IP) system does not adequately account for the realities of bringing agricultural chemical and crop biotechnology products to market in a small and highly regulated jurisdiction.

Patent term extensions and enhanced data protection provisions are essential reforms to ensure that the Australian market remains attractive to global innovators and that farmers retain access to the tools they need to remain internationally competitive. Their adoption would increase the likelihood of timely product launches and support greater investment by companies developing transformational technologies that will support productivity growth in the agricultural industry.[12] In doing so, an Australian patent credit scheme would work to prevent the high opportunity costs of foregone production currently borne by Australian farmers when crop protection products available elsewhere in the world do not have specific permitted uses in Australia.[13]

The plant science sector is subject to mandatory, rigorous, and science-based regulatory approval processes administered by the APVMA and the OGTR. These processes, while essential for ensuring safety and efficacy, can span multiple years, during which time patent-protected technologies are denied access to the market.

Unlike other sectors, this pre-market barrier results in the real erosion of patent value. During the regulatory review period, patent time continues to lapse, but the innovator is prevented from generating any commercial return. This reduces the effective patent life and undermines the incentive to invest in Australia-specific research and development (R&D).

In recognition of this issue, many jurisdictions, including as the United States of America, European Union, and Japan, have implemented patent term extension mechanisms to compensate innovators for time lost during the regulatory approval process. These provisions apply not only to human pharmaceuticals but, in several cases, also extend to regulated agricultural products.

Australia's IP framework; however, offers such extensions only for pharmaceutical patents under section 70 of the *Patents Act 1990*, despite agricultural and biotech products

[12] See W Chancellor and C Boult, "Australia's farm productivity slowdown – why it matters, and what it means for policy makers", (ABARES Insights, Issue 2, July 2024) DOI: https://doi.org/10.25814/dcvj-7934.

[13] See Grain Producers Australia, preliminary submission to the Independent Review of the Pesticides and Veterinary – Medicines Regulatory System in Australia, Issues paper review of the agvet chemicals regulatory system Future reform opportunities, February 2020.

undergoing similarly intensive regulatory scrutiny. This inconsistency disadvantages the plant science industry. It discourages the Australian launch of new technologies, reduces R&D investment, and creates a market environment less favourable to innovation compared to international peers.[14]

In particular, the development of an Australian patent credit scheme for plant science technologies would complement the "springboarding reforms" introduced by the 2012 *Raising the Bar reforms*. It would do this by supporting the commercial feasibility of bringing new and transformative technologies to market, while still facilitating generic competition at the conclusion of the protected patent period.

Australia represents a small share of the global agricultural technology market. The cost of regulatory compliance in this environment makes Australia a low priority for product development and commercialisation, especially when coupled with uncompensated patent erosion. This is particularly acute for minor uses and specialty crops, which are already under-served.

The absence of patent term extension for highly regulated crop protection products presents a structural disincentive to investment. The result is a thinning innovation pipeline, delayed or forgone product launches, and reduced access to technologies that support productivity, environmental outcomes, and food security.

Documents appended:

- Deloitte Access Economics, 'Economic Contribution of Crop Protection Products in Australia', August 2023.
- Mandala, "An Australian patent credit system: Boosting investment and innovation in agriculture" (report, 30 June 2023).

Gene Technology

Over the period 1996-2015, PG Economics calculated that the use of genetic modification in cotton and canola production had increased farm income by $1.37 billion.[15] Farmers would have been required to plant an additional 350,000 hectares of conventionally bred cotton and canola over the same period to achieve the extra productivity gained by the use of genetically modified crops.[16] The value of crops bred using gene technology will only grow more important under climate change scenarios, characterised by hotter and drier

[14] Mandala, "An Australian patent credit system: Boosting investment and innovation in agriculture" (report, 30 June 2023).
[15] Graham Brookes, 'Adoption and impact of genetically modified (GM) crops in Australia: 20 years experience', May 2016.
[16] Ibid.

production environments. A climate change risk assessment undertaken by the Commonwealth Bank in 2019 identified that biotechnologies, such as GM, can increase the climate resilience of crops, including pasture crops, by up to 40 per cent over the next 40 years.[17]

National Gene Technology Scheme

While historically Australia had been a global leader in the regulation of gene technologies, commercial uncertainty caused by delays in implementing the recommendations of the Third Review of the National Gene Technology Scheme has seen Australia's standing decline.

The Third Review of the National Gene Technology Scheme commenced in 2017 but over seven years later, the recommendations made by the review remain unimplemented. In October 2018, the Legislative and Governance Forum on Gene Technology met to endorse the Third Review and its 27 recommendations. However, the implementation delay has left the Scheme lagging in numerous areas of accumulated scientific evidence, undermining Australia's global reputation as a leader in agricultural innovation and biotechnology investment. This stagnation has had a chilling effect on R&D investment and has delayed the introduction of advanced biotechnologies essential for the agricultural sector's sustainability and growth.

Australia needs to take urgent action to avoid being left behind. The protracted and unresolved regulatory review process has dramatically undermined the confidence required by members of the plant science industry to commercially invest in Australia. Because the regulatory framework also underpins other biotechnology applications, the delay has also stalled the growth to our broader bioeconomy. At the same time other jurisdictions across the world have updated their gene technology regulatory frameworks to better reflect the settled science of the safety of biotechnology. This has resulted in farmers, and other bioeconomy stakeholders, in these jurisdictions having access to new technologies not available in Australia, impacting our international competitiveness.

Progress towards implementation has been made by the Department of Health and Aged Care (DHAC) in the past 12 months, including the release of the draft Gene Technology Bill. However, the lack of certainty on when the reform process will be complete leaves industry without the certainty necessary to plan for the investment needed to support R&D and commercialisation. By comparison, the New Zealand Government has recently released its

[17] 2019 Annual Report' (CommBank, 2019), https://www.commbank.com.au/about-us/investors/annual-reports/annual-report-2019.html.

Gene Technology Bill to establish an entirely new regulatory scheme for gene technology in a little over 12-months. This Bill will incorporate the recommendations made as part of the Australian Third Review of the National Gene Technology Scheme.

The amendments to the National Gene Technology Scheme provided by the Australian Gene Technology Bill remain modest. While the introduction of risk tiering is an important step forward, the scheme will not adequately provide Australia with a future-proofed regulatory framework. Although the continuation of process-based triggers, as opposed to an outcomes-based system, needlessly burdens innovators, this was agreed upon in the review. However, as it stands the amendments will not adequately implement all the agreed recommendations. Furthermore, the definitions governing the organisms under the framework remain overly restrictive, limiting innovation and the integration of emerging technologies.

Food regulation

Commencing in June 2017 and with the final report being published December 2019, FSANZ undertook a review of food derived using new breeding techniques (NBTs). Subsequently, proposal P1055 was commenced by FSANZ to amend definitions of food produced using gene technology in the Australia New Zealand Food Standards Code (the Code). With the recent completion of the proposal P1055 public consultation, it is critical that these amendments to the Code be finalised as soon as possible.

CropLife supports updates to the Code that result in foods being regulated in a manner proportionate to the risk they pose. The recognition that NBT foods have the same characteristics as conventional foods and therefore should be regulated in the same manner as conventionally produced food is welcomed. This is consistent with current scientific knowledge and understanding, as elaborated in FSANZ's detailed safety assessment of NBTs. Furthermore, this approach is in line with progressive approaches being implemented in other international jurisdictions.

As noted in CropLife's submission to the second P1055 call for comment, the proposed definition amendments are a significant step towards a science-based regulatory system but still fall short in the development of a risk-proportionate outcome-based system. The proposed definitions potentially regulate food as GM even if they are indistinguishable from those developed through conventional breeding. This includes the classifying intragenesis as GM, despite its similarity to naturally occurring processes.

An outcome-based, rather than process-based, risk-proportionate regulatory approach ensures Australian consumers benefit from biotechnology innovations by having rapid access to food that is potentially both cheaper and better for the environment.

Furthermore, continued delays in updating the code are having a chilling effect on innovation and investment in the bioeconomy. With the rapid global expansion of NBT-related products, many of our largest trading partners are leaping ahead by introducing modernised regulatory frameworks.

CropLife would like to acknowledge the considerable body of work undertaken as part of P1055 with respect to the analysis and summary of stakeholder concerns and the relevant scientific literature that relates to the proposed changes.

CropLife recommends that sufficient resourcing and support is provided to FSANZ to ensure the timely completion of P1055 in a manner consistent with science-based regulatory practices. This will provide industry with the certainty necessary to introduce additional products to the comparably small Australian market and thus provide access to Australian consumers.

Reducing Regulatory Duplication

Regulatory duplication can significantly delay the commercialisation of cutting-edge technologies and create additional administrative burdens for innovators. When multiple agencies assess the same product or process, overlapping requirements and inconsistent timelines increase costs and uncertainties. This, in turn, can discourage investment in Australian R&D and slow the delivery of potential benefits—whether in agriculture, medicine, or the broader economy. CropLife supports efforts to reduce regulatory duplication through improved coordination between regulators.

An excellent recent example of effective inter-agency collaboration is the simultaneous assessment of a GM banana developed for resistance to Fusarium wilt tropical race 4 by the Queensland University of Technology.[18] The OGTR and FSANZ worked in tandem to review the GM banana, streamlining data requests and coordinating approvals. This alignment not only reduced duplication of effort but also provided greater certainty for the project's proponents. By receiving timely, coordinated feedback, researchers and investors were better able to manage resources and prepare for eventual commercialisation. Such collaboration could also be expanded to other regulatory agencies. For example, between the APVMA and OGTR. This is critical for GM crop varieties with herbicide resistance traits—a space that has seen significant delays.

[18] See, eg, Office of the Gene Technology Regulator, 'DIR 199:Commercial release of banana genetically modified for resistance to Fusarium wilt tropical race 4 (TR4)' (Website, Accessed March 2025) <https://www.ogtr.gov.au/gmo-dealings/dealings-involving-intentional-release/dir-199>.

This kind of inter-agency cooperation should be the norm rather than the exception. When agencies proactively share information, standardise protocols, and synchronise review timelines, Australia's regulatory frameworks become more transparent and efficient. This fosters an environment that attracts global innovators, secures funding for local research projects, and brings novel technologies and products to market sooner—without compromising safety or integrity. By prioritising cohesive, science-based regulatory approaches, Australia can strengthen its leadership in agricultural, environmental, and medical innovation.

2.1.2 Extended Producer Responsibility

CropLife Australia supports high regulatory standards that achieve measurable environmental and economic outcomes. However, the regulatory framework must also enable commercial predictability and support private sector investment if it is to contribute meaningfully to a dynamic and resilient economy.

Extended Producer Responsibility (EPR) schemes, when poorly designed, risk embedding structural inefficiencies and inflationary costs into supply chains. This is particularly evident where regulation mandates a single provider or prescribes centralised delivery models that limit flexibility, stifle innovation, and crowd out more cost-effective, industry-led approaches.

CropLife and its members have a proven record of delivering effective national product stewardship through programs such as drumMUSTER® and bagMUSTER®. These industry-led schemes demonstrate that high regulatory outcomes, such as reduced environmental impact and circularity in packaging stewardship, can be achieved efficiently when regulatory settings are:

- Outcome-focused, not input-prescriptive.
- Competitively neutral, allowing multiple providers to delivery stewardship outcomes.
- Commercially predictable, providing confidence for long-term investment e.g., recycling infrastructure.
- Science-based and risk-proportionate regulation to ensure actual risks are mitigated and also enabling dynamic adaptation.

Embedding overly rigid or monopolistic EPR models into regulation risks undermining this investment confidence. It bakes in fixed compliance costs, increases inflationary pressure, and discourages innovation in packaging design, recovery logistics, and data systems—each of which are critical to achieving circular economy outcomes.

CASE STUDY – APCO

One such example is the EPR scheme currently being developed by the Australian Packaging Covenant Organisation (APCO). While APCO provides services that are essential to the current co-regulatory scheme for packaging stewardship, it has consistently failed to meet national targets despite decades of data collection.

Its centralised approach, lack of accountability to participating businesses and government, and its historical unwillingness to embrace successful industry stewardship schemes make it ill-suited to lead the next generation of packaging reform. More critically, APCO's model imposes non-transparent, non-contestable cost structures on businesses. Such an approach is inherently inflationary and incompatible with the need for regulatory systems that promote efficiency and resilience and deliver outcomes for Australians and our natural environment.

The Government's national reform of packaging regulation and stewardship must take these structural concerns seriously. Embedding a single, underperforming body into regulatory design risks entrenching inefficiencies, undermining public trust, and deterring commercial investment in packaging innovation and recovery. Instead, the reform process must ensure that the regulatory architecture promotes competition, enables multiple fit-for-purpose stewardship providers, and maintains flexibility for industry-led investment in circular economy outcomes.

To support economic dynamism, regulation must therefore evolve beyond compliance enforcement and become a framework that actively encourages private investment in public outcomes. A well-calibrated regulatory system provides the certainty needed for businesses to invest, while retaining the flexibility for market-led solutions to emerge and succeed.

3 PILLAR 5 INVESTING IN CHEAPER, CLEANER ENERGY AND THE NET ZERO TRANSFORMATION

3.1. Are there gaps in the emissions-reduction policies in the industrial, electricity and transport sectors which should be addressed?

Expanding the role of Low Carbon Liquid Fuels (LCLF) provides a key opportunity to decarbonise Australia's economy. Moreover, the domestic production of LCLFs presents opportunities to the Australian economy beyond the role it will play in lowering emissions in hard to abate industries, such as transport and logistics. In particular, the production of LCLF will see the development of domestic manufacturing focused around adding value to the existing strengths of Australia's primary production capacities.

Although there is considerable policy work on the LCLF sector, feedstock production has received scant attention. A sustainable and commercially viable Australian LCLF industry depends on secure access to low-emissions feedstock. The consultation paper does recognise the importance of efficient crop production to this aim, but beyond advocating consistent demand for feedstock crops, it neglects the policy measures needed to guarantee supply. Any policy response must also heed global concerns that low-carbon biofuels are confronting a feedstock crisis and growing scrutiny over competing uses of arable land for food versus fuel.[19]

Feedstock production depends on Australian farmers. However, our primary producers face uncertain times. They are at the rockface of climate change while also contributing to the range expansion of invasive pests, weeds and disease. They need access to every possible tool available.

This primarily includes access to inputs, most notably Crop Protection Products (CPPs). More than $31 billion of the value of Australia's agricultural production, or 74 percent, is directly attributable to the responsible use of CPPs. Herbicide use in particular has underpinned the widespread adoption of no-till farming in Australia. Consequently, Australian farmers are world leaders in the adoption of no-till practices.[20] These no-till practices preserve soil structure, reduce erosion and maintain crop residues as a protective cover. This cover conserves moisture, fosters microbial activity and contributes to carbon

[19] International Energy Agency, 'Renewables 2022' (2022 IEA Report) 'https://www.iea.org/reports/is-the-biofuel-industry-approaching-a-feedstock-crunch'

[20] A Read, J Rollan, C Creed and James Fell, 'Environmental Sustainability and Agri-Environmental Indicators – International Comparisons', (ABARES Insights, Issue 2, July 2023), DOI: https://doi.org/10.25814/zzdq-4t23.

sequestration, aligning with efforts for carbon neutrality and climate change mitigation in Australian agriculture. Across the Australian crop production landscape, the high adoption of no-tillage practices over the 1990s and 2000s resulted in the sequestration of approximately 5 million tonnes CO2~e annually compared to conventional tillage practices.[21]

This is not unique to Australia. A life cycle analysis study recently published by the University of Arkansas bolsters the global literature describing the vital role of CPPs in fostering improved carbon outcomes.[22] Importantly, without pesticides, the yields of corn, cotto, and soybeans declined up to 70 percent. Cultivating corn, cotto, and soybeans without pesticides resulted in upwards of three times more land, water, energy use and greenhouse gas emissions. The targeted and judicious use of pesticides not only enhance productivity but significantly reduce pressure on water, land and energy resources per unit of production.

Enhancing yield per cultivated area through sustainable intensification has been identified as a climate change abatement tool. This is because it eliminates the need to convert more land (and the resultant emissions created by this deforestation) to meet the increasing global food and fuel demand.[23] Consequently, this approach may contribute to a global reduction in GHG emissions associated with crop production. As a nation whose sustainable agricultural practices are already world-leading, increasing production intensity also alleviates the requirement to convert natural habitats elsewhere in the world into arable land as global demand for food and feedstock increases.[24]

The toolbox must also include the latest developments in biotechnology. With recent unprecedented advances, there are numerous innovations capable of supporting decarbonisation while also providing resistance to adverse conditions. With GM technology already providing enormous opportunity for canola feedstock production, Australian farmers could soon have access to hundreds of new varieties through gene editing.

[21] Macintosh A et al, 'Improving Carbon Markets to Increase Farmer Participation' (July 2019 Agrifutures Report), 'https://agrifutures.com.au/wp-content/uploads/2019/07/19-026-Digital-1.pdf'.

[22] Thoma G et al, 'Life cycle assessment of impacts of eliminating chemical pesticides used in the production of U.S. corn, soybeans, and cotton ' (25 March 2024 CropLife America Report) 'https://static1.squarespace.com/static/5faeee45a363746603d1c6e1/t/661e95a6e057f947a1185c5e/1713280424229/CLA+LCIA+ISO+Finalized+Report.pdf'.

[23] Maartje S et al, 'Australian Grains Baseline and Mitigation Assessment' (January 2022 CSIRO Report) 'https://publications.csiro.au/publications/publication/PIcsiro:EP2022-0163'.

[24] A Read, J Rollan, C Creed and James Fell, 'Environmental Sustainability and Agri-Environmental Indicators – International Comparisons', (ABARES Insights, Issue 2, July 2023), DOI: https://doi.org/10.25814/zzdq-4t23.

Gene editing technologies have already emerged as a tool for small-scale crop development. They reduce both the time and number progenitor plants needed to develop a novel crop variety. This means that despite our small and niche market size, Australian innovators can rapidly develop Australia-adapted varieties. When combined with conventional breeding and GM, we can rapidly enhance our agricultural sector. So far, innovation in this area has included:

- **Enhanced Crop Yield**s: As a major exporter of agricultural products, Australia could increase its global market share with gene-edited crops. Uncertain regulations, however, may dissuade agribusinesses from adopting these innovations.
- **Pest Resistance**: Although Australia is fortunate with respect to biosecurity, it is a constant battle. This might be best exemplified by recent emergence of fall armyworm, varroa mite and red ants as agricultural major pests. However, solutions to these problems are constantly emerging. For example, rust disease resistance in wheat[25] and Panama's disease in banana.[26]
- **Ensuring Sustainability**: With ambitious environmental targets, Australia requires significant innovation to ensure these targets are met while not adversely impacting food security. Since the emergence of gene editing techniques, there are continuously new examples of novel crop varieties with improved yields and resistance to numerous abiotic or biotic stresses.[27]
- **Investment in Bio-Fortified Crops**: With Australia's focus on premium and nutritional food exports, there's a window to lead in bio-enhanced food production. Unclear regulations could halt ventures from investing in this niche yet growing segment. One example, approved last year for use in Norwegian fish farms, is the Australian-developed Omega-3 canola.[28]

[25] Grains Research and Development Corporation, 'ACRCP Phase 5: Optimising genetic control of wheat rusts through identification of gene editing targets for broad spectrum wheat rust control', (04 April 2023 Webpage) 'https://grdc.com.au/grdc-investments/investments/investment?code=CSP2304-010RTX'

[26] Hort Innovation, 'A platform for gene editing vegetative propagated crops (AS20000)', (February 2023 Webpage) 'https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/as20000'

[27] Hamdan MF et al, 'Genome Editing for Sustainable Crop Improvement and Mitigation of Biotic and Abiotic Stresses' (2022 Plants, 11, 2625).

[28] Aquaterra, 'Norway Approves Aquaterra Omega-3 Oil for Use in Aquafeed' (28 June 2023 Webpage) 'https://aquaterraomega3.com/norway-approves-aquaterra-omega-3-oil-for-use-in-aquafeed'.

