



Insight. Innovation. Impact.

Australian Cotton Industry:
Third Environmental
Assessment

September 2012

Inovact Consulting Pty Ltd

Level 1, AMP Building

1 Hobart Place

GPO Box 2067

Canberra City ACT 2601

P 02 6140 3900

F 02 6262 9307

www.inovact.com.au

ABN 17 587 520 145

Acknowledgements

Inovact Consulting wishes to acknowledge the support, feedback and encouragement given to the compilation of this report by a project steering committee comprising members from Cotton Research and Development Corporation, Cotton Australia, Cotton Catchment Communities Cooperative Research Centre and cotton growers.

We also sincerely thank growers who volunteered to show and discuss their cotton growing operations with the consultants, and the growers and cotton value chain companies that discussed the industry by telephone. Auscott showed and explained cotton ginning in their Narrabri Gin to the consultants and we gratefully acknowledge their assistance. We are particularly indebted to the growers, cotton industry stakeholder and others with an interest in the industry for participating in the surveys. Without their participation, the data available for this report would have been diminished. We also thank the Sydney residents who participated in the small market research study conducted for this Third Environmental Assessment. Finally, we express our appreciation to Rachel Holloway, the Project Coordinator for the Cotton Research and Development Corporation for her enthusiasm and knowledge of the cotton industry, the access to the industry she provided for the consultants through her contacts, and her interest and comments on the drafts of the report.

Disclaimer

The information contained in this report has been compiled from data and other materials supplied by Cotton Research and Development Corporation, the Cotton Catchment Communities Cooperative Research Centre, Cotton Australia and publicly available information. Primary data was also collected through surveys of cotton growers and cotton industry stakeholders.

Every effort has been made to ensure the information presented and the conclusions reached are realistic and not misleading. However, Inovact Consulting Pty Ltd makes no warranty as to the accuracy of the information contained in this report and will not accept responsibility or liability for any loss incurred by any person or entity relying on the information in this report.

This report is solely for the use of client personnel. No part of it may be circulated, quoted or reproduced outside the client organisation without their prior written approval.

Table of Contents

Table of Contents.....	i
List of Figures.....	ii
List of Tables.....	iv
Executive summary and recommendations	1
Key industry achievements in environmental performance since 2003	3
Recommendations of the Third Environmental Assessment	5
Section 1: Third Australian Cotton Industry Environmental Assessment	8
1.1 Purpose of the Third Environmental Assessment	8
1.2 The 1991 Environmental Audit.....	8
1.3 The Second Environmental Audit	9
1.4 The Third Environmental Assessment: scope and methodology	10
1.5 Structure of this report.....	14
Section 2: The Australian cotton industry	16
2.1 Features of Australian production	16
2.2 Australia's place in the global market	20
Section 3: Innovation in cotton growing	24
3.1 Introduction.....	24
3.2 Research, development and extension.....	24
3.3 Best Management Practices (BMP) program.....	27
3.4 Monitoring and reporting environmental performance	39
Section 4: On-farm environmental performance.....	45
4.1 Introduction.....	45
4.2 Perceptions of grower and stakeholders towards environmental performance.....	45
4.3 Water Use and Management.....	54
4.4 Chemical Use, Application and Management.....	62
4.5 Natural Resource Management	75
4.6 Energy Efficiency, Carbon Emissions and Climate Change	86
Section 5: The emerging drivers of improved environmental performance.....	94
5.1 Introduction.....	94
5.1 Market drivers for environmental sustainability.....	96
5.2 Maintenance of the 'social licence to farm'.....	97

Bibliography	111
Abbreviations.....	119
Appendix 1: Cotton Grower Environmental Performance Survey 2012.....	120
Appendix 2: Cotton Stakeholder Environmental Performance Survey 2012	139

List of Figures

Figure 1: Australian production, total number of bales produced and 2002-03 to 2010-11	17
Figure 2: Cotton growing regions of Australia 2012	19
Figure 3: Cotton growers' awareness and use of myBMP	35
Figure 4: myBMP certification	36
Figure 5: Attractions to using myBMP	37
Figure 6: Barriers to using myBMP	38
Figure 7: Cotton growers' perceptions of the impact of cotton growing on the environment compared with other crops grown.....	46
Figure 8: Ratings of cotton industry performance in reducing environmental impacts	47
Figure 9: Grower perceptions on industry's performance in providing information.....	48
Figure 10: Grower perceptions of importance of improving cotton's environmental performance.....	49
Figure 11: Grower concerns in terms of environmental issues	50
Figure 12: Grower perceptions on the top environmental issues today.....	51
Figure 13: Stakeholder perceptions on future environmental priorities for the industry	53
Figure 14: Grower perceptions of actions to take to influence stakeholders	54
Figure 15: Grower perceptions on improvements in water management.....	61
Figure 16: Insecticide use on conventional, Ingard® and Bollgard II® varieties in Australia from 1995-96 to 2009-10	70
Figure 17: Herbicide use on conventional and Roundup Ready Flex® in Australia, 2009-10	70
Figure 18: Grower perceptions on improvements in chemical management.....	74
Figure 19: Grower perceptions on improvements in land management	84
Figure 20: Australian annual mean temperature anomalies from 1901 to 2006.....	89
Figure 21: Stakeholder perceptions of improvements in greenhouse gas emissions	92
Figure 22: Stakeholder perceptions on future environmental priorities for the industry	108
Figure 23: Personal characteristics of cotton growers interviewed.....	121
Figure 24: Distribution of grower involvement in the cotton industry.....	122
Figure 25: Cotton crop's impact on the environment in comparison to other crops and livestock	123

Figure 26: Grower perceptions on industry performance in improving environmental impacts	123
Figure 27: Grower perceptions on industry performance in providing information.....	124
Figure 28: Grower perceptions on the importance of improving environmental performance.....	124
Figure 29: Grower perceptions on their own improvements in reducing environmental impacts of cotton	125
Figure 30: Grower perceptions on improvements in water management.....	126
Figure 31: Grower perceptions on improvements in chemical management.....	127
Figure 32: Grower perceptions on improvements in land management	127
Figure 33: Grower perceptions of improvements in greenhouse gas emissions	128
Figure 34: Grower perceptions on regional improvements in reducing environmental impacts of cotton.	129
Figure 35: Grower perceptions on further improvements to be made	130
Figure 36: Grower perceptions of barriers to their own improvement	131
Figure 37: Grower perceptions on barriers to regional improvements	132
Figure 38: Grower concerns in terms of environmental issues	132
Figure 39: Grower perceptions of actions to take to influence stakeholders	133
Figure 40: Grower perceptions on the top environmental priorities	134
Figure 41: Cotton growers' awareness and use of myBMP	135
Figure 42: Cotton grower myBMP certification.....	136
Figure 43: Attractions to using myBMP.....	137
Figure 44: Barriers to using myBMP	138
Figure 45: Sample and response rate	140
Figure 46: Stakeholder classification and distribution.....	140
Figure 47: Stakeholder perceptions of industry's overall performance.....	141
Figure 48: Stakeholders' level of awareness of farming practices	142
Figure 49: Stakeholders' perceptions on importance of the industry informing others on environmental performance.....	143
Figure 50: Stakeholders' perceptions on the overall performance of the industry in reducing the environmental impact of cotton	143
Figure 51: Stakeholder perceptions of the cotton industry's environmental performance relative to other agricultural industries	144
Figure 52: Stakeholder perceptions on water-use efficiency	145
Figure 53: Stakeholder perceptions on protection of ground (underground) water quantity and quality	145
Figure 54: Stakeholder perceptions on improvements in the level of chemicals used to combat cotton pests and disease	147
Figure 55: Stakeholder perceptions on improvements in the method of application of chemicals to reduce spray drift	148

Figure 56: Stakeholder perceptions in improvements in pesticide or other chemical run-off to rivers and wetlands.....	149
Figure 57: Stakeholder perceptions of improvements in pesticides or other chemical run-off to rivers and wetlands.....	149
Figure 58: Stakeholder perceptions on improvements in fertiliser run-off to rivers and wetlands.....	150
Figure 59: Stakeholder perceptions of improvements in the extent of planting or conservation of native vegetation on farms.....	150
Figure 60: Stakeholder perceptions of improvements in protection of biodiversity (native flora and fauna) on farms	151
Figure 61: Stakeholder perceptions on improvements in the protection of riparian areas	152
Figure 62: Stakeholder perceptions of improvements in practises to conserve or improve soil health	153
Figure 63: Stakeholder perceptions of energy efficiency on cotton farms.....	153
Figure 64: Stakeholder perception on fuel efficiency on farms	154
Figure 65: Stakeholder perceptions on industry actions towards reducing levels of greenhouse gas emissions from farms	155
Figure 66: Stakeholder perceptions on future environmental priorities for the industry	156
Figure 67: Stakeholder perceptions on the implications of a lack of action on the industry's future	157

List of Tables

Table 1: Australian production, total number of bales produced and 2002-03 to 2010-11	16
Table 2: Cotton production of six largest producers (Millions of 480 lb. bales).....	21
Table 3: Cotton consumption of world's six largest consumers (Millions of 480 lb. bales)	22
Table 4: Cotton exports of world's six largest suppliers (Millions of 480 lb. bales)	22
Table 5: Cotton imports of world's six largest buyers (Millions of 480 lb. bales)	22
Table 6: Rating of adoption of the Second Environmental Audit recommendations	27
Table 7: Results of a BMP SWOT Analysis	30
Table 8: BMP and myBMP certifications and involvements from 2000 to 2012.....	33
Table 9: Rating of adoption of the Second Environmental Audit recommendations	40
Table 10: Rating of adoption of the Second Environmental Audit recommendations.....	56
Table 11: Rating of adoption of the Second Environmental Audit recommendations.....	63
Table 12: Introduction of transgenic cotton varieties to Australian cotton growing.....	67
Table 13 : Rating of adoption of the Second Environmental Audit recommendations	76
Table 14: Major retailers and targets for their use of cotton	97

Executive summary and recommendations

This report presents the findings and recommendations of an assessment of the environmental management and performance of Australian cotton growing. The study period of the report is 2003-2012 as it appraises the cotton industry's implementation of the recommendations of the Second Environmental Audit that reported in 2003 and the cotton industry's progress since then.

The industry's location in the riverine areas of the Murray Darling and Fitzroy Basins means that its interactions with rivers, floodplains, wetlands and the Great Barrier Reef (in the case of the Fitzroy Basin) places it under public and government scrutiny in terms water use and environmental stewardship.

Environmental stewardship of Australian cotton growing

Through its research and development investments and effective interrelationships between industry research institutions, grower organisations, commercial service providers and growers themselves, the industry has been substantially transformed since 2003. This transformation has occurred in production practices, the cotton farming system and farm planning and management. The result of the changes has been a substantially reduced impact of cotton growing on the riverine environments in which it exists. Growers have made considerable improvements in water, chemical and natural resource management on-farm and across cotton growing landscapes. The adoption of new technology has been a significant factor in the improvements that have been made.

BMP is the industry's main vehicle for technology transfer from research and development outputs into guidelines and tools for growers to achieve best management practices and enhance their businesses and environmental performance. The current online version known as myBMP is a sophisticated information source for growers that also has processes for self-assessment and formal on-farm audits in order to attain certification. Increasing grower uptake of myBMP remains a major challenge to the industry and this Third Environmental Assessment finds that there are significant weaknesses and confusion in its purpose, objectives, marketing, implementation strategy and accounting for grower participation.

Genetically modified cotton and Integrated Pest Management (IPM)

Cotton growers have had access to progressively improved genetically modified cotton varieties since 1996. A new generation Bollgard II® variety was introduced in 2003 to counter potential resistance from *Helicoverpa armigera*. Similarly the Roundup Ready® variety was enhanced through Roundup Ready Flex® to improve the plant's resistance to glyphosate. A further innovation was the release of Liberty Link® cotton which has been genetically modified to tolerate applications of the broad-spectrum herbicide glufosinate ammonium.

The introduction of transgenic cotton varieties began a major change in pesticide management and use. It enabled substantial reductions in the number of spray applications during a growing season and in the amount of pesticide applied. Bollgard II® cotton was reported to require 85 per cent less insecticide than conventional cotton varieties and was grown on 90 per cent of the 2009-10

crop area. For the same crop Roundup Ready Flex® and Liberty Link® cotton was reported to require 48 per cent less herbicide than non-herbicide tolerant cotton. Over 98 per cent of the crop contained the Roundup Ready Flex® trait.

Bollgard II® also provided growers with the opportunity to implement more effective integrated pest management (IPM) strategies into their farming systems because it had less impact on 'beneficials' (insects, spiders, micro-bats, etc, that predate on cotton pests). IPM has become a major success story in cotton growing. The practice links crop protections with biodiversity conservation measures such as protecting and growing native vegetation on-farm to provide habitat to beneficials.

Water management

During the past ten years, a period of national water reform and severe drought, irrigated agricultural industries including cotton have focussed their research, development and extension investments on water use and management. As a result of the uptake of research and development outputs, growers have succeeded in improving their water use efficiency by three to four per cent per annum. They have also introduced more effective water management on-farm such as improving water storage to reduce evaporation, reducing leakage from channels and storages, capturing and recycling irrigation tailwater, managing stormwater and improving on-farm water quality.

Natural resource management

Since 2003 natural resource management has increased in prominence and the industry has worked effectively through its research institutions to develop partnerships with catchment management authorities, regional natural resource management organisations and groups such as Landcare. The Third Environmental Assessment finds evidence that cotton growers have improved soil, riparian and native vegetation management which is contributing to improved biodiversity and delivering important ecosystem services. However this is an area that requires increased monitoring and reporting of the uptake of improved practices and the outcomes achieved by growers. Deriving a practical set of measures and indicators of improved natural resource management is inherently difficult, but it would assist the industry to demonstrate its environmental credentials in this area.

Energy use, greenhouse gas emissions and adaptation to climate change

There is evidence of improvements in all of these areas, but the industry is still in an early period of development regarding improved practices and management. Improvements in the fuel efficiency of farm machinery, controlled traffic systems, innovations such as the round baler reducing traffic, and farm system innovations such as minimum tillage have been and will continue to be key drivers for improved energy efficiency and reduced greenhouse gas emissions on cotton farms.

Climate change has longer term impacts and it is too early to assess the outcomes of the industry's initiatives in this area.

Key industry achievements in environmental performance since 2003

This Third Environmental Assessment reviewed the extent to which the industry adopted the recommendations of the Second Environmental Audit (2003). The assessment covered 46 recommendations and these have been rated as shown below.

High level of industry adoption	26 (56.5 per cent);
Medium level of industry adoption	8 (17.4 per cent);
Low level of industry adoption	4 (8.7 per cent);
myBMP growers comply, but wider adoption unknown	8 (17.4 per cent).

The finding of this assessment is that the majority of the recommendations have been adopted at a high level. In particular, there has been a high level of adoption in areas such as water, chemical and natural resource management. There were some recommendations particularly in the area of chemical management (including a large number of sub-recommendations) that were incorporated into myBMP. Growers who have been audited and gained myBMP certification have adopted these recommendations. However wider adoption by growers is unknown and could only be determined through myBMP audits or other specific on-farm studies.

Major achievements:

The major achievements of the industry in improving its environmental performance since 2003 are listed below. Evidence for these findings is provided in the main body of the report.

- 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.

Priorities for future industry action to improve environmental outcomes:

This assessment notes the significantly changed context in how the industry now faces its environmental management challenges. 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 requirements 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; and public expectations for good environmental and social stewardship.

This Third Environmental Assessment considers that the priorities for the industry in continuing to improve its environmental performance are as listed below. Evidence for these findings is provided in the main body of the report.

1. Delivering and demonstrating environmental performance that meets the needs of a demanding global market environment in terms of the corporate social responsibility aspirations of retailers, the values held by consumers and wider public perceptions of cotton growing.
2. Re-invigorating myBMP so that it is linked to market drivers and the commercial needs of growers, its purpose and objectives are clarified and the program is valued and widely used by cotton growers and is recognised by governments and the market.
3. Maintaining effective crop protection through risk management for mitigating against potential insect resistance and developing weed resistance.
4. Continuing to make significant improvements in water use efficiency and water quality on and off-farm to achieve further productivity and environmental benefits, and in preparation for future droughts.
5. Continuing to prioritise on-farm natural resource management in the context of catchment-wide resilience and targets. The location of cotton growing in riverine landscapes subject to variable climate and the impact of climate change means on-farm practices that contribute to catchment health and resilience will in turn improve the resilience of cotton farms.
6. Successfully dealing with energy efficiency, greenhouse gas emissions and climate change issues in response to the national and international agendas around these issues. This includes continuing to prioritise these issues in research, development and extension and improving monitoring and reporting on performance.
7. Achieving effective outcomes on land and water use conflicts particularly the impact of coal mining and coal seam gas extraction and issues around the Murray Darling Basin Plan when approved.
8. Improving the monitoring, evaluation and reporting of the uptake of best management practices by growers and the actual environmental outcomes that result.
9. Meeting the new challenges for research, development and extension (RD&E) that are arising from an increasingly complex and interrelated operating environment. The Cotton Research and Development Corporation will face increased responsibility for the effective

delivery of RD&E with the conclusion of the Cotton Catchment Communities Cooperative Research Centre.

Recommendations of the Third Environmental Assessment

Taking into consideration the findings of this assessment and the priority challenges listed above, the following recommendations are proposed to the industry to advance its environmental stewardship agenda and performance.

Recommendation 1:

It is recommended that Cotton Research and Development Corporation 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.

Rationale

Recommendation 1 addresses priorities numbered 3-9 above. The rationale of the environmental RD&E strategy is to develop a strategic and risk management approach to environmental management and performance that will meet emerging market requirements, the commercial and practical needs of growers, public policy requirements and the broader expectations of the Australian community on environmental stewardship in agriculture. The strategy should outline intended pathways for the uptake of R&D by growers and establish key performance metrics to measure outcomes. It is acknowledged that the environmental RD&E strategy would be integrated into the industry's existing planning framework and plans particularly the next strategic R&D plan of the Cotton Research and Development Corporation (i.e. for 2013-2018).

Recommendation 2:

It is recommended 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.

Rationale

Recommendation 2 addresses the priority numbered 2 above. myBMP needs to be re-appraised to clarify the present confusion in its overall purpose, objectives and value to growers. Of particular importance is the clarification of the objectives of grower certification under the program. The re-appraisal also needs to address how myBMP can deliver results to the industry from a consideration of what consumers, retailers, the community and governments are demanding in terms of the sustainability of cotton growing. From the reappraisal, a marketing and implementation strategy needs to be developed to more effectively market the benefits of myBMP to growers and to re-invigorate the program to meet its objectives. In addition performance metrics need to be specified to measure outcomes. This should include accounting for the numbers of growers (or farm businesses) who are participating and the level of their participation.

Recommendation 3:

It is recommended that Cotton Research and Development Corporation 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.

Rationale

Recommendation 3 addresses all of the priorities listed. The present databases of growers and key industry stakeholders are inadequate for effective engagement on priority industry issues. This was apparent during this study when samples were established for the surveys of growers and stakeholders respectively. In addition, the more favourable production conditions over the past two seasons has seen many new growers enter the industry without previous experience. These growers need to be targeted in extension activities to ensure that they adopt best management practices. The need for accurate and usable databases is reinforced by the requirement of the Rural Research and Development Policy Statement (Australian Government, July 2012) for CRDC to prepare an extension plan that incorporates adoption pathways and strategies for improving the uptake of R&D.

Recommendation 4

It is recommended 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 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.

Rationale

Recommendation 4 addresses all of the priorities listed. The industry has a 21 year history of independent environmental assessments and is unique amongst Australian agricultural industries in documenting performance information and assessments over such a long period. With increasing demands for evidence-based performance reports from markets, governments and the community, the industry should continue to build on this record. While the annual reports of the Cotton Research and Development Corporation and Cotton Australia report on achievements, these and other environmental reports from the industry could be improved by establishing a monitoring, evaluation and reporting framework that includes a practical number of environmental metrics. The industry has put a lot of effort into researching sustainability indicators, but it has not reached a position on a workable set of metrics that can be used and meet the demands of target audiences.

Recommendation 5

It is recommended 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.

Rationale

Recommendation 5 meets the priority numbered 1. The industry competes in a global market. Key international retailers which operate in that market have strong corporate social responsibility agendas and are setting sustainable cotton targets. This is being partly driven by environmental interest groups, consumers and the wider public directly engaging retailers to influence those companies to improve and demonstrate sustainability through the value chain including on farms. The industry also needs to be engaged with retailers and consumers to both understand their positions and to have influence in the setting of sustainability targets to ensure that they are reasonable and practical in commercial terms.

Recommendation 6

It is recommended 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.

Rationale

Recommendation 6 addresses the priorities numbered 1 and 9. It follows that the industry needs to be armed with sophisticated market research information to influence the perceptions of consumers, the community, politicians, government officials and environmental groups. The information gathering and media world is changing rapidly and the industry needs to keep abreast so that its voice is heard and it is able to substantiate its performance. Cotton Australia has recently commissioned a small market research survey on the perceptions of key policy makers of the cotton industry.

Section 1: Third Australian Cotton Industry Environmental Assessment

1.1 Purpose of the Third Environmental Assessment

In January 2012 Cotton Research and Development Corporation (CRDC) commissioned this review of the environmental practices and performance of cotton growing in Australia. In commissioning the work CRDC observed that the cotton industry remains an important agricultural industry to Australia that generates a large export income and employs a significant number of people in regional Australia. CRDC noted that since the Second Environmental Audit in 2002-03 the industry had experienced change and challenges from drought, floods, competition for land, water, food, energy and labour, growing demand of premium quality cotton, changes to the myBMP program, and new policies related to climate change, carbon trading and water reform. It concluded that it was time to conduct a further comprehensive review of the environmental performance of cotton growing.

As distinct from previous studies the term 'environmental assessment' rather than 'environmental audit' is used in this study. The approach used was to conduct a strategic assessment of environmental practices that sits above the industry's present auditing process at the grower level. This is available to growers through the myBMP program. The study also brings the terminology of the approach into line with the understanding of the Commonwealth and state governments of strategic environmental assessments.

1.2 The 1991 Environmental Audit

This First Environmental Audit by Gibb Environmental Sciences and Arbour International in 1991 was influenced by public criticisms of the cotton industry about pesticide use and its off-site impact on fish populations and residues in beef. The objective of the First Environmental Audit was to create a foundation of information on cotton industry performance by giving an overview of industry practices, identifying key issues and concerns, reviewing existing data, and addressing the publicised environmental challenges of the industry.

The First Environmental Audit identified issues where improvements could be achieved and made recommendations relating to pesticide use included tighter controls over pesticide handling and use, further research into integrated pest management techniques, retention on-farm of all tail-water and the first flush of stormwater, and monitoring of noise levels and conducting annual hearing tests of permanent staff in cotton processing facilities.

Recommendations under the land use category included separating new residential development and cotton farms, the development of environmental policies for land use, greater documentation of practices, retention of natural vegetation on-farm, promotion of wildlife, minimisation of soil compaction and erosion and greater dissemination of information.

Recommendations under the water use category included recognition of wetlands in water policies, greater research on methods to reduce water use, documentation of monitored groundwater reserves, and greater research on the impacts of pesticides on fish and other aquatic wildlife.

1.3 The Second Environmental Audit

The Cotton Research and Development Corporation commissioned the Second Australian Cotton Industry Environmental Audit in 2002-03 undertaken by GHD to:

- assess the industry's response to the recommendations of the First Environmental Audit conducted in 1991;
- identify the environmental issues then facing the industry; and
- recommend strategies and priorities to further improve the cotton industry's environmental management practices.

The Second Environmental Audit which reported in 2003 found that much had changed as a result of the previous environmental incidents and that the cotton industry had developed and implemented a wide range of improvements in its operations and environmental management practices. It reported that the most significant and far-reaching environmental improvements were driven by considerable investment into research and its adoption. This included:

- Formulating and implementing a Best Management Practices (BMP) approach to cotton farming and environmental management. The BMP program had been a driving factor for the improved environmental management observed on cotton farms.
- Ongoing increases in water use efficiency as measured by lower quantities of water applied per unit of production.
- Improved pest management including less reliance on pesticides through planting genetically modified cotton and the adoption of Integrated Pest Management strategies.
- Improved spray application to more effectively target spray placement and minimise off-target drift.
- Increased recycling of chemical containers to reduce disposal in landfills (Drum Muster).
- Improved land management through minimising erosion, identifying and managing salinity and reducing soil compaction.
- Development and adoption of farm management tools, directed to achieve environmentally positive outcomes (such as improved soil structure and health by implementing SOILpak).
- Conducting a strong research, extension and development program. This enabled the identification of the important environmental issues and the introduction of improved management practices based on research results. Key advances were noted in pesticide use, pest management, water use, vegetation and land management, waste recycling and disposal, wildlife management and biodiversity conservation.

The Second Environmental Audit found that the broad strategic issues identified in the First Environmental Audit under the headings of pesticide use, land use, water use and cotton processing had been addressed or were no longer valid. In particular, it concluded that:

- *With regard to pesticide use:* a high level of compliance was achieved with respect to aerial spraying, chemical use and OH&S, pesticide storage, spray drift management, integrated pest management and research. A lower level of compliance was found for nuisance odour and the disposal and recycling of pesticide containers.
- *With regard to land use:* a high level of compliance was achieved with respect to soil compaction and erosion recommendations. A lower level of compliance was found for retention of vegetation and encouraging wildlife and for lower priority recommendations such as the development of land acquisition guidelines, documentation of land use changes, and impact assessment.
- *With regard to water use:* a high level of compliance was achieved for all recommendations including those concerning water conservation, tailwater and stormwater management, and research and monitoring.

One of key findings was that farmers who had adopted the BMP Program all experienced greater improvements in their farming practises and environmental management. The Second Environmental Audit reported an observable correlation between categories that experienced the most improvements and the modules that were outlined within the BMP manuals provided to farmers. It was observed that BMP also improved the documentation of farm processes, environmental policies, stormwater management strategies, pesticide management, and record monitoring and analysis.

1.4 The Third Environmental Assessment: scope and methodology

As noted previously this study uses the term ‘environmental assessment’ rather than ‘environmental audit’. This present study is not an audit in the sense of having undertaken on-farm inspections of an appropriate sample of growers to assess whether they are meeting agreed industry standards on best management practices. Auditing is already available to growers through myBMP. Under this program, growers can voluntarily opt to gain myBMP certification through a standardised and detailed audit process undertaken by certified myBMP auditors. This process examines on-farm practices, systems and documentation against industry agreed best practice as set out in myBMP modules.

This present study is an assessment of the evidence from a variety of sources of the cotton growing sector’s environmental performance. Part of this assessment is an examination of the extent to which the cotton industry has adopted recommendations made in the Second Environmental Audit report of 2003.

The terms of reference for this third independent environmental assessment are to:

1. Assess the cotton industry’s response to the recommendations made in the Second Environmental Audit.
2. Assess the environmental issues currently facing the industry.

