



Fourth Environmental Assessment of the Australian Cotton Industry

GHD Report

Cotton Research & Development Corporation

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→ The Power of Commitment



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Acknowledgement of Country

GHD acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land, water and sky throughout Australia on which we do business. We recognise their strength, diversity, resilience and deep connections to Country. We pay our respects to Elders of the past, present and future, as they hold the memories, knowledges and spirit of Australia. GHD is committed to learning from Aboriginal and Torres Strait Islander peoples in the work we do.



Executive Summary

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.4 and the assumptions and qualifications contained throughout the report. The approach to gathering evidence for the assessment relied on a range of methods, including desktop review, grower and community surveys, farm visits and targeted stakeholder consultation. Further detail on the assessment approach and methods are outlined in section 2. It is important to note that like previous environmental assessments, GHD did not attempt to obtain a representative sample of stakeholders in consultation activities, rather the intent was to hear from a diverse range of industry stakeholders, as well as those members of the community who wished to participate and share their perspectives.

Background

In 1991, cotton became the first Australian agricultural industry to conduct a full external examination of its environmental performance. Each decade since, the industry has re-committed to reviewing its environmental performance by commissioning an independent assessment. GHD Pty Ltd (GHD) was engaged by the Cotton Research and Development Corporation (CRDC) to complete the Fourth Environmental Assessment of the Australian Cotton Industry. This assessment was undertaken between October 2021 and October 2022 and covers the period since the Third Environmental Assessment, being 2013-2022. The delivery of the project was overseen by a Project Steering Committee (PSC) from CRDC and Cotton Australia, and the industry's Sustainability Working Group (SWG), which comprises membership from CRDC, Cotton Australia, CottonInfo, myBMP, and the Australian Cotton Shippers Association.

The Terms of Reference for the Fourth Environmental Assessment of the Australian Cotton Industry were to:

1. Assess the cotton industry's response to the recommendations made in the Third Environmental Assessment (see Section 3.3.1)
2. Identify current and emerging industry environmental issues and their implications for the industry and on-farm management. Policy developments, recognised global sustainability goals or initiatives, and industry and non-industry stakeholder perceptions and expectations should be considered (see Section 4)
3. Assess current industry action on environmental issues in light of the Third Environmental Assessment and identified environmental issues (see Section 5). This includes, but is not limited to:
 - a. Impact: if the industry's on-farm environmental practices and outcomes are in line with current and future expectations and trends
 - b. Responsiveness: how well industry bodies, the myBMP Program, CottonInfo and sustainability programs are aligned; how well is industry able to identify and respond appropriately to environmental issues
 - c. Consideration of stakeholder concerns and perceptions of industry action to address environmental issues. Different perspectives should be considered e.g. cotton industry (gins, shipping), state government, federal government, community and non-government organisations
4. Recommend priorities for action based on the findings from 1, 2 and 3 above (see Section 6).

The environmental assessment was guided by an Assessment Framework (Appendix B), which was developed by GHD with input from the PSC. GHD conducted a desktop review of relevant literature, including sustainability publications, myBMP resources, and previous environmental audits and assessments. GHD also attended and presented at SWG (Sustainability Working Group) and ACSRG (Australian Cotton Sustainability Reference Group) meetings. Separate stakeholder and grower questionnaires were undertaken (gaining 53 and 16 responses respectively), as well as targeted stakeholder interviews and 25 on-farm site visits across four growing regions.

Industry Response to Third Environmental Assessment

The Third Environmental Assessment was completed in 2012 by Inovact Consulting. The report summarised the major achievements of the industry in improving its environmental performance since the 2003 Environmental Audit. This was in the context of the industry facing environmental challenges, with greater complexity and demands in terms of improving business productivity and profitability; global competitiveness and market expectations of environmental stewardship; the policies, programs and regulatory requirements of government relating to the environment; the long-term pressures on Murray-Darling Basin water resources and the prospective introduction of a Murray-Darling Basin Plan; and public expectations for good environmental and social stewardship. The report summarised the major achievements of the industry in its environmental performance as:

- Effective and responsible management of the industry's use of genetically modified cotton varieties
- The substantial reduction in the use of chemicals particularly insecticides and residual herbicides for cotton growing and the disappearance of serious off-farm impacts in rivers and wetlands
- Major gains in water use efficiency in cotton growing calculated at three to four per cent per year and effective management and stewardship of water resources on-farm
- Major advances in grower attitudes and action concerning natural resource management on farm and active engagement in landscape and catchment wide natural resource management, particularly management of deep drainage, riparian management, groundwater conservation and delivery of ecosystem services
- Significant uptake of integrated pest management (IPM) and the link being established between IPM and biodiversity conservation in terms of ecosystem services on-farm and at a landscape scale
- Development of an integrated research, development and extension system that delivers priority research and development and extends this to growers through an online best management practices program (myBMP) and the extension activities of the industry's key organisations such as Cotton Australia and the commercial sector.

The Third Environmental Assessment identified nine priorities for industry and made six recommendations. A summary of the recommendations and GHD's assessment of the industry's response are provided below.

2012 Recommendation	Progress	Comments supporting GHD's assessment
1. CRDC work with various stakeholders to develop a five-year RD&E strategy	✓✓✓	The cotton industry has a number of strategic plans all of which have identified environmental management and sustainability priorities. The CRDC Strategic Plan guides the industry's RD&E investment and is currently being developed for a new 5-year period, and will align with the PLANET.PEOPLE.PADDock. goals.
2. Re-invigorating myBMP and re-appraise its role in industry assurance	✓✓	Re-appraisal of myBMP occurred (recognised as being important for international marketing) but continued focus is needed on grower uptake.
3. CRDC and Cotton Australia collaborate on establishing an accurate up-to-date database of growers and industry organisations	✓✓	Continued effort is needed to maintain an up-to-date database of growers and industry stakeholders, and to drive their engagement in environmental management and reporting.
4. Commission independent environmental assessments every five years to determine longer term trends	✓✓✓	CRDC and CA are committed to five yearly comprehensive reporting against sustainability targets, including environmental indicators, and annual snapshot reports/updates in the interim.
5. Cotton industry value chain engages with market based initiatives like Better Cotton Initiative	✓✓✓	The cotton industry continues to actively engage in market based initiatives like cottonLEADS and Better Cotton. The industry has recently embarked on the development of the Australian Cotton Industry Strategic Roadmap with the aim of creating alignment between industry and customer needs.
6. Continue market research on perceptions of the cotton industry	✓✓✓	The ACSRG provides the opportunity to connect various stakeholders and gather insights and perceptions. The industry has undertaken a range of other market research activities including through its Cotton to Market program and partnership in the Community Trust in Rural Industries program.

Current and Emerging Environmental Issues

GHD reviewed a range of information sources and undertook consultation with various industry stakeholders to consider the current and emerging environmental issues relevant to the industry and its on-farm management. We found that the emerging drivers identified in the Third Environmental Assessment have continued to gather pace, with public interest in environmental issues triggering a new swathe of international agreements and commitments, more stringent market requirements, and a range of domestic policy and program responses relevant to the industry's operating environment. The implications for industry can be summarised as:

- Industry improvement in environmental performance and reporting over time does not always align with public perception. Water management and use remains a particularly contentious issue, and competition for increasingly scarce water resources, particularly in the context of climate change, will continue to lead to public scrutiny in this area, along with increased regulatory pressures
- The industry's expansion into new growing areas will create new Research, Development and Extension (RD&E) needs, as well as the need to engage with a new communities and stakeholders to maintain its social licence to operate
- The industry is also facing increasing pressure to meet new expectations in its international markets, with the need to keep up with international competitors in this area
- Global markets are demanding increased transparency of environmental stewardship and sustainability, and there is also an expectation of greater ambition in target setting. Market assurance programs like myBMP are likely to become a minimum requirement for some markets in the future
- There is also an increasing demand at the international level for product traceability to provide market assurance and counter the potential for 'greenwashing'. Traceability however has the potential to provide new opportunities for growers to connect with their end-users.

The Australian cotton industry has sound processes in place to identify and respond to current and emerging environmental issues, including through the implementation of an industry-wide sustainability framework, having commenced sustainability reporting in 2014. Through its SWG, materiality scans are undertaken quarterly to identify and consider current and emerging issues and their relevance to the industry's sustainability agenda. As was found in previous assessments, the industry is backed by a strong RD&E model and industry organisational structure. The industry's new Cotton to Market Strategic Roadmap and CRDC's Digital and Data Strategy will be critical in helping adapt to the identified current and emerging issues at least cost to industry.

Current Industry Performance and Recommendations

GHD assessed the industry's current environmental performance and progress since the previous environmental assessment in the areas of environmental management and reporting; water use and management; pest management; agrichemical and petrochemical storage, handling and waste; natural resource management, including soils and biodiversity; and energy emissions and climate. Our assessment considered the industry's current priorities and key initiatives, on-farm practices and outcomes, and stakeholder concerns and perceptions on specific environmental issues.

Our key findings and priorities for improvement are summarised below.

Environmental management and reporting

GHD found that the industry has made great strides in its environmental management and reporting systems in the ten years since the Third Environmental Assessment. Together, myBMP, CottonInfo, PLANET, PEOPLE, PADDOCK. (overseen by the SWG), CRDC and Cotton Australia all have a role in this work and GHD found strong alignment and clear signs of collaboration across the respective industry organisations.

Continued industry effort is needed going forward to increase the awareness amongst growers and other industry stakeholders about the industry's sustainability framework. While awareness around the industry's myBMP program is relatively high amongst growers and stakeholders, the uptake of myBMP certification, and therefore the usefulness of the program in market assurance is still limited at levels of 25-30% of production. To achieve the full benefits from the industry's efforts in this area, growers themselves have an active role to play not only in environmental management on-farm, but in engaging with the industry's sustainability agenda more broadly.

In terms of its on-farm observations, GHD found a positive correlation between the use of myBMP and improved environmental performance when aggregating findings across all farms visited and criteria considered. That being said, close to 90% or higher of the environmental criteria observed on-farm were ranked as ‘excellent’, ‘very good’ or ‘good’ across all growers, regardless of myBMP status indicating a strong level of on-farm environmental performance was observed overall.

GHD makes the following recommendations for further improvement in this area:

1. *Continue to undertake updates to the existing myBMP website to ensure all information is current and weblinks and video content are accessible. Regular updates to both the main website and module content should be undertaken to ensure information remains current. This will become increasingly important as module content and supporting resources are updated to incorporate new research and information applicable to new growing areas.*
2. *Continue to increase the transparency and consistency of reporting of the number of growers both registered and certified with the myBMP program. Subject to privacy considerations, this should include the total number of growers and/or farms, and the total area and/or volume of cotton produced by farms with myBMP certification, both in aggregate and by region. This information should be available on the myBMP website as well as reported in the relevant annual publications, e.g. the Better Cotton and Cotton Australia Annual Reports.*
3. *Ensure a whole-of-industry commitment to increasing the uptake of myBMP certification. This may require further research into identifying real and perceived barriers to uptake. Following this, there may be a need to develop and implement a comprehensive communications and engagement plan that incorporates regionally specific adoption targets and actions for each of the supporting industry organisations.*
4. *Evolution and possible transformation of the myBMP program is required over time toward a performance-based tool that both adds value to participating farm businesses and provides clear outputs and data to support the implementation of the industry’s sustainability agenda. This could include considering if the platform could be used to measure and monitor the stocks of natural capital at the farm scale.*
5. *The sustainability framework and reporting process should continue to move toward science-based targets, acknowledging the difficulties of achieving ambitious targets in a complex system. The SWG has already undertaken considerable work in this area and should be encouraged to continue.*

Water use and management

Water use and management has been an area of considerable industry RD&E investment which has resulted in demonstrable on-farm improvement over many years. GHD observed that water use was monitored thoroughly on the farms throughout the cotton growing regions where on-site farm visits were undertaken. Most growers, regardless of myBMP status, were also found to take advantage of information from canopy temperature sensors, moisture probes, on-farm weather stations, and software for irrigation scheduling.

Despite this, water remains a highly contentious issue amongst stakeholders. Consistent with the previous assessment, water was rated as the highest current and emerging issue for the industry by both growers and broader stakeholders throughout our consultation. Consistent with the level of public interest in water use, governments have and will continue to respond through a range of legislative, policy, and program initiatives. Governments also have a role to play in the provision of information and data on the use of water resources in Australia, including increasing the education and awareness of the regulation and compliance measures that are in place for water extraction.

In addition to its ongoing RD&E efforts, the cotton industry will need to continue its engagement with the national water reform agenda into the future, which will include the need for an ongoing focus on compliance (including metering and monitoring) activities, implementation of floodplain harvesting policies and programs, expansion of irrigation in Northern Australia, and further implementation and review of the Murray-Darling Basin Plan. The issue of fish entrainment has also emerged in recent years as an environmental issue that the industry needs to further consider given its implications for on-farm management.

GHD makes the following recommendations in relation to water use and management:

6. *Continue to work with the respective government agencies to include, where available, information on the status of water compliance in major cotton growing regions (e.g. number/size of breaches compared to total*

number of holdings) in industry sustainability reporting, as was flagged in the 2020 stakeholder consultation report on the setting of industry targets and indicators for the Australian cotton industry.

7. *Continue to support research and trial work that is underway to better understand the impacts of fish entrainment and encourage broader adoption by cotton growers and infrastructure operators of screening on irrigation pumps and/or other identified mitigation measures.*

Pest management

Pest management is another area where industry has made continual progress, with pesticide use significantly reduced due to the introduction of Bt cotton and implementation of IPM strategies. There has also been a decrease in overall Environmental Toxic Load (ETL), representing a more targeted approach to herbicide use in efforts to reduce the environmental impact. GHD observed that farmers are working closely with their agronomists to look for innovative ways to manage pests, weeds and disease throughout the season with many farmers retaining native and remnant vegetation as habitat for beneficials, noting the benefit to their production. Biosecurity is a concern for growers, with over 50% of farms having a farm biosecurity plan, however there is room for improvement in this (biosecurity) area.

Stakeholders contributing to this Assessment indicated generally positive views in relation to the industry's IPM strategies, including the use of genetically modified varieties, and biosecurity practices. Survey results did however indicate that a degree of poor perceptions continue around the industry's overall chemical use and practices to manage spray drift.

Based on our overall findings, GHD has made the following recommendations for improvement in this area:

8. *Use regionally targeted approaches to increase the level of biosecurity planning to ensure sound biosecurity practices are in place on-farm. There is room for improvement in this area to ensure that growers are prepared and have strategies already in place for any future outbreaks or incursions of new pests, weeds or diseases.*
9. *Continue to work with the broader agricultural community to increase the understanding and awareness of off-target spraying to minimise the potential for environmental impacts.*

Agrichemical and petrochemical storage, handling and waste

GHD found that storage and handling of agrichemicals (such as fertiliser, pesticide, herbicide etc.) and petrochemicals, and waste management is an area where improvement is required across the industry. Cost was found to be the biggest barrier to growers improving their storage, handling and waste management, particularly as these activities do not directly correlate with productivity or profitability. Additionally, the cost prohibitive nature of upgrading storage, handling and waste infrastructure on farm was found to be inhibiting myBMP uptake for many growers who would otherwise be likely to achieve myBMP certification.

Practice in this area was found to be poorer in regions where supporting waste infrastructure, such as drumMUSTER, is unavailable or not accessible or convenient. As these practices are typically not isolated to cotton production, there is a role for other agricultural industries and community service providers, to work with the industry to increase focus in this area and aid the necessary on-farm improvements.

Despite GHD's on-farm observations, this was not identified as an area of particular concern in stakeholder consultation and is not currently reported on in the industry's sustainability framework. With the transition to a circular economy becoming an increasing area of focus for governments, stakeholder perceptions around waste management in particular may become more important in the future.

GHD has made the following recommendations for improvement:

10. *Engage partner industries and service providers to aid improvement in on-farm storage, handling and waste practices.*
11. *Undertake regionally targeted education and awareness campaigns to improve storage, handling and waste practices on farm. This should be supported by the industry's broader extension and myBMP programs.*
12. *The SWG should undertake a materiality assessment of waste management to consider if targets and indicators, or other explicit reporting of industry performance in this area is required.*

Natural Resource Management

GHD considered practices relating to both soils and biodiversity in its assessment. It is noted that the industry has established goals for improvement for both of these topics in its sustainability framework, however challenges around defining and measuring improvement has meant that clear indicators and targets are not yet established. GHD observed that the industry is undertaking a number of projects regarding soil health and biodiversity, alongside broader agricultural industry initiatives.

GHD found that there is a strong understanding of the importance of soil health and its overall benefits to productivity amongst cotton growers, and to a lesser extent the benefits of remnant vegetation and riparian areas. Often where vegetation is retained, this is on the least productive land and faces additional pressures including grazing, exotic weed invasion, feral pests, changes to fire regimes, dryland salinity, and soil erosion.

It is important to note that broader stakeholder interest in biodiversity has increased since the Third Environmental Assessment and this is expected to continue with the introduction of a new Global Biodiversity Framework. Particular attention should be given to stakeholder concerns around biodiversity and native vegetation management as the industry continues its expansion in Northern Australia.

GHD makes the following recommendations in relation to the industry's ongoing work in this area:

13. *Continue cross sector work to establish indicators and targets for biodiversity and soil, including continuing industry specific investigations on nitrogen use and links to emissions.*
14. *Increase extension efforts to assist grower understanding and awareness of how they can increase their natural capital on farm.*

Energy, emissions and climate

Issues around energy use, emissions and adapting to climate change have received considerable global attention and subsequent shifts in stakeholder perceptions in the period since the Third Environmental Assessment. GHD observed that grower sentiment has also changed with an increasing focus on carbon and emissions, even if growers are not yet in a place to implement on-farm changes.

The industry has set itself a goal through the sustainability framework to contribute to the Paris Agreement's aim of a climate neutral world. This essentially means reducing the emissions released in cotton production while sustaining carbon in the soil and vegetation on cotton farms. Similar to soils and biodiversity, however, a GHG emissions target has not yet been developed by the SWG.

GHD found that growers were especially interested in the prospects of carbon sequestration to offset emissions and opportunities for carbon farming. The general consensus around this at present amongst growers was that the carbon farming system is still in its infancy and is hard to navigate. The agriculture sector as a whole is becoming increasingly aware of the role they can play in emissions reductions and offsets, and communications resources are becoming available to assist farmers in making choices for their own production systems such as the AgriFutures Australia publication 'A farmers handbook to on-farm carbon management' (Carbon Count 2022).

Growers participating in on-farm assessments and stakeholder consultation indicated that this is an area where they require more information to ensure they can make informed decisions. Resources and decision-making tools will help aid on-farm knowledge for growers to confidently implement changes to their practice.

GHD makes the following recommendations in relation to the industry's ongoing work in this area:

15. *Continue cross sector work to establish indicators and targets for GHG emissions and carbon storage, and ensure alignment with government policies and programs on the establishment of agreed methodologies.*
16. *There is a need for increased extension to growers in the area of energy, emissions and climate change. Due to the complex nature of climate change, carbon and GHG reporting, there is a role for industry to provide high-level information and share case studies and learnings amongst industry participants, with specialist, likely private sector, services required to offer growers more specific information to support on-farm decision making in respect to investment and/or market participation in this area.*

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1. Introduction

In 1991, cotton became the first Australian agricultural industry to conduct a full external examination of its environmental performance. This marked the first industry-wide commitment to improved sustainability of cotton production in Australia.

Each decade since, the industry has re-committed to reviewing its environmental performance by commissioning an independent assessment. Environmental assessments in 2003 and 2012 have recognised the cotton industry's achievements and driven further improvements. In response to the 2012 assessment, the industry made a public commitment to continue to undertake environmental assessments every decade. At the same time, the industry committed to five yearly progress reporting against agreed sustainability indicators and targets, which are aligned with the globally recognised United Nations Sustainable Development Goals (SDGs).

GHD Pty Ltd (GHD) was engaged by the Cotton Research and Development Corporation (CRDC) to complete the Fourth Environmental Assessment of the Australian Cotton Industry.

The recommendations from the assessment will be used to inform decisions for the industry to:

- Target its investments to deliver improved environmental outcomes
- Work with growers to continually improve environmental outcomes in cotton production
- Demonstrate responsiveness to community and stakeholder expectations on the impact of the industry on the environment.

The Fourth Environmental Assessment of the Australian Cotton Industry was undertaken between October 2021 and October 2022 and covers the period since the Third Environmental Assessment, being 2013-2022. The delivery of the project was overseen by a Project Steering Committee (PSC) from CRDC and Cotton Australia, and the industry's Sustainability Working Group (SWG), which comprises membership from CRDC, Cotton Australia, CottonInfo, myBMP, the Australian Cotton Shippers Association and industry growers.

1.1 The Australian Cotton Industry

Cotton is the most widely produced natural fibre in the world, and although Australia only produces around 3% of the world's cotton, it is the third to sixth largest exporter of cotton, depending on season (SWG 2014; Cotton Australia 2022a). Between 2014-2019, Australia's average annual gross value of cotton lint and seed production was \$1.8 Billion (SWG 2020). ABARES figures¹ estimate that between 2012-2022 the average annual gross production of cotton lint was 749 kt and cotton seed was 1,018 kt (ABARES 2022).

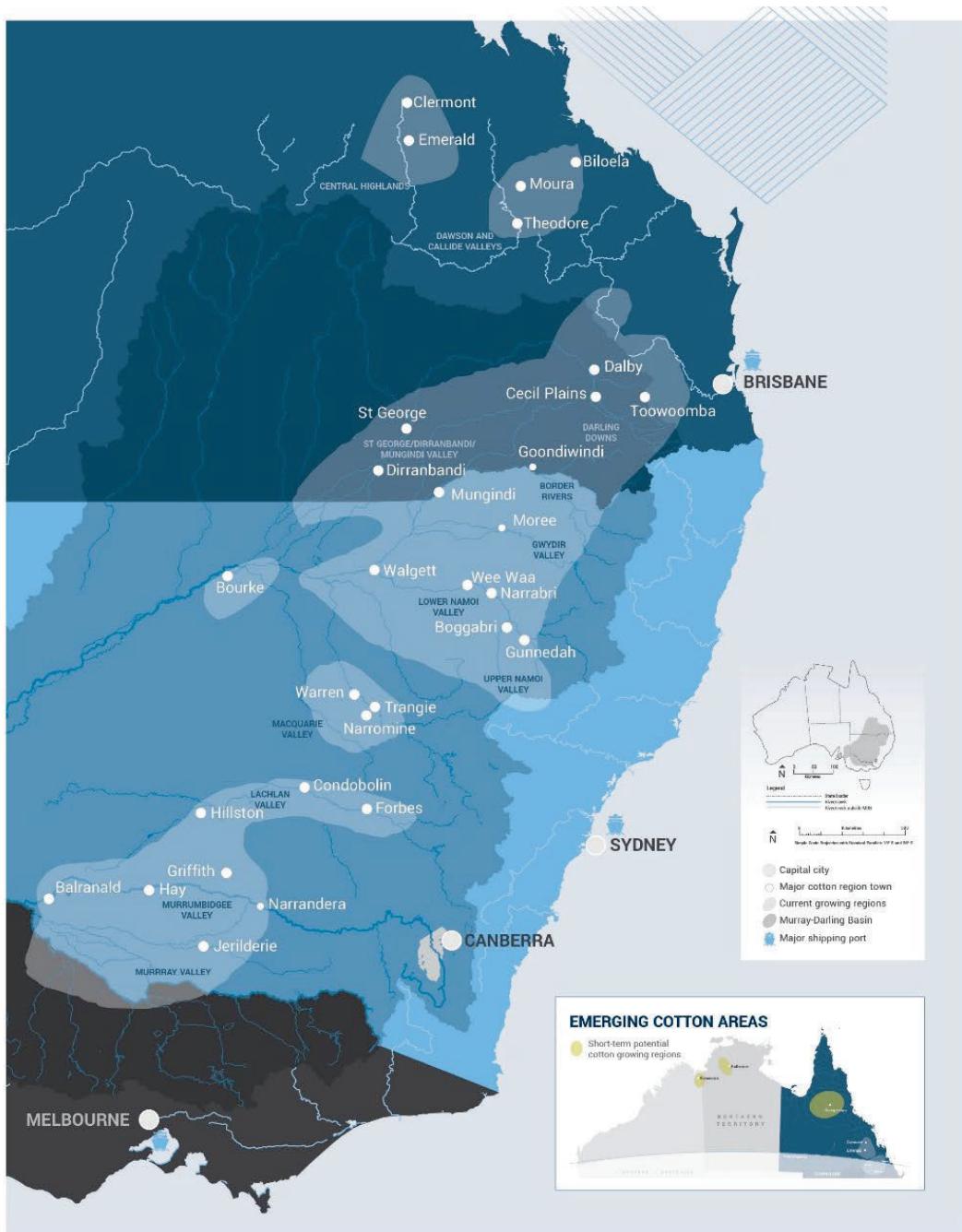
The Australian cotton industry is made up of approximately 1,500 farms, 90% of which are family-owned and operated (Cotton Australia 2022a). Cotton farms are estimated to employ around 10,740 people per year with further industry employment provided by regional ginning facilities and a range of farm services, including crop consultants, input suppliers, farming contractors, cotton classers and cotton merchants (SWG 2014, SWG 2020).

Cotton production in Australia is mostly focussed in the 400-800 mm summer rainfall zone, such that a proportion of the crop's water needs are met by rain during the growing season (SWG 2014). In 2020-21, approximately 75% of the area of cotton grown in Australia was irrigated, with the rest rain fed (ABS 2022). It is important to note that irrigation allocation across Australia is in accordance with government regulations. The major cotton growing regions across Australia are shown in Figure 1.

Expansion of the industry's footprint is one of the most significant changes to cotton production in Australia in the ten years since the last environmental assessment. In particular, the proportion of the crop grown in southern NSW, including the Lachlan, Murrumbidgee and Murray, has increased from 14% of NSW cotton production in the five years to 2014-15, to 28% of NSW cotton production in the five years to 2019-20 (NSW DPI 2021). This increase in cotton production in southern NSW is largely attributable to improved technology, including cotton varieties, which has meant a shift from rice production into cotton. Small areas of cotton have also been trialled as far south as northern Victoria.

¹ ABARES data used to give an indication for the period from the previous environmental assessment to this current assessment. Figures are estimates and therefore slightly lower than the industry figures (which do not cover the whole period)

Another major expansion has begun in the Northern Territory (NT), in line with the NT Government's plan to create new regional and remote jobs and build the economy (Cotton Australia 2022a). This will include a new cotton gin near Katherine (Rowley 2022). Due to significant improvements in the water efficiency of cotton crops and the large amount of wet season rainfall, it is estimated that 80% of cotton in the NT will be rain fed (not irrigated). In 2020/21, twelve farmers in the NT had planted 8,000 ha of cotton, only 2% requiring irrigation (Cotton Australia 2022a; Rowley 2022). Cotton expansion in northern Australia has also included production in Kununurra in Western Australia and on the Atherton Tablelands in Far North Queensland.



COTTON AUSTRALIA LIMITED
www.cottonaustralia.com.au



Figure 1 Major Australian cotton growing areas. Source: Cotton Australia

1.2 Key Industry organisations

There are five key organisations that underpin the Australian cotton industry as outlined below.

Industry organisation	Description
 CRDC COTTON RESEARCH AND DEVELOPMENT CORPORATION	The Cotton Research and Development Corporation (CRDC) is a partnership between cotton growers and the Australian Government, investing in world-leading cotton research, development and extension outcomes for cotton and its communities (SWG 2020).
	Cotton Seed Distributors Ltd. are Australia's supplier of cotton planting seed; investing in plant breeding (in partnership with CSIRO), variety and agronomic research, development and extension (SWG 2020).
	Cotton Australia provides a united voice for cotton growers across R&D priorities, government policy, stewardship, and cotton production issues (SWG 2020).
	CottonInfo commenced in 2012 as the Australian cotton industry's extension program, delivered by a joint venture between Cotton Australia, Cotton Seed Distributors and CRDC. The program connects growers, consultants and agronomists with the latest research, technologies and innovations, supporting the industry to achieve best practice.
	myBMP is the Australian cotton industry's voluntary certification standard, demonstrating cotton growers' achievement of best management practice at the farm level and allowing them to access certain markets

1.3 Structure of the report

This report presents the findings of the Fourth Environmental Assessment of the Australian cotton industry. Section 2 outlines the approach to completing this Environmental Assessment and includes reference to the Assessment Framework contained in Appendix B. It describes the process for selecting stakeholders and growers to engage with, and the procedure used for on-site farm visits. Section 3 provides a summary of the outcomes of the three previous environmental audits and assessments of the industry. Current and emerging environmental issues and their implications for industry and on-farm management are discussed in Section 4, with the findings from the assessment of whether industry action and on-farm practices align with the identified trends and expectations presented in Section 5. The summary of recommendations from the assessment are provided in Section 6. Supporting information is found in the Appendices.

1.4 Scope and limitations

This report has been prepared by GHD for Cotton Research & Development Corporation and may only be used and relied on by Cotton Research & Development Corporation for the purpose agreed between GHD and Cotton Research & Development Corporation as set out in sections 1 and 2.1 of this report.

GHD otherwise disclaims responsibility to any person other than Cotton Research & Development Corporation arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Cotton Research & Development Corporation and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.5 Acknowledgements

GHD acknowledges the guidance and feedback from the PSC and SWG, as well as input from the numerous stakeholders consulted, including representatives of the Australian Cotton Sustainability Reference Group (ACSRG). In particular, GHD acknowledges the time and effort provided by growers hosting on-site farm visits.

2. Methodology

2.1 Terms of Reference

The Terms of Reference for the Fourth Environmental Assessment of the Australian Cotton Industry were to:

1. Assess the cotton industry's response to the recommendations made in the Third Environmental Assessment (see Section 3.3.1)
2. Identify current and emerging industry environmental issues and their implications for the industry and on-farm management. Policy developments, recognised global sustainability goals or initiatives, and industry and non-industry stakeholder perceptions and expectations should be considered (see Section 4)
3. Assess current industry action on environmental issues in light of the Third Environmental Assessment and identified environmental issues (see Section 5). This includes, but is not limited to:
 - a. Impact: if the industry's on-farm environmental practices and outcomes are in line with current and future expectations and trends
 - b. Responsiveness: how well industry bodies, the myBMP Program, CottonInfo and sustainability programs are aligned; how well is industry able to identify and respond appropriately to environmental issues
 - c. Consideration of stakeholder concerns and perceptions of industry action to address environmental issues. Different perspectives should be considered e.g. cotton industry (gins, shipping), state government, federal government, community and non-government organisations
4. Recommend priorities for action based on the findings from 1, 2 and 3 above (see Section 6).

The scope of the Fourth Environmental Assessment included investigations of the environmental impacts of cotton production on-farm, including myBMP and non-myBMP farms, and excluded cotton gins, seed companies and other input suppliers. It is further noted that on-site farm visits were limited to the major growing areas of NSW and Queensland due to logistical challenges arising from COVID-19 and other factors restricting the ability to visit farms in northern Australia during the period of the assessment.

2.2 Approach

The environmental assessment was guided by an Assessment Framework (Appendix B), which was developed by GHD with input from the Project Steering Committee. The Assessment Framework outlines the assessment approach and evidence sought to address the Terms of Reference. There were five key elements to the approach, as further outlined in the sections below.

It is noted that similar to previous environmental assessments, GHD did not attempt to obtain a representative sample of stakeholders in consultation activities, rather the intent was to hear from a diverse range of industry stakeholders, as well as those members of the community who wished to participate and share their perspectives.

2.2.1 Desktop review

GHD undertook a desktop review of a range of information and data sources to inform the assessment. This included international and national literature to inform the understanding of current and emerging environmental issues, as well as a comprehensive review of publications, grower and stakeholder surveys, previous environmental assessments, sustainability reports, myBMP standards, organisational strategic plans, and media and communication products specific to the Australian cotton industry.

The reference list for this report is provided in Appendix A.

2.2.2 Online stakeholder questionnaire

An online questionnaire was developed to gather insights and perspectives from a wide range of stakeholders to inform the assessment. The survey was open for a period of approximately 4 months, from February to June 2022.

GHD emailed the survey link to approximately 270 individuals or organisations inviting them to participate and/or distribute the survey to others in their networks. This list included the following key stakeholder groups:

- Agricultural and environmental peak groups and representative bodies
- State and federal government environmental and agricultural agencies, including Rural Research and Development Corporations
- Local government organisations across the growing regions in the various states
- Natural resource management regional bodies
- Community groups and other non-government organisations (NGOs).

The online questionnaire was also widely distributed by CRDC and Cotton Australia through their own networks and newsletter distribution lists. This included the SWG and ACSRG. It is important to note that the online questionnaire was not intended to achieve a representative sample but rather to gain insights to the various stakeholder perceptions that exist around the Australian cotton industry's environmental management and performance, as well as to inform the identification of current and emerging issues.

A total of 53 responses were received, including members of the cotton industry and its supply chain, other agricultural producers or organisation representatives, government agencies, NGOs, education and research institutions, community groups and private citizens. While respondents indicated they were located across all states and territories (excluding Victoria and the ACT), the majority of responses came from participants in the NT (36%) and NSW (35%).

The online stakeholder survey questionnaire and a summary of responses is provided in Appendix C.

2.2.3 On-site farm visits

A key component of the Fourth Environmental Assessment was to undertake on-site farm visits in a number of the major growing regions, with the aim to assess both myBMP and non-myBMP farms and incorporating a range of different farm characteristics, e.g. corporate vs. family farm, dryland vs. irrigated production, etc.

It is noted that while the environmental assessment considered the whole of the Australian industry, site visits were focused on the major growing regions of Queensland and NSW. Northern Australia was excluded as a result of COVID-19 travel restrictions in place at the time, while the relatively small area under production in Victoria meant that it was not practical to include visits to this area. Growers from these areas were invited to participate in the online grower questionnaire.

A total of 25 farm visits were undertaken in four separate regional trips to Northern NSW / Southern QLD (5), Southern NSW (8), Central NSW (5), and Central QLD (7). It is noted that there were some disruptions to farm visit program due to both COVID-19 implications and ongoing wet weather conditions. Of the 25 farms visited, 9 (36%) were myBMP certified, 8 (32%) registered with the myBMP program, and 8 (32%) were not participating in the myBMP program. Three (12%) of the farms visited were managed by corporate entities, with the remaining 22 (88%) family farms.

Farm assessments were undertaken by experienced and certified Exemplar Global Environmental Management Systems Auditors. It is important to note that while the relevant audit standards were referenced in developing assessment criteria, the visits were not audits in themselves. Farmers remain anonymous and were not issued with 'non-conformances' or 'corrective actions' as is standard auditing practice.

Farms were assigned with a grading of 'excellent', 'very good', 'good' or 'poor' for each assessment criteria based on a combination of both grower responses in interviews and by site observations.

A summary of the assessment criteria and gradings used for the on-site farm visits is provided in Appendix E.

2.2.4 Online grower survey

An online grower survey questionnaire was utilised to gather grower specific insights on current and emerging issues as well as perceptions in relation to industry practice and performance. Further, the online grower questionnaire was intended to provide the opportunity for growers across Australia's cotton growing areas to participate in and contribute to the assessment.

The online grower survey was open for approximately two months across August and September 2022 and widely promoted by CRDC and Cotton Australia, including through their regional staff as well as at the 2022 Australian Cotton Conference. A total of 16 grower responses were received, 9 of which were from growers in the Macquarie Valley. It is likely that the number of responses received reflected a degree of survey fatigue amongst cotton growers given the annual CRDC grower survey, which received over 200 responses, was completed only a month prior. Despite the relatively low level of responses received, the grower responses provided a useful comparison of perceptions of current environmental issues, and industry performance against those provided by other stakeholder groups. For the purposes of the assessment, additional information relating to on-farm practice was compared against information contained in the CRDC's annual cotton grower surveys and the on-farm observations undertaken as part of this assessment.

The online grower survey questionnaire and a summary of responses is provided in Appendix D.

2.2.5 Targeted stakeholder consultation

Finally, targeted consultation activities were undertaken to inform the assessment. Targeted consultation was undertaken to gain more detailed insights from stakeholders with a reasonable knowledge and/or exposure to the industry, as well as input from relevant subject matter experts. Over 50 individuals participated in the various consultation activities undertaken during the course of the assessment, which included:

- Input from the CRDC/Cotton Australia Project Steering Committee
- Consultation with and observations of quarterly Sustainable Working Group meetings (October 2021, March, June and October 2022)
- Consultation with and observations of the Australian Cotton Sustainability Reference Group (November 2021 and November 2022)
- Key informant consultations to gather stakeholder insights and perceptions, clarify industry information and/or obtain expert advice. These consultations typically followed a semi-structured interview approach using questions similar to that contained in the online stakeholder survey.

Targeted stakeholder consultation activities were at the discretion of the Assessment Team and included anonymous input from growers and industry organisations, supply chain participants, other agricultural, government, NGO, education/research, and community representatives.

3. Industry response to previous environmental assessments

3.1 First environmental audit

The first environmental audit of the Cotton industry was completed in 1991. The scope was to investigate the environmental impacts of cotton production, from the establishment of new cotton farms to the production of ginned, raw cotton (Arbour International and Gibb Environmental Sciences 1991).

This audit included a detailed literature review, synthesising the vast amount of information on various aspects associated with the industry, an environmental questionnaire sent to key stakeholders (including growers), targeted interviews (71) and site visits (20). There were 31 recommendations concerning pesticide use, 7 concerning land use, 11 concerning water use, and 20 concerning cotton processing.

3.2 Second environmental audit

GHD completed the second environmental audit of the Cotton Industry in 2003. The aims of the second audit were to assess the industry's response to the first audit's recommendations, identify current environmental issues faced by the industry and recommend strategies and priorities to further improve the cotton industry's environmental management practices (GHD 2003). It was found that all 44 applicable recommendations from the first environmental audit had been implemented with high or partial compliance, only 5% rated as low compliance. The industry was (at that time) facing increased scrutiny due to fish kills from pesticides, pesticide impacts on the cattle industries (endosulfan), and perceived high water use.

The audit methodology included a review of documentation, surveys and interviews of relevant stakeholders (government, community and environment groups, industry) (including two workshops), and site inspections (farms, cotton gins and seed processing facilities). GHD reported standout industry improvements from the previous audit, which included:

- Formulation and implementation of Best Management Practices (BMP) approach to cotton farming and environmental management
- Improved pest management, including less reliance on pesticides and Integrated Pest Management strategies including use of genetically modified cotton
- Conducting strong research, extension and development program (leading to improved management practices in relation to pesticide use, pest management, water use (and efficiency), vegetation and land management, waste recycling and disposal, wildlife management and biodiversity).

The Audit made 48 recommendations (broken into 126 sub-recommendations) across various areas (mostly aligned with BMP modules) for both farms and processors. The audit concluded that despite vast improvements from the 1991 audit, there were still improvements to be made by industry specifically in the areas of water management, pest management and pesticide use, and waste management.

3.3 Third environmental assessment

The third environmental assessment was completed in 2012 by Inovact Consulting. A terminology change from 'Environmental Audit' to 'Environmental Assessment' was enacted to reflect the auditing capabilities of the myBMP program (update of BMP program to online myBMP in 2010) and alignment with State and Commonwealth government understanding of strategic environmental assessments.

The approach included a computer aided telephone interviewing survey of 150 growers, visits to 10 farms, online stakeholder survey, telephone discussions with organisations in the industry's value-chain, and a small market research study of community perceptions. The assessment found 'High' adoption rates of 26 of the recommendations from the second audit report; 4 were rated as 'Low' adoption, 8 were 'Medium', and numerous had compliance by myBMP participants but unknown compliance by others; with the BMP/myBMP program shown to have driven cultural change and improvement across the industry.

The report summarised the major achievements of the industry in improving its environmental performance since the 2003 Environmental Audit as:

- Effective and responsible management of the industry's use of genetically modified cotton varieties
- The substantial reduction in the use of chemicals particularly insecticides and residual herbicides for cotton growing and the disappearance of serious off-farm impacts in rivers and wetlands
- Major gains in water use efficiency in cotton growing calculated at three to four per cent per year and effective management and stewardship of water resources on-farm
- Major advances in grower attitudes and action concerning natural resource management on farm and active engagement in landscape and catchment wide natural resource management, particularly management of deep drainage, riparian management, groundwater conservation and delivery of ecosystem services
- Significant uptake of integrated pest management (IPM) and the link being established between IPM and biodiversity conservation in terms of ecosystem services on-farm and at a landscape scale
- Development of an integrated research, development and extension system that delivers priority research and development and extends this to growers through an online best management practices program (myBMP) and the extension activities of the industry's key organisations such as Cotton Australia and the commercial sector.

The recommendations from the Third Environmental Assessment (Inovact Consulting 2012) and GHD's assessment of the industry's response (ToR 1) are outlined below.