- **Improved Plant Oil Content**: In addition to bio-fortification, Australia continues to develop crops for highly efficient biofuel. This is achieved through the selection and engineering of plants for increased oil production.[29]

Attachments:

- Submission to the Ag and Land Sector Plan
- Submission to the Low Carbon Liquid Fuel consultation

[29] Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's next oil boom might just come from plants, (4 April 2017 Webpage) 'https://www.csiro.au/en/news/All/News/2017/April/Australias-next-oil-boom-might-just-come-from-plants'.

Attachment A

Deloitte
Access Economics

Economic contribution of crop protection products in Australia

August 2023

Contents

Charts

Tables

Figures

Glossary

Short name	Full name
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
APVMA	Australian Pesticides and Veterinary Medicines Authority
CPP	Crop protection product
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPI	Department of Primary Industries (NSW Government)
FTE	Full-time equivalent
GDP	Gross Domestic Product
GRDC	Grains Research and Development Corporation
IO	Input-output
UNFAO	Food and Agriculture Organization of the United Nations
USDA	United States Department of Agriculture

Executive summary

Deloitte Access Economics has been engaged by CropLife Australia to estimate the contribution of the crop protection industry to the Australian economy, and the Australian agricultural output attributable to the use of crop protection products (CPPs). This report represents an update to a report released in 2013 and 2018 by Deloitte Access Economics.

CPPs include herbicides, fungicides and insecticides, and are widely used in many sectors of the economy. For industry — particularly agriculture — it is a means of increasing the productivity of land. Governments also use CPPs to control invasive or non-native species on public land (such as roadsides and in national parks). They are also widely used by households for backyard gardening and pest control, in commercial buildings, on sporting fields and in maritime applications. This report focuses on the contribution of the CPP industry to value added in the Australian economy (as an employer and purchaser of inputs from other industries), and the contribution of CPP use to crop production. The value and importance of CPPs to public land and other environmental land managers has been discussed qualitatively in this report.

The approach used in this study is two-fold:

- First, the direct and indirect economic contributions of the CPP industry to the economy (in terms of contribution to Gross Domestic Product (GDP) and employment) are estimated.
- Second, the share of crop production in Australia attributable to CPPs is estimated. This utilises previous work undertaken for the United States, with adjustments made to reflect differences in Australian production systems.

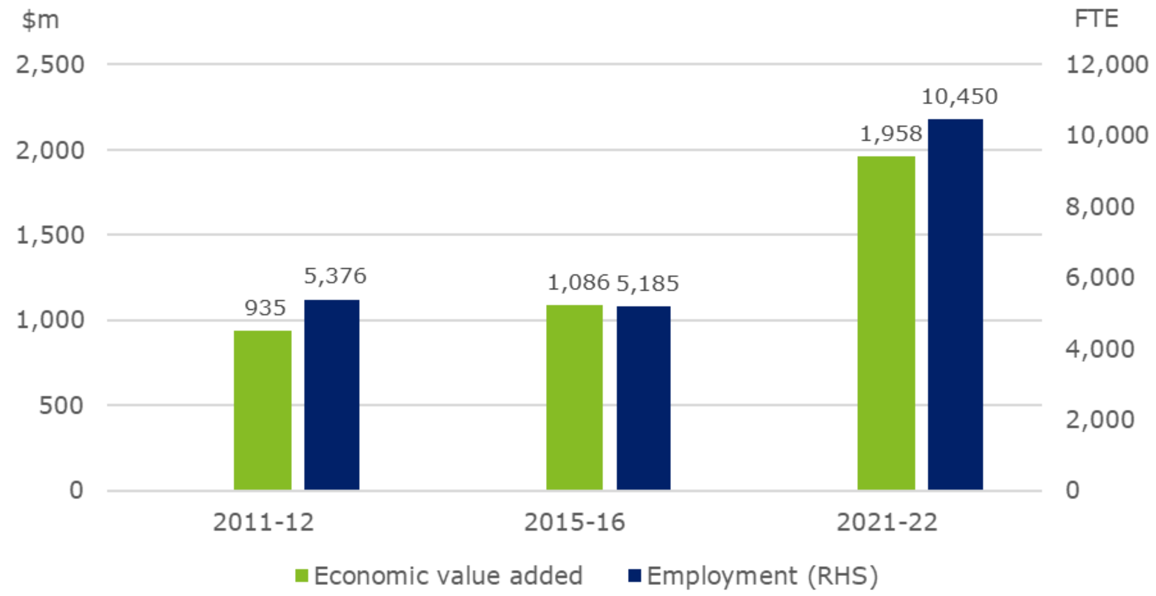
Economic contribution

$5.1 billion of CPPs were used in Australia in 2021-22.[i] This output was associated with an economic contribution of $2.0 billion of value-added to GDP, which consists of a direct economic contribution of $955 million and indirect economic contribution of $1,003 million in sectors supplying the CPP industry with intermediate inputs. These value-added contributions comprise both gross operating surplus and wages.

In terms of employment, the CPP industry contributed 10,450 full time equivalent (FTE) employees in 2021-22, which consists of 4,615 directly in the CPP manufacturing sector and 5,835 in the sectors that supply inputs to the CPP industry. The primary industries contributing employment include Professional, Scientific and Technical Services, Wholesale Trade and Road Transport.

The contribution of the CPP industry to the Australian economy has grown significantly since it was last estimated in 2015-16, the year for which Deloitte Access Economics last undertook this study. Over this 5-year period, it is estimated that total employment generated by the sector has more than doubled to 10,450, whilst value-added from the sector has increased by 80 per cent to nearly $2 billion in 2021-22 compared with 2015-16.

Chart i: Contribution of the CPP industry to the Australian economy, 2011-12, 2015-16 and 2021-22



Source: Deloitte Access Economics

Note: The approach used for the 2021-22 estimates has changed from previous editions to better reflect the role of imports in the sector. The 2011-12 and 2015-16 results have been revised to reflect this approach and allow direct comparison.

Crop production attributable to CPPs

The total value of Australian crop production attributable to CPPs is estimated as the sum of the attributable value of production for field crops (broadacre), vegetables, fruits and nuts and other crops (mostly forage crops). The output attributable to CPPs is based on current farming practices and assumes that all other necessary production inputs (sufficient water, nutrients, etc.) are available. The analysis does not consider the impact if all CPPs suddenly become unavailable, which would necessitate significant changes to farming practices (and likely involve significant changes in crop mix and land use).

Updated modelling shows that $31.6 billion of Australian crop output in 2020-21 was attributable to the use of CPPs, or 73 per cent of the total value of crop production in that year. This represents nominal growth of 53 per cent on the previous estimate in 2015-16, driven primarily by the increased value of production. Over half of this contribution is from fungicides, reflecting their significant contribution to the value of production of vegetables, fruits and nuts.

Broader benefits of CPPs

CPPs offer broader social benefits to Australia outside of the economic and agricultural values outlined above. These include:

- **Community benefits from non-agricultural uses –** 15 per cent of CPPs are used for non-agricultural uses such as gardens, sports ovals and public spaces. This provides a variety of benefits such as accessibility, amenity and health benefits.
- **Environmental and climate benefits –** The use of CPPs by Australian farming system reduces tillage and deforestation in other parts of the world to accommodate the required increase in food production. In turn, this avoids any greenhouse gas emissions and nature loss that would be associated with this land use change around the world.
- **Food security and biosecurity –** CPPs increase agricultural productivity, thus increasing the amount of food available to consume domestically or export. CPPs also protect Australia's environment by helping to control invasive pests and diseases.
- **Spillover benefits to scientific research and development –** Existing CPPs provide a foundation for extensive research on pests and diseases affecting Australian crops. For example, herbicides enable innovation in modern farming practices such as minimum- or no-

till farming, which provide a range of indirect benefits outside of the cropping industry (e.g to broader plant and animal science).

1 Background

Deloitte Access Economics has been engaged by CropLife Australia to estimate the economic contribution of crop protection product (CPP) use in the Australian economy, and the Australian agricultural output attributable to the use of CPPs. This report is an update of a similar piece of work that Deloitte Access Economics produced for CropLife Australia in 2013 and 2018. This report also includes a summary of published literature on the broader qualitative benefits of CPP usage, outside of agriculture.

This report presents estimates of the CPP industry's economic contribution and of the share of cropping output attributable to the use of CPPs in Australia. A summary of qualitative research on the broader benefits of CPPs is also presented. This study is not a cost-benefit analysis and does not consider or compare the relative magnitudes of costs in relation to the benefits; for example, potential costs to the environment or health implications of their consumption.

The CPP industry's economic contribution (the amount of value added involved in the production and sale of CPPs) is a different concept to the amount of cropping output that is attributable to the use of CPPs. The two concepts are different ways of looking at economic value, but they are not additive and hence should not be combined.

1.1 Crop protection products

Conventional synthetic CPPs include herbicides, fungicides and insecticides, which are widely used in many sectors of the economy. For industry – particularly agriculture – it is a means of increasing the productivity of land. Governments often use CPPs to control invasive or non-native species on public land (such as roadsides and in national parks). They are also widely used by households for backyard gardening and pest control, in commercial buildings and maritime applications.

Crop protection products and organic produce

The scope of CPPs is broad and includes chemical products that are naturally occurring as well as chemicals which are synthetic. CPPs generally contain at least one active substance that protects plants and plant products from pests, weeds and disease. These active substances can be from plant extracts, chemicals, pheromones, or micro-organisms. As such, any chemicals derived from naturally occurring substances, as used by the organic agriculture sector, are included as CPPs.

The three main groups that contribute to this part of the chemical industry are herbicides, fungicides and insecticides, contributing a total of 85 per cent of product sales for the 2021-22 financial year.[ii]

In addition to traditional chemical CPPs, there are also several non-chemical measures for protecting crop products – such as mechanical methods and farm practices which can include traps, fences, crop rotation and irrigation practices. Non-chemical controls can also refer to pest products that are derived from a biological origin such as animals, plants, bacteria, or minerals.[iii] CPPs in varying forms have improved the efficiency of the agriculture sector for over 150 years.[iv]

In Australia, agricultural chemicals are regulated by the Australian Pesticides and Veterinary Medicines Authority (APVMA) up until the point of final retail sale. This includes pre-market risk assessment, approval and registration of products as well as defining the content of labels describing instructions for safe and responsible use. States and territories control the use of products after this point including creating and administering rules for access to products, training and licensing of users, as well as any additional requirements for use such as record keeping or other restrictions.

As more products have been registered in recent years, the value of chemical CPP sales has continued to grow, highlighting the agricultural sector's acceptance of new chemical innovation, as shown in Chart 1.1 and Chart 1.2. In the 2021-22 financial year, around $5.1 billion was spent on 10,100 registered crop protection products in Australia.

Chart 1.1: Number of registered CPPs in Australia, 2011-12 – 2021-22

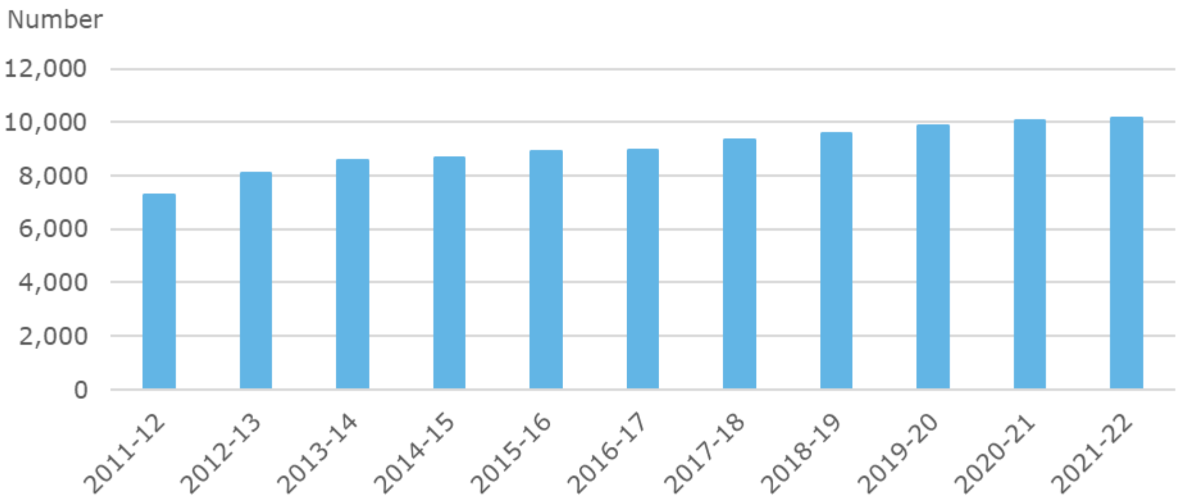
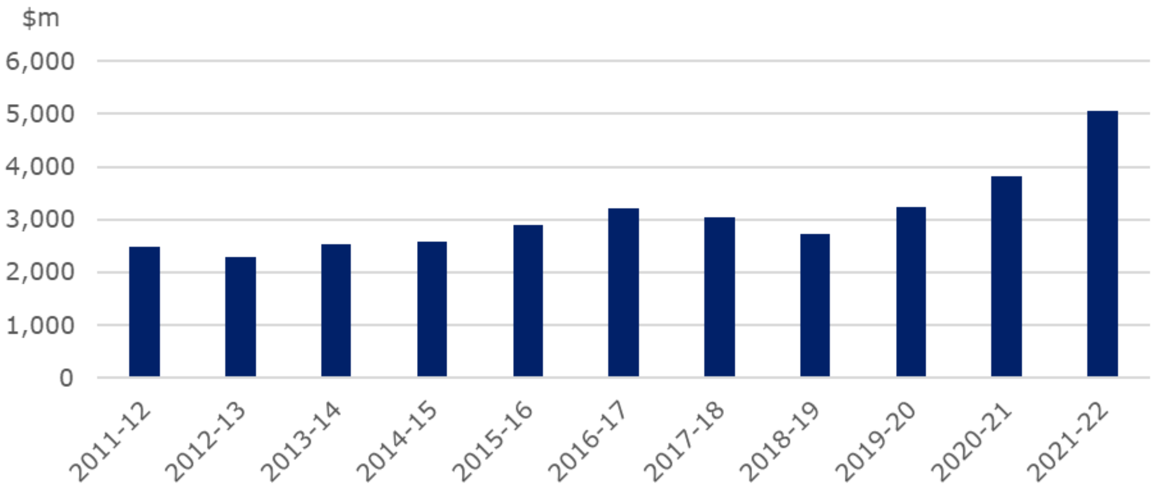


Chart 1.2: Annual CPP sales in Australia, 2011-12 – 2021-22



Source: APVMA, 2023.

CPPs can be classified into four broad categories:

- Herbicides – products intended to prevent or reduce the growth of weeds. These can be either:
    - selective (chemicals which kill weeds specifically without harming crops); or
    - non-selective (chemicals which stop the growth of plants indiscriminately).
- Insecticides – chemicals which aim to control insects in plants and crops.
- Fungicides – products whose purpose is to prevent or manage fungal diseases in plants.
- Other – includes other pesticides (such as miticide, molluscicide, vertebrate poison) as well as chemical agents (adjuvants and surfactants).

Key reasons for use of CPPs include to:

- decrease and control pests and diseases;
- reduce the need for crops and plants to compete with weeds and other invasive plants;
- increase the yield of crops;

- increase the quality of crops
- protect biodiversity;
- improve amenity; and
- protect and maintain infrastructure such as buildings and roads through pest or weed control.

For this report, APVMA data on agricultural (pesticides) product sales are used as indicative of CPP industry revenue. This includes all of the major categories of chemical products used in crop production, as well as some products that may not be used in crop production (for example, household insecticides, pool products/algicide) but these make up a small share of total sales (see Table 2.1). The total value of agricultural (pesticide) product sales is used in the calculation of the economic contribution of the CPP industry because of the close links in the production and sale of all of those products, and the fact that the industry exists, by and large, to service the crop production sector.

1.2 Previous studies into the economic value of crop protection products

Although CPPs are well established worldwide, there is limited research on their economic contribution. This section details a few key studies.

The most comprehensive study undertaken to date is Mark Goodwin Consulting's 2011 report "The Contribution of Crop Protection Products to the United States Economy". The Goodwin study was commissioned by CropLife America, and it details the value of selected crops which is attributable to CPPs.

The study adopted a three-stage methodology. For each crop identified, Goodwin Consulting:

1. determined the proportion of crop value attributable to herbicides, insecticides and fungicides, using previous studies published by the Crop Protection Research Institute[1];
2. determined the total value of the crop by state; and
3. determined the total economic value attributable to agrochemical use by multiplying (1) and (2).

Aggregating, Goodwin concludes that that the direct contribution of CPPs to the US economy is $81.8 billion, with flow-on benefits amounting to $166.5 billion across 20 industries, and approximately one million jobs across the country.

This study was followed by a similar report, "Cultivating a vibrant Canadian economy", published by CropLife Canada in 2011. This report considered the contributions of CPPs as well as plant biotechnology. After evaluating several potential methodologies, the Canadian report quantifies the contribution of agrochemicals by comparing yields between conventional and organic crops. It then calculates the value of crops attributable to CPPs as the difference in yields multiplied by the price of crops. The report concludes that, for the most commonly grown crops in Canada, the value generated by the increased yields associated with the use of agrochemicals and plant biotechnology is almost CA$8 billion.[2]

In Australia, the AECgroup published a report on the "Economic Impact of State and Local Government Expenditure on Weed and Pest Animal Management in Queensland" in 2002. The report conducted a cost benefit analysis of state and local government spending on a set of pest and weed management initiatives. One of the initiatives examined was the eradication of Siam Weed. The study found that every $1 spent on this program (including spraying, maintenance and border protection costs) resulted in $3.70 in benefits. Another study from the Local Government Association of Queensland found that each dollar spent on weed and pest animal management initiatives in Queensland can deliver $6.40 in benefits.

A Deloitte Access Economics study from 2013 based on the methodology of the CropLife America report, adjusted appropriately for the Australian context, estimated that $17.6 billion of Australian crop production in 2011-12 could be attributed to the use of CPPs. A 2018 update of this estimate

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[1] Gianessi, L., and Regier, N., 2006; Gianessi, L., and Regier, N., 2005; Gianessi, 2009.
[2] Including 16 field crops, 29 vegetable crops, 13 fruit crops and potatoes.

found that this value had risen to $20.6 billion in 2015-16. The economic contribution section of this report follows a revised version of the methodology used in the 2013 and 2018 Deloitte Access Economics study, which is detailed further in the following chapters. These two previous studies are used throughout this report in presenting time series results for the economic value of CPPs.