3. Assess current industry action in light of the Second Environmental Audit and current environmental issues. Different perspectives should be taken in account (i.e. cotton industry (gins, shipping), state government, federal government, community and non-government organisations).
4. Review core information and data to provide basis for identifying significance to the cotton industry.
5. Recommend priorities for action, strategies and risk assessment processes for cotton farms.

The study period for the Third Environmental Assessment is from 2003 to 2012. Its scope covers cotton production in New South Wales and Queensland. In contrast to the First and Second Environmental Audits this assessment excludes the environmental performance of cotton gins and seed companies.

Data sources and collection processes

This strategic environmental assessment collected and examined evidence from the following sources:

- Industry documentation provided by the Cotton Research and Development Corporation, Cotton Australia and the Cotton Catchment Communities Cooperative Research Centre.
- A large body of Australian and international literature on cotton growing sourced from publicly available databases. A review of international literature examined Australia's position as a producer in world terms and it's environmental performance relating to key measures of water and chemical use.
- A Computer Aided Telephone Interviewing (CATI) survey of 150 growers. Details of the *Cotton Grower Environmental Performance Survey 2012* are provided in Appendix 1.
- Visits to ten cotton growing farms in New South Wales and Queensland to observe growing practices and farm management associated with cotton production.
- An online survey of cotton industry stakeholders defined broadly to include those that have a commercial or service provider stake in the industry and other groups that have an interest in how the industry performs such as government departments, regional natural resource management bodies, water supply corporations, non-government environmental groups and organisations of other industries. Details of the *Cotton Stakeholder Environmental Performance Survey 2012* are provided in Appendix 2.
- Telephone discussions with key executives of organisations in the industry's value chain including ginners and marketers.
- A small market research study of community perceptions of the cotton industry.

Desktop research

As noted above, a key aspect of the Third Environmental Assessment is an examination of the industry's adoption of the recommendations of the Second Environmental Audit. The industry's published response to the Second Environmental Audit entitled *Taking Responsibility for Future* (CRDC, 2005) and a 2012 update of the action taken against the recommendations (*Taking Responsibility for our Future, 2012*) were examined in this assessment. These responses were analysed along with other data, such as the *Cotton Grower Environmental Performance Survey 2012*, against a number of ratings as shown below:

High level of industry adoption	Adoption of the recommendations with evidence of a specific plan of action, priority assessment, budget allocation, measurement against key performance indicators (KPIs) and subsequent reporting showing outcomes, participation and trends.
Medium level of industry adoption	Adoption through a general of plan of action with broad evidence indicating relevant new processes, research, product development, capacity building or on-ground changes. Strategic goals and KPIs either not clearly stated or not fully met.
Low level of industry adoption	Broad recognition of the value of recommendation, low level of uptake through research or farm-focussed programs, some discursive information available about adoption, but not provided in the context of an action plan, associated investment plan or KPIs.
myBMP growers comply, wider adoption unknown	There were some recommendations (including a large number of sub-recommendations) that were incorporated into myBMP. Growers who have been audited and gained myBMP certification have adopted these recommendations. However wider adoption by growers is unknown and could only be determined through myBMP audits or other specific on-farm studies.

Cotton Grower Environmental Performance Survey 2012

A questionnaire was devised to obtain the views of growers about their practices in managing environmental issues on-farm. The text of the questionnaire is included in Appendix 1. A total of 150 interviews were conducted between 26 March and 10 of April 2012. The sample was obtained by calling individuals listed in the grower database held by Cotton Research and Development Corporation. There were problems with the accuracy of the data base and it was an incomplete list of growers in comparison with the number of growers that the industry's peak body Cotton Australia reports on their website.

Nearly all the cotton growers interviewed are also involved in other forms of agricultural production as well as growing cotton. Most of the growers had first grown cotton before 2003, most were males, about half were aged 50 or more, one in three reported having a university degree, and a similar proportion that they had a TAFE, VET or trade certificate or diploma.

Of those interviewed 56 per cent were located in NSW and 44 per cent in Queensland. Some interviews were conducted in every growing region. For the analysis the regions were classified as follows:

NSW Regions:

- Gwydir River
- Namoi
- Macquarie

- Inland NSW (Bourke, Lachlan, Murrumbidgee, Menindee).

Queensland Regions:

- Central Queensland
- Darling Downs
- Border Rivers Queensland (St George, Dirranbandi, McIntyre Valley.)

Cotton Stakeholder Environmental Performance Survey 2012 and interviews

An online survey was devised to evaluate the perceptions of industry stakeholders towards the key environmental issues faced by the cotton industry. The key objectives of the stakeholder survey were to assess stakeholders' views on the progress of the industry in meeting environmental challenges; to assess the environmental issues currently facing the industry from stakeholders' perspectives; and to identify the environmental issues that the industry is likely to face in the future (next 3-5 years).

The survey was meant to gauge not only the perceived highlights, shortcomings and supporting evidence of the industry's progress in improving environmental progress, but also perceptions of urgency for further action, barriers, and priority issues for the future. The survey instrument is included in the Appendix 2.

A total of 133 stakeholders identified by the Cotton Research and Development Corporation were emailed invitations to complete the online survey. There were a total of 70 responses out of the 133 stakeholders that were contacted by email resulting in a response rate of 53 per cent.¹

Of these responses:

- 64 per cent were males;
- 44 per cent were aged between 30 and 49 years and 53 per cent were aged above 50 years;
- 33 per cent were classified as having environmental interests (such as catchment management authorities or natural resource management organisations; and local, national, and/or international non-government organisations;
- 27 per cent were classified as having government interests (such as Australian government departments, state government departments or agencies, intergovernmental agencies);
- 13 per cent were classified as industry interests (such as cotton grower organisations, cotton industry organisations (non-grower), water organisations, merchants, etc.);
- 7 per cent were classified as other farm industries (such as Grain Producers Australia, Cattle Council of Australia, Queensland Farmers Federation, Cane Growers, and Rice Growers Association of Australia) and

¹ Research shows that the average response rate for online surveys with incentives is 17 per cent.

<http://illume.arizona.edu/sites/illume.arizona.edu/files/nonrespbiast.pdf>

- 20 per cent were classified as other, including researchers (from government research organisations, private research organisations and universities).

2012 community perceptions of cotton growing focus groups

A small market research study was included as part of the Third Environmental Assessment to complement existing research and it employed qualitative research methodologies.

The broad research questions that the focus groups addressed were:

1. How is Australian cotton farming perceived by the general community, particularly in terms of its environmental performance?
2. To what extent has cotton farming changed and improved in the past decade, particularly in terms of its environmental performance, as perceived by the general community?
3. What does the community perceive the cotton production industry needs to improve the most in future to be more environmentally and how important is it to act?

Two focus groups: one group with participants aged 20-25 years and the other with participants aged 36-55 years were conducted in central Sydney. Both groups contained an equal number of males and females.

Participants were recruited on the basis of their consumption of more serious media such as broadsheet newspapers and ABC or SBS television or online news.

In summary the focus groups explored how the cotton industry's environmental performance is perceived by the general community; how the general community perceives the change in the cotton industry over the previous decade (especially with regard to its environmental performance); and what the community perceives as the most important issues the cotton industry needs to address to become more environmentally friendly.

1.5 Structure of this report

This report addresses key issues in the environmental performance of cotton growing in the study period 2003 to 2012.

Section 1 reflects on the history of the industry's independent reviews of its environmental performance over a period of 21 years from 1991.

Section 2 provides a brief overview of cotton growing in terms of its economic contribution, its key features, history in Australia, growing regions, its place in the global market and key challenges for cotton production worldwide.

Section 3 shows how the Australian cotton industry is inherently an innovative industry in terms of its commitment to research, development and extension (RD&E) as a pathway to its advancement and prosperity. It also describes the features and challenges of the myBMP program which is the industry's key extension tool that translates research into practical information and tools for the implementation of best management practices in cotton growing. In addition it examines the industry's commitment to monitoring and reporting environmental performance.

Section 4 assesses the cotton industry's response to the recommendations of the Second Environmental Audit relating to environmental on-farm environmental practices and the action it has taken since 2003. This covers the specific areas of on-farm water use and management; chemical use and management; natural resource management; energy efficiency, greenhouse gas emissions and climate change. For each of these areas the progress achieved is examined, perceptions of grower and stakeholders are described and the Third Environmental Assessment's conclusions and recommendations are outlined.

Section 5 addresses emerging environmental issues for Australian cotton growing as found by this study and as perceived by growers and stakeholders. It examines the importance of the global market economy and community perceptions to the environmental stewardship of the industry.

Section 2: The Australian cotton industry

2.1 Features of Australian production

This section provides a snapshot of Australian cotton production which is part of a global industry and its position in the world.

Cotton is now a major Australian agricultural industry with Gross Value of Production of \$1.7 billion (lint and cotton seed) in 2010-11. It is the seventh largest industry in value terms after cattle, wheat, milk, sheepmeat, wool and poultry. The value of exports was \$1.4 billion in 2010-11. In a global context, Australia is the third largest exporter behind the USA and India, and on average, around the sixth largest producer, behind China as the world's largest producer and consumer.

In Australia cotton is both an irrigated and a dryland crop grown from rainfall, although some dryland growers use strategic irrigation to supplement rainfall during critical growth periods. Production levels fluctuate depending on the availability of water for irrigation and seasonal conditions as shown in Table 1 since 2002-03.

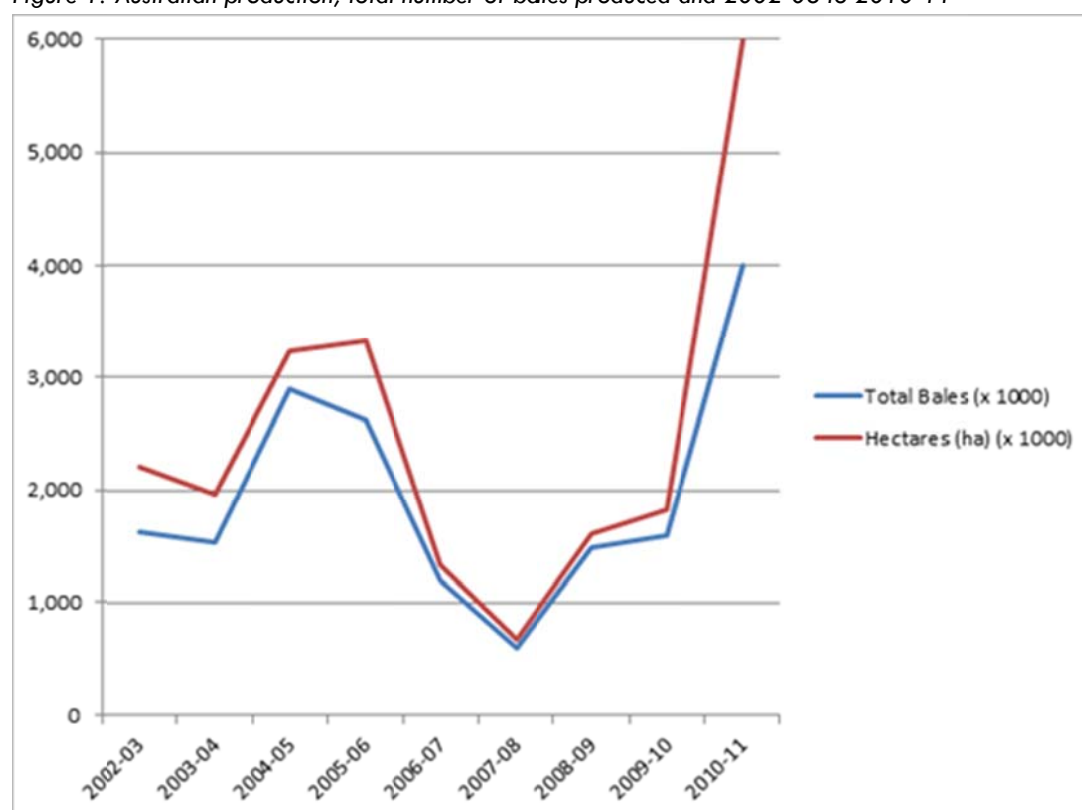
Table 1: Australian production, total number of bales produced and 2002-03 to 2010-11

Year	Total Bales	Planted Hectares (ha)	Bales per ha (irrigated cotton)
2010-11	3,999,600	599,630	9.2
2009-10	1,594,850	182,000	9.7
2008-09	1,494,300	161,390	10.1
2007-08	601,810	68,585	9.3
2006-07	1,199,700	134,290	8.9
2005-06	2,618,000	333,385	8.7
2004-05	2,904,000	323,450	9.7
2003-04	1,531,000	196,500	8.4
2002-03	1,630,100	220,500	7.5

Planted ha represents the footprint of the Australian crop.

Source: Cotton Australia industry statistics

Figure 1: Australian production, total number of bales produced and 2002-03 to 2010-11



Source: Cotton Australia industry statistics

In the severe drought conditions and low water allocations of 2007-08, production dropped to only 600,000 bales – the lowest amount for 30 years. Cotton production in 2011-12 is expected to be a record 4.7 million bales following on from the 2010-11 record of 3.9 million bales.

Yield (bales per hectare) has fluctuated considerably over time and reached a record high of 10.1 bales per hectare for irrigated cotton in 2008-09. Flood damage to some crops reduced the yield in 2010-11 and 2011-12.

Australian cotton growers produce yields two and a half times the global average. In 2009-10 Australia recorded cotton lint yields of 2,063 kilograms per hectare. The next highest yielding countries were Israel (1,667 kg/ha), Brazil (1,439 kg/ha) and Turkey (1,333 kg/ha). In 2009-10, Australia's average yield under irrigated conditions was 9.68 bales/ha compared with 5.2 bales/ha under dryland conditions.

History of cotton growing

A timeline of the Australian industry published by Cotton Australia shows its long history in Australia extending back to the First Fleet, the rise of the industry in the 1960s and 1970s, high production levels (more than 3m bales) from 1997-98 to 2001-02, the impact of the drought from 2000-03 to 2009-10 and then the resurgence of the industry in 2010-11 and 2011-12.

The modern industry stems largely from the period of major dam constructions in New South Wales and Queensland. Associated areas have become the main production areas in Australia and these now stretch from Emerald in Queensland to Berrigan in New South Wales. The major production area in NSW stretches south from the Macintyre River on the Queensland border and covers the Gwydir, Namoi and Macquarie valleys. In NSW, cotton is also grown along the Barwon and Darling Rivers in the west and the Lachlan and Murrumbidgee Rivers in the south. In Queensland, cotton is grown mostly in the south in the Darling Downs, St George, Dirranbandi and the Macintyre Valley regions. The remainder is grown near Emerald, Theodore and Biloela in Central Queensland.

Cotton production has moved further south in southern New South Wales with the availability of irrigation water and favourable seasons. The industry estimates that the planted area grew from around 3,000ha in the recent past to more than 22,000ha in the 2010-11 season, and that 75 per cent of the 2010-11 growers had not previously grown cotton. New growing areas include Jerilderie, Coleambally, Hay, Darlington Point, Lachlan, Hillston and Griffith to Swan Hill. The southernmost cotton farm is at Berrigan NSW about 47 kilometres north of the Victorian border. The ending of the drought has also seen a reinvigoration of cotton growing in a number of areas such as the Macquarie Valley.

The land use footprint of the cotton industry in the Murray Darling Basin (MDB) is very small. The total agricultural land area in the MDB is 88.9m ha in a Basin that is 1.06m square kilometres (Australian Bureau of Statistics, May 2012). As such the 2010-11 crop which was grown on almost 600,000ha is only 0.7 per cent of the total agricultural land area in the Murray Darling Basin, although it is 24.4 per cent of land used for irrigated agriculture.

However the industry's location in the riverine areas of the Murray Darling and Fitzroy Basins means that its interactions with rivers, floodplains, wetlands and the Great Barrier Reef (in the case of the Fitzroy Basin) places it in the spotlight in terms water use and environmental stewardship. National and state environmental policies and programs are major influences on environmental management in the industry.

Cotton was grown in the Ord Irrigation Area in the 1960s, but ceased in 1974 due to insect resistance to pesticides and the large quantities of pesticides used. However since 2009 there have been research and field trials of new cotton varieties with the Genuity Bollgard III trait. The trait is modified for resistance to the *Helicoverpa armigera* and *Helicoverpa punctigera* moth species and has some resistance to glyphosate allowing growers to spray for weed control without harming the crop. From the success of the trials, it appears that the Ord Irrigation Area could become a significant region for cotton production grown as a winter crop in future.

Figure 2: Cotton growing regions of Australia 2012



Source: Cotton Australia website: <http://cottonaustralia.com.au/australian-cotton/basics/where-is-it-grown/>

The number of farmers growing cotton varies according to the impact of seasonal conditions, water availability and cotton prices relative to substitute crops. The Cotton Australia website (*Cotton Fact File: The Australian Cotton Industry*) reports there are around 1,500 growers and that the average Australian cotton farm:

- is family owned and operated with 40 per cent of the farms having women as business partners;
- provides jobs for eight people;

- grows 705 hectares of cotton;
- is run by farmers with an average age of 39;
- grows other crops and often grazes sheep and cattle.

2.2 Australia's place in the global market

In assessing the environmental performance of cotton it is important to consider Australia's position in a world context because of the growing expectations of international retailers and consumers for sustainable production practices. In addition the industry's aspiration to supply the most environmentally and socially responsible cotton on the globe is a matter of international reputation and standing for Australia. The Australian industry will face increasing competition from not only other suppliers such as the US, India, Brazil and emerging African countries, but also from synthetic fibres.

While the amount of cotton Australia produces is small, it is a significant producer due to the volume of exports, production yields achieved and the high quality of cotton supplied. Australia's exports are supported by a very sophisticated industry in terms of on-farm management practices, a productive and integrated value chain, high quality service providers and strong investment in research, development and extension.

The global market and competitive edge

There are three basic factors that drive the consumption rates of the textile and fibre industries: income growth, population growth, and fibre prices. The world price of cotton is dependent on a number of factors:

- the state of the world economy and hence demand for fibre;
- world supply and stocks;
- consumer preferences and demand for cotton fibre which in turn are influenced by fashion trends, retailers' advertising, seasonal conditions and product quality consumer; and
- relative fibre prices particularly for synthetics.

The global cotton price peaked at AU\$1,050 per bale during 2010-11, but dropped back to around AU\$500 per bale in 2011-12 which is more in line with the long term trend. The price drop reflected a decline in fibre demand due to global economic uncertainty and an increase in global cotton supply and world cotton stocks.

China's imports of cotton tend to provide a 'floor' in the global market. For 2012 their purchases are expected to be of the order of 11.8 million tonnes of cotton which is around 25 times higher than Australia's total exports. The actual price received by Australian cotton growers continues to be influenced by the high Australian dollar. However, strong market conditions and record cotton crops in Australia have again placed the industry in a strong position to be a significant competitor in world markets.

In terms of population growth and demand for fibre, the prospects for cotton production should be strong for an extended period. For example, the world's total population has grown from 2.5 billion people in 1950 to just under 7 billion today, and is projected to grow to 9 billion by 2044 (USDC 2012). In terms of income, the world's gross domestic product (GDP) has risen from about \$1.3 trillion in 1960 to just over \$63 trillion in 2010 (World Bank 2012) and world fibre use has risen from 7.6 million to 56 million tonnes between 1950 and 2004 (ITC 2012a).

Tables 2-5 show cotton production, consumption, exports and imports respectively of the top six nations. Australia is ranked sixth in the world in terms of production and third in terms of exports. China is the largest producer, but is also the largest importer. With a small domestic market most of the Australian crop is exported.

While Australia is presently able to comfortably market its crop it will face very strong competition in the future. The US is the largest exporter and the *USDA Agricultural Projections to 2020* Report predicts that the US share of the export market may decline slightly by the year 2020. India which is presently the second largest exporter is expected to increase production and exports due to increasing yields with the adoption of Bt cotton. Brazil is a rapidly rising competitor and is likely to double its exports as its cotton growing area expands. It has been predicted that it will soon surpass India and Australia to become the second largest exporter of cotton. Sub-Saharan African exports are also projected to increase by about 60 per cent in the next decade due to their improving economies and the adoption of Bt cotton (USDA 2011).

Table 2: Cotton production of six largest producers (Millions of 480 lb. bales)

	2007/08	2008/09	2009/10	2010/11	2011/12 May (est.)
China	37.0	36.7	32.0	30.5	33.5
India	24.0	22.6	23.8	26.4	26.5
United States	19.2	12.8	12.2	18.1	15.6
Pakistan	8.6	8.7	9.6	8.8	10.6
Brazil	7.4	5.5	5.5	9.0	9.1
Australia	0.6	1.5	1.8	4.2	4.7

Source: USDA via <http://www.cottoninc.com/MarketInformation/MonthlyEconomicLetter/>

Table 3: Cotton consumption of world's six largest consumers (Millions of 480 lb. bales)

	2007/08	2008/09	2009/10	2010/11	2011/12 May (est.)
China	51.0	44.0	50.0	46.0	42.0
India	18.6	17.8	19.8	21.1	19.5
Pakistan	12.0	11.3	10.8	10.0	10.0
Turkey	6.2	5.1	5.8	5.6	5.3
Brazil	4.6	4.2	4.4	4.3	4.0
United States	4.6	3.5	3.6	3.9	3.2

Source: USDA via <http://www.cottoninc.com/MarketInformation/MonthlyEconomicLetter/>

Table 4: Cotton exports of world's six largest suppliers (Millions of 480 lb. bales)

	2007/08	2008/09	2009/10	2010/11	2011/12 May (est.)
United States	13.6	13.3	12.0	14.4	11.4
India	7.5	2.4	6.6	5.4	9.5
Australia	1.2	1.2	2.1	2.5	3.9
Brazil	2.2	2.7	2.0	2.0	4.5
Uzbekistan	4.2	3.0	3.8	2.7	2.5
EU-27	1.6	1.0	1.1	1.0	1.3

Source: USDA via <http://www.cottoninc.com/MarketInformation/MonthlyEconomicLetter/>

Table 5: Cotton imports of world's six largest buyers (Millions of 480 lb. bales)

	2007/08	2008/09	2009/10	2010/11	2011/12 May
China	11.5	7.0	10.9	12.0	21.5
Bangladesh	3.6	3.8	3.9	3.7	3.2
Turkey	3.3	2.9	4.4	3.4	2.3
Indonesia	2.6	2.3	2.2	2.1	2.0
Vietnam	1.2	1.3	1.7	1.6	1.5
Thailand	1.9	1.6	1.8	1.8	1.3

Source: USDA via <http://www.cottoninc.com/MarketInformation/MonthlyEconomicLetter/>

Global challenges to cotton production

The world textile market is highly competitive and all exporting countries need to ensure that cotton remains a preferred textile in the face of competition from an innovative synthetic fibre industry. Future challenges for cotton production worldwide include land and water availability, rising costs of inputs such as fuel and fertilisers, managing the risks of insect and weed resistance to pesticides, and dealing with emerging issues such as climate change and carbon-dioxide emissions.

International studies have shown a correlation between environmental best practice and market positioning. For example, a study of the Organisation for Economic Cooperation and Development (OECD) found a positive relationship between “*companies’ socially responsible conduct and financial performance*” (OECD 2008). Similarly Khan (2006) found a higher demand for products that are grown and nurtured in ways that do not damage the environment. The author found that environmentally-friendly products have greater opportunities to be ‘*rewarded through price premiums and increased market access*’.

Khan cited international case studies where environmental compliance has led to increased earnings through market access. For example after Century Textiles of Bombay gained Oeko-tex certification for its products it not only increased its market access by 10 per cent, but was also able to raise its market prices due to its new reputation for compliant behaviour (Khan 2006).

As noted earlier in this report factors which reduce production inputs in cotton growing are also environmentally friendly. The growing of transgenic cotton varieties in the world has reduced pesticide use and its environmental impacts (Morgan 2004). In the US, India and Australia where Bt cotton varieties have been grown for the longest periods, the amounts of pesticides used are very much lower than in the past (De Blecout 2010). For Australia the industry reports that the introduction of best practice in chemical management has led to a 90 per cent decrease in overall chemical usage (Cotton Australia 2012).

Similarly China’s hazardous pesticide use has also decreased due to greater Bt cotton plantings, reducing pesticide use from 10 kg a.i./ha to 2-3 kg a.i./ha. In China this is a very significant result because previous hazardous pesticides were used in ways that were not only detrimental to the environment, but also to the health of farmers who manually sprayed chemicals without protective clothing and equipment (Huang 2003).

Other cotton producing nations such as Brazil, Sub-Saharan Africa and Eastern Europe are following suit and giving greater emphasis to environmental stewardship in agriculture and increased funding of environmental research.

While Australia has a good reputation internationally because of the high quality of its cotton and its innovative nature in adopting new technologies and practices, its competitive edge cannot be assured without ongoing effort and investment. Water availability, input cost increases and risk management of insect and weed resistance will challenge the industry into the future.

Section 3: Innovation in cotton growing

3.1 Introduction

Since 2003 there have been many innovations in cotton growing and significant advances through new technology, knowledge and practice change. Some of these advances have come from technological innovation such as the introduction of transgenic insect and herbicide resistant cotton varieties, and the recent introduction of the self –propelled picker and round baler. Others have come from engagement with changes in the national policy agenda and government programs operating at national, state and regional levels. Of particular note is the industry's investment in research, development and extension activities (RD&E) through the Cotton Research and Development Corporation (CRDC), the Cotton Catchment Communities Cooperative Research Centre and Cotton Australia the growing sector's peak industry body.

3.2 Research, development and extension

The Australian cotton industry is inherently an innovative industry in terms of its commitment to research, development and extension (RD&E) as a pathway to its advancement and prosperity. The industry's investments are made within the context of an Australian Government legislative, policy and funding framework for rural research and development (R&D). The enactment of the *Primary Industries and Energy Research and Development Act 1989* (PIERD Act) has provided a stable institutional platform over the past 23 years for the industry to invest in RD&E. The Act provided for the establishment of the Cotton Research and Development Corporation (CRDC), the collection of compulsory levies to fund industry R&D and the provision of Australian Government funding for industry R&D. The Government matches industry research levies dollar for dollar up to 0.5 per cent of the gross value of production of the cotton crop.

The PIERD Act requires CRDC to produce a five-yearly strategic RD&E plan and to report to the cotton industry through Cotton Australia. This is a two-way process whereby Cotton Australia provides advice to CRDC on RD&E via its grower panels and CRDC reports annually Cotton Australia on the performance of its functions.

Cotton research funding through CRDC must comply with the objectives of the PIERD Act which are:

- Increasing the economic, environmental or social benefits to members of primary industries and to the community in general by improving the production, processing, storage, transport or marketing of the products of primary industries.
- Achieving the sustainable use and sustainable management of natural resources.
- Making more effective use of the resources and skills available in the community in general, and in the scientific community.