3.3.1 Assessment of industry response to recommendations from the Third Environmental Assessment

Inovact Consulting (2012) made six recommendations in its final report on the Third Environmental Assessment of the Australian cotton industry as outlined in Table 1. The industry issued a [formal response to the recommendations](#) of the Third Environmental Assessment via a joint statement from CRDC and Cotton Australia in February 2016. GHD has considered this response along with information reviewed as part of the Fourth Environmental Assessment on industry initiatives undertaken since the response was issued, and feedback obtained from consultation with industry stakeholders. GHD's assessment of the industry's response to the recommendations is based on a subjective scoring system (✓✓✓ - achieved, ✓✓ - partially achieved, some progress made, X - not achieved) and is summarised in Table 1 below.

Table 1: Assessment of industry response to the Third Environmental Assessment recommendations

No.	Recommendation	Progress	Comments
1	That CRDC work with its grower base, Cotton Australia, the industry's value chain, cotton industry service providers, the Australian Government and relevant state government agencies to develop a five-year RD&E strategy for continuous improvement in environmental management and performance in cotton growing.	✓ ✓ ✓	The cotton industry has a number of strategic plans, as outlined in Appendix C, all of which have identified environmental and sustainability areas of focus. The CRDC Strategic Plan, which guides the industry's RD&E investment is currently being developed for a new five-year period, i.e. 2023-2028, and aims to more closely align with the SWG PLANET. PEOPLE. PADDOCK. goals.
2	That the industry undertakes a significant re-appraisal of myBMP and its role in the industry's assurance to markets and other stakeholders of best practice environmental stewardship by growers.	✓ ✓	In its 2016 response to the recommendations, the Australian cotton industry reported that it had undertaken a reappraisal of myBMP and its role in both delivering on-farm environmental stewardship and helping to underpin access to market strategies. A key milestone was the recognition of myBMP by the then Better Cotton Initiative, allowing myBMP certified growers access to this market. The industry also noted that an upgrade was underway to improve the value, impact and accessibility of the myBMP program and its platform for the direct benefit of growers. In the Fourth Environmental Assessment, GHD found that myBMP has continued to drive the standards for best management practice across the industry. While the program is well recognised and its resources extensively used, widespread myBMP accreditation has not yet been achieved.
3	That CRDC and Cotton Australia collaborate on establishing accurate and up to date databases of cotton growers and key industry stakeholders to ensure that the industry organisations effectively engage levy paying growers and influential stakeholders on industry plans and performance reporting regarding environmental management and practices.	✓ ✓	GHD concludes that while progress has been made since the Third Environmental Assessment, the myBMP program will need to continue to evolve to provide a more effective and efficient environmental management and performance tool. The program has significant potential to achieve the complementary objectives of adding value to growers at the farm level, substantiating the industry's sustainability credentials, and ultimately, underpinning market assurance.
4	That the industry continue to commission independent environmental assessments of cotton growing in five-yearly time periods to establish longer term trends in its environmental	✓ ✓ ✓	CRDC and Cotton Australia have outlined that they are committed to, and are working together to achieve, collaboration on accurate and up to date databases of cotton growers and key industry stakeholders to ensure greater communication and engagement with industry. Through our consultation with CRDC, Cotton Australia and the SWG, it is clear that an extensive distribution list is maintained of growers and other stakeholders with an interest in the industry's sustainability work. During the course of this Assessment, however, GHD found a number of discrepancies in the grower list, particularly in relation to myBMP status (note that this related to myBMP registration rather than myBMP certification). The Assessment Team also experienced difficulties in engaging growers to participate in the Assessment. While it is clear that efforts are being made to ensure currency of databases, and we acknowledge that there are challenges in sharing contact information across the different industry organisations due to privacy considerations, GHD considers that this is an area that will require ongoing work.
			Following the Third Environmental Assessment, the industry reaffirmed its commitment to commissioning independent environmental assessments every ten years. In addition to this commitment, the industry has commenced comprehensive sustainability reporting, incorporating environmental indicators, on a five-yearly basis with annual progress updates. The industry's

No.	Recommendation	Progress	Comments
	performance and data sets that provide evidence based assessments over long periods of time. It is also recommended that a practical monitoring, evaluation and reporting framework be established that will support evidence based annual reporting on the outcomes of environmental management in cotton growing.		SWG oversees the implementation of its sustainability framework and undertakes quarterly materiality scans to ensure its ongoing currency and relevance. GHD considered whether the sustainability framework that has been developed since the Third Environmental Assessment negated the need for the ten yearly environmental assessments, given it includes material measures of environment performance. It was concluded that environmental assessments, with a particular focus on independent on-farm assessments of both myBMP and non-myBMP growers across the various growing regions, are still warranted. The industry might re-consider the ongoing need for independent environmental assessment when and if the certification of farms through the myBMP program is taken up more broadly.
5	That the cotton industry value chain, including the grower sector, actively engage with market based initiatives such as the Better Cotton Initiative to monitor international consumer preferences and retailer strategies and actions so that this intelligence can be incorporated into industry strategies and actions for improvements in environmental practices that are market driven.	✓ ✓ ✓	Since the previous assessment, the industry has actively engaged in market-based initiatives in response to this recommendation through the Cotton to Market strategy, which was established in 2013, driven by Cotton Australia, and underpinned by research from CRDC. Key achievements during this time have included the establishment of the cottonLEADS partnership, the benchmarking of myBMP with the Better Cotton Initiative (now Better Cotton) and establishing relationships with 30 active brand partners. GHD notes that as the Cotton to Market strategy is now at the ten-year mark, the industry is appropriately reviewing and redeveloping its strategy to ensure alignment between industry and customer needs. The new Strategic Roadmap will consider how increasing demands for transparency and traceability can be met through the industry's sustainability framework, myBMP program, and other industry data.
6	That the industry continue its market research on consumer, community and stakeholder perceptions of the environmental performance and practices of cotton growing that updates and extends the previous studies to take account of how individuals and organisations now access information through contemporary media which has changed considerably since these studies.	✓ ✓ ✓	GHD observed that the industry undertakes a range of market research activities in relation to consumer, community, and stakeholder perceptions. Examples include research projects undertaken through the Cotton to Market program, partnership in the Community Trust in Rural Industries Program, and establishment of the Australian Cotton Sustainability Reference Group (ACSRG). An ongoing challenge remains as to how the industry is best able to use this information to undertake the range of necessary communication, education and marketing activities that are required to target its wide range of stakeholders. The recently announced Strategic Roadmap will provide a further opportunity for the industry to engage with its stakeholders with the aim of ensuring alignment between the industry's needs and that of its customers.

4. Current and emerging issues

The Third Environmental Assessment of the Australian cotton industry (Inovact Consulting 2012) was undertaken at a time of considerable national interest in the industry's water use and environmental stewardship, particularly in the context of the industry's location in the riverine areas of the Murray-Darling and Fitzroy Basins. In developing its priority areas for future industry action, Inovact Consulting noted that there had been a significant change in the context in which the industry faced its environmental management. It highlighted the following emerging drivers for improved environmental performance:

- The operating environment for the industry is much more complex and demanding in terms of improving business productivity and profitability
- Global competitiveness and market expectations of environmental stewardship
- The policies, programs and regulatory requirement of governments relating to the environment
- The long-term pressures on Murray-Darling Basin water resources and the prospective introduction of a Murray-Darling Basin Plan
- Public expectations for good environmental and social stewardship.

In line with Terms of Reference for the Fourth Environmental Assessment (ToR 2), GHD has reviewed a range of information sources and undertaken consultation with industry stakeholders to consider the current and emerging environmental issues relevant to the industry and its on-farm management. It found that the emerging drivers identified in the Third Environmental Assessment have continued to gather pace, with increasing public interest in environmental issues triggering a new swathe of international agreements and commitments, market responses, and domestic policies and programs relevant to the industry's operating environment. A summary of the key drivers and trends, and the implications for the Australian cotton industry are summarised in the following sections.

4.1 International trends and drivers

A major global policy development since the Third Environmental Assessment has been the United Nations (UN) Sustainable Development Goals (SDGs). The 17 Sustainable Development Goals (SDGs) were adopted by all United Nations (UN) member states in 2015, along with the 2030 Agenda for Sustainable Development (UN n.d.). The SDGs aim to involve all countries in taking simultaneous action to move towards ending poverty, improving health and education, reducing inequality, spurring economic growth, whilst tackling climate change and working to preserve our oceans and forests (UN, n.d.). The Australian cotton industry has recognised the importance of the UN SDGs and the role they can play in contributing to achieving the SDGs, aligning their own sustainability framework with the relevant SDGs, as outlined in Table 2 (Cotton Australia and CRDC 2020).

Table 2: *Australian cotton industry's alignment with the UN Sustainable Development Goals*

SDG	Description	Australian Cotton's contribution
6  CLEAN WATER AND SANITATION	Ensure availability and sustainable management of water for all.	WATER: Research has shown a long-term trend of a reduction in the volume of water needed to grow a bale of Australian cotton every five years. This trend is the result of sustained research and practice change. Maintaining this trend will become increasingly difficult over time and will require increasingly more effort. There is alignment with CRDC's 'less drops per crop' sustainability initiative.
13  CLIMATE ACTION	Take urgent action to combat climate change and its impacts.	CARBON: The industry is working to reduce emissions, increase the amount of carbon stored on farms, and accurately measure their net carbon footprint. For many years the industry has invested in research and adoption to strengthen grower resilience.

SDG	Description	Australian Cotton's contribution
15 LIFE ON LAND 	Protect, restore and promote sustainable use of terrestrial ecosystems, halt and reverse land degradation and halt biodiversity loss.	BIODIVERSITY: The industry is working toward more accurate measurements of native vegetation and to increase the area of cotton farmland managed for conservation. Biodiversity on cotton farms can provide natural pest control and pollination, control erosion, store carbon and enhance water retention.
12 RESPONSIBLE CONSUMPTION AND PRODUCTION 	Ensure sustainable consumption and production patterns	PESTICIDES: The industry is working to reduce the volume of pesticides, & to reduce their toxicity to human health and the environment. Central to this is Integrated Pest Management, a strategy to manage pests with a range of practices including crop rotations, weed control, and native vegetation and refuge crops to house 'beneficial' insects and birds.
2 ZERO HUNGER 	Promote sustainable agriculture.	EFFICIENCY: The industry invests heavily in research to increase yields, and innovative cotton growers spend time and money adopting this research and new technologies.
8 DECENT WORK AND ECONOMIC GROWTH 	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.	PROFITABILITY: Profitability is a fundamental sustainability indicator for growers. Profitable cotton growers can re-invest in their own business, and contribute to local communities, economies and the environment. SAFETY: Agriculture contributes disproportionately to workplace health and safety incidents across Australia. The industry acknowledges that more needs to be done to reduce the number of deaths and serious injuries on cotton farms.
5 GENDER EQUALITY  10 REDUCED INEQUALITIES 	Achieve gender equality and empower all women and girls. Reduce inequality	DIVERSITY: The industry has programs to support a diversity of age, gender, and Aboriginal and Torres Strait Islander people in the cotton industry. The industry also monitors the cultural diversity of our workforce.
4 QUALITY EDUCATION 	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	TRAINING: Building the adaptive capacity of the Australian cotton industry is essential to maximise opportunities and minimise disruptions caused by technological transformation and environmental changes. The industry is investing in science and innovation capability, new knowledge and futures thinking to build this capacity.
3 GOOD HEALTH AND WELL-BEING  17 PARTNERSHIPS FOR THE GOALS 	Ensure healthy lives and promote well-being for all at all ages. Strengthen the means of implementation and revitalise the global partnership for sustainable development.	WELLBEING: The industry has just started to monitor the wellbeing of cotton growers and their communities. They are using this information to understand if and how they can do more to work with government, communities, other industries and individuals to improve the welling and social capital of their people and regional communities.

Also in 2015, another significant international development occurred with the Paris Agreement, which was entered into force in November 2016 (AGDISER 2021). The Paris Agreement is a legally binding international treaty aiming to limit temperature increase to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels (UN 2022). Global (averaged) air temperature has increased 1°C since 1850 and each decade since the 1980s has been warmer than the last (CSIRO and BoM 2015). While the Paris Agreement is focused on reduction in emissions, additional key aspects are climate change mitigation and adaptation, which will include managing water use to adapt to increasing temperature, extreme weather events and drought. Parties to the Agreement (of which Australia is) are required to communicate their Nationally Determined Contribution (NDC) every five years (UN 2022). These NDCs provide information on actions and progress towards the Paris Agreement goals. Additionally, all countries are required to annually report GHG emissions and progress towards their NDC.

More recently, the Secretariat of the UN Convention on Biological Diversity (CBD) released the draft of the new post-2020 Global Biodiversity Framework, which is due to be further considered at the CBD's next meeting of its 196 Parties, COP-15, to be held in Montreal in December 2022 (CBD 2021). The Framework in its current form sets out targets and milestones to be achieved by 2030 on the path toward 'living in harmony with nature' by 2050. It includes 21 targets, one of which is a global conservation target for land and sea areas of 30% by 2030 – a goal which the new Federal Environment Minister, the Hon Tanya Plibersek MP, announced support for when she released the 2021 State of the Environment report in July of this year.

Increasingly, there is now reference to becoming 'nature positive' following G7 leaders agreeing to halt and reverse biodiversity loss by 2030, announcing that it is not just necessary to reach net zero by 2030, but also to become 'nature positive' (G7 2021). The G7 2030 Nature Compact, agreed at Cornwall in 2021, contains four pillars:

- Leading the transition to sustainable and legal use of natural resources
- Investing in nature and driving a nature positive economy
- Protecting, conserving and restoring nature, including through ambitious global targets
- Prioritising accountability and implementation of commitments for nature.

With many of these international commitments being driven by European leaders, it is no surprise that European countries are amongst the first implementing strict new legislations and market requirements focused on improved environmental stewardship and sustainability. In a presentation titled, 'What's lurking over the horizon?' at the 2022 Australian Cotton Conference, CRDC's General Manager, R&D Investment, Allan Williams, pointed to the following European Union (EU) initiatives as having particular relevance to the Australian cotton industry:

- EU Green Deal – a set of policy initiatives agreed by the European Commission in 2020 with the overarching aim of making the EU climate neutral in 2050, to be supported by the investment of 1 trillion Euros in funding. The textile industry is explicitly called out in these policies, identified as having the 4th highest environmental impact
- EU Circular Economy Action Plan (CEAP) – the European Commission adopted a new CEAP in March 2020 as one of the main building blocks of the EU Green Deal. The plan aims to reduce pressure on natural resources and to create sustainable growth and jobs
- EU Textile Strategy – a strategy for sustainable and circular textiles that aims to create a 'greener' and more competitive textiles sector by looking at the entire lifecycle of textile products. The four-part 2030 vision for textiles includes that "fast fashion is out of fashion".

In another session on sustainability at the 2022 Australian Cotton Conference, Senior Commodity Analyst for Rabobank Analyst, Cheryl Kalisch Gordon, addressed the question as to whether the current world economic turbulence would affect the international environment and sustainability agenda. She concluded that while the current global turmoil does challenge political and consumer resolve for sustainability, it is not expected to change the direction of the trend.

4.2 Global market responses

4.2.1 Market transparency and reporting

Globally, markets and their participants are adjusting to comply with a changing regulatory environment as well as respond to consumer expectations around sustainability and environmental stewardship. There are now an increasing number of frameworks, standards and reporting mechanisms aimed at allowing entities to increase the level of transparency relating to their environmental credentials and sustainability more broadly. These include:

- ESG is the terminology used to describe how entities are incorporating Environment, Social and Governance (ESG) priorities into their strategy, operations and reporting. The Australian Farm Institute (AFI) has been doing considerable work in this area and recently hosted its Annual Roundtable event on the topic, to provide a forum to discuss the capability and capacity of Australian agriculture in ESG
- The Global Reporting Initiative provides a set of standards and tools for increasing transparency through sustainability reporting
- The Science Based Targets initiative (SBTi) is a partnership between not-for-profit charity CDP (previously Carbon Disclosure Project), the UN Global Compact, World Resources Institute and the World Wide Fund for Nature (WWF) established to support the private sector and provide guidance to setting science-based emissions reduction targets. Rabobank (2022) reports that globally, the number of food and agribusiness organisations registering with SBTi more than doubled in 2021
- The Taskforce on Nature Related Financial Disclosures (TNFD), currently in draft form, intends to provide a methodology for entities, to quantify and report their impact on nature. The Taskforce comprises 34 individual Taskforce Members representing global financial institutions, corporates and market service providers representing a total US\$19.4 trillion in assets with a footprint in over 180 countries (TNFD n.d.)

Efforts by industries and individual entities to promote their environmental and sustainability credentials has also given rise to the term “greenwashing”, which is essentially the misrepresentation of credentials to gain a market advantage. This in turn has given rise to a new raft of international laws to counter this practice and ensure confidence in markets. The Australian Consumer & Competition Commission (ACCC) is one such regulator increasing their focus in this area. Markets are also responding to this threat through an increased focus on product traceability.

4.2.2 Sustainable brands

Through its Cotton to Market program, which began in 2013, Cotton Australia has actively sought to increase the global demand for Australian cotton by communicating and marketing it as a high quality, sustainable natural fibre. Key initiatives have included:

- Cotton LEADS: established in 2013 as a partnership between Cotton Australia and the US cotton industry (The Cotton Foundation), Cotton LEADS promotes the use of responsibly sourced cotton and providing evidence of best practice cotton production and traceability (SWG 2014). Cotton LEADS has over 200 global partners
- Better Cotton: in 2014 Cotton Australia joined the global program Better Cotton (formerly known as Better Cotton Initiative (BCI)). Better Cotton is focused on improving the sustainability of cotton farming globally and bringing together farmers, ginners, manufacturers, retailers, brands, civil society and grassroots organisations in a unique global community committed to developing Better Cotton (BC) as a sustainable mainstream commodity. The BC Standard System includes Better Cotton Principles and Criteria, which lay out the global definition of Better Cotton through seven guiding principles. These include crop protection, water management, soil health, biodiversity and decent work. The alignment of the myBMP program to BC allows Australian cotton growers to participate more effectively in the world market. In the 2021/22 Cotton Australia Annual Report it is reported that those producing BC marketed cotton were achieving a \$3-\$7 per bale price premium as textile brands lean towards sustainably produced cotton
- Textile Exchange: in 2016 myBMP became recognised as a Preferred Fibre by Textile Exchange (Textile Exchange 2022). Textile Exchange is a global non-profit organisation that publishes an annual Preferred

Fibre and Materials Benchmark, which is a platform that enables brands and retailers to measure, manage and track their use of preferred fibres and materials (Textile Exchange 2022).

A review of Better Cotton's Annual Reports for the past five years provides information on the global supply and demand of Better Cotton. The 2021 Annual Report (Better Cotton 2022) stated that it had been a record year for Better Cotton, with 260 Retailer and Brand Members collectively sourcing 2.5 million tonnes of Better cotton, accounting for 10% of global production. Importantly, this represented a 47% increase on 2020 sourcing volumes. Figure 2 shows the increase in the volume of Better Cotton grown throughout the world for the five year period from 2016/17 to 2020/21. It is also worth noting that the volume of Australian cotton produced as Better Cotton over the same period has remained relatively stable, representing around 3% of total Better Cotton produced. The volume from major competitor Brazil, has more than doubled over the same period and made up 42% of Better Cotton produced in 2020-21, with the second largest contributor being India, whose production of Better Cotton has almost tripled over the same period and in 2020-21 made up close to 20% of Better Cotton production.

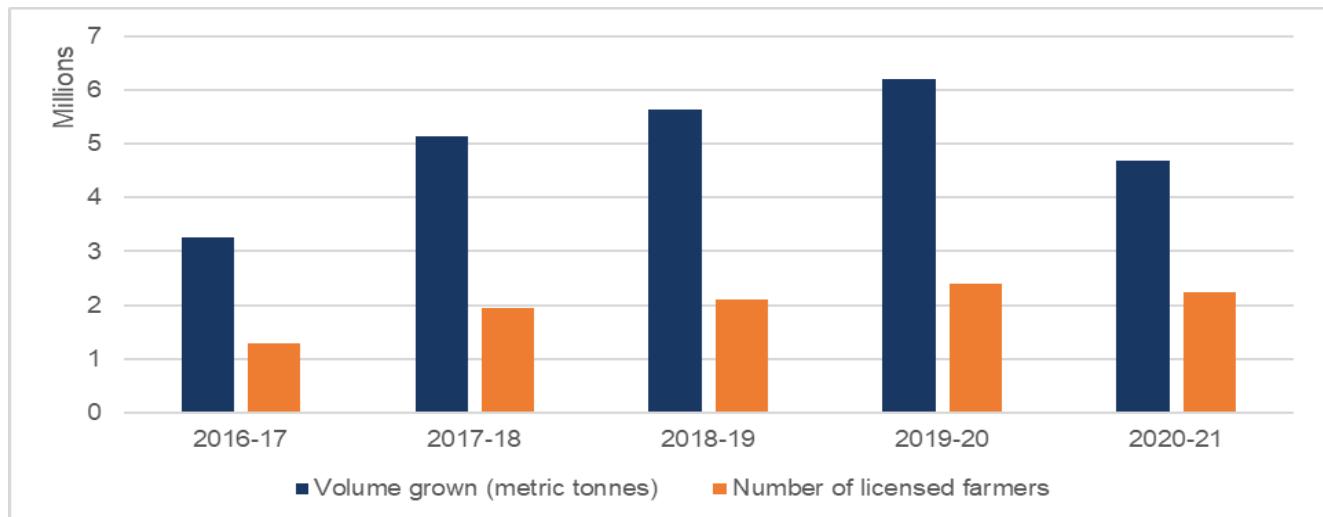


Figure 2 *Growth in world Better Cotton production and licenced farmers*

Cotton Australia has worked to increase awareness amongst brands operating in Australia. In 2016, the increased awareness and changing societal/consumer preferences led to the partnership between a prominent Australian clothing supplier and Cotton Australia. The supplier desired to transition to a sustainable cotton and minimise impacts on the environment and had customer research which perceived Australian Cotton as superior quality and a way to support local jobs and industry (SWG 2020). The supplier looked favourably on Cotton Australia's leadership in the sustainability space, the industry's partnership with Better Cotton (global sustainable cotton initiative) and the myBMP program as an example of global best practice in environmental management (SWG 2020).

Cotton Australia has successfully partnered with leading fashion labels to market ethically and sustainably sourced cotton garments. Some of the current brand ambassadors include Kmart, Country Road, Sussan, Bonds, Rod and Gunn and Elk the Label. Country Road is currently working with Landcare Australia on the Biodiversity Project to restore farmlands and support local farmers and responsible farming practices. The project is funded via sales of their Verified Australia cotton heritage sweats and profiles two NSW based cotton farming families and their commitment to sustainable farming (Country Road 2022).

4.3 Domestic context

4.3.1 Environmental policy and legislation

In the domestic setting, environmental management is heavily regulated as governments respond to both its international commitments and the Australian community's expectations around environmental management and protection. In its 2019 Sustainability Report, SWG reports that the Australian cotton industry is regulated by a strict legislative framework which is applied at federal, state and local government levels affecting all aspects of cotton farming operations, and in an environmental context includes:

- Management of irrigation water from dams and underground supplies
- Application of pesticides
- Storage and handling of pesticides and petrochemicals on-farm
- Licensing arrangements for access and use of transgenic traits
- Management of trees and native vegetation.

The industry's myBMP program is designed to assist growers manage and comply with their legal obligations. Around half of the 300 myBMP checklist items relate to industry best practice and provide evidence of legal compliance (SWG 2020).

The Third Environmental Assessment (Inovact Consulting 2012) cited long-term pressures on Murray-Darling Basin water resources, flagging the introduction of a Murray-Darling Basin Plan. Ten years later, there are still key elements of the Murray-Darling Basin Plan to be implemented, including water recovery in some of the industry's key growing areas. The Plan itself is also scheduled for review in 2026. Addressing the future challenges associated with climate change, and improving the recognition of First Nation's values and enhancing their involvement in water management are already flagged as key areas of focus (Houston 2022).

In the period since the previous assessment, the cotton industry has continued to suffer community backlash in relation to water use. In 2017, a report by the ABC program *Four Corners* alleged that water purchased by the Commonwealth Government was being pumped by irrigators and stored for irrigation of crops, including cotton, and that there were instances where water meters used by irrigators had been tampered with. The report prompted a number of government responses, including a Royal Commission by the South Australian Government, and establishment of the National Resource Access Regulator by the NSW Government to ensure compliance with NSW water laws, including use of water for irrigation.

Floodplain harvesting, a process by which overland flows are harvested following rainfall, flooding or natural rising of water to the surface, is an important source of irrigation water in northern NSW and Queensland growing areas, but has also been subject to considerable public scrutiny in recent years. Floodplain harvesting extraction is to be managed within the Sustainable Diversion Limits established in the Murray-Darling Basin Plan, with both NSW and QLD have licensing processes in place to limit floodplain harvesting to levels taken in the year 2000.

The NSW Floodplain Harvesting Policy has been in place since June 2021, and contains processes for determining floodplain harvesting entitlements, issuing of floodplain harvesting licences and monitoring and reporting of floodplain harvesting activities. Despite floodplain harvesting licences already being determined and issued for eligible water users in the NSW Border Rivers and Gwydir Valleys, regulatory amendments to support implementation of the NSW Floodplain Harvesting Policy have been disallowed three times in the NSW Parliament, resulting in a considerable degree of uncertainty for water users.

Queensland had previously issued a moratorium on additional floodplain harvesting in 2000 to prevent growth in harvesting volumes. At the time of writing this assessment, Queensland is planning (through the Queensland Rural Water Management Program) to improve measurement and monitoring of floodplain harvesting and has committed to full measurement and licensing of the Border Rivers and Moonie Floodplains to be in place by 2022.

In coming to Government in May 2022, the Federal Labor Government has been particularly critical of the previous government's implementation of the Murray-Darling Basin Plan and environmental policy more broadly. On release of the 2021 State of the Environment Report, which showed decline in Australia's natural environment, the Federal Environment Minister made a number of policy commitments, including promising a response to the Samuel Review of the EPBC Act and establishment of a Federal Environmental Protection Agency to enforce environmental law.

The Federal Water Minister also recently met with Australia's state and territory Environment Ministers where they made three **"landmark commitments"** to halt and reverse biodiversity loss across the nation:

- To work collectively to achieve a national target to protect and conserve **30% of Australia's landmass and 30% of Australia's marine areas by 2030**
- To note the Commonwealth's intention to establish a national **nature repair market** and work together to make nature positive investments easier, focusing on a consistent way to measure and track biodiversity

- To work with the private sector to **design out waste and pollution, keep materials in use**, and foster markets to achieve a **circular economy by 2030**.

The increased focus by governments on ‘nature-based solutions’, including the establishment of carbon and biosecurity markets, does provide some opportunity for Australian agricultural producers as the stewards of a large amount of Australia’s land and water resources. In its **2030 Roadmap**, the National Farmers Federation (NFF) has set a goal that the net benefit to farmers for the provision of ecosystem services is equal to 5% of farm revenue. Natural capital markets, however, have proven to be a complex and rapidly evolving area for growers to navigate. Consultation with stakeholders as part of this assessment and our observations through other work, suggests that while there is much interest from landholders around natural capital markets, there is also much confusion.

At the same time increasing restrictions have been placed on the use of natural resources in south-eastern Australia, government policies and programs have sought to expand irrigated agricultural production across Northern Australia. As noted in section 1.1, in recent years this has included the expansion of the Australian cotton industry to Far North Queensland, the Northern Territory and Western Australia.

4.4 Stakeholder perceptions of the Australian cotton industry’s environmental performance

As outlined in section 2.2, GHD sought to obtain a broad range of stakeholder views on the industry’s environmental performance through a combination of online grower and stakeholder surveys, and targeted consultations. There was a large change in demographic of the stakeholders participating in surveys and interviews carried out from the Third to the Fourth Environmental Assessment, resulting in different survey outcomes. The Third Environmental Assessment contained relatively positive perceptions from the stakeholder group about the environmental performance of the industry, whereas the Fourth received more diverse responses, possibly due to the greater diversity of respondents. It is noted that 19 of the 53 responses to the online stakeholder survey in the Fourth Environmental Assessment were from the Northern Territory, of which 9 rated the overall environmental performance of the industry as ‘very poor’. Growers were asked the same set of questions about overall industry performance and were far more positive in the responses, with all 16 respondents providing ratings of ‘very good’ or ‘good’.

The responses to the surveys and interviews provide some interesting insights to the varying perspectives across regions and stakeholder groups, as shown in Figure 3, Figure 4 and Figure 5 below.

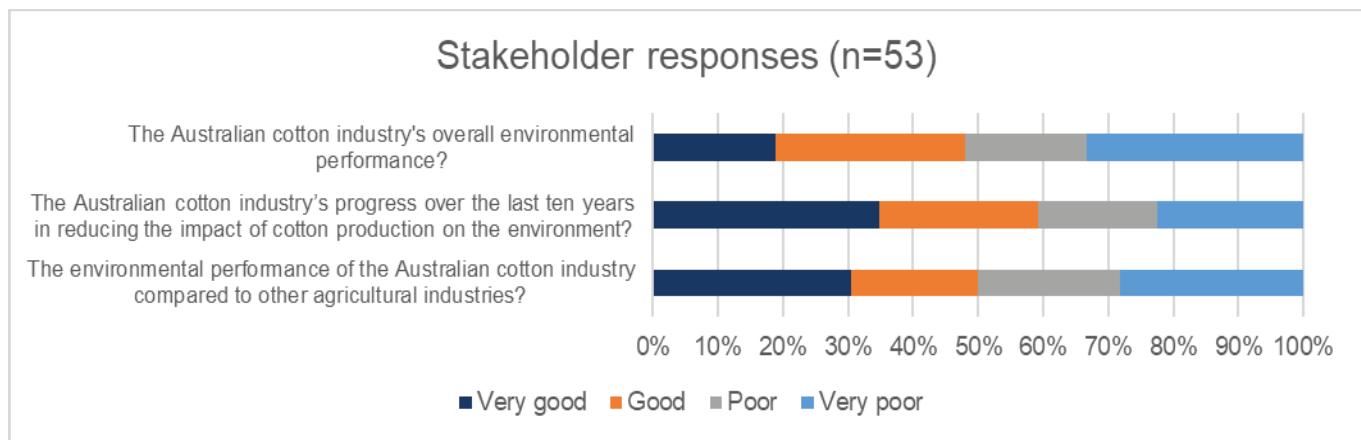


Figure 3 Stakeholder perceptions of the industry’s overall current environmental performance (online stakeholder survey responses)

Stakeholder responses (n=34, excluding NT)

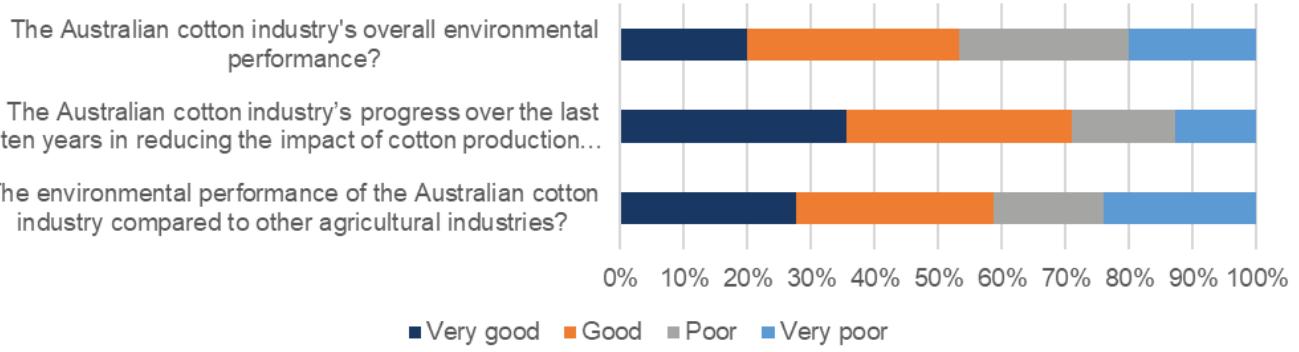


Figure 4 Stakeholder perceptions of the industry's overall current environmental performance, excluding responses from the NT

Grower responses (n=16)

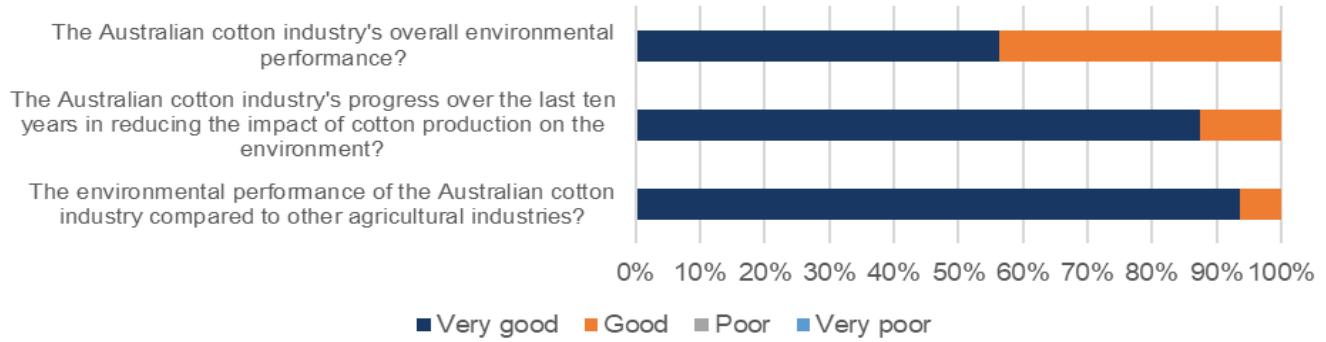


Figure 5 Grower perceptions of the industry's overall current environmental performance (online grower survey responses)

Both growers and stakeholders were also asked to identify the top environmental issues they considered the industry to be *currently* facing, as well those that the industry would need to take action on *over the next 5-10 years*. The responses are shown in Figure 6.

The stakeholder survey identified perceptions that ongoing focus will be on water, biodiversity, chemical use and climate change. Areas which are seen to be of an increasing focus over the next 5-10 years include resistance and climate change related issues. In the 2012 Environmental Assessment, water was the primary environmental concern, followed by emissions on-farm and soil health as emerging issues. Water remains the priority issue amongst stakeholders in 2022, followed by chemical use and biodiversity. Biodiversity was previously ranked as 8th most important, showing some shift in stakeholder perceptions of the importance of this issue. However, it is also worth noting that biodiversity did not feature in grower responses, with no grower participants rating it in the top three as either a current issue or an issue the industry needs to take action on in the next 5-10 years.

The issues of land clearing for cotton use and its related impacts on biodiversity, soil health and water use is a current and potentially growing issue in the Northern Territory leading to increased public interest. The stakeholder survey, along with in person calls, identified that there may be a different scope of environmental issues currently facing the Northern Territory compared to the more established cotton districts in Queensland and New South Wales.

In the case of the responses to the same question in the grower suvey, while water also ranked as the highest current and emerging issues, climate change was also considered important, as was issues around public perception, chemical and fertiliser use, and energy. This compares to grower responses in the Third Environmental Assessment where water use efficiency, pesticide/ herbicide use/ management, and managing sprays/spray drift ranked as the highest issues for growers, indicating that climate change related issues have increased in importance for growers since the previous assessment.



Figure 6 Stakeholder (left) and grower (right) perceptions of current and emerging environmental issues

4.5 Implications for industry

In summary, our review of current and emerging environmental issues with the potential to impact the Australian cotton industry and on-farm management found that the emerging drivers identified in the Third Environmental Assessment have continued to gather pace. Public interest in environmental issues has continued to increase, triggering a new swathe of international agreements and commitments, more stringent market requirements, and a range of domestic policy and program responses relevant to the industry's operating environment.

Throughout the course of our assessment, GHD has observed that the industry has sound processes in place to identify and respond to such issues, through the implementation of an industry-wide sustainability framework which is overseen by the SWG. In particular, materiality scans are undertaken quarterly to ensure current and emerging issues are identified and to identify their relevance to the industry's sustainability agenda. Having commenced sustainability reporting in 2014, the cotton industry is now contributing to work the Australian agricultural industry is undertaking more broadly, through the development of the **Australian Agricultural Sustainability Framework**². This framework seeks to communicate the sustainability status and goals of the Australian agricultural industry overall to markets and the community.

As was found in previous assessments, the industry is backed by a strong RD&E model – stakeholders commonly use the terms 'progressive', 'innovative' and 'collaborative' when referring to its track record. That being said, evidence of industry improvement over time and current observations of performance on-farm does not always align with public perceptions. Water management and use remains a particularly contentious issue, and competition for increasingly scarce water resources, particularly in the context of climate change, will continue to lead to public scrutiny in this area and increased regulatory pressures.

Expansion into new growing areas has the potential to increase the overall contribution of the Australian cotton industry to the national economy but will create new RD&E needs, as well as challenges for the industry's communication and engagement efforts. The industry has faced a number of challenges to its social licence to operate in the past (as outlined in previous assessments), and in this assessment stakeholders have flagged that as the industry's footprint expands, some of these issues may be revisited by new communities. It was also raised that the need to trial new approaches under different growing conditions, has the potential to increase the risk of environmental incident/s.

As well as the need to maintain social licence in the communities in which it operates, the industry will come under increasing pressure to meet new market expectations globally, as well as keep up with international competitors in this area. Not only are markets demanding increased transparency of the sustainability of industries and entities at the international level, but there is also an expectation of greater ambition in target setting. While it is clear that Australia's efficient production of high-quality cotton fibre presents opportunity for the domestic industry, and the industry has committed to goals and targets through its sustainability framework, market assurance through programs like myBMP are likely to become a minimum requirement for some markets in the future. That is, sustainability credentials may not attract significant premiums but will be necessary for Australian growers to retain market access.

In addition to increased transparency and ambition around the industry's environmental stewardship, traceability is also flagged to become increasingly important, predominantly as a means to counter 'greenwashing', but also as an opportunity for growers to connect with their end-users. The industry's new Strategic Roadmap and CRDC's digital and data strategy will be critical in helping the industry adapt to these needs efficiently.

² [The Australian Agricultural Sustainability Framework - Australian Farm Institute](#)

5. Assessment of industry performance

This section provides a summary of GHD's assessment of current industry action on environmental issues in light of the Third Environmental Assessment and the current and emerging issues identified in section 4. Consistent with ToR 3, our assessment has considered the industry's current priorities and key initiatives, on-farm practices and outcomes, and stakeholder concerns and perceptions on specific environmental issues. GHD's findings, conclusions and recommendations are presented under the key themes of:

- Environmental management and reporting
- Water use and management
- Pest management
- Agrichemical and petrochemical storage, handling and waste
- Natural resource management, including soils and biodiversity
- Energy, emissions and climate.

5.1 Environmental management and reporting

5.1.1 Overview of key industry initiatives

Since commissioning its first independent assessment of environmental performance in 1991, the Australian cotton industry's approach to environmental management and reporting has continued to mature and evolve. The Second Environmental Assessment (GHD 2003) found that the development and implementation of an industry BMP program was a driving factor behind improvement in environmental management observed on cotton farms between the first and second assessments.

While the Third Environmental Assessment (Inovact Consulting 2012) also found considerable improvements had been made in water, chemical and natural resource management on-farm and across cotton growing regions, it highlighted that increasing grower uptake of the BMP program, which by that stage been re-developed as myBMP, would be a major challenge for the industry. Re-invigorating myBMP and re-appraisal of its role in industry assurance was one of six key recommendations arising from the Third Environmental Assessment.

In response to another of the key recommendations from the Third Environmental Assessment, the Australian cotton industry released its first sustainability report in 2014, incorporating social, economic and environmental considerations (SWG 2014). Since this time, the industry has developed a comprehensive sustainability framework and reporting process, known as PLANET. PEOPLE. PADDock. The sustainability framework is overseen by the Sustainability Working Group (SWG) as depicted in Figure 7.



Figure 7 Sustainability Working Group overview. Source: SWG 2020

In the same year as the release of the Third Environmental Assessment (Inovact Consulting 2012), the industry launched a new extension program, CottonInfo, jointly funded by Cotton Australia, CRDC and Cotton Seed Distributors Ltd.

Together, the myBMP, CottonInfo and PLANET. PEOPLE. PADDOCK. underpinned by CRDC's research agenda and Cotton Australia's work in policy, communications and marketing, comprise the industry's key initiatives for managing and reporting on the environmental performance of Australian cotton producers. Further information on each of these three initiatives is provided below.

5.1.1.1 myBMP

Between the first and second environmental audits, the Australian cotton industry developed and implemented a Best Management Practices (BMP) program comprising of a BMP manual and audit program for assessing compliance against BMP guidelines (GHD 2003). The original 1997 program was reviewed and redeveloped in 2006-07 and relaunched as an online system titled 'myBMP' in 2010 (myBMP 2022).