2 Economic contribution of CPPs

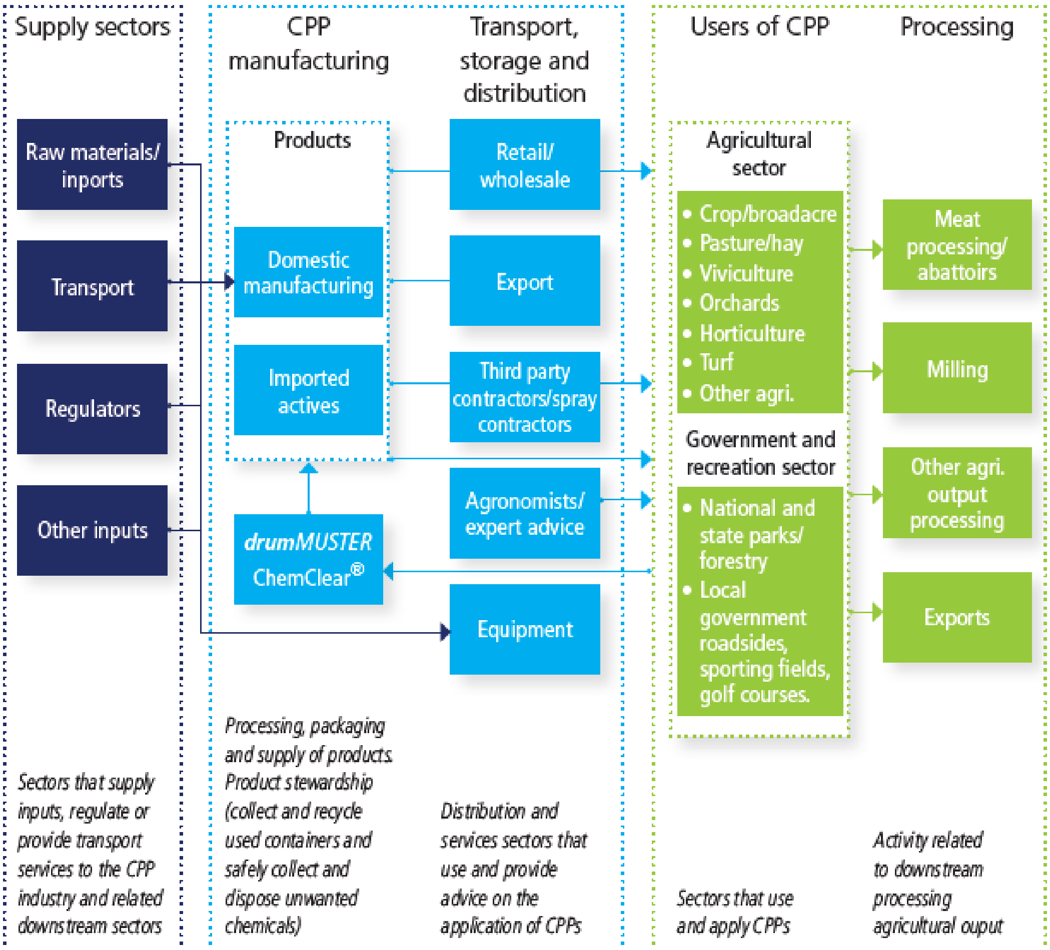
This section outlines the economic contribution of CPP production and use in Australia in 2021-22.[3] This includes the direct economic contribution of the CPP industry, in gross value added and full time equivalent (FTE) employment terms, and the indirect contribution associated with its purchases of intermediate inputs, as illustrated in Figure 2.1.

2.1 CPP industry linkages and relationships

The CPP supply sectors includes the suppliers of raw materials from which CPPs are manufactured, as well as third-party contractors and the agronomists that service the sector and help to optimise farm practices. It is noted that there are several types of agronomists. Some are employed by CPP companies (distribution agronomists), hence have their costs embedded in the retail cost of CPPs as employees of chemical resellers. Private agronomists, on the other hand, independently generate revenue (over and above sales of CPPs) through their work as consultants.

Figure 2.1 provides an overview of the value chain associated with CPP use, including the intermediate suppliers, producers, importers and end users.

Figure 2.1: CPP industry linkages and relationships



[3] To reflect the role that CPPs play across the entire Australian economy, both local production and imports are deemed to contribute to the economy and agriculture sector for the purposes of this study.

2.2 CPP use in Australia

In 2021-22, $5.1 billion worth of CPPs were sold in Australia.[v] This figure has increased from the $3.0 billion figure measured in 2017-18, representing a compound average growth rate of 14 per cent over this period. Herbicide sales (the largest product type by level of sales) grew by an average of 16 per cent over this period. This level of growth is higher than that seen in the agricultural sector – the value of crops produced in Australian grew at an average of seven per cent over the same period.[vi]

Herbicides, insecticides and fungicides making up 86 per cent of sales. Herbicides alone account for 60 per cent of sales, worth nearly $3.1 billion in 2021-22. Insecticides accounted for 15 per cent of sales (with 80 per cent of these being insecticides for use on farms and 20 per cent for use in households). Fungicides made up nearly 10 per cent of sales.

The sector also provides a number of chemical products that are used in non-crop production processes, such as dairy cleanser, seed treatments and wood preservatives. Collectively, these other agricultural products comprise six per cent of total sales.

This dataset also includes a number of products that are used in aquatic applications, for example anti-fouling marine paints and water sanitisers for use in pools and spas. APVMA data also outlines that the sector produces $2 million in dog and bird repellents, this is an increase from 2017-18 figures which report $1.4 million. The value of production of these products has been included in the calculation of the economic contribution of the CPP industry. The reasons are twofold: firstly, because of the close links between the production and sale of the various types of products, and secondly because the industry as a whole exists, by and large, to service the crop production industry.

Table 2.1: CPP industry output by type of product $m, 2021-22

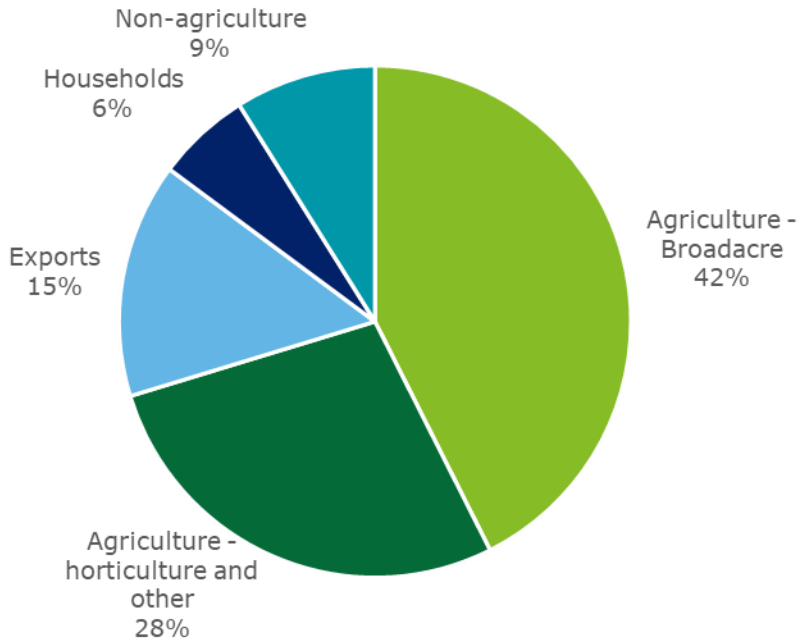
Output	$m	Share of total
Adjuvants / Surfactants	187.3	3.7%
Antifouling - Boat	19.5	0.4%
Dairy Cleanser	14.3	0.3%
Disinfectant / Sanitiser	15.0	0.3%
Fungicide	496.5	9.8%
Growth promoters / Regulators	78.9	1.6%
Herbicide	3,085.8	60.9%
Household Insecticide	158.0	3.1%
Insecticide	599.5	11.8%
Miscellaneous	10.2	0.2%
Miticide	32.7	0.6%
Mixed Function Pesticide	32.2	0.6%
Molluscicide	28.3	0.6%
Nematicide	3.6	0.1%
Pool Products / Algicide	80.5	1.6%
Repellent – Dogs / Birds etc.	2.1	0.04%
Seed Treatments	89.4	1.8%
Vertebrate Poison	62.4	1.2%
Wood Preservative	71.5	1.4%
Total	5,067.5	100%

Source: APVMA, 2023.

2.3 Where are CPPs used?

As outlined above, actives are formulated into products and then distributed to a number of consumers. The agriculture sector remains the highest consumer, accounting for 70 per cent total consumption. Of this, 43 per cent is used in broadacre industries. Within these industries, the relative importance of various herbicides, fungicides and insecticides depend on the crop being grown. Horticulture and other agricultural industries then consume 27.5 per cent of Australia’s CPPs, with 14.5 per cent of CPPs being exported, and the remaining used by households and other non-agricultural users (Chart 2.1).

Chart 2.1: Major Australian CPP market segmentation, 2022



Source: IBISWorld, 2022.

Note: Non-agriculture uses include local government for weed and other pest-control programs.

2.4 Industry economic contribution

This section provides estimates of the CPP industry's total economic contribution to the national economy in 2021-22. Economic contribution refers to value added, which is equal to the sum of gross operating surplus and wages. The sum of value added across all industries in the economy equals GDP. The industry's total economic contribution is made up value added within the industry (its direct economic contribution), and value added generated in other industries through the supply of intermediate inputs to the CPP industry (its indirect economic contribution).

The CPP industry's total economic contribution is estimated using information on the value of CPP production, imports and the most recent 2020-2021 Australian Bureau of Statistics (ABS) Input-Output tables.[vii] Locally manufactured products were separated from imports to represent the different ways in which the CPP sector contributes to the Australian economy. As such, the results presented in Table 2.2 are not directly comparable with those presented in previous editions of this report. For a detailed overview of the approach used in this section, refer to Appendix A.

Table 2.2: Economic contribution of CPP industry, 2021-22

	Direct	Indirect	Total
Value added ($m)			
Gross operating surplus	400	510	910
Wages	555	493	1,048
Total	955	1,003	1,958
Employment (FTE)	4,615	5,835	10,450

Source: Deloitte Access Economics.

The CPP industry contributed a total of $1.96 billion in value added to the Australian economy in 2021-22. Of this figure, $1.05 billion was in the form of wages (or returns to labour), and $910 million was gross operating surplus, otherwise known as returns to capital. In 2021-22, the CPP industry also contributed a total of 10,450 FTE employees, 4,615 of whom are directly employed in the industry. The remaining 5,835 jobs supported by the industry are in downstream suppliers.

The CPP industry also indirectly supports economic activity in upstream sectors through its demand for and use of intermediate inputs. In 2021-22, the CPP industry indirectly contributed $1.0 billion to value added, and supported a further 5,835 FTE jobs in Australia.

A breakdown of indirect value added by industry is given in Table 2.3. Professional, scientific and technical services capture the largest share of indirect value added resulting from CPP demand for intermediate inputs, at 11.2 per cent, or $112.7 million. The same sector indirectly employs the most FTEs (863), contributing 14.8 per cent of total indirect employment attributable from upstream expenditure by the CPP industry.

Table 2.3: Indirect contribution of CPP industry, 2021-22

Industry value added	$m	Share of indirect contribution (%)
Professional, Scientific and Technical Services	112.7	11.2
Oil and gas extraction	98.3	9.8
Finance	64.9	6.5
Wholesale trade	48.2	4.8
Employment, travel agency and other administrative services	48.2	4.8
Other industries	630.8	62.9
Total	1003.2	100
Industry employment contributions	**FTE**	**Share of indirect contribution (%)**
Professional, Scientific and Technical Services	863	14.8
Employment, Travel Agency and Other Administrative Services	533	9.1
Road Transport	345	5.9
Wholesale Trade	324	5.6
Non-Residential Property Operators and Real Estate Services	264	4.5
Other industries	3,506	60.0
Total	5,835	100

Source: Deloitte Access Economics

2.4.1 Comparison with previous estimates

To demonstrate the change in size of the CPP industry over time, Table 2.4 presents the key results from 2021-22 alongside comparable figures from the 2013 and 2018 reports. It shows that the CPP industry's contribution to GDP has increased by 80% since 2015-16, and employment has more than doubled.

Table 2.4: Estimates of CPP contribution to Australian economy over time

Value added ($m)	2011-12	2015-16	2021-22
Direct - CPP	366	525	955
Indirect - supply sector	570	561	1003
Total	935	1,086	1,958
Employment	**2011-12**	**2015-16**	**2021-22**
Direct	1,804	1,838	4,615
Indirect	3,572	3,347	5,835

Total	5,376	5,185	10,450

Source: Deloitte Access Economics

Note: The 2011-12 and 2015-16 estimates have been revised to reflect the approach taken in the 2021-22 estimates.

2.5 Market dynamics and trends

Several supply- and demand-side factors explain the significant rise in the CPP sector's economic contribution, as well as the increase in aggregate CPP sales value over the past five years. Price factors include increases in energy costs, manufacturing disruptions, and reliance on CPP imports, while demand-side drivers include wetter than average seasonal growing conditions across Australia in 2020-2022. These drivers are explained in further detail below.

2.5.1 Supply-side drivers

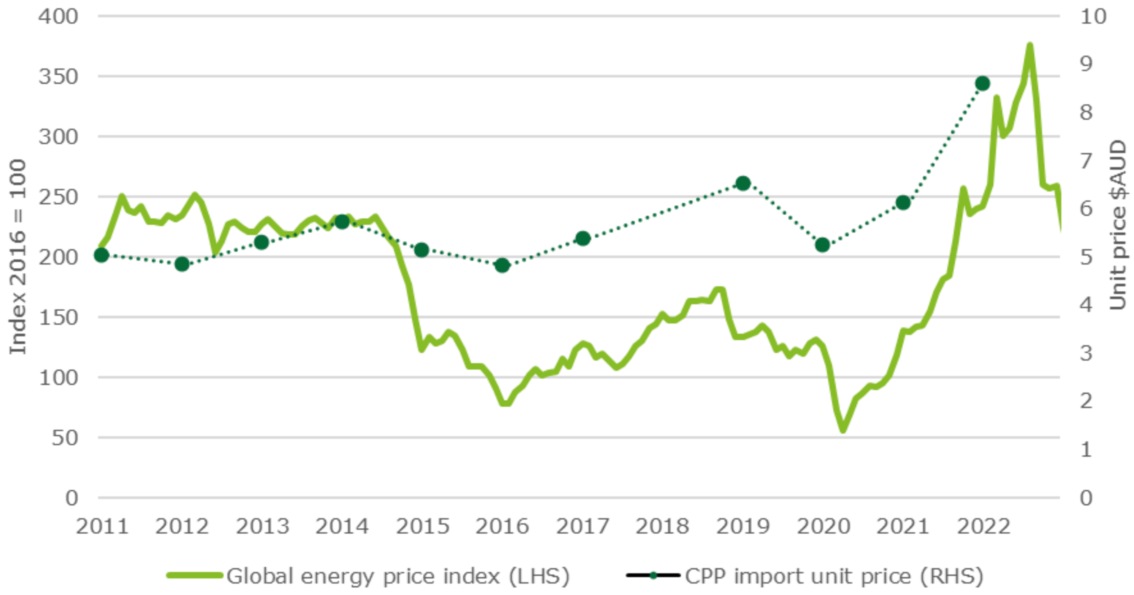
2.5.1.1 Rise in global energy prices

Focussing on CPP imports, the average per-unit of price of imported CPPs rose 60 per cent from 2020 to 2022, from $5.6/kg to $8.6/kg, shown in Chart 2.2. A key driver of the average price increase in CPP imports has been an increase in the price of glyphosate.[4] The sharp price rise at the beginning of 2022 was in part caused by China's industrial policy in the lead-up to the Winter Olympics.[viii] The reduction in Chinese production had a material impact on global supply and therefore price, since China manufactures about 65 per cent of the world's glyphosate. Additionally, a mechanical failure on the production line of a key glyphosate raw material supplier further reduced global supplies and placed upward pressure on price.[ix]

The global energy shortage driven by Russia's invasion of Ukraine in March 2022 also drove up glyphosate prices and CPP prices more broadly. The price of gas increased by 150 per cent from January to August 2022[x], which fed into higher glyphosate prices, since gas is a key input in glyphosate manufacturing.[xi] Additionally, China reduced production of yellow phosphate, a raw material used in the production of glyphosate in the second half of 2021, due to energy restrictions driven by tight coal supplies and high prices.[xii] The combination of high energy prices and electricity rationing in China likely pushed up glyphosate and other CPP prices from 2020 to 2022.

[4] The wholesale price of CPP imports, as well as glyphosate (herbicide) prices can be used as proxies to explain trends in aggregate CPP prices, given that data on the per-unit price of CPPs sold in Australia does not exist. CPP import prices are a suitable proxy for the per-unit price of domestic retail sales, since a large proportion (just over 50 per cent) of CPPs used in Australia are imported. Additionally, the price of broad-spectrum herbicide glyphosate can also be used to help explain trends in CPP expenditure, since glyphosate (and other herbicides) comprise around 61.5 per cent of total CPP use in Australia.[4]

Chart 2.2: CPP import unit price and global energy price index.



Source: Comtrade (2022); Federal Reserve Economic Data (FRED, 2023)

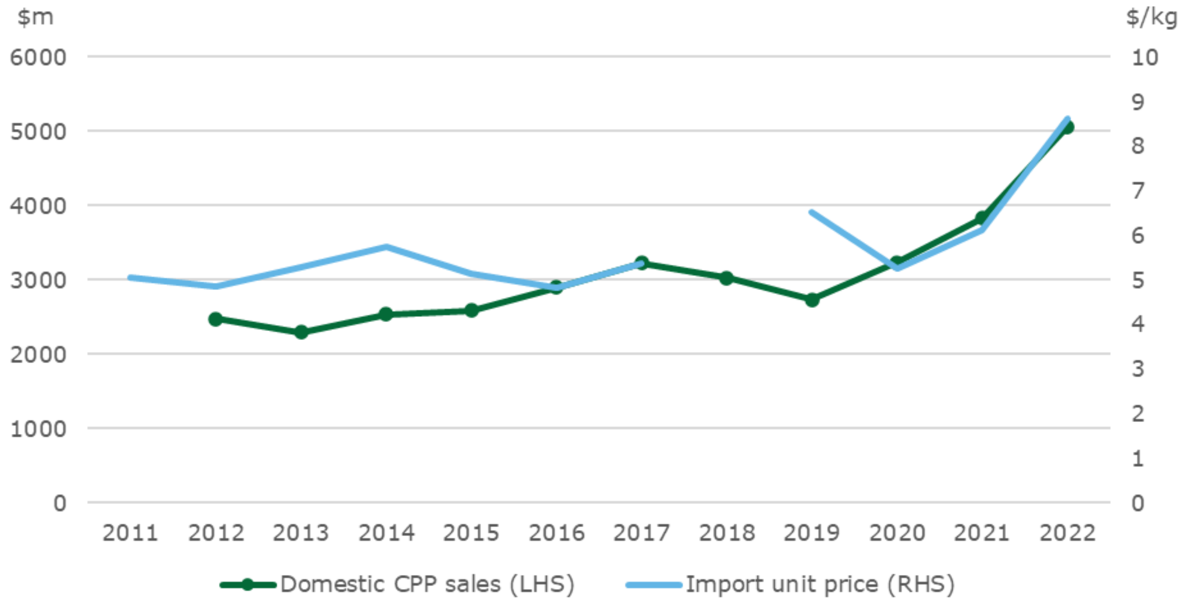
Note: The data encompasses "insecticides, rodenticides, fungicides, anti-sprouting agents, plant growth regulators, disinfectants and the like, put up in forms or packings for retail sale or as preparations for articles."

Domestic producers of agrichemicals have also faced rising energy and other input costs. ABS data indicated that chemical manufacturers recorded input price rises of 23.9 per cent for the year end June 2022. Robust demand and tight supply of natural gas was a key contributor to this trend.[xiii]

2.5.1.2 Trade exposure of the CPP industry

The high level of international trade in the CPP industry has meant that international price shocks (described in Chapter 2.5.1.1) are transmitted to the domestic CPP market. Imports play an important role in meeting domestic demand (primarily from agriculture), with around 50 per cent of CPPs being imported.[xiv] As shown in Chart 2.3, there is a positive correlation between the per-unit price of imports, and domestic CPP sales data. Despite one CPP manufacturer doubling its domestic chemical manufacturing footprint in the last two years, the import share of CPP use in Australia has remained relatively steady.[xv]

Chart 2.3: CPP sales data and import unit prices, Australia, 2011-2022



Source: APVMA; Comtrade (2022).

Note: Comtrade import data is not available in 2017.