The industry's RD&E needs to be consistent with the Australian Government's National Research Priorities, one of which is an 'An environmentally sustainable Australia'. The Government also specifies priorities for rural research and development including natural resource management,

climate variability and climate change and biosecurity along with several others. In addition as an Australian Government statutory authority and the industry's vehicle for RD&E investments funded by grower levies and Australian Government funding CRDC must comply with the Rural Research and Development Policy Statement (July 2012). This policy includes a set of principles to guide the activities of the rural research and development corporations. The policy statement is seeking increase transparency and accountability in the research and development corporation model. Of particular significance to CRDC and grower levy payers, the Corporation will need to commission independent performance reviews that assess outcomes achieved and the implementation of an extension plan that results in the uptake of research by levy payers.

CRDC's strategic research and development plans and Cotton Australia's research advice have given priority to the sustainability of the cotton industry. The CRDC's *Strategic Research and Development Plan, 2003-08* listed the sustainability of the natural resource base as one of the three research and development outputs to be pursued. It also introduced a new strategy for Integrated Natural Resource Management to strengthen environmental links throughout the production process and enable better environmental outcomes. The Plan addressed key environmental issues such as water, salinity and biodiversity, and recognised the need to integrate the management of cotton farms into the wider effort to maintain the environmental health of catchments.

The *Strategic R&D Plan 2008-13* has brought together the importance of productivity growth, stewardship of natural resources and protection against biosecurity threats under a goal of producing cotton in a highly productive farming system with improved environmental performance.

The Plan identifies connections between improved productivity, natural resource management and addressing climate change. It gives emphasis to the market and the need to remain globally competitive. It also seeks to establish cotton growing as a valued enterprise in the Australian farming landscape. The Plan identifies the emerging issues of increasing competition for resources of land, water, food, energy and labour. These factors led to CRDC articulating the purpose of future R&D priorities as a 'quest for sustainable competitive advantage'.

Cooperative Research Centres

Australian Government research and science policy has also supported the cotton industry's research capacity through the Cooperative Research Centre program. Three cotton CRCs were approved and implemented:

- The Sustainable Cotton Production CRC – 1994 to 1999;
- The Australian Cotton CRC – 1999 to 2005; and
- The Cotton Catchment Communities CRC – 2005 to 2012.

The Cotton Catchment Communities Cooperative Research Centre (CRC) closed on 30 June 2012 after a life of seven years. It became a key research, development and extension (RD&E) provider the industry with research covering cotton farms, cotton catchments and cotton communities. It was multi-partnered with 11 core participants 36 affiliate partners. These participants gave the CRC local, regional and national perspectives across the broad range of research fields.

The Cotton Catchment Communities CRC funded projects in five programs of relevance to the cotton industry. Of relevance to this study is Program 2 which was concerned with best practice cotton enterprises delivering sustainable ecosystems and reduced impacts on catchments. Investments provided research on: river health and ecological responses to flow variability; riparian health indicators; benchmarking current groundwater conditions in cotton catchments; establishing baselines for on-farm water quality; developing best practice techniques and guidelines to enable industry and catchment bodies to better assess, manage and monitor biodiversity and ecosystem services in cotton catchments; and developing a set of farm and catchment information resources and tools that are consistent with good science, best practice, practical adoption and catchment goals.

The CRC has compiled a legacy report on its achievements over its life: *Weaving a future for Australia's cotton, catchments and communities: Seven years of cooperative research*, 2012 that describes the achievements and outcomes over its life.

PISC Cotton Sector RD&E Strategy

In 2011–12 a Primary Industries Standing Committee (PISC) Cotton Sector RD&E Strategy was implemented under the National Primary Industries RD&E Framework. PISC is the Primary Industries Standing Committee which is an intergovernmental committee of officials that sits under the Primary Industries Ministerial Council.

The PISC Cotton Sector RD&E Strategy is seen by the Government as a platform for fostering ongoing industry research collaboration following the closure of the Cotton CRC. The Strategy identifies five goals: better plant varieties; improved farming systems; people, businesses and communities; product and market development; and development and delivery. A Cotton Innovation Network has been formed with responsibility for the strategic oversight, coordination and communication of the five goals. The network aims to improve cotton RD&E through prioritisation and enhanced collaboration on four interdependent functions: strategy and investment, R&D, capability management, and development and delivery.

Both the better plant varieties and improved farming systems goals relate to production sustainability with the latter focussing on water use efficiency; natural resource management; and systems integration at crop, farm and catchment scales. The Strategy notes that 'improved farming systems have the potential to improve the productivity and profitability of cotton, as well as minimising environmental impact and enhancing the natural resource base'.

Grower resources for improved production and environmental practices

As a result of the extensive RD&E investments of the industry cotton growers now have access to information on best management practices relating to all aspects of cotton growing. The information resources currently available to cotton growers are listed in the bibliography for this report. This is a key resource for the industry that is not only valuable to growers, but provides assurance to government policy makers and other industry stakeholders that the industry is extending the results of R&D. Extension plans are a key requirement of the Australian Government's *Rural Research and Development Policy Statement* (2012).

Cotton Australia is a key information provider to growers through its website. This includes information about participation in myBMP, work health and safety in the industry, environmental

stewardship, biosecurity and transport regulations amongst a broad range of topics. Cotton Australia plays a key role in supporting growers achieve best management practice through the myBMP program and also the effective management of technologies that support cotton production. The commercial sector also plays a vital role in providing the latest information to growers.

3.3 Best Management Practices (BMP) program

The first iteration of the program, known as BMP, was introduced in 1997 in response to concerns about the environmental impacts of pesticide use on riverine health. The program was based on research funded by Land and Water Resources Research and Development Corporation, Cotton Research and Development Corporation and the Murray-Darling Basin Commission.

The purpose of BMP was to improve cotton growing practices and reduce the impact of cotton growing on the environment. This was necessary to address government and community concerns. It covered on-farm chemical management, the storage and handling of pesticides and petrochemicals, integrated pest management, and land and water management. The process set out in the BMP manual was for growers to work through each BMP module, identify areas of risk and implement action plans for improvements to be made. BMP was delivered to growers through Cotton Australia's regional staff, extension staff and cotton consultants. It also had a voluntary audit program whereby farms could elect to have their farm audited for compliance with BMP.

The industry reported that by 1999 around 3,000 stakeholders including most cotton growers had been introduced to BMP through workshops run by the peak industry body (then the Australian Cotton Foundation). Reference was made to an industry survey that found 64 per cent of cotton growers had made changes to their farming practices as a result of BMP and that 96 per cent saw BMP as essential to cotton's long term viability. The Agriculture and Food Policy Reference Group that reported to the Minister for Agriculture, Fisheries and Forestry stated in a 2006 report that *'the industry had embraced the BMP program to the extent that about 60 per cent of Australian cotton was being grown on BMP-accredited farms.'*

The Second Environmental Audit examined the role of BMP program and found that it was a *'driving factor for the improved environmental management observed on cotton farms'* since the First Environmental Audit in 1991. It made two recommendations relating to BMP as shown in Table 6.

Table 6: Rating of adoption of the Second Environmental Audit recommendations

Second Environmental Audit recommendations	Third Environmental Assessment: Rating of industry adoption
It is recommended that Cotton Australia continue to encourage cotton growers to adopt the BMP system	High
A target should be set by the cotton industry to have most irrigated growers undertaking the initial BMP audit (changed to Pre-Certification Assessment) by the end of year 2004.	Low

In November 2003 the Australian Cotton Foundation (now Cotton Australia) set a target of: '*At least 80 per cent of growers to formally participate in Best Management Practices (BMP) program by either a Pre-Certification Assessment or Certification Audit by 30 March 2006*'.

The industry reported that in 2002, 33 per cent of cotton growers were certified BMP compliant and this rose to 46 per cent in 2006. However by 2008 this had fallen to 12 per cent. The fall is attributed to the drought and the need at that time to update the program with more contemporary issues given much of the early focus was on pesticides.

The industry has quoted independent reviews that have found at least 85 per cent of cotton growers have changed their practices as a result of the BMP Program. It also considers that achievements of the BMP program were monitored in a variety of ways including:

- surveys of growers;
- surveys of BMP audits;
- the Second Australian Cotton Industry Environmental Audit (GHD 2003); and
- reviews of the BMP Program (Macarthur Agribusiness in 2003 and Hassall & Associates in 2006).

Cotton Australia's 2007-08 Annual Report lists the achievements of the BMP program in 2008 as:

- 10 consultants and 14 growers had participated in BMP water use efficiency training;
- 69 properties in the Namoi Valley were provided sophisticated farm maps and 22 properties were provided with groundwater monitoring data;
- BMP objectives were mapped against the nine local regional natural resource management bodies' organisational catchment target;
- increased effort to link cotton and grain BMPs; and
- BMP certification as an alternative pathway to develop a statutory Land and Water Management Plan enshrined in the Queensland Water Act.

Following the Second Environmental Audit there were several reviews to assess the effectiveness of the program. A range of insights were gathered from each of these reviews providing relevant information on the benefits and shortcomings of the program. Surveys found that the BMP Manual provided excellent information and tools for comprehensive and methodical evaluations of environmental practices and the implementation of improved plans and strategies. Additionally, the BMP modules were found to be directly linked to improvements in practices on cotton farms.

In 2004 Gunningham provided some insights on the BMP Program in the *Australasian Journal of Natural Resources Law and Policy*. He argued that 'in order to convince sceptical third parties that claimed improvements in performance are genuine, it is crucial that a self-regulatory initiative develop clearly defined targets.' However Gunningham also emphasised the fact that goals must be attainable and economical or else participants will be less likely to adopt the program and make commitments to changing practices.

In 2006 Hassall & Associates conducted a grower and stakeholder review of the BMP program. The review found that growers considered that the water efficiency modules were the most beneficial, especially with the rising costs of water management.

The risk assessment and planning procedures that BMP required were also considered to be useful. BMP was perceived to make 'order out of disorder' and provide a means of demonstrating 'success stories' to the public on cotton farming practices. The program was also seen as providing evidence to potential farm buyers, of 'due diligence' by the owner in the management of the farm and its natural resources.

The key barriers to uptake that the growers outlined in this review were time, cost, low perceived value, and low general uptake by the industry. Even growers that supported the BMP program reported that they still had trouble finding enough benefit to be part of 'doing the right thing'. Other concerns that were expressed were:

- 'BMP may not be a valuable process for negotiation with government or the community if high uptake cannot be reached';
- 'community perceptions may be influenced by the bad press from the few who do the wrong thing.'

Although many growers considered the practices outlined in BMP to be essential farming practices, they understood that many would not see the same benefits and that investment in incentives were necessary for greater uptake.

Stakeholder perceptions were generally positive and supportive of BMP. They found BMP to be a systematic process that it was a great aid to the management of complex farming challenges. However some had problems with the complexity of the system and stated that simplifying the auditing system would make it more popular amongst growers.

The key barriers to uptake that the stakeholders listed were:

- lack of financial drivers to encourage growers to take up BMP;
- lack of market benefit; and
- a lack of knowledge of BMP's importance.

Areas of improvement that emerged in the review were:

- develop clear goals for the program;
- provide regular revision to remove duplication and contradictions;
- 'establish an electronic versions with web server access to spatial data'; and
- provide 'more consistency in the standards and communications applied to the completion of PCAs. (Hassall 2006)

A benchmarking review was conducted in 2006 to analyse the difference in farm characteristics between BMP-accredited growers and non-BMP accredited growers. This study suggested that growers that are BMP accredited are much more likely to measure water use efficiency (WUE) in bales per megalitre, monitor groundwater levels, measure soil sodicity and use soil pits to monitor soil profiles. However the review also showed that 90 per cent of non-BMP accredited growers reported that they followed BMP guidelines regardless of not being accredited.

With regard to native vegetation and wildlife, the review found that BMP-accredited growers were also more likely to: 'plant native vegetation along waterways, provide alternative watering points for stock and monitor feral animal species.'

Regarding educational levels of growers, the review found just over half of accredited growers had finished tertiary studies compared with about a third of non-accredited growers.

BMP accredited growers were found to average significantly higher yields of cotton than non-accredited growers in the previous two seasons to the review. The accredited growers averaged 8.09 bales per ha in 2005-06 compared with 7.35 bales per ha the season before.

The review concluded that cotton growers that are BMP-accredited tend to be understood as 'more serious' cotton growers because of their larger cotton area, greater likelihood to adopt a range of improved cotton management practices, and produced higher yields. They also employed more staff to run larger farming operations and had higher levels of education. This report suggested that BMP accreditation is one way in which growers can maximise the gains from their cotton crop.

Results of a BMP SWOT Analysis undertaken with the review were as follows.

Table 7: Results of a BMP SWOT Analysis

Strengths	Opportunities
<ul style="list-style-type: none"> Public perception – increased credibility Improved farm practices 	<ul style="list-style-type: none"> Make program relevant Deliver the benefits and values to growers Make program more adaptive Raise the focus on water Focus more on practices, rather than the processes and audits
Weaknesses	Threats
<ul style="list-style-type: none"> Program is complex and daunting for growers Seen as difficult, intrusive, not always relevant No direct financial benefit from BMP certification No benefits to individuals No effective measurements of changed farm practices or of adoption other than certification Funding only available to move a ranking from high risk to low risk No government review (just peer reviews) 	<ul style="list-style-type: none"> Loss of credibility through exposure of weaknesses Imposition of regulation Measurement/reporting of the wrong things

myBMP

After the reviews of BMP described above, the program was revamped and brought up to date through the introduction of a web-based program called myBMP in 2008. The new myBMP was co-funded by Cotton Australia, Cotton Research and Development Corporation and the Cotton Catchment Communities CRC. It comprises of 11 modules on best management practices for areas of farm management that growers face. The modules are:

- Biosecurity (covering the avoidance, management and control of pests and diseases);
- Biotechnology (for GM cotton varieties);
- Energy and Input Efficiency (more efficient use of energy inputs such as fuel and fertilisers);
- Fibre Quality (for growing the best quality cotton);
- Human Resources (best management practices for staff and contractors);
- Integrated Pest Management (for weeds, pests and diseases);
- Natural Assets (managing the vegetative and riparian assets on-farm);
- Pesticide Management (for all aspects of pesticide storage and use);
- Petrochemical Storage and Handling (for all aspects of petrochemical storage and use on farm);
- Soil Health (practices for managing for soil health including to sequester soil carbon);
- Water Management (covering water quality, efficiency of storage and distribution as well as both dryland and irrigated farming practices).

The levels of participation in myBMP are initial registration on the website to use the resources in the modules, pre-certification assessment where the grower works through the levels of compliance as shown below and then being audited and achieving myBMP certification.

Auditing and certification under myBMP are voluntary as for the previous BMP. If a grower chooses to be myBMP certified the process involves the following:

- The grower must first register as a grower on the myBMP website.
- After registering the grower will be contacted by the myBMP Audit Office confirming the undertaking to go through the auditing process for myBMP certification.
- Once the request has been received, a list of approved myBMP auditors and their contact details will be sent directly to the grower, who can then proceed to contact one of the approved auditors.
- The selected auditor will then visit and conduct the on-farm audit, which once complete, will be submitted by the auditor back to the myBMP Audit Office.

- The audit office will assess the report and if complete, will finalise, enter the details onto the myBMP system and forward a copy of the final report and a myBMP certificate to the grower.
- This certificate will be current for a period of five years before needing to be renewed.
- The myBMP Audit Office is also required to conduct random audits on 10 per cent of the certified growers each year. These random audits are conducted at no charge to the grower and reset the myBMP audit commencement period to zero.

Each of the 11 modules is audited and graded on cotton farms based on the following four levels of compliance:

- Level 1 – Basic legal requirements relevant to the module;
- Level 2 – Industry identified best practice beyond legal requirements;
- Level 3 – Those practices that may be considered best practice within the next five years;
- Level 4 – Those practices that may be considered best practice within the next 10 years.

Levels 1 and 2 together comprise the content required to complete myBMP accreditation. Levels 3 and 4 are aspirational levels that cover those practices that will be considered best practice in the next 5 and 10 years respectively.

Table 8 outlines data on BMP and myBMP involvement and certifications of cotton farms and growers beginning from the year 2000 through to 2012 as supplied by Cotton Australia. The table illustrates the numbers of farms and growers that were audited, certified, and pre certified under BMP and myBMP each year along with any other involvements in the program.

Table 8: BMP and myBMP certifications and involvements from 2000 to 2012

Year	Farms Audited	Certified	Pre Certified	Involvement	Total participants
2000	100 farms second party audited.				
2001	105 farms audited. 35 second audited.			50% of industry actively involved.	
2002	208 growers booked for audit.	33% of growers.	18% of growers.		
2003-04	156 farms at initial audit stage.	Further 112 farms certified.		60% of crops produced under BMP.	
2004	335 total Farms audited 590 total audits.	84 farms certified.			
2005	218 farms at initial audit stage. 640 total audits.	Further 117 farms certified.		363 farms in BMP process	
2006		Further 118 farms certified.	175 farms		894 farms
2007		Further 104 farms certified.	313		743 farms
2008		102 growers	272 growers	20 QLD growers and 10 NSW growers participating in BMP for first time.	850 growers
2009	Information unavailable				

Year	Farms Audited	Certified	Pre Certified	Involvement	Total participants
2010	Information unavailable				
2011		9 myBMP certified farms and 2 myBMP certified growers Certified myBMP: <ul style="list-style-type: none"> • 3 Businesses • 27 Cotton Gins • 5 Classers 		Involved in myBMP: 180 Growers, 58 Researchers, 16 Certified Advisors, 10 Consultants, 53 Industry (Total – 379) 92 businesses have started assessments 41 have ticked more than 100 practices 21 have started attaching evidence	
2012		8 myBMP certified growers (116 farms under Cotton Australia BMP Extension)			

Other data provided by Cotton Australia shows that 198 growers had completed Level 1 from 2009 to 2012 and 21 had completed Level 2 from 2010 to 2012.

The data for 2011 shows nine myBMP certified farms, two myBMP certified growers and 180 growers involved in myBMP (i.e. registered on the website, started assessments, achieved assessments on more than 100 practices and started attaching evidence). The data for 2012 shows eight myBMP certified growers and 116 farms that had certification under the Cotton Australia's BMP Extension.

Roth (2010) showed that the BMP program had great potential for monitoring long term trends and a high standard legal compliance on farms where the program was adopted. The analysis showed average BMP rankings for certified audited farms between the years 2006 and 2008 to be 24 per cent better than pre-certified audited farms, and evidence that they BMP external audit system correlates with on-farm improvements in environmental practices.

Roth's review found that BMP offers the cotton industry: 'a means to offer traceability, sustainable production practices and high quality cotton in the world textile market.'

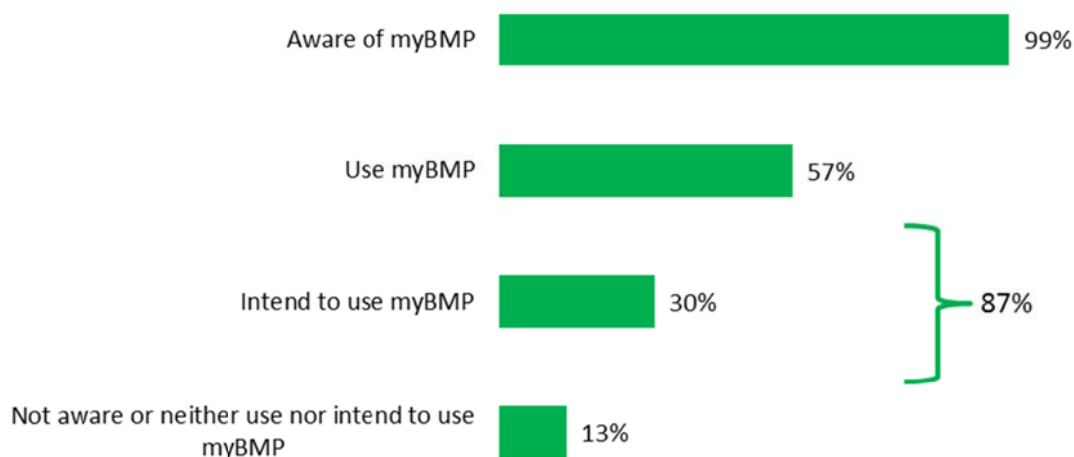
In the 2010-11 NRM Survey (Women in Cotton 2011) (Wincott)'s, many of the insights from previous reviews resurfaced. In that study 70 per cent of survey respondents found the environmental aspects of the myBMP program to be beneficial to extremely beneficial. In terms of adopting the program, those surveyed cited four core factors that would encourage further uptake including: anonymity, previous uptake of practices within BMP, unique qualities that differ from best practice programs in other industries, and myBMP's relationship to natural and introduced pastures and livestock.

However myBMP yielded different opinions from those who were surveyed with 33 per cent of respondents who were not aware of myBMP and about two thirds who expressed no interest of learning more about myBMP. The survey respondents acknowledged the benefits of myBMP, with one respondent commenting that myBMP should become 'more than just a grower-friendly tool.' Focus group held in association with the survey showed participants believing that greater customer demands, acknowledgements of farm accreditations, international recognition and dissemination of information regarding myBMP would create more of a reason for growers to sign up for myBMP.

Cotton Grower Environmental Performance Survey 2012

As shown in Figure 3 the myBMP name in this survey is almost universally recognised by growers (99 per cent of those surveyed). Just over half of the growers report using the myBMP website (57 per cent) and another 30 per cent state that they intend to do so in future. However 13 per cent of those surveyed state that they are not aware of myBMP or do not intend to use the website.

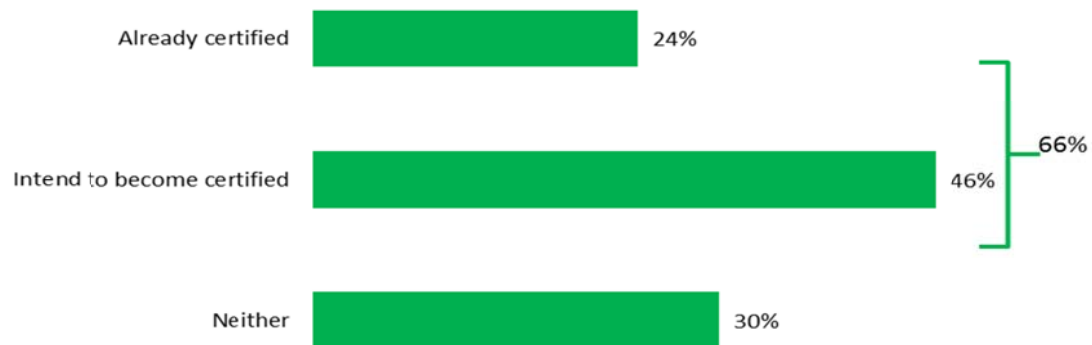
Figure 3: Cotton growers' awareness and use of myBMP



Source: Cotton Grower Environmental Performance Survey 2012

While myBMP records show only a limited number of growers with certification, 24 per cent of those surveyed state that they are certified under myBMP. This may indicate uncertainty of what constitutes certification. Another 46 per cent of the survey respondents indicate an intention to gain certification.

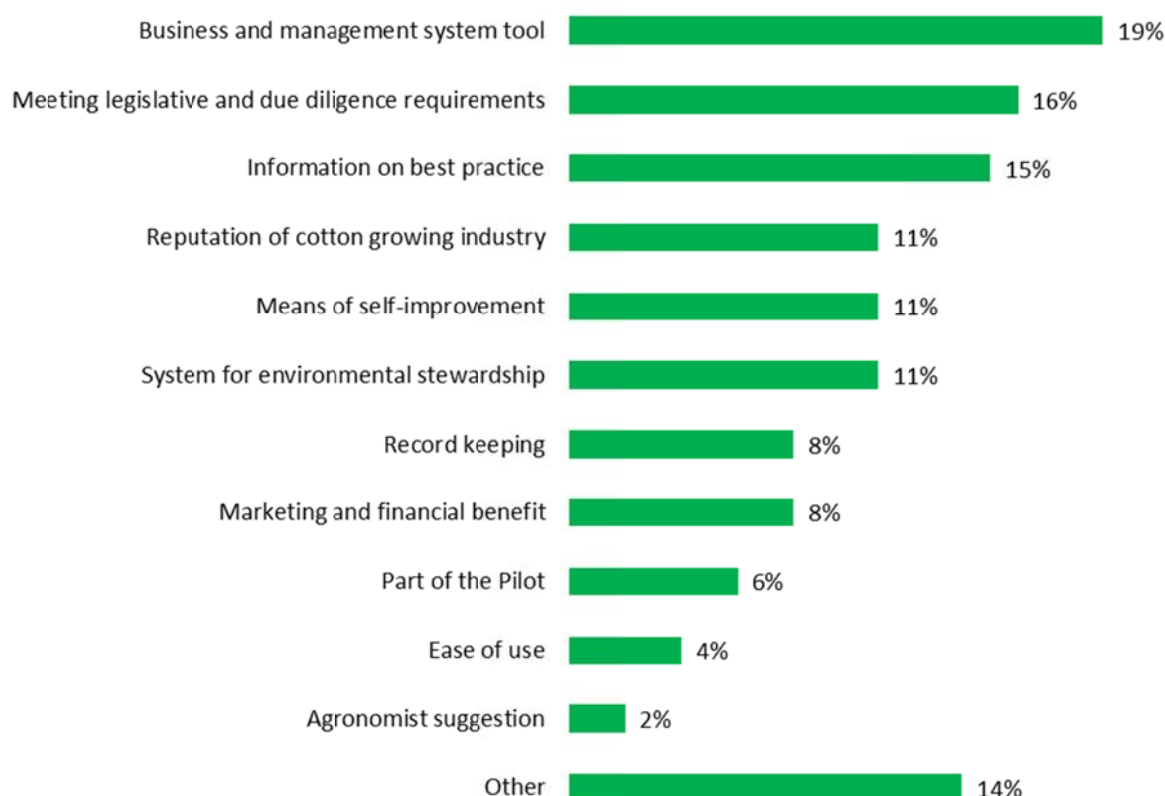
Figure 4: myBMP certification



Source: Cotton Grower Environmental Performance Survey 2012

The growers who are using myBMP and considered that they had gained certification or were intending to become certified identified a range of perceived benefits as shown in Figure 5.