The myBMP program is supported by the industry's research, development and extension efforts, and provides growers with a range of technical support and practical tools that allows them to assess, document and monitor their performance across ten modules:

Biosecurity	Sustainable natural landscape (natural assets)
Energy and input efficiency	Pesticide management
Fibre quality	Petrochemical storage and handling
Human resources and work health and safety	Soil health
Integrated pest management (IPM)	Water management

myBMP is structured such that each module identifies key areas, against which standards are established. These key areas and standards are supported by checklists, additional information, and resources. Each checklist item is assigned one of three levels:

- Level 1: identified legal requirements (i.e. what you must do)
- Level 2: industry identified best practice standards (i.e. what you should do)
- Level 3: innovative practices (i.e. new, cutting-edge practices).

Farmers may register for the voluntary program or undergo a formal audit to become certified. In this way, myBMP acts as the industry's assurance mechanism, helping the industry manage risks, and providing a central access point to the industry's best practice standards.

To achieve certification, growers must register and undertake a self-assessment of their farm/s, and once all level 1 and 2 checklist items have been achieved, they can request to progress through the audit process. Once achieved, certification remains current for five years, at which time re-certification through the audit process is required. It is noted that 10% of myBMP certified farms are randomly audited in any given year, with growers able to re-start the five-year certification period if they achieve compliance with the random audit.

In 2014, Cotton Australia was successful in achieving recognition of the myBMP program with the global Better Cotton program. As noted in section 4.2.2, the alignment of myBMP allows growers access to the Better Cotton market, which is currently estimated to achieve a small price premium in the range of \$3-\$7 per bale (Cotton Australia 2022b).

5.1.1.2 CottonInfo

CottonInfo was initiated in 2012 as a joint venture of Cotton Australia, CRDC and CSD targeting extension of research and best practice amongst growers and other industry participants in cotton. CottonInfo's purpose is highly aligned with that of myBMP, delivering research and development on best practice to inform myBMP's criteria framework for growers to voluntarily follow and achieve certification. The overarching aims of CottonInfo are centred around:

- Improving industry best practice
- Improving research and development communication
- Improving industry responsiveness.

The environmental areas which CottonInfo supports industry with include nutrition, soil health, water management, pesticide use efficiency, energy use, carbon and climate, biosecurity, disease and insect management, and natural resource management. CottonInfo has also published a strategic plan from 2018-2023, detailing strategic goals in:

- Improving the rate and reach of adaptation and adoption of research and development
- Enable successful cotton industry expansion
- Prepared to respond to biosecurity threats and assist in the event of natural disasters
- Provide an effective extension team, and a trusted information source.

CottonInfo's team includes sub-teams of; Regional Extension officers, Technical Leads, and myBMP experts. This team has been designed to encourage collaboration between researchers and industry.

5.1.1.3 PLANET. PEOPLE. PADDOCK.

Since the Third Environmental Assessment, Cotton Australia and the CRDC have made great strides in identifying and progressing towards sustainability targets, committing to review and produce an industry-wide sustainability report on a regular basis to support continuous monitoring and improvement of its performance. In 2014, the industry produced the first Sustainability Report which provided data on 45 social, economic and environmental indicators. The Sustainability Working Group (SWG) was formed in 2016 with the purpose to oversee the industry's ongoing commitment to sustainability reporting and implementation and coordinate its work to become a global leader in sustainable cotton production.

The Australian cotton industry now operates within a sustainability framework – PLANET. PEOPLE. PADDOCK. This framework is not a compulsory standard or brand for the industry, rather it is a framework that recognises sustainability as an integral part of doing business. The framework has been created to guide work to:

- Set sustainability targets in the areas most important to industry and stakeholders
- Coordinate a whole-of-industry strategy to achieve these targets
- Engage effectively with stakeholders on actions and progress.

In 2018 the SWG sought feedback on draft sustainability targets from a greater stakeholder group including: cotton industry representatives, the Cotton Innovation Network, research community, all levels of government, community groups, agriculture RDCs, interest groups, retailers and customers, and suppliers and service providers.

Nine topics have been identified under the three key areas and these topics align with the UN SDGs. Five relate directly to the environment, including water, carbon, biodiversity, pesticides and soil health (Figure 8).

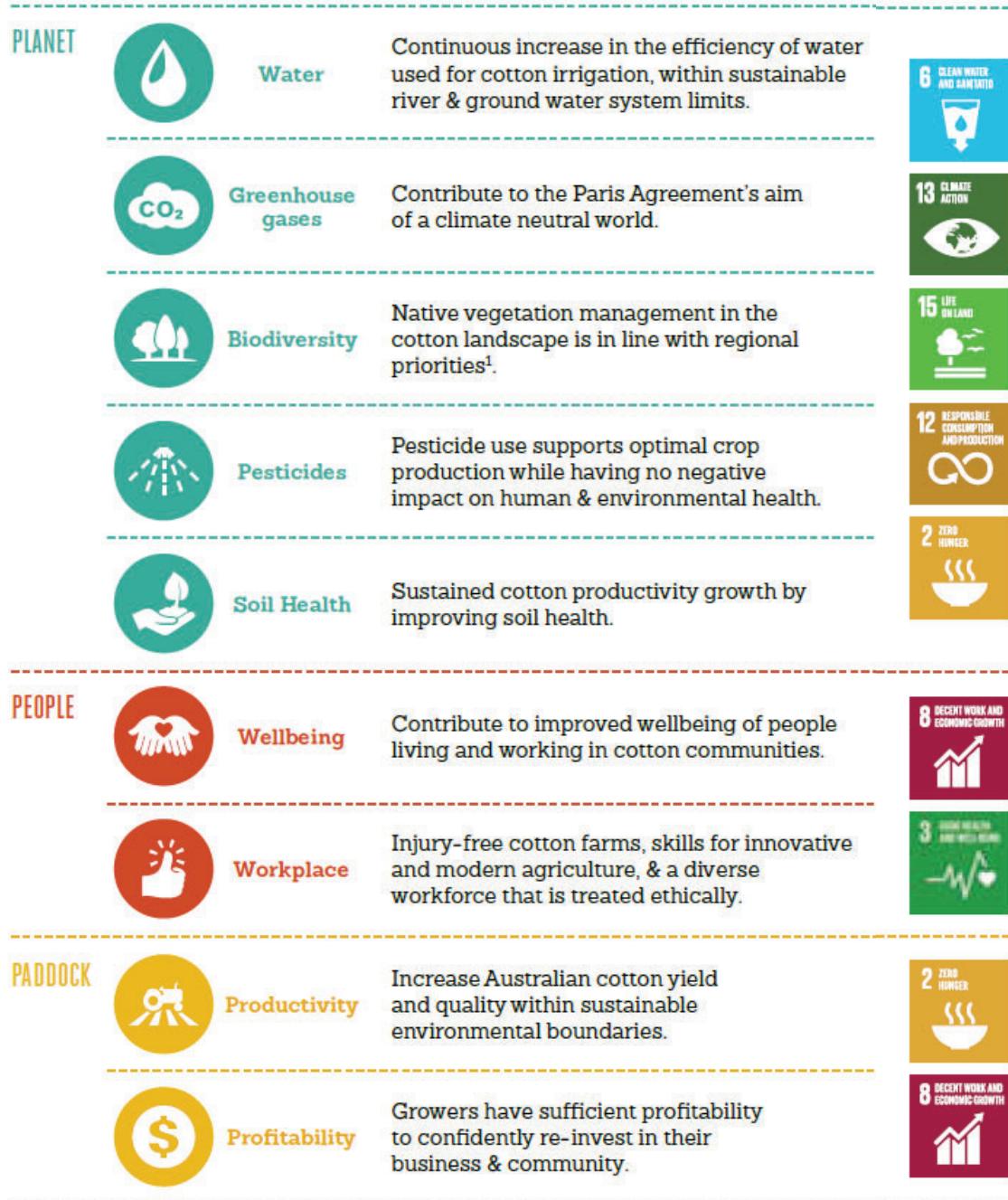


Figure 8 Sustainability framework and alignment with the UN SDGs. Source: SWG 2021

The second Sustainability Report was released in 2019, reporting on the nine priority topics and comparing performance from 2014-2019. The industry has committed to 5-yearly Sustainability Reports and an annual snapshot of progress being provided in between. In 2020, expert groups reviewed data from the Sustainability Reports and drafted targets for the priority topics, with consultation underway before targets are finalised and published. Some topics have a high degree of crossover with other Australian agriculture sectors and therefore targets are slower to be finalised as priority is given to ensuring consistency with other agriculture sustainability frameworks.

To support the implementation and currency of the framework, the SWG undertakes a quarterly materiality scan focussed on the nine identified themes. This scan picks up on any new developments nationally and internationally to ensure the most up-to-date environmental and sustainability practices are discussed.

Additional to this work, the Australian Cotton Stakeholder Reference Group (ACSRG) was formed in late 2021. This group includes representatives from cotton growers, other agricultural industries, researchers, environment groups, community groups, first nations, finance, government, regulators, health and safety, input providers and brands/merchants. The ACSRG meets every six months to provide a two-way exchange of information to update stakeholder groups on industry progress and seek feedback from stakeholders on their expectations and suggestions. It is an important formal process of regular stakeholder engagement to inform Sustainability Working Group decision-making.

5.1.2 Stakeholder perceptions of the industry's environmental management and reporting initiatives

As part of the Fourth Environmental Assessment, GHD asked both growers and broader industry stakeholders participating in the respective online surveys about their awareness of PLANET. PEOPLE. PADDOCK. and the myBMP program, as well as how important they considered these initiatives to be for the cotton industry.

It was found that there was widespread awareness (>70%) amongst the broader stakeholders participating in the online survey of the myBMP program, with less recognition of the industry's sustainability framework (42%). However, it is noted that the PLANET. PEOPLE. PADDOCK. sustainability framework was only created in 2020 (compared to BMP and myBMP in 1997 and 2010 respectively) and therefore has gained a level of awareness in a short timeframe. The vast majority of stakeholder respondents (>80%) rated these types of initiatives as either 'very important' or 'somewhat important' for the industry.

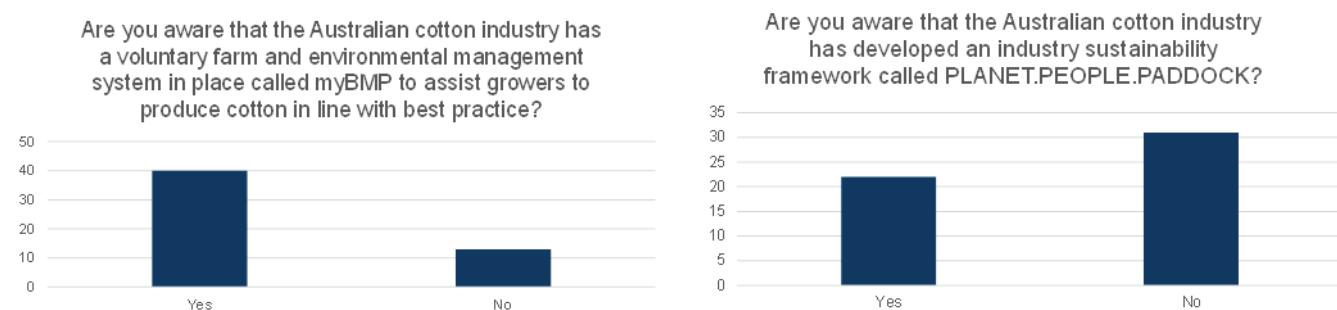


Figure 9 Stakeholder awareness of myBMP (left) and PLANET. PEOPLE. PADDOCK. (right)

In comparison, there was >90% awareness of myBMP amongst growers participating in the online survey and approximately 56% were aware of PLANET. PEOPLE. PADDOCK. Grower awareness and attitudes toward key industry programs and initiatives have also been tested over time through the annual Cotton Grower Surveys. In response to questions around myBMP in the 2019 survey, 9% of respondents indicated that they had never heard of or didn't know enough about myBMP. In the 2020 survey, growers were asked questions about their perceptions of CRDC and CottonInfo. In response, 91% of growers indicated they were supportive of CRDC and its research investments and activities, and 96% agreed that CRDC is a trusted information source. Similarly 86% of respondents source information from the CottonInfo team or resources, and 97% agree that CottonInfo is a trusted information source. In response to a question in the 2021 survey, 46% of growers responded that they were aware of the industry sustainability framework, PLANET. PEOPLE. PADDOCK. As noted above, this is a strong level of awareness achieved in its first year.

5.1.3 Grower uptake of myBMP

Despite widespread awareness of the myBMP program and recognition of its importance to industry, certification levels amongst growers is still only estimated to cover 25-30% of cotton produced in Australia.

Figure 10 provides the number myBMP certified farms and the number of farms opting into Better Cotton as reported by Cotton Australia in its Annual Reports for the period 2015/16 to 2020/21. While it is noted that not all myBMP certified farms will produce cotton in any given year, the figures do suggest that not all growers with myBMP certification market their cotton through Better Cotton. GHD has also estimated the percentage of Australian cotton that is produced under Better Cotton by comparing the volume of Better Cotton production that comes from Australia, as reported in Better Cotton Annual Reports from 2017 to 2021, with the total volume of cotton lint production grown in Australia over the same period.

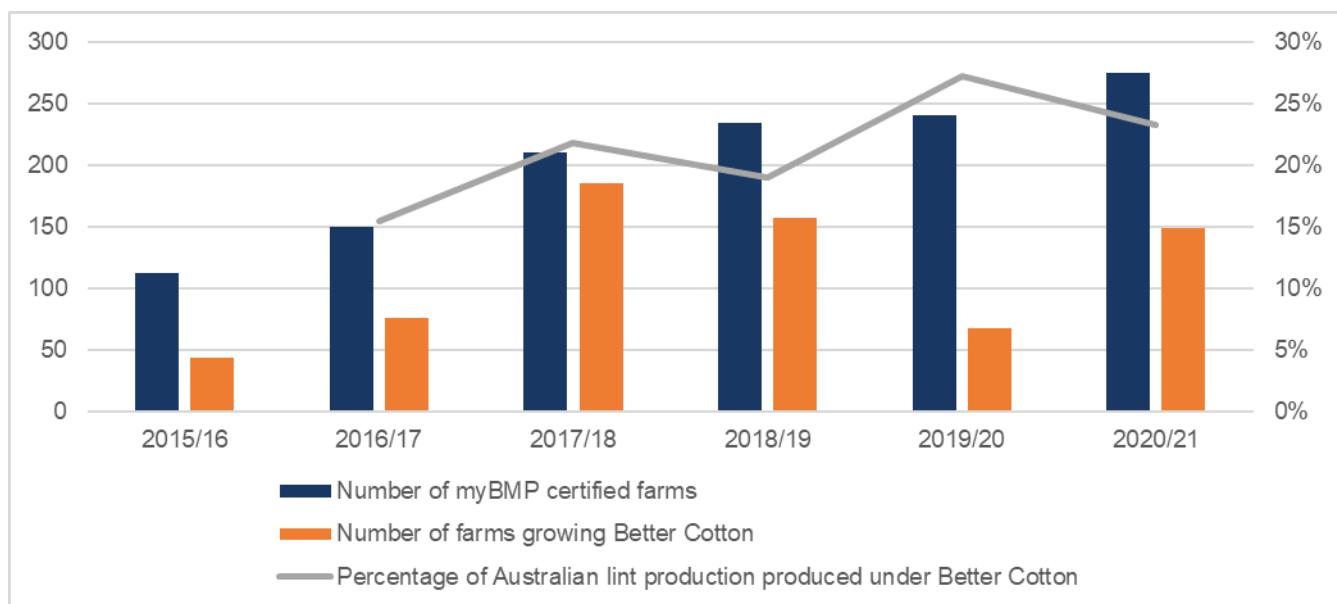


Figure 10 Participation in myBMP and Better Cotton (sources: Cotton Australia, Better Cotton, ABARES and GHD estimates)

The figures suggest that there has been a steady increase in the number of farms with myBMP certification from the 116 reported in the Third Environmental Assessment (Inovact Consulting 2012). myBMP reports that the current number of certified farms is 343, representing a further increase on the 2020/21 figure and an almost three-fold increase in the ten years since 2012 (N. Scott, personal communication, October 05, 2022).

In contrast to the number of farms that are myBMP certified, i.e. representing around 25% of the industry, the number of growers registered and therefore likely to be making some use of its resources, is much greater. With the exact number of growers in the industry not known and changing every year, it is difficult to provide a robust estimate of the percentage of the industry's growers participating (in some degree) in myBMP. In the 2019 Sustainability Report, it was reported that 66% of the Australian cotton industry were registered for myBMP (SWG 2020). At the time of this report, myBMP indicated that there are 1,065 businesses/growers registered in myBMP. Using the figure of approximately 1,500 cotton growers (total) in Australia, this equates to about 66% involvement in the program.

Growers participating in the online grower survey were asked about the barriers to myBMP adoption.

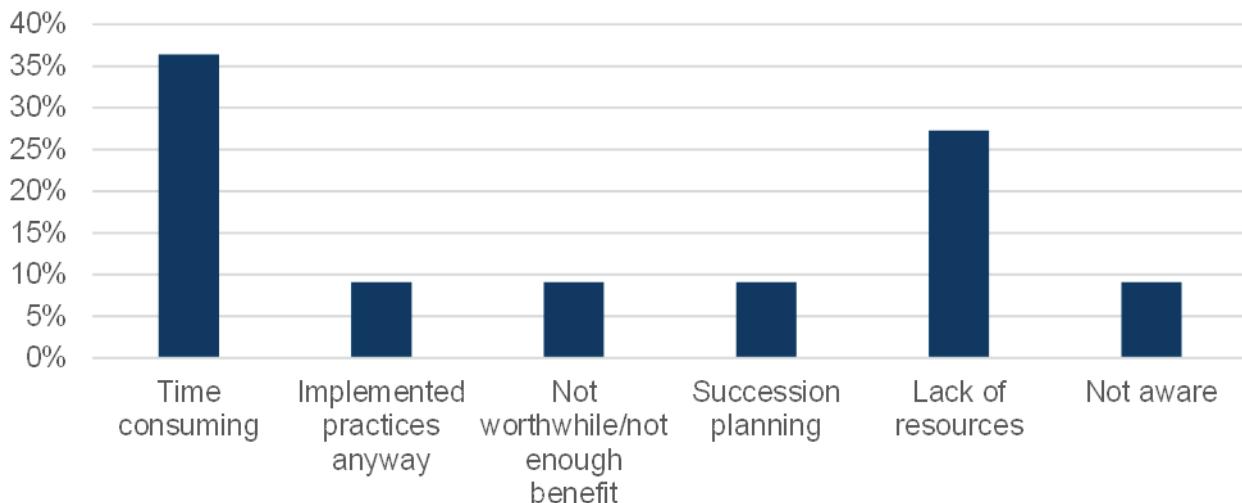


Figure 11 Barriers to myBMP certification as identified in the online grower survey

While it is recognised that the grower survey undertaken for this assessment represents a small sample size, the responses around barriers to adoption are similar to those provided in the Third Environmental Assessment, as well as the 2019 *Cotton Grower Survey*.

Growers participating in the on-site farm visits were also asked about barriers to adoption of myBMP, with the most common response being lack of time and money. Scale also came up as a consideration and barrier to some. Most, even if not certified, saw the benefit to becoming myBMP certified, with some reporting improved professionalism and credibility, and noting that certification would/does give better access to premium markets. However, some were unsure or did not know what benefits (in terms of market access and profitability) certification would bring. Some grower sentiments were that myBMP should be industry standard and some thought that there could be stronger benchmarks for some of the myBMP areas, including biodiversity.

In terms of its on-farm observations, GHD has also assessed whether myBMP status correlated with improved environmental performance across all criteria considered. As depicted in Figure 12, GHD found that there was a higher number of ‘excellent’ and ‘good’ ratings across all the environmental performance criteria observed on-farm amongst those growers with myBMP certification. Further, it was observed that those not using myBMP received more ‘poor’ ratings, than those who were myBMP registered, who in turn received more ‘poor’ ratings than those who were myBMP certified. That being said, close to 90% or higher of the environmental criteria observed on-farm were ranked as ‘excellent’, ‘very good’ or ‘good’ across all growers, regardless of myBMP status indicating that a strong level of on-farm environmental performance was observed overall.

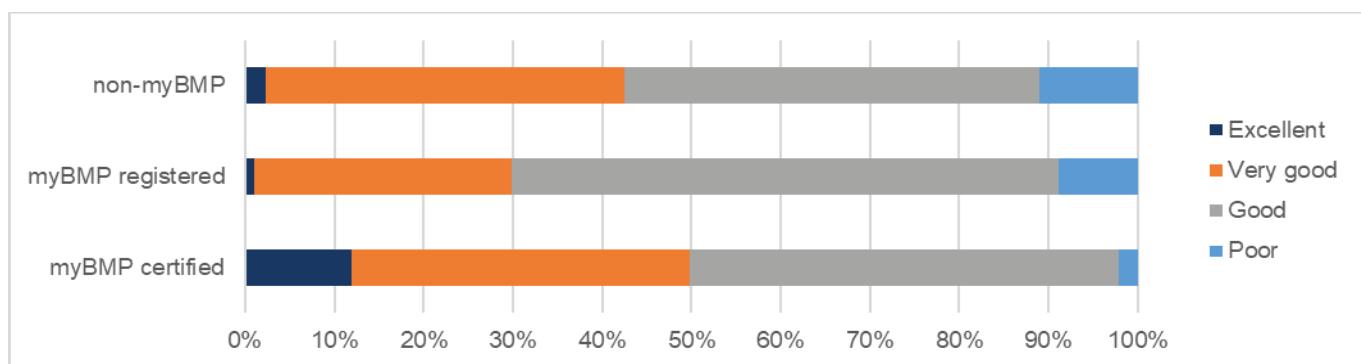


Figure 12 Aggregate rankings across all environmental criteria observed on-farm by myBMP status

5.1.4 Conclusions and recommendations

GHD found that the industry has made great strides in its environmental management and reporting systems in the ten years since the Third Environmental Assessment. Together, myBMP, CottonInfo, PLANET, PEOPLE.

PADDock. (overseen by the SWG), CRDC through its investment in RD&E, and Cotton Australia's work in policy, communications and marketing, all have a role to play in improving the management and reporting of environmental performance of cotton production in Australia. There is strong alignment and clear signs of collaboration across the respective industry organisations.

Going forward it is important that efforts continue to drive awareness and educate growers and other industry stakeholders about the industry's sustainability framework. While awareness around the industry's myBMP program is relatively high amongst growers and stakeholders, the uptake of myBMP certification, and therefore the usefulness of the program in market assurance is still limited at levels of 25-30% of production. To achieve the full benefits from the industry's efforts in this area, growers themselves have an active role to play not just in environmental management on-farm, but in engaging with the industry's sustainability agenda more broadly.

GHD notes that while it is commendable that the industry has committed to continuous improvement, in some cases like water use efficiency, the rate of improvement has or will slow as it reaches maximum efficiency. It is therefore important that the industry move towards science-based targets rather than pursue an impossible target of continuous improvement.

Recommendations

- Continue to undertake updates to the existing myBMP website to ensure all information is current and weblinks and video content are accessible. Regular updates to both the main website and module content should be undertaken to ensure information remains current. This will become increasingly important as module content and supporting resources are updated to incorporate new research and information applicable to new growing areas.
- Continue to increase the transparency and consistency of reporting of the number of growers both registered and certified with the myBMP program. Subject to privacy considerations, this should include the total number of growers and/or farms, and the total area and/or volume of cotton produced by farms with myBMP certification, both in aggregate and by region. This information should be available on the myBMP website as well as reported in the relevant annual publications, e.g. the Better Cotton and Cotton Australia Annual Reports.
- Ensure a whole-of-industry commitment to increasing the uptake of myBMP certification. This may require further research into identifying real and perceived barriers to uptake. Following this, there may be a need to develop and implement a comprehensive communications and engagement plan that incorporates regionally specific adoption targets and actions for each of the supporting industry organisations.
- Evolution and possible transformation of the myBMP program is required over time toward a performance-based tool that both adds value to participating farm businesses and provides clear outputs and data to support the implementation of the industry's sustainability agenda. This could include considering if the platform could be used to measure and monitor the stocks of natural capital at the farm scale.
- The sustainability framework and reporting process should continue to move toward science-based targets, acknowledging the difficulties of achieving ambitious targets in a complex system. The SWG has already undertaken considerable work in this area and should be encouraged to continue.

5.2 Water use and management

5.2.1 Industry priorities and key initiatives

The availability of water, its use, and impacts to water quality have consistently been priority issues for the Australian cotton industry both in terms of production and environmental management. In response, the industry has invested heavily in research, development and extension to improve on-farm practice in relation to water use and management, engaged in the development of national water policy and programs, and undertaken awareness and education activities to increase the understanding of how water is allocated to and used in cotton production.

The industry's sustainability framework, PLANET. PEOPLE. PADDOCK., has identified water as one of its nine environmental, economic and social topics of most importance to customers, cotton growers, industry organisations, regional communities and other stakeholders. The framework articulates the industry wide goal for water management as *delivering a continuous increase in the efficiency of water used for cotton irrigation, within sustainable river system and plant physiology limits*. This goal has been developed to directly align with UN Sustainable Development Goal 6.4 to *substantially increase water use efficiency and ensure sustainable withdrawals of freshwater*, and is underpinned by a target to increase irrigated cotton water use efficiency by 12.5% every five years.

Industry investment over the last decade in support of this goal has included (SWG 2020):

- The Smarter Irrigation for Profit project, led by CRDC under the Australian Government's Rural R&D for Profit program
- Annual monitoring and benchmarking of industry-wide water productivity
- The Keytah System Comparison, which is a grower-led program to assess the efficiencies of different irrigation systems.

The industry has acknowledged, however, that its target to increase irrigated water use efficiency by 12.5% every five years will be difficult to achieve as the target approaches the current scientific understanding of the theoretical maximum performance for megalitres of water used per bale of cotton produced. Despite this and given the ongoing importance of water use and management, particularly in the context of a changing climate, the industry has committed to the ambitious target 12.5% target in this area and has identified the following practices as key to achieving it (SWG n.d.a):

- Continued adoption of practices to reduce losses in storage and transmission
- Continued adoption of practices to improve efficiency in application.

In more recent years the effects of irrigation infrastructure, in particular irrigation pumps, on native fish has emerged as an area of focus. Fish entrainment (the removal of fish permanently from the river system via irrigation infrastructure) in cotton infrastructure was rated as the highest R&D priority at the fish stewardship R&D priority workshop in 2019 (*Spotlight Magazine* 2020). There is also potential for increased water efficiency through addressing this issue as less debris taken in by the pumps means less blockages/stemmed flows.

In 2021 the Commonwealth Government, as part of its Northern Basin 'Toolkit' of environmental works and measures, provided over \$26 million to the NSW and Queensland governments to run fish screening programs that decrease the number of fish being removed from natural waterways by irrigation infrastructure.

CRDC has co-invested with OzFish unlimited to assist administration of the Australian Screen Advisory Panel (ASAP). Currently CRDC is partnered with QLD Department of Agriculture and Fisheries to evaluate how fish interact with irrigation infrastructure and flow. A new research partnership has recently been formed with Fisheries Research and Development Corporation and NSW Department of Primary Industries to evaluate the capital and operating costs and environmental and economic benefits of fish screens for reducing fish entrainment.

The Trangie Nevertire Irrigation Scheme has invested in a large scale, self-cleaning, filtration/fish screening infrastructure. This project was in partnership with NSW DPI Fisheries and the NSW Department of Planning, Industry and Environment who have conducted research into the efficacy of this infrastructure.

5.2.2 Water use and management on farm

ABS data for agricultural water use suggests that in 2020-21, cotton accounted for an estimated 17% of agricultural irrigation with a total 1,322,587 ML applied. Water use by irrigated agricultural industries in Australia, including cotton, continues to be the subject of public scrutiny, as has been shown through media coverage and commentary from environmental and conservation groups.

In considering water use by irrigated agricultural industries however, it is important to consider the drivers for on-farm decision-making, which include the reliability of water entitlement, soil type, climate, farming systems, and return per ML of water applied. It is also important to note that water allocations are regulated by the relevant government jurisdictions, such that producers will seek to maximise the return for the water they have available under their given water licence in any given year.

Table 3 provides context to the market drivers behind the amount of irrigated cotton production. For the purpose of this discussion, a comparison of the return (\$/ML) of different annual crop types is shown for two of the major cotton growing regions in Australia, the Namoi and Murrumbidgee valleys (adapted from Marsden Jacob Associates 2022). The indicative gross margins explain that given a set amount of water made available by catchments for agricultural use, market conditions have pushed producers operating annual cropping regimes toward cotton production to achieve the highest value per ML applied with the water that is made available to them.

Table 3: *Case study of the economics of water use in annual cropping systems in the Namoi and Murrumbidgee regions (Marsden Jacob Associates 2022)*

	Namoi		Murrumbidgee	
	Gross Margin \$/ML	ML/ha	Gross Margin \$/ML	ML/ha
Cotton	\$350.00	6.9	\$225.00	9.0
Rice	-	-	\$175.00	11.5
Wheat	\$175.00	2.3	\$150.00	7.8
Oats	\$150.00	3.0	\$150.00	2.5
Barley	\$150.00	4.8	\$150.00	4.1
Lucerne	\$150.00	7.5	\$150.00	3.0
Sorghum	\$175.00	3.5	-	-

As noted in section 1.1, the majority of cotton grown in Australia is irrigated, and with water typically the limiting resource for production, growers are incentivised to maximise the value of production relative to the volume of water applied. Through a combination of sustained research and on-farm practice change, continued improvement in water use efficiency is one of the industry's headline achievements since the first industry-wide environmental assessment was undertaken in 1991.

SWG (2020) reported that it took 48% less water to produce a bale of irrigated cotton in 2019 than it did when industry first commenced measuring its water use efficiency in 1992, representing an average 2.5% improvement in water use efficiency per year.

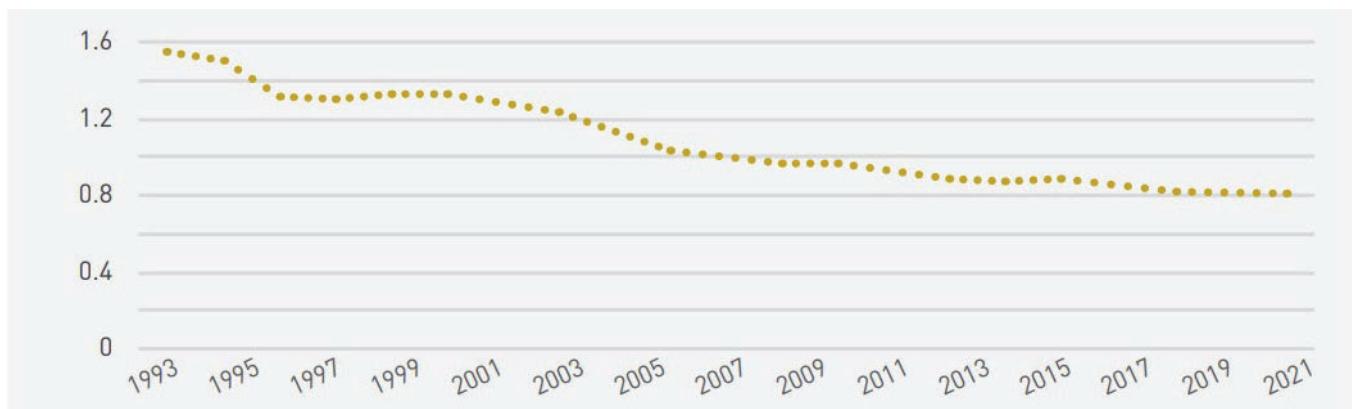


Figure 13 5-year average water use (rainfall and applied water), ML/bale. Source: SWG n.d.a.

Figure 13 indicates that while there has been a continued trend of improvement in water use efficiency over the ten years since the Third Environmental Assessment, i.e. since 2012, the change has been less marked, which is consistent with the industry's own assessment that continuing to improve water use efficiency will become more difficult with time, requiring increasingly more effort.

The industry obtains additional information about on-farm practices in relation to water use and management through CRDC's annual Cotton Grower Surveys and Crop Consultants Australia's annual Cotton Consultants Survey.

A review of CRDC *Cotton Growers Surveys* from 2018 – 2021 and Cotton Growing Practices from 2013 – 2016 found that areas of focus for growers in these years were water availability, use of irrigation systems, and water use efficiency. Additional areas of focus were groundwater quality and automation. In 2018, only 31% of growers reported monitoring groundwater quality, with 47% of those growers reporting that they monitor at least once per year (CRDC 2018). 28% of growers in 2021 reported using automation, with a further 38% considering irrigation automation, however 69% reported utilising sensors or automation of some kind that required digital connectivity. Examples of automation technologies reported were depth sensors in channels, remote operation of irrigation hardware such as pump and gates, and sensors combined with software (e.g. soil moisture probes) to inform irrigation frequency. Developments in automation have been backed by research, such as that undertaken by the CRDC Smarter Irrigation for Profit Phase 2 project. While this project is in its early stages at the time of writing, sub-projects funded focus on new irrigation technologies such as advanced sensors and analytics to improve irrigation scheduling and reduce water loss. Automation was not discussed in the Third Environmental Assessment (Inovact Consulting 2012), indicating that it is a novel management technique for the industry.

Water capture/extraction and water loss were areas of focus in the *Cotton Growers Survey* 2021, with 46% reporting using water on other crops or reporting operational losses. The *Cotton Growers Survey* 2021 reported that 82% of growers use some practices to minimise water loss with 29% using three or more practices. Practices included transferring water, raising storages height or dividing storages into cells, tracking water use in software, and lining storages/channels. Transfer of water was the most common method of mitigating water loss (65%).

The water management module in myBMP provides information and checklists to support growers to achieve best practice in water use and management, and assurance of best management practice amongst those growers who have achieved myBMP certification. The standards to be achieved under the water management module are:

- Information is recorded each season to help make better whole-farm irrigation decisions
- Information is used each season to help make better field irrigation decisions
- Practices are used for efficient management of storage and distribution systems
- Surface irrigation systems are designed, installed and managed appropriately
- Drip irrigation systems are designed, installed and managed appropriately
- Centre Pivot and Lateral Move irrigation systems are designed, installed and managed appropriately
- Irrigation bore systems are designed, installed and managed appropriately
- Practices are used to take advantage of rainfall
- Management strategies are implemented to prevent off-farm water quality impacts

- Plans are developed and implemented to manage the impact of tailwater and stormwater runoff off-farm.

GHD observed that water use was monitored thoroughly on the farms throughout the cotton growing regions where on-site farm visits were undertaken. Most growers, regardless of myBMP status, were also found to take advantage of information from canopy temperature sensors, moisture probes, on-farm weather stations, and software for irrigation scheduling. Figure 14 provides a summary of the on-farm observations by region and myBMP status relating to water use and management.

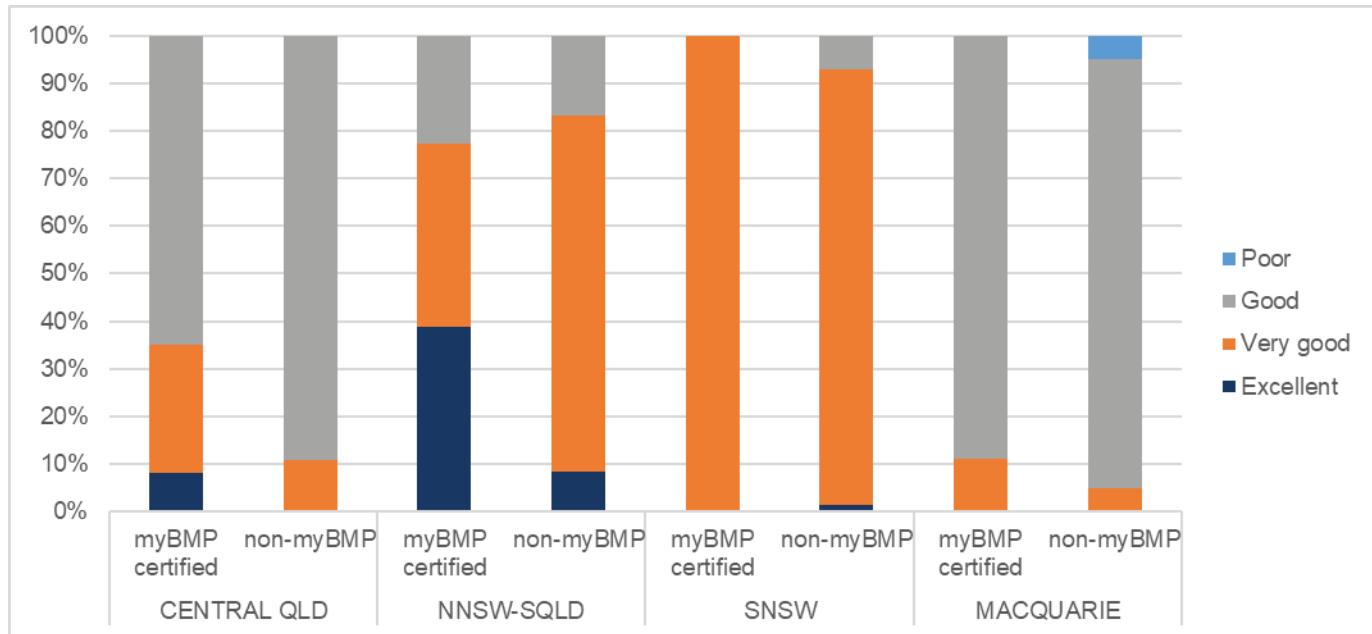


Figure 14 On-farm observations relating to water use and management by region and myBMP status

An analysis of the on-farm observations for water by myBMP status alone, shows that there were no ‘poor’ ratings in the area of water management and use for myBMP certified growers. This comparison also shows that with only one poor rating received in the water management use categories for each of the non-myBMP and myBMP registered, on-farm observations were in the main rated as ‘good’ or above, regardless of myBMP status.

5.2.3 Stakeholder perceptions of water use and management

The environmental implications of water use and management have been found to be of considerable public interest during all four of the industry’s environmental assessments. At the time of the Third Environmental Assessment (2012), it was noted that water scarcity during the millennium drought had triggered a new wave of investment in water programs, as well as a range of policy, institutional and regulatory reforms. It further identified continued long-term pressure on Australia’s water resources, and in particular, the development and implementation of the Murray-Darling Basin Plan, as one of the priority areas for future industry action to improve environmental outcomes.

While it is important to note that water use for irrigation is regulated by governments, there is continued public interest and scrutiny on the industries that rely on access to irrigation water, including cotton. The *Communities Trust in Australia’s Rural Industries Report 2022* (Voconiq 2022) supports the public interest in water use with the view that water should only be given to agricultural industries after the environmental needs are met. Interestingly though, the relative importance of this metric has dropped in the last 2 years as water availability has increased.

As noted in section Current and emerging issues⁴, water was ranked as the highest current and emerging issue by both growers and stakeholders participating in the online surveys as part of this assessment. This is consistent with grower and stakeholder survey undertaken for the Third Environmental Assessment.

Growers and stakeholders were also asked to rate the performance of the Australian cotton industry in respect to specific on-farm practices and environmental issues. Figure 15 and Figure 16 show the stakeholder and grower responses related to water use and management. The responses suggest that stakeholders are generally aware

of the improvements the industry has made in irrigation practices and water use efficiency, with more than 50% rating this as ‘very good’ or ‘good’. The areas where the perception of practice was poorest were ‘reducing run-off to rivers and wetland’, ‘compliance with water licenses and extraction limits’ and ‘management of water storages’. Approximately one-third of respondents felt they didn’t know or were unsure in relation to ‘tailwater and stormwater management’.

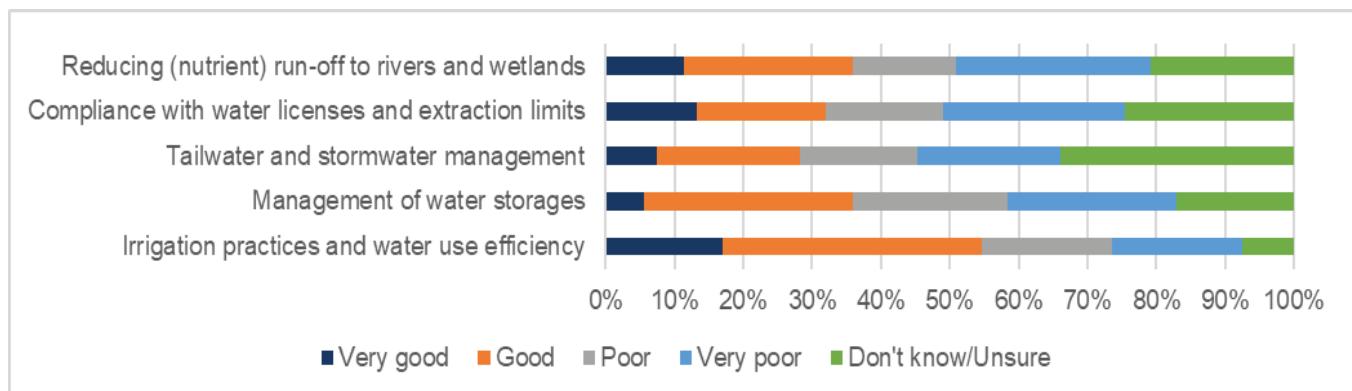


Figure 15 Stakeholder questionnaire responses related to current water use and management

In contrast, growers were more positive in relation to industry water use and management practices, with all practices typically perceived to be ‘very good’ or ‘good’.