2.5.2 Demand drivers

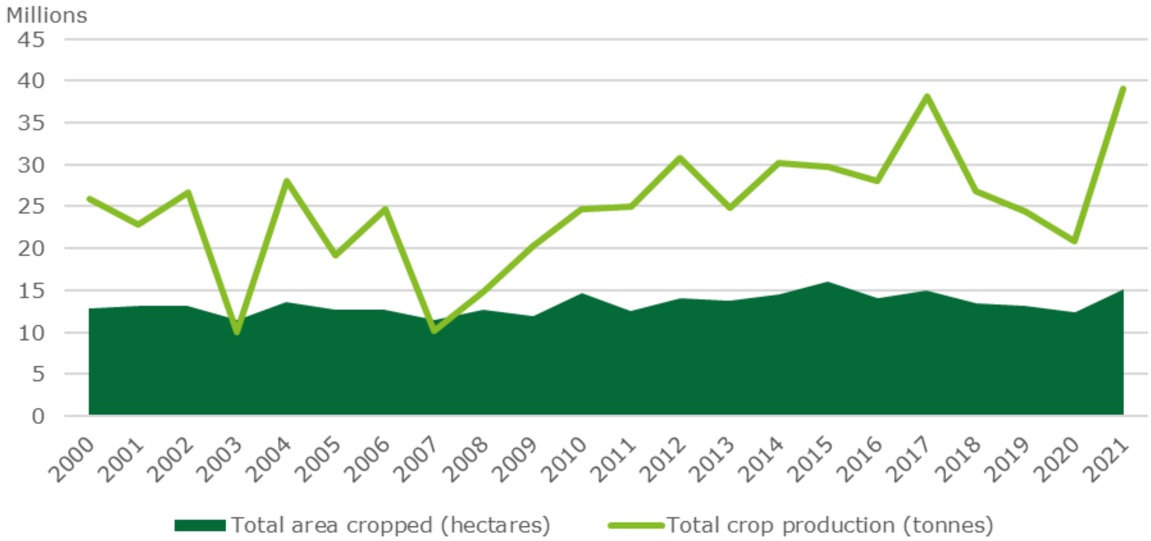
In addition to supply-side shocks, heightened demand for CPPs since 2020 have also placed upward pressure on CPP prices, and in turn, aggregate CPP sales value. Two primary demand drivers discussed below are favourable seasonal conditions and historically high prices for broadacre crop commodities.

2.5.2.1 Wetter seasonal conditions from 2020-2022

Above-average rainfall recorded across much of Australia from 2020-2022 increased variables such as weed growth, disease pressure, areas cropped and crop yield potential, all collectively acting to fuel strong demand for CPPs over the period. Three consecutive La Nina events, combined with a negative Indian Ocean Dipole in the winter and spring of 2022, and a persistently positive phase of the Southern Annular Mode from mid-autumn onwards were the main climate influences of wetter conditions.[xvi] In 2022, nationally averaged rainfall was 26 per cent above the 1961-1990 average at 587.8mm, while rainfall was very much above average for key cropping and horticulture regions in the south-eastern quarter of the mainland (Figure 2.2).[xvii]

It is likely that farmers increased use of CPPs over this period to take advantage of more favourable seasonal conditions to sow more areas and produce higher yields, as well as sowing more land into crop. Chart 2.4 shows total broadacre cropped area rebounded from 13.2 million hectares during the drought year of 2019 to 15.1 million hectares in 2021. Accordingly, aggregate broadacre crop production (grains and oilseeds) jumped from 24.3 million tonnes in 2019 to 39 million tonnes in 2021.

Chart 2.4: Total area cropped and total crop production, Australia, 2000-2021

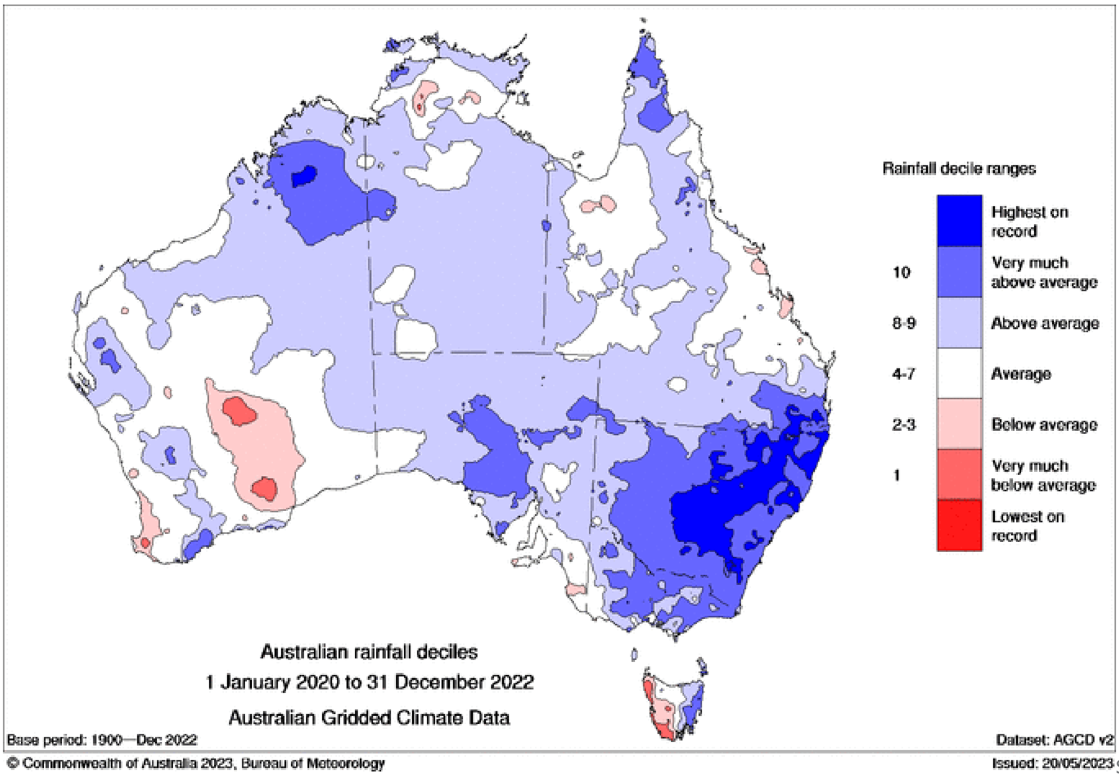


Source: ABARES

Note: Data pertains to the 'wheat and other crop' industry.

Greater demand for CPPs also would likely have stemmed from increased weed and disease pressure due to wetter conditions. Strong La Niña conditions particularly during the winter and spring of 2022 contributed to greater incidence of disease in crops, such as fungal diseases, which stimulated sales of post-emergent fungicides to reduce impact on yield and quality. Weed pressure was also elevated, resulting in higher demand for pre- and post-emergent herbicides. While generally wetter seasonal conditions likely contributed to greater demand for CPPs (and indirectly higher prices) over the last 2-3 years, the end of La Nina and possible declaration of El Niño in 2023 could result in CPP demand returning to more normal long-run levels, or even be temporarily lower should drought conditions prevail.[xviii]

Figure 2.2: Australian Rainfall deciles, 2020-2022



Source:

Source: Bureau of Meteorology (2023)

2.5.2.2 Strong commodity prices

Despite recent elevated prices for CPPs, high agricultural commodity prices (particularly grains and oilseeds) and robust demand for Australian agricultural production has further supported expenditure on CPPs. The disruption of Ukrainian exports of cereal crops in early 2022, combined with drought conditions in some northern hemisphere cropping regions pushed grain and other commodity prices to highest-on-record levels (Chart 2.5).[xix] Historically high prices across a range of commodities enabled farmers to increase crop planting and CPP use while maintaining or increasing profitability. Agricultural commodity prices have since eased with resumed trade flows from Ukraine and increased southern hemisphere production boosting supply.

Chart 2.5: Producer Price Index – Grains

Source: Federal Reserve Economic Data (2023)

2.5.3 Summary of recent market dynamics

The coinciding of demand- and supply-side shocks has caused CPP prices (and aggregate expenditure on CPPs) to rise substantially since 2020. On the supply side, sharp increases in energy input prices and manufacturing disruptions reduced supply and increased per-unit production costs. On the other hand, wetter seasonal conditions in Australia from 2020-2022 due to consecutive La Nina events stimulated demand for CPPs, particularly herbicides and fungicides.

The combination of multiple local and global shocks forcing CPP prices to record levels is an exceptional circumstance which is unlikely to reoccur in the short term. The gradual return of global energy prices to more normal levels will reduce pressure on manufacturing costs. Additionally, the predicted occurrence of El Nino in 2023 may reduce weed and disease pressure and therefore dampen demand for CPPs in Australia. CPP prices are therefore likely to moderate in the short- to medium-term.

2.5.4 Market trend: Increasing prevalence of natural CPPs

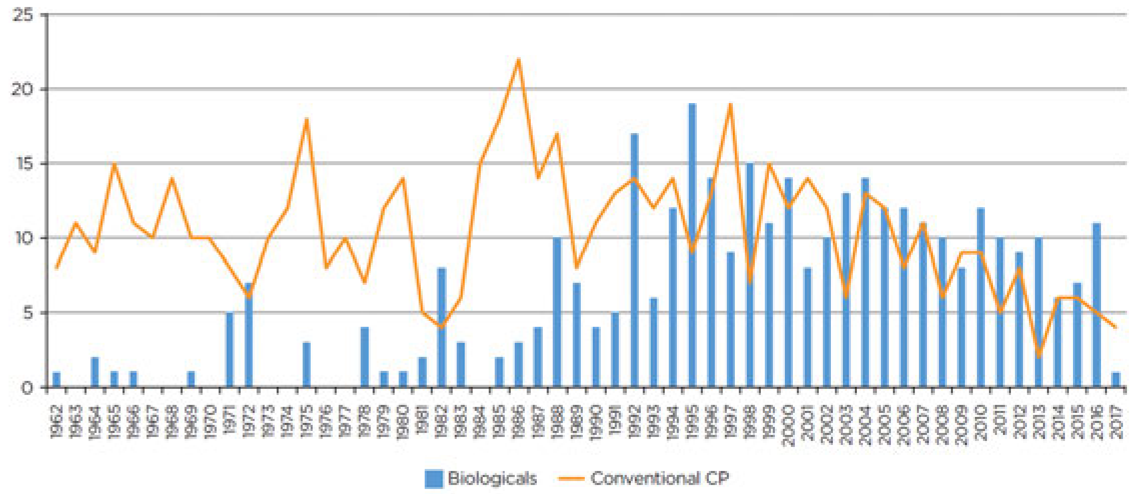
Another recent market trend within the CPP industry is the increasing interest in naturally derived CPPs, also known as biological agricultural products (biologicals), biopesticides, or biocontrol products.[xx] According to the APVMA, a biological product is defined by having an active constituent that is derived from a living organism (plant, animal, micro-organism, etc). There are four main groups of biological products:[xxi]

1. Biological chemicals, which contain naturally occurring substances with indirect toxicity or modifying effects in target species. Substances include potassium carbonate, phosphorus acids, pheromones for insect mating disruption, enzymes and vitamins.
2. Plant and other extracts, including botanic oils.
3. Microbial agents, including bacteria, insect viruses, fungi, actinomycetes, protozoa, etc. that function as bio-control agents, affect the target species directly or indirectly through the compounds they produce.
4. Other living organisms, including microscopic insects, plants and animals, as well as some organisms that have been genetically modified.

Biologicals are associated with several advantages relative to chemical CPPs. Notwithstanding some challenges discussed shortly, they can help improve crop yield and quality when used in addition to synthetic CPPs, although efficacy is highly location-specific. This is partly because of improved resistance management, as biologicals have different modes of action to chemical CPPs.[xxii] Another advantage is related to their safety of use in agroecosystems. Biologicals generally only affect the target pests or plant pathogens, and pose little to no risk to birds, fish, beneficial insects, pollinators, mammals, and other non-target organisms. They pose minimal risks to workers, and as readily biodegradable products, do not pollute air and water.[xxiii]

The rate of introduction of biological products has grown significantly since 1960 (Figure 2.3).Over the last 20 years, the rate of new biological product introduction has frequently exceeded that of conventional products. Increasing interest in biologicals has in part been encouraged by a less demanding regulatory process faced by manufacturers, the growth of integrated pest management (IPM) approaches (discussed further in Section 3.5.1), and farmers' demand for a more diverse range of tools to manage insects and disease. Other drivers include restrictions on chemical pesticides, increasing incidence of pesticide resistance, and residue management.[xxiv]

Figure 2.3: Annual new product introduction for biological products and conventional CPPs



Source: Phillips McDougall (2018)

Commercially available biological crop protection product – NPV

Nucleopolyhedrovirus (NPV) is a commercially available biopesticide used to manage the Helicoverpa and Heliothis species of insects in a variety of field crops, including sorghum, chickpeas, cotton and maize. NPV is a virus which occurs naturally in the Australian environment. It was first available to Australian farmers in the 1990s, however subsequent research has produced newer products that utilise the local virus strain.

The virus works by infecting and killing the larvae of target pests following ingestion of the virus particles. Commercial NPV products only kill target species, and do not harm other insects, wildlife or humans. Insect resistance to insecticides and greater understanding of integrated pest management (IPM – see Section 3.5.1) is leading to increased use of technologies such as NPV in Australian agriculture.

However, there are challenges to the uptake of biologicals. Biological products are best integrated into crop production and pest management programs, rather than used as complete substitutes for synthetic CPPs. A lack of awareness and understand in how to deploy the unique modes of action of biological CPPs in integrated programs can be a barrier for farmers. Perceptions (whether real or not) of higher cost and lesser efficacy also exist.[xxv] Consequently, the biological share of the overall global CPP market is small, around US$3-4 billion of the US$61.3 billion CPP market.[xxvi] Despite these challenges, the growth of biological products is projected to outpace that of chemical CPPs in coming decades.[xxvii]

3 Australian crop production attributable to CPPs

This chapter presents the methodology and estimation of the Australian crop production attributable to CPPs. This estimate is conceptually different to the contribution to GDP discussed in the previous chapter. This chapter highlights the value of the *output* of crop production that is attributable to CPPs, as distinct from the contribution to GDP of the previous chapter. For many agricultural crops (particularly some horticultural and tree crops) it would not be possible to produce a crop without the use of CPPs, for other crops yields would decline without the use of CPPs. The estimate of crop production attributable to CPPs captures this reality.

Importantly, the value of crop production attributable to CPPs is not the same as the 'economic impact' that would occur in a scenario where all CPPs became unavailable – such a scenario may involve changes in behaviour and changes in farm practices that partly offset the absence of CPPs. Rather, this report estimates the current production attributable to CPPs (in 2020-21[5]) based on current farm practices.

The methodology for estimating the contribution of CPPs is based on work by Mark Goodwin Consulting (2011) and the scientific literature on attributions of different crops that underpinned that report. The report was commissioned by CropLife America, and detailed the value of selected crops attributable to CPPs (specifically herbicides, insecticides and fungicides). This methodology is a replication of previous iterations to allow for consistency and a time series comparison of results. An update of the literature on this topic since the last estimate was developed is also discussed. Note that this method captures most of the value of CPPs to agriculture, but not all. Importantly it doesn't capture the use of CPPs in the livestock industry, most notably through the use of herbicides in pasture management.

Deloitte Access Economics has adjusted previous estimates of the contribution of CPPs to the production of different crops in the USA to reflect salient features of Australian production practices. Differences in crop mix between the USA and Australia also impact the value of Australian crop production attributable to CPPs. Each of these is discussed in Sections 3.1 and 3.2. The value of CPPs to Australian crop production in 2021-22 is discussed in Section 3.3.

3.1 The Island Factor

The Australian and American cropping industries utilise different agricultural systems and practises due to a number of factors:

- Australia is an island continent – Geographic isolation from other countries and a rigorous quarantine system limit the prevalence of overseas crop pests and diseases. On the other hand, there are some pests and diseases unique to Australia, such as the native Queensland fruit fly.
- Climate and rainfall – Australia generally has a warmer, drier climate, which affects growth of weeds as well as crops.
- Soils – Australia is an old continent, with soils older and less fertile than those in the USA. This has implications for fertiliser use and plant competition from weeds and hence the use of CPPs.
- Agricultural practices – Minimum tillage and GPS controlled cropping systems have been adopted more quickly in Australia than in the USA (Australian Farm Institute, 2012) which can have an effect on soil-borne pests and diseases and need for pesticides. American agricultural production has a greater penetration of genetically modified crops (such as corn and soy)

[5] ABS crop production data for FY22 and CY22 were available, but not used, due to a reduced set of statistics being available for Australia. This is due to lower quality responses to the Rural Environment and Agricultural Commodities Survey, a major data input to this publication. As such, FY21 data (the latest year with a full set of statistics) were used as the basis for these estimates.

which can reduce the requirement of CPP inputs into these farming systems, particularly where crop varieties are resistant to specific pests and diseases.

- Labour costs – Australian agricultural sector wages are around double those in the United States, which could make farmers more likely to use CPPs in Australia to reduce reliance on labour (Australian Farm Institute, 2012).

An effect of these differences in agricultural industries is different use of CPPs in production. For example, application rates of particular pesticides vary, which entails differences in the use of CPPs per unit of production and per unit of cropping area.

A factor is applied to the USA data to make it applicable to the Australian context. This Island Factor takes into account the differences in crop production outlined above through a ratio comparing CPP use in Australia and the USA. This is summarised in Table 3.1 below.

Table 3.1: The Island Factor, 2016-2021

	Australia	USA
Total CPP use ($m)	3,158	19,682
Total crop area (million ha)	29	396
Total crop production ($m)	32	263
CPP use/ha (AUD/ha)	89	50
CPP use/$ production (USD)	83	75
Island factor (ha)	1.80	
Island factor (production)	1.10	
Average Island Factor	1.45	

Source: APVMA (2022), ABARES (2022) ABS (2022), USDA (2022), UNFAO (2023). Note: All dollar values used have been converted to 2021 Australian dollars.

Note: Data on CPP use is presented in expenditure terms, and therefore does not necessarily reflect the relative volume of CPP used, due to varying prices and disparate product selection across regions.

Data for Australian spend on CPPs, crop area and the value of total crop production was collected for 2013-14 to 2021-22 inclusive. Using the average across these years allows the methodology to account for differences in the use of CPPs across different growing conditions.

All values were converted to USD using yearly average exchange rates to make them comparable across countries. CPP use per hectare and CPP use per dollar of production were then estimated from the above data. Australian CPP use per hectare was divided by American CPP use per hectare to derive an Island Factor of 1.10. Similarly, Australian CPP use per dollar of production was divided by American CPP use per dollar of production to derive an Island Factor of 1.80. The average of these provided an Island Factor of 1.45.

The Australian farming system has been advanced in its adoption of newer farming practices that maximise soil moisture[xxviii] and reduce soil erosion. This has included the adoption of no-tillage and minimum tillage technologies that are enabled through the use of chemical weed control. The adoption of chemical weed control has also been incentivised as a way for Australian farmers to manage labour shortages and relatively high labour costs[xxix] compared to international competitors.

As discussed in the following section, the relative crop mix also affects the use of pesticides in agriculture, with horticulture representing a greater proportion of production Australia compared to the USA.

The Island Factor used in this report is equivalent to the value of 1.45 calculated for use in the 2018 report. However, the per-hectare component of the Island Factor has increased, while the per-dollar value has decreased.

3.2 The crop mix

In addition to the differences accounted for in the previous section, the Australian crop mix also differs from production in the USA. To some degree, the factors outlined above affect the relative proportions of crops produced in both countries.

Crops can be categorised into four broad categories:

- broadacre crops;
- vegetables;
- fruits and nuts; and
- other crops (mostly forage crops produced for livestock consumption).

The relative proportions of these crop groups have implications for the contribution of CPPs. In particular, higher applications of CPPs are generally used in high-value horticultural production compared to broadacre cropping. The Australian crop mix has a higher share of horticultural production compared to the USA (Table 3.2).

The share of production attributable to CPP use varies among individual crops within each category. For example, the proportion of production attributable to CPPs is higher for potatoes than it is for barley. These differences are accounted for in the calculation of the proportion of the total value of production of each broad category attributable to CPP use.