Figure 5: Attractions to using myBMP

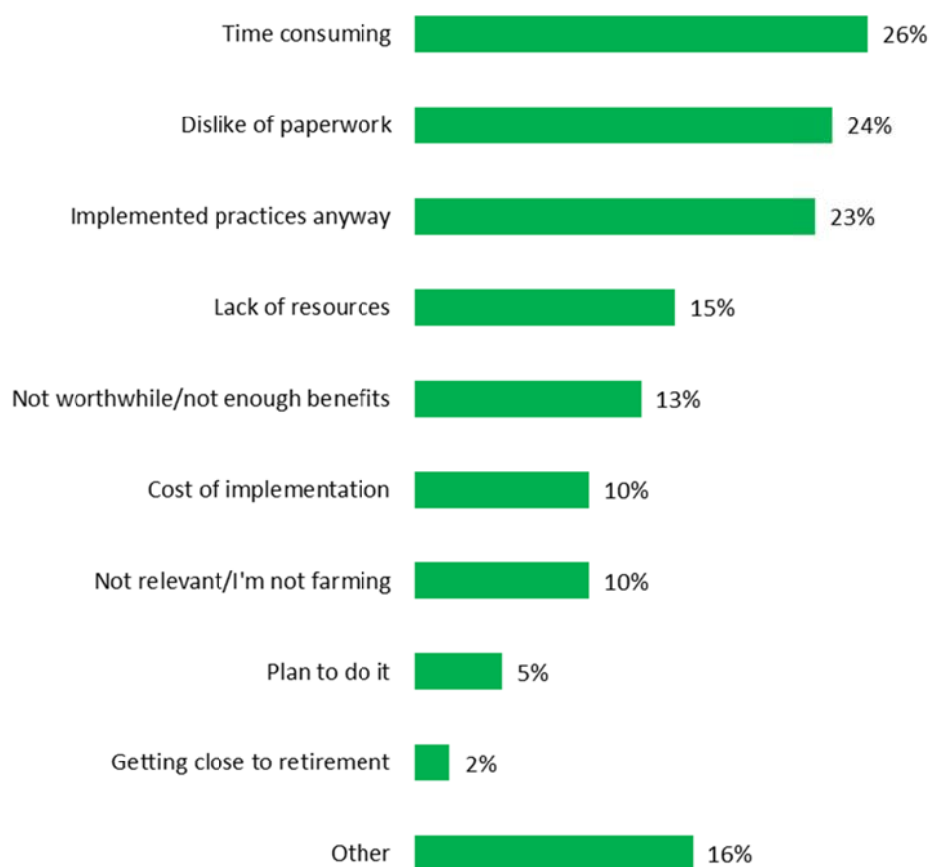


Source: Cotton Grower Environmental Performance Survey 2012

Some growers state that myBMP supported better management of their cotton growing as a business or provided essential information on best practice. Others nominate its benefit as showing compliance with environmental regulations, while others saw the benefits in terms of improved industry acceptance and reputation in the wider community.

The growers who do not use myBMP state that the barriers to using myBMP included: a dislike of paperwork or believing there was too much paperwork involved; certification requiring excessive time and effort, certification being too costly or growers lacking resources to complete the process; and perceptions of a lack of value for money or benefits that meet the opportunity cost of completing the process. Amongst the growers with negative views of myBMP, greater support in using the program and greater ease of adoption are considered necessary for the program to achieve higher numbers of growers gaining certification.

Figure 6: Barriers to using myBMP



Source: Cotton Grower Environmental Performance Survey 2012

The majority of cotton industry stakeholders who responded to the online survey considered myBMP to be an efficient and appropriate tool for the industry to use in order to identify and assess best environmental practice. One stakeholder stated that:

'myBMP has made significant environmental and productivity improvements to the cotton industry. Its uptake should be seen as a good example of how an industry can be proactive concerning its viability and environmental footprint. Continuous improvement through myBMP is essential.'

The benefits of myBMP that were identified by stakeholders included: reduced pesticide use because of myBMP and improvements in riparian areas and care of native vegetation. Some industry stakeholders also considered that myBMP provides a 'social licence' to farm and it provides a good reference point when policy makers are addressing the environmental impacts of the industry.

'MyBMP provides the statistics and information that people look for when assessing the environmental compliance of the cotton industry and provides proof that the industry is working to improve its practices to benefit the environment.'

Although the general consensus amongst stakeholders is that myBMP is a positive factor for the cotton industry, a government respondent to the survey voiced a concern that:

‘Most cotton producers are engaged in myBMP for the minimum regulatory or legal aspects in general and that although certifications are increasing, the industry opinion on the value of myBMP is still questionable.’

On the positive side, a cotton researcher commented that:

‘The cotton industry should be proud and promote itself more in the leadership it has provided Australian agriculture in research. BMP evolved from community concern over environmental mishaps and the industry should not forget (nor should let the wider community forget) that it has come a long way, but not lay idle or believe that it can't make further improvements. Whilst environmental issues are still to the fore, I don't think the same incremental changes are being made as they were by a couple of lead growers at the beginning, i.e. in the late 80s early 1990s.’

Another industry stakeholder commented that:

‘More needs to be done to create a “myBMP FIRST” culture in the industry. Normalising BMP instead of creating something special that is perceived to be out-of-reach to the average grower is a key issue for the industry leadership. This applies to the whole supply chain...’

3.4 Monitoring and reporting environmental performance

The Australian cotton industry has been formally monitoring and assessing the environmental impact of cotton growing for over 21 years commencing in 1991. This Third Environmental Assessment represents the continuation of this long standing commitment of the industry to systematically review its performance and identify and act on environmental issues. In this respect the industry is unique in Australian agriculture in taking such a strategic and sustained approach to analyse and invest in improving environmental outcomes.

The industry's response to the Second Environmental Audit

The industry's response *Taking Responsibility for our Future, 2005* prepared by Cotton Australian and the Cotton Research and Development Corporation outlined actions the industry had taken regarding the recommendations of the Second Environmental Audit. This was updated in 2012 (*Taking Responsibility for our Future, 2012*). These documents have been assessed along with other data sources such as the *Cotton Grower Environmental Performance Survey 2012* and a rating of the industry's adoption of the recommendations determined.

Table 9: Rating of adoption of the Second Environmental Audit recommendations

Second Environmental Audit recommendations	Third Environmental Assessment: Rating of industry action
Organise for an independent cotton industry audit to be conducted more regularly, say at least every 5 years.	Medium
Conduct the audit over an extended time period (the full season from planting to harvesting to processing), to ensure that all activities are observed by the audit team.	Medium
Determine the most appropriate environmental performance indicators for routine monitoring and reporting, for the cotton industry and individual cotton farms. Indicators should include water and pesticide management indicators as these are the primary areas of concern of stakeholders.	Low
Publish a regular environmental performance report for cotton farms, with results validated by an external expert.	Low

It is noted that the Third Environmental Assessment was conducted almost nine years after the Second Environmental Audit reported in 2003. The Australian Cotton Industry Council discussed the feasibility of conducting a third environmental audit in 2007. At that time drought had reduced production and available R&D funds. With the return to good seasons in 2009-10, the industry decided on the next environmental audit which was finally commissioned in January 2012.

The Second Environmental Audit recommended that the next audit be conducted over the full cotton season (planting to ginning). The Third Environmental Assessment was conducted between January and June 2012 which corresponded to most of the growing season and cotton picking.

The Second Environmental Audit recommended that environmental performance indicators be determined for routine monitoring and reporting. The Audit also recommended that a regular environmental performance report on cotton farms be prepared and validated by an external expert.

Cotton Research and Development Corporation and Cotton Australia report that a large number of research projects have been concerned with environmental performance and they cite many papers that contain environmental performance data such as Pyke and Roth (2010), *Sustainability reporting of the Australian cotton against world cotton producers. Proceedings of the 15th Australian Cotton Conference*, Broadbeach, Queensland in August 2010.

Roth (2010) listed 85 economic, environmental and social sustainability indicators. In addition the industry reports that it held discussions with the regional catchment bodies so that indicators are aligned with regional and jurisdictional needs.

While Cotton Australia and Cotton Research and Development Corporation produce formal annual reports, there is no specific and regular industry report on environmental performance with independent validation. An annual production survey is conducted that collects some environmental performance data. However Cotton Australia advise that it will seek to clarify and agree on

environmental performance indicators and establish a way for these results to be communicated through appropriate publications.

Some issues are apparent from the examination of the industry's reporting on its actions. The industry responses do not clearly distinguish 'effort' from 'outcomes'. A more rigorous approach that could be adopted in future is to show strategic goals (intentions), investment plans (a reflection of the priority and commitment), the action plan (delivery goals and timelines), the subsequent research plans (targeted knowledge acquisition), adoption programs (education and training), development of new tools (capacity building), and outcomes at each relevant level of the improvement program.

In addition the industry responses provided in both 2005 and 2012 do not include any risk assessment in relation to the recommendations. This should be another feature of monitoring and reporting – specifically risks associated with compliance or non-compliance. It is necessary for the industry to assess whether such risks have been averted or mitigated by the action taken.

Throughout the recommendations of the Second Environmental Audit there is frequent use of the word 'encourage' in relation to farmer participation and action. In future reporting where this terminology is used, information is needed on what action is required to 'encourage' farmers (e.g. incentives, opportunities, requirements, and penalties) and the results of those actions.

Future reporting on environmental performance needs to:

- adopt an evidence-based approach to reporting with key performance metric use;
- use harmonised terminology to improve measurement, increase transparency and provide greater ease of use; and
- involve risk assessment regarding performance to show major threats and how these can be mitigated.

The industry has not been able to settle on a workable set of performance indicators that can guide the preparation of environmental performance reports. A solution to this issue would be to develop a soundly based monitoring, evaluation and reporting framework that will provide the basis for monitoring, data collection, analysis and reporting.

Conclusions and recommendations

Research, Development and Extension (RD&E)

The key recommendations of the Second Environmental Audit have been incorporated in the industry's R&D agenda over the past decade and in its extension and information resources. This has been a collaborative effort through Cotton Australia, Cotton Research and Development Corporation and the Cotton Catchment Communities Cooperative Research Centre (CRC). As a result growers have ready access to information on best practices through myBMP, industry reports and through the referral service provided by Cotton Australia's regional staff.

The future presents some major challenges. The operating environment for the industry is becoming increasingly complex and demanding as discussed previously in this report and this has important implications for how industry faces its environmental management challenges.

Cotton Research and Development Corporation's (CRDC) *Strategic R&D Plan 2008-13* concludes on 30 June and the industry is commencing work on a new five-year R&D Plan. The industry's next Strategic R&D Plan will need to be developed without a Cooperative Research Centre as a key RD&E provider for the industry – the first time in 18 years. This places greater responsibility on CRDC for the delivery of the industry's RD&E agenda which has been heightened by greater transparency and accountability requirements from Government.

In addition the Australian Government's recently released *Rural Research and Development Policy Statement* (Australian Government, July 2012) will require greater transparency and accountability by the CRDC in terms of achieving outcomes from RD&E investments.

Recommendation:

It is recommended that Cotton Research and Development Corporation 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 rationale of the environmental RD&E strategy is to develop a strategic and risk management approach to environmental management and performance that will meet emerging market requirements, the commercial and practical needs of growers, public policy requirements and the broader expectations of the Australian community on environmental stewardship in agriculture. The strategy should outline intended pathways for the uptake of R&D by growers and establish key performance metrics to measure outcomes. It is acknowledged that the environmental RD&E strategy would be integrated into the industry's existing planning framework and plans particularly the next strategic R&D plan of the Cotton Research and Development Corporation (i.e. for 2013-2018).

Recommendation:

It is recommended that Cotton Research and Development Corporation 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.

The rationale for this recommendation is that the present databases of growers and key industry stakeholders are inadequate for effective engagement on priority industry issues. This was apparent during this study when samples were established for the surveys of growers and stakeholders respectively. In addition, the more favourable production conditions over the past two seasons has seen many new growers enter the industry without previous experience. These growers need to be targeted in extension activities to ensure that they adopt best management practices. The need for accurate and usable databases is reinforced by the requirement of the Rural Research and Development Policy Statement (Australian Government, July 2012) for CRDC to prepare an extension plan that incorporates adoption pathways and strategies for improving the uptake of R&D.

myBMP

BMP and its successor myBMP have been successful as the industry's main vehicle for transforming research and development outputs into guidelines and tools for growers to achieve best management practices and enhance their businesses and environmental performance. myBMP which is a web-based system is a sophisticated and robust system to provide information to grower and for them to self-assess their compliance with best practices or take the further step of being audited and achieving certification.

However there has been a systemic difficulty in achieving or maintaining high levels of grower participation. Following the Second Environmental Audit, Cotton Australia set a target in November 2003 of: *'At least 80 per cent of growers to formally participate in Best Management Practices (BMP) program by either a Pre-Certification Assessment or Certification Audit by 30 March 2006'*. Cotton Australia reported that 46 per cent in cotton growers were certified BMP compliant in 2006, but this dropped to 12 per cent in 2008.

myBMP data provided by Cotton Australia to this Third Environmental Assessment shows 198 growers having completed Level 1 of the program (met basic legal requirements relevant to each module) between 2009 and 2012 and 21 growers having completed level 2 (met industry identified best practice beyond legal requirements) between 2010 and 2012.

No data was provided on the number of farms audited and certified in 2009 and 2010. For 2011 the data is nine myBMP certified farms and two certified growers and for 2012 the data provided is eight certified grower and 116 farms certified under a Cotton Australia extension of BMP certification.

Monitoring and reporting on grower participation uptake and particularly grower certification has been limited. This can greatly disadvantage the myBMP Program because it limits the analysis of the program's progress. Observing trends over time in terms of uptake and certification provides critical data on the type of growers and farms getting involved, along with what time periods showed greatest adoption.

The program's purpose and objectives lack clarity and particularly in relation to certification are confusing. There is also no clearly defined marketing strategy based on market research, practical and realistic implementation strategy and monitoring framework that records and reports grower participation at its various levels particularly registration, use of information, pre-certification assessment, auditing and certification. Without substantial numbers of growers gaining certification, BMP and now myBMP has not been able to achieve its intended status as the industry's system for objective assessment of on-farm environmental practices.

Recommendation

It is recommended 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.

The rationale for this recommendation is that myBMP needs to be re-appraised to clarify the present confusion in its overall purpose, objectives and value to growers. Of particular importance is the clarification of the objectives of grower certification under the program. The re-appraisal

also needs to address how myBMP can deliver results to the industry from a consideration of what consumers, retailers, the community and governments are demanding in terms of the sustainability of cotton growing. From the reappraisal, a marketing and implementation strategy needs to be developed to more effectively market the benefits of myBMP to growers and to re-invigorate the program to meet its objectives. In addition performance metrics need to be specified to measure outcomes. This should include accounting for the numbers of growers (or farm businesses) who are participating and the level of their participation.

Monitoring, evaluation and reporting

Having a history of independent reviews of its environmental performance represents a significant achievement for the Australian cotton industry and builds baseline information and data sets that make ongoing assessments more meaningful. This information should be actively communicated to stakeholders.

This report finds that there are a number of lessons deriving from the industry's past experience in reporting on environmental performance that could improve future reporting such as annual reports. These improvements include specific evidence based reporting undertaken on the basis of a clear monitoring, evaluation and reporting framework, using consistent performance terminology and metrics, and undertaking risk management for poor performance or non-compliance with best practice.

The industry has put a lot of effort into researching sustainability indicators, but it has not reached a position on a workable set of metrics that can be used and meet the demands of target audiences.

Recommendation:

It is recommended 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 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.

The rationale for this recommendation is that the industry has a 21 year history of independent environmental assessments and is unique amongst Australian agricultural industries in documenting performance information and assessments over such a long period. With increasing demands for evidence-based performance reports from markets, governments and the community, the industry should continue to build on this record. While the annual reports of the Cotton Research and Development Corporation and Cotton Australia report on achievements, these and other environmental reports from the industry could be improved by establishing a monitoring, evaluation and reporting framework that includes a practical number of environmental metrics.

Section 4: On-farm environmental performance

4.1 Introduction

The Second Environmental Audit presented findings relating to cotton growing under 18 subject headings with 37 specific recommendations. These covered various issues of water, chemical, land and energy management. This section of the report analyses industry action regarding those recommendations, the views of growers and stakeholders of improvements in environmental practices since the Second Environmental Audit and their views of priority environmental issues for the future. It also covers growers' intentions regarding their farm plans for further reducing the environmental impact of cotton growing.

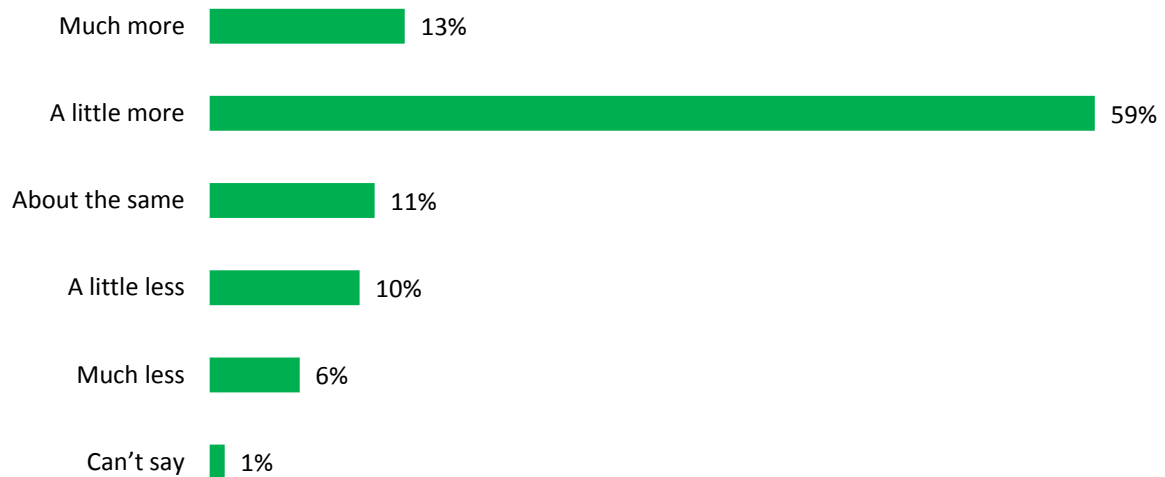
4.2 Perceptions of grower and stakeholders towards environmental performance

The two surveys conducted for the Third Environmental Assessment provide quantitative and qualitative information on the perceptions of growers and cotton industry stakeholders of the environmental performance of cotton growing during the study period of 2003 to 2012.

It is important to note that cotton growers generally produce other crops in rotation with cotton and many also farm cattle and sheep. Therefore from the perspective of many growers cotton is one crop in a multi-enterprise production system. In the *Cotton Grower Environmental Performance Survey 2012*, cotton growers were asked about the relative environmental impact of growing cotton compared with other forms of agricultural production on their farms.

Figure 6 shows that most growers consider that the impact of cotton growing is greater than the impact of other forms of production they are involved in (72 per cent). Only one in five growers believe that the impact of cotton growing is less than from other forms of production (21 per cent). Most, however, consider that its impact on the environment is only a little more than other crops grown on the farm. The farms visited confirmed this with growers stating that over the past decade the impact of cotton growing had been drastically reduced relative to other agricultural pursuits.

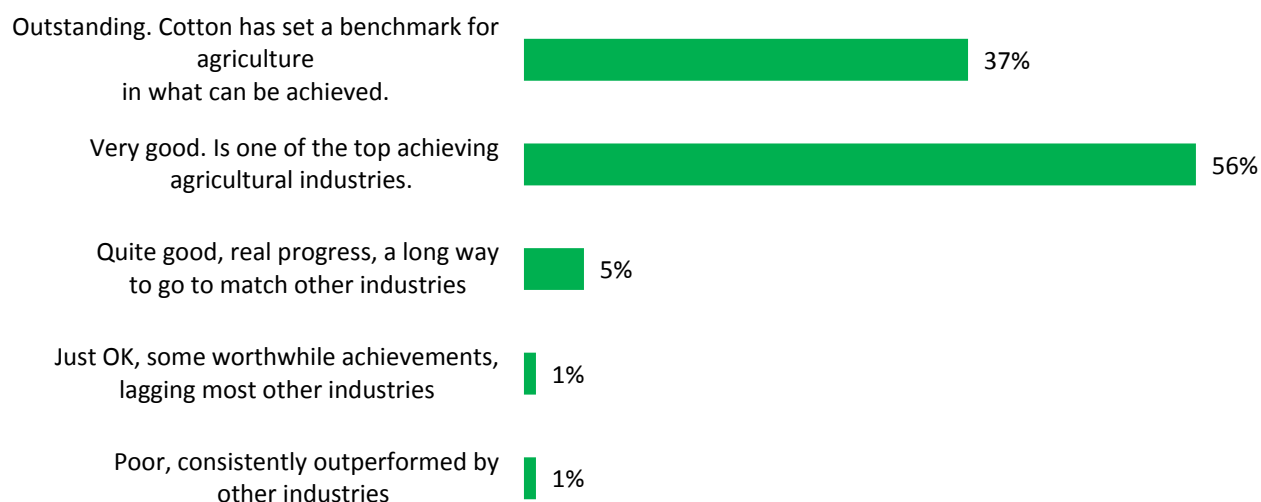
Figure 7: Cotton growers' perceptions of the impact of cotton growing on the environment compared with other crops grown



Source: Cotton Grower Environmental Performance Survey 2012

When asked to rate the performance of the cotton growing industry in reducing its environmental impact compared to other agricultural industries most indicate this is outstanding or very good (93 per cent) as shown in Figure 8.

Figure 8: Ratings of cotton industry performance in reducing environmental impacts

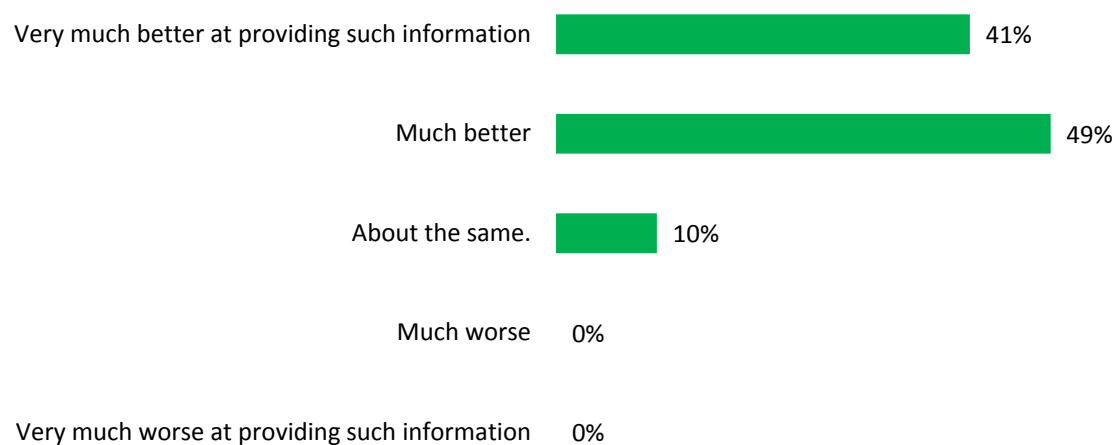


Source: Cotton Grower Environmental Performance Survey 2012

The Cotton Industry Stakeholders' Environmental Performance Survey 2012 shows the majority of respondents agree with growers that the performance of the industry is very good to outstanding relative to other industries. This included responses from government, other industry and environmental respondents. Most of these respondents have links with the cotton industry and are familiar with its practices.

Growers consider that the industry's performance in providing information to growers about how to reduce the environmental impact of its production is better than in other agricultural industries (90 per cent) with none believing it to be worse.

Figure 9: Grower perceptions on industry's performance in providing information



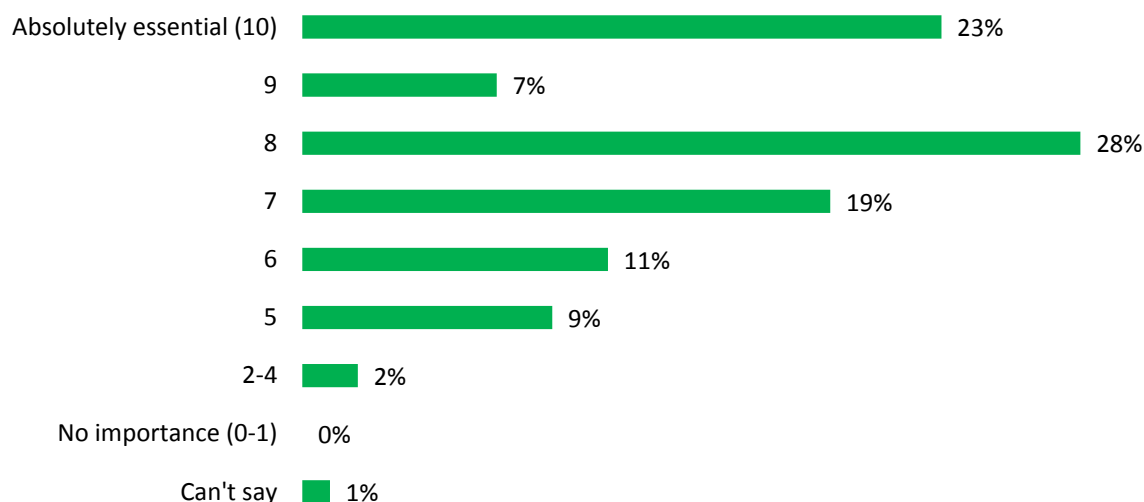
Source: Cotton Grower Environmental Performance Survey 2012

Need for continued concerted action to improve environmental performance

While growers consider they have made worthwhile gains in improving the environmental performance of cotton growing most rate the need to continue to make improvements as being very important.

Growers were asked to consider how important is it for the industry to be taking concerted action to improve its environmental performance compared with other actions the industry is taking such as improving productivity. Their responses show that further action to improve environmental performance is seen as very important. When rated on a ten-point scale, 27 per cent believe that improving environmental performance scored a 10 (absolutely essential) and 58 per cent rate it at 8. At the other end of the scale only 2 per cent a rate it below 5 and no growers give a rating of below 2 (of little importance).

Figure 10: Grower perceptions of importance of improving cotton's environmental performance



Source: Cotton Grower Environmental Performance Survey 2012

In a similar vein, stakeholders were asked whether they think that the Australian cotton industry faces a threat to its future regarding cotton growing if it does not take further action on its environmental performance. A large proportion believes the cotton industry faces a moderate to major threat. Few respondents consider that there is only a minor threat, and no respondents believe that there is no threat at all.