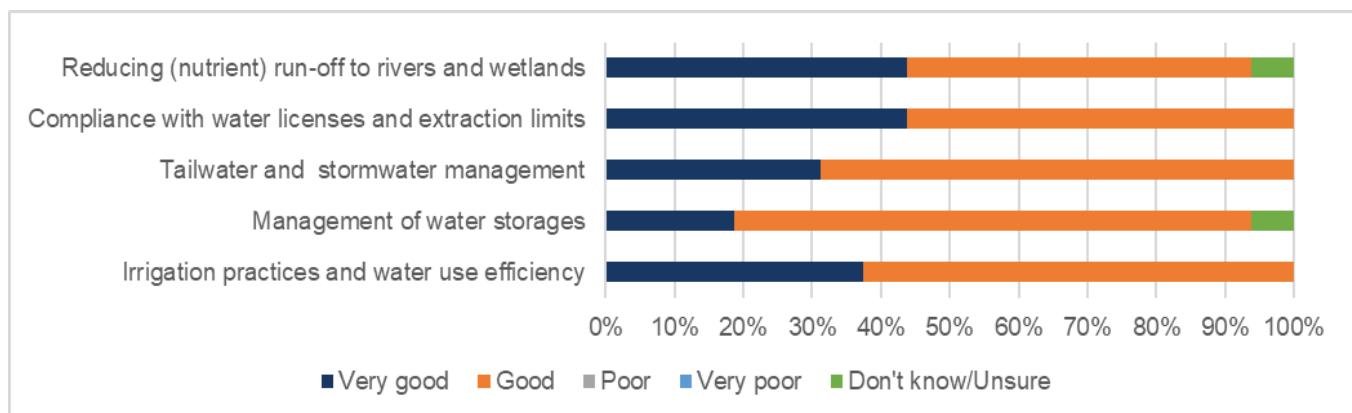


Figure 16 Grower questionnaire responses related to current water use and management

5.2.4 Conclusions and recommendations

Water use and management is an area of considerable industry effort and demonstrable on-farm improvement over many years, with GHD’s assessment supporting this. Despite this, water remains highly contentious amongst stakeholders, and has been subject to continued policy and regulatory change over the ten years since the previous assessment, with these external pressures likely to continue. In addition to its RD&E efforts, the industry will need to continue its engagement with the national water reform agenda – pressure points for the industry will include an ongoing focus on compliance (including metering and monitoring), implementation of floodplain harvesting policies and program, expansion of irrigation in Northern Australia, and further implementation and review of the Murray-Darling Basin Plan. Governments have a role to play in the provision of information and data on the use of water resources in Australia, including increasing the education and awareness of the regulation and compliance measures that are in place for water extraction. The issue of fish entrainment has also emerged in recent years as an environmental issue that has gained prominence, with the industry commencing new research work to better understand the likely implications for on-farm management.

Recommendations

- Continue to work with the respective government agencies to include, where available, information on the status of water compliance in major cotton growing regions (e.g. number/size of breaches compared to total number of holdings) in industry sustainability reporting, as was flagged in the 2020 stakeholder consultation report on the setting of industry targets and indicators for the Australian cotton industry.
- Continue to support research and trial work that is underway to better understand the impacts of fish entrainment and encourage broader adoption by cotton growers and infrastructure operators of screening on irrigation pumps and/or other identified mitigation measures.

5.3 Pest management

5.3.1 Industry priorities and key initiatives

5.3.1.1 Pest management strategies

Pest management in agriculture has historically been centred around the application of pesticides. From the 1960's to early 2000's, Australian cotton production was heavily reliant on the use of pesticides, and those used were largely broad spectrum, non-specific in nature such as organophosphates, carbamates and pyrethroids and well as endosulfan (Wilson et al. 2013). In 1996, the first insect-resistant transgenic cotton varieties were commercially released in Australia, known as Ingard®, for the control of both Cotton bollworm (*Helicoverpa armigera*) and Native budworm (*Helicoverpa punctigera*). The development of insect-resistant transgenic cotton changed the face of pest management in the Australian cotton industry and has continued to be instrumental to this day.

Since the Third Environmental Assessment in 2012, the third iteration of this technology, Bollgard 3®, has been introduced. This consistent iteration to add expression of additional proteins makes it increasingly difficult for the pest to develop resistance. The technology is the cornerstone of strong pest management practices on-farm with implementation in 99% of the Australian cotton crop (Cotton Australia 2022c). The adoption of transgenic cotton in pest management and implementation of the associated Regional Management Plans (RMPs) on-farm has provided an ideal platform for Integrated Pest Management (IPM) strategies to provide continued improvement in pest management by greatly reducing insecticide use for the target pest species. IPM aims to reduce insecticide use while maintaining profitability of cotton crops by promoting natural control from beneficial insects while suppressing pests.

Supporting pest and weed management is management of biosecurity, to prevent the entry, spread and establishment of invasive pest species. Biosecurity practices are integral to pest, weed and disease management particularly in managing outbreaks or incursions.

5.3.1.2 Pesticide and agrichemical use

The use of pesticides is a key sustainability area for the cotton industry, with the current goal for pesticide use to support optimal crop production while having no negative impact on human or environmental health. The target for the cotton industry is to reduce the environmental impact of pesticides by five per cent, every five years.

The Australian Cotton industry has worked hard to decrease the hazard and volume of pesticides used, with a 18.2% decrease between 2014-2019 (SWG 2020). While insecticide use has been significantly reduced due to the introduction of Bt cotton and implementation of IPM strategies, over the same period there has been a 20% increase in herbicide use. Despite the increased volume of herbicides, the overall Environmental Toxic Load (ETL) has reduced dramatically and represents the more targeted approach to herbicide use adopted by the industry to reduce the environmental impact of herbicide use.

Environmental Toxic Load (ETL) has been created specifically to assess human health and environmental hazards associated with pesticides used in cotton. ETL represents the average amount of toxic pressure by the pesticide applied on one hectare of cotton in one year, based on the volume sold. ETL monitors the hazard to four different ecological components. For simplicity, the industry uses two of these as a public sustainability target: bees for insecticide hazard and algae for herbicide hazard.

Insecticides, herbicides and chemical fertilisers are a significant input cost for successful cotton growing but require appropriate management to ensure that environmental health is maintained. The inappropriate use of these chemicals can cause contamination of the environment through flushing into waterbodies and seepage into ground water, and also result in significant production losses in the case of spray drift.

A number of crops grown throughout cotton growing regions of Australia, including cotton itself, are sensitive to spray drift, with cotton particularly sensitive to spray drift from Group I herbicides. In 2018, the impact of spray drift, affecting only 10% of the summer crop, summed an estimated \$18 million in production losses (Cotton Australia 2022d).

In the period since the last environmental assessment in 2012, the industry has established further tools and resources to reduce the economic impact and subsequent environmental impact of spray drift. In 2018, a group of concerned parties formed a committee called ‘Stop Off-target Spraying’ (SOS) which received overwhelming support from the industry and bore the first SOS group, SOS Maquarie Valley Inc. The SOS group has grown to now incorporate other regions across NSW, engaging with the agricultural community to increase awareness of off-target spraying (SOS NSW 2020). For the 2019-20 summer season, following a successful trial in Qld’s Central Highlands, SataCrop became available for use by growers. SataCrop is a tool to mitigate the risk of spray drift by allowing operators to understand where sensitive crops (not restricted to cotton) are located in proximity to their spray operation. The SataCrop tool is an industry initiative developed by Cotton Australia and Precision Cropping Technologies (PCT). Additionally, the Grains Research and Development Corporation and CRDC, in partnership with private industry, are in the final stages of developing a spray drift hazardous weather warning system that will provide real-time weather data and alerts to growers and spray operators about the presence of temperature inversions (CRDC 2022).

5.3.2 Pest management on farm

On farm, the cotton industry’s adoption of round-up ready (herbicide resistant) and Bt (pest resistant) transgenic cotton varieties over the past 20 years has driven strong understanding and awareness of herbicide and insecticide resistance. Farmers are working closely with their agronomists to look for innovative ways to manage pests, weeds and disease throughout the season. Many farmers noted the adoption of Bt cotton has minimised unintended harm to beneficials during spray practices by allowing more targeted insecticides to be used and decreasing frequency of insecticide use.

Biosecurity is a key component of pest management for cotton growers, with 84% of growers surveyed in the *Cotton Growers Survey 2021* using at least one biosecurity management practice and 56% of farms holding a farm biosecurity plan. While all growers participating in the grower survey for this assessment rated the industry’s understanding and awareness of biosecurity practices as ‘good’ or ‘very good’, the results of the *Cotton Growers Survey 2021* found that 16% of farmers surveyed are not using practices to manage their farm biosecurity indicating there is still room for improvement, particularly in implementation and planning.

GHD observed that growers had a sound understanding of the role of IPM in crop management with several farms visited actively engaging with their agronomist to implement IPM not only for decreasing input costs by lowering insecticide use but also to ensure long-term environmental benefits. Many farmers were consciously retaining native and remnant vegetation as habitat for beneficials and understood the benefit to their production system to manage beneficial insects effectively.

Minimal ‘poor’ ratings were recorded in relation to pest management (refer Figure 17), and these were each attributed to biosecurity practices. Vehicle and machinery washdown, biosecurity signage and visitor records are vital to effective pest, weed and disease management. These strategies are particularly important when outbreaks occur or new pests, weeds or diseases are introduced, spreading, and establishing. Pest management was observed as being particularly strong (i.e. ‘very good’ or ‘excellent’ ratings) in the Northern NSW/Southern QLD and Southern NSW regions.

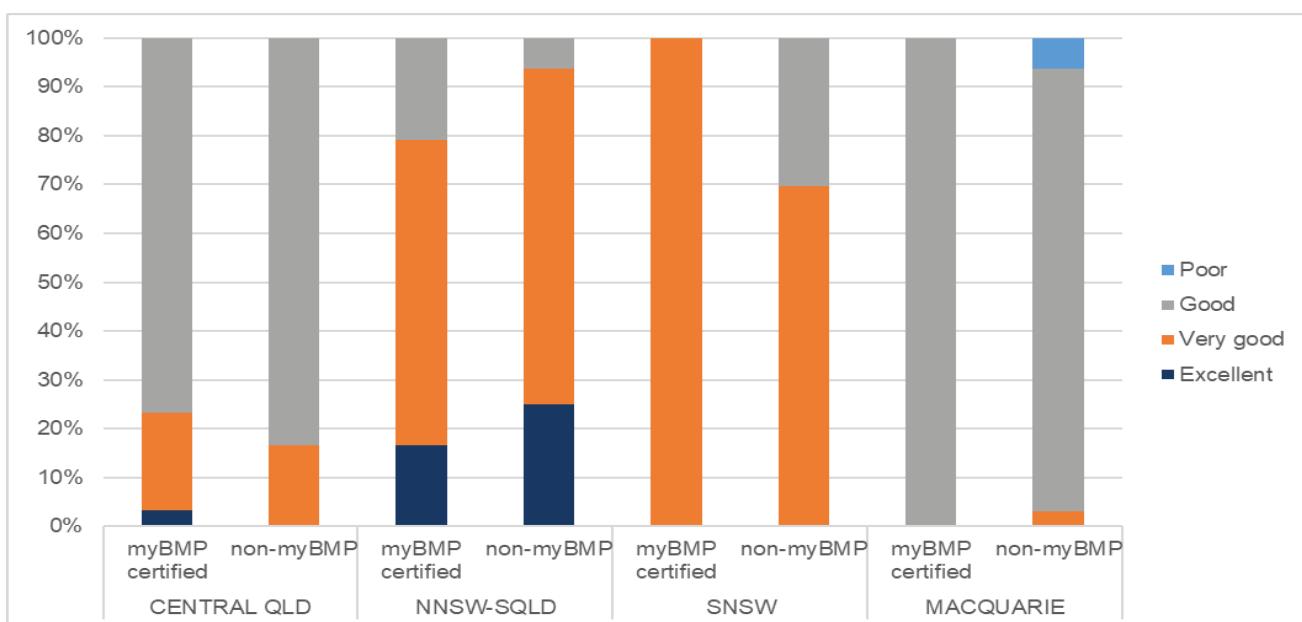


Figure 17 On-farm observations relating to pest management by region and myBMP status

Similar to the on-farm observations for water use and management, GHD observed widespread ‘good’ practice in relation to pest management regardless of myBMP status.

5.3.3 Stakeholder perception of pest management

Pest management is an area of significant industry progress and demonstrated on-farm improvement over the years of environmental assessments. The increased uptake of IPM was identified in the Third Environmental Assessment (Inovact Consulting 2012) as a major achievement for the cotton industry in reducing pesticide use and undertaking biodiversity conservation, however it reported that only 3% of growers at the time considered IPM a ‘top environmental priority’, compared with 15% for pesticide/herbicide use/management. However, the grower perception survey included in the Third Environmental Assessment found that 95% of growers attributed major or smaller worthwhile improvements in chemical management to adoption of IPM.

The grower survey for this assessment suggests continued improved performance in pest management over the 10-year period. 94% of respondents to the grower survey rated IPM and pesticide reduction overall industry performance as ‘good’ or ‘very good’. 88% rated the improvement in IPM practices over the 10-year period as ‘good’ to ‘very good’, and 94% ‘good’ to ‘very good’ improvement in pesticide and chemical use generally.

All growers surveyed rated the industry’s overall environmental performance to manage and reduce spray drift as ‘good’ to ‘very good’. On-farm many growers noted their agronomists registering their crops on SataCrop and most noted that issues with spray drift were not common but mostly occurred from neighbours with non-sensitive crops.



Figure 18 Grower questionnaire responses related to current pest management practices

Respondents to this Assessment's stakeholder survey indicated a greater awareness of the reduction of pesticide use and implementation of IPM practices, presenting a more positive perception when compared with other environmental categories assessed.

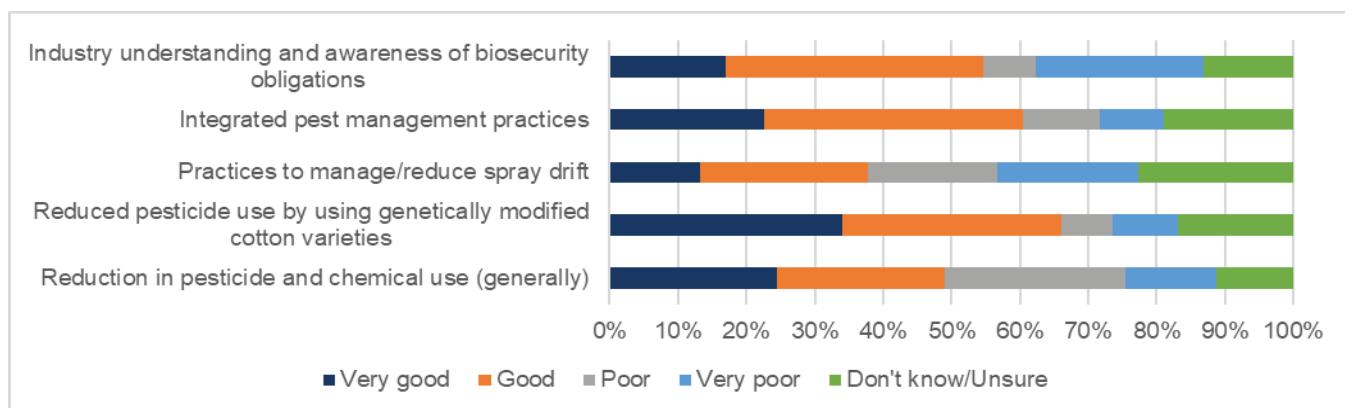


Figure 19 Stakeholder questionnaire responses related to current pest management practices

5.3.4 Conclusions and recommendations

The industry has made continual progress in this area, with pesticide use significantly reduced (due to the introduction of Bt cotton and implementation of IPM strategies), and a decrease in overall Environmental Toxic Load (ETL), representing a more targeted approach to herbicide use in efforts to reduce the environmental impact. Farmers are working closely with their agronomists to look for innovative ways to manage pests, weeds and disease throughout the season with many farmers retaining native and remnant vegetation as habitat for beneficials, noting the benefit to their production. Biosecurity is a concern for growers, with over 50% of farms having a farm biosecurity plan, however there is room for improvement in this (biosecurity) area.

Recommendations

- Use regionally targeted approaches to increase the level of biosecurity planning to ensure sound biosecurity practices are in place on-farm. There is room for improvement in this area to ensure that growers are prepared and have strategies already in place for any future outbreaks of new pests, weeds or diseases.
- Continue to work with the broader agricultural community to increase the understanding and awareness of off-target spraying to minimise the potential for environmental impacts.

5.4 Agrichemical and petrochemical storage, handling and waste

5.4.1 Industry priorities and key initiatives

The appropriate storage and handling of agrichemicals (such as fertiliser, pesticide, herbicide etc.), petrochemicals and waste products reduces the environmental risk posed by these products and associated activities. These products have the potential to contaminate soils, waterways and release pollutants to the air which can be persistent, bioaccumulative and toxic. Due to the highly persistent nature of some of these compounds they can accumulate in soils, sediments and organisms in the environment. Activities that can lead to contamination on agricultural land include:

- Disposal of wastes (controlled and uncontrolled)
- Accidental spillage
- Storage or transportation of raw materials, finished products or wastes
- Migration of contaminants into a site from neighbouring land, as vapour, leachate. Movement of liquids through the soil or as dust and other particles
- Use of agricultural chemicals (Barzi et al. 1996).

The open burning of agricultural waste, including drums used for agrichemical storage, crude oil and general waste in on-farm landfills also results in significant emissions of air pollutants (Lemieux et al. 2004).

Accidental spillage to ground occurs when safety measures such as bunding around fuel storage are not in place. Like the overuse of agrichemicals, spills can result in contamination not only of the immediate land but can be transported off-farm through surface and groundwater movement. Contamination with chemical compounds affects the functioning of the soil habitat, reducing soil biodiversity, and soil quality (Gworek et al. 2018).

Contamination can be caused by:

- Inorganic compounds
- Organic chemicals
- Oils and tars
- Combustible substances
- Hazardous wastes
- Toxic, explosive or asphyxiant gases (including from the decomposition of waste in landfills) (Barzi et al. 1996).

Petrochemical storage and handling is a module within the myBMP program, with storage, handling and waste management practices also contained within the Pesticide management module. Currently there are no explicit goals, indicators or targets established for storage, handling and waste management practices within the industry's sustainability framework and reporting.

5.4.2 Storage, handling and waste on farm

The Third Environmental Assessment did not focus on storage, handling and waste, however concluded that all recommendations of the 2002 assessment were implemented. The on-farm assessments conducted for the 2022 environmental assessment found that this area of environmental management demonstrated the poorest performance with little to no improvement between the 2002 assessment and 2022 assessment.

Criteria relating to storage handling and waste practices received the highest number of 'poor' ratings in the on-farm assessment process (Figure 20). GHD observed a number of key areas for improvement throughout the on-farm assessments including:

- Bunding of storages
- Chemical storage and segregation
- Waste management

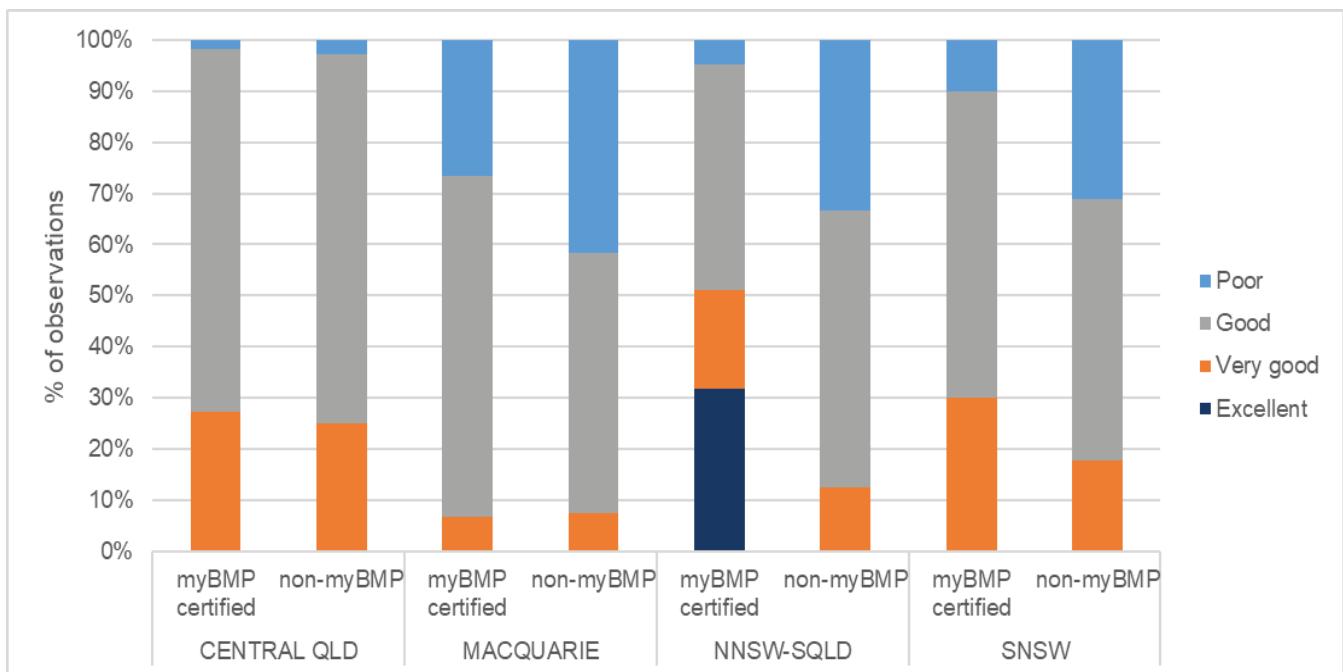


Figure 20 On-farm observations related to storage, handling and waste by region and myBMP status

This was an area where there was a clear correlation observed of improved practice for myBMP certified farms when compared to non-myBMP farms. It should also be noted however, that it was the area where the highest number of 'poor' ratings were observed on myBMP certified farms across all valleys.

Many growers felt that the implementation of storage, handling and waste strategies were cost prohibitive, particularly as they do not directly correlate with productivity or profitability. Despite this, a number of growers were progressively upgrading storages across their property to varying degrees. Both fuel and waste oil storages were often unbunded and showed evidence of past spillage to ground with spill kits not always available or in an appropriate location.

The cost prohibitive nature of upgrading storage, handling and waste infrastructure on-farm is consequently inhibiting myBMP uptake for some growers. The improvement in storage, handling and waste management practices by myBMP participants can be seen in each region with a decrease in the prevalence of poor performance indicators. Where this change is less evident is in the Central Queensland region where poor performance was negligible, and can be attributed to a relatively good regional waste management network that is discussed in detail in the *Case Study: Collaboration for effective waste management (page 46)*. Particularly in the Southern NSW and Macquarie regions, on-farm tips were prevalent.

Chemical storage and segregation was also variable across on-farm assessments, with many growers unsure of the correct segregation requirements, and only some showing compatible hazardous substance diamond placards on the outside of storages. Only one grower had a chemical storage segregation chart available in the storage shed. Growers were very receptive to feedback in this area and eager to understand correct procedures.

5.4.3 Stakeholder perceptions of storage, handling and waste

Stakeholders did not demonstrate a strong focus or visibility in this area, evidenced by the high proportion of 'don't know/unsure' responses. Where stakeholders did provide an indication of the views on industry performance in this area, it was generally positive. However, the online grower survey undertaken for this Assessment showed that

there is also a considerable disconnect between the grower perception of the current industry performance and the on-farm practices observed.

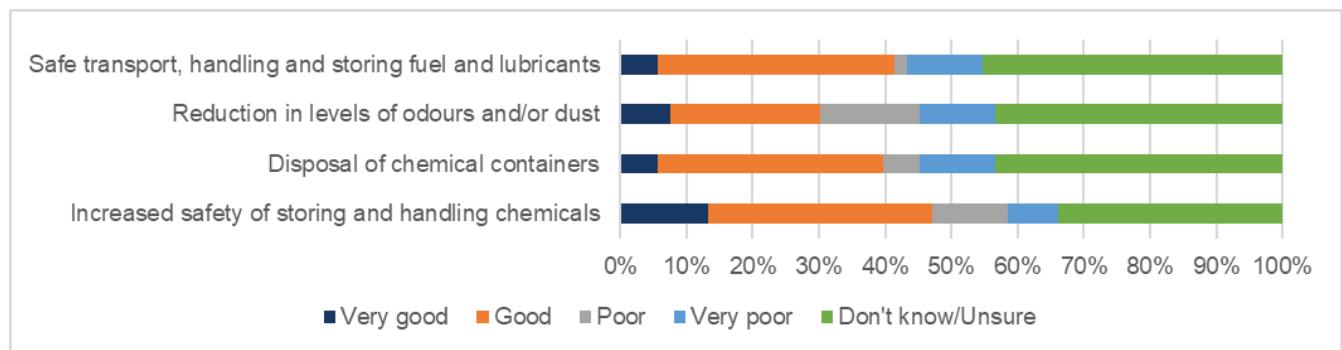


Figure 21 Stakeholder questionnaire responses related to current storage, handling and waste practices

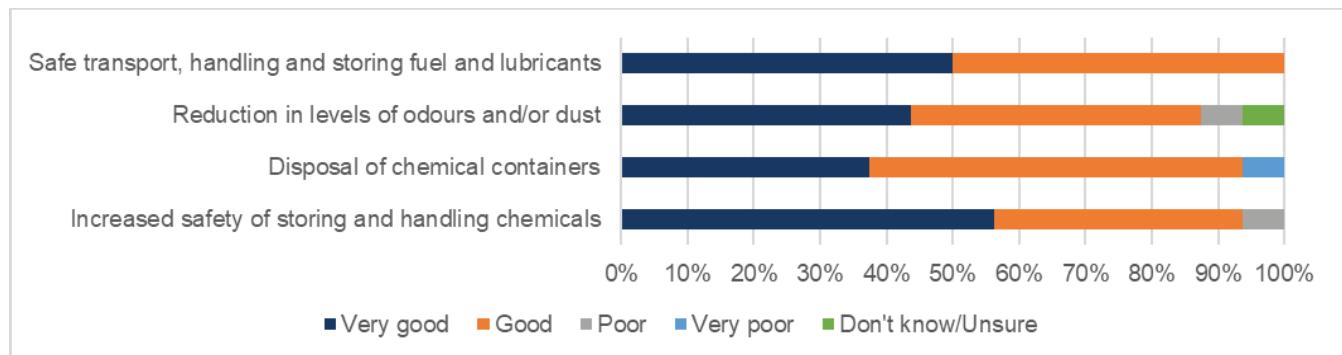


Figure 22 Grower questionnaire responses related to current storage, handling and waste practices

5.4.4 Conclusions and recommendations

GHD found that storage, handling and waste management is an area for improvement across the industry. Cost was found to be the biggest barrier to growers improving their storage, handling and waste management, particularly as these activities do not directly correlate with productivity or profitability. Additionally, the cost prohibitive nature of upgrading storage, handling and waste infrastructure on-farm is consequently inhibiting myBMP uptake for some growers. In areas where supporting waste infrastructure is unavailable or not accessible or convenient, growers have poorer waste management practices. There is a need for increased focus and support to lead to on-farm improvements in this area. As these practices are not isolated to cotton production, there is a role for other agricultural industries and local government, or other local service providers, to increase focus in this area to lead to the necessary on-farm improvements.

Despite GHD's on-farm observations, this was not identified as an area of particular concern in stakeholder consultation and is not currently reported on in the industry's sustainability framework. With the transition to a circular economy becoming an increasing area of focus for governments, stakeholder perceptions around waste management in particular may become more important into the future.

Recommendations

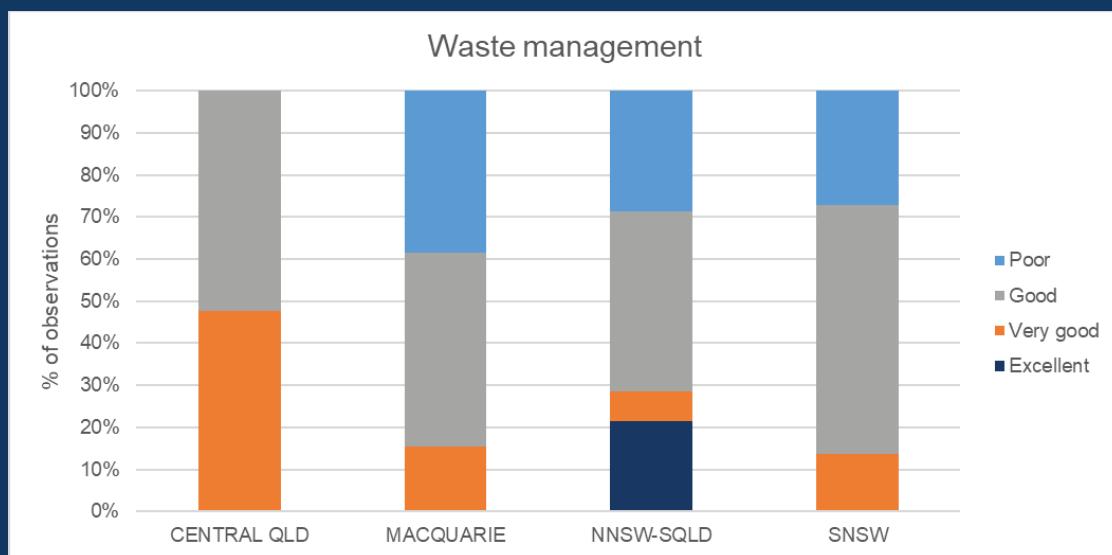
- Engage partner industries and service providers to aid improvement in on-farm storage, handling and waste practices.
- Undertake regionally targeted education and awareness campaigns to improve storage, handling and waste practices on farm. This should be supported by the industry's broader extension and myBMP programs.
- The SWG should undertake a materiality assessment of waste management to consider if targets and indicators, or other explicit reporting of industry performance in this area is required.

Case study: Collaboration for effective waste management

On farm waste management is governed not only by individual best management practice but also waste management infrastructure in the areas that farms operate. Waste management trends were therefore evident at a regional scale, with quality of waste management practice varying greatly between growing regions. Supporting infrastructure for waste management on-farm across the growing regions came from:

- DrumMuster
- ChemClear / ChemCollect
- Local tips general and segregated waste collection
- Independent services for waste oil and rags collection
- Local agrochemical suppliers

The support this infrastructure provides to farmers to implement best practice was evident through the regional breakdown of observations on-farm.



In the Southern NSW region where external support of waste management was seen as unavailable, cost prohibitive and time consuming, they were not utilised effectively and resulted in a reduction in quality waste management on-farm. This was observed through the increased presence of on-farm tips, burning of drums and other on-farm waste material. The lack of supporting waste management services was noted as a key reason for poor performance in this area. This is emphasised when contrasted with the Central QLD region where access constraints are relatively low, and no instances of poor waste management performance were observed. In the Central QLD region, growers spoke highly of the regional DrumMuster and had local services easily available for waste oil collection. The barrier to access waste management services was reduced, lowering perceived effort to participate, making the integration of best management practice easy to adopt on-farm.

Implementation of best practice waste management does not directly correlate to profitability on farm as it does not affect yield or quality of cotton produced. Waste management therefore needs to be accessible and affordable to invite participation and deliver positive outcomes.

5.5 Natural resource management

Natural resource management on-farm encompasses practices that promote soil health, biodiversity, regeneration of vegetation and management of native and remnant vegetation, and awareness of and positive management of ecological values present on-farm. Farmers are stewards of the land on which they operate, with management of natural resource fundamental to balancing the farmed/managed environment.

5.5.1 Soil health and biodiversity management

5.5.1.1 Soils

Soil health has a number of definitions in the literature particularly as knowledge of the soil resource has developed. Soil health in the context of natural resource management can be defined as 'the soils ability to perform its functions and ecosystem services sustainably'.

The soil provides a number of functions (CEC 2006) which are reliant on soil health to function effectively. These include:

- Biomass production
- Storing, filtering & transforming of nutrients, substances and water
- Biodiversity pool
- Physical and cultural environment
- Source of raw materials
- Acting as a carbon pool
- Archive of geological and cultural heritage.

Managing the soil resource to optimise soil function and health contributes more broadly to natural resource management across global challenges (Table 4). Effective management of the soil resource is integral to sustainable farming practices.

Table 4: The relationship of the six global challenges supported through the seven soil functions. Table reproduced from Field (2017) based on McBratney et al. (2014)

Global challenges	Role of the soil functions
Food security	The quantity, quality and accessibility of food are affected by having soil that can produce an adequate <i>biomass</i> (1) through the soil being able to <i>store, filter and transform nutrients, substances and water</i> (2) and avoiding contamination
Water security	Soil contributes to clean water by <i>storing, filtering and transforming nutrients, substances and water</i> (2)
Energy security	The use of plants for energy is supported by soil's ability to produce <i>biomass</i> (1) linked with <i>storing, filtering and transforming nutrients, substances and water</i> (2) but may not be synergistic with food production and sustainable water use
Biodiversity	Soil has the largest biodiversity pool, <i>demonstrated through the diversity of habitats, species and genes</i> (3) enabling plant growth and recycling of waste and a source of products that benefit human and ecosystem health
Human health	In addition to the security of food and water and the potential resources that can be gained from maintaining a diverse gene pool in soil, human health is also supported through the <i>provision of physical and cultural environments for their activities</i> (4). Also, being an <i>archive</i>

	<i>of geological and archaeological heritage</i> (7) provides an opportunity for connecting with history or cultural identity, all of which contributes to well being
Climate change	Soil acts as a <i>pool for organic carbon</i> (6), which contributes to the reduction of greenhouse gases, the use of soil as a <i>resource for raw materials</i> (5) is a concern as this removes a potential sink for carbon

5.5.1.2 Biodiversity

On average, about 21% of the area of a cotton farm has remnant native vegetation, and about 4% is managed for biodiversity (SWG 2020). Homogenisation of agricultural landscapes and historic land clearing has caused fragmentation of the landscape to the detriment of biodiversity. Where vegetation has been retained, it is often on the least productive land with additional pressures to biodiversity including grazing, exotic weed invasion, feral pests such as rabbits, changes to fire regimes, dryland salinity, and soil erosion (Gagic et al. 2018). Biodiversity supports many ecosystem functions that can not only be beneficial to human wellbeing but also more broadly to agricultural land management including carbon sequestration, decomposition and pest control (Macfadyen et al. 2012). The response of Australian native organisms to agricultural land use intensity is a function of their mobility and habitat specificity (Figure 23).

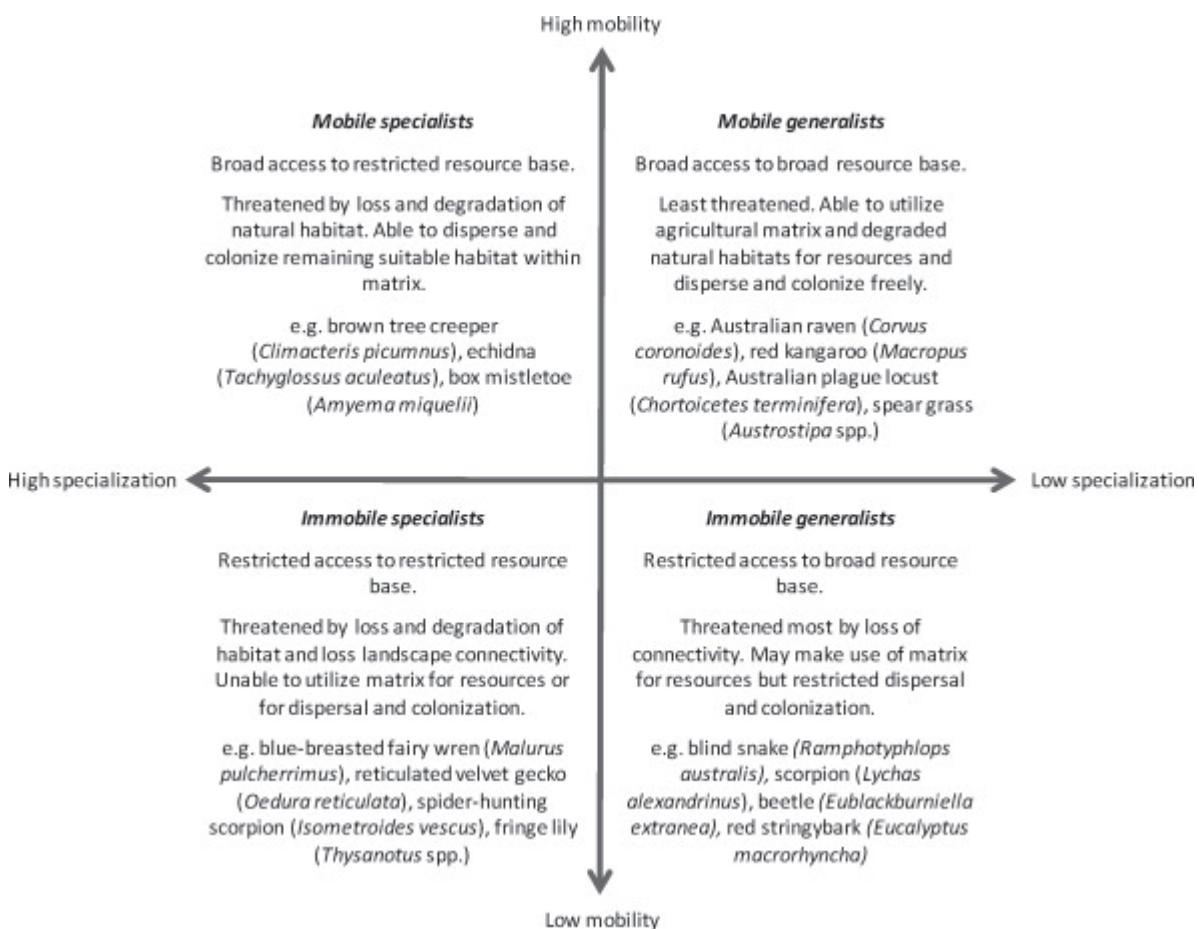


Figure 23 The response of Australian native organisms to agricultural land use as presented in Smith et al. (2013)

Remnant vegetation (as opposed to revegetation) continues to be the vegetation type with greatest biodiversity and ecological value in agricultural landscapes. However, remnant vegetation is managed at a local scale (individual land holders) for ecological values, where biodiversity occurs at a large spatial scale and provides landscape connectivity for biodiversity conservation. Despite this, there are clear benefits of remnant vegetation in agricultural landscapes including carbon sequestration, flood mitigation and erosion management, particularly along slopes and banks, and pest control (MacFadyen et al. 2012).

In agricultural landscapes the retention of native remnant vegetation is crucial in maintaining populations of beneficial insects (Schellhorn 2010). Native plants within non-crop habitats such as remnant vegetation patches have shown to have low occurrence of pests and high occurrence of their natural enemies (Gagic et al. 2018). This is particularly prevalent where woody vegetation is in good condition and has a mid and understorey with good ground cover (Gagic et al. 2018).

Characteristics of remnant and native vegetation habitats such as structural complexity, diversity and disturbance affect the abundance and diversity of organisms (Gagic et al. 2018; Lentini et al. 2012; Munro et al. 2007).

Revegetation as part of on-farm management to enhance biodiversity takes time to develop the level of floristic diversity and structural complexity present in remnant vegetation patches, with organisms differing in time taken to recolonise (Munro et al. 2007). Revegetation will be important in meeting the cotton industry goal for biodiversity to improve biodiversity condition on farms across the cotton landscape. It provides a whole of industry approach that can meet the large spatial scale that presents a challenge to improving biodiversity in agricultural landscapes.

5.5.2 Industry priorities and key initiatives

The cotton industry is undertaking a number of projects in this area as part of its commitment to the sustainability goals developed as part of the PLANET. PEOPLE. PADDOCK. initiative.

The cotton industry sustainability goal for soil health is to deliver sustained cotton productivity growth by improving soil health. Currently, there is no standardised approach to soil monitoring and evaluation at a national level, as part of the National Soil Strategy released in 2021 it is intended to deliver nationally consistent KPIs and methods to measure and report soil conditions. The industry has committed to working to progress this objective, such that it is able to establish clear indicators and targets for soil management. In the interim, it has developed a soil health framework that aims to take the complexity out of soil health, and encourage growers to follow two key principles (provide food and shelter to soils), which will improve soil health, regardless of how soil health is ultimately measured.

Similarly with biodiversity, the industry has set a goal to improve biodiversity condition on farms and across the cotton landscape but at this stage the goal does not have associated indicators and targets. The industry is working with other stakeholders to test approaches to measuring change in biodiversity condition at the industry scale.