Table 3.2: Crop production mix, Australia and USA (A$m)

	Australia (2020-21)		USA (2021)	
Crop type	A$m	%	US$m	%
Field crops (broadacre)	22,948	53.1%	213,003	83.2%
Vegetables	6,900	16.0%	30,163	11.8%
Fruit and nuts	11,070	25.6%	12,974	5.1%
Other crops	2,293	5.3%	-	-
Total crops	43,211	100.0%	256,139	100.0%

Source: ABARES (2022), USDA (2022).

3.3 Value of CPPs to Australian crop production

Gianessi (2005, 2006 and 2009) conducted a series of studies on the contribution of fungicides, herbicides, insecticides to crop production in the USA. These studies presented data by crop, for the share of value attributable to each CPP. A summary of this data is provided at Appendix A.

Mark Goodwin Consulting combined the findings of these studies in their 2011 report to provide an overall estimate of the contribution of CPPs for the USA. This was done by adding the herbicide, insecticide and fungicide percentage contributions to provide a total CPP contribution. These totals were capped at 100 per cent even if the sum of herbicide, insecticide and fungicide contributions exceeded this amount.

For this study, the crops were split into the four crop categories of: field crops, vegetables, fruit and nuts, and other crops. Average herbicide, insecticide and fungicide contributions to the production for each crop category were then estimated based on the mix of individual crops. This is separately described for each crop group below.

These averages were then multiplied by the Island Factor to determine the Australian contribution to production. Finally, these contributions were multiplied by the value of crop production in the four groups (field crops (broadacre), vegetables, fruit and nuts, and other crops) to calculate the value of Australian crop production attributable to CPP use.

Field crops (broadacre)

Field crops include barley, canola, cotton, sorghum, sugarcane and wheat, among other crops. The full list of crops in this category is shown in Appendix A.

Within this category of crops, the proportion of value attributable to herbicide ranges from 16 per cent for sunflowers up to 53 per cent for rice. Overall, corn and sorghum are relatively hardy, with a smaller proportion of total production being attributable to CPPs (23 per cent and 34 per cent of value attributable to CPPs, respectively).

The value contribution of herbicide, insecticide and fungicide was estimated based on data from Gianessi (2005, 2007 and 2009), weighted for the Australian crop mix by value of production. Wheat and sugarcane combined make up over half of the value of these broadacre crops in Australia.

Adjusting for differences in use of CPPs in Australian agriculture, these weighted average contributions were then multiplied by the Island Factor. This produces an overall contribution to the value of Australian broadacre production of 54 per cent. Herbicides make up more than half of this, with a contribution of 35 per cent of crop value. In dollar terms, the contribution of CPPs to Australian broadacre production is estimated at $12.3 billion.

Table 3.3: Australian field crop production attributable to CPP use

	Herbicide	Insecticide	Fungicide	Total CPP
Weighted average contribution (%)	24%	6%	11%	39%
Australian contribution (%)	35%	9%	16%	54%
Value to Australia ($m)	7,141	1,914	3,236	12,292

Source: Mark Goodwin Consulting 2011, Deloitte Access Economics, ABS, ABARES.

Vegetables

Crops included in this category include broccoli, carrots, lettuce and onions, with a full list included in Appendix A. For the purposes of estimation, herbs have been included in this category.

Vegetable crops have a relatively high dependence on CPPs, in particular fungicides. Onions, for example, attribute 100 per cent of their production to fungicides, and CPPs account for 95 per cent and 92 per cent of crop value for carrots and celery respectively. That is, these vegetables would be very difficult to grow commercially without the use of CPPs.

In the absence of sufficiently detailed data to weight the mix of vegetable crops by value or volume of Australian production, an average was taken of the contribution of herbicides, insecticides and fungicide contributions for the range of crops analysed by Gianessi (2005, 2006 and 2009).

The contribution of each type of CPP to vegetable production was calculated by multiplying the total value of vegetable production by the average percentage of production attributable to CPP use across the range of crops for which Giannessi provided estimates (multiplied by the Island Factor).

Calculating the contribution of CPP use as a whole to vegetable production first requires summing the percentage of production attributable to each CPP category, which in many cases is greater than 100 per cent. The simple average of these is taken, which equals 83 per cent, and then multiplied by the Island Factor of 1.45 to calculate the contribution of CPP use as a whole to Australian vegetable production.

Using this method produces the result that 100 per cent of Australian vegetable production – $6.9 billion in 2020-21 – is attributable to the use of CPPs. The increase over the estimate produced for

2015-16 is solely due to the increase in the value of vegetable production (because, as in the 2018 analysis, 100 per cent of the value of vegetables is attributed to the use of CPPs).

Along with CPPs, vegetables also require water, labour and land to produce a crop. The use of (say) water could also be attributed with 100 per cent of onion output, as without water there would be no production. As such, the estimates here should be interpreted as the amounts of production attributable to CPPs, assuming all other requisites for production (water, labour, etc.) are readily available.

Table 3.4: Australian vegetable production attributable to CPP use

	Herbicide	Insecticide	Fungicide	Total CPP
Weighted average contribution (%)	21%	34%	54%	83%
Australian contribution (%)	30%	49%	78%	100%
Value to Australia ($m)	2,059	3,379	5,385	6,900

Source: Mark Goodwin Consulting 2011, Deloitte Access Economics, ABS, ABARES, IBISWorld.

Fruits and nuts

The fruits and nuts category includes apples, almonds, bananas, grapes, oranges and peanuts among others. The full list is presented in Appendix A.

Similar to vegetables, the value of fruits and nuts are more dependent on fungicides than other CPPs, and have a relatively small contribution from herbicides. Grapes and papaw are particularly reliant on fungicides, with 100 per cent of their value attributed to their use according to the Gianessi estimates. Peanuts and almonds attribute 92 per cent and 70 per cent of production to fungicide use, respectively.

The weighted average contribution of herbicides, insecticides and fungicides was estimated using data on the value of production of the relevant crops. This is preferred to the approach of using a weighted average based on volume (which had to be used in the 2013 report due to insufficient value data) or a simple average (which has been used for vegetables due to insufficient volume or value data).

Multiplying by the Island Factor provides the estimate for the contribution of CPPs to Australian crop production. While fungicide alone accounts for 100 per cent of fruits and nuts production on average, and the contribution of all CPPs is capped at 100 per cent, herbicides and insecticides also contribute to the value of production.

As with vegetables, 100 per cent of the value of fruit and nuts production is attributed to the use of CPPs under the methodology used. This is primarily due to the important role of insecticides in the production of a number of major crops, including apples and grapes.

The total value of CPP use on fruits and nuts production in Australia is estimated to be valued at $11.1 billion (the total value of fruit and nut production). As with vegetables, the increase over the figure in 2013 is entirely due to the increase in the value of fruit and nut production.

Table 3.5: Australian fruit and nut production attributable to CPP use

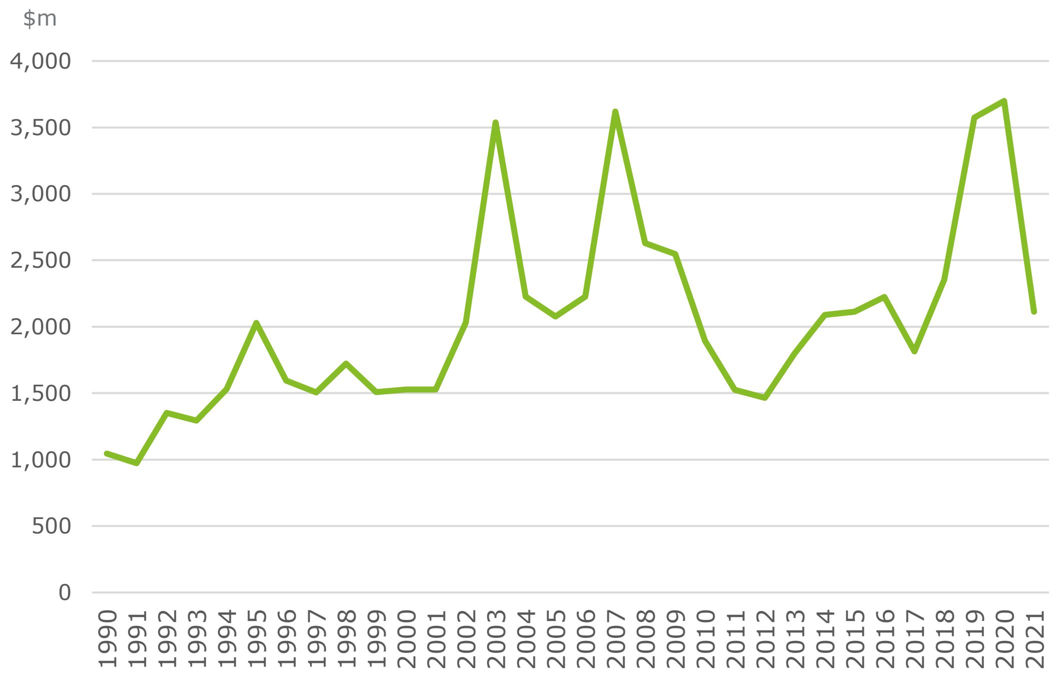
	Herbicide	Insecticide	Fungicide	Total CPP
Weighted average contribution (%)	7%	46%	75%	93%
Australian contribution (%)	10%	67%	100%	100%
Value to Australia ($m)	1,052	7,387	11,070	11,070

Source: Mark Goodwin Consulting 2011, Deloitte Access Economics, ABS, ABARES, IBISWorld.

Other crops

This category of crops is mainly comprised of forage crops; those grown to be grazed directly from the field by livestock, or harvested and conserved as hay or silage. These crops support a broad range of livestock production, including dairy cattle, beef, lamb and white meat – particularly in drought years where availability of pasture is limited. As shown in Chart 3.1, spending on fodder across Australian farms can vary significantly from year to year, and has reached over $3.5 billion in recent dry years.

Chart 3.1: Annual fodder costs, all farms, Australia



Source: Australian Bureau of Agricultural Resource Economics and Sciences (2023)

The proportional contribution of CPPs to value of production for these crops is assumed to be the same as for broadacre crops. Adjusting by the Island Factor suggests a contribution of 58 per cent of the value of production. In dollar terms, this is estimated at $1,300 million, a slight increase over the figure of $934 million estimated in 2018. Note that these figures only capture the value of CPPs to forage crops harvested and sold. It does not capture the value of CPPs to either forage crops grown and consumed on the same farm (i.e without any forage sale), or the wider value of CPPs in pasture management for the livestock industry.

Table 3.6: Australian other crop production attributable to CPP use

	Herbicide	Insecticide	Fungicide	Total CPP
Weighted average contribution (%)	24%	6%	11%	39%
Australian contribution (%)	35%	9%	16%	57%
Value to Australia ($m)	798	214	362	1,300

Source: Mark Goodwin Consulting 2011, Deloitte Access Economics.

3.4 Results summary

The total value of CPPs to Australian crop production is calculated as the sum of their contribution to each of the four categories of crops discussed in Section 3.3.

In aggregate, it is estimated that $31.6 billion of cropping production is attributable to the use of CPPs, or 73 per cent of the total value of crop production in 2020-21. Over half of this contribution is from fungicides, reflecting their significant contribution to the production of vegetables, fruit and nuts. This is equivalent to the 73 per cent estimated in 2015-16. A summary of the results discussed in Section 3.3 is shown in Table 3.7.

Table 3.7: Australian crop production attributable to CPP use

	Herbicide	Insecticide	Fungicide	Total CPP	% of total
Field crops (broadacre) ($m)	7,141	1,914	3,236	12,292	53.7%
Vegetables ($m)	2,059	3,379	5,385	6,900	92.0%
Fruit and nuts ($m)	1,052	7,387	11,070	11,070	93.5%
Other crops ($m)	798	214	362	1300	56.7%
Total ($m)	**11,050**	**12,894**	**20,053**	**31,562**	**73.0%**

Source: Mark Goodwin Consulting 2011, Deloitte Access Economics.

Note: Subtotals do not add to total due to the use of multiple CPPs in some crops.

The value of Australian crop production attributable to CPPs in 2021 is 53 per cent higher than the equivalent that was calculated for 2015-16. This result is primarily driven by an increase in the value of production (58% higher than 2015-16).

3.5 Additional research relating to CPP attributable production

Various crop protection technologies have had a considerable influence on long-term agricultural production in Australia and overseas. Synthetic and non-synthetic products have enabled significant gains in agricultural productivity, and are the dominant tool for maintaining consistently high yields in the absence of alternative farming systems or methods.[xxx] CPPs are often the first line of defence against insects and diseases that can damage crops, and generally contribute to higher crop yields at a lower cost to farmers. Without CPPs or other integrated strategies (outlined in 3.5.1 below), farmers could face challenges in managing pests and diseases that reduce crop yield and quality.

The importance of CPPs to crop production and supply is not limited to the farming process, as the integrity of crop quality needs to be maintained after harvesting. There is evidence to suggest that throughout the entirety of agricultural production and storage, pests (including invertebrates, weeds, and plant pathogens) cause nearly 40 per cent of global crop yield loss, with a further 20 per cent destroyed by postharvest pests and diseases.[xxxi] Natural disasters including flooding and drought, labour shortages and changing commodity prices are other factors that contribute to crop losses and waste.[xxxii]

In the Australian context, limited empirical literature presents differing outcomes for farm production and profitability resulting from CPPs no longer being available. A 2021 study estimated the economic impacts of the loss of herbicides glyphosate and paraquat on mixed-enterprise farms in the Central Wheatbelt region of Western Australia. The results showed that there would be a decline in farm profits if these herbicides were unavailable, and the average Central Wheatbelt farm could lose as much as $250,000 in revenue per year.[xxxiii] Another study used a bioeconomic model to simulate crop yields and profitability generated by southern Australian cropping farms in the context of no glyphosate use.[xxxiv] In contrast to the 2021 study, the model showed that it is possible to maintain crop yields and profitability without glyphosate. The authors emphasised that various cultural management practices appropriately tailored to specific agricultural contexts, for example early seeding, and strategic use of mechanical weed control to minimise detrimental soil disturbance are necessary in the absence of glyphosate use prior, during and after cropping. The divergent outcomes predicted in the literature suggests that the loss of key CPPs such as herbicides could present challenges to productivity and profitability of magnitude that differs across regions.

The impact of reduced CPP use on the agriculture sector has also been estimated in other markets. In response to incoming legislation restricting the use of certain pesticides in Europe, studies have measured the potential impact on the European agriculture industry and international trade. One study reported a potential decline in agricultural production of seven per cent globally to 12 per cent in the EU. This decline would tighten the food supply, and consequently would see a rise in household consumer spending. This was also found to exacerbate international food insecurity.[xxxv] While there is limited academic literature mirroring these tests in an Australian context, it does illustrate the potential disruptions to the industry that could occur without CPP use.

3.5.1 Emerging trends: agroecological systems and CPP use

Despite the dominance of CPPs in modern Australian agriculture, alternative agricultural systems which use CPPs more strategically (or in some cases, not at all) to produce food and fibre have existed since the early 20th Century.[xxxvi] Interest in such systems has grown over the past five to ten years, in part due to the recent increase in prices for CPPs and mineral fertilisers[xxxvii] (See Section 2.5), greater focus on the environmental sustainability of agricultural production,[xxxviii] as well as farmers' demand for a more diverse toolkit to deal with insect, weed and disease issues.[xxxix]

One such system is Integrated Pest Management (IPM).[6] The United Nations Food and Agriculture Organisation (UNFAO) defines IPM as 'the growth of a healthy crop with the least possible disruption to agroecosystems and encourages natural pest control mechanisms, and only using pesticides when needed'.[xl] It focuses on managing insects, weeds and diseases through a combination of cultural, physical, biological and chemical methods that are cost effective, environmentally sound and socially acceptable. It is important to note that IPM involves the careful consideration of all pathogen management techniques, including chemical and biological products (Section 2.5.4), and subsequent integration of appropriate measures.[xli]

A diverse range of practices are used under IPM to manage insect and weed pressure while reducing reliance on CPPs. In general, practices must be tailored to specific farming contexts, considering the farm enterprise mix, climate, soil type, topography, as well as the goals of the farm manager (or enterprise). In relation to weeds, practices such as planting multi-species cover crops can help reduce summer weed burdens and reduce reliance on herbicides for winter crop weed control, particularly in summer-dominant rainfall regions such as northern NSW.[xlii] Higher summer rainfall means the risk of reducing starting soil moisture in the winter crop phase is lower, relative to winter-dominant or indeterminate rainfall regions. Summer cover crops have also been evaluated in the Central West region of NSW which is more winter rainfall-dominant. The primary advantage described by Department of Primary Industries (DPI) researchers pertaining to CPP use was reduced herbicide applications over the summer fallow due to lower weed burdens. This was somewhat offset by the high herbicide rate required to terminate the cover crop and establish the following winter crop. Additionally, the risk of starting soil moisture deficiency (and therefore yield penalty) in the Central West region is higher, relative to aforementioned summer rainfall-dominant areas.[xliii] Findings from field trials underscore the importance of context when implementing IPM strategies to manage weeds, insects and diseases.

Furthermore, the biological management of plant diseases is also becoming increasingly recognised as a viable broadacre disease management tool. Promoting diversity of beneficial soil microbiota can help to increase plant health and resilience against disease, and therefore the need for fungicide applications.[xliv] Additionally, integrating livestock such as sheep and cattle into cropping-only systems can help to reduce grassy and broadleaved weeds, reduce herbicide use, and enhance nutrient cycling which benefits crop nutrition.[xlv] The use of 'virtual fencing' to allow grazing in discrete spatial areas (particularly those with high weed burdens) has been trialled by the CSIRO. The results from one trial in South Australia showed that strip-grazing using virtual fencing more than halved the amount of ryegrass seed heads compared to the paddock grazed

[6] There are a range of overlapping systems, each with similar principles, but differing practices, regulatory framework and academic literatures. They include (but are not limited to) agroecology, precision agriculture, permaculture, organic agriculture, biodynamic agriculture and regenerative agriculture.

without virtual fencing, thereby reducing future weed burden and necessary rates of herbicide use.[xlvi]

Various farm management practices can therefore be used to produce crops whilst reducing (but not necessarily eliminating) CPP use. Such practices are not generalisable across the broad range of enterprise types and climatic zones that characterise the Australian agriculture system, but must be specifically developed to suit particular farming contexts. Notwithstanding these developments in the sector, CPPs remain integral to agricultural production.

4 The broader benefits of CPPs

CPPs offer broader social benefits to Australia outside of the economic and crop production values estimated so far in Chapters 2 and 3.

For the purposes of this report, the wider benefits of CPPs are split into four categories: community benefits, environmental protection and climate benefits, food security and biosecurity, and the spillover benefits from Australia's scientific research and development in the CPP space.

While discussed in these distinct headings, these benefits are interrelated. For example, advances in scientific research and development will lead to benefits in food security, environmental protection, and to communities, while the benefits of environmental protection also have a positive externality on communities (and vice versa).

This analysis does not provide a monetary valuation of these benefits but provides a tangible understanding of the broader gains to Australia through CPP use. Furthermore, this chapter does not consider or compare the relative magnitudes of costs in relation to these benefits. For example, costs to the environment and potential health implications of their use are not covered in this report.

4.1 Community benefits from non-agricultural uses

Approximately 15 per cent of all CPPs are used by households, local councils and other non-agricultural users.[xlvii] Primarily, households use CPPs for gardening and lawn maintenance purposes. Other non-agricultural users include sporting facilities (golf courses, football ovals etc) and local government bodies, who use CPPs to control weeds and other invasive species.

Cooper and Dobson[xlviii] provide a comprehensive overview of benefits of non-agricultural use of CPPs. They contend that pests can have a negative impact on human activity, infrastructure, and the materials of everyday life unless they are controlled (by CPPs or other techniques).