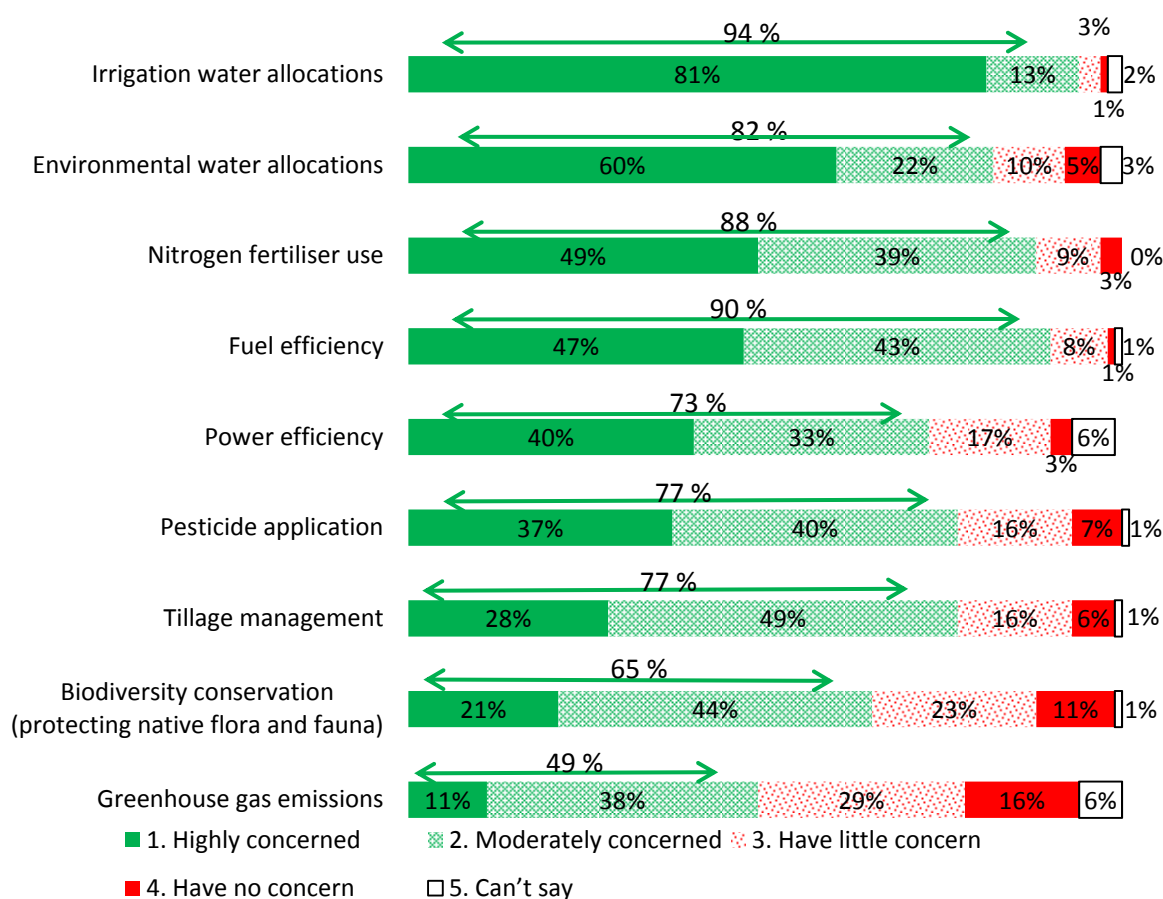
Current environmental concerns of growers and stakeholders

Growers were asked about their current environmental concerns and their responses indicate that the priorities are those issues that have the greatest implications for the survival and profitability of their cotton growing enterprise – water, fertiliser and fuel availability or use.

With regard to the issues about which growers are moderately or highly concerned:

- 94 per cent are concerned about irrigation water allocations;
- 90 per cent are concerned about fuel efficiency;
- 88 per cent are concerned about nitrogen fertiliser use;
- 82 per cent are concerned about environmental water allocations determined by governments;
- 77 per cent are concerned about pesticide application;
- 77 per cent are concerned about tillage management;
- 65 per cent are concerned about biodiversity conservation; and
- 49 per cent are concerned about greenhouse gas emissions.

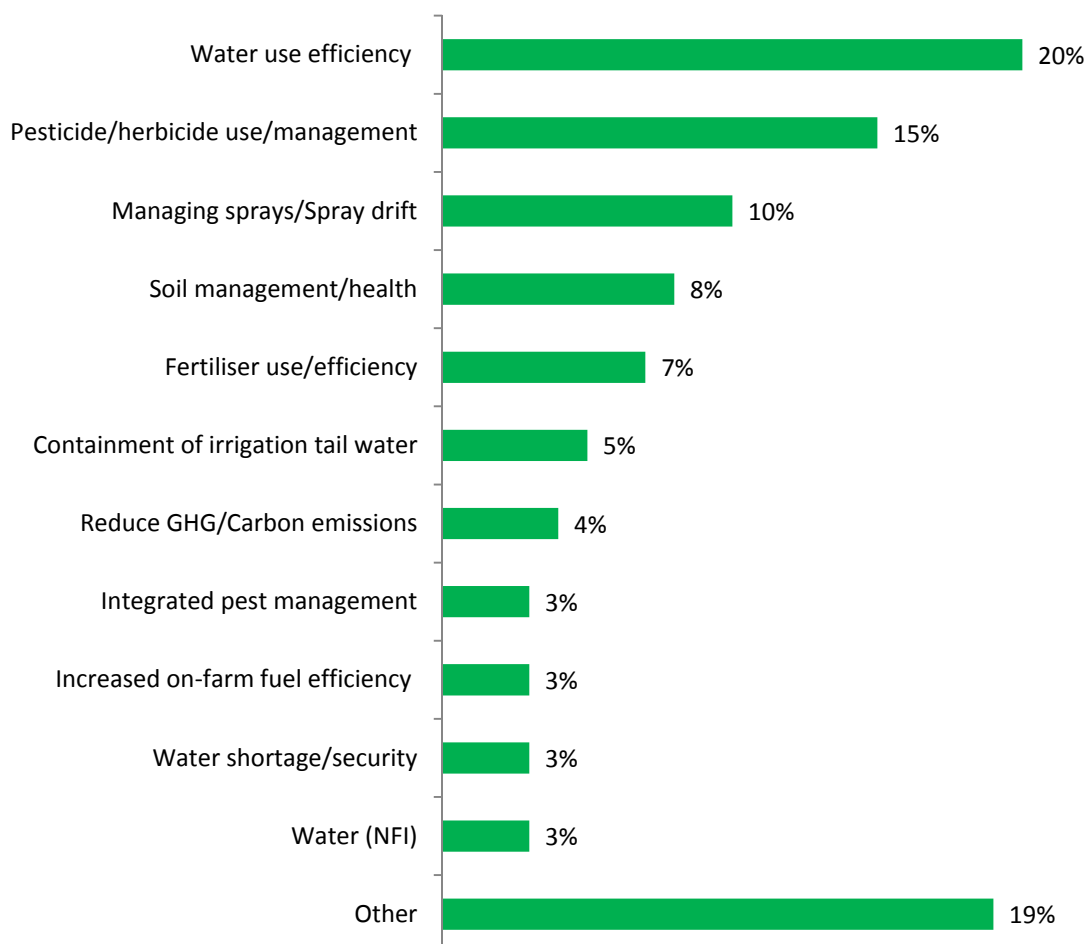
Figure 11: Grower concerns in terms of environmental issues



Source: Cotton Grower Environmental Performance Survey 2012

When asked to nominate what three environmental management issues are the main priority for cotton growers to deal with today, water use efficiency is by far the top ranked issue, followed by pesticide use and management, soil health and fertiliser use and management. There are a large number of other issues mentioned, but only by small percentages of growers.

Figure 12: Grower perceptions on the top environmental issues today



NFI – Water was listed as a top environmental issue but no further information was provided.

Other – includes a large number of issues including tillage management, industry reputation, energy cost and efficiency, soil salinity, resistance of weeds and other pests, use of GM varieties, government policy/interference, carbon tax, mining impact on agriculture, reduce water storage evaporation and leakage, improve soil health, protect native vegetation, soil and leaf monitoring, increased electricity efficiency and implement BMP practices.

Source: Cotton Grower Environmental Performance Survey 2012

Cotton industry stakeholders agree with growers on the priority environmental issues at present. A large majority (78 per cent) of the total respondents identify water use and management as one of the top three environmental issues that the industry needs to act on today. The water issues include water quality, water use, ground water quality, water conservation, water efficiency, water security, water availability, water management, and irrigation.

Emerging environmental concerns of growers and stakeholders

The *Cotton Grower Environmental Performance Survey 2012* found that water use efficiency, pesticide use and managing spray drift continue to be rated by growers as the top three environmental priorities for the future (*Figure 11*). Efficiency is an underlying theme in the use of water, chemicals, fuel, and energy.

Reduced emissions of greenhouse gases (GHG) is also identified as an emerging issue, but only by four per cent of growers as a top three priority. Use of genetically modified (GM) cotton varieties is less prominent as a priority, but is accompanied by comments about the need to stop GM cotton plants growing outside planted fields. Only a few growers appear concerned that other stakeholders might object to the use of GM cotton. The effects of coal mining and/or coal seam gas extraction are also considered as an emerging issue for the industry by some growers.

Emerging resistance of insects and weeds to the available pesticides and herbicides is expressed as a concern for the future. There is particular concern that Round Up Ready varieties might become more vulnerable over time.

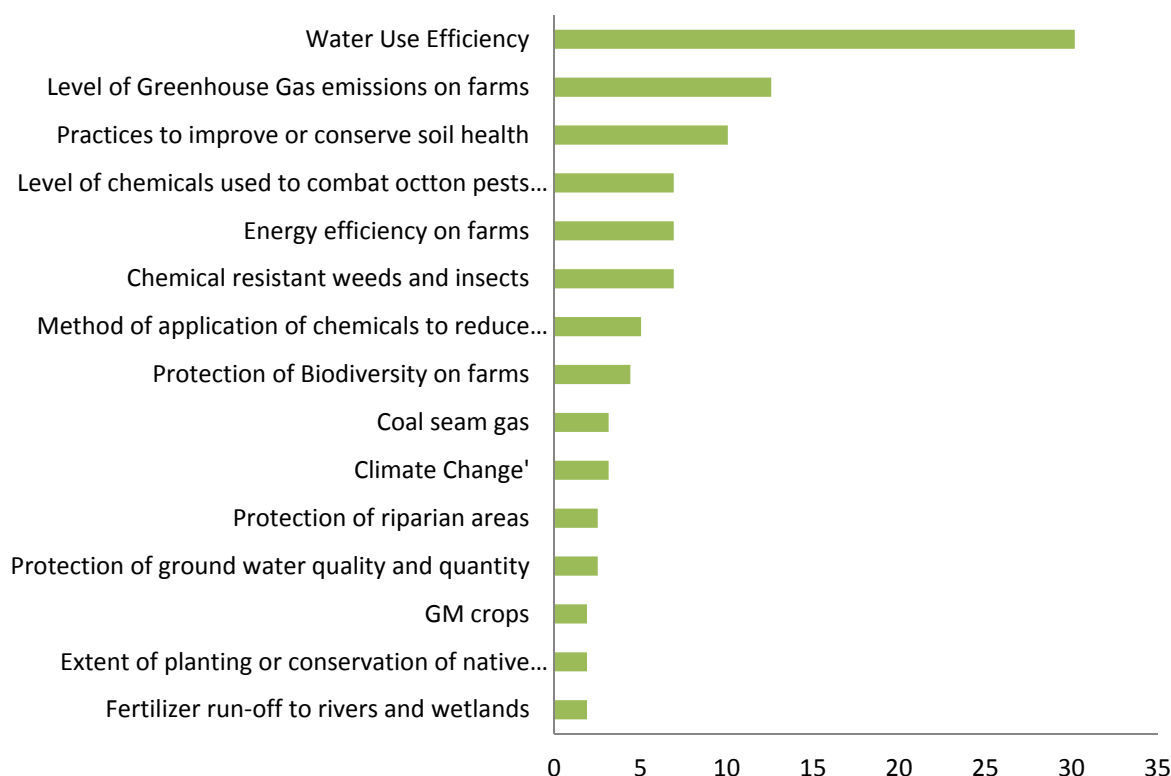
As with the reported achievements and their own future plans the primary focus is on issues that have implications for profitability and long term financial viability, with the industry's 'social license to operate' being a secondary issue in terms of priorities.

Putting these replies together with the reported achievements and plans for further improvement, it is clear that growers are proud of what the industry is achieving to reduce its environmental impact, while concentrating most on the changes that also have potential financial benefits.

Stakeholders

When asked what environmental issues stakeholders saw as becoming important over the next three to five years in terms of impacting on cotton growing, water availability and use is again ranked by most as the first priority. Energy use, carbon emissions and coal seam gas extraction are rated prominently.

Figure 13: Stakeholder perceptions on future environmental priorities for the industry



Source: Cotton Stakeholder Environmental Performance Survey 2012.

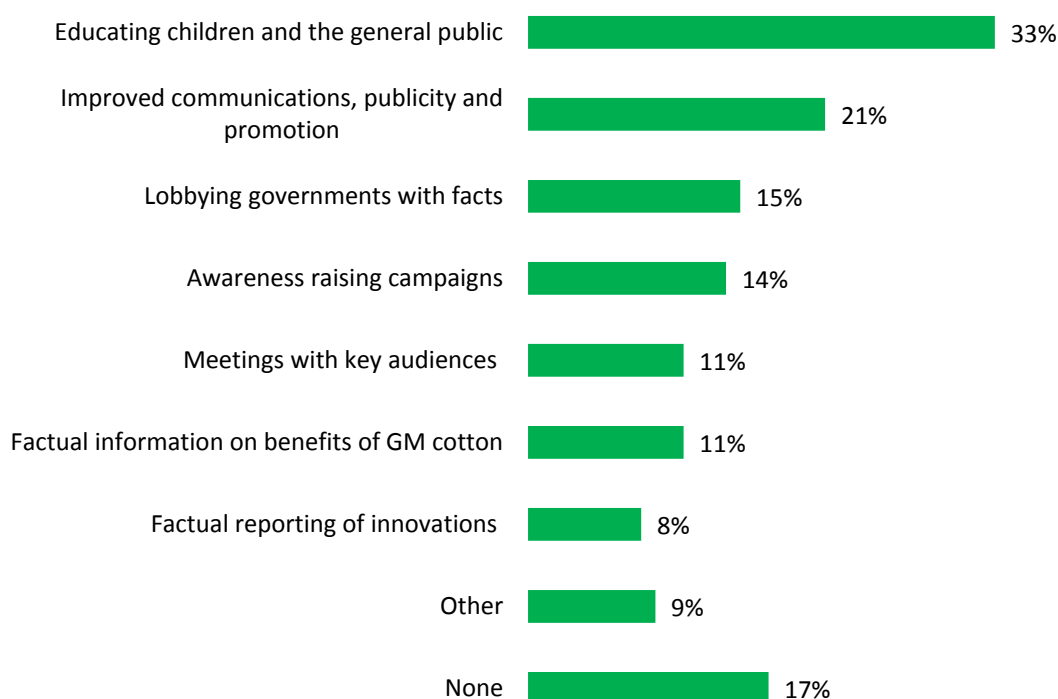
Informing others of environmental performance

Despite the industry's very positive view on its efforts, 83 per cent of growers surveyed consider that more action is needed to influence the views of governments and the general community about the industry's environmental impact. There is a strong perception amongst growers that the industry's efforts have not been recognised.

A large proportion of the stakeholders surveyed also consider it important for the cotton industry to take more action to inform governments, the general public and other sectors on the environmental performance of cotton farming.

In terms of what needs to be done to achieve greater recognition of the industry's achievements, educating the general public and/or children; improved communication, publicity or promotion; actively lobbying governments with the facts about the industry's efforts; awareness raising campaigns, having meetings to communicate with key audiences and disseminating factual information about the benefits of GM cotton varieties are rated highly. Some 20 per cent of growers, however, believe that nothing more can be done to improve perceptions of the industry.

Figure 14: Grower perceptions of actions to take to influence stakeholders



Source: Cotton Grower Environmental Performance Survey 2012

4.3 Water Use and Management

Water availability and its use and management on-farm remains the top priority production and environmental issue for cotton growing. On the production side it is a significant input and cost- not only a cost of production, but also an infrastructure cost of delivering water from its source to the plant.

Availability is a constraint on cotton produced in Australia. When water is available more cotton is grown and if seasons are favourable more dryland cotton is produced (grown from rainfall alone). The *Cotton Grower Environmental Performance Survey 2012* conducted for this Third Environmental Assessment showed that most growers produced both irrigated and dryland cotton in 2011-12.

On the environmental side water used is drawn from groundwater and rivers or other water bodies. Consumptive water use reduces the amount available for the environment. In addition without

appropriate practices for the use of chemicals and fertilisers, farm water quality can be compromised.

In the time since the Second Environmental Audit the cotton industry has made a concerted effort to improve its water management and the efficiency and productivity of water use on-farm. This has coincided with the period of water reform in the Murray Darling Basin and the impact of the decade-long drought that ended in 2010-11.

Water scarcity in the Murray Darling Basin during the drought led to a new wave of water investments and a range of policy, institutional and regulatory reforms. Since 2004 the National Water Initiative (NWI) which is Australia's enduring blueprint for water reform has created a shared commitment by governments to increase the efficiency of Australia's water use and to improve water planning for future supplies to rural and urban communities, and for the environment (Inovact Consulting, 2011). The implementation of the NWI was accompanied by an investment of \$10 billion by the Australian Government to facilitate the water reforms; raise national water standards through a specific program of funding (Raising National Water Standards Program - RNWS) and fund 'watersmart' projects around the nation (Watersmart Australia). The RNWS Program has had significant impact on water management through investments in water planning, water trading, groundwater, wetland and river health and rural water (Inovact Consulting, 2010). The NWI and the associated investments have a significant external driver for improved water management in the cotton industry particularly relating to groundwater.

An additional driver is the *Water Act 2007* which commenced in March 2008 and implemented further reforms for water management in Australia. It included the establishment of the Murray Darling Basin Authority and its charter to prepare a Murray Darling Basin Plan to provide for the integrated management of the Basin's water resources. To date a proposed plan has been prepared based on a draft plan that was the subject of extensive public consultation and comment. The proposed Basin Plan aims to balance the water needs of the environment and other uses, through the establishment of new limits (known as sustainable diversion limits, or SDLs) on the volumes of water use. The proposed Plan, if approved and implemented, will have significant implications for the amount of Basin water available for consumptive purposes including irrigation, which in turn will impact on cotton growing catchments.

The Australian Government has also implemented the Water for the Future initiative. This includes funding to help irrigation water providers develop modernisation plans for their districts, upgrade irrigation infrastructure and assess options to adapt to a future with less water. It also provides funding for private irrigation infrastructure operators to modernise and upgrade irrigation infrastructure both on and off farm. The industry has sought funding from these initiatives, but only with moderate success.

In summary the national water reforms since 2004 have aimed to deliver transparent, soundly based and adaptive water planning, secure water rights for consumptive and environmental purposes, and efficient pricing and markets to drive the most productive use of Australia's water resources. In line with the water reform agenda, the Australian cotton industry has made transformative changes in its water management and use.

Progress in implementing the recommendations of the Second Environmental Audit

The Second Environmental Audit highlighted improvements in water management made since the First Environmental Audit and proposed many recommendations for further improving water practices on-farm. Key recommendations related to constructing deeper water storages, measuring water losses through seepage and evaporation, encouraging farmers to calculate volume of water lost and leakage of water storage units, lining and leak testing of water storages and distribution channels, ensuring capture and recycling of tailwater and stormwater, and improving water use efficiency. Table 10 outlines industry action taken in response to these recommendations and an assessment of this progress by the Third Environmental Assessment.

Table 10: Rating of adoption of the Second Environmental Audit recommendations

Second Environmental Audit recommendations	Third Environmental Assessment: Rating of industry adoption
<u>Water storages:</u>	
Deeper water storages (which maximise the depth to storage ratio) be installed for new storages to minimise evaporative losses, where it is economically practical and within legal limits.	Medium
Existing water storages be reviewed for rectification works to transform them into multi-cell, deeper ponds.	myBMP growers comply, but wider adoption unknown
Growers be encouraged to calculate the volume of water lost (and corresponding economic loss) through evaporation from their water storages and distribution channels.	Medium
Lining and leak testing of water storages and distribution channels be encouraged.	myBMP growers comply, but wider adoption unknown
<u>Water use efficiency:</u>	
Growers encouraged to assess where their losses are and to quantitatively measure their water usage and losses.	High
The cotton industry continues field investigations for improving application methods and increasing water use efficiency.	High
Participation of growers in water and irrigation management courses be encouraged.	High
The cotton industry pursue the government to continue the Queensland Rural Water Use Efficiency Initiative (or similar programs) beyond December 2003 and a similar program be adopted in New South Wales.	Low

Second Environmental Audit Recommendations**Third Environmental Assessment: Rating of industry adoption.****TailWater:**

It is recommended that investigations be conducted and actions implemented to retain tailwater on farms (in Queensland), so that all farms have such systems over the next 10 years.

High

Stormwater:

Reviews be undertaken of the stormwater management systems that would specifically identify:

Medium

- The actual system capacity to retain a storm event.
- Weak links in the complex systems such as the likelihood of breakthrough during high intensity storms at control points such as pump stations.
- Minimum freeboard which must be kept in storage ponds to retain design storm events.
- Improvements to increase the capacity of the runoff retained.

Dryland farmers investigate and manage stormwater runoff (and soil erosion) from areas of their farms that may be used for cotton or other crops which have been sprayed with pesticides.

Medium

Water storages:

Considerable progress has been made in the industry with on-farm water storages. The industry's WATERpak manual and myBMP Land and Water Management module address the design of new water storages. Other achievements have been the measurement of seepage and evaporation, evaluation of commercial evaporation mitigation technologies, investments in novel evaporation mitigation polymers, and development of tools and calculators to help growers measure losses.

On-farm assessments were undertaken in a Cotton Catchment Communities CRC (Cotton CRC) project that measured seepage and evaporation losses from 137 assessments undertaken by commercial consultants. This study found that more than 85 per cent of storages assessed had seepage losses of less than 3mm per day. It showed that for well sited storages losses due to seepage are small compared with losses due to evaporation and within-field losses.

A Cotton Catchment Communities CRC Cotton Storages Project that involved on-farm assessments by consultants using the Irrimate™ Seepage and Evaporation Service found that storage loss accounted for 24.7 per cent of water use. Channel loss was 0.5 per cent, drain loss 0.7 per cent; field application loss 11.4 per cent and crop water use 62.6 per cent.

Given the small losses from seepage, evaporative losses are still a significant problem. A partnership between the Cotton Catchment Communities CRC, the Polymers CRC and the CRC for

Irrigation Futures researched polymers and monolayer products as storage covers. This research has not yet progressed to viable commercial application. However to mitigate some of the storage losses growers are leaving water orders in provider storages until needed where possible.

Water use efficiency:

Regarding measurement of water usage and losses, the *Cotton Grower Survey 2011* (GHD) found that 41 per cent of irrigator respondents did not know their water use efficiency (WUE) in bales per megalitre (ML). Of those who had calculated this metric approximately 75 per cent had not included rainfall in this calculation of water use efficiency. This finding conflicts with the industry's intention that measuring water usage and losses should be part of measuring the whole water balance on the farm.

In relation to field investigations for improving water application methods and increasing water use efficiency, the Cotton Research and Development Corporation in association with Cotton Australia and Cotton Catchment Communities CRC convened a water research review in August 2011 (GHD 2011). This found that over the previous 5 years, 96 per cent of irrigators surveyed had made improvements to their furrow irrigation systems or had changed to an alternate irrigation type. It also found that almost half of the surveyed irrigators had made changes to the flow or size of their siphons and 20 per cent had metered their siphons. Furthermore the study found that growers were using other practices including the redesign of fields, irrigating to deficits, better accounting of soil variations, changed bed shapes, using irrigation scheduling probes, pump optimisation and reducing distribution losses.

These practices were backed by RD&E investments. For example, the Cotton Catchment Communities CRC's Farm Program aimed to 'grow more crop per drop' and focused on measuring water use efficiency, investigating alternative irrigation application systems, building understanding of water movement through the soil, and improving the productivity of plant water use through understanding plant water needs and improved irrigation scheduling.

Cotton Australia has reported to the Third Environmental Assessment that there has been a large extension program underpinning water R&D. Action taken includes the BMP program (and later myBMP) outlining how to calculate and record the irrigation water use index and the gross water use index, and the release of HydroLOGIC in 2003 and WATERpak in 2004 to help growers assess their water use efficacy in the field. The release of these tools have been backed by grower training with Montgomery (2011) citing the New South Wales Department of Primary Industries as having conducted 35 training events for 436 cotton growers between 2008 and 2011.

The Cotton Catchment Communities CRC has reported on a number of projects quantifying deep drainage losses on cotton farms using lysimeters and electromagnetic induction (EM38) technology. One project monitored soil water at a range of depths throughout a cotton growing season and provided cotton growing input to a model HowLeaky which is intended to enable analysis of the implications of alternative land-uses on water balance, runoff, erosion, and drainage.

The main incentive to growers to improve water use efficiency is increased profitability and this is reflected in the growth in grower demand for private irrigation and consulting services in on-farm water management. Regarding government incentives as recommended in the Second Environmental Audit, the Queensland Rural Water Use Efficiency Initiative has concluded and a similar scheme was

not taken up by the New South Wales Government. The Australian Government has invested \$5.8 billion in a Sustainable Rural Water Use and Infrastructure program with most funding being provided to the Murray Darling Basin. Efforts were made by the industry to secure irrigation infrastructure projects for the Macquarie Valley and on-farm irrigation modernisation in the Border Rivers and Gwydir regions with mixed results (Cotton Australia Annual Report, 2010-11).

The improvement in water use efficiency in cotton growing is considered to be around 40 per cent over the decade 1996-97 to 2006-07 or four per cent per annum. A comparison between the studies of Tennakoon and Milroy (2003) in 1996-99 and Williams and Montgomery (2008) in 2006-07 showed the Gross Production Water Use Index increased on average from 0.79 bales per megalitre to 1.13 bales per megalitre. Montgomery and Bray (2010) found a Gross Production Water Use Index of 1.14 from 46 farms during the 2008-09 season. Roth (2010) reported that an analysis of various reports shows that on average water use efficiency has been improving by three to four per cent per annum.

The Cotton Catchment Communities CRC cites a New South Wales Department of Primary Industries study that collected water use and production data on 36 farms using Watertrack Rapid™. This found that water use efficiency had improved substantially over less than a decade, but that it varied considerably across the farms (Cotton Catchment Communities Cooperative Research Centre, 2012).

A key issue in measuring improvements in water use in agriculture is having consistency in water use efficiency measures. The cotton industry has adopted standard measurements and these are set out in their *WATERpak* manual which was developed by the Cotton Catchment Communities CRC in association with Cotton Research and Development Corporation and Cotton Australia. The measurements include:

- Crop Water Use Index (CWUI): lint produced per millimetre of evapotranspiration from a field during the cotton season;
- Gross Production Water Use Index (GPWUI): the lint produced per megalitre (ML) of total water used on a farm or a field;
- Irrigation Water Use Index (IWUI): the lint produced per ML of net irrigation water applied to a field or supplied to a farm, and the
- Whole Farm Irrigation Efficiency (WFIE): the amount of irrigation water used by the crop for evapotranspiration as a percentage of that applied to the crop.

Roth (2010) considers that GPWUI is the most important indicator for long term comparisons of water use efficiency as it measures the efficiency of water supplied to the crop including rainfall which varies a lot from season to season. WFIE provides the entire view of irrigation efficiency on a farm, and CWUI measures the efficiency with which the crop converts water into cotton lint.