The soil health and biodiversity natural resource management areas are a focus for cross-sector initiatives including participation in the Australian Agricultural Sustainability Framework project being coordinated by National Farmers' Federation to identify consistent indicators for biodiversity targets, and partnerships such as a project between Country Road, Landcare and the Australian cotton industry which saw 34 hectares of land revegetated in 2020/21.

In 2020 a CRDC-funded project began to monitor native vegetation sites to support landholders to improve biodiversity. The project sites were established by CottonInfo Regional Extension Officers (REOs) with regional natural resource management groups and universities collaborating to assist with monitoring and technical advice. The project aims to understand the challenges and gains for biodiversity and the farm business resulting from vegetation management actions and identify potential funding opportunities to assist landholders in implementing land practice change.

5.5.3 Natural resource management on farm

The *Cotton Grower Survey 2021* found there are significant variations in native and remnant vegetation areas between regions and farm sizes and this was supported during GHD's on-farm assessments. The *Cotton Growers Survey 2021* found that, on average, only 3% of total farm area is native vegetation that is not usually grazed. More than 2/3 (69%) growers report having a riparian area on their property.

Growers visited in the central Queensland region reported that many properties were part of the Queensland governments' historic land ballots. Compliance with the ballot system involved the removal of trees and was the result of policies to encourage the more intensive use of agricultural land. This has resulted in many properties having little to no remnant vegetation while also generally being smaller in size relative to other growing regions. Despite this, all growers in central Queensland that were visited for on-farm assessment were engaged in soil

management strategies including stubble retention, crop rotations, and cover cropping and were managing remnant vegetation where present.

On-farm common practice for the majority of farms visited included:

- Monitoring soil moisture using in field probes (the number of these per hectare varied)
- Crop rotations
- Minimum till practices
- Regular soil testing through their agronomist.

There was variation between farms in how soil management techniques were implemented. For example where growers were retaining stubble between rotations some farmers were then incorporating the organic matter into the soil using tillage just prior to sowing, where others were using direct drill methods to plant directly into stubble. Less common practices included:

- Cover cropping
- Controlled traffic farming
- Application of soil conditioners/ameliorants outside NPK fertiliser as directed by agronomists.

The aggregate of the ratings for criteria relating to natural resource management (i.e. soils and biodiversity) are shown in Figure 24 by myBMP and region visited. Observations of ‘very good’ were dominant in the Northern NSW / Southern QLD and Southern NSW areas. Some ratings of ‘poor’ were observed on myBMP-registered and non-myBMP farms in the Macquarie valley though it is noted this is a small sample size.

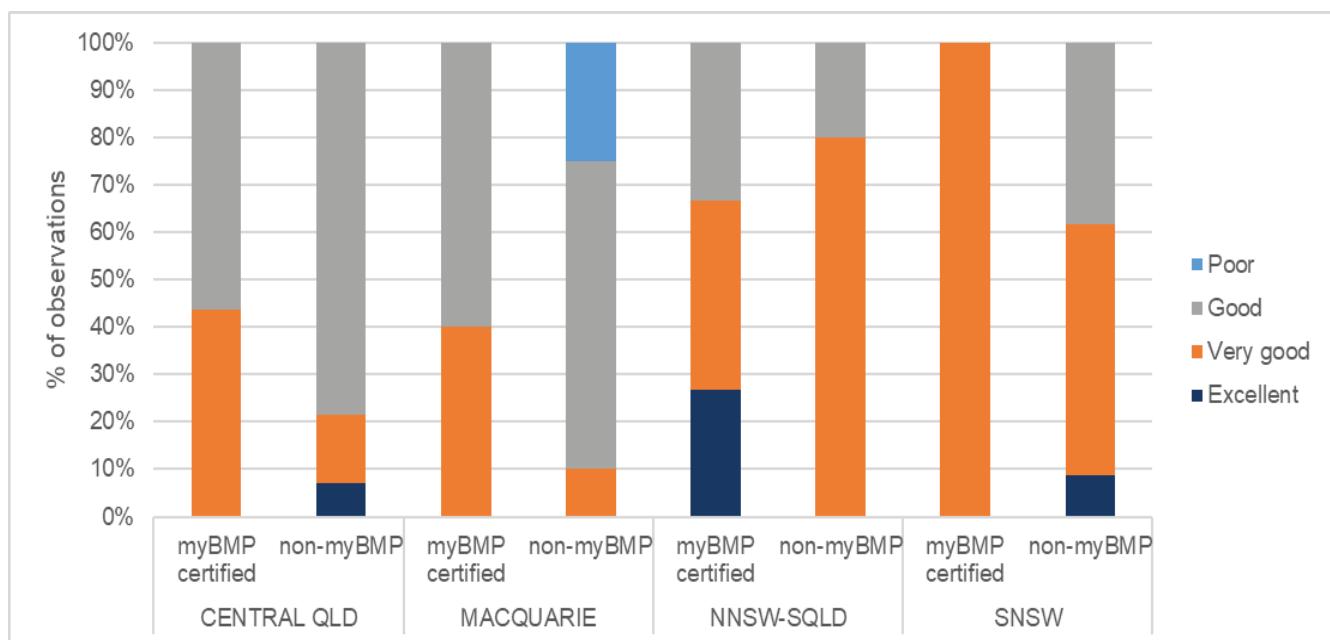


Figure 24 On-farm observations relating to natural resource management by region and myBMP status

5.5.4 Stakeholder perceptions of natural resource management

Stakeholder interest in biodiversity generally has increased relative to the Third Environmental Assessment in 2012. This is reflective of the global and domestic trends and pressures in this area. Stakeholders participating in the online survey for this assessment, indicated that there is a generally negative perception around ‘protection of riparian area’, ‘increased plantings and/or conservation of native vegetation’ and less so in respect to ‘management of environmental weeds and feral pests’ and ‘practices to conserve or improve soil health’. Approximately 20% of stakeholders provided a ‘don’t know/unsure’ response in relation to the industry’s performance in these areas.

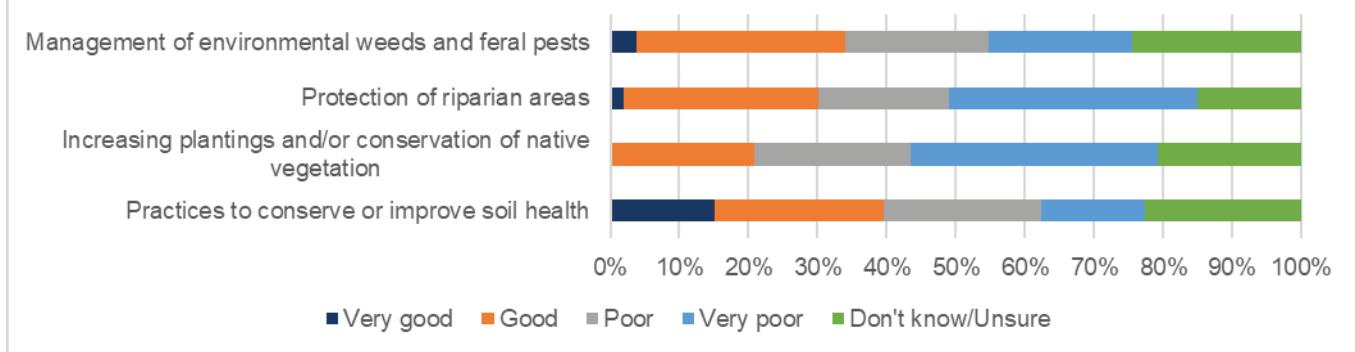


Figure 25 Stakeholder questionnaire responses related to current natural resource management

The CRDC-commissioned 2019 report on the *Perceptions of Strategies to Strengthen Biodiversity Management – Perspectives from the Cotton Industry* found that 62.5% of respondents agreed that biodiversity loss was a serious issue in Australia (Dean and Uebel 2021). This was not a universal perception however, with some participants not in agreement with statements in this area. Some of the main challenges identified in improving biodiversity in general were the lack of a clear definition of biodiversity and tangible goals. There is a want by participants “to do the right thing” but the need for support which participants identified would need be strongly supported through industry leadership.

In the grower survey conducted for this assessment, 100% of growers felt that the current overall industry performance was ‘good’ to ‘very good’ for ‘protection of riparian areas’. There was some (<10%) feeling that the ‘management of environmental weeds and feral pests’ was poor.

Growers surveyed further indicated the current industry performance to conserve and improve soil health and native vegetation still has room for improvement with 12.5% of growers indicating performance as poor. Further to that, when asked about the industry’s improvement in soil health conservation practices over the 10-year period, 19% indicated improvement was ‘poor’.

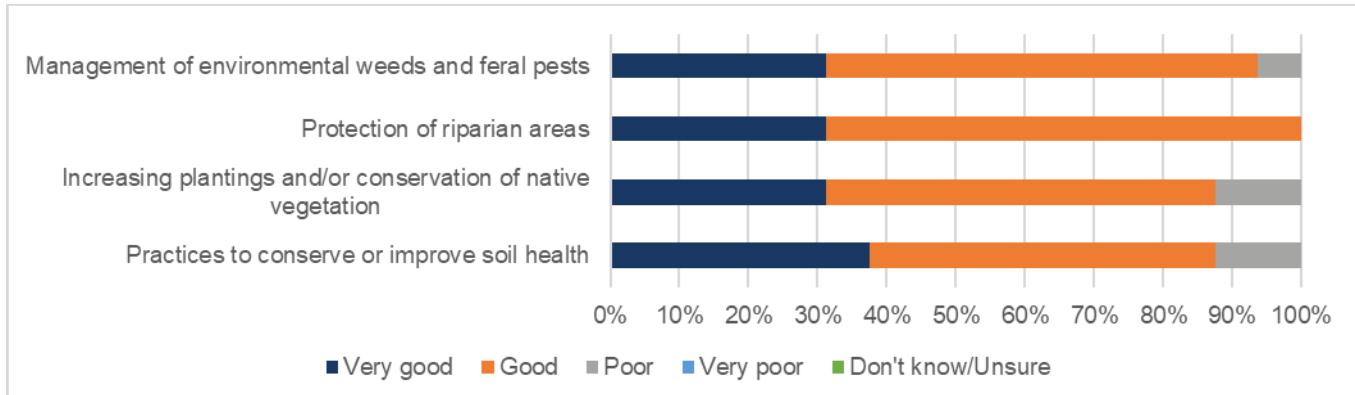


Figure 26 Grower questionnaire responses related to current natural resource management

5.5.5 Conclusions and recommendations

GHD found that there is a strong understanding of the importance of soil health and its overall benefits to productivity amongst cotton growers, and to a lesser extent the benefits of remnant vegetation and riparian areas. Often where vegetation is retained, this is on the least productive land and faces additional pressures including grazing, exotic weed invasion, feral pests, changes to fire regimes, dryland salinity, and soil erosion. Broader stakeholder interest in biodiversity has increased since the Third Environmental Assessment and this is expected to continue with the introduction of a new Global Biodiversity Framework. GHD observed that the industry is undertaking a number of projects regarding soil health and biodiversity, alongside broader agricultural initiatives. Particular attention should be given to stakeholder concerns around biodiversity and native vegetation management as the industry continues its expansion in Northern Australia.

Recommendations

- Continue cross sector work to establish indicators and targets for biodiversity and soil, including continuing industry specific investigations on nitrogen use and links to emissions.
- Increase extension efforts to assist grower understanding and awareness of how they can increase their natural capital on farm.

Case study: Excellence and innovation in natural resource management

Natural resource management on farm is fundamental to a balanced managed ecosystem. It encompasses practices that promote soil health, regeneration of vegetation and management of native and remnant vegetation, and awareness of and positive management of ecological values present on-farm. Across the growing regions there are private farms utilising technology and driving innovation for natural resource management in their businesses.

Cotton composting and cover cropping for soil health

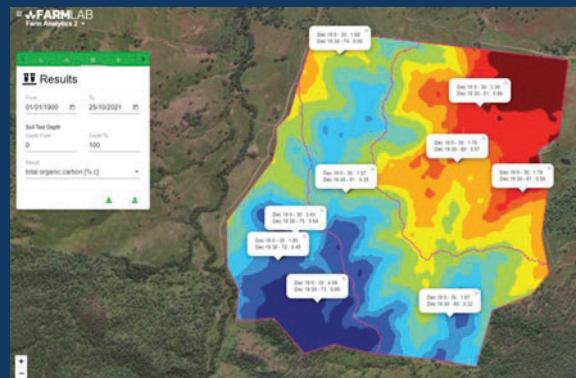
In Queensland, the combination of a cotton farm and a composting business has resulted in net benefit for the farmed environment, particularly soil health. The composting business uses crop waste and transforms it into a soil conditioner to be reapplied across the farm. The benefits of this have compounded over the 12 years of ownership of the property and has allowed the composting business to expand while fostering excellence in soil management in the cotton enterprise. The benefits of the use of the compost seen on farm included:

- Improved soil structure
- Improved soil chemistry resulting in reduced fertilizer use
- Increased soil water retention
- Increased soil organic matter (SOM)
- Reduced erosion risk

The application of compost to the soil is coupled with cover cropping and a no-till system (outside what is required for the technology user agreement) to ensure maximum benefit to the soil. After the cotton season, compost is applied and radish is sown to improve soil structure and improve organic matter.

Digital solutions for natural resource management

Advances in technology over the past 10 years have driven significant improvements in natural resource management. It is likely that technology and its adoption will continue to play an important role in future improvements for the industry across all components of environmental management. Some farms are using the full extent of data availability and digital technology to sustainably manage their natural resource.



One family farm is striving for excellence through the use of digital solutions for effective management of their farm and natural capital. In the native and remnant vegetated areas of the farm, biodiversity surveys have been undertaken for the past 10 years, including records of both flora and fauna. The farmers feel that they have to be good stewards of the land they manage, and maintain or improve the natural resource present. The native vegetation is managed as a carbon store for the farm to offset their energy use.

Carbon farming is in the early stages of adoption across Australian farms, despite the high level of interest. From this example farm, the carbon farming markets to trade and profit from carbon capture and storage are not used, rather they keep clear records of their own emissions and carbon storage to ensure they are maintaining balance within their own farming system. The farm uses this data to manage the land and natural resources to maintain carbon neutrality as a minimum.

5.6 Energy, emissions and climate

5.6.1 Industry priorities and key initiatives

Climate change refers to long-term shifts in temperature and weather patterns. While shifts are natural, the main driver since the industrial revolution has been human activities, namely the consumption of fossil fuels but also the clearing of land for industry and agriculture. Burning fossil fuels releases greenhouse gases (GHGs) which include (amongst others) carbon dioxide, methane, nitrous oxide, water vapour and fluorinated carbons. These GHGs trap heat in the atmosphere (instead of the heat escaping to space) and therefore increase the land and ocean temperature. Extreme temperatures and weather systems, increased risk of droughts and floods, as well as the changes in pest, weed and disease ranges are all consequences of a warming planet.

The CSIRO and Australian Bureau of Meteorology (BoM) have collaboratively produced a comprehensive set of climate change projections covering the whole of the Australian continent (CSIRO and BoM 2015). Climate projections are organised into clusters of NRM regions with similar climate and weather. The main cotton growing regions of QLD and NSW fall into three of the clusters, Central Slopes, East Coast, and the Murray Basin (Figure 27). Across all the growing regions, future climate projections show:

- Higher temperatures
- Hotter and more frequent hot days with less frost
- Increased intensity of heavy rainfall events
- Harsher fire weather climate
- Increased evaporation rates and reduced soil moisture (Timbal et al. 2015; Ekstrom et al. 2015; Dowdy et al. 2015).

In the Central Slopes projections also show less winter and spring rainfall, and less rainfall in the cool season for the Murray Basin (Ekstrom et al. 2015; Timbal et al. 2015). The Murray Basin is also projected to spend more time in drought (Timbal et al. 2015).

Agriculture is an important source of greenhouse gas emissions with Australian agriculture being the second largest contributor to greenhouse gas (GHG) emissions (Panchasara et al. 2021). 30% of Australian agriculture emissions are from the management of soils, application of urea as fertiliser, liming, rice cultivation and burning of agricultural residues (Panchasara et al. 2021). There are a number of management practices that can be implemented to reduce on-farm emissions including but not limited to:

- IPM which can decrease total pesticide use
- Revegetation and remnant vegetation management to sequester carbon
- Minimum / no tillage practices reduce energy consumption during land preparation
- Weather based advisory where technology is used to do weather forecasting and gather relevant information on climate condition to make informed management decisions about the environmental resource (Panchasara et al. 2021).

In addition to crop and land management practices, energy efficiency can be taken into account during acquisition of machinery, and alternative energy uses can be implemented on-farm.

The ambition set by the cotton industry sustainability framework PLANET. PEOPLE. PADDOCK. is to contribute to the Paris Agreement's aim of a climate neutral world. This would mean reducing the emissions released in cotton production while sustaining carbon in the soil and vegetation on cotton farms. A GHG emissions target has not yet been developed by the SWG. The industry's strategies to achieve reduced GHG emissions include:

1. Improving nitrogen use efficiency
2. Reducing energy emissions from fuel and electricity use
3. Increasing carbon sequestration and storage on farms (SWG n.d.b).

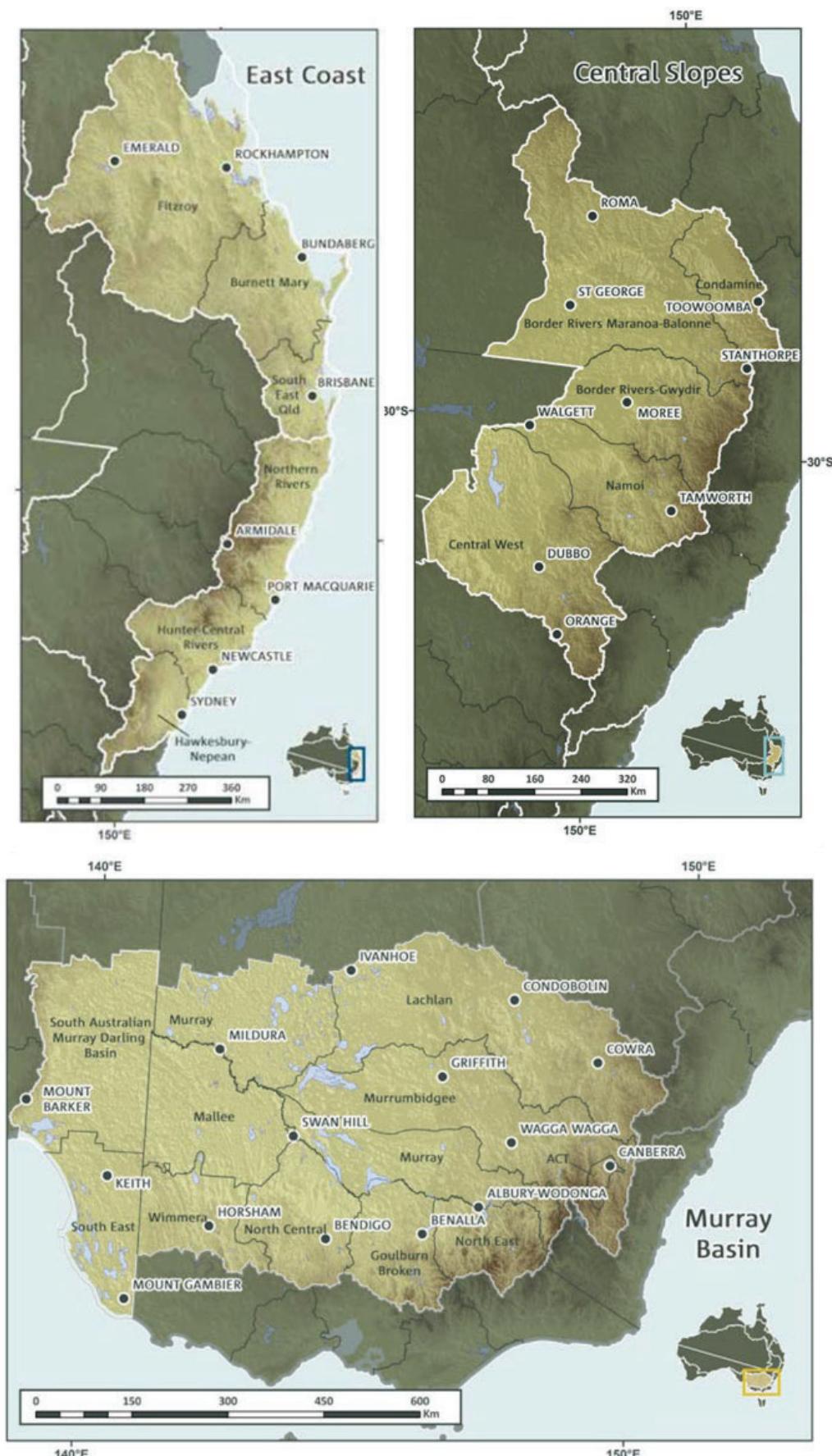


Figure 27 NRM regions grouped into clusters for climate projections (CSIRO and BoM 2015)

5.6.2 Energy, emissions and climate on farm

The *Cotton Grower Survey 2021* found that 51% of growers reported they believed their regional climate patterns will result in a change to their production systems over the next 10 years. Only 50% of growers believed they had regionally specific information and forecasting tools available to them to support any plan to change their production system that may be required. The *Cotton Grower Survey 2021* found there remains one in three growers who don't believe they will need to adapt their production systems to accommodate changing regional climate patterns.

The on-farm assessments considered a number of criteria relating to energy use efficiency. Technological advancements with on-farm machinery have supported increased efficiency in this area. Machinery purchase comes standard with associated technology such as software with platforms and user interfaces which can provide real-time tracking of fuel use in field and optimise distance travelled by machinery to cover a field with minimum passes. On-farm growers used this technology as part of their regular operations.

On-farm assessment found that very few farms had implemented renewable energy on-farm. Some growers had installed solar on their homes on the property and some had also installed solar to sheds. The majority of feedback during the on-farm assessments found that the regional infrastructure to support broadscale adoption of renewables on-farm outside of domestic use was limited. Some growers were also unsure of the industry's performance in these areas.

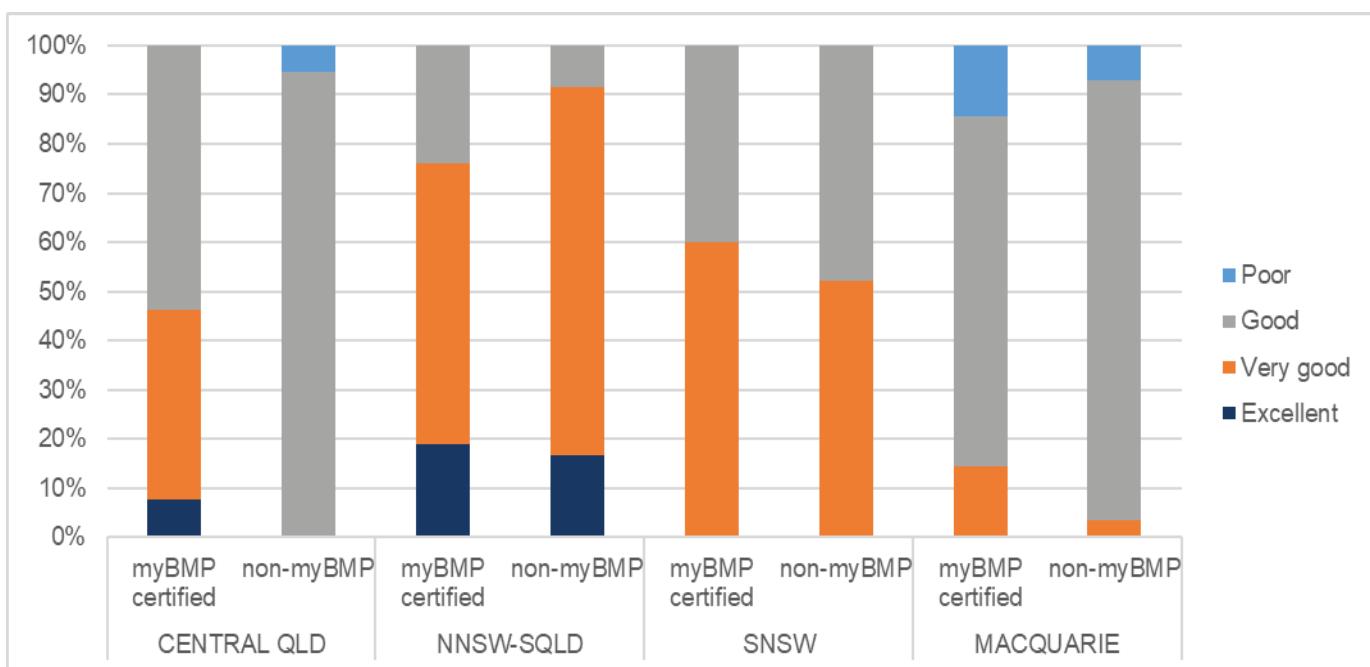


Figure 28 On-farm observations related to energy, emissions and climate by region and myBMP status

The *Cotton Grower Survey 2021* found that 29% of growers were actively assessing the carbon footprint of their production system. This was more common with larger farms. The on-farm assessment found that most growers were informally assessing their practices, particularly where changing their activities would result in increased cost efficiency. Growers were especially interested in the prospects of carbon sequestration to offset emissions and opportunities for carbon farming. The consensus around this at present amongst growers was that the carbon farming system is still in its infancy and is hard to navigate. While some are measuring their sequestration as a measure of their own carbon neutrality (see natural resources Case study) no growers partaking in the on-farm assessment were actively participating in carbon markets. The agriculture sector as a whole is becoming increasingly aware of the role they can play in emissions reductions and offsets, and communications resources are becoming available to assist farmers in making choices for their own production systems such as AgriFutures Australia publication 'A farmers handbook to on-farm carbon management' (Carbon Count 2022). Resources and decision-making tools will help aid on-farm knowledge for growers to confidently implement changes to their practice.

5.6.3 Stakeholder perceptions of energy, emissions and climate

Similar to biodiversity, increased focus has caused stakeholder attitudes and perceptions of energy, emissions and climate to change over the past decade. Many stakeholders were unsure of what strategies were being used on-farm within the cotton industry, with the majority of stakeholders who commented on performance rating it 'poor' or 'very poor' in terms of renewable uptake, actions towards climate change and reducing GHG emissions.

Stakeholders perceived the industries performance on increasing efficiencies in energy efficiency and on-farm fuel efficiency overall 'good' to 'very good' where a response was provided. This sentiment was echoed by growers with over 80% of growers indicating current performance in this area as 'good' to 'very good'.

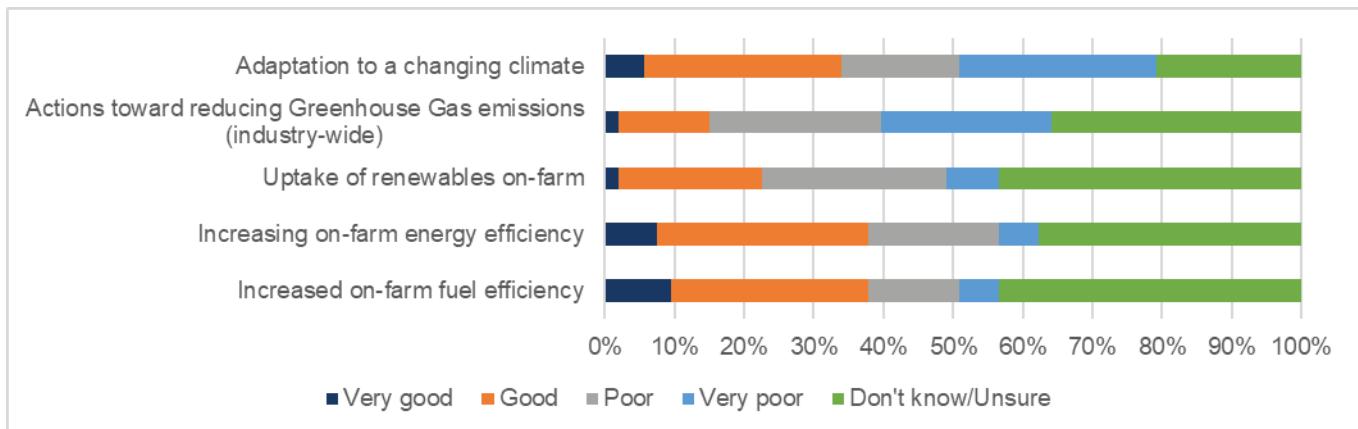


Figure 29 Stakeholder questionnaire responses related to current energy, emissions and climate practices

In the online grower survey undertaken for this assessment, approximately 80% of respondents perceived the industry's performance to uptake renewable energy sources as good – very good. This contrasts with the findings from the on-farm assessments, which found that very few of the farms visited had implemented renewable energy on-farm.

Interestingly, the set of five questions relating to energy, emissions and climate change had a much higher proportion of 'poor' responses than the other areas. 'Actions toward reducing Greenhouse Gas emissions' received by far the greatest number of 'poor' responses from growers.

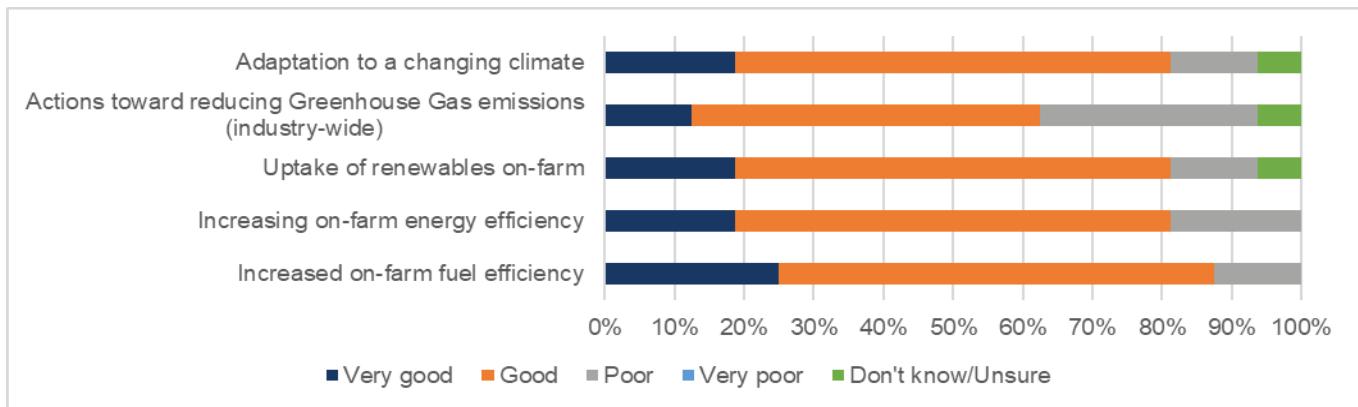


Figure 30 Grower questionnaire responses related to current energy, emissions and climate practices

5.6.4 Conclusions and recommendations

This is another area that has received increased global attention and shifts in stakeholder perceptions in the period since the Third Environmental Assessment. Grower sentiment has also changed with an increasing focus on carbon and emissions, even if they are not yet in a place to implement on-farm changes. Growers participating in on-farm assessments and stakeholder consultation indicated that this is an area where they require more information to ensure they can make informed decisions.

Recommendations

- Continue cross sector work to establish indicators and targets for GHG emissions and carbon storage and ensure alignment with government policies and programs on the establishment of agreed methodologies.
- There is a need for increased extension to growers in the area of energy, emissions and climate change. Due to the complex nature of climate change, carbon and GHG reporting, there is a role for industry to provide high-level information and share case studies and learnings amongst industry participants, with specialist, likely private sector, services required to offer growers more specific information to support on-farm decision making in regard to investment and/or market participation in this area.

6. Summary of recommendations

This section presents a summary of the recommended priorities for action based on the findings outlined in this report (i.e. ToR 4). Priorities for industry action have been assigned based on the following considerations: **High** – recommendation is considered to require immediate or short-term (i.e. 1-2 years) action; **Medium** – the recommendation may require further research, consultation or collaborative action to progress and therefore a timeframe of 2-5 years is likely to be required; and **Low / Ongoing** – industry already has initiatives or plans in place to progress this recommendation. Plans or initiatives require ongoing action and are likely to need review in 5-10 years.

No.	Recommendation	Priority for action
1	Continue to undertake updates to the existing myBMP website to ensure all information is current and weblinks and video content are accessible. Regular updates to both the main website and module content should be undertaken to ensure information remains current. This will become increasingly important as module content and supporting resources are updated to incorporate new research and information applicable to new growing areas.	High
2	Continue to increase the transparency and consistency of reporting of the number of growers both registered and certified with the myBMP program. Subject to privacy considerations, this should include the total number of growers and/or farms, and the total area and/or volume of cotton produced by farms with myBMP certification, both in aggregate and by region. This information should be available on the myBMP website as well as reported in the relevant annual publications, e.g. the Better Cotton and Cotton Australia Annual Reports.	Medium
3	Ensure a whole-of-industry commitment to increasing the uptake of myBMP certification. This may require further research into identifying real and perceived barriers to uptake. Following this, there may be a need to develop and implement a comprehensive communications and engagement plan that incorporates regionally specific adoption targets and actions for each of the supporting industry organisations.	High
4	Evolution and possible transformation of the myBMP program is required over time toward a performance-based tool that both adds value to participating farm businesses and provides clear outputs and data to support the implementation of the industry's sustainability agenda. This could include considering if the platform could be used to measure and monitor the stocks of natural capital at the farm scale.	Medium
5	The sustainability framework and reporting process should continue to move toward science-based targets, acknowledging the difficulties of achieving ambitious targets in a complex system. The SWG has already undertaken considerable work in this area and should be encouraged to continue.	Medium

6	Continue to work with the respective government agencies to include, where available, information on the status of water compliance in major cotton growing regions (e.g. number/size of breaches compared to total number of holdings) in industry sustainability reporting, as was flagged in the 2020 stakeholder consultation report on the setting of industry targets and indicators for the Australian cotton industry.	High
7	Continue to support research and trial work that is underway to better understand the impacts of fish entrainment and encourage broader adoption by cotton growers and infrastructure operators of screening on irrigation pumps and/or other identified mitigation measures.	Low / Ongoing
8	Use regionally targeted approaches to increase the level of biosecurity planning to ensure sound biosecurity practices are in place on-farm. There is room for improvement in this area to ensure that growers are prepared and have strategies already in place for any future outbreaks of new pests, weeds or diseases.	Low / Ongoing
9	Continue to work with the broader agricultural community to increase the understanding and awareness of off-target spraying to minimise the potential for environmental impacts.	Low / Ongoing
10	Engage partner industries and service providers to aid improvement in on-farm storage, handling and waste practices.	High
11	Undertake regionally targeted education and awareness campaigns to improve storage, handling and waste practices on farm. This should be supported by the industry's broader extension and myBMP programs.	High
12	The SWG should undertake a materiality assessment of waste management to consider if targets and indicators, or other explicit reporting of industry performance in this area is required.	High
13	Continue cross sector work to establish indicators and targets for biodiversity and soil, including continuing industry specific investigations on nitrogen use and links to emissions.	Low / Ongoing
14	Increase extension efforts to assist grower understanding and awareness of how they can increase their natural capital on farm.	Low / Ongoing
15	Continue cross sector work to establish indicators and targets for GHG emissions and carbon storage and ensure alignment with government policies and programs on the establishment of agreed methodologies.	Low / Ongoing
16	There is a need for increased extension to growers in the area of energy, emissions and climate change. Due to the complex nature of climate change, carbon and GHG reporting, there is a role for industry to provide high-level information and share case studies and learnings amongst industry participants, with specialist, likely private sector, services required to offer growers more specific information to support on-farm decision making in regard to investment and/or market participation in this area.	Low / Ongoing

Appendices

Appendix A

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Appendix B

Assessment Framework

The environmental assessment was guided by the development of an Assessment Framework, which was drafted by GHD and finalised after receiving comments from the Project Steering Committee. The Assessment Framework outlines the assessment approach and evidence sought to address the Terms of Reference.