CPP use on public council areas helps to provide secondary benefits to local community through the maintenance and accessibility of urban facilities and green spaces, which have been found to reduce stress and improve quality of life.[xlix]

Urban environments can influence the health of its residents through providing exercise and recreation areas that are accessible and neatly maintained. Herbicides are utilised by local councils to ensure that community facilities remain unspoiled from weeds.[l] For example, railways can be susceptible to weeds, and keeping tracks free of weeds is required to maintain good traction and braking distance of trains on the tracks. In Australia, Horticulture Innovation has established a Green Cities Fund which is undertaking research into science-based solutions to incorporating green spaces into urban development. Given the unique constraints of urban environments, CPPs could help ensure the establishment and ongoing maintenance of any urban greening initiatives.[li]

Households primarily implement CPPs for gardening and lawn maintenance. Urban and rural gardens play an important role in human wellbeing and sustainable urban development. Gardening is often cited as a beneficial activity as it combines physical activity with exposure to nature and sunlight.[lii] Increased gardening and greenspaces in urban areas can contribute to lower energy usage as more shade is planted and can also have a positive impact on local biodiversity and at-home food production.[liii] Having access to house-hold friendly herbicides and pesticides is essential for sustainable gardening by households and communities. The use of CPPs by governing bodies, communities and households can positively contribute to environmental protection and to offset the impacts of climate change in urban areas.

4.2 Environmental Protection and Climate Benefits

The global demand for food will continue increasing and Australia is a key contributor to global food supply chains. The agricultural industry can be a significant emitter, but CPPs can help reduce the impact. CPPs contribute to environmental protection and climate benefits in three ways:

- the benefits gained from reduced tillage practices
- minimising the prevalence of invasive species
- the avoidance of deforested land for agricultural purposes.

The use of CPPs by Australian farming system reduces deforestation in other parts of the world to accommodate the required increase in food production. In turn, this avoids any greenhouse gas emissions and nature loss that would be associated with this land use change around the world.[liv]

Tillage is a method used to prepare soil for planting which can be conducted by digging, stirring, and overturning and often requires machinery. As well as preparing soil for planting, tillage is often used to control weeds in between crops being planted. Conversely, no-till or reduced-till planting is where a new crop is planted directly into where the previous crop was planted, without any ploughing. For no or reduced-tillage practices to be implemented, CPPs such as herbicides are often employed to control weeds in the crops. Australia is one of the leading countries of conservation tillage practices, with 74 per cent of Australia's grain crop area using these practices in 2016.[lv]

There are several benefits of herbicide enabled no-tillage practices, including minimised soil degradation, enhanced water conservation and nutrient retention.[lvi] Herbicide enabled no-till farming has been found to reduce soil erosion by 80 per cent, which consequently protects water quality by preventing sediment run-off.[lvii] Another key benefit is that it can lead to fewer greenhouse gas emissions being released into the atmosphere. This is done through avoiding burning fossil-fuels to power machinery required for tillage, and it also lessens the amount of greenhouse gases that are released from the soil.[lviii] In Australia, there was a significant uptake of minimum tillage practices during the 1990s and 2000s spanning approximately 33.7million hectares of Australia’s croplands. This resulted in approximately 5 million metric tonnes of carbon dioxide being sequestered in the soil annually, relative to what would have occurred if these practices were not implemented.[lix]

Furthermore, research has found that if glyphosate — a commonly used herbicide — use was restricted by farmers, the global environmental impact would be equivalent to adding over 11 million cars to the roads. This is due to the decreased soil carbon sequestration and additional carbon emissions from fuel usage by farm equipment.[lx] This figure is likely to be an underestimate as it pertains only to CPPs which use glyphosate and does not capture the equivalent if use of all CPPs was restricted. In addition, this estimate only considers the use of glyphosate on herbicide tolerant crops. This is a small subset of herbicides applied to crops in Australia, compared to North America where these crops are more widely deployed.

Invasive weeds would have a significant impact on Australian agricultural production if left unmanaged, with research estimating they generate an average annual cost of nearly $5 billion across Australia.[lxi] These weeds can also harm areas that are difficult to quantify such as ecosystems, wildlife and community areas. Invasive species can lead to a loss or alteration of native habitat and even extinction of native species. For example, the Chytrid fungus, which was introduced to Australia in the 1970s, directly contributed to the extinction of four native frog species, and the decline of many others.[lxii] CPPs such as herbicides and fungicides can be used to control the spread of these invasive weed species, helping to preserve Australian crops as well as native flora and fauna.

Case Study – Gamba Grass in the Northern Territory[lxiii]

Gamba grass (Andropogon gayanus) is an African pasture grass that can grow very tall and provides more feed for livestock than native grasses. Gamba grass was introduced to the Northern Territory in 1931 and has since been introduced and naturalised in parts of Queensland and Western Australia. It was declared a Weed of National Significance once it became evident that it was displacing native pasture species, contributing to intense bushfires, and altering soil-nutrient cycles.

Gamba grass is tolerant to fire and infested pastures have up to eight times higher fuel loads than native forest and pastures, and the presence of gamba grass has increased the season of extreme fire weather in the Northern Territory by six weeks. It is particularly prevalent around Darwin where the costs of fire-fighting have increased 9-fold since its introduction. In addition to the fire danger, Gamba grass is a highly invasive species that is displacing existing eucalypts and is dramatically altering native plant communities.

Gamba grass will never be fully eradicated in the Territory, but it can be effectively managed through the application of glyphosate, the only known effective herbicide. While Gamba grass can be removed manually, they have extensive root systems. Physically removing these weeds from the roots can disturb the soil, making it more susceptible to rain and wind erosion. Disturbed soil is often unsuitable for native plant seedlings. Given this, spraying with herbicides is the most effective option for minimising the impact of Gamba grass in national parks and reserves. Other non-chemical methods of control, such as steam spraying, can be used effectively in small areas (such as city recreational facilities) but is not effective when the weed is spread over a larger area, such as farms, nature reserves and national parks.

4.3 Food Security and biosecurity

By 2050, the world population is expected to reach 10 billion people, with a large concentration of them in developing countries. Historical population increases can be partially attributed to the rising availability and stability of global food crops, however, by 2050 it is estimated that the demand for food will be 56 per cent greater than in 2010.[lxiv] Developing countries are also more susceptible to the impacts of climate change, however Australian farmers are not without climate risks themselves. Extreme weather events that are increasing due to climate change bring with them a higher number of agricultural pests. This can be due to changing temperatures and precipitation patterns expanding the geographical distribution of pests and increasing the risk of invasion by migratory pests and the increased incidence of insect-transmitted plant diseases.[lxv] The subsequent losses to crop yields can have drastic impacts on food security. CPPs can help mitigate climate change risks and can also alleviate domestic and global food security pressures.

Given advances in agriculture, over the last century there are fewer individuals farming while producing greater yields. For example, 98 per cent of the population in the USA and Canada relies on the remaining 2 per cent of their population to produce food.[lxvi] CPPs allow for increased productivity per hectare, as they help to eliminate pests and pathogens that contribute to crop losses. Evidence suggests that without implementing CPPs in some key crops, there could be a global decline by 78 per cent in fruit production, 54 per cent in vegetable production, and 32 per cent in cereal production.[lxvii] The use of CPPs is necessary to combat food and nutritional insecurity, especially in the face of climate change impacts to crop yields.

Maintaining Australia’s biosecurity is essential to protect the unique biodiversity in the country, as well as promoting ongoing food security. A biodiverse environment is better suited to withstand pest outbreaks, and Australia’s biosecurity agencies look to protect food crops and livestock from pests as well as protecting ecosystems from invasive species.

Case Study – Sri Lanka's pesticide ban exacerbating food insecurity[lxviii] [lxix]

In April 2021, the Sri Lanka Government imposed a ban on importing and using conventional agricultural chemicals including pesticides. Since the 1960s, Sri Lanka has utilised synthetic CPPs in agricultural production, and this has made the country largely self-sufficient in rice crops. From a food security perspective, being sufficient in a staple crop such as rice is essential. The ban was implemented quickly, and it was not staggered to allow farmers time to switch to non-synthetic CPPs.

A direct result of this ban was increased challenges to purchasing the conventional products that were used in farming inputs. 80 per cent of farmers had to pay higher prices for conventional pesticides and 79 per cent were not able to purchase products at all.[lxix] Consequently, most farmers had to change their existing farming practices. These included reducing the dose rate (which has a direct impact on crop yield) and delaying or bringing forward when these products would be applied to crops.

The swift ban of these products led to a 20 per cent reduction in rice production; and the production of tea (one of Sri Lanka's largest exports) fell by 18 per cent. Overall, there were reports of Sri Lankan farmers losing over half of their normal crop yield throughout the season due to significantly higher weed, disease and pest infestations. Over 80 per cent of farmers reported a higher weed infestation, over 70 per cent noticed higher insect activity and 77 per cent experienced a higher disease infestation in their crops. These were noted across the country and were observed in multiple crops including tea, vegetables and maize.

This decrease in crop yields, in conjunction with other ongoing political and economic factors of the country, led to large inflation of food prices (at around 30 per cent for rice), a decrease in exports, and an increase in food insecurity for the nation, particularly those at the lower end of the income distribution. While some farmers were able to sell their produce at a higher price due to these shortages, it was not enough to offset lower crop yields and higher input costs. The strain was felt across with the sector and 25 per cent of Sri Lankan farmers have noted they would have resigned farming if the ban continued.

The drop in crop yields caused by the lack of CPPs also contributed to high domestic food prices. These high food prices exacerbated existing inflation which was already high due to COVID-19 economic disruptions, high fuel-costs and prevailing political conditions. Food crops that were previously produced locally now needed to be imported, including staple crops like rice. A majority of the country relies on their own agricultural output to meet their daily food requirements as well as for an income stream.

Food inflation reached 95 per cent in September of 2022, ranking Sri Lanka among the top five countries for high food price inflation. This has led to 37 per cent of the Sri Lankan population experiencing food insecurity in August 2022. This figure has since reduced to 32%, but it remains a large increase over the 9 per cent recorded in 2019. To manage this crisis, nearly 80 per cent of households in Sri Lanka are adopting food-based coping strategies as a result which include reducing the number of meals or skipping them entirely. The increasing food insecurity has exacerbated existing inequalities in the country, with poorer households and female-led households being more food insecure on average, largely attributable to their higher reliance on food-based coping strategies.

4.4 Contributions to Scientific Research and Development

Existing CPPs provide a foundation for extensive research on pests and diseases affecting Australian crops. Although the primary objective of CPP development and use is for agricultural productivity (see Section 3), it can also provide spillover benefits to other related industries. For example, CPP research enables innovation in adjacent fields, such as biosecurity and pest control.

Broad use of CPPs has been associated with increased pest resistance, particularly when the same product is used multiple times in the same area.[lxx],[lxxi] Additionally, Australia is one of the countries with the highest cases of herbicide resistant weeds and it is expected that the level of insecticide resistance in major grain growing regions of Australia will increase in the coming years.[lxxii] Consequently, an area of ongoing research globally and within Australia, is the development of alternative CPPs that can replace pest-resistant products. By understanding pest and disease dynamics, researchers can develop new practices. This includes integrated pest management (IPM), which combines a range of practices to control insect pests in agricultural production and innovate new forms of CPPs that can target specific pests while mitigating any negative impacts of chemical use.

There are several research institutions and organisations across the country participating in the conducting or funding the research and development of CPPs. This includes the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Horticulture Innovation Australia, Cotton Research and Development Corporation and the Grains Research and Development Cooperation, who have targeted research and funding areas for key Australian crops such as cotton, grains, and horticulture.[lxxiii] Their research investigates methods to protect these crops as well as native plants from threats from pathogens, pests and weeds, as well as understanding disease resistance genes. The development of innovative practices and CPPs because of this research will have positive contributions to Australia’s environment, food security and agricultural sustainability. Research and development of CPPs is also undertaken at various universities across the country.

The importance of conducting research into CPPs and the adjacent industries (i.e., agriculture) is also felt directly by the research institutions. Conducting this research can create revenue streams that contribute to the overall operation of the institute as well as providing opportunities for innovation and new products and businesses. DemAgtech in Western Australia provides a recent example. A newly established business, DemAgtech have commercialised herbicides that were researched and developed at the University of Western Australia, and aim to continue to develop products that address increasing herbicide resistance in Australia.[lxxiv] This joint venture demonstrates the value and importance of research into CPPs to the wider community as well as various institutions.

Concerns over the negative impacts of chemical CPPs on human health and the environment has encouraged intensive research and development in the CPP industry, spurred by changes in registration requirements of CPPs. For example, the European Union made changes to their registration requirements on active ingredients found in CPPs, and this led to the removal of over half of the CPP active ingredients in the 1990s.[lxxv] There has been a high rate of new biological products being registered as CPPs since the 1960s, and in 2016 there were more patents lodged for biological products compared to conventional CPPs.

Case Study - Australia Research Council Hub: Sustainable Crop Protection and BioClay™

The Australian Research Council supports a research hub focusing on Sustainable Crop Protection, in partnership with Nufarm and The University of Queensland.[lxxvi] The research being conducted aims to develop and commercialise a biological alternative to chemical fungicides that are targeting broad-acre and horticultural crop diseases. This research can address fungicide resistance, chemical residues in food, and environmental harm. Consequently, the broader benefits of this research to the Australian community are immense. By reducing crop losses due to fungal pathogens in an environmentally sustainable way, this can protect Australia's biodiversity as well as increasing crop productivity, reducing the risk of residue remaining on food products, and have positive impacts on domestic and global industries.

While based at the University of Queensland, this ARC Hub has partnerships with universities and research institutes around the country, as well as in the United States. Such partnerships foster knowledge exchange and contribute to advancements in crop protection science and technology, and result in collaboration. For instance, the CPP being developed at this hub, BioClayTM, targets fungal pathogens that affect globally significant crops such as strawberries, grapes, chickpeas, canola, cotton and cereals.[lxxvii] The Tasmanian Institute of Agriculture based out of the University of Tasmania is currently working with BioClayTM to investigate its use in suppressing botrytis disease in wine grapes. If successful, this could hold significance to the wine industry, as it offers growers an innovative alternative to chemical fungicides.[lxxviii] This is just one example of innovation in this space, but it is indicative of the wide-reaching gains that could be harnessed from ongoing research and development of CPPs. The development and findings of this research have the capacity to have a global reach beyond Australia's borders.

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Appendix A : Economic contribution methodology

A.1. Analysis introduction

Economic contribution studies are intended to quantify measures such as value added, exports, imports and employment associated with a given industry or firm, in a historical reference year. The economic contribution is a measure of the value of production by a firm or industry.

All direct, indirect and total contributions are reported as gross operating surplus (GOS), labour income, value added and employment (with these terms defined in Table A.1).

Table A.1: Definitions of economic contribution estimates

Estimate	Definition
Gross operating surplus (GOS)	GOS represents the value of income generated by the entity's direct capital inputs, generally measured as the earnings before interest, tax, depreciation, and amortisation (EBITDA).
Labour income	Labour income is a subcomponent of value add. It represents the value of output generated by the entity's direct labour inputs, as measured by the income to labour.
Value added	Value added measures the value of output (i.e. goods and services) generated by the entity's factors of production (i.e. labour and capital) as measured in the income to those factors of production. The sum of value added across all entities in the economy equals GDP. Given the relationship to GDP, the value added measure can be thought of as the increased contribution to welfare.
Employment (FTE)	Employment is a fundamentally different measure of activity to those above. It measures the number of workers (measured in full-time equivalent terms) that are employed by the entity, rather than the value of the workers' output.
Direct economic contribution	The direct economic contribution is a representation of the flow from labour and capital committed in the economic activity.
Indirect economic contribution	The indirect contribution is a measure of the demand for goods and services produced in other sectors as a result of demand generated by economic activity.
Total economic contribution	The total economic contribution to the economy is the sum of the direct and indirect economic contributions.

Source: Deloitte Access Economics, 2018

A.2. Definitional notes

When calculating the GOS for a typical for-profit firm or industry, income streams from government (such as transfers or production subsidies) are excluded as they are a transfer of public funds, not reflective of income generated by the activities of the firm or industry.

Similarly, value added is typically calculated as GOS plus labour income net of subsidies; under the ABS Australian System of National Accounts (ASNA) (ABS 2013):

> *A subsidy on a product is a subsidy payable per unit of a good or service. An enterprise may regard a subsidy as little different from sales proceeds. However, in the national accounts, subsidies are regarded as transfer payments from general government, enabling enterprises to sell their output for less than would otherwise be the case.*

A.3. Value added

The measures of economic activity provided by this contribution study are consistent with those provided by the Australian Bureau of Statistics. For example, value added is the contribution the sector makes to total factor income and gross domestic product (GDP).

There are a number of ways to measure GDP, including:

- expenditure approach – measures expenditure: of households, on investment, government and net exports; and
- income approach – measures the income in an economy by measuring the payments of wages and profits to workers and owners.

Below is a discussion measuring the value added by an industry using the income approach.

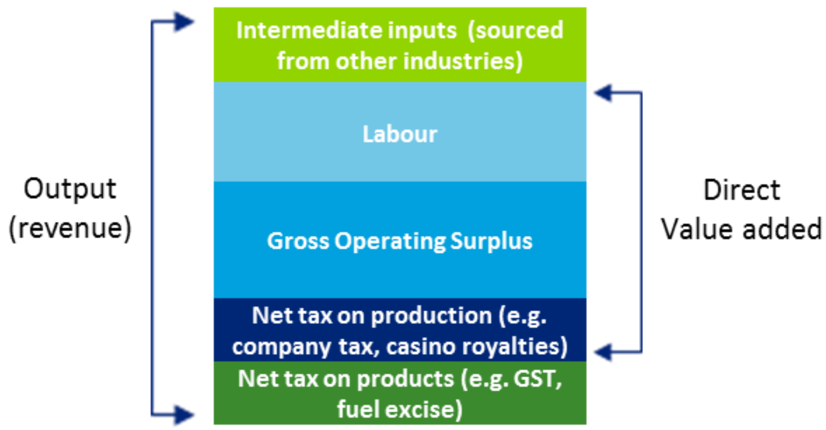
A.4. Measuring the economic contribution – income approach

There are several commonly used measures of economic activity, each of which describes a different aspect of an industry's economic contribution:

- Value added measures the value of output (i.e. goods and services) generated by the entity's factors of production (i.e. labour and capital) as measured in the income to those factors of production. The sum of value added across all entities in the economy equals gross domestic product. Given the relationship to GDP, the value added measure can be thought of as the increased contribution to welfare.
  Value added is the sum of:
  - Gross operating surplus (GOS) represents the value of income generated by the entity's capital inputs, generally measured as the earnings before interest, tax, depreciation and amortisation (EBITDA).
  - Tax on production less subsidy provided for production. Note: given the manner in which returns to capital before tax are calculated, company tax is not included or this would double-count that tax. In addition it excludes goods and services tax, which is a tax on consumption (i.e. levied on households).
  - Labour income is a subcomponent of value added. It represents the value of output generated by the entity's direct labour inputs, as measured by the income to labour.

Figure A.1 shows the accounting framework used to evaluate economic activity, along with the components that make up output. Output is the sum of value added and the value of intermediate inputs used by the firm or industry. The value of intermediate inputs can also be calculated directly by summing up expenses related to non-primary factor inputs.

Figure A.1: Economic activity accounting framework



Source: Deloitte Access Economics.

Contribution studies generally outline employment generated by a sector. Employment is a fundamentally different measure of activity to those above. It measures the number of workers that are employed by the entity, rather than the value of the workers' output.

A.5. Direct and indirect contributions

The direct economic contribution is a representation of the flow of labour and capital to businesses in the CPP industry.

The indirect contribution is a measure of the demand for goods and services produced in other sectors as a result of demand generated by the direct economic activity of the CPP industry. Estimation of the indirect economic contribution is undertaken in an input-output (IO) framework using Australian Bureau of Statistics IO tables which report the inputs and outputs of specific sectors of the economy (ABS 2023).

The total economic contribution to the economy is the sum of the direct and indirect economic contributions.

Other measures, such as total revenue or total exports are useful measures of economic activity, but these measures alone cannot account for the contribution made to GDP. Such measures overstate the contribution to value added because they include activity by external firms supplying inputs. In addition, they do not discount the inputs supplied from outside Australia.