The industry has ambitious goals for improving water use efficiency. In March 2006 the Australian Cotton Industry Council set itself a goal to double again water use efficiency by 2015.

Tailwater and stormwater management:

Tailwater and stormwater capture and management are covered extensively in myBMP. The requirement is for all irrigation tailwater to be contained on-farm or in a shared group water

supply scheme. A documented management plan is also required to manage storm events. myBMP also provides guidance for managing off-farm water quality impacts through buffers, managing discharge points and water quality sampling.

Cotton Australia reports that it is working with other industry bodies such as Grains Research and Development Corporation (GRDC) on extension activities with growers to ensure uptake of best practices. It also reports that it has consulted state governments on determining equitable overland regulations and quality targets.

Regarding stormwater management on dryland farms the industry has implemented an extension program through the Cotton Australia Grower Service Managers to support dryland farmers to adopt new technologies and other management techniques such as using Roundup Ready® and Bollgard II ®cotton, stubble retention, row spacing, integrated pest management, buffer areas and grassed waterways that will reduce environmental impacts from stormwater runoff.

The Cotton Catchment Communities CRC has managed a specific sub program to provide R&D to produce “more crop per drop”. Issues covered include: reducing deep drainage; mitigation of evaporation; plant physiology studies to better understand plant and soil water relationships; irrigation of Bollgard® varieties; improved Irrigation scheduling; comparing alternative irrigation systems; plant breeding to improve water use efficiency; and optimising furrow irrigation.

Broader water management considerations:

A key achievement of the Cotton Catchment Communities CRC is the focus it provided on water management issues at the catchment scale. As a result, partnerships between grower groups, research providers, catchment management authorities and regional natural resource management organisations, local water organisations and some local environmental group have developed to address catchment management. Issues such as surface and groundwater connectivity, aquifer connectivity, recharge of groundwater and groundwater quality are being addressed, but this has a long way to go before these issues are resolved.

The CRC concluded on 30 June 2012 and has published a legacy report *Weaving a future for Australia's cotton, catchments and communities: Seven years of Cooperative Research* that outlines its achievements. While the closure of the CRC will leave a gap in the industry's RD&E capacity, the intellectual property developed over the past decade ensures the industry is well placed to continue its efforts and achievements.

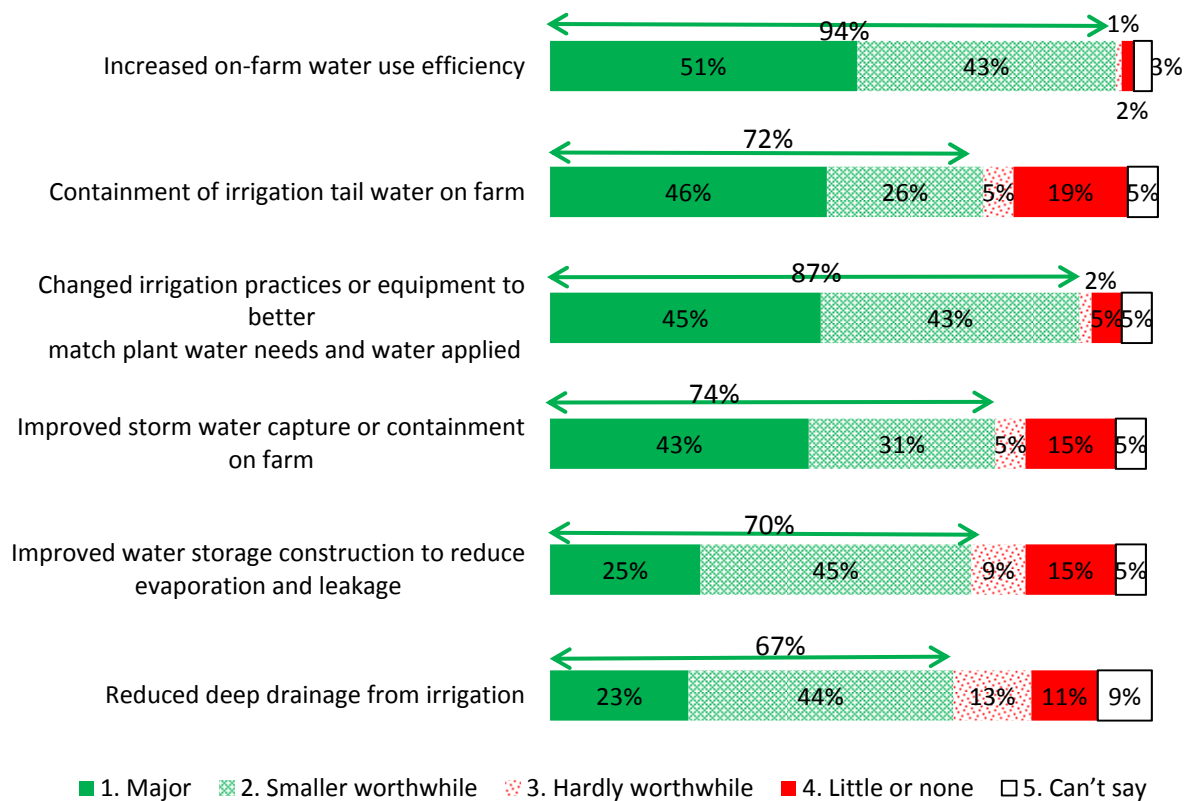
Perceptions of grower and stakeholders on the industry's water use and management

The *Cotton Grower Environmental Performance Survey 2012* shows strong grower endorsement of achievements across the specific aspects of improved water management. In terms of ratings of worthwhile to major improvements:

- 94 per cent of growers believe that this has been achieved for increased on-farm water use efficiency;
- 87 per cent for changed irrigation practices or equipment to better match plant water needs and water applied;

- 74 per cent for stormwater capture or containment on-farm; and
- 72 per cent for containment of irrigation tail water on-farm;
- 70 per cent for improved water storage construction to reduce leakage and evaporation;
- 67 per cent for reducing deep drainage from irrigation.

Figure 15: Grower perceptions on improvements in water management



Source: Cotton Grower Environmental Performance Survey 2012

Industry stakeholders and observers generally agree with growers that the industry has made either outstanding improvements or worthwhile improvements in water use efficiency and in the protection of groundwater quantity and quality over the past decade

Conclusions

The specific recommendations of the Second Environmental Audit concerning improvements in water management and stewardship on-farm have been subject to considerable extension efforts. Guidelines have been included in myBMP and other extension materials, and training provided to growers. All priority water management issues have been addressed such as constructing deeper water storages, measuring water losses through seepage and evaporation, encouraging farmers to calculate volume of water lost and leakage of water storage units, lining and leak testing of water storages and distribution channels, ensuring capture and recycling of tailwater and stormwater, and

improving water use efficiency. While there are some studies that examine the actual uptake of some of these practices such as water use efficiency improvements, it is not possible to confirm the adoption of all of these practices and the extent of variability in uptake across the industry.

The *Cotton Grower Environmental Performance Survey 2012* showed that the majority of growers consider that they had made worthwhile to outstanding improvements in these aspects of water management. At the same time most growers consider that there are still some major improvements to be made in addressing the issues surrounding water use efficiency and quality. Growers state that increased water use efficiency remains the top environmental issue for cotton production over the next three to five years. Similarly on their own farms it is rated as the top issue for planned improvements over the next three to five years.

This indicates that growers need continue to be informed by strategic and targeted ongoing RD&E across priority areas of water management to enable continuous improvement in irrigation practice and technology. Growers still require advice on practical and financially viable solutions to further reduce transmission and farm storage water losses, and invest in more efficient irrigation technology and management including surface irrigation, lateral/centre pivot and sub-surface drip irrigation that is 'right for site'. Much of this support can be provided by the commercial water consultants, but they also need access to the latest and best research evidence.

In addition the industry's RD&E efforts need to continue to explore opportunities for further transformational change in water management and use. This may come from developments in:

- biotechnology (e.g. traits in improved cotton varieties to use less water and successfully adapt to water stress),
- irrigation technology (e.g., improved integration of field weather, soil moisture and plant canopy temperature sensors to optimise irrigation scheduling and water delivery to the plant);
- in practical and affordable covers for reducing evaporation losses in storages or seals for irrigation storages and channels); and
- breakthrough improvements in sub-surface irrigation, lateral move, centre pivot and surface irrigation technology.

The cotton industry needs to remain engaged with national water policy and programs to ensure the industry shares equitably in programs and growers receive benefits.

4.4 Chemical Use, Application and Management

Introduction

Chemical management remains a top priority production and environmental issue for cotton growing. Insecticides, herbicides and chemical fertilisers are a significant input and cost for successful cotton growing.

On the environmental side appropriate management is critical to avoid contamination of the environment through flushing into waterways and other water bodies, seepage into groundwater or contamination of soil.

In New South Wales and Queensland there is environmental protection legislation that makes it illegal to allow chemicals or other substances to be washed into water bodies or contaminate land. The Protection of the Environment Operations Act 1997 is the main piece of NSW environmental legislation covering water, land, air and noise pollution and waste management. In Queensland, the *Queensland Environmental Protection Act 1994* regulates contamination of environmental assets.

The *Cotton Grower Environmental Performance Survey 2012* shows that pesticide use and management is rated as the second highest priority for growers after water use efficiency. The survey found managing sprays and spray drift is the third highest priority.

The *Cotton Stakeholder Environmental Performance Survey 2012* shows that spray drift is rated by 13 per cent of survey respondents as the highest priority environmental issue that the industry needs to act on today and by 9 per cent as the third highest priority. Fifteen per cent of the respondents rate chemical application as the second highest priority.

Progress in implementing the recommendations of the Second Environmental Audit

The Second Environmental Audit made a large number of specific recommendations relating to chemical management on farm. These are shown in Table 11 along with ratings of the level of industry action made by the Third Environmental Assessment. While many of the recommended practices were incorporated in myBMP and will have been achieved by growers who have undertaken the precertification assessments or have been myBMP certified, there is no data available on the adoption of many of the specific recommendations by other growers.

Table 11: Rating of adoption of the Second Environmental Audit recommendations

Second Environmental Audit recommendations	Third Environmental Assessment: Rating of industry adoption
Growers be encouraged to extend the PAMP to cover all pesticides used.	High
In the interests of neighbourly harmony and courtesy, growers notify neighbours of all sprays if requested by the neighbours.	High
Where neighbour sign-off of the PAMP cannot be achieved, the farm map, contact details and location of the cotton fields for the season be sent to neighbours.	High
PAMPs be reviewed and updated each season to identify any changed practices, new neighbours and communication to neighbours of different areas planted to cotton.	High
Checks of PAMPs continue to be conducted, during BMP audits, as a means of checking the effectiveness of the PAMP.	High

Second Environmental Audit Recommendations	Third Environmental Assessment: Rating of industry adoption.
The standard PAMP could be expanded to cover current aerial operator AAAA accreditation certificate, and current FarmCare chemical handling certificates for all groundrig operators (contractors and on-site personnel)	High
The Groundrig Operators Association develop competency-based assessment procedures for its members to provide assurance on the competency of the operators and the equipment.	High
Complaints from all cotton growing areas be collated on an annual basis, analysed and used as a performance indicator.	Medium
A consistent complaints management process be developed in consultation with local and state government and Cotton Australia. This approach will allow improved consistency in management and potential for compilation of complaints data.	Medium
PAMPs for all farms clearly identify sensitive areas and buffer zones on a farm map and that future BMP audits closely monitor the adequacy of farm maps in this regard.	High
<p>Pesticide storage be improved by checking against “best practices” outlined in the Best Management Practice manual and implementing the following, where required:</p> <ul style="list-style-type: none"> - Growers establish, by measurement, that bunding in pesticide stores can retain 25% of the storage contents. - Wooden floors, or other porous materials, not be used in pesticide stores as spilled chemicals may seep into the wood or penetrate the gaps. - Improved roof and low-level vents are required for adequate ventilation of some pesticide storage sheds and containers. - Thermally insulated containers be used in preference to single skinned shipping containers. - Storage sheds/containers be painted white or be of reflective metal and be sited in the shade where possible, to minimise temperatures within the store and hence minimise release of odours or vapours. - Managers ensure that incompatible chemicals and pesticides are segregated 	myBMP growers comply, but wider adoption unknown

<ul style="list-style-type: none"> - Pesticides be stored within the designated bundied areas and an adequate distance away from the bund walls (as specified in AS2507 and AS1940). - Increased security controls are required at storages where it is currently lacking - First aid kits and spill kits be available near all pesticide stores. - Drainage from the mixing area be to a properly constructed evaporation pit. - Closure of the sump drain should be possible using a valve or similar mechanism. - Old chemicals be removed off site and disposed of correctly. 	
To reduce the inventory of pesticides held on site, growers be encouraged to order chemicals as they are required, particularly for farms within a reasonable distance from chemical suppliers.	High
Growers check that they have the correct signage for the type of dangerous goods stored on site and signs need to be replaced if they are faded	myBMP growers comply, but wider adoption unknown
New South Wales, growers check the maximum quantities of each Class and Packing Group of chemicals held on site and apply for a dangerous goods licence if quantities are exceeded.	myBMP growers comply, but wider adoption unknown
Chemical inventories be expanded to cover all the chemicals and fuels used on site, and corresponding up-to-date MSDS should be obtained.	myBMP growers comply, but wider adoption unknown
Farm maps be extended to cover main chemical storage areas and diesel storage tanks, particularly located adjacent to water bodies, and indicate the maximum quantities of fuel and chemicals at each location.	myBMP growers comply, but wider adoption unknown
<p>Petrochemical storage:</p> <ul style="list-style-type: none"> - Growers check that storage of all fuels and chemicals are above 1:100 flood levels and that bunding, or other protection measures, are put in place around diesel tanks near creeks and rivers. - Facilities be provided for pumping out uncontaminated stormwater that collects in the bunds. - New fuel tank and bund installations be checked against the requirements of AS 1940, with respect to bund height and distance from the 	myBMP growers comply, but wider adoption unknown

<p>tank.</p> <ul style="list-style-type: none"> - Fire extinguishers or other protection measures be provided around large, permanent diesel tanks, in accordance with AS1940. - Growers need to ensure that signage is correct on all fuel installations. - Aboveground diesel tanks be installed in preference to underground tanks. - Conduct tank integrity testing for underground tanks greater than twenty years old and rusting or damaged above-ground tanks. - Petrol storage tanks have appropriate signage, bunding or other means of preventing a spillage, locks on fuel dispensers or improved site security. - An inventory of fuel delivery against fuel drawn from underground tanks be maintained to assist in identifying any leakage. - Routine tank integrity testing be undertaken for underground petrol tanks. - Tanks requiring decommissioning be pumped out and gas freed, then either dug up, crushed and tipped at an approved site or filled with an inert substance such as sand in accordance with (AS1940, WorkCover and API Guidelines). - Tanks requiring decommissioning be pumped out and gas freed, then either dug up, crushed and tipped at an approved site or filled with an inert substance such as sand in accordance with (AS1940, WorkCover and API Guidelines). - It is recommended that a risk assessment be conducted on oil storage areas, and where required, protection measures be provided within workshops and for any external storage areas. 	
--	--

The above assessment indicates a high level of industry action relating to chemical use, application and management since 2003. This follows on from the findings of the Second Environmental Audit that a high level of compliance was achieved post the First Environmental Audit with respect to aerial spraying, chemical use and occupational health and safety, pesticide storage, spray drift management, integrated pest management and research.

The industry's efforts in this area have been focussed on overcoming the problems of high chemical use that existed in the 1990s. It had to take action to ensure the future of the industry and its prosperity. Considerable effort has been put into extension and training on the requirements and best practices in managing transgenic cotton varieties, the uptake of integrated pest management (IPM) and associated integrated weed management, chemical application to avoid spray drift and safe storage and handling of chemicals. This has been a collaborative effort involving Cotton Australia, Cotton Research and Development Corporation, Cotton Catchment Communities CRC, state

government agencies, state farm organisations and the Australian Pesticides and Veterinary Medicines Authority.

Insecticide and residual herbicide use

A key factor in a transformational reduction in the use of chemicals in cotton growing has been through biotechnology and the introduction of Bt cotton. Table 12 shows the history of transgenic cotton's introduction in Australia, the features and the benefits of the various transgenic varieties.

Table 12: Introduction of transgenic cotton varieties to Australian cotton growing

Transgenic Variety	Year of approved for commercial release	Features	Benefits
Ingard® Monsanto	1996	Bt or Ingard® cotton was developed by CSIRO using a gene owned by Monsanto. This gene was sourced from the soil bacteria <i>Bacillus thuringiensis</i> (Bt) and it enabled the plant to produce the Bt protein which killed <i>Helicoverpa armigera</i> and <i>H. punctigera</i> cotton's major pests.	The introduction of Ingard® cotton resulted in about a 50% reduction in insecticide use over the seven-year period when this variety was used. However Ingard® was limited to 30% of the total cotton area to manage potential resistance (Constable et.al. 2011).
Roundup Ready® Monsanto	2000	The first genetically modified glyphosate-tolerant cotton. Cultivars with the Roundup Ready trait had vegetative tolerance, but not reproductive tolerance.	Glyphosate application was over the top of the plants at an early growth stage, but reduced residual herbicide use. (Constable et.al. 2011).
Bollgard II® Monsanto	2004	New generation insect-resistant cotton that superseded Ingard® Contains two genes from the soil bacterium <i>Bacillus thuringiensis</i> (Bt) rather than one. The genes produce two proteins in the leaves of the cotton plant that are toxic to <i>Helicoverpa</i> caterpillars. Bollgard II® with Bt genes only kills Lepidopteran pests.	Reduction in pesticide use by about 85% relative to earlier years and in comparison with contemporary conventional varieties which had reduced their pesticide use. Bollgard II® grown on about 90% of total cotton area (Constable et.al. 2011). The reduction in insecticide use Bollgard II® on this variety has allowed beneficial insects to thrive. 'Beneficials' have become an important part of integrated pest management.

Transgenic Variety	Year of approved for commercial release	Features	Benefits
Roundup Ready Flex® Monsanto	2006	<p>CSIRO backcrossed transgenic varieties provided by Monsanto with elite germplasm to produce a new generation herbicide tolerance gene. This variety contains two copies of a glyphosate tolerance gene derived from a soil bacterium rather than just one.</p> <p>Over-reliance can lead to development of glyphosate resistant weeds. Licence for Roundup Ready® and Liberty Link® use requires Resistance Management Plans that include inspection for weed survivors after the application of glyphosate or glufosinate.</p>	<p>The use of these varieties gives growers greater flexibility in weed control by extending the period during which glyphosate can be applied to control weeds.</p> <p>Roundup Ready Flex® and Liberty Link® cottons have allowed growers to reduce their use of residual herbicides which pose risks to soil, water and biodiversity.</p> <p>Reduction in total herbicide use in 2009-10 with these varieties is estimated at 48% compared with non-herbicide tolerant varieties. For the 2010 crop, 98% contained the Roundup Ready Flex® trait (Constable et.al. 2011).</p>
Liberty Link® Bayer	2007	Genetically modified variety that tolerates applications of the broad-spectrum herbicide, glufosinate ammonium.	Liberty-Link® herbicide allows growers to control a different range of broad leaf weed species, as well as minimising the risks of herbicide resistance. It is useful for weeds that are hard to kill in cotton crops such as volunteer (self-sown) cotton, peach vine, sesbania pea and bladder ketmia.

The use of transgenic varieties is subject to legally enforceable licensing requirements imposed by the owner of the varieties that enables licensee access to the GM technology. Growers as licensees of the technology must meet the requirements of a resistance management plan (RMP).

The Bollgard II® Resistance Management Plan (RMP) has been designed to reduce the rate of development of pest resistance to the two Bt proteins expressed by Bollgard II® cotton plants. The components of the RMP are aimed at minimising the frequency in the pest population of individuals carrying the resistance genes to either or both proteins (Cry1Ac and Cry2Ab) by:

1. Minimising the exposure of *Helicoverpa spp.* to the Bt proteins (Cry 1Ac and Cry 2Ab);
2. Providing a population of susceptible individuals that can mate with resistant individuals to dilute potential resistance; and
3. Removing resistant individuals at the end of the cotton season.

An industry Transgenic and Insect Management Strategies (TIMS) Committee oversees the development of the industry's resistance management strategies for insecticides and Bt cotton. This stewardship group is facilitated by Cotton Australia and has representation from growers, researchers, crop consultants and members of the pulse and grains industries. The TIMS committee endorses amendments to the RMP if appropriate and also provides advice on issues associated with developing resistance management plans for new or existing technologies to agricultural chemical, biotechnology and planting seed companies that provide crop protection tools to Australian cotton growers (Kauter et al 2009).

The control of Bollgard II® volunteers and ratoon cotton is a key component of the RMP. These are seeds or plants from the previous crop that have survived spraying, cultivation and/or the winter to germinate and regrow in the following season. In addition to the RMP, crop protection sections of myBMP, IPM guidelines and the *Cotton Pest Management Guide* place emphasis on removal of these plants.

A potential problem in terms of community perceptions is the survival of volunteers along roadsides. Seeds from cotton debris left after transporting bales can germinate due to the grading of roadsides and rain or councils using glyphosate to control weeds. The industry reports that studies conducted by CSIRO and the Australian Cotton CRC have shown that GM cotton does not have a significant capacity to spread by itself, but volunteers on-farm or off-farm are not controlled when other weeds are being controlled with glyphosate.

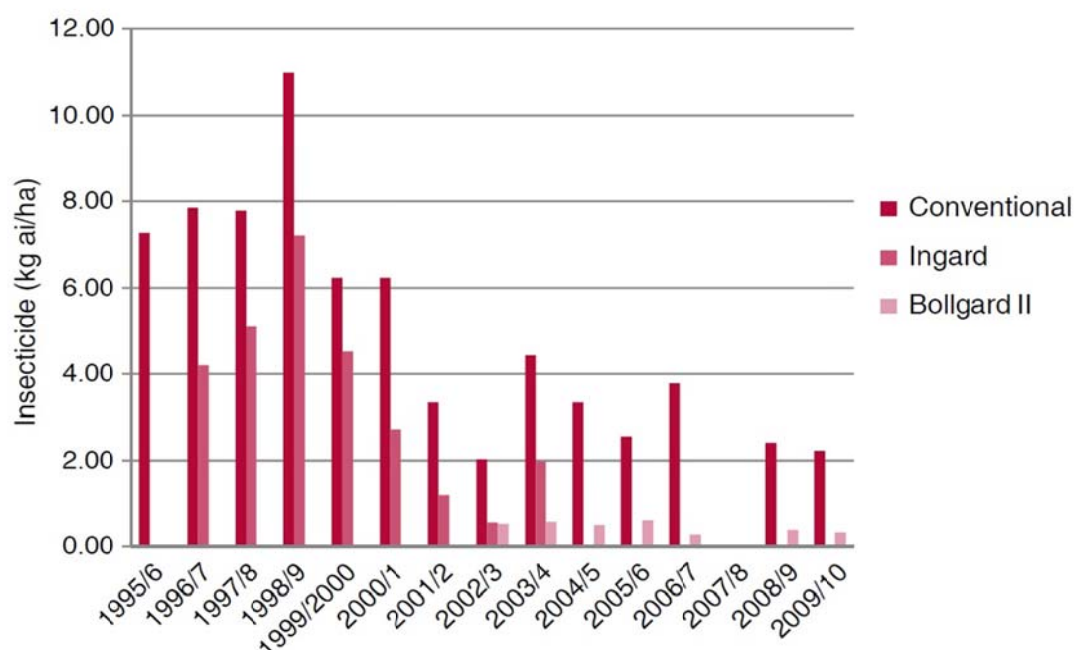
Research findings on insecticide and herbicide use

In terms of pesticide use Pyke (2007) found that Bollgard® crops received less than one spray per hectare compared with seven to eleven sprays on conventional crops. Pyke also published data on annual quantities of insecticides applied to crops between 1995 and 2006 that demonstrated a large reduction in insecticides and acaricides applied to the Australian cotton crop. This was measured as kilogram of active ingredient per hectare. Over the four seasons 2002-03 - 2005-06 Pyke noted that average insecticide usage was 82 per cent less on Bollgard® crops than on conventional cotton crops. He also observed that: 'Growers have adopted Bollgard® varieties because of perceived economic and environmental benefits. Other benefits of using transgenic cotton varieties and less spraying have included lifestyle benefits and worker safety benefits.'

Later research (Constable, et.al. 2011) shows the dramatic differences in insecticide use between conventional, Ingard® and Bollgard II® varieties from 1995-96 to 2009-10. The authors also reported a survey of herbicide use in 2009-10 that showed the average total herbicide application was 3.9 kg a.i./ha on non-herbicide resistant cotton and an average of 2.02 kg a.i./ha on herbicide

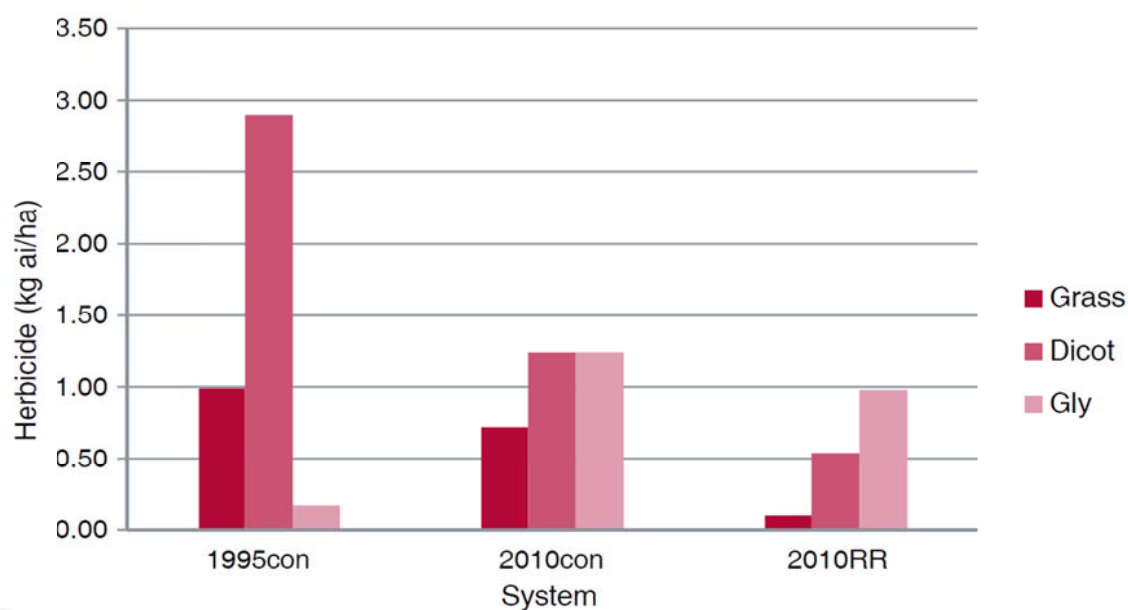
resistant cotton (Roundup Ready Flex® and Liberty Link®). The reduction was largely in non-residual herbicides.