Table B.1 *Assessment Framework used for the Fourth Environmental Assessment of the Australian cotton industry*

Terms of Reference	Assessment Approach	Evidence Sought
1. Assess the cotton industry's response to the recommendations made in the Third Environmental Assessment	Assess response as: Complete Partial Incomplete Commentary relating to appropriateness and timeliness of response	<ul style="list-style-type: none"> – Documented evidence of recommendations being implemented – Feedback from SWG and senior industry representatives on progress made, any barriers to implementation, and/or why recommendations have not been pursued – Perceptions from growers and key industry stakeholders via targeted consultation
2. Identify current and emerging industry environmental issues and their implications for the industry and on-farm management. Policy developments, recognised global sustainability goals or initiatives, and industry and non-industry stakeholder perceptions and expectations should be considered	Identify and document current and emerging environmental issues and their implications for the industry and on-farm management under the general themes of: <ul style="list-style-type: none"> • Stakeholder concerns • Environmental management (including myBMP) • Water use and management (dryland and irrigated) • Pest management (IPM and biosecurity) • Genetically modified cotton • Pesticides and other agrichemicals • Environmental incidents (storage and handling) • Waste management • Land management (including soil health) • Vegetation management • Climate change (air emissions and energy) • Potential impact and response to climate variability trends and adaptation measures • Education/information transfer (sustainability targets) Commentary on alignment or changes compared to past environmental assessment/s	<ul style="list-style-type: none"> – Literature review – national and international scan – Input from Sustainability Working Group – Cotton industry environmental assessments and sustainability reports – Previous CRDC / cotton industry market research and grower sentiment questionnaires – Input from Australian Cotton Sustainability Reference Group – Grower, industry stakeholder and broader community views on current and emerging issues via online questionnaire

Terms of Reference	Assessment Approach	Evidence Sought
3. Assess current industry action on environmental issues in light of the Third Environmental Assessment and identified environmental issues. This includes, but is not limited to:		
a. Impact: if the industry's on-farm environmental practices and outcomes are in line with current and future expectations and trends	<p>Assess on-farm practices against criteria and performance ratings to be determined and agreed</p> <p>Compare with findings from previous environmental assessments, and against available data and stakeholder consultation</p>	<ul style="list-style-type: none"> - Background information and assessment criteria from previous assessments - Uptake and impact of myBMP program - Onsite farm visits with a sample of myBMP and non-myBMP participants across the major growing regions - Information about farm practices obtained through annual grower surveys
b. Responsiveness: how well industry bodies, the myBMP Program, CottonInfo and sustainability programs are aligned, how well is industry able to identify and respond appropriately to environmental issues	<p>Assess industry coordination and responsiveness against stakeholder consultations and in comparison, to related industries</p> <p>Identify what might be coming at the industry from overseas trends, consumer expectations and regulatory environment/s</p>	<ul style="list-style-type: none"> - Desktop review of industry policies and programs - Literature review – national and international scan - Desktop review of environmental management/ sustainability policies and frameworks of other key Australian agricultural industries - Information and feedback from SWG, ACSRG and targeted consultation with a number of cotton and broader agricultural industry representatives
c. Consideration of stakeholder concerns and perceptions of industry action to address environmental issues. Different perspectives should be considered e.g. cotton industry (gins, shipping), state government, federal government, community and non-government organisations	<p>Identify and document stakeholder perspectives</p> <p>Analysis of views by different interest groups / stakeholder categories / demographics</p> <p>Commentary on alignment or changes compared to past environmental assessment/s</p>	<ul style="list-style-type: none"> - Previous CRDC / cotton industry market research and grower sentiment surveys - Insights from SWG and ACSRG - Feedback from growers and key industry stakeholders via targeted consultation - Perceptions from growers, industry stakeholders and broader community obtained via online questionnaire
4. Recommend priorities for action based on the findings from 1, 2 and 3 above	<p>Develop findings and recommendations from assessment components and test with SWG</p> <p>Draft Preliminary and Final Reports</p>	<ul style="list-style-type: none"> - Analysis and review of evidence obtained in 1-3 above

Appendix C

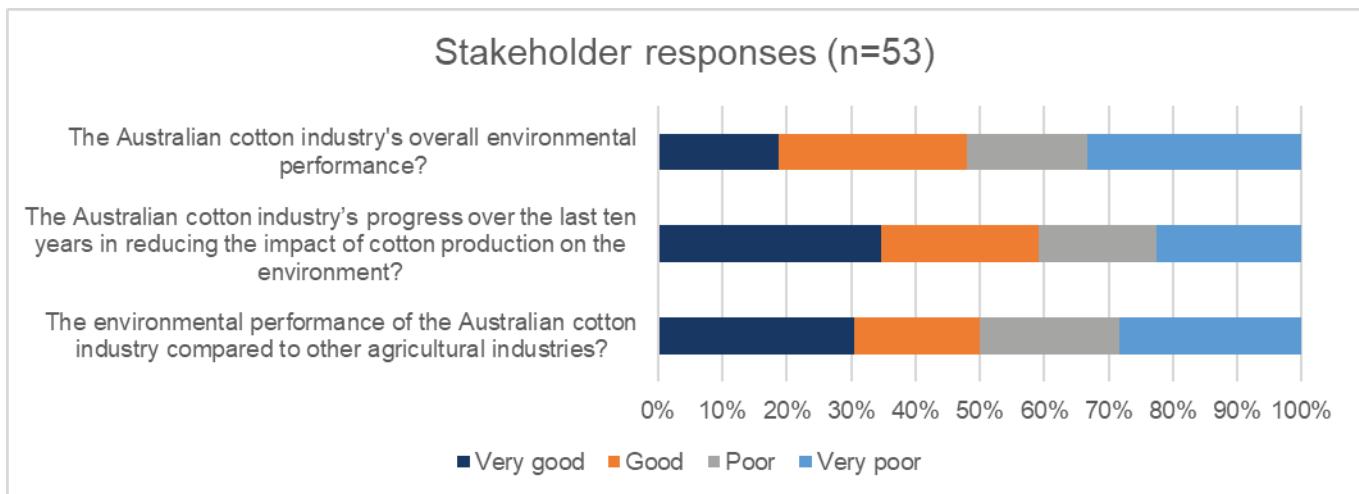
Stakeholder survey questions and responses

C-1 Online stakeholder questionnaire and summary of responses (n=53)

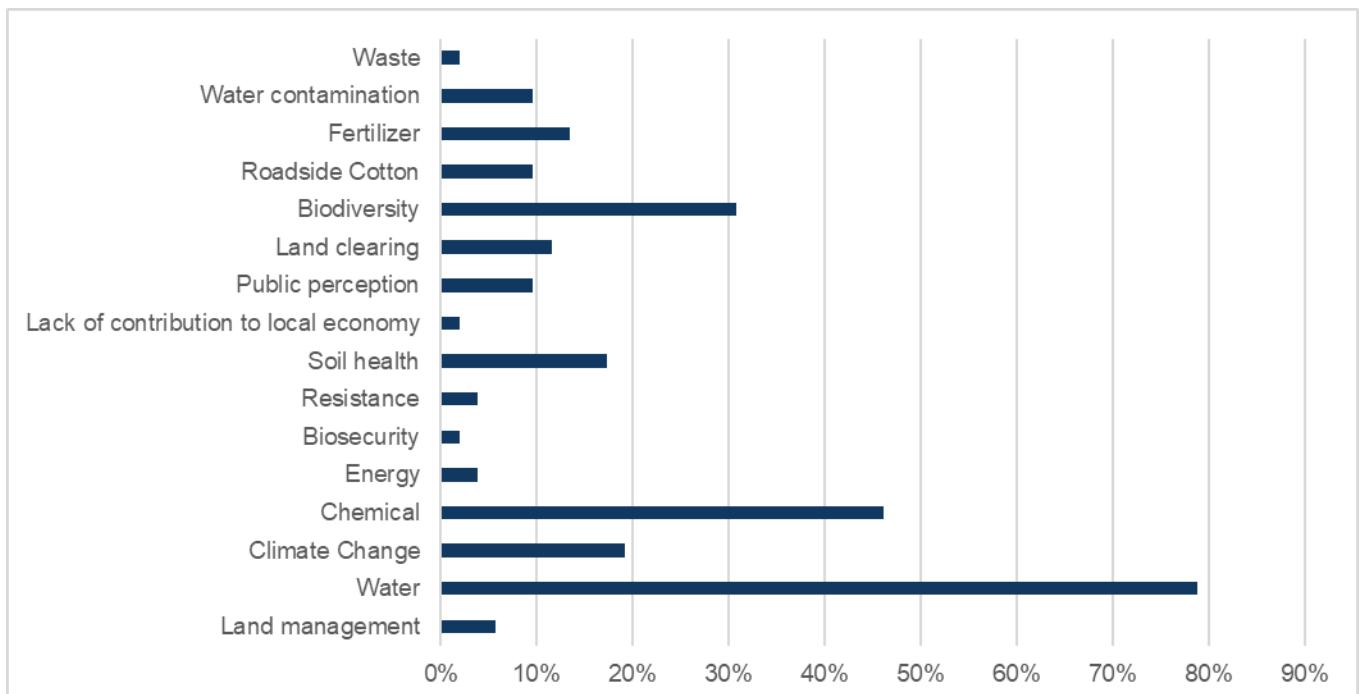
C-1-1 Overall industry performance

1. How would you rate the following:

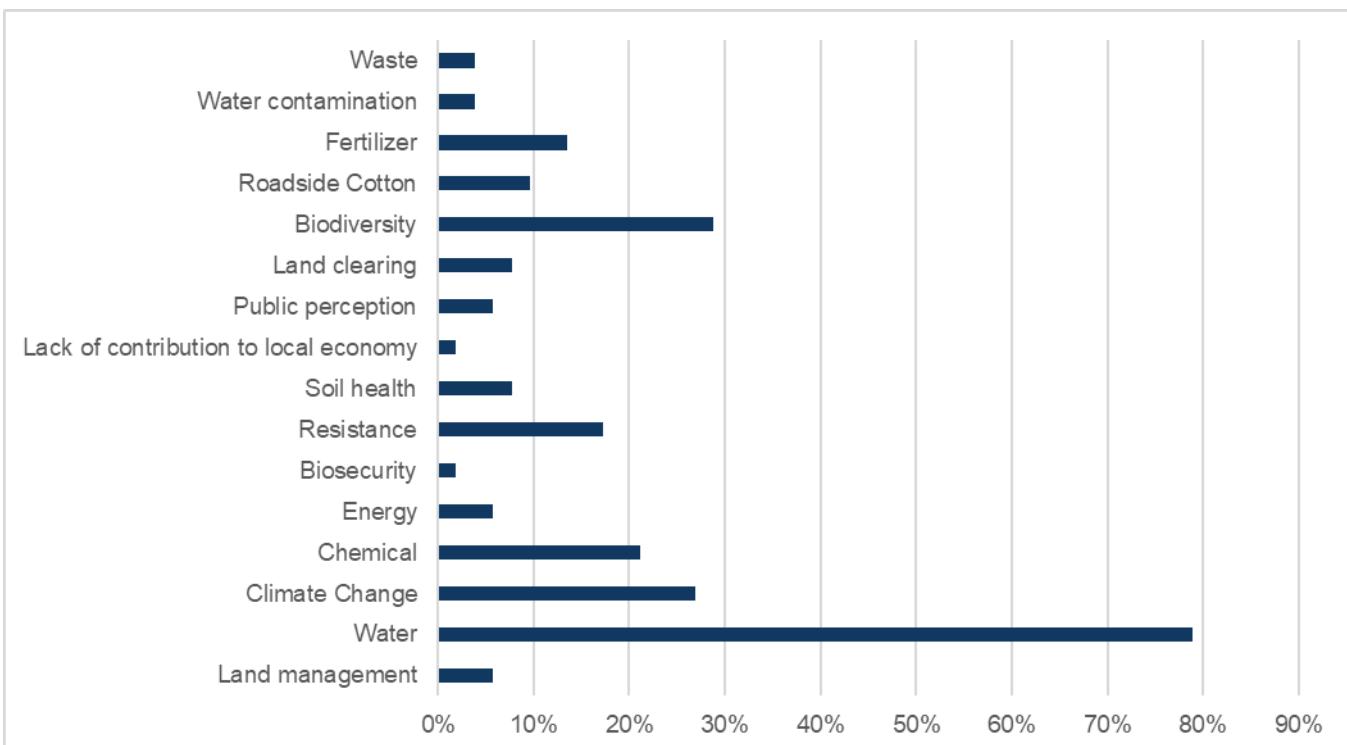
- The environmental performance of the Australian cotton industry compared to other agricultural industries?
- The Australian cotton industry's progress over the last ten years in reducing the impact of cotton production on the environment?
- The Australian cotton industry's overall environmental performance?



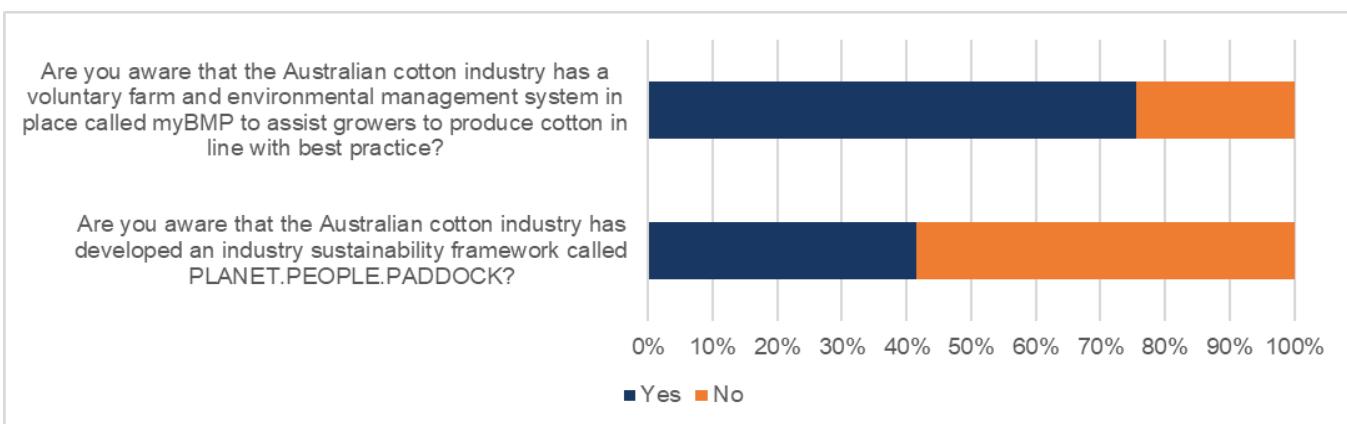
2. What do you consider to be the top three environmental issues currently facing the Australian cotton industry?



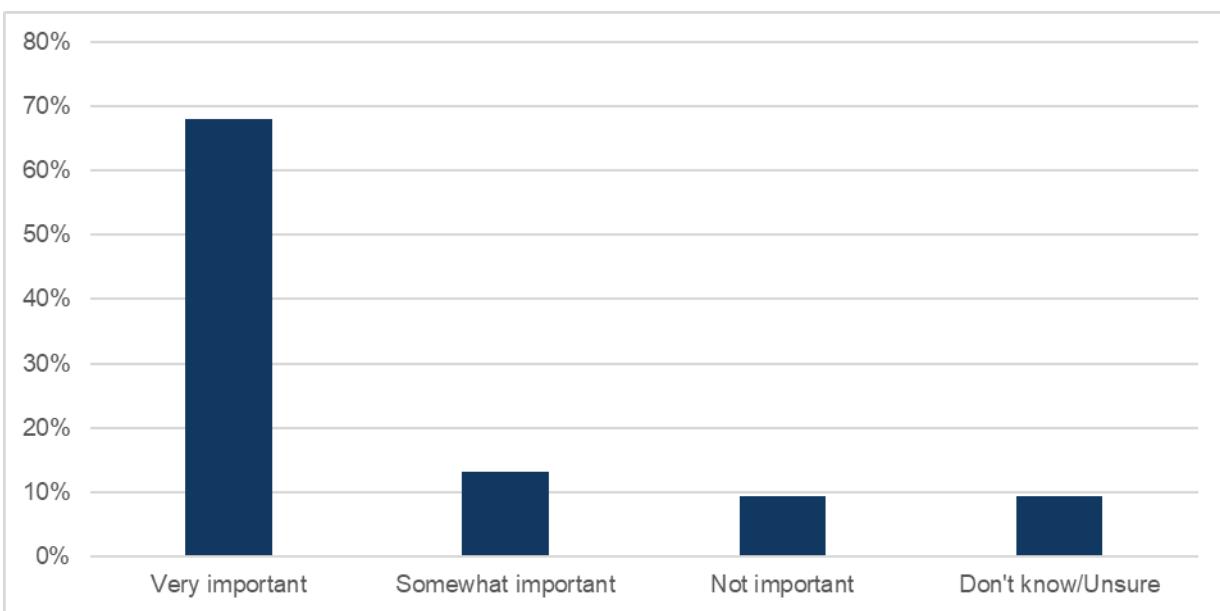
3. What do you think will be the three most important environmental issues that the industry will need to take action on over the next **5-10 years**?



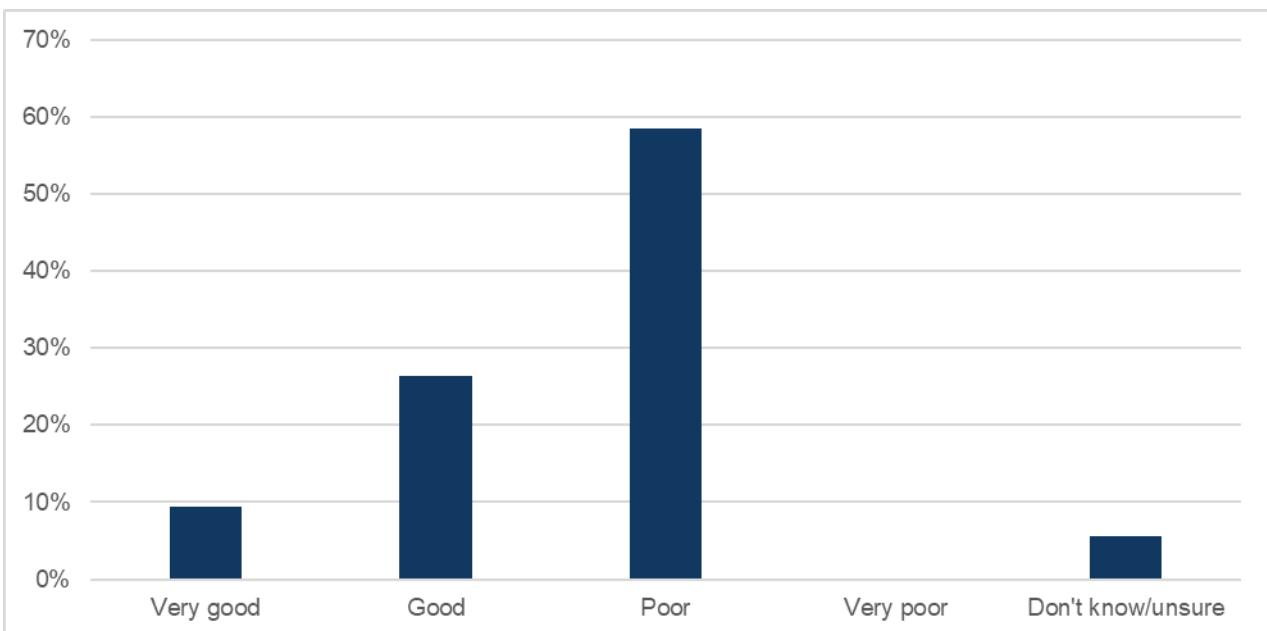
C-1-2 Industry initiatives



4. How important do you think initiatives such as myBMP and PLANET. PEOPLE. PADDOCK. are to the Australian cotton industry



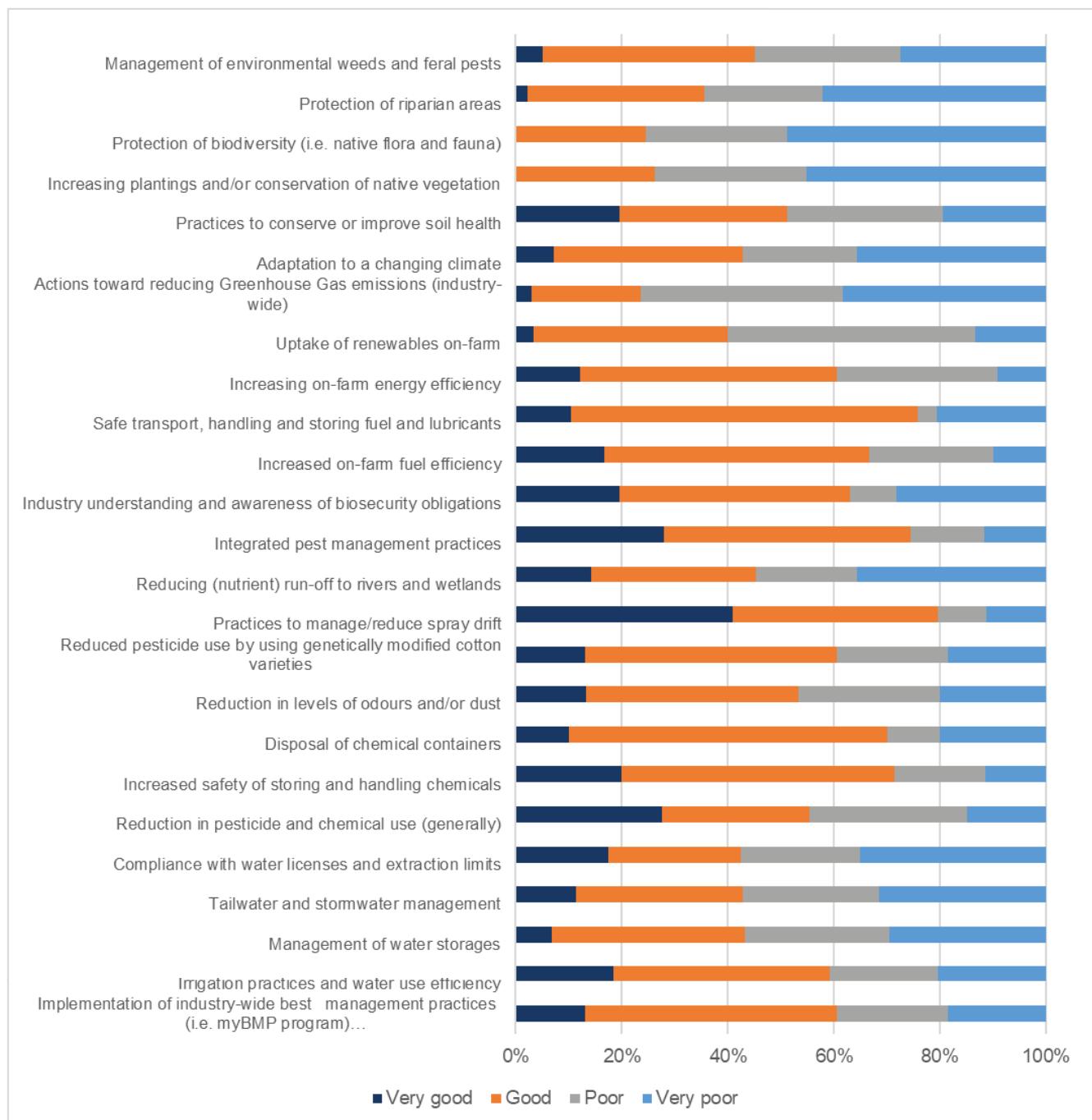
5. How would you rate the Australian cotton industry's performance in communicating its environmental performance to others?



6. What if any, other actions or initiatives should the industry undertake to improve its environmental performance and/or reporting?

C-1-3 On-farm implications

7. Below is a list of practices and/or environmental issues at the farm scale. In your opinion, how would you rate the Australian cotton industry's performance in relation to each?

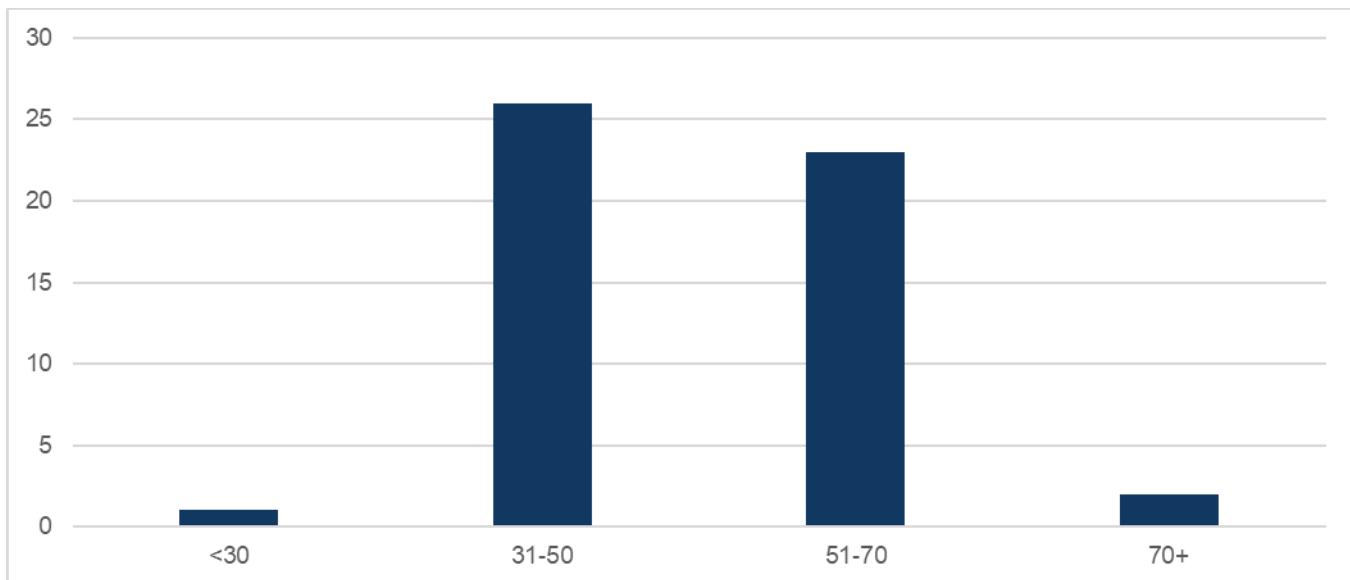


C-1-4 Follow up

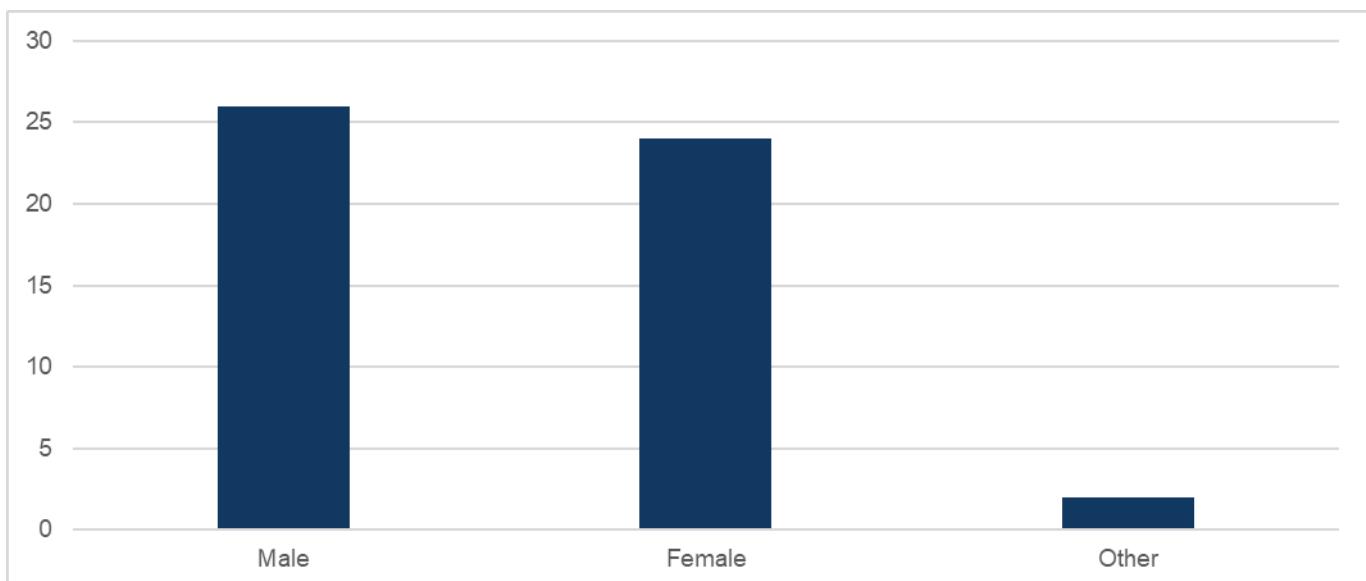
8. Do you have any further comments you would like to make in regards to the environmental performance of the Australian cotton industry
9. Do you have any environmental data or reports that could assist us in the assessment of the environmental performance of the Australian cotton industry? If so, please outline below.
10. Would you like to participate in a follow up call with one of our project team to discuss your responses in more detail? If so, please provide your name, organisation (if relevant) and contact number.

C-1-5 Respondent information

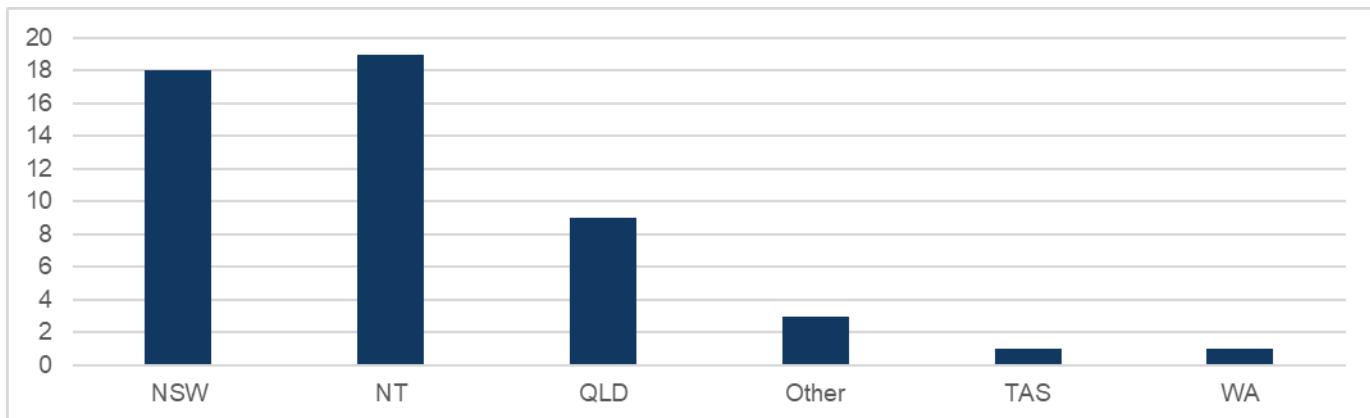
11. What age category do you fall into?



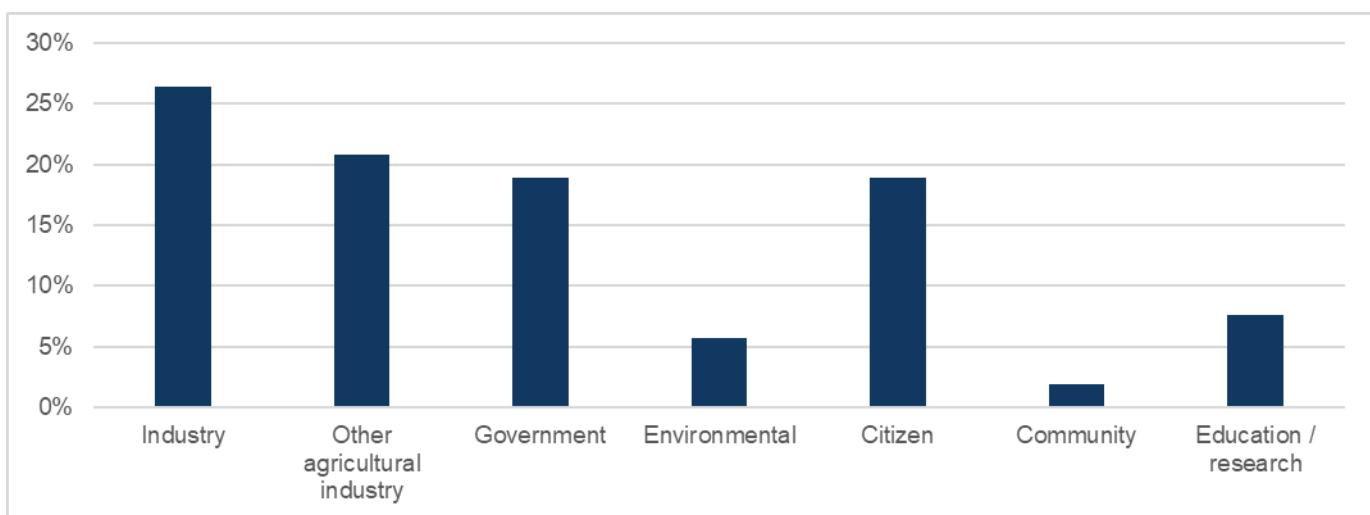
12. What is your gender?



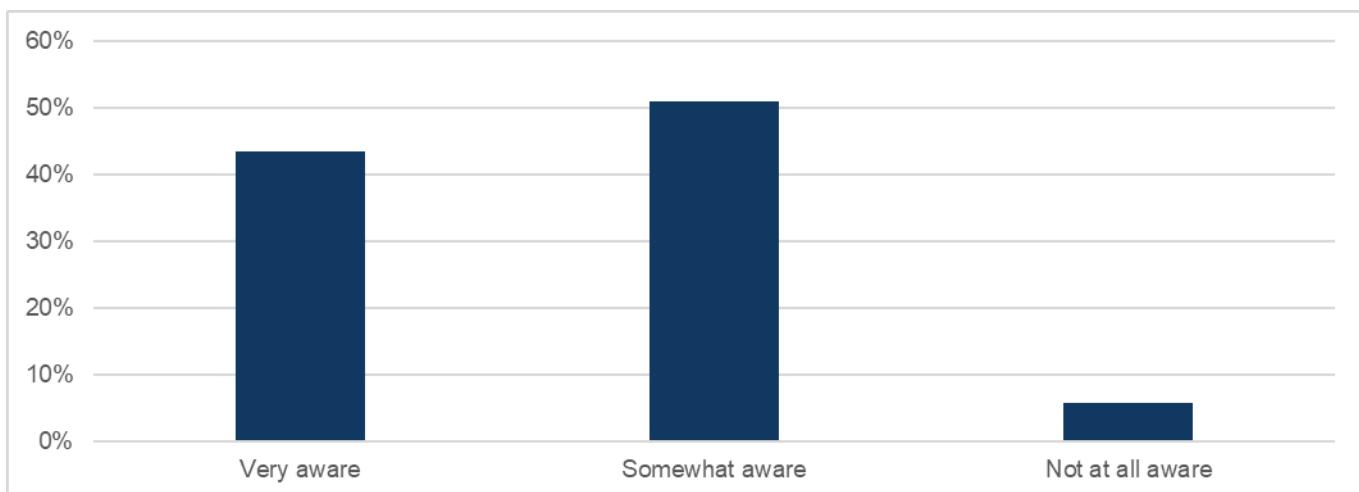
13. What is your postcode?



14. What category best describes your association with the Australian cotton industry?



15. How would you describe your level of awareness and understanding of Australian cotton farming practices?



C-2 Online stakeholder questionnaire: additional information and analysis

The stakeholder questionnaire was distributed through a range of avenues and hence received a much broader demographic of response than the Third Environmental Assessment, in which the survey was sent to an identified list of contacts suggested by the steering committee at that time. It is important to note the differences in the approach before attempting to compare the results directly with those received in 2012. It is also important to consider that the online questionnaire was not intended to achieve a representative sample but rather to gain insights to the various stakeholder perceptions that exist around the Australian cotton industry's environmental management and performance, as well as to inform the identification of current and emerging issues. To that end, an online questionnaire distributed widely to stakeholders across the many cotton growing regions as well as metropolitan based interest groups provided the opportunity for a diverse range of views to be obtained.

Overall, the 2022 survey received 53 responses. The overall perceptions did tend to be more negative than those obtained in the 2012 Assessment. A key observation from the survey is a significantly larger engagement and negative sentiment towards cotton growing from a group of respondents from the Northern Territory. This aligns with recent media and GHD's experience consulting with stakeholders in the Northern Territory for other agricultural projects. An example of how this has affected the results is seen in the rating of 'The Australian cotton industry's overall environmental performance.' Of the 53 responses, 15 classified it as 'very poor'. 10 of these responses were from the Northern Territory (19 total responses from the NT).

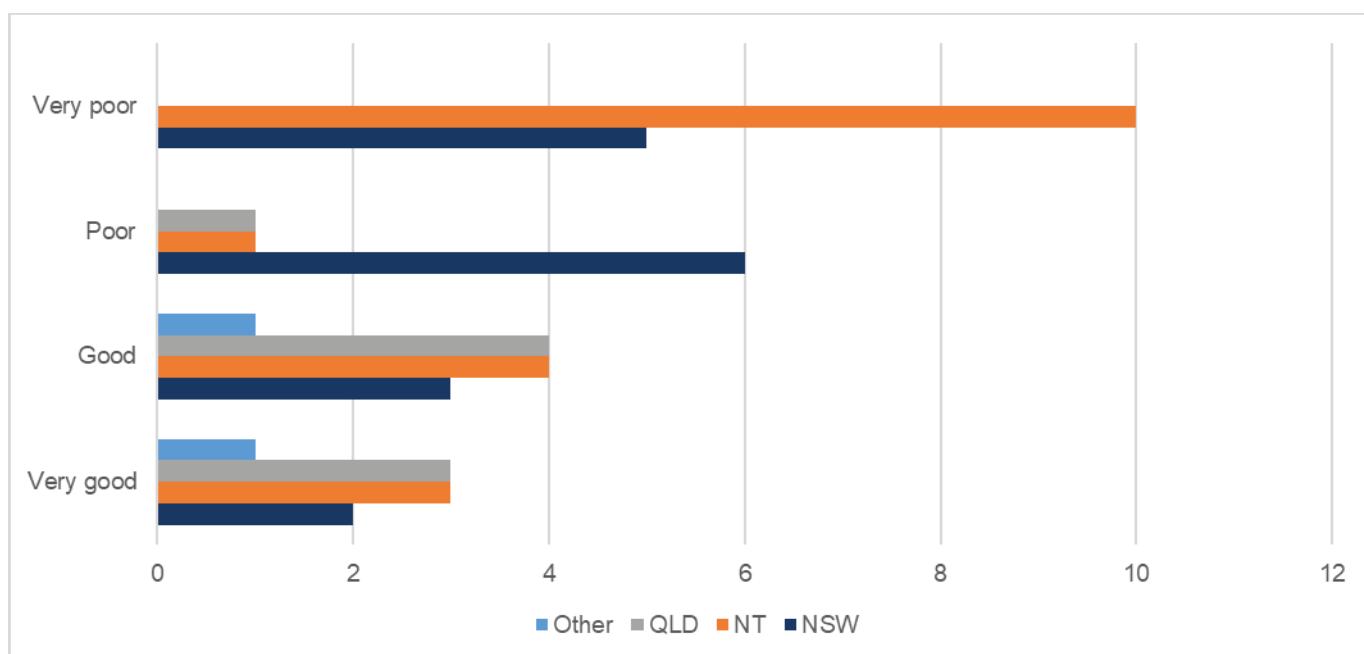
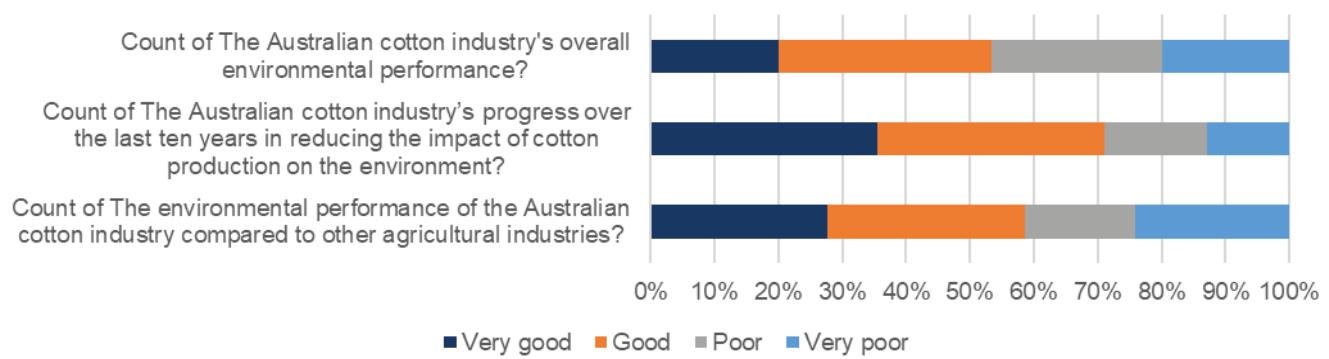


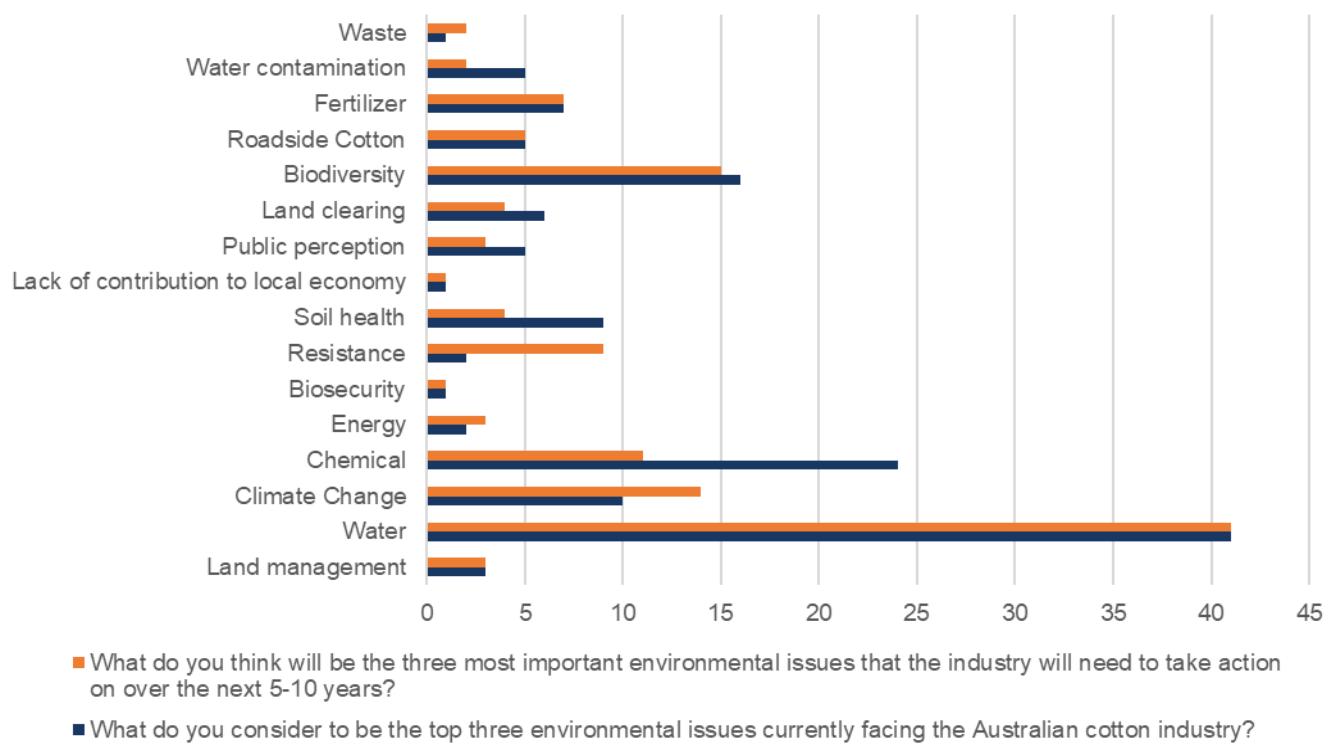
Figure C.1 Responses to "The Australian cotton industry's overall environmental performance" by State

Further consultation provided additional insights to the responses received. As Northern Territory agriculture has typically constituted native pastures/bushland utilised for cattle grazing, the current developments of cropping land is causing the clearing of land and implementation of new cropping systems. Although this requires governmental and section 19 approval, questions have been raised by stakeholders over the environmental effects of establishing the cotton industry in the Northern Territory. As cotton is the main crop being pursued in these developments, stakeholders consider that without the introduction of cotton, the clearing of land would not be occurring.