A.6. Limitations of economic contribution studies

While describing the geographic origin of production inputs may be a guide to a firm or industry's linkages with the local economy, it should be recognised that these are the type of normal industry linkages that characterise all economic activities.

Unless there is unused capacity in the economy (such as unemployed labour) there may not be a strong relationship between a firm's economic contribution as measured by value added (or other static aggregates) and the welfare or living standard of the community. The use of labour and capital by demand created from the industry comes at an opportunity cost as it may reduce the amount of resources available to spend on other economic activities. This is not to say that the economic contribution, including employment, is not important. As stated by the Productivity Commission in the context of Australia's gambling industries: (Productivity Commission 1999):

> *Value added trade and job creation arguments need to be considered in the context of the economy as a whole … income from trade uses real resources, which could have been employed to generate benefits elsewhere. These arguments do not mean that jobs, trade and activity are unimportant in an economy. To the contrary they are critical to people's well-being. However, any particular industry's contribution to these benefits is much smaller than might at first be thought, because substitute industries could produce similar, though not equal gains.*

In a fundamental sense, economic contribution studies are simply historical accounting exercises. No 'what-if', or counterfactual inferences – such as 'what would happen to living standards if the firm or industry disappeared?' – should be drawn from them.

The analysis – as discussed in the report – relies on a national IO table modelling framework and there are some limitations to this modelling framework. The analysis assumes that goods and services provided to the sector are produced by factors of production that are located completely within the state or region defined and that income flows do not leak to other states.

The IO framework and the derivation of the multipliers also assume that the relevant economic activity takes place within an unconstrained environment. That is, an increase in economic activity in one area of the economy does not increase prices and subsequently crowd out economic activity in another area of the economy. As a result, the modelled total and indirect contribution can be regarded as an upper-bound estimate of the contribution made by the supply of intermediate inputs.

Similarly the IO framework does not account for further flow-on benefits as captured in a more dynamic modelling environment like a Computerised General Equilibrium (CGE) model.

A.7. Input-output analysis

Input-output tables are required to account for the intermediate flows between sectors. These tables measure the direct economic activity of every sector in the economy at the national level. Importantly, these tables allow intermediate inputs to be further broken down by source. These detailed intermediate flows can be used to derive the total change in economic activity associated with a given direct change in activity for a given sector.

A widely used measure of the spill-over of activity from one sector to another is captured by the ratio of the total to direct change in economic activity. The resulting estimate is typically referred to as 'the multiplier'. A multiplier greater than one implies some indirect activity, with higher multipliers indicating relatively larger indirect and total activity flowing from a given level of direct activity.

The IO matrix used for Australia is derived from the ABS 2020-21 IO tables, the latest available IO data at the time of the analysis. The industry classification used for IO tables is based on the Australian and New Zealand Standard Industrial Classification (ANZSIC), with 114 sectors in the modelling framework.

A.8. Change in methodology from previous reports

The methodology employed to calculate the economic contribution of the CPP industry to the Australian economy was altered from previous reports. The method was necessarily changed because of an adjustment in the multipliers underpinning the ABS IO tables, and an improved approach to capture the economic contribution of imported CCP products and their sales to Australian farmers.

In the revised approach, Deloitte Access Economics partitioned the contribution of domestic CPP manufacturing to GDP and employment, as well as the contribution of imported CPPs that are retailed in Australia.

To achieve this, the contribution of domestic CPP manufacturing and CPP imports were entered separately in the IO model. The value of domestic pesticide manufacturing was obtained from ABS datasets. The total value of imports was calculated by subtracting the value of domestic CPP manufacturing from the APVMA sales data. The total imported value was scaled down to capture the logistics contribution of the imported goods.

Acknowledging that imports are mostly handled by the wholesale and retail trade industries in Australia, the scaled value of imports figure was split across these two industries. Data from Table 2 – Merchandise importers, by industry of importer and state of final destination of imported commodity was used to inform the relative shares.

The inclusion of CPP imports into the model marginally increased the direct share of value added, relative to shares in the 2018 and 2013 reports. This can be attributed to the wholesale and retail trade industries which handle and distribute imported CPPs to end users. These industries utilise relatively more labour than manufacturing, which is reflected in a higher ratio of wages to total value added. Overall, despite imported CPPs accounting for approximately 25 per cent of total CPP income, around 30 per cent of direct value added can be attributed to imports.

Appendix B : Attributable production estimates (USA)

Table B.1: Share of yield attributable to CPPs, USA (%)

Crop	Herbicide	Insecticide	Fungicide	Total CPP	Category*
Alfalfa		5		5	V
Almond	5	43	70	100	FN
Apple	15	93	86	100	FN
Artichoke	16	60	35	100	V
Asparagus	55	67	22	100	V
Avocado		48		48	FN
Banana			75	75	FN
Barley			9	9	FC
Blueberry	67	69	75	100	FN
Broccoli	14	75		89	V
Cabbage		64	65	100	V
Canola	45			45	FC
Cantaloupe			60	60	FN
Carrot	48	10	95	100	V
Celery	0	48	92	100	V
Cherries		84	92	100	FN
Citrus	0		88	88	FN
Collard			78	78	V
Corn	20	3		23	FC
Cotton	27	30	12	69	FC
Cranberry	50	50	87	100	FN
Cucumber	66	34	77	100	V
Date		85		85	FN
Dry bean	25			25	FC
Eggplant		25		25	V
Garlic			61	61	V
Grape	1	35	100	100	FN
Green bean	20	58	65	100	V
Green pea	20	22		42	FC
Hazelnut		45	60	100	FN
Hop	25	100	100	100	FC
Hot pepper	0		44	44	V
Kiwi			33	33	FN
Lettuce	13	50	85	100	V
Mint	58	54	16	100	V
Nectarine		64	89	100	FN
Olive		90	84	100	FN
Onion	43	22	100	100	V
Orange		77		77	FN
Papaya			100	100	FN
Parsley			66	66	V
Peach	11	51	91	100	FN
Peanut	52	55	92	100	FN
Pears		85	89	100	FN
Pecan		56	72	100	FN
Pistachio		64	39	100	FN

Crop	Herbicide	Insecticide	Fungicide	Total CPP	Category*
Plums and prunes			66	66	FN
Potato	32	29	94	100	FC
Raspberry	0	55	97	100	FN
Rice	53	13	54	100	FC
Sorghum	26	8		34	FC
Soybean	26	5	3	34	FC
Spinach	50	16	71	100	V
Strawberry	30	56	97	100	FN
Sugar beet	29	23	78	100	V
Sugarcane	25	22		47	FC
Sunflower	16	50		66	FC
Sweet corn	25	28	36	89	FC
Sweet peppers		53	80	100	V
Sweet potato	20	45		65	V
Tomato	23	53	77	100	FN
Walnut		36	54	90	FN
Wheat	25	3	9	37	FC
Wild Rice	50		20	70	FC

Sources: Gianessi 2005, 2006 and 2009. *Note: categories FC=field crop (broadacre), V = vegetables (includes herbs), FN = fruits and nuts. Blanks indicate no data was available.

Limitation of our work

General use restriction

This report is prepared solely for the use of CropLife Australia. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose set out in the engagement letter dated 15 March 2023. You should not refer to or use our name or the advice for any other purpose.

Attachment B

December 2023

The agriculture and land sector plan

contributing towards Australia's goal of net zero by 2025

Department of Agriculture, Fisheries and Forestry

INTRODUCTION

CropLife Australia (CropLife) is the national peak industry organisation representing the plant science (registered agricultural chemicals and plant biotechnology innovations) sector in Australia. CropLife represents the innovators, developers, manufacturers, formulators and suppliers of crop protection products (organic, synthetic and biological based pesticides) and crop biotechnology seed innovations. CropLife's membership is made up of both large and small, patent holding and generic, Australian and International companies and accordingly, CropLife only advocates for policy positions that deliver whole-of-industry and national benefit. Our focus is, however, specifically on an Australian farming sector that is internationally competitive through globally leading productivity and sustainability and enable the most effective protection of the nation's precious biodiversity and environment. Both of which are achieved through access to world-class technological innovation and products of the plant science sector.

The plant science industry contributes to the nation's agricultural productivity, environmental sustainability and food security through innovation in plant breeding and pesticides that protect crops against pests, weeds and disease. More than $31 billion of the value of Australia's agricultural production is directly attributable to the responsible use of crop protection products (CPPs), while the plant science industry itself directly employs thousands of people across the country.[1] CropLife Australia is a member of CropLife Asia and part of the CropLife International Federation of 91 CropLife national associations globally.

CropLife welcomes the opportunity to makes a submission to the Department of Agriculture, Fisheries and Forestry's consultation to support the development of a fit-for-purpose net zero plan for the agriculture and land sectors. CropLife supports Australia's commitment to the global climate change ambitions outlined within the Paris Agreement and our economy wide goal to balancing greenhouse gas emissions and removals. As outlined in the Paris Agreement, it is important that this is undertaken in a manner that not only promotes resilience to the adverse effects of climate change, but also develops low greenhouse gas (GHG) emissions in a manner that does not threaten food production.[2]

1 Deloitte Access Economics, 'Economic Contribution of Crop Protection Products in Australia', August 2023, https://www.croplife.org.au/resources/reports/economic-contribution-of-crop-protection-products-in-australia/.

2 Paris Agreement (Dec. 13, 2015), in UNFCCC, COP Report No. 21, Addenum, at 21, U.N. Doc. FCCC/CP/2015/10/Add, 1 (Jan. 29, 2016) [hereinafter Paris Agreement], Article 2.

As Australia considers the opportunities for agriculture to contribute to Australia's Net Zero Plan, the global importance of food systems and consequential impacts associated with any changes to policy settings in Australia must be at the front of mind. This includes inadvertent impacts on the attainment of other global Sustainable Development Goals, as well as the risks of perverse outcomes in other countries that may negate or indeed outweigh any net emissions reductions achieved in Australia due to impact on global supply and demand of food commodities.

Additionally, given the acknowledged difficulties in driving emissions mitigation across Australian agriculture,[3] the role of agriculture in achieving a net zero emissions economy must identify technological pathways that will enable the decoupling of growth in food production from emissions. These pathways must consider the suite of policy, investment and market incentives that will facilitate adoption of new technologies across the many different businesses that make up our agricultural industry. Commercial investment in the development and deployment of these technologies in a way that is profit maximising for Australian farmers has been proven to support practice change.

Sustainable agriculture practices in Australia are world leading

The discussion paper highlights that Australia's agricultural sector boasts an internationally commendable track record in terms of environmental sustainability.[4] With over 70 per cent of Australian agricultural products exported, Australians can have confidence knowing that the positive impacts of their locally applied sustainable practices extend globally.[5]

Herbicide use has underpinned the widespread adoption of no-till farming in Australia, crucial for carbon sequestration in soil. Australian farmers are world leaders in the adoption of no-till practices.[6] These no-till practices preserve soil structure, reduce erosion and maintain crop residues as a protective cover. This cover conserves moisture, fosters microbial activity and contributes to carbon sequestration, aligning with efforts for carbon neutrality and climate change mitigation in Australian agriculture. Across the Australian crop production landscape, the high adoption of no-tillage practices over the 1990s and 2000s resulted in the sequestration of approximately 5 million tonnes CO_2~e annually compared to conventional tillage practices.[7]

3 Dominic Davis et al., 'Final Modelling Results | Net Zero Australia', 19 April 2023, https://www.netzeroaustralia.net.au/final-modelling-results/.

4 Department of Agriculture, Fisheries and Forestry and ABARES, 'Environmental Sustainability and Agri-Environmental Indicators – International Comparisons', July 2023, https://www.agriculture.gov.au/abares/products/insights/environmental-sustainability-and-agri-environmental-indicators.

5 Department of Agriculture, Fisheries and Forestry and ABARES, 'Snapshot of Australian Agriculture 2023', n.d., https://www.agriculture.gov.au/abares/products/insights/snapshot-of-australian-agriculture#around-72-of-agricultural-production-is-exported.

6 Department of Agriculture, Fisheries and Forestry and ABARES, 'Environmental Sustainability and Agri-Environmental Indicators – International Comparisons'.

7 Macintosh Andrew, Roberts Geoff, and Buchan Sarah, 'Improving Carbon Markets to Increase Farmer Participation' (AgriFutures, July 2019), https://agrifutures.com.au/wp-content/uploads/2019/07/19-026-Digital-1.pdf.

No-till farm practices are enabled by the use of herbicide weed control over summer fallow periods. This has increased the productivity of Australian farmers in the face of climate change, improving water use efficiency and declining yield sensitivity to drought conditions.[8] The Grains Research and Development Corporation's Water Use Efficiency Initiative identified the use of herbicides during summer fallow resulted in an average 60 per-cent increase in seasonal water use efficiency and returned farmers on average $5.60 for every dollar they invested in weed control.[9] This clear return on investment has been a major driver of farmers adopting no-till farming, creating consequential environmental benefits, including the climate change abatement created by improved soil sequestration and reduced loss of soil carbon.

Additionally, enhancing yield per cultivated area through sustainable intensification has been identified as a climate change abatement tool. This is because it eliminates the need to convert more land (and the resultant emissions created by this deforestation) to meet the increasing global food demand.[10] Consequently, this approach may contribute to a global reduction in GHG emissions associated with food production. As a nation whose sustainable agricultural practices are already world-leading, increasing production intensity also alleviates the requirement to convert natural habitats elsewhere in the world into arable land as global demand for food increases.[11]

8 Neal Hughes, Kenton Lawson, and Haydn Valle, 'Farm Performance and Climate: Climate-Adjusted Productivity for Broadacre Cropping Farms' (Department of Agriculture and Water Resources, ABARES, May 2017), https://www.agriculture.gov.au/abares/research-topics/climate/farm-performance-climate.

9 Grains Research & Development Corporation, 'Water Use Efficiency Research Is Transforming the Productivity Potential of Australian Farming Systems, Demonstrating That Efficiency Gains of 20-40 per Cent Are Possible with Optimal Pre-Crop and in-Crop Management Practices', n.d., https://grdc.com.au/about/rde-investment-strategy/delivering-impact/investing-in-water-use-efficiency-yields-results.

10 Maartje Sevenster et al., 'Australian Grains Baseline and Mitigation Assessment' (CSIRO, January 2022), https://publications.csiro.au/publications/publication/PIcsiro:EP2022-0163.

11 Department of Agriculture, Fisheries and Forestry and ABARES, 'Environmental Sustainability and Agri-Environmental Indicators – International Comparisons'; Aaron T. Simmons, Annette L. Cowie, and Philippa M. Brock, 'Climate Change Mitigation for Australian Wheat Production', *Science of The Total Environment* 725 (10 July 2020): 138260, https://doi.org/10.1016/j.scitotenv.2020.138260.

Reducing future climate risk though access to innovation

ABARES modelling has demonstrated that to date, the adoption of innovation has been a critical part of Australian farmers' adaptation to climate change.[12] However, as noted in the discussion paper, there is a risk that under future climate change scenarios, the negative impacts will outpace productivity growth.

As such, it is important that Australia's response to climate change focuses on providing producers and environmental land managers with access to new productivity enhancing innovations that will also improve environmental outcomes. Key to achieving this access is ensuring Australia's operating environment does not deter innovators from investing in the development and commercialisation of products that will support productive and sustainable outcomes when used on Australian farms. This includes both products that are specifically developed for the Australian market, as well as global innovations that will support Australian farming.

Agricultural input products, including modern pesticides, are crucial to maintaining and increasing agricultural output in the face of climate change challenges. Overwhelmingly, the weight of scientific evidence does not support claims that suggest a shift away from chemical inputs in agricultural systems will support a potential reduction in GHG emissions by 2050. The analysis that is used by those advocating these solutions overlook a crucial aspect and do not fully capture the complexity of the situation. Namely, these low input agricultural systems come at a cost of a 35 per cent decline in production compared to 2010 levels.[13]

Such an outcome would deteriorate global food production and food stocks. This not only risks outcomes opposite to the Paris Agreement's stipulation that the development of a low emissions environment should not threaten food production but also presents perverse global outcomes for food system emissions. For example, a study that undertook a global consequential lifecycle analysis of conventional and organic farming systems in the UK concluded the following:

> "… *widespread adoption of organic farming practices would lead to net increases in GHG emissions as a result of lower crop and livestock yields and hence the need for additional production and associated land use changes overseas. It is not obvious how additional overseas land could be found, without expanding the existing area of tilled land by ploughing up grassland.*"[14]

12 Neal Hughes and Peter Gooday, 'Climate Change Impacts and Adaptation on Australian Farms', 29 July 2021, https://doi.org/10.25814/589V-7662.

13 Xavier Poux and Pierre-Aubert Aubert, 'An Agroecological Europe in 2050: Multifunctional Agriculture for Healthy Eating', IDDRI, 1 January 2014, https://www.iddri.org/en/publications-and-events/study/agroecological-europe-2050-multifunctional-agriculture-healthy-eating.

14 Laurence G. Smith et al., 'The Greenhouse Gas Impacts of Converting Food Production in England and Wales to Organic Methods', *Nature Communications* 10, no. 1 (22 October 2019): 4641, https://doi.org/10.1038/s41467-019-12622-7.

For crop biotechnology innovations, next generation (plant) breeding techniques (NBT) alongside conventional genetic modification (GM) have already provided enormous benefit to Australian farmers' efforts as part of their sustainable agricultural practices. The opportunity for biotechnology traits will only grow more important under climate change scenarios, characterised by hotter and drier production environments. A climate change risk assessment undertaken by the Commonwealth Bank in 2019 identified that biotechnologies, such as GM, can increase the climate resilience of crops, including pasture crops, by up to 40 per cent over the next 40 years.[15]

Importantly, the impact of climate change on the environment will also reduce the ability for nature-based solutions to sequester carbon across the landscape.[16] Through crop biotechnology innovation, the plant science industry can develop plants that are adapted to these environmental conditions to improve the ability for vegetative and soil sequestration.

However, restrictive and outdated regulatory frameworks and systems, the absence of pathways to market and uncertainty created in the lengthy review process of the Gene Technology Scheme have inhibited the opportunity for these technologies to enhance environmental services and biodiversity protection.

Australia's small market size negatively impacts the business decision for innovating companies to undertake the investment necessary to develop new technologies here in Australia, as well as bring new technologies to Australia. This risks providing farmers with the tools to be more productive under climate change scenarios and to further contribute to emissions reductions through more input efficient farming systems and removals through sequestration. Furthermore, it also risks the investment necessary to maintain the national scientific expertise necessary to ensure that niche products can be developed for Australian conditions when required.

[15] '2019 Annual Report' (CommBank, 2019), https://www.commbank.com.au/about-us/investors/annual-reports/annual-report-2019.html.

[16] Sarah E. McDonald et al., 'Grazing Management for Soil Carbon in Australia: A Review', *Journal of Environmental Management* 347 (1 December 2023): 119146, https://doi.org/10.1016/j.jenvman.2023.119146.

Global and national food security

With Australian food production playing an important role in global food security,[17] it is important that policy settings for agriculture's contribution to an Australian net zero economy considers the impact of decarbonisation on global food production. As outlined above, any reductions in Australian productivity related to reducing our agriculture industry's net emissions may inadvertently result in an increase of GHG emissions related with global agriculture. This is due to the shift in agricultural production from Australia to elsewhere in the world and the GHG emissions related to the necessary conversion of land from native vegetation to land suitable for cropping or grazing.[18]

This indeed was the scenario considered by the CSIRO as part of its recent examination of the potential of the Australian grain industry's ability to mitigate its GHG emissions. This study found that under current technology scenarios, net reductions were most likely to be accompanied by reductions in production, with consequential food-based emissions exceeding the reductions in Australia resulting elsewhere. Because of the relatively low GHG emissions intensity of Australian production, these impacts are more acute due to the combination of deforestation and production emissions.[19]

To mitigate these risks, it is important for the plans developed for agriculture's contribution to Australia's Net Zero Plan include a focus on the development and adoption of technologies that decouple agricultural production from emissions. This will require the Australian Government to form strong relationships with the agriculture sector and science-based input industries, such as the plant science industry. Members of the plant science industry have a demonstrable commitment to working with Australian farmers as part of their significant investment in R&D to develop and provide science-based innovations that can be safely and profitably deployed.