Figure 16: Insecticide use on conventional, Ingard® and Bollgard II® varieties in Australia from 1995-96 to 2009-10



Source: Constable, G. Llewellyn, D. Wilson, L. and Stiller, W. An Industry Transformed: The impact of GM technology on Australian cotton production, Farm Policy Journal, Vol. 8 No. 1, Autumn Quarter 2011, p30

Figure 17: Herbicide use on conventional and Roundup Ready Flex® in Australia, 2009-10



Gly – glyphosate; con – Conventional cotton varieties; RR – Roundup Ready FLEX®

Source: Constable, G. Llewellyn, D. Wilson, L. and Stiller, W. An Industry Transformed: The impact of GM technology on Australian cotton production, Farm Policy Journal, Vol. 8 No. 1, Autumn Quarter 2011, pp33

Internationally Australian growers perform well in relation to pesticide use. The 2010 Alterra Report showed that the average amount of pesticides applied on Australian cotton crops decreased from 12.2 kg a.i./ha in 1999 to 1.0 kg a.i./ha in 2007. For India, Turkey, the US, and Brazil, no such trends were evident.² Additionally all 'highly hazardous materials' decreased in Australia between 1999 and 2007 from 2 kg a.i./ha to 0.07 kg a.i./ha. Although the US, India, and Turkey also experienced decreases in hazardous chemical use, only Turkey matched Australia's 0.07 kg a.i./ha although that country has lower pest pressure on its cotton crops than Australia.

With regard to herbicide use Roth (2010) published figures that showed some herbicides had decreased in use while others particularly glyphosate had increased. He reported that herbicide use peaked in 2000-01 and declined for several years as a result of new herbicide products and a more integrated weed management approach. Then from 2004-05 there was a substantial increase in the total use of herbicides coinciding with the introduction of Roundup Ready® cotton. Roth reported that the use of some environmentally problematic herbicides such as trifluralin (Treflan®), Diuron®, and Cotogard® (fluometuron, prometryn) had dropped significantly. For example since 2001-02 Diuron® and trifluralin dropped by about 80 per cent.

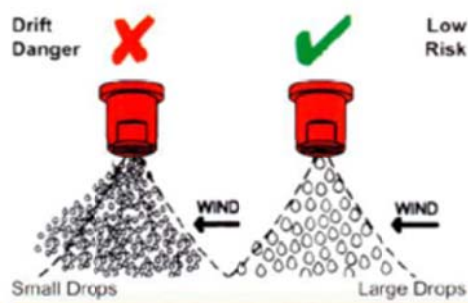
CRDC's Annual Report (2006-07) cited a 32.4 per cent reduction in residual herbicide use and reported that the introduction of Roundup Ready® technology had increased support from cotton growers in the application of Integrated Weed Management practices. This led to a reduction in waterway contamination by herbicides used in cotton production. The then NSW Department of Natural Resources reported that average detections of four residual herbicides used on cotton in north western NSW rivers declined by 29 per cent over the four seasons 2003-04 to 2006-07 compared with the previous five seasons.

Pesticide application and spray drift

There has been a considerable awareness and extension effort on spray application and drift by the industry. Cotton Research and Development Corporation (CRDC) and Grains Research and Development Corporation (GRDC) have funded very successful spray drift workshops that have been delivered over the past six years. In addition Cotton Australia reports that it has addressed the impact of spray drift on cotton crops from sprays applied to other crops/fallows which has been a significant environmental issue over the last decade. A key tool is CottonMap, a collaboration between Cotton Australia, CRDC, GRDC and Nufarm.

² http://www.icac.org/seep/documents/reports/2010_alterra_report.pdf, Pg. 10

Grower workshops have also addressed new spray nozzle design as a key contributor to reduced spray drift. This included both droplet drift (airborne movement of liquid pesticide droplets away from the target) and vapour drift (airborne movement of vaporised pesticides from sprayed areas) as shown in the diagram below.



Source: PIRSA, SA

Integrated pest management

Adoption of Integrated Pest Management (IPM) has become another factor in improved chemical management on cotton farms. IPM is described as a process that involves all means of managing pest populations over the whole year with the aim of reducing insecticide use whilst maintaining profitability (Wilson and Williams in the *Cotton Pest Management Guide*, 2011-12).

Integrated Pest Management is encouraged in myBMP through the module, *Integrated Pest Management (for weeds, pests and diseases)*. The industry has supported cotton growers and cotton consultants to record beneficial insect information through various information packages used by cotton growers and consultants – e.g. *Integrated Pest Management Guidelines for Cotton Production Systems in Australia* released in February 2005 and CottonLOGIC. In addition the industry produces an annual *Cotton Pest Management Guide* and has published a *Pest and Beneficials in Australian Cotton Landscapes* (Cotton Catchment Communities Cooperative Research Centre).

The introduction of Bollgard II® cotton with Bt genes that only kill Lepidopteran pests has been a major factor in the increased uptake of IPM by growers. It has allowed beneficial insects to thrive in Bollgard II® crops and as a result ‘beneficials’ have become an important part of IPM.

However cotton pest management will remain an ongoing challenge for growers. Gregg and Wilson (2008) have suggested that the cotton industry is relying too much on Bollgard® technology. They suggest that the ‘industry reminds itself of the basic principles of integrated pest management (IPM) - that is not to become too dependent on one approach, in this case the use of transgenes, but rather to use a range of approaches, including some new tools and products that will soon be available for commercial use such as bio-pesticides, semio chemicals, and new pesticides.’

Chemical and petrochemical storage

With regard to compliance with regulatory requirements and best practices in chemical handling, application, storage and disposal of un-used chemicals and used containers, the industry provides training and resource materials to encourage growers to comply. The *Cotton Grower Environmental Performance Survey 2012* shows that growers consider they have improved practices since 2003 but there is no independent data to prove the level of compliance. In some respects the issue is

resolving itself as growers now order on demand where practical to reduce the need for storage and return used containers to suppliers. DrumMuster across all cropping industries has been very successful for the disposal of any remaining containers.

Similarly with greater fuel efficiency of machinery and to reduce the potential of theft, fuel storage on-farm is being centralised with upgraded storage facilities to meet legal requirements. myBMP includes a petro chemical storage module that was reviewed in December 2011 to meet changed legislation.

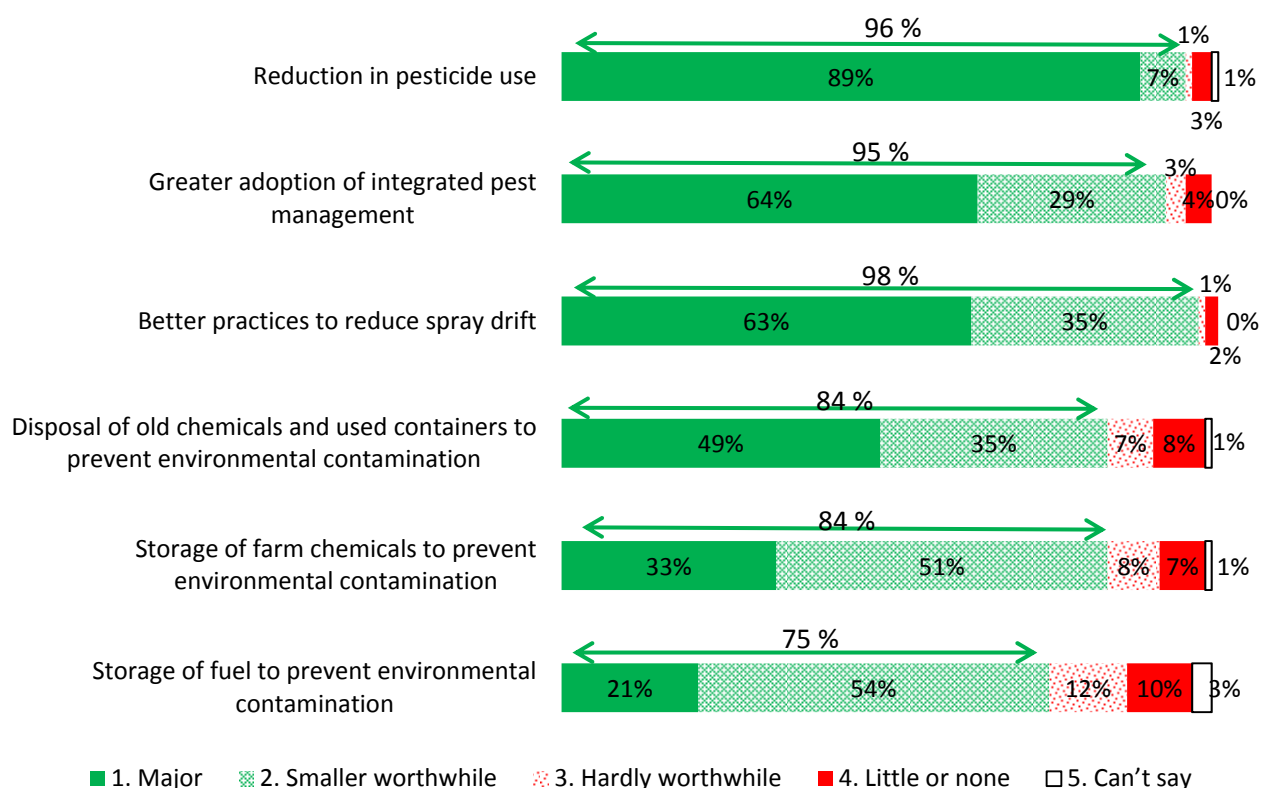
Perceptions of grower and stakeholders on the industry's chemical use and management

The *Cotton Grower Environmental Performance Survey 2012* shows strong grower endorsement of specific improvements that have been made by the industry since 2003 covering aspects of management of chemicals:

- 98 per cent of growers consider that worthwhile to major improvements have been achieved through better practices to reduce spray drift;
- 96 per cent for reducing pesticide use;
- 95 per cent for increasing adoption of integrated pest management;
- 84 per cent for improvements in disposing old chemicals and used containers to prevent environmental contamination;
- 84 per cent for improvements in storage of farm chemicals to prevent environmental contamination; and
- 75 per cent for improvements in the storage of fuel to prevent environmental contamination.

In terms of environmental improvements on their own farms a reduction in chemical use is ranked in the top three achievements.

Figure 18: Grower perceptions on improvements in chemical management



Source: Cotton Grower Environmental Performance Survey 2012

The Cotton Stakeholder Environmental Performance Survey 2012 found that forty two per cent of the stakeholders consider factors relating to chemical use and application as core environmental issues for cotton growers. Most stakeholders rate the industry's achievements as being worthwhile to outstanding in relation to reducing the use of pesticides, improving the methods of application to reduce spray drift, protection of groundwater quality from chemical infiltration and reducing pesticide run-off to rivers and wetlands.

Conclusions

This Third Environmental Assessment finds that the industry is continuing to improve the use and management of all chemicals on-farm. Since the introduction of GM cotton in 1996 there has been a significant reduction in pesticide use and growers have taken the opportunity to implement more effective integrated pest management (IPM) strategies into their farming systems. RD&E resources support the responsible management of transgenic crops and the adoption of IPM to limit insecticide and residual herbicide use.

In growing GM cotton varieties growers are required to follow due diligence and best practice in managing these varieties. The compelling evidence is that the cotton industry has introduced and uses transgenic cotton varieties in a highly responsible way. In response to any potential problems,

the cotton industry introduced a planting cap, a resistance management plan and weed resistance management practices.

The research and data gathered on transgenic cotton clearly shows the economic, social and environmental advantages of transgenic cotton varieties. This and the due diligence demonstrated with all aspects of managing transgenic cotton provides a strong basis for the industry to explain the benefits of GM cotton to the wider community.

Growers still rate chemical management as a high priority issue and one where they are planning to make further improvements over the next three to five years.

This Third Environmental Assessment has found that there are no significant weaknesses in the industry's chemical management practices. The industry gives priority to improved practices and provides targeted extension and knowledge adoption activities regarding chemical management. This is part of a continuous improvement agenda for environmentally and socially responsible chemical use and greater uptake of integrated pest management and integrated weed management.

The industry also gives priority to monitoring and risk management practices to prevent the emergence of insect resistance to current cotton varieties. In relation to weed resistance to glyphosate, which is an emerging problem across all cropping industries, the cotton industry invests in collaborative research with other relevant research institutions including the private sector to address this issue.

4.5 Natural Resource Management

Introduction

In this review natural resource management (NRM) relates to the following practices:

- Conservation of remnant native vegetation on-farm by fencing to prevent access by livestock and weed control;
- Native vegetation planting to increase the coverage especially in strategic areas such as corridors and riparian zones;
- Protection of riparian zones by fencing to exclude livestock and providing watering points away from water bodies;
- Soil health management to reduce soil structure breakdown; prevent increasing salinity, acidity and sodicity; avoiding over fertilising, and soil amelioration through the addition of organic matter or carbon sequestering elements like biochar.

This report also considered land and water competition and conflict with mining and coal seam gas extraction. This issue is of considerable concern to many cotton growers. This was stated during farm visits and many growers have placed signs along their properties voicing opposition to mining on their farms.

Some aspects of natural resource management (NRM) are regulated such as the clearing of native vegetation. In New South Wales, land clearing is regulated by the *Native Vegetation Conservation Act 1997*. The Act covers the clearing of any type of indigenous vegetation and provides for

controls in relation to the clearing of any vegetation on protected land, including exotic or dead vegetation. The primary management mechanism for native vegetation under the Act is the Regional Vegetation Management Plans. Where there is no such Plan in place, development consent is required for the clearing of native vegetation. There are a number of exemptions allowing for clearing without consent. These include the clearing of up to 2 hectares of land per year, the clearing of regrowth under 10 years old, and minimal clearing for the construction, operation and maintenance of farm structures.

There are types of land, which are excluded from the operation of the Act, such as critical habitat under the *Threatened Species Conservation Act 1995*, land that is the specific subject of a State Environmental Planning Policy.

In Queensland land clearing is regulated by the Vegetation Management Act 1999 and operates through the *Integrated Planning Act 1997*. Where leasehold land is involved, the applicable statute is the *Land Act 1994*. As in NSW, the Vegetation Management Act 1999 covers clearing of all native trees or plants.

The Vegetation Management Act 1999 identifies certain regional ecosystems as being endangered, of concern or not of concern. This is relevant in that landowners must retain any endangered regional ecosystems, however, can obtain permits to clear those which are merely 'of concern'.

Regardless of the regulatory requirements the conservation of native biodiversity on-farm is accepted as a best management practice under myBMP which has a module, Natural Assets (managing the vegetative and riparian assets on your farm). The role of biodiversity conservation is also recognised in Integrated Pest Management to build populations of beneficial insects (those that predate on cotton pests).

Progress in implementing the recommendations of the Second Environmental Audit

The Second Environmental Audit made a number of recommendations on natural resource management issues including vegetation management, riparian zone management, soil health and wildlife conservation. Table 13 shows the ratings of the Third Environmental Assessment regarding the industry's adoption of the recommendations.

Table 13 : Rating of adoption of the Second Environmental Audit recommendations

Second Environmental Audit recommendations	Third Environmental Assessment: Rating of industry adoption
A Best Management Practice approach be established for the assessment and management of vegetation on farm and within a regional catchment context. The draft Land and Water BMP module should cover these issues.	High
Cotton growers be encouraged to retain and manage native vegetation on farms.	High

Second Environmental Audit recommendations	Third Environmental Assessment: Rating of industry adoption
Cotton growers need to be encouraged to plant trees and native vegetation on farms.	High
Access of livestock to rivers and creeks be managed to prevent erosion and degradation of stream banks, avoid damage to vegetation and riparian habitat, and prevent pollution of watercourses.	High
Growers with riparian areas on their farms be encouraged to follow best practice guidelines for management of riparian zones, such as those currently being produced by CRDC.	High
“Bug checkers”/consultants be encouraged to record beneficial insects if they don’t already do so.	High
On-farm testing of salinity indicators, including routine conductivity tests of irrigation water, be increased in potential salinity problem districts.	High
Guidelines be provided via the BMP manual for the identification and management of potentially contaminated sites.	High
A short information brochure be produced for farmers, which sets out low cost features that could be incorporated in existing and new water storage ponds to provide suitable habitat for wildlife.	High
More vegetated ‘islands’ be designed into new ponds (or constructed in existing water storages when low – like this season) for waterbird habitat.	High
Projects on waterbird-related biodiversity values of on-farm wetlands and storages be conducted.	High
Further studies on biodiversity of other species on cotton farms should be conducted.	High

Native vegetation

The conservation of native vegetation on their farms is valued for a number of reasons, but importantly due to its role in the effective implementation of integrated pest management (IPM) as it provides habitat for beneficials.

The Cotton Catchment Communities CRC (2012) estimates that cotton farms have on average approximately 40 per cent of their total land area dedicated to native vegetation. The Cotton Grower Practices Survey 2011 (GHD) found that 40 per cent of growers surveyed had actively managed native vegetation and riparian zones (96,323ha) over the previous five years and that 15 per cent of growers had revegetated areas on their farm.

The CRC (2012) also reports that in partnership with the Namoi Catchment Management Authority they have supported growers with property management plans covering 120,000 hectares of farming land and helped to conserve 65 kilometres of riparian zones and 900 hectares of native vegetation.

A key reference publication for growers is *Growing trees on cotton farms: a guide to assist cotton farmers to decide how, when, where and why to plant trees*, 1999 which was released in by the Rural Industries Research and Development Cooperation through a collaborative agro-forestry program.

Riparian management

The Second Environmental Audit considered that riparian zones were not always well managed. However since 2003 there has been considerable RD&E in riparian zone management in cotton growing areas. As a consequence there are extensive resources available to growers on riparian zone management including the myBMP natural assets module and the publication *Managing riparian lands in the cotton industry* (Cotton Catchment Communities CRC, CRDC and Land & Water Australia 2003). The previous Land & Water Australia had a National Riparian Lands Research & Development Program that produced extensive research reports on managing riparian zones on-farm.

The Cotton Grower Practices Survey 2011 (GHD) found that on average growers were actively managing eight kilometres of riparian country.

Sustainability and biodiversity conservation

The Second Environmental Audit reported that the industry, as a whole, had demonstrated increased awareness of sustainable development and biodiversity on farms.

These improvements have continued since then. The myBMP Natural Assets module provides guidance on conserving vegetated and riparian areas on farms and taking stock of soil and water assets. The key performance indicators for various levels of certification are as follows:

Level 2	Native vegetation is protected from negative impacts such as spray drift.
Level 3	Revegetation activities have been undertaken on areas of the farm.
Level 3	The condition of native vegetation is monitored/assessed over time.
Level 3	Important habitat features are retained in areas of native vegetation.
Level 3	Grazing in native vegetation areas is limited to promote natural regeneration.
Level 3	Regular weed and pest management is conducted in areas of native vegetation where required.
Level 4	A planned approach is used when enhancing or expanding remnant vegetation communities.
Level 4	Where practical, scattered paddock trees have been maintained to improve connectivity between areas of remnant vegetation.
Level 4	Corridors of native vegetation have been created with neighbours.
Level 4	A catchment approach has been taken to link areas of native vegetation on farm with stock routes, road reserves and other areas of remnant vegetation.
Level 4	A conservation covenant is in place to protect native vegetation areas.
Level 4	Seeds have been collected from native trees/grasses in areas of remnant vegetation on farm, and a nursery has been established.

The Second Environmental Audit also reported on the importance of wetlands and water storages to encourage wildlife on farms. Healthy wetlands attract birdlife and farmers are using water storages to produce fish, yabbies and mussels for harvesting.

Industry action following the Second Environmental Audit has been substantial through myBMP and the research and extension activities. The Cotton Catchment Communities CRC implemented a specific sub program targeting developing best practice techniques and guideline to enable industry and catchment bodies to better assess, manage and monitor biodiversity and ecosystem services.

The industry has invested in many R&D projects and publications such as:

- Biodiversity literature review (UNE);
- Ecosystem services and landscape patterns (CSIRO);
- Ecosystems services (UNE);
- Vegetation assessments (UNE);
- Birds (Cleland 2008), Partridge (2004),
- Biodiversity in Cotton landscapes calendar;
- Birds on Cotton farms book and calendar;
- IPM guidelines;
- A new pest and beneficial guide for cotton landscapes;
- Fish on cotton farms book / calendar; and
- Lippia Management Book.

Roth 2010 reviewed some wildlife research projects and concluded that there is a diverse range of wildlife on cotton farms, which is aided by the presence of water in rivers, billabongs and irrigation infrastructure. He noted that there are also common feral animals including wild pigs, cats and foxes.

A baseline study of water bird abundance associated with on farm water storages was conducted in the lower Gwydir valley during 1999-01 (Jarman and Montgomery 2002). Over 42,000 birds were counted, representing 45 species. Four of the eight water bird species listed on Schedule 2 of Threatened Species Act (maggie geese, blue billed duck, freckled duck and Australian bittern) were found in low numbers on the farm water storages. The water bird community included ducks, pelicans, darters, cormorants, herons, egrets, spoonbills, ibises, coots, and some water hens.

The study found very few water birds bred on the irrigation storages and found significant differences between sites with those storages featuring trees, logs, vegetation, mud islands and other diverse habitat having the most wildlife.

Research has shown that many small insectivorous bats have been found in around cotton crops and feed on the pest moth *Helicoverpa* spp and other species.

Soil health

The Second Environmental Audit also noted that there had been improvements in the management of cotton stubble, erosion, soil structure and condition, as part of implementing sustainable farming practices. Salinity in areas where it was a concern was being addressed with salinity investigations, testing, mapping and improved management.

Best practices for soil health and nutrition management are provided in the myBMP module *Soil Health*. A key soil management tool for growers is NutriLOGIC which is a web based decision support tool for interpreting soil and plant tissue results and calculating nutrition requirements. Inefficient use of fertilisers affects profitability through increased input costs, while excessive use of nitrogen fertilisers may impact on the environment through increased greenhouse gas emissions and groundwater pollution through leaching.

The Cotton Catchment Communities CRC (2012) reports that in collaboration with the Queensland Department of Agriculture, Fisheries and Forestry they coordinated a campaign which aimed to have 50 per cent of cotton growing hectares compliant with industry best practice (as defined by myBMP guidelines for soil health and crop nutrient practices) and 70 per cent of hectares using objective measurements to determine optimum nitrogen applications.

They also report that 85 per cent of Crop Consultants Australia growers surveyed are developing and implementing soil health and crop nutrition management plans. The CRC states that growers are incorporating crop rotations, minimum or conservation tillage, GPS guidance systems, permanent beds and yield mapping in their management plans. In addition they state a further 85 per cent of growers and 100 per cent of consultants are utilising soil tests to calculate crop nutrient requirements.

To assist in managing field productivity, the Self-Propelled Cotton Picker and Round Baler (John Deere 7760) can be equipped with Harvest Doc™ to collect harvest information. With the use of new software systems, growers can document and map yield data that can help to manage soil nutrition and any soil health issues at a very localised level.

In terms of soil structure, the increasing use of minimum tillage across crop rotations and precision agriculture in cotton growing has led to less soil disturbance and compacting. With precision agriculture, vehicle movement over paddocks is restricted to defined areas. The introduction of the round baler has been a recent innovation in picking, baling and handling that is showing significant increases in harvesting productivity and reduced soil compaction from machinery traffic.

Public policy and national programs

The period since the Second Environmental Audit has seen major changes in environmental and natural resource management public policy and programs that are being implemented at regional and local levels and therefore impact on cotton growing. This has included Government investments made through the Natural Heritage Trust and Caring for our Country which was introduced in 2008. Recently introduced initiatives such as the Biodiversity Fund which is part of the Government's Clean Energy Future package and the Carbon Farming Initiative.

A new phase of Caring for our Country will commence in 2013-14 for five years with funding of \$2.25 billion. The next phase of Caring for our Country will be delivered through two themes: sustainable environment and sustainable agriculture.

The Biodiversity Fund which will invest around \$946m over the next six years will provide opportunities for industry organisations, regional natural resource management organisations, Landcare groups and landholders to collaborate and undertake both on-farm and landscape scale projects in sustainable farming and improving the environment. Some of the intended projects fit well with current land management activities of cotton growers such as:

- expanding native habitat on properties through planting mixed vegetation species appropriate to the region in order to build landscape resilience and connectivity;
- protecting and enhancing existing native vegetation in high conservation areas on their land for its carbon storage and biodiversity benefits;

- managing threats to biodiversity by controlling invasive pests and weeds in a connected landscape.

The Carbon Farming Initiative (CFI) introduced by the Australian Government in 2011 allows farmers and other land managers to earn carbon credits by storing carbon or reducing greenhouse gas emissions on the land. These credits (Australian Carbon Credit Units) can be sold to businesses wishing to offset their emissions (buyers of carbon offsets). The Government also states that the CFI also helps rural communities and the environment by supporting sustainable farming and creating incentives for landscape rehabilitation.

Cotton Australia is leading the industry's involvement in the Carbon Farming Initiative during the initial phases of methodology development and the establishment of carbon trading. They are liaising with policy makers and the relevant R&D, industry and natural resource management agencies to coordinate industry participation and monitor developments.

Land use competition and conflict with mining and coal seam gas extraction

The issue of mining and coal seam gas (CSG) extraction is of concern to cotton growers in both Queensland and New South Wales. This was stated during farm visits and many growers have placed signs along roadsides voicing opposition to mining on their farms.

Many studies are currently being undertaken on this issue, including the work of the National Water Commission (NWC). In December 2010 the Commission issued a position statement on CSG) and water issues which arose out of community concerns about the potential risks to water resources. This statement set out high-level principles for managing the water impacts of CSG production. The Commission noted that at the time, objective information on CSG co-produced water volumes and management options was not readily available in the public domain. Therefore, the Commission funded the preparation of a Waterlines report, *Onshore co-produced water: extent and management* which explored the key issues.

The NWC considers that the principles listed in the CSG Position Statement provide a robust framework for the implementation of regulatory arrangements for managing the water impacts of CSG development. It has estimated that the Australian CSG industry could extract in the order of 7,500 gigalitres of water from groundwater systems over the next 25 years. This is equivalent to about 300 gigalitres per year. In comparison the current total extraction from the Great Artesian Basin is approximately 540 gigalitres per year.

The NWC highlighted the need for appropriate management of CSG developments consistent with the objectives of the National Water Initiative (NWI). It recommended that industry, water and land-use planners, and governments adopt a precautionary approach to CSG developments, ensuring that risks to the water resource are carefully and effectively managed.

The potential risks to sustainable water management have been listed by the Commission as including:

- Extracting large volumes of low-quality water will impact on connected surface and groundwater systems, some of which may already be fully or over allocated, including the Great Artesian Basin and Murray-Darling Basin.