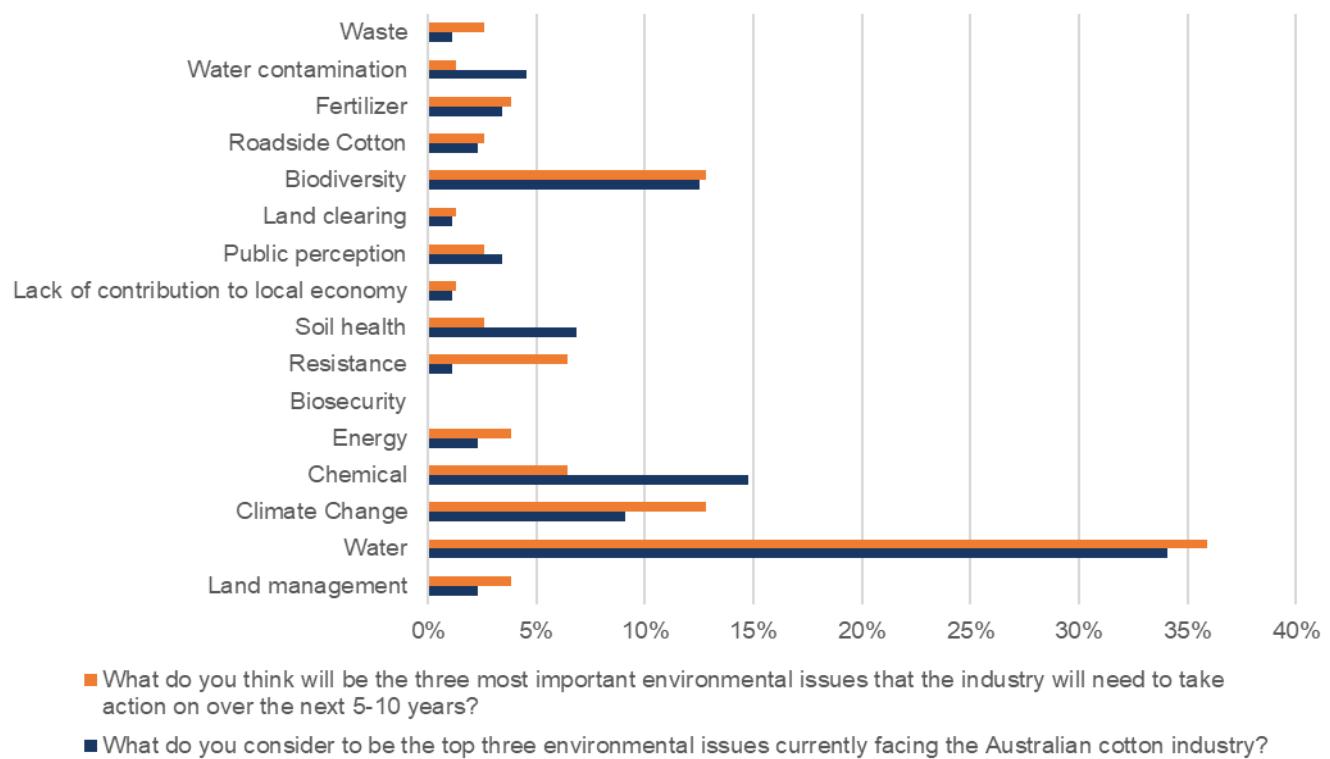
Stakeholder responses (n=34, excluding NT)



Stakeholder responses (n=53)



Stakeholder responses (n=34, excluding NT)



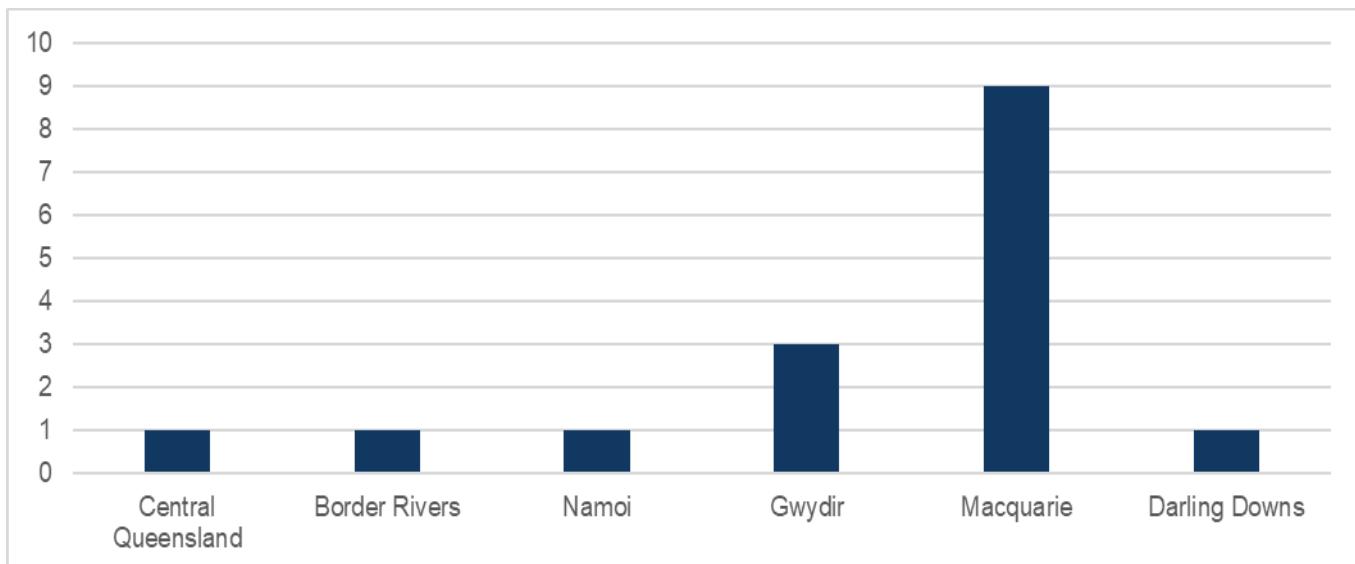
Appendix D

Grower survey questions and responses

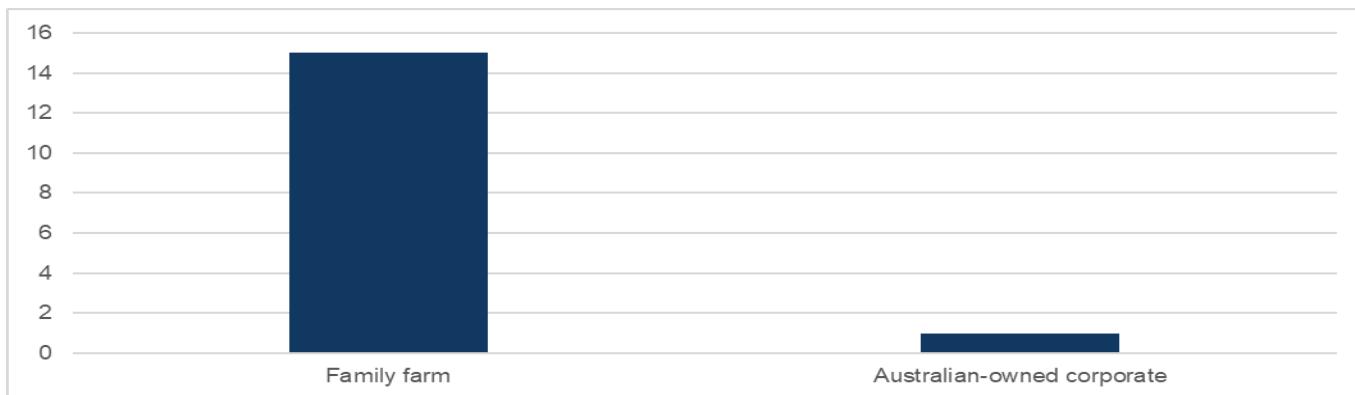
D-1 Online grower questionnaire and summary of responses (n=16)

D-1-1 Description of farming business

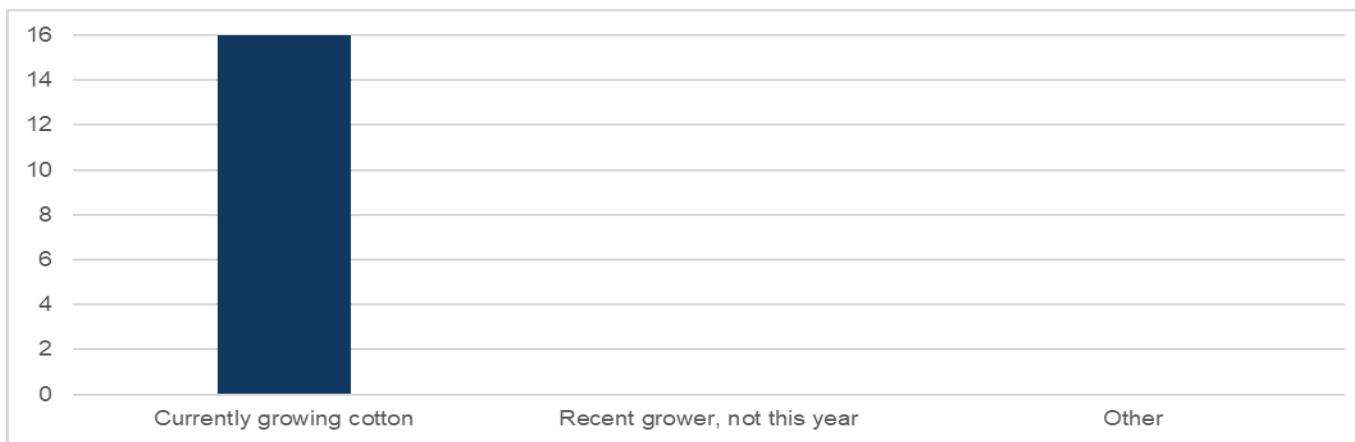
1. In which region are you located?



2. How would you describe your farming business?

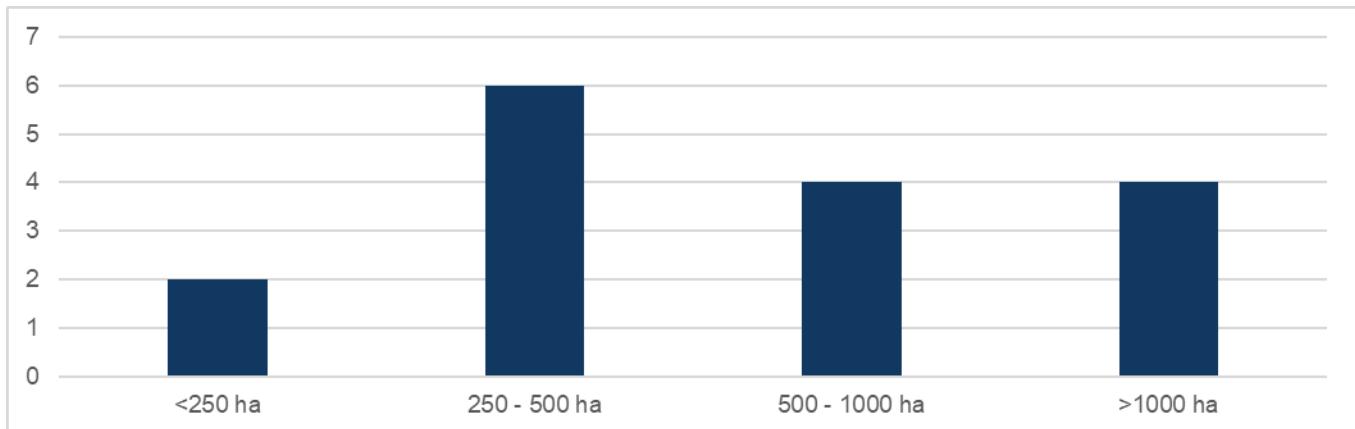


3. What is your level of involvement in cotton growing?



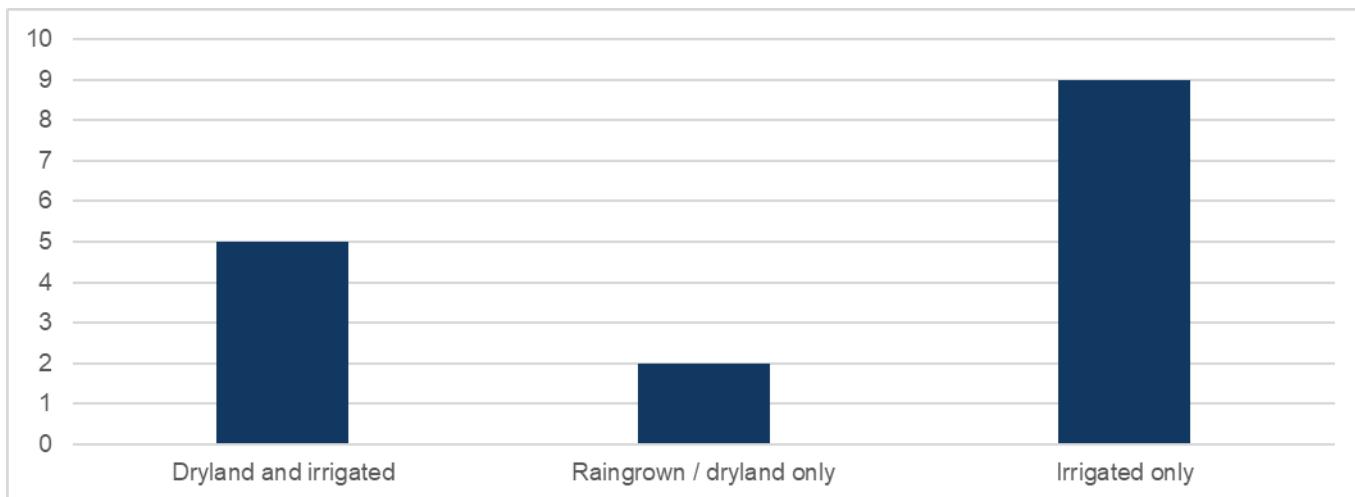
4. In a full production year, what is your total area planted for cotton (ha)?

- <250 ha
- 250-500 ha
- 500-1000 ha
- >1000 ha



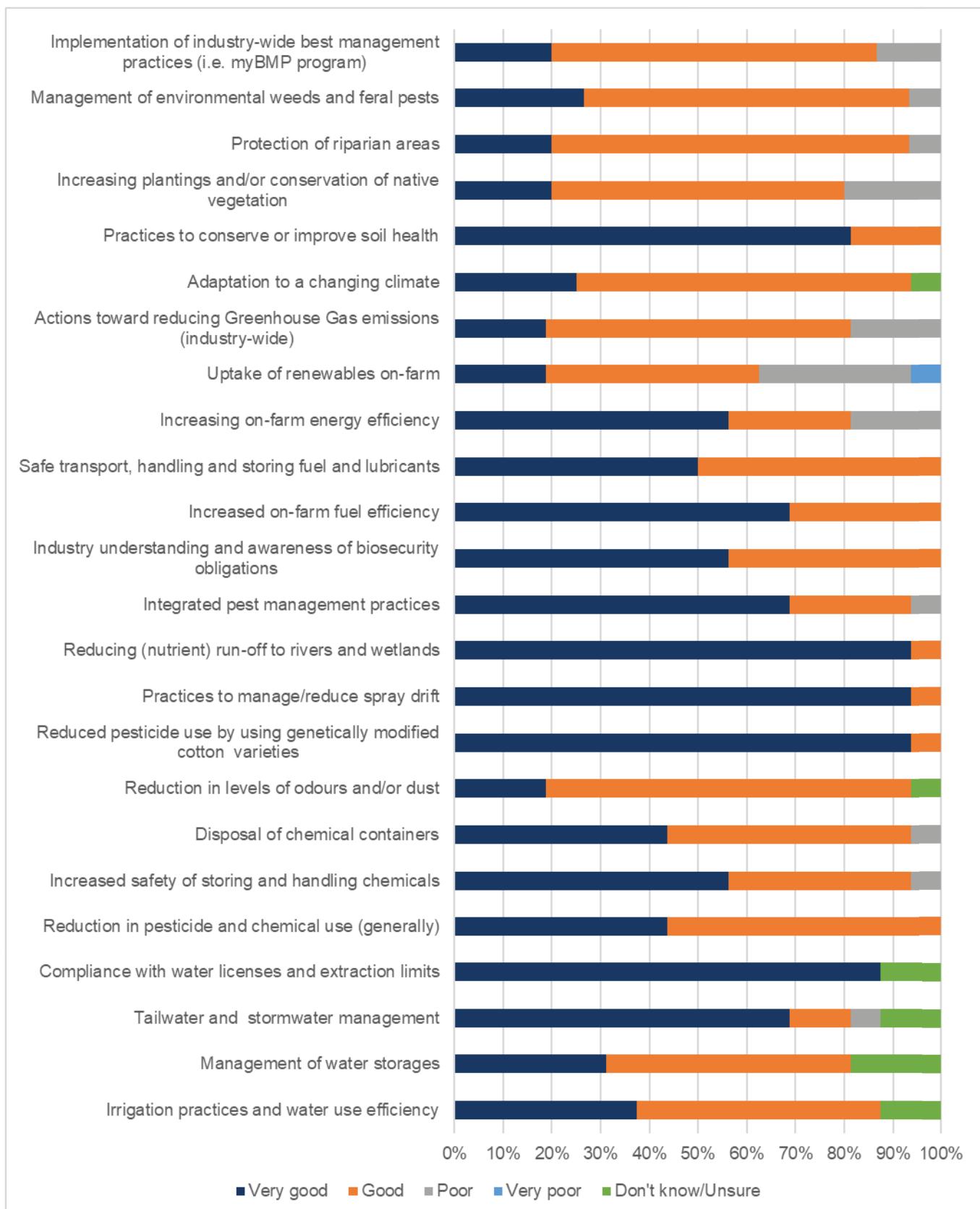
5. What is your production type/mix?

- Irrigated only
- Dryland and irrigated
- Rain grown / dryland only



D-1-2 On-farm environmental management

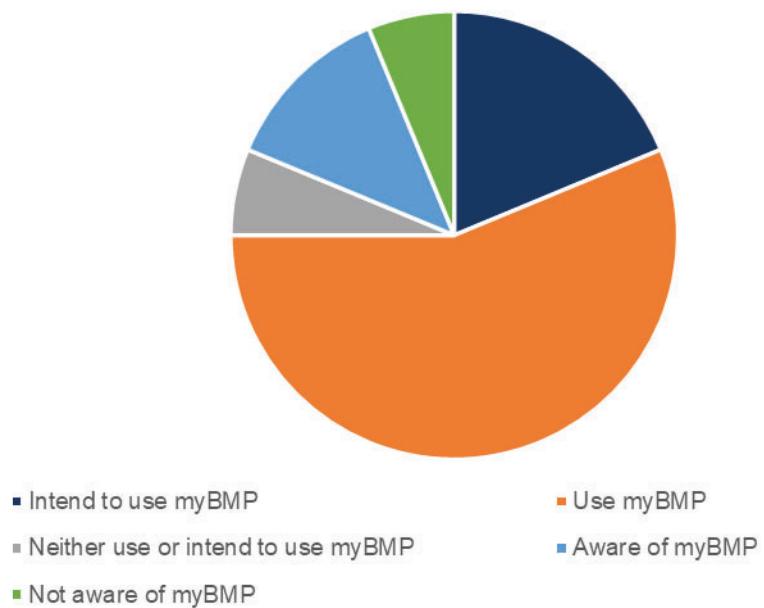
6. Below is a list of practices and/or environmental issues at the farm scale. In your opinion, how would you rate the **performance on your own farm/s** in relation to each?



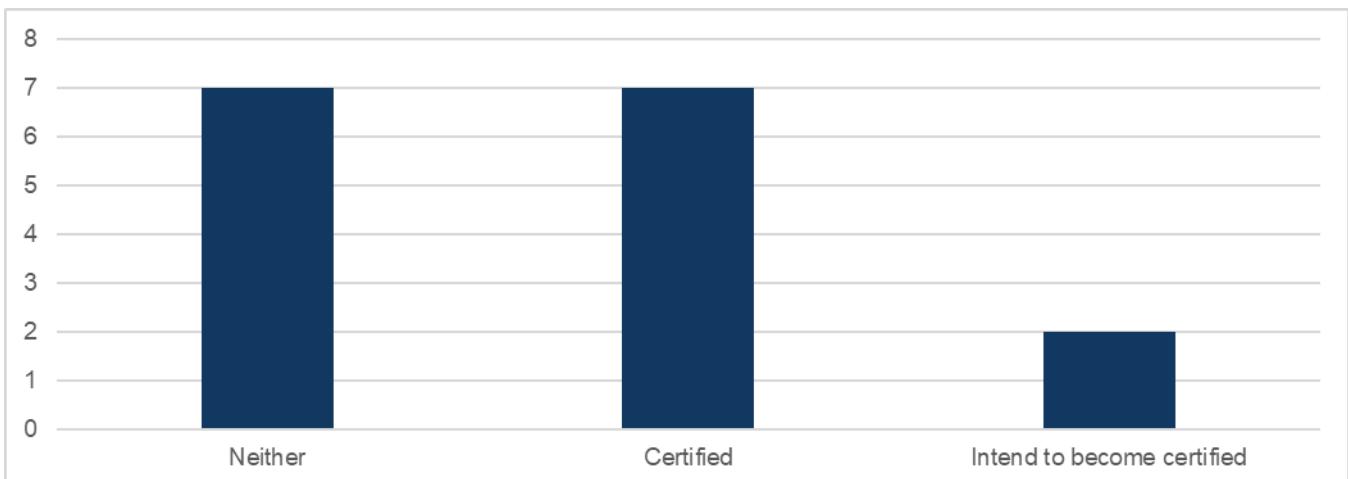
7. What, if any, barriers are you facing to further implement improvements in the above areas? (tick all that apply)



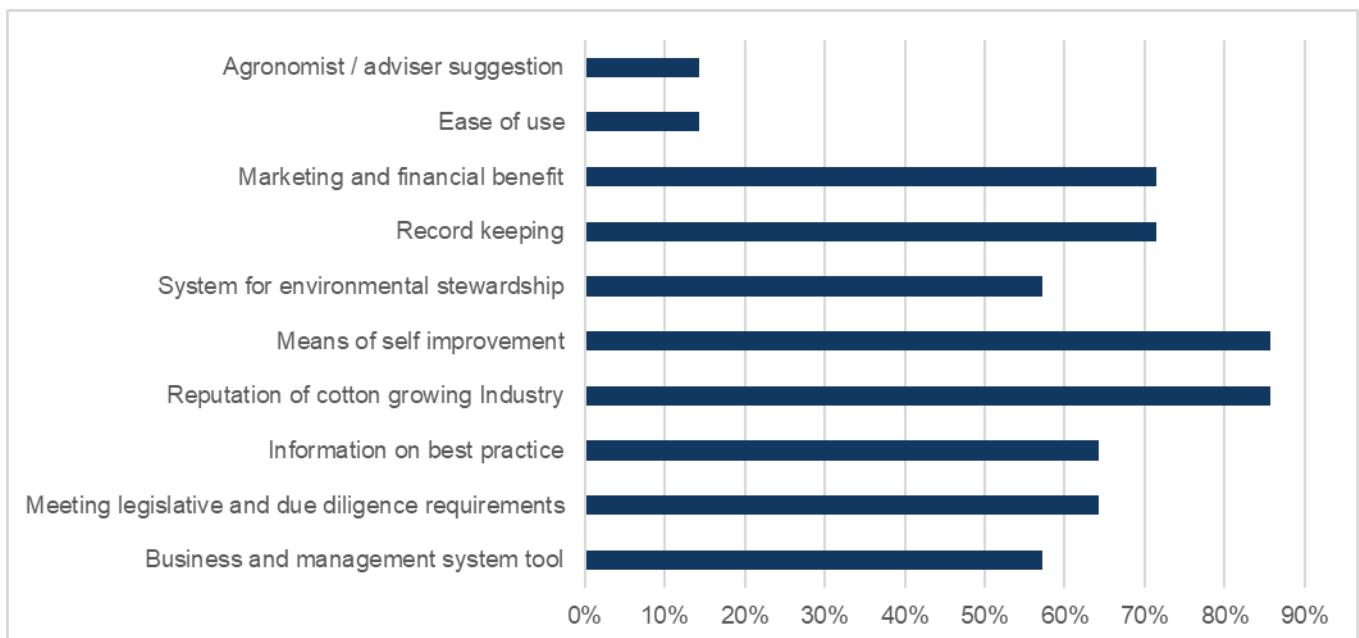
8. What is your level of awareness and use of myBMP (tick all that apply)? *Question 8 used branching in the questionnaire to skip direct to either q10 or q11 where applicable*



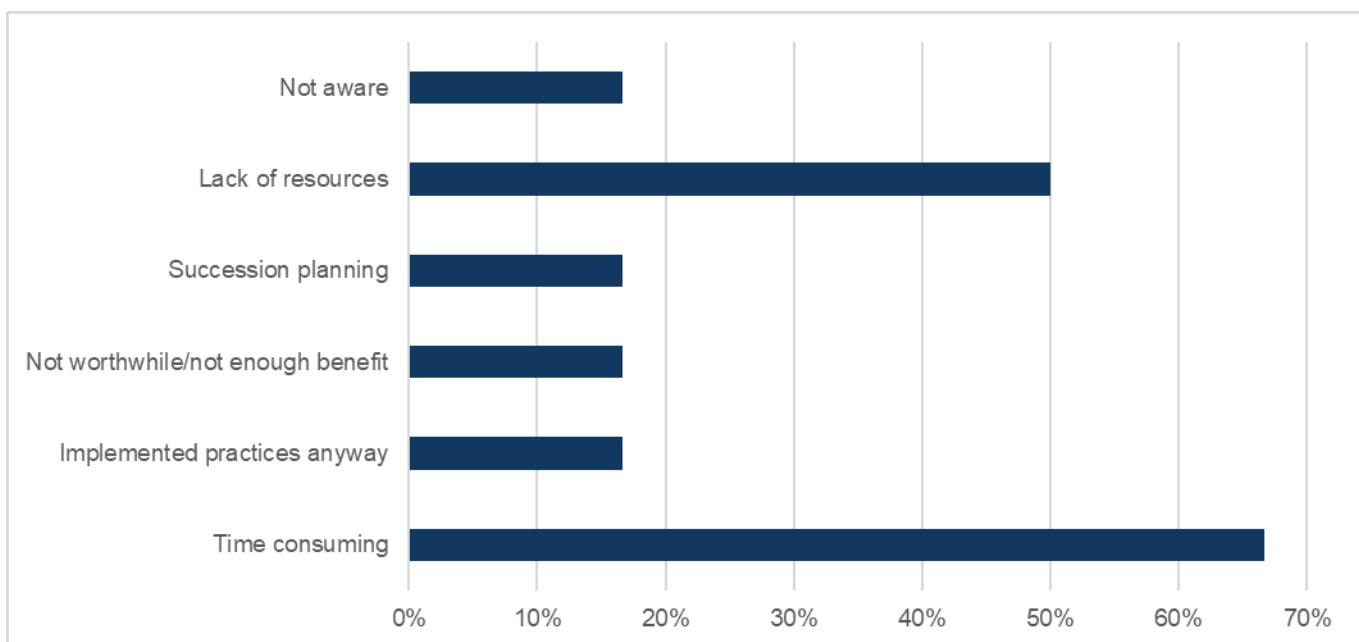
9. What is your level of certification of myBMP?



10. If you are currently using or intending to use myBMP, what are the main reasons for this (tick all that apply)?

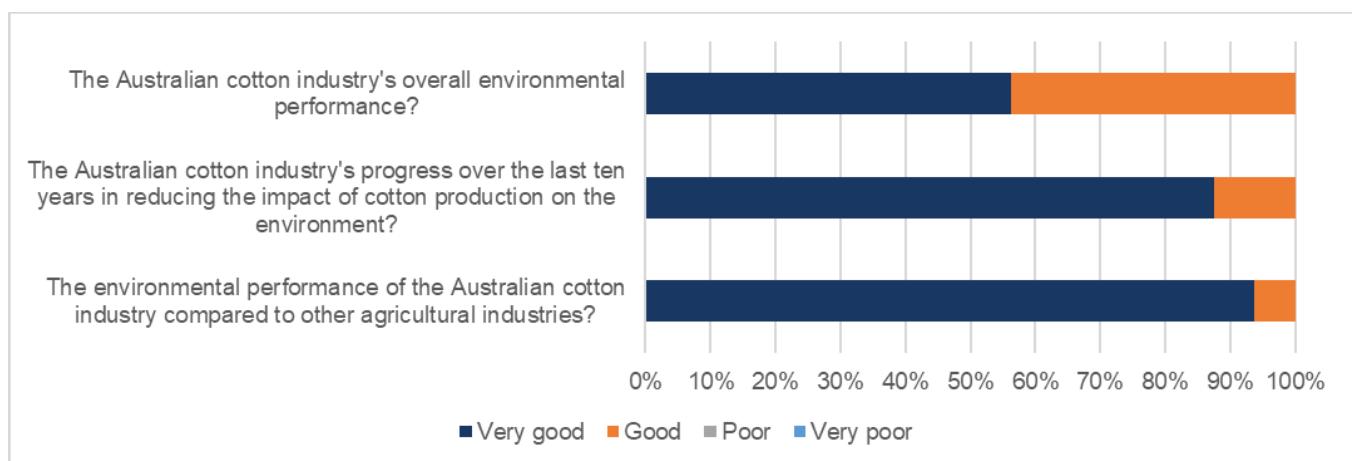


11. If you are not currently using or don't intend to use myBMP, what are the main reasons for this (tick all that apply)?

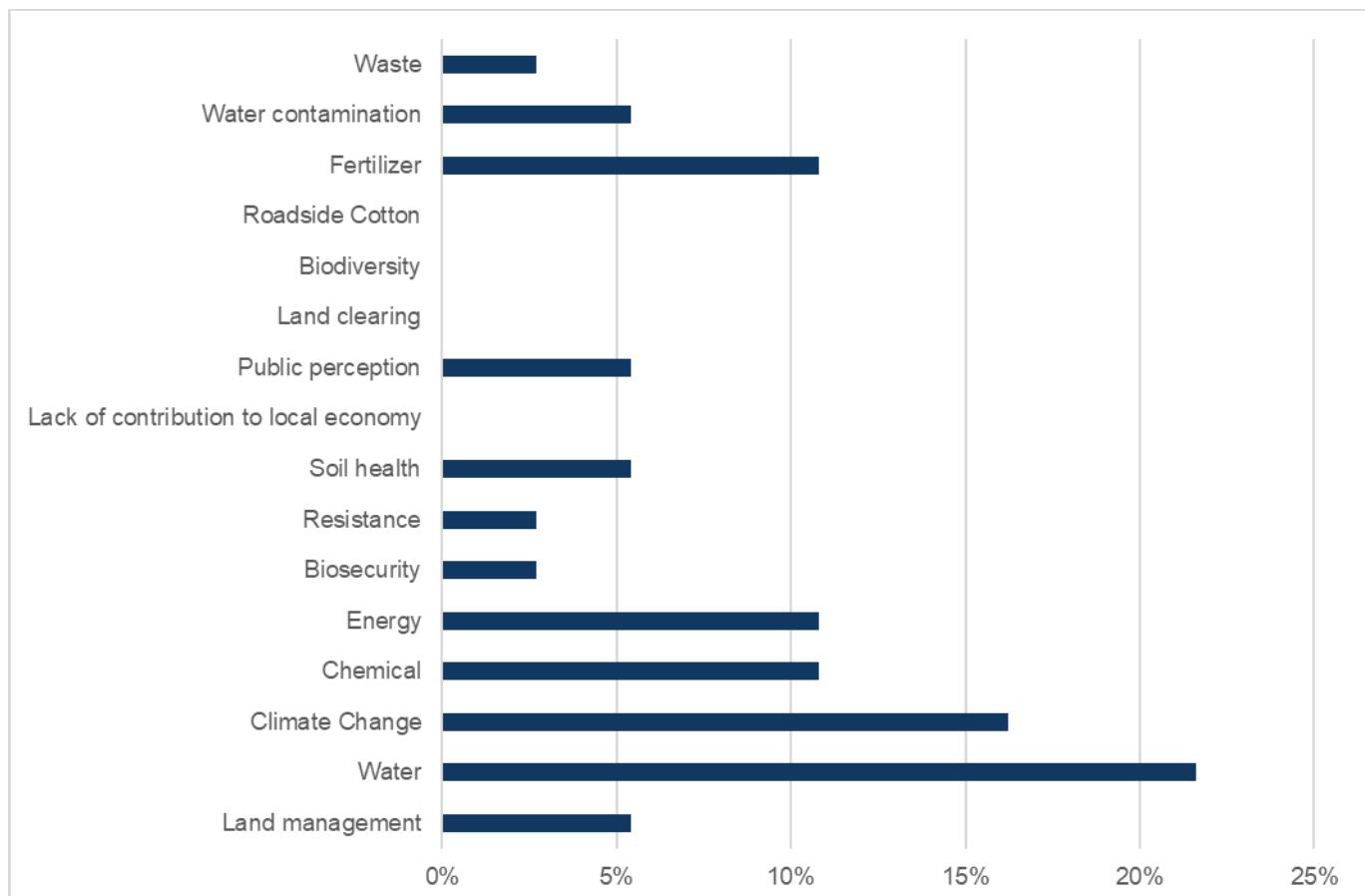


D-1-3 Overall industry performance

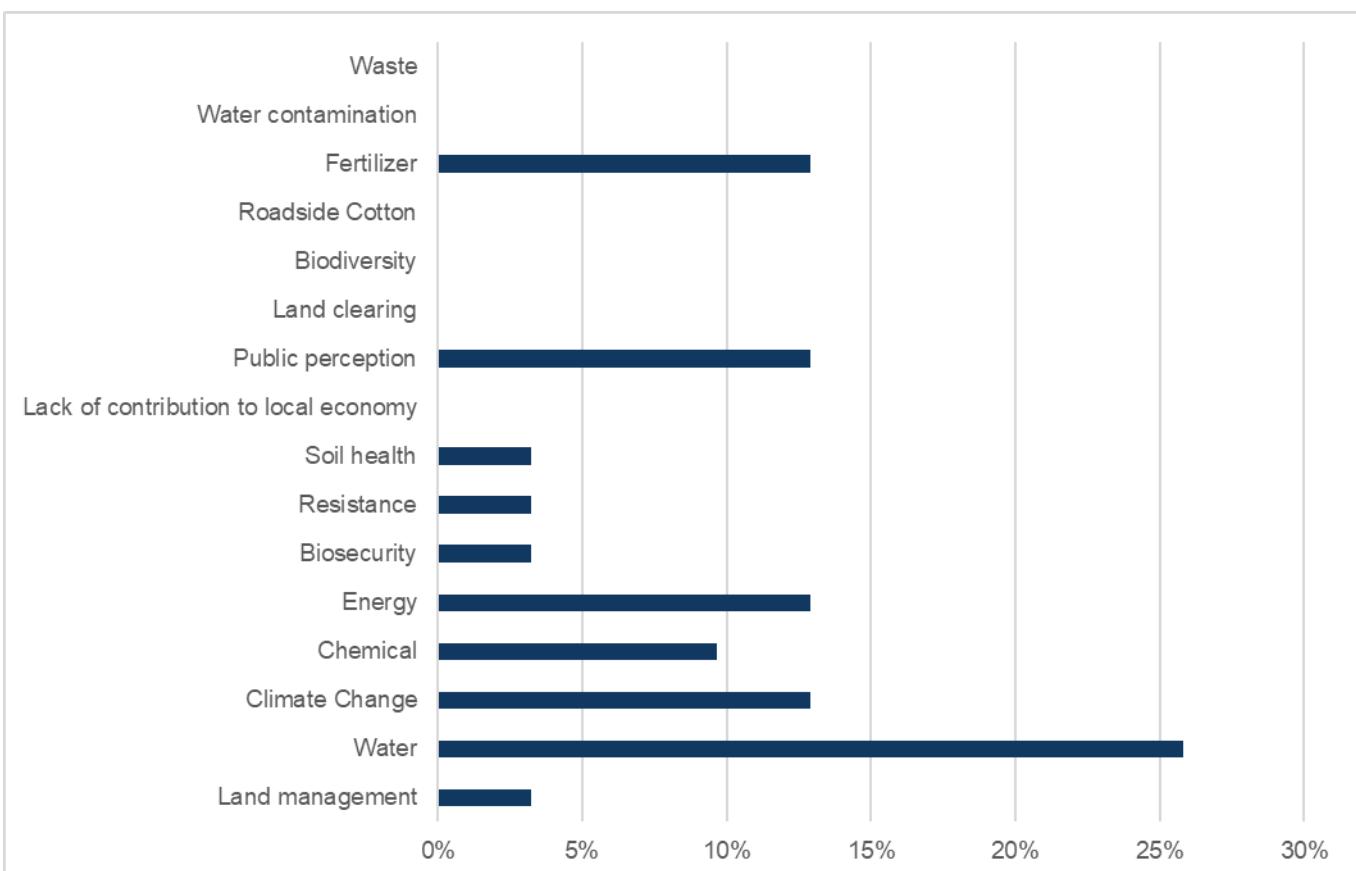
12. Thinking about the **industry overall**, how would you rate the following?



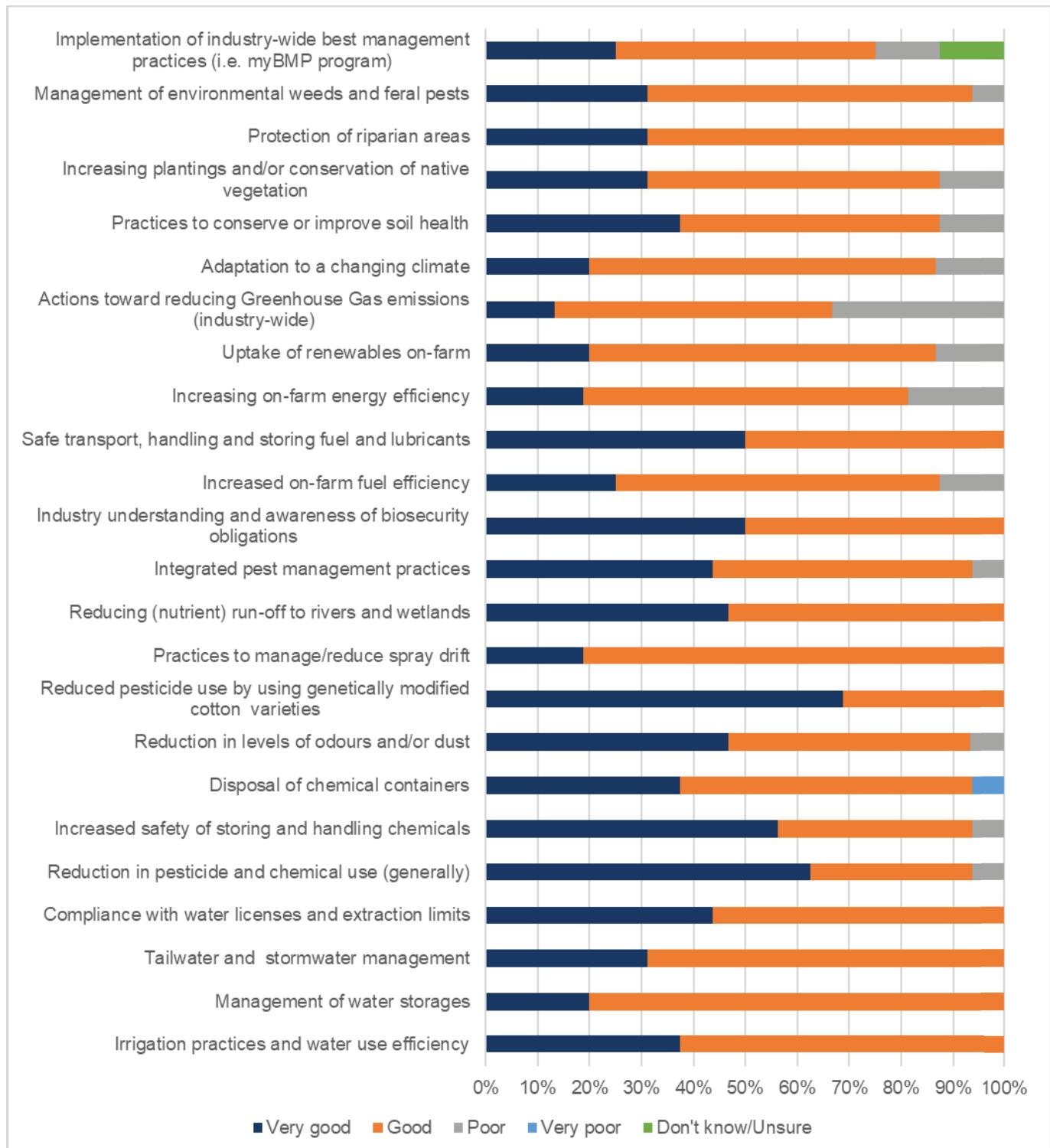
13. What do you consider to be the top three environmental issues **currently** facing the Australian cotton industry?