With recent global events demonstrating that food security is paramount for national security and stability, the role of plant science innovations in growing food security, while reducing agricultural emissions, is important to the goals of the Paris Agreement.

17 Canberra, 'Australian Food Story: Feeding the Nation and Beyond', text (Parliament of Australia, House of Representatives), Australia, accessed 11 December 2023, https://www.aph.gov.au/Parliamentary_Business/Committees/House/Agriculture/FoodsecurityinAustrali/Report.

18 Sevenster et al., 'Australian Grains Baseline and Mitigation Assessment'.

19 Ibid.

Enabling a circular economy

CropLife and its members have a long-standing record and commitment to the stewardship of their products with a whole-of-lifecycle approach. This approach ensures human health and safety and the responsible and sustainable management of the environment and trade issues associated with agricultural chemical and crop biotechnology use in Australia. Our member companies contribute millions of dollars each year to stewardship activities that ensure the safe and effective use of their products.

CropLife ensures the responsible use of these products through its mandatory Members' Code of Conduct and a suite of comprehensive and world-leading industry stewardship initiatives and programs, StewardshipFirst. Spearheading industry stewardship, CropLife has established a benchmark for waste management and recycling programs – enabling a circular economy. Notably, ***drum**MUSTER*®, bagMUSTER® and ChemClear®, administered by CropLife's wholly-owned stewardship and safety organisation, Agsafe, exemplify this. These programs provide a pathway for removing waste off farm and responsibly disposing or recycling it, including those classified as dangerous goods, containers and agricultural plastics waste.

Protecting our biodiversity

CropLife member company products enable the sustainable intensification of agricultural production systems to deliver increased global food security and minimising the need for further deforestation of natural environments, here and internationally, to meet global nutrition requirements. Since 1940, advances in crop varieties and farming practices have improved yields of our most critical crops by over an order of magnitude. This means more can be grown in a much smaller space with a much lower environmental impact. By adopting these practices and embracing new technologies, Australian farmers have boosted agricultural productivity, successfully shifting land use from agriculture to nature conservation.[20]

With arable lands predicted to decline and weather patterns becoming more variable due to climate change, Australia requires access to crops and crop protection products capable of thriving in droughts or high salt conditions. Now more than ever, access to the innovations of the plant science industry for sustainable agricultural intensification is paramount for achieving the Paris Agreement.

20 Department of Agriculture, Fisheries and Forestry and ABARES, 'Environmental Sustainability and Agri-Environmental Indicators – International Comparisons'.

In addition to food security, sustainable intensification of agricultural production systems also plays a prominent role in protecting Australia's rich biodiversity, both during containment and eradication of invasive species incursions, but also in managing and mitigating established invasive species. Australia now has more foreign plant species than native species.[21] This is not a new trend. In 2006, the then NSW Department of Environment and Conservation listed weeds and other pests as second only to habitat loss as a cause of biodiversity decline and cautioned that weeds presented the greatest threat to our National Parks.[22] Not only do invasive species threaten Australia's unique biodiversity, invasive plants are the costliest pests in Australia, costing $200 billion since 1960.[23] Herbicides offer the only truly effective option for removing invasive weeds from Australia's bushland reserves.[24]

21 'Key Findings | Australia State of the Environment 2021', accessed 30 November 2023, https://soe.dcceew.gov.au/land/key-findings.

22 Department of Environment and Conservation (NSW), 'State of the Parks', 2004, https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/state-of-the-parks-2004-050051.pdf; Aaron Coutts-Smith and Paul DOWNEY, *The Impact of Weeds on Threatened Biodiversity in New South Wales: Technical Series No. 11, CRC for Australian Weed Management*, CRC for Australian Weed Management Technical Series (CRC for Australian Weed Management, 2006).

23 Corey J. A. Bradshaw et al., 'Detailed Assessment of the Reported Economic Costs of Invasive Species in Australia', *NeoBiota* 67 (29 July 2021): 511–50, https://doi.org/10.3897/neobiota.67.58834.

24 Invasive Species Council, 'Glyphosate: A Chemical to Understand', November 2020, https://invasives.org.au/wp-content/uploads/2020/11/Glyphosate-A-Chemical-to-Understand.pdf.

Attachment C

July
2024

A Future Made in Australia:
Unlocking Australia's carbon liquid fuel opportunity

1. INTRODUCTION

CropLife Australia (CropLife) is the national peak industry organisation representing the agricultural chemical and plant biotechnology (plant science) sector in Australia. CropLife represents the innovators, developers, manufacturers, formulators and suppliers of crop protection products (organic, synthetic and biologically based pesticides) and agricultural biotechnology innovations. CropLife's membership is made up of both large and small, patent holding and generic, Australian and International companies. Accordingly, CropLife only advocates for policy positions that deliver whole of industry and national benefit.

CropLife Australia is also a member of CropLife Asia and part of the CropLife International Federation of 91 national associations globally. Our focus is, however, specifically on the Australian agricultural sector and ensuring it remains internationally competitive through globally leading productivity and sustainability achieved through access to world-class technological innovations and products of the plant science sector.

The plant science industry contributes to the nation's agricultural productivity, environmental sustainability and food security through innovations in both plant breeding and pesticides that protect crops against pests, weeds and disease. More than $31 billion of the value of Australia's agricultural production is directly attributable to the responsible use of crop protection products (CPPs), while the plant science industry itself directly employs thousands of people across the country.[1]

CropLife welcomes the opportunity to provide a submission to the Department of Infrastructure, Transport, Regional Development, Communications and the Arts' consultation on the role of Government in expanding the role of Low Carbon Liquid Fuels (LCLF) in decarbonising Australia's economy.

Enhancing Australia's capacity to domestically produce LCLFs presents opportunities to the Australian economy beyond the role it will play in lowering emissions in hard to abate industries, such as transport and logistics. In particular, the production of LCLF will see the development of domestic manufacturing focused around adding value to the existing strengths of Australia's primary production capacities.

Critical to the development of a sustainable and viable industrial base for the Australian production of LCLF is ensuring the availability of low emissions intensity feedstock. While the consultation paper recognises the critical nature of efficient crop production to this outcome, outside of creating consistent demand for feedstock crops, insufficient attention is provided to the policy issues to ensuring this supply. Identifying these policy solutions must be cognisant of the international recognition that low carbon biofuels are facing a crisis of feedstock supply and increasing scrutiny over competition between the use of arable land for food or fuel.[2]

[1] Deloitte Access Economics, 'Economic Contribution of Crop Protection Products in Australia', (August 2023 Report) 'https://www.croplife.org.au/resources/reports/economic-contribution-of-crop-protection-products-in-australia/'.

[2] International Energy Agency, '*Renewables 2022*' (2022 IEA Report) 'https://www.iea.org/reports/is-the-biofuel-industry-approaching-a-feedstock-crunch'

This comes at a time when almost 50 percent of Australians now feel anxious or struggles to consistently access adequate food.[3] Handled well, however, the sector could provide additional opportunities to our farmers. For example, the development of a local low carbon fuel industry provides a synergistic opportunity with the goal of agricultural decarbonisation.

Existing and emerging innovations developed and/or implemented by the plant science industry means that there are technically feasible solutions to ensuring the necessary volume of feedstock is available to an emerging Australian LCLF production sector. However, current policy settings have meant that Australia is no longer a favoured jurisdiction for the commercial investment necessary for many of these newer technologies being made available to Australian farmers.

As such, settings that focus on supporting the commercialisation of agricultural innovation that enable the following outcomes should be included within any Government policy to grow the production of LCLF in Australia.

- Increased productivity and reduced emissions intensity of biofuel feedstock from agricultural crops. This will not only enable more food and more feedstock to be grown from available arable land, but also reduce the agricultural emissions that will be accounted within the scope of any LCLF produced.
- Increase adaptation of feedstock crops to more marginal land to reduce conflict with the production of food crops.
- Develop feedstock crop varieties that are more suitable for use in the production of LCLF.

[3] Foodbank, '*Foodbank Hunger Report 2023*' (2023 Foodbank Report) 'https://reports.foodbank.org.au/foodbank-hunger-report-2023'

2. ENSURING FEED STOCK SUPPLY

CropLife supports Australia's commitment to the global climate change ambitions outlined within the Paris Agreement and our economy-wide goal to balancing greenhouse gas emissions and removals. As outlined in the Paris Agreement, it is important that this is undertaken in a manner that not only promotes resilience to the adverse effects of climate change, but also develops low greenhouse gas (GHG) emissions in a manner that does not threaten food production.[4] As such, policy settings that will support increasing feedstock production and which will support the industrial production of LCLF need to balance potential impacts on food production.

To achieve this all sectors of the Australian economy must work together using every tool available. This includes leveraging traditional knowledge, existing proven tools and emerging innovations.

CropLife agrees with the position that Australia has significant 'advantages in feedstock production' asserted in the LCLF consultation document, however, this cannot be taken for granted. While Australian farmers are some of the world's most efficient and Australian scientists and plant breeders some of the most innovative, inaction and limited policy support have placed this in great jeopardy.

The pongamia (*Pongamia pinnata*), a large tree that produces oil-rich seeds, acknowledged in the consultation paper, is proving to be an exciting feedstock capable of growing in adverse conditions. However, it is far from a panacea for decarbonisation. With the perennial trees having a long maturation time of 4-6 years which, when combined with inconsistent government policy, can create significant risks for farmers and potential delays. To ensure a viable industry and consistent feedstock supply it is critical that we also acknowledge our existing successes. For example, genetically modified (GM) canola has lowered inputs required while reducing the carbon output of our crop.[5] This has ensured the Australian canola industry meets the strict European Union greenhouse gas emissions targets and thus providing a highly lucrative market for Australian Producers.[6] However government must ensure that non-science based international policy positions driven by some overseas jurisdictions, such as many we see in the EU, do not warp the foundation of good policy in Australia in achieving better outcomes in decarbonising the economy.

[4] United Nations, '*Paris Agreement to the United Nations Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No. 16-1104*', Article 2.

[5] Grains Research and Development Corporation (GRDC), '*GM Canola Impact Survey*' (2013 GRDC Report) 'https://grdc.com.au/resources-and-publications/all-publications/publications/2014/03/gm-canola-impact-survey'.

[6] Commonwealth Scientific and Industrial Research Organisation (CSIRO), '*Greenhouse credentials of canola industry recognised by European Commission*' (September 2023 Webpage) 'https://www.csiro.au/en/news/all/news/2023/september/greenhouse-credentials-of-canola-industry-recognised-by-european-commission'.

3. EXPANDING THE TOOLBOX

Feedstock production depends on Australian farmers. However, our primary producers face uncertain times. They are at the rockface of climate change while also contributing to the range expansion of invasive pests, weeds and disease. They need access to every possible tool available.

This primarily includes access to inputs, most notably Crop Protection Products (CPPs). More than $31 billion of the value of Australia's agricultural production, or 74 percent, is directly attributable to the responsible use of CPPs. Herbicide use in particular has underpinned the widespread adoption of no-till farming in Australia. Consequently, Australian farmers are world leaders in the adoption of no-till practices.[7] These no-till practices preserve soil structure, reduce erosion and maintain crop residues as a protective cover. This cover conserves moisture, fosters microbial activity and contributes to carbon sequestration, aligning with efforts for carbon neutrality and climate change mitigation in Australian agriculture. Across the Australian crop production landscape, the high adoption of no-tillage practices over the 1990s and 2000s resulted in the sequestration of approximately 5 million tonnes CO_2~e annually compared to conventional tillage practices.[8]

This is not unique to Australia. A life cycle analysis study recently published by the University of Arkansas bolsters the global literature describing the vital role of CPPs in fostering improved carbon outcomes[9]. Importantly, without pesticides, the yields of corn, cotto, and soybeans declined up to 70 percent. Cultivating corn, cotto, and soybeans without pesticides resulted in upwards of three times more land, water, energy use and greenhouse gas emissions. The targeted and judicious use of pesticides not only enhance productivity but significantly reduce pressure on water, land and energy resources per unit of production.

Enhancing yield per cultivated area through sustainable intensification has been identified as a climate change abatement tool. This is because it eliminates the need to convert more land (and the resultant emissions created by this deforestation) to meet the increasing global food and fuel demand.[10] Consequently, this approach may contribute to a global reduction in GHG emissions associated with crop production. As a nation whose sustainable agricultural practices are already world-leading, increasing production intensity also alleviates the requirement to convert natural habitats elsewhere in the world into arable land as global demand for food and feedstock increases.[11]

7 Department of Agriculture, Fisheries and Forestry and ABARES, '*Environmental Sustainability and Agri-Environmental Indicators – International Comparisons'* (July 2023 Report) 'https://www.agriculture.gov.au/abares/products/insights/environmental-sustainability-and-agri-environmental-indicators'.

8 Macintosh A et al, '*Improving Carbon Markets to Increase Farmer Participation*' (July 2019 Agrifutures Report), 'https://agrifutures.com.au/wp-content/uploads/2019/07/19-026-Digital-1.pdf'.

9 Thoma G et al, '*Life cycle assessment of impacts of eliminating chemical pesticides used in the production of U.S. corn, soybeans, and cotton* ' (25 March 2024 CropLife America Report) 'https://static1.squarespace.com/static/5faeee45a363746603d1c6e1/t/661e95a6e057f947a1185c5e/1713280424229/CLA+LCIA+ISO+Finalized+Report.pdf'.

10 Maartje S et al, 'Australian Grains Baseline and Mitigation Assessment' (January 2022 CSIRO Report) 'https://publications.csiro.au/publications/publication/PIcsiro:EP2022-0163'.

11 Department of Agriculture, Fisheries and Forestry and ABARES, 'Environmental Sustainability and Agri-Environmental Indicators – International Comparisons'; Aaron T. Simmons, Annette L. Cowie, and Philippa M. Brock, '*Climate Change Mitigation for Australian Wheat Production*' (10 July 2020 *Science of The Total Environment* 725:138260), 'https://doi.org/10.1016/j.scitotenv.2020.138260'.

The toolbox must also include the latest developments in biotechnology. With recent unprecedented advances, there are numerous innovations capable of supporting decarbonisation while also providing resistance to adverse conditions. With GM technology already providing enormous opportunity for canola feedstock production, Australian farmers could soon have access to hundreds of new varieties through gene editing.

Gene editing technologies have already emerged as a tool for small-scale crop development. They reduce both the time and number progenitor plants needed to develop a novel crop variety. This means that despite our small and niche market size, Australian innovators can rapidly develop Australia-adapted varieties. When combined with conventional breeding and GM, we can rapidly enhance our agricultural sector. So far, innovation in this area has included:

- **Enhanced Crop Yields**: As a major exporter of agricultural products, Australia could increase its global market share with gene-edited crops. Uncertain regulations, however, may dissuade agribusinesses from adopting these innovations.
- **Pest Resistance**: Although Australia is fortunate with respect to biosecurity, it is a constant battle. This might be best exemplified by recent emergence of fall armyworm, varroa mite and red ants as agricultural major pests. However, solutions to these problems are constantly emerging. For example, rust disease resistance in wheat[12] and Panama's disease in banana[13].
- **Ensuring Sustainability**: With ambitious environmental targets, Australia requires significant innovation to ensure these targets are met while not adversely impacting food security. Since the emergence of gene editing techniques, there are continuously new examples of novel crop varieties with improved yields and resistance to numerous abiotic or biotic stresses.[14]
- **Investment in Bio-Fortified Crops**: With Australia's focus on premium and nutritional food exports, there's a window to lead in bio-enhanced food production. Unclear regulations could halt ventures from investing in this niche yet growing segment. One example, approved last year for use in Norwegian fish farms, is the Australian-developed Omega-3 canola.[15]
- **Improved Plant Oil Content**: In addition to bio-fortification, Australia continues to develop crops for highly efficient biofuel [16] This is achieved through the selection and engineering of plants for increased oil production.

[12] Grains Research and Development Corporation, '*ACRCP Phase 5: Optimising genetic control of wheat rusts through identification of gene editing targets for broad spectrum wheat rust control*', (04 April 2023 Webpage) 'https://grdc.com.au/grdc-investments/investments/investment?code=CSP2304-010RTX'

[13] Hort Innovation, '*A platform for gene editing vegetative propagated crops (AS20000)*', (February 2023 Webpage) 'https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/as20000'

[14] Hamdan MF et al, '*Genome Editing for Sustainable Crop Improvement and Mitigation of Biotic and Abiotic Stresses*' (2022 *Plants*, 11, 2625).

[15] Aquaterra, '*Norway Approves Aquaterra Omega-3 Oil for Use in Aquafeed*' (28 June 2023 Webpage) 'https://aquaterraomega3.com/norway-approves-aquaterra-omega-3-oil-for-use-in-aquafeed'.

[16] Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's next oil boom might just come from plants, (4 April 2017 Webpage) 'https://www.csiro.au/en/news/All/News/2017/April/Australias-next-oil-boom-might-just-come-from-plants'.

4. REGULATORY CERTAINTY

Despite the potential in emerging technologies and products, delays in regulatory reform have stymied investment and worked to keep the farmer toolbox closed. It will soon be seven years since the commencement of the Third Review of the Gene Technology Scheme and six years since the recommendations were published. There is still no timeline for their implementation. Additionally, the finalisation of Food Standards Australia & New Zealand Proposal P1055 – 'Definitions for gene technology and new breeding techniques' – has been ongoing since 2018. The current timeline is mid-2024, but this has slipped several times previously. These two delays have created regulatory uncertainty and lack of clarity of a pathway to market. This is proving to be one of the most significant barriers for the Australian biotechnology sector and the source of sector-wide concern

With an existing substantial investment from Australia's 15 Rural Research and Development Corporations, CSIRO, universities, NGOs, farmers and companies, Australian agriculture remains highly innovative. However, to realise the potential of this investment, a clearly defined pathway from lab to field is desperately needed.

Australia, once a world leader in the regulation of biotechnology, has fallen behind many of our largest trading partners and competitors including Argentina, Brazil, Canada, China, Japan, the United Kingdom and the United States. The greatest risk is that Australian-, developed innovations will be purchased cheaply and introduced into foreign markets, where they would compete directly with Australian farmers. Moreover, without constant innovation, it may be impossible to ensure Australian grown feedstocks, such as canola, maintain their certification as green.

To establish a local low carbon fuel sector, with the economic benefits that entails, it is important that government policy settings and associated regulatory frameworks provide the stability and support the confidence necessary to underpin commercial investment decisions by the agricultural sector. Policies need to consider the regulatory settings that impact up and downstream of fuel manufacturing, as well as the nation's farming sector. They must also consider how incentives for feedstock may impact food security and land clearing.

5. CONCLUSION

CropLife commends the move towards low carbon fuel made in Australia. However, we remain concerned about the narrow focus of the current consultation. To simply conclude Australia has sufficient capacity for feedstocks, does an enormous disservice to our producers and over-simplifies a highly complex process. For a local low carbon fuel industry to thrive inter-sector dialogues and genuine engagement must be undertaken. This needs to include, to name just a few, the agricultural industry, food manufacturers, transport sectors and consumer groups.

It is also important and now indeed critical for government to finalise regulatory reviews, principally the Third Review of the National Gene Technology Scheme, to provide the agricultural sector with the certainty needed for investment and innovation. Without this, our nation’s farmers and producers are left behind in the global race for green feedstocks. This seemingly simple undertaking will provide access to the tools our innovators need.

A low carbon liquid fuel sector will support both the diversification and decarbonisation of the Australian economy. However, climate action cannot be a Ponzi scheme. We need sustainable action created by economically viable initiatives and frameworks that will stand the test of time. This needs to be built upon policies and regulation that provides stability.