- Impacts on other water users and the environment may occur due to the dramatic depressurisation of the coal seam, including:
 - changes in pressures of adjacent aquifers with consequential changes in water availability;
 - reductions in surface water flows in connected systems; and
 - land subsidence over large areas, affecting surface water systems, ecosystems, irrigation and grazing lands.
- The production of large volumes of treated waste water, if released to surface water systems, could alter natural flow patterns and have significant impacts on water quality, and river and wetland health.
- The practice of hydraulic fracturing (fracking) to increase gas output, has the potential to induce connection and cross-contamination between aquifers, with impacts on groundwater quality.
- The reinjection of treated waste water into other aquifers has the potential to change the beneficial use characteristics of those aquifers.
- In addition to these water management risks, CSG development could also cause significant social impacts by disrupting current land-use practices and the local environment through infrastructure construction and access.

The National Water Commission is concerned that CSG development represents a substantial risk to sustainable water management given the combination of material uncertainty about water impacts, the significance of potential impacts, and the long time period over which they may emerge and continue to have effect.

The cotton industry, through Cotton Australia, is participating in policy and research discussions on mining and CSG issues. Cotton Australia has a full time Mining and CSG Policy Officer who is engaged with growers, other farm groups and government on the issue. This officer works in cooperation with Cotton Australia's National Water Policy Manager to address common water issues and produce both a CSG policy and beneficial water use policy.

Cotton Australia has also established a grower advisory Mining and CSG Committee that is considering a draft policy position for the industry. It reports that it is addressing key issues including the harmonisation of land use conflicts between farming and mining practices in this policy. The intention of this work is to provide information to the resources sector on differences in farming practices such as between irrigated farmland and extensive grazing.

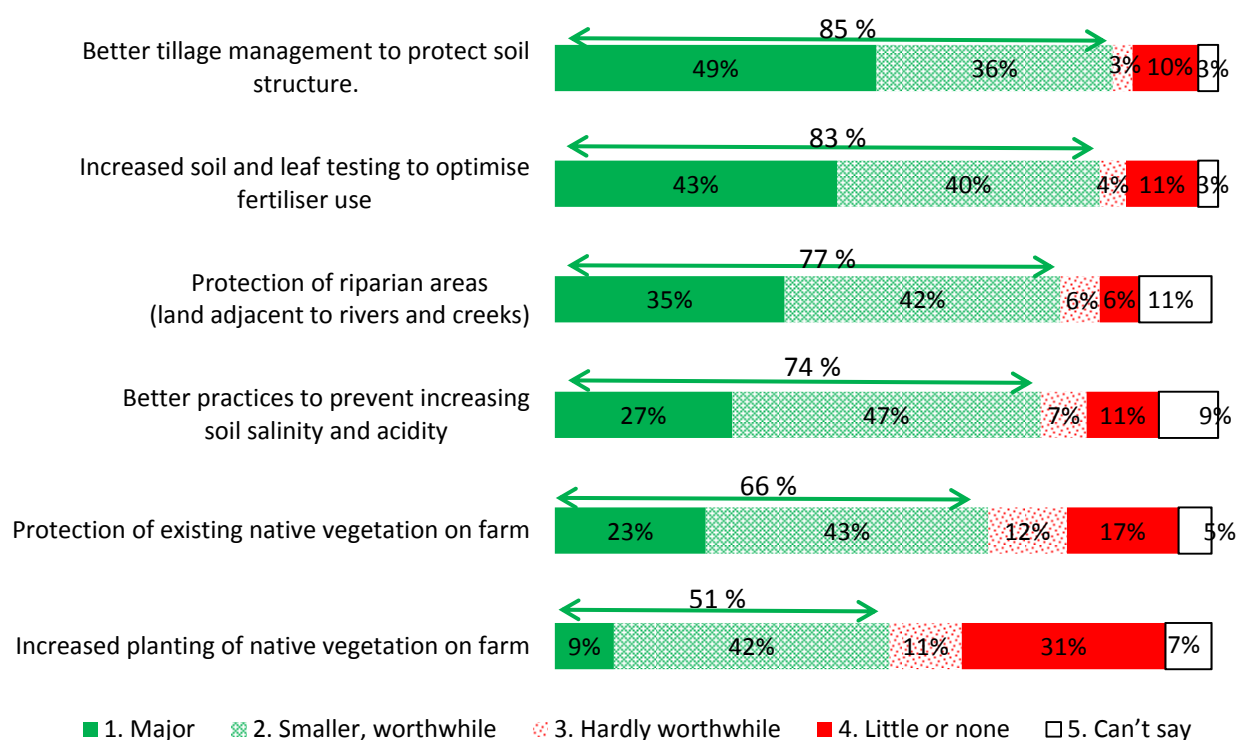
It also reports that it is participating in the development of acceptable access arrangements in New South Wales and conduct and compensation arrangements in Queensland. The aim is to secure suitable compensation arrangements for growers and to ensure on-site work practices of miners do not unreasonably hinder farming operations. The issue of compensation for water quantity or quality losses and concerns about mineral extraction such as health impacts, noise and visual amenity impacts from open cut mining are being addressed.

Perceptions of grower and stakeholders industry's land management

The *Cotton Grower Environmental Performance Survey 2012* shows that growers have made significant improvements in land vegetation management since 2003:

- 85 per cent growers consider that worthwhile to major improvements have been achieved for better tillage management to protect soil structure;
- 83 per cent for soil and leaf testing to optimise and reduce fertiliser use;
- 77 per cent for protection of riparian areas;
- 74 per cent for better practices for preventing increasing soil salinity and acidity;
- 66 per cent for protecting native vegetation on-farm; and
- 51 per cent for planting native vegetation on-farm.

Figure 19: Grower perceptions on improvements in land management



Source: *Cotton Grower Environmental Performance Survey 2012*

When asked what three key improvements they have made to reduce the environmental impact of their own cotton growing since 2003, better tillage management figured prominently, soil health improvement somewhat lower and vegetation and riparian protection only rated by a few growers as a top three achievement. When considering where the main achievements have been made across their growing their region, improve soil health and better tillage management are rated relatively highly, but native vegetation management figured outside the top three achievements by most growers.

Ratings of improvement in land management are not quite as positive amongst stakeholders compared with growers, although stakeholders see improved tillage and optimising fertiliser use as major achievements. Although the largest proportion of stakeholders rate planting or conservation of native vegetation to be a worthwhile improvement, some survey respondents including individuals from government and the cotton industry consider that there had been very little improvement. Stakeholder perceptions of progress in protecting of biodiversity on farms and riparian zone protection are similar with the largest proportion of stakeholders rating these aspects as illustrating worthwhile improvement with some considering that there has been very little improvement.

Stakeholders' assessments of practices to improve soil health are more positive with more respondents rating the improvements as outstanding or worthwhile. Practices mentioned included preventing soil structure breakdown; preventing increasing salinity, acidity and sodicity; avoiding excessive nitrogen use and increasing soil carbon.

Conclusions

In the past decade the industry has given priority to conservation of remnant native vegetation on-farms by fencing to prevent access by livestock and weed control; native vegetation planting to increase the coverage especially in strategic areas such as corridors and riparian zones; protection of riparian zones by fencing to exclude livestock and providing watering points away from water bodies; and soil health management to reduce soil structure breakdown; prevent increasing salinity, acidity and sodicity; avoiding over fertilising, and soil amelioration through the addition of organic matter or carbon sequestering OR practices to enhance soil health and sequester.

With the establishment of the Cotton Catchment Communities Cooperative Research Centre in 2005, the CRC introduced a Catchment Program and embarked on developing an extensive portfolio of research and publications about biodiversity on cotton farms. There have been many benchmarking and specific studies that show that it is a high priority area for growers and that substantial efforts have been made and many outcomes achieved.

The evidence demonstrates that while substantial progress has been made regarding land management practices, growers continue to identify elements of land management such as improving soil health as an area in which they are planning further improvement in the next three to five years. Industry RD&E strategy needs to continue to inform growers as part of a continuous improvement agenda for all areas of land, vegetation, soil and biodiversity management both on-farm and across landscapes.

The industry is engaging with new national initiatives or funds under the Australian Government's Clean Energy Future package (the Carbon Farming Initiative, Carbon Farming Futures and the Biodiversity Fund) and phase two of Caring for our Country which will run from 2013 to 2018. Investigation should continue on how cotton growers can access carbon credits and benefit from planting native vegetation according to the approved methodology. This could include investigation of how growers can cooperate and pool credits from their on-farm planting across a landscape such as valley catchments.

Natural resource management is an area where the progress and the excellent results need to be communicated to the community, the industry value chain and international retailers and consumers. It is an area that conservation groups should recognise.

4.6 Energy Efficiency, Carbon Emissions and Climate Change

Introduction

Energy efficiency, carbon emissions and climate change are relatively new environmental concerns for the Australian cotton industry. There were only two recommendations in the Second Environmental Audit relating to energy efficiency, both of which have been implemented:

- the cotton industry assess overall energy use and develop guidelines for energy and cost savings; and
- a research project on the life cycle assessment of cotton compared with synthetic fibres could be considered.

Life Cycle Assessments have been undertaken for a 100 per cent cotton T-shirt (Grace and Navarro, Institute of Sustainable Resources, QUT, 2009). This study compared 'cradle to grave' production of a cotton tee shirt with a polyester tee shirt. The reported results show that a cotton tee shirt has lower impact in relation to climate change, ozone layer depletion, mineral resources depletion and fossil fuel depletion.

The issues of greenhouse gas emissions and climate change were not addressed in the Second Environmental Audit, but the industry has actively engaged in research and other initiatives in these areas. With the implementation of the Clean Energy Future package including the Carbon Farming Initiative in 2011-12, and the introduction of the carbon tax on 1 July 2012, these issues are likely to become more prominent for the industry in future. It should be noted that the carbon tax has not been imposed on agriculture, but it will have some flow on effects to the cotton industry in terms of prices of inputs including energy. The industry has researched the impact and this is being addressed through policy forums.

Industry action since 2003

Energy efficiency

In 2007 the Cotton Research and Development Corporation commissioned a project with the National Centre for Engineering in Agriculture (NCEA) to assess energy use on a series of representative cotton farms. The resulting report *Development of energycalc - a tool to assess cotton on-farm energy uses* showed that energy use on cotton farms was dominated by harvest and pumping for irrigation. The project also developed a prototype on-farm energy calculator 'EnergyCalc' which is available for use by growers through NCEA.

This research has been extended to build on the original project with more detailed energy use assessments, including on the original seven case study farms. Some case studies show improved

energy use efficiency from changes to pumping systems on cotton farms. Training modules on irrigation pump efficiency have also been developed.

The cotton industry has been active in researching options for greater energy efficiency on farm. This includes developing energy use benchmarks and tools to audit, assess and improve energy efficiency, and being ready to exploit opportunities such as bio-diesel.

Improved cotton growing operations are also resulting in lower fuel use. These include:

- the introduction of Bt cotton and improved integrated pest management has reduced the number of spray applications required,
- adoption of minimum tillage for crop rotations which has reduced cultivation;
- innovations in picking, baling and handling through the self-propelled picker and round baler has resulted in major increases in harvesting productivity and reduced machinery operation; and
- more fuel efficient machinery (e.g. tractors and pumps) are being purchased by growers and contractors.

Greenhouse gas emissions

Cotton growing emits greenhouse gases (GHG) through:

- carbon dioxide being released from soils through the decomposition of soil organic matter especially after cultivation;
- carbon dioxide being emitted from fuel use during cultivation, planting, harvesting and water pumping;
- nitrous oxide being emitted from the application of nitrogen fertiliser and from organic nitrogen sources; and
- methane being emitted from water logging after flooding or excessive irrigation.

Nitrous oxide released from processes of denitrification and inefficient application of nitrogen based fertilisers are a significant source greenhouse gas emissions on cotton farms. However the industry reports that estimates of energy use compared to average soil greenhouse gas emissions from nitrogen fertilisers suggest that emissions on an 'average' cotton farm are about equal for each source. They conclude that improvements in energy use efficiency and nitrogen use efficiency are equally important from a cost and greenhouse gas (GHG) emissions viewpoint.

Although research has shown that nitrous oxide emissions from Australian cotton farms are actually substantially lower than those of other cotton growing regions throughout the world, issues associated with increased levels of unused nitrogen could increase nitrous oxide emissions into the atmosphere.

While cotton growing is a small contributor to agricultural GHG emissions, the industry has explored, and where feasible implemented, different opportunities for the management and reduction of emissions. These include:

- improved fertiliser management (optimising application and use of fertilisers with reduced nitrogen loss);
- increasing soil carbon through adding more organic matter (e.g. stubble, cotton trash and manure);
- planting vegetation in farm corridors, riparian zones and on areas of less productive land and composting using cotton trash and manure;
- maximising machinery performance and exploring bio-fuel;
- purchasing more fuel efficient machinery and equipment;
- reducing frequency of operations in spraying and tillage;
- using the self-propelled picker and round baler resulting in less machinery use and lower emissions from harvesting and handling; and
- improving water use efficiency to reduce excessive irrigation and waterlogging;

The industry has developed a Cotton Greenhouse Gas calculator through the work of the Queensland University of Technology's Institute for Sustainable Resources in collaboration with the Cotton Research and Development Corporation and the Cotton Catchment Communities CRC. The calculator allows growers to gain an overall indication of the GHG emissions from farm operations. The online version enables individual growers to calculate an estimate of the GHG footprint of their farms.

Cotton Australia is leading the industry initiative to participate in government policies and programs for carbon farming and its implications for reducing GHG emissions in cotton growing and capitalising on the opportunities for mitigation and abatement. The industry has been actively engaged in the Climate Change Research Strategy for Primary Industries (CCRSPI) through the Cotton Research and Development Corporation. It operates under the mandate of the Primary Industry Ministerial Council and Primary Industry Standing Committee and produced a climate change cross-sectoral strategy for all agricultural industries.

Cotton Australia is also a member of the National Farmers' Federation's Carbon Taskforce which contributes two members for the Australian Government's Expert Panel that provides advice on the Land Sector package including the Carbon Farming Initiative under the Clean Energy Future initiative. In addition the Cotton Australia Policy Manager is a participant in the inaugural PIARN Master Class on climate change adaptation in the primary industries. This initiative aims build capacity amongst early and mid-career researchers, research managers and policy analysts in the climate change adaptation field.

The industry reports that its engagement with these national initiatives has been valuable for providing cotton industry perspectives into national policy and program design and giving feedback to the industry on its participation in programs and possible funding opportunities.

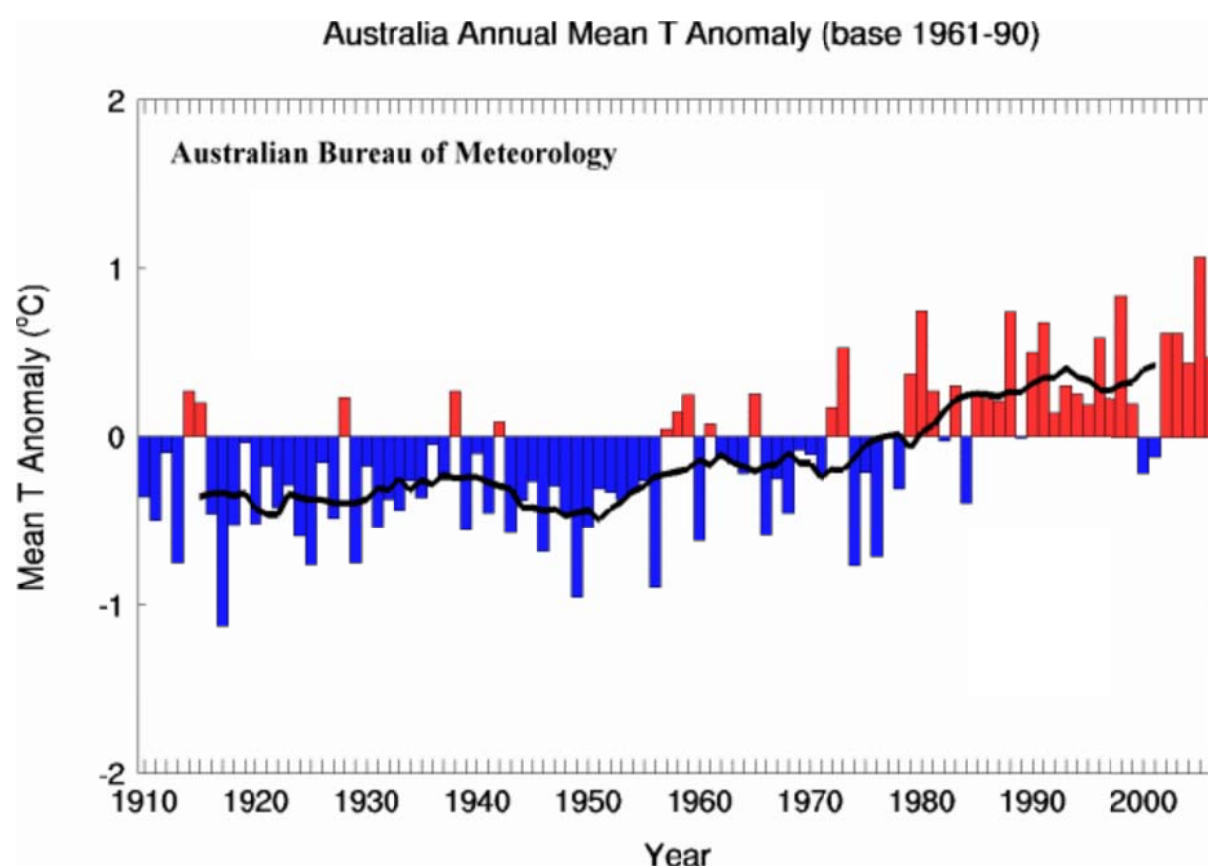
The Australian Government has implemented two significant programs as part of the Land Sector Package of the Clean Energy Future package. These are the \$201 million *Filling the Research Gap* program and the \$99 million *Action on the Ground* program. Both of these programs have been

implemented to provide support for further research and analysis into innovative technologies and practices that would aid in reducing GHG emissions, increasing soil carbon, and enhancing sustainable agricultural practices. The *Filling the Research Gap* program supports research into new technologies and practices for the reduction of emissions and sequestration through soil carbon, while the *Action on the Ground* program provides assistance to industry and farm groups in testing and applying the research. These programs are both in their initial stages and will continue to develop into the future as part of the carbon and energy efficiency initiative.

Climate change

Australia's average maximum temperature has risen 0.06°C per decade and its average minimum temperature has increased 0.12°C per decade in the past century. Although these trends have varied in different regions, almost all of Australia has experienced a rise in mean temperatures. These trends in climate change have been observed throughout cotton growing regions across Australia.

Figure 20: Australian annual mean temperature anomalies from 1901 to 2006



Seasonally, maximum summer temperatures have risen up to 0.3°C per decade in many areas across Australia. Concurrently, the number of 'hot' days has been increasing while cold nights have been decreasing. Although such small increases in temperature may not appear to yield dramatic changes in climate, research suggests that such increases have resulted in increases in severity of heatwaves and decreases in temperature cool downs at night. If these trends continue, it will affect agriculture including cotton growing.

Similarly to temperature changes, historic rainfall rates have also seen changes in the past century. Rainfall averages were generally high during the late 1800s, but at the turn of the 20th century rainfall rates began to experience declines. These declines picked up through the mid- to late 1900s, but since then trends have been mixed; eastern and south-west Western Australia have seen dryer trends in climate, while north-west Western Australia has seen increases in rainfall.

Research in climate change suggests that although trends of variable rainfall have been associated with natural causes, factors such as changes in pollution, stratospheric ozone depletion and increasing atmospheric greenhouse gas concentrations have also influenced weather patterns across Australia. For example, in the north-western regions of Australia, increases in rainfall have been attributed partially to heightened levels of greenhouse gases.

CSIRO has made projections for what the climate may look like in Australia in the next few decades. Key projections for Australia that are also applicable to cotton growing areas are:

- most of Australia to warm 0.4 to 2.0°C by 2030;
- most of Australia to warm 1 to 6°C by 2070;
- warming is expected to be higher inland;
- a higher rate of warming in spring and summer than autumn and winter; and
- an increase in the average number of extreme hot days and decrease in the average number of extreme cold days and frosts

In terms of rainfall, CSIRO has projected the following which are applicable to cotton growing areas:

- a tendency towards a lower annual average rainfall in the south east and parts of Queensland (-10 to +5 per cent by 2030, -35 to +10 per cent by 2070);
- A tendency towards less rainfall across most of Australia (especially southern Australia) during winter and spring: -20 to +5 per cent by 2030, -60 to +10 per cent by 2070.
- Projected rainfall changes during summer and autumn towards less rainfall during summer and autumn: -10 to +5 per cent by 2030, -60 to +10 per cent by 2070.
- There will be increases in extreme daily rainfall

Implications of climate change for the cotton industry

The rise in overall temperature and varying rainfall patterns across Australia will continue to affect the agricultural sector including cotton. Research shows that even if rainfall remains consistent with long term averages, the rise in overall temperatures and potential decreases in water balance indicates greater moisture stress throughout Australia. This suggests that access to water and water use efficiency will be even more important in the future.

With regard to cotton growing the net impact of the climate change projection is uncertain. For example, rises in atmospheric carbon dioxide levels could increase plant photosynthesis and potentially result in higher crop yields. However, simultaneous declines in rainfall and increases in

temperature resulting in increased evapotranspiration could counter the growth benefits from higher atmospheric carbon dioxide levels.

Similarly, increases in temperatures at the beginning and end of the growing season could positively influence cotton yield by prolonging the window for cotton growth. However, a greater frequency of days and nights with high temperatures would hinder both growth and development of cotton.

In view of the uncertain implications of climate change for cotton growing, the Cotton Catchment Communities CRC has outlined two areas that will need to be investigated thoroughly in the future:

- the inter-relationships of impacts on cotton growing resulting from changes in rainfall, in carbon dioxide concentration, reduced water availability, increased atmospheric evaporative demand (lower humidity), and increases in temperature; and
- the relative degree to which these impacts may occur in different growing regions.

One of the planning assumptions of the Cotton Research and Development Corporation (CRDC) in its Strategic Research and Development Plan for 2008-13, is that *'changing climate and energy consumption are intrinsically entwined in any existing and new farming system.'* This implies that cotton growing must be resilient, sustainable, and profitable.

The former Australian Greenhouse Office and the Cotton Catchment Communities CRC funded climate change workshops under a *Climate Change in Cotton Communities* project. These workshops covered important themes in climate change such as the implications for cotton farming, changes in crop agronomy and management, new cotton farming systems and research needs.

The CRDC also provided support for research to improve the cotton crop simulation model, OZCOT. OZCOT is a crop simulator model used under the HydroLOGIC irrigation management tool that assesses the impact of different management strategies for irrigated cotton production and the prospects for rain-fed cotton production in the major cotton growing regions. This model enables the analysis of how cotton crops react to different environmental and management conditions. The industry reports that by using long-term weather data, OZCOT can effectively predict the behaviour of cotton crops, providing scientists with information on successes and challenges of implementing certain crop management actions.

In summary, the key actions of the industry in response to climate change include:

- improving management of climate variability (improving use of short medium and long-term weather and climate forecasts, improving climate risk management including understanding and managing the trends and extremes regionally and globally for production and implications for our markets such as the impact of potential global drying trends on Australia's competitors);
- undertaking plant breeding and research into changed farming systems to take advantage of increased temperatures, to manage increased water stress and to respond to elevated atmospheric carbon dioxide levels; and
- improving water use efficiency to provide savings in allocations that can be used during droughts.

The myBMP module *Energy and Input Efficiency* provides extension information for growers that is relevant to carbon farming and emissions reduction in cotton growing.

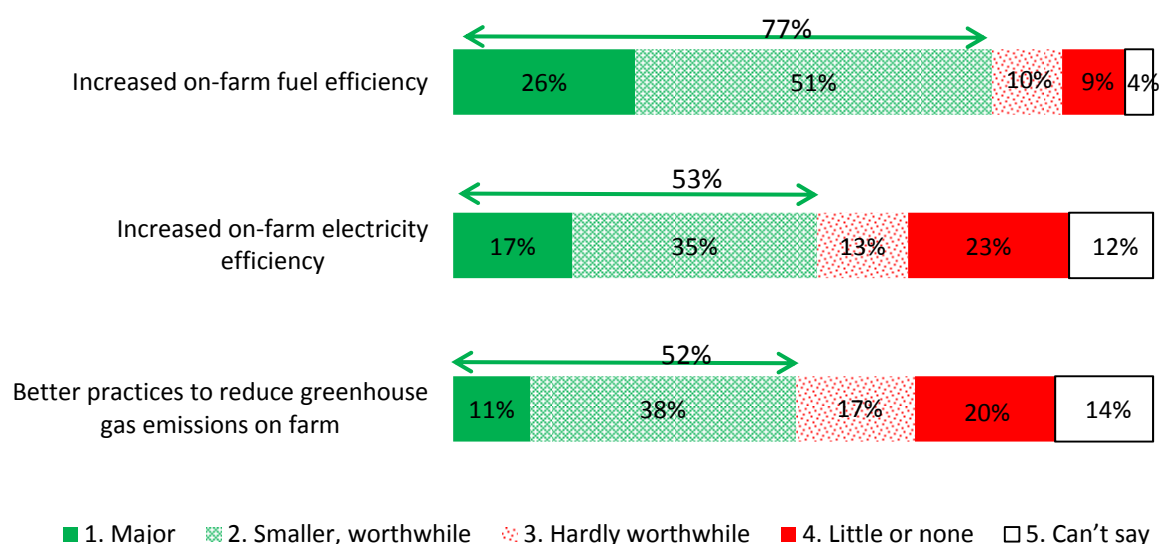
Perceptions of grower and stakeholders on energy efficiency, greenhouse gas emissions and climate change

The majority of growers surveyed consider that they had made worthwhile to major improvements in various aspects of GHG management in the past decade:

- 77 per cent believe that worthwhile or major improvements have been achieved for increased fuel efficiency;
- 53 for greater electricity efficiency; and
- 52 per cent for better farming operations and land management practices to reduce greenhouse gas emissions.

Farm visits confirmed that fuel efficiencies have been achieved through new generation machinery having greater diesel fuel efficiency, less use of machinery because of minimal till regimes across their crop rotations and reduced use of spraying equipment.

Figure 21: Stakeholder perceptions of improvements in greenhouse gas emissions



Source: Cotton Grower Environmental Performance Survey 2012

Growers rate a reduction in greenhouse gas emissions from their cotton operations as the seventh highest priority and further fuel efficiencies as the eighth priority over the next three to five years.

Conclusions

The cotton industry has been active in researching and developing techniques for greater energy efficiency on farm. This includes developing energy use benchmarks and tools to audit, assess and improve energy efficiency, and being ready to exploit opportunities such as bio-diesel.

On the ground, improved cotton growing operations and machinery are