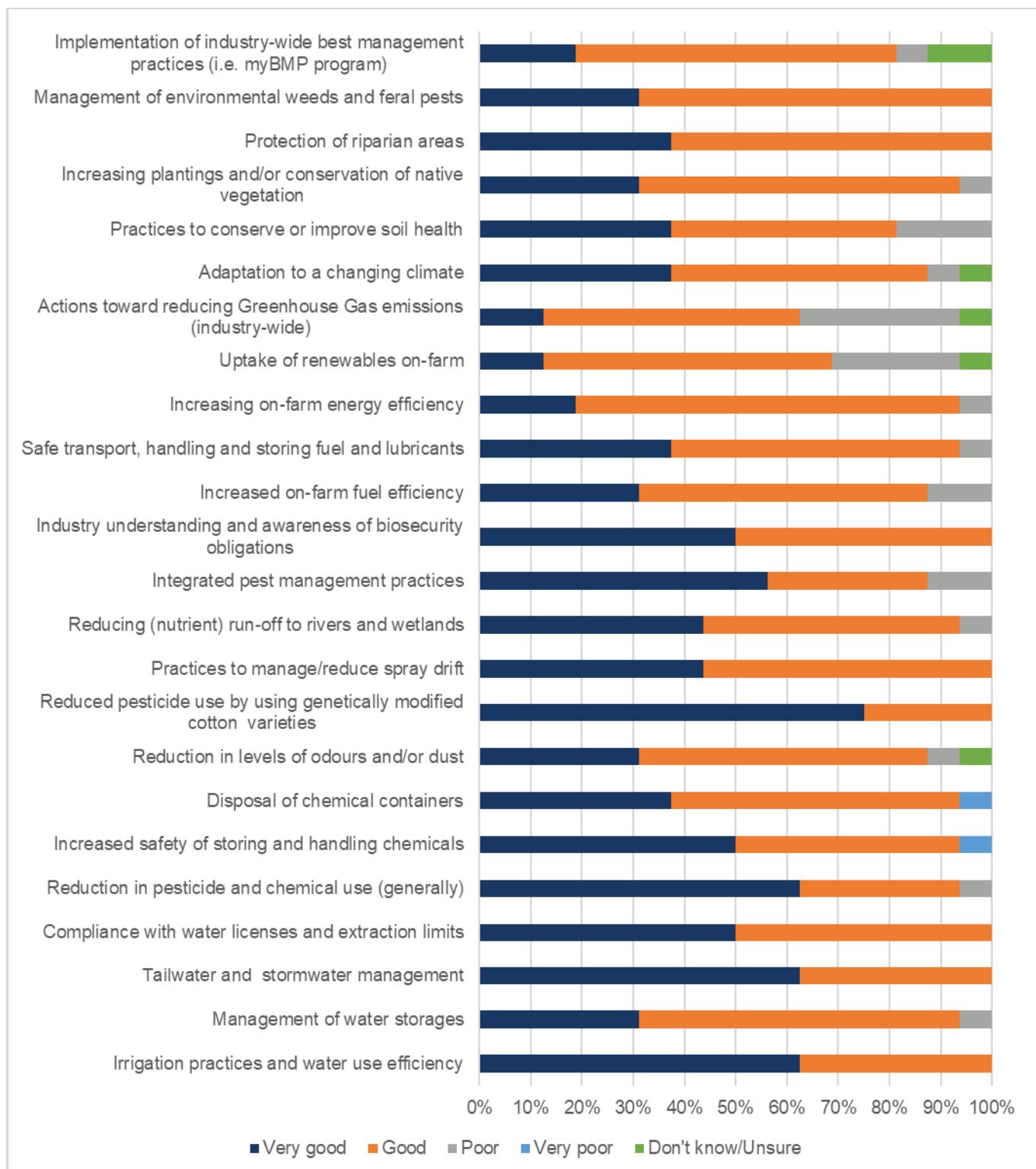
14. What do you think will be the three most important environmental issues that the industry will need to take action over the next **5-10 years**?



15. Thinking about the **Australian cotton industry overall**, how would you rate its current performance in relation to the following on farm practices and/or environmental issues?



16. How would you rate the **industry's improvement in environmental performance in each of these areas over the last 10 years**? Please provide comments on the above table

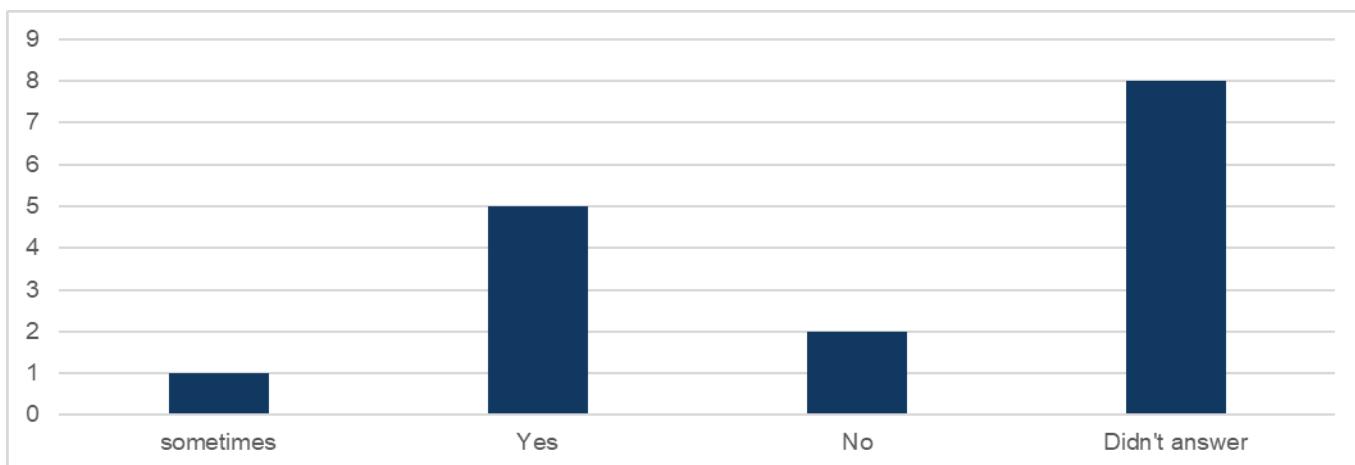


D-1-4 Industry initiatives

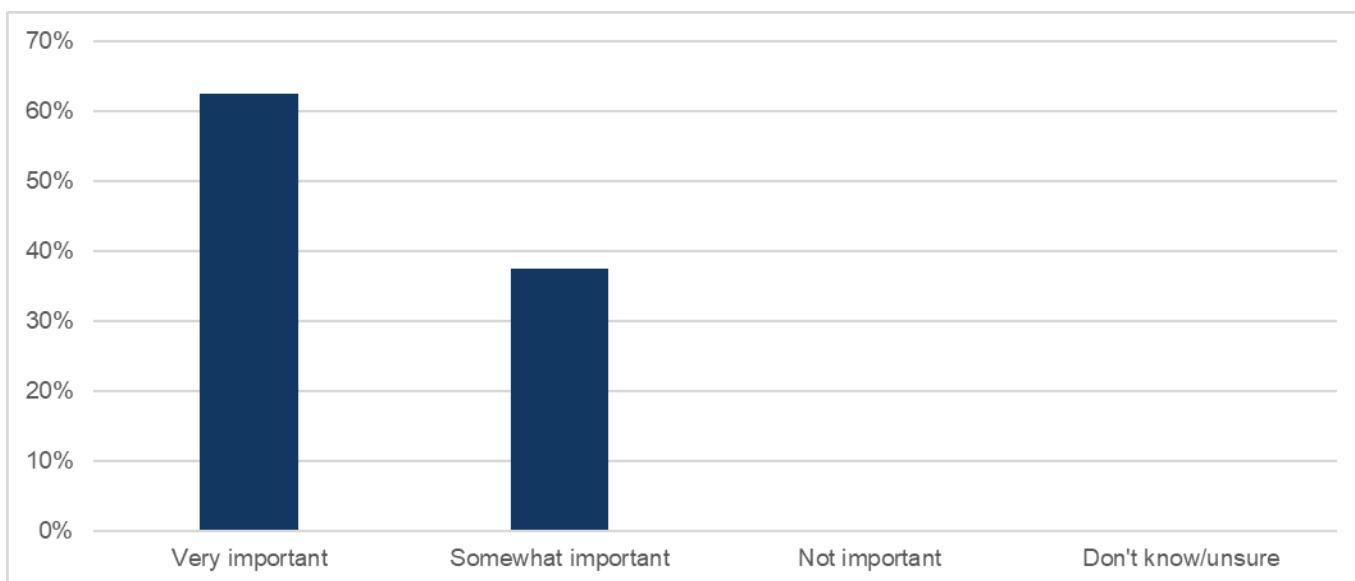
17. Are you aware that the Australian cotton Industry has developed an industry sustainability framework called PLANET.PEOPLE.PADDock.?



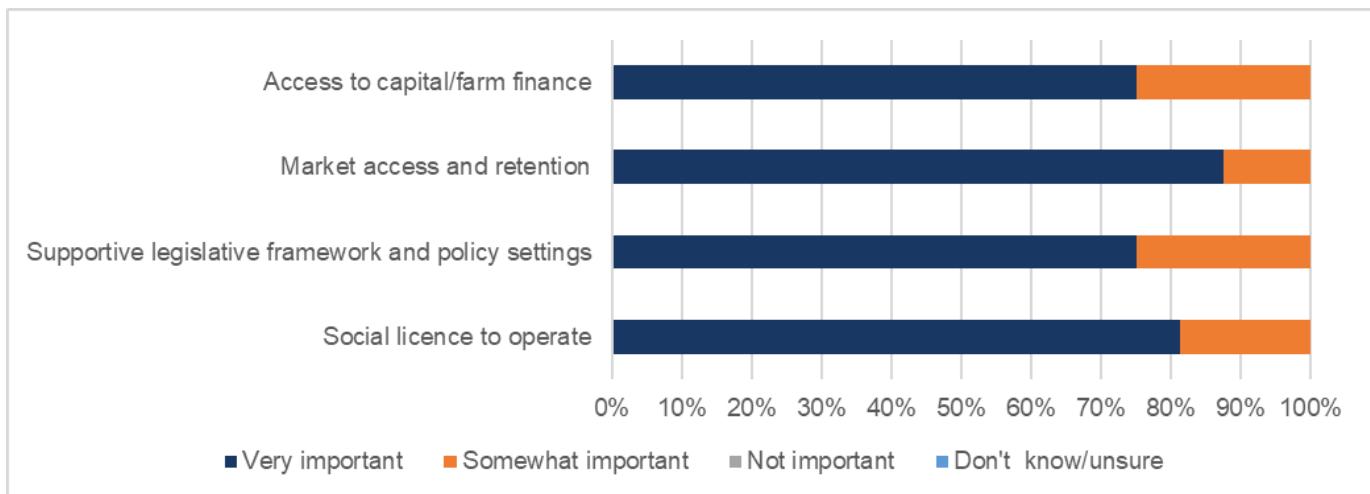
18. Do you consider the sustainability framework in your on farm decision making? Q18 Is a branched question from a 'Yes' response to q17



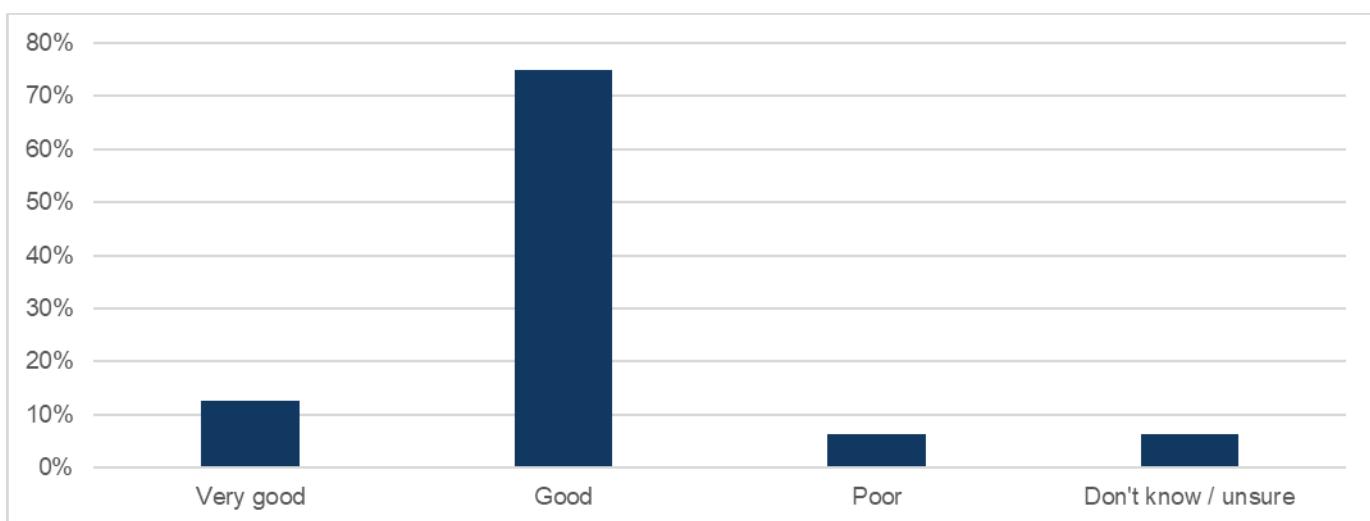
19. How important do you think industry initiatives such as myBMP, CottonInfo and PLANET.PEOPLE.PADDock. are to the Australian cotton industry?



20. How important do you think improvement in the industry's environmental management is to ensuring the following outcomes in the future?



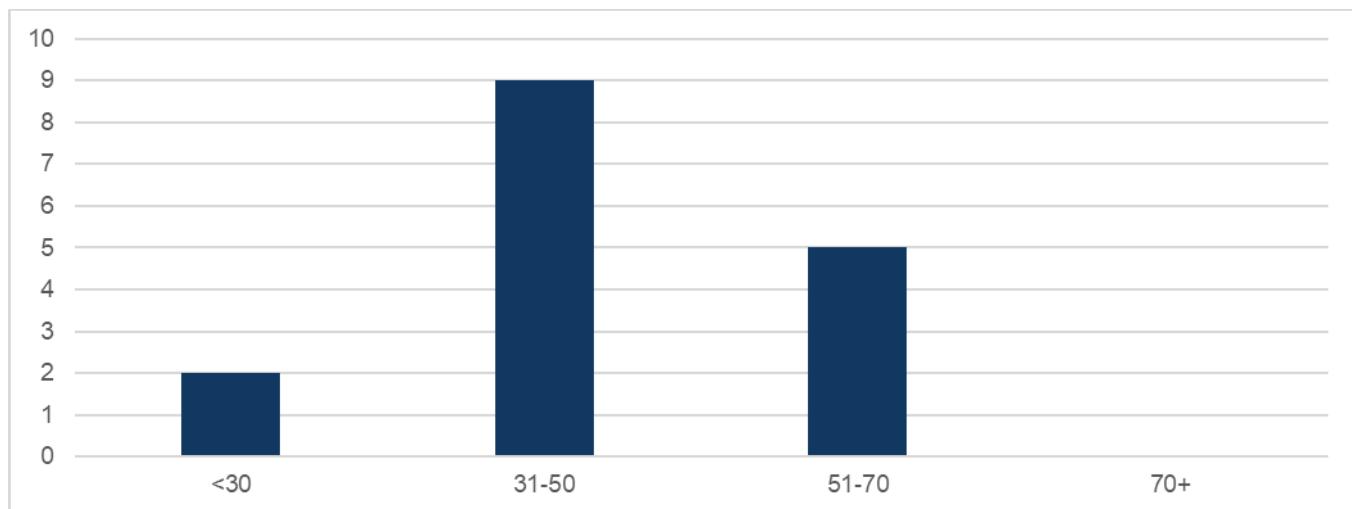
21. How would you rate the Australian cotton industry's performance in communicating its environmental performance to others?



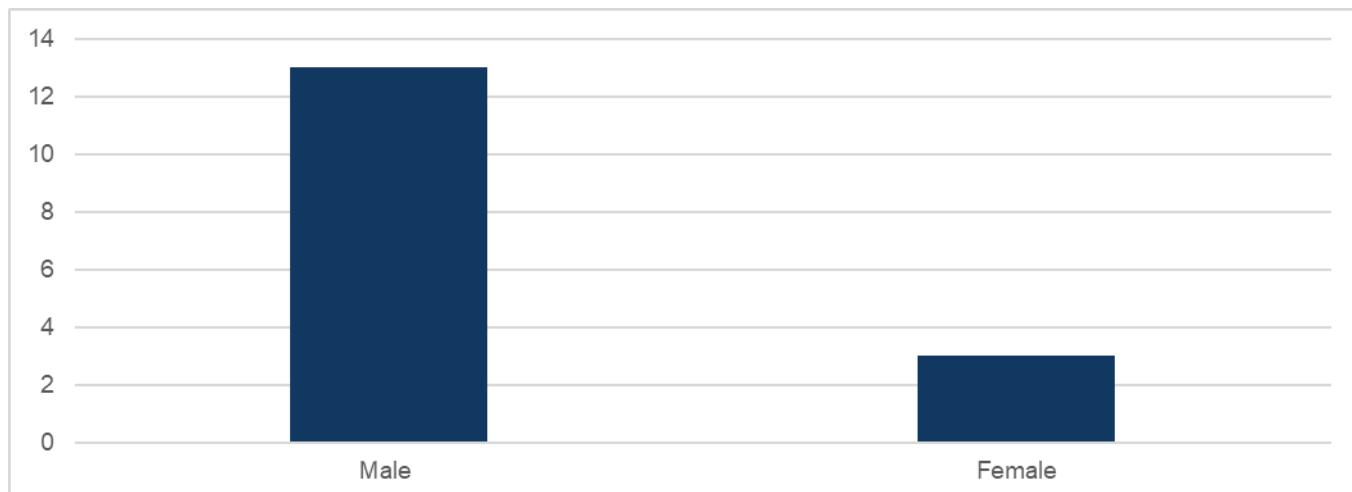
22. What, if any, other actions or initiatives should the industry undertake to improve its environmental performance and/or reporting?

D-1-5 Grower information

23. What age category do you fall into?



24. What is your gender?



25. Do you have any other comments you would like to make in regard to the environmental performance of the Australian cotton industry and/or your own farm practices?

Appendix E

**On-farm assessment schedule, criteria
and ratings**

E-1 On-farm assessment schedule

A series of on-farm site visits were undertaken across the major growing regions to provide an understanding of the performance, challenges, perspectives and opportunities that are unique to, and common across the different growing areas. It is noted that while the environmental assessment considered the whole of the Australian industry, site visits were focused on the major growing regions of Queensland and NSW. Northern Australia was excluded as a result of COVID-19 travel restrictions in place at the time, while the relatively small area under production in Victoria meant that it was not practical to include visits to this area. Growers from these areas were invited to participate in the online grower questionnaire.

Northern NSW / Southern QLD – 22nd to 25th March 2022

Table E.1 Northern NSW and Southern QLD participants

myBMP status	Private (Family)/Corporate
Certified	Private
Certified	Corporate
Certified	Corporate
Not signed up	Private
Not signed up	Private

A 6th visit was scheduled but the participant had to pull out at the last minute due to Covid.

Southern NSW – 4th to 8th April 2022

Table E.2 Southern NSW participants

myBMP status	Private/Corporate
Certified	Private
Registered	Private
Registered	Private
Registered	Private
Not signed up	Private

Macquarie, NSW – 14th to 16th June 2022

Table E.3 Macquarie participants

myBMP status	Private/Corporate
Certified	Private
Registered	Private
Registered	Private
Registered	Private
Not signed up	Private

A 6th visit was scheduled but the participant had to pull out at the last minute due to Covid.

Central QLD – 20th to 23rd June 2022

Table E.4 Central QLD participants

myBMP status	Private/Corporate
Certified	Private
Certified	Private
Certified	Private
Certified	Corporate
Registered	Private
Registered	Private
Not signed up	Private

Summary of Farm Visit Outcomes

A total of 25 of 27 scheduled farm visits were completed across the four regions selected for on-farm assessments. Some disruptions to the original farm visit program were experienced as a result of COVID-19 and seasonal conditions, in particular, ongoing wet weather impacting grower availability, however the GHD project team, CRDC and participating growers were able to be flexible in their approach to ensure the completion of an average 6.25 visits per region.

Effort was made to select a sample of farms that included a representative mix of BMP status, farm size (i.e. average hectares grown), and business type (i.e. corporate v family farms). Given participation in the farm visits was a voluntary process, however, it was not always possible to get the preferred mix of growers at the regional level to agree to host a farm visit. That being said, the overall mix of growers was largely consistent with that targeted. Of the 25 farms visited, 22 (48%) are private family farms and 3 (12%) were corporate farms. A total of 9 (36%) farms visited were myBMP certified, a further 8 (32%) had registered with myBMP, and 8 (32%) did not use myBMP. All of the corporate farms visited were myBMP certified.

The farm visits allowed the Assessment Team to validate grower practices and attitudes, and proceeded in line with the agreed On-Farm Assessment Plan. Growers participated in good faith, engaging openly and constructively in the process, which included assessment across the following criteria:

- Environmental management (i.e., strategies employed, myBMP or other)
- Water management (dryland and irrigated)
- Pest management (integrated pest management and biosecurity)
- Genetically modified cotton (if used and how this has improved their environmental management)
- Pesticides and other agrichemicals
- Petrochemicals storage and handling
- Waste management
- Land management (including soil management)
- Vegetation management
- Biodiversity
- Climate change
- Industry drivers for change and improvement

E-2 Assessment criteria

E-2-1 Environmental Management & Reporting

1. Does the farmer participate in any compulsory or voluntary industry initiatives? Such as myBMP, organic, other
2. If 'yes' answered above, what value does the farmer consider this has brought to the business? Ask for examples of specific aspects where an improvement in environmental performance has been observed
3. What is industry change and improvement being driven by? Adherence to identified legal requirements for the industry; Adherence to industry identified best practice standards; Innovative practices (new cutting edge practices); Adoption of Herbicide Resistance Management Strategies (HRMSs); Adoption of Insecticide Resistance Management Strategies (IRMSs); Participation in other industry or regional strategies and groups; Awareness of industry issues and market drivers and opinions at a local and international scale
4. What records are maintained as evidence of environmental management? How do these records support ongoing improvement in farm operations, productivity and environmental performance?

E-2-2 Water use management

1. A current water licence is held and the conditions are complied with, including metering and recording
2. Irrigation scheduling tools are used to determine when and how much to irrigate
3. Any planned new infrastructure which effects the flow of water to or from a river complies with legislation
4. Water use requirements are understood and managed: plant water use at different times of season understood; readily available water (RAW) estimated and understood for soil types; water use efficiency has been estimated using kg/mm or bales/ML where the term water means stored water and effective rainfall; water requirements for crop types for the region are known and understood; water use benchmarking is performed
5. Information is used each season to make better decisions: irrigation scheduling tools are used to determine when and how much to irrigate; there is awareness of deep drainage as an issue and of the measures that can be taken to reduce its impact
6. Water storage distribution: Any planned new infrastructure which effects flow of water to or from a river complies with legislation; Aware of State legislation for the capture of overland flow and rainfall runoff; storages and channels (new and reconfigured) are located designed to minimise evaporation, seepage losses and constructed by a qualified person; Storages are surveyed to determine accurate storage volumes; regular monitoring and maintenance of storage and channels for leaks and seepage; storages are managed to minimise evaporation and seepage losses; losses from storages and channels have been measured
7. Tailwater and stormwater management: All irrigation tailwater is contained; Irrigation discharge points should direct tailwater away from sensitive areas; Where possible vegetative barriers at least 6 metres wide are maintained between cropping lands and sensitive areas; The grower is aware of any priority issues identified in catchment water quality improvement plans that are relevant to their farm; an effective stormwater management system is in place for managing storm events (e.g. minor, moderate, severe events); The first flush of stormwater runoff from treated areas is retained on farm; any planned new infrastructure to contain tailwater and/or stormwater storages complies with legislation; stormwater planning and ability to control runoff from moderate to severe storm events
8. CENTRE PIVOT and LATERAL MOVE irrigation systems are designed, installed and managed appropriately including: the system has been planned, designed and installed by a qualified person; the system capacity can meet peak crop water requirements; the drip irrigation system considers topography and soil characteristics; water quality is known and monitored according to risk; training provided to the operator to ensure appropriate skills to operate the system; Pre-season and in-season maintenance

- checks of the system are undertaken including flushing (fertigation), flow rates, filtration system and pressures; regular maintenance of the system is undertaken including flushing, monitoring pressure, fertigation (if used) and flow rates
9. Surface irrigation (FURROW/FLOOD) systems are designed, installed and managed appropriately including: Use good design (including field length, bay size, slope, drainage); Flow rates and cut off times are appropriate for the soil type, run length and slope to ensure that furrows come out evenly; aim for uniform applications (e.g. water in furrows comes out evenly)
 10. DRIP IRRIGATION systems are designed, installed and managed appropriately including: The drip irrigation system has been planned, designed and installed by a qualified person; the system capacity can meet peak crop water requirements; drip irrigation system takes into account your soil characteristics; water quality is known and monitored according to risk; training provided to the operator to ensure appropriate skills to operate the drip irrigation system; regular maintenance of the system is undertaken including flushing, monitoring pressure, fertigation (if used) and flow rates; a system evaluation was undertaken after installation to check the system meets specifications
 11. GROUNDWATER BORE systems designed, installed and managed appropriately: new bore and old bore decommissioning compliant with laws; new bores installed by licenced drillers; Groundwater licence held and conditions understood and complied with; salinity of bore water is understood and managed to prevent plant and soil impacts; bores maintained; records of water use and groundwater levels monitored and recorded
 12. What is done to maximise energy and water use efficiency for irrigation infrastructure? How important is energy and water use efficiency to the farmer/business? For example: regular pump maintenance; Site-specific design with consideration to layout, zoning, efficiency; timing of irrigation to reduce evaporative losses; design and installation by a qualified designer/installer; measurement of energy use (fuel/electricity) by pumps and engines; estimation and monitoring of water use delivered
 13. Onsite practices take advantage of rainfall and maximise water use efficiency: cover cropping; stubble retention; minimum tillage is practiced when soils are dry and tillage practices are used to minimise the impact on stubble cover; compaction is minimised; weeds controlled; planting row configuration; fertiliser inputs are matched to pre-season soil water status and are reviewed during crop growth. Additional fertiliser can be applied in crop if needed while minimising soil moisture loss

E-2-3 Pest management

1. Documents and processes for biosecurity are in place: ensure all farm inputs (seed, fertiliser, etc.) that are brought onto farm are pest free. Records are kept of farm inputs and where they came from. Other records are appropriate
2. Managing resistance in Bt cotton: Resistance Management Practices (RMP) are being adhered to, including defined planting windows, refuges, control of volunteer and ratoon cotton, restrictions on use of foliar Bt and pupae busting, Technology User Agreement is being followed
3. Integrated pest, disease and weed management (IPDWM) processes are documented, communicated and regularly updated in line with industry best practice. For example: crop monitoring and disease/pest mapping; staff awareness of reporting; records of pre-spray monitoring and post-spray monitoring for effectiveness; spray records, including spray rotation and timing; herbicide/pest tolerant cotton managed in accordance with licence terms and conditions of Technology User Agreements; compliance with industry herbicide resistance management strategy; twice-weekly monitoring of pests and beneficials, crop development and damage recorded; post season analysis of IPM; copies of SDS, permits for registered chemicals; records of no-spray zones for pesticide spray drift restraints on use; HSE incident and event records
4. Biosecurity processes are in place such as: farm biosecurity signs are displayed at property entrances to communicate biosecurity procedures and contact details for appropriate farm personnel; maintain a visitor register (for those accessing production areas); all farm personnel and consultants are aware that in the event of identifying suspect exotic pest/weed/disease or unexpected crop failures, call the Exotic Plant Pest Hotline 1800 084 881 or report to State Agricultural Development Officer; on-farm biosecurity is

included in staff inductions and discussions had with visitors accessing production areas to ensure they are aware of your farm biosecurity expectations and practices; if moving or receiving used cotton machinery from interstate or relevant biosecurity zones, ensure all Australian state and territory biosecurity legislation is met and machinery is mud and trash free; a wash down facility is available; all machinery, vehicles, equipment and shipping containers entering and exiting the farm are mud and trash free. Those with soil and plant debris, if found, cleaned in the wash down facility before moved on and off your property (come clean, go clean principles); a designated parking area provided for visiting vehicles that is away from production areas; farm vehicles are used to transport visiting people around the farm

5. Integrated disease management is carried out, including disease resistant varieties; integrated disease management approaches applied to minimise risk of disease; disease vector awareness control
6. Integrated weed management: Crops are monitored for weeds including after each herbicide application; timing of herbicide applications is managed for weed species and growth stage to ensure effectiveness of the application; herbicides are selected based on rotating herbicide modes of action, residues and re-cropping intervals; two non-glyphosate tactics (e.g. other herbicide modes of action, chipping, spot spraying and cultivation) are used to manage weeds in cotton crops as per the Industry's Herbicide Resistance Management Strategy; Weeds that survive a herbicide application are controlled using an alternative mode of action or other methods; good farm hygiene is practiced
7. Integrated pest management: Insecticide application is based on pest species, regional insecticide resistance management strategy (RIMS) and impacts on bees/beneficial species; IPM tactics include consideration of field, variety, seed treatment, strategic planting time, impacts on natural enemies and bees, glyphosate interactions, weed host control, industry crop defoliation dates for pupae busting and trap cropping (hot regions); following a spray failure, the same insecticide group is not reapplied; managed promotion of beneficial species (planting native vegetation, trap corridors, food sprays, releasing parasites or predators, bat nesting boxes); area wide IPM (participation in a group)
8. Selecting and applying pesticides: Only registered products with current permits are being used; pesticide labels that state 'spray drift restraints' and mandatory no spray zones are kept; the Insecticide Resistance Management Strategy (IRMS) for the region and Herbicide Resistance Management Strategy (HRMS) are followed for product selection and timing of application; application only takes place during appropriate weather conditions

E-2-4 Agrichemical and petrochemical storage, handling and waste

1. Pesticides and farm chemicals are stored appropriately: DG regulation signs and labels in place; Away from sensitive areas, houses, property boundaries, ignition sources, floodways, other chemicals; in minimum quantities; in bunded areas; in fire-resistant shed with adequate ventilation and accessible eye-wash bay and emergency shower; with a manifest record, site plan, SDSs and emergency procedures
2. Mixing and loading pesticides: Label recommendations are followed; Suitable equipment for measuring is available; mixing site/washdown bay is an appropriate locations; closed transfer system for abamectin and highly hazardous pesticides
3. Fuel use records are kept, an annual risk assessment is undertaken for all tanks, incidents, inspections and corrective actions, training and awareness (use, spills, emergency management), storages on farm maps
4. Emergency procedures include: fire response, large fuel spill response, emergency contact details, roles and responsibilities, map of storage facility and emergency equipment
5. Correct application equipment and techniques: continuous monitoring of meteorological conditions during application; drift-reducing nozzles and shielded sprayers in use where practical; spray equipment is checked and adjusted for conditions and application rates; spray equipment is cleaned and decontaminated between applications
6. The safe use of pesticides includes: application requirements discussed with consultants and spray applicators (ground and aerial) – orders and job completion are provide in writing; all persons have accredited training, accreditation and instruction in transport, application, mixing, loading and emergency

procedures for pesticides; spray guidelines have been developed and are adhered to; neighbours are notified where legally required; SDSs available for all chemicals on farm; PPE is provided and used; Pesticide preparation and application is only carried out by those who are not pregnant, breast feeding or under 18 years of age; Sprayed areas and re-entry periods are marked on arm map and displayed at central location

7. Pesticides and farm chemicals are transported securely
8. Fuels on farm are stored appropriately: DG Regulation signs and labels in place; tanks and supports are free from corrosion and rust, painted earthed, bunded and structurally secure; tanks are protected by bollards, bunding walls or other structures; tanks are separated appropriately with adequate ventilation if indoors; no tripod stands used for tanks >2200L; all tanks >10,000L are bottom fill with Kamlock fitting (with cap) and a gate valve to eliminate backflow; tank volume can be measured or monitored using manual dipping or sight tube; an inline restrictor valve is installed to reduce the loss of fuel in the event of a broken line; spill kits available
9. Bulk fuels are appropriately located: away from houses, property boundary, workshops, offices, power lines, other chemicals, waterbodies, floodways; on bunds
10. Mobile fuel tanks are appropriately handled: Maintained in good condition and secured to vehicle/trailer; parked away from buildings and other tanks
11. Lubricants are appropriately stored on farm: in bunded areas; away from ignition sources; leaks and spills managed; safe manual handling
12. When purchasing liquid fuels consideration is given to: buying strategy, storage life of fuel (e.g. old fuel), fuel quality
13. Onsite waste management practices are applied in accordance with legislation and guidelines, such as: dedicated waste receptacles for different waste types (green waste / putrescible waste) recycling and hazardous waste; processes are in place to manage potential hazardous/ dangerous waste (i.e. asbestos, oils, fuels and chemical management, segregation and storage); stormwater, soil and other materials (i.e. oily rags) are captured stored and disposed of to an appropriate disposal facility; spill kits are present, complete and regularly inspected, waste from spill kit clean up is disposed of appropriately; site is kept tidy and free from litter and debris
14. Chemical containers and unwanted chemicals are being disposed of appropriately: pesticides are purchased in recyclable/returnable containers where available; containers are triple rinsed during mixing – rinsate added to the spray tank; empty containers are stored securely prior to disposal; IBCs and other containers are recycled through drumMUSTER or returned to the local reseller; Products that are out of date or registration has expired are disposed of using Chemclear, ChemCollect or an appropriate hazardous waste disposal centre
15. Waste petrochemicals are appropriately stored and disposed: Secure, bunded and away from sensitive areas and ignition sources; collected by licenced waste collector; storage containers checked for leaks

E-2-5 Natural resource management

1. Suitable plans and documentation: Riparian vegetation and native vegetation is included on farm map/plan; approvals are obtained prior to clearing or modifying native flora/fauna; carbon sequestration and emissions are considered and understood for the farm (if applicable, best practice); condition of native vegetation is being monitored including ground cover; spraying practices and procedures consider the potential impacts from spray drift and mitigation
2. Documentation on land management is maintained for: Erosion – risk, detection, mitigation, corrective actions; soil chemical health – nutrients and organic levels, salinity, sodicity; Soil structural health – compaction, dispersion, hard setting.; Cover cropping, residues, minimal tillage; irrigation water quality; water table or other land productivity risks
3. Biodiversity and remnant vegetation is being appropriately managed. Planting and/or natural regeneration is occurring to increase the size, connectivity, diversity of native vegetation on farm; habitat features in riparian areas are being maintained for native wildlife (e.g. hollows in trees, large logs, soil cracks);

wetlands and billabongs are being maintained/enhanced; stock is being managed to protect bank stability, groundcover, native vegetation

4. Erosion risks are monitored and managed: Risk areas are assessed, recorded and monitored; action is taken to prevent re-occurrence of erosion
5. Soil structure is assessed, maintained and improved: fertilisers, tillage /residue management; remediation for salt; crop rotations; management of compaction

E-2-6 Energy, emissions and climate

1. Regular machinery maintenance is undertaken in line with manufacturers instruction to maintain best energy use efficiency. Machinery includes: All site vehicles, tractors, harvesters, pumps and motors etc
2. Energy inputs for the cotton season are kept for diesel, electricity, petrol, fertilizer and gas to coarsely monitor high energy use (e.g. total diesel usage per season). If this information is kept, why, what is it used for? Does it drive continuous improvement?
3. Energy usage is considered important in procurement (machinery, infrastructure, goods and services) as part of good environmental practice
4. Site managers, workers and contractors actively engage in strategies to minimize energy use
5. Seasonal forecasting and multi-week weather models are used to prepare the farm for high energy demands (e.g. flood harvestable rain, heat waves resulting in periods of high energy use)
6. Tractor operations take into account: working depth to ensure optimum energy efficiency; optimising number of farming operations
7. Alternative energy sources are being used on the farm (e.g. wind, solar, solar thermal, waste to energy fuels – biofuels)

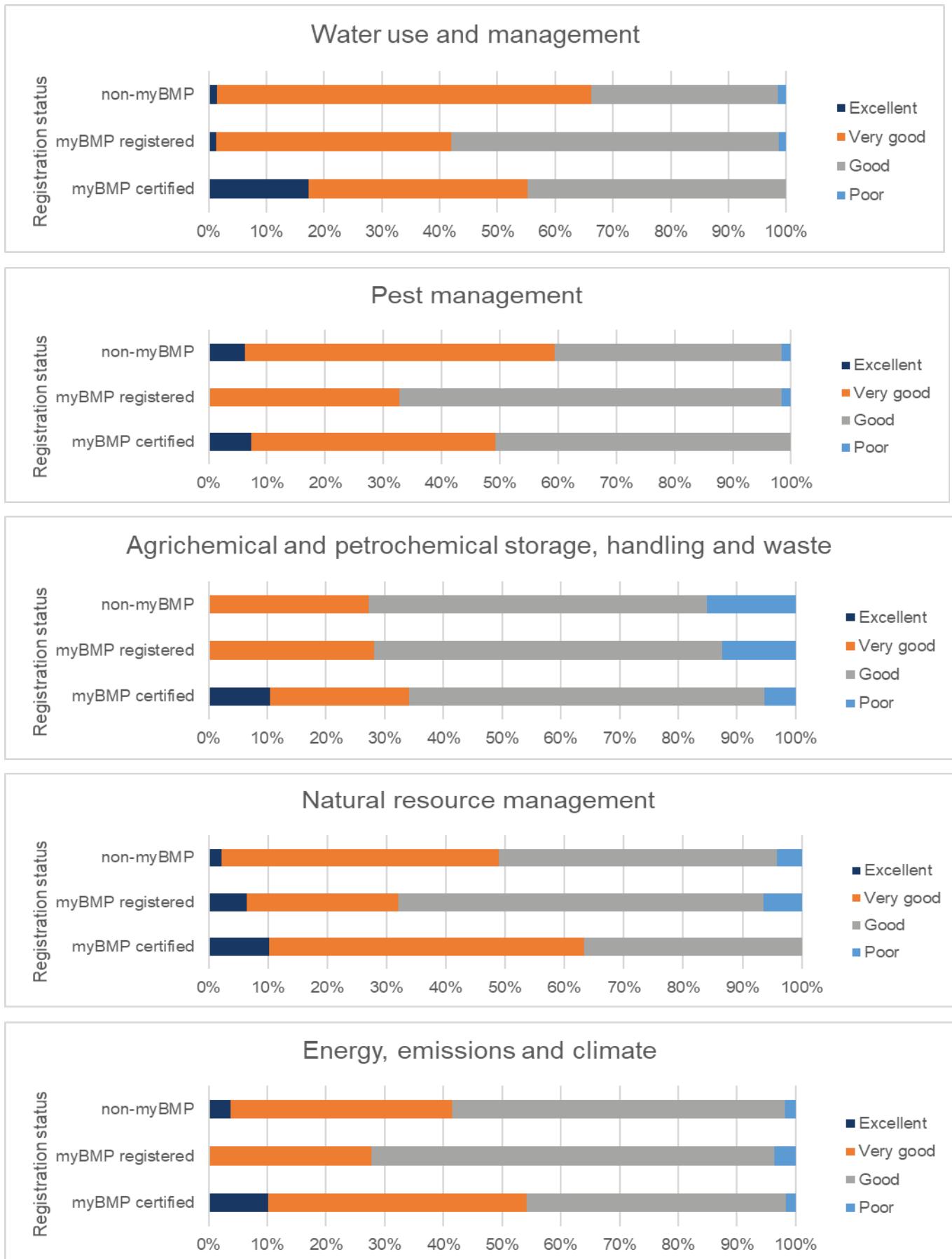
E-3 Assessment ratings

Each item in the assessment checklist was assessed using indicative ratings as set out in the table below. Assignment of these ratings was based on responses by farmers in interviews and by site observations. The purpose of the ratings was not to critically assess the environmental performance of participating farmers but to provide a standardised approach to assessment so results can be compared and compiled for the project report.

Table E.5 Indicative assessment gradings

Rating	Description
Excellent	Criteria is an aspect of on-farm practice that can be described as more than one of the following: <ul style="list-style-type: none"> – Established practice – embedded as a core component of on-farm operations, well understood by farmer/manager/employees and routinely conducted – Considered exemplary based on the assessors' observations onsite and in discussions with site staff – Actively pursuing ongoing improvement against industry benchmarks of 'best practice'
Very good	Criteria is an aspect of on-farm practice that can be described as at least one of the following: <ul style="list-style-type: none"> – Implemented practice – formally implemented as a core component of on-farm operations, communicated to employees and contractors with ongoing efforts to make it established practice – Considered of a high standard based on the assessors' observations onsite and in discussions with site staff, observation of minor potential improvements that the farmer/staff are aware of – Openness to implementing ongoing improvement and plans to identify and fund/implement improved practice in the short-medium term
Good	Criteria is an aspect of on-farm practice that can be described as more than one of the following: <ul style="list-style-type: none"> – Emerging practice – not yet fully implemented as a core component of on-farm operations, is currently being communicated to employees and contractors with documented processes and under development – Considered good/acceptable practice based on assessor's observations onsite and in discussions with site staff, some inconsistencies in answers and observations – Aware of improvements that can be made and consider them worthwhile, but no immediate plans to change current operational practice in pursuit of leading/best practice
Poor	Criteria is an aspect of on-farm practice that can be described as more than one of the following: <ul style="list-style-type: none"> – Not implemented – good industry practice is not implemented or is implemented inconsistently, potential for regulatory non-compliance – Considered less than average practice based on assessor's observations onsite and discussions with site staff, significant inconsistencies in answers vs observations – Not aware of issues identified or aware of improvements that should be made but do not consider them worthwhile or valid
Not applicable	Criteria is not applicable to the farm assessed. The criteria will provide an explanation for this grading.
Key observation	May pertain to any observation made that is considered highly relevant to the scope of the assessment to highlight it for further investigation as part of the final report for the environmental assessment

E-4 Assessment results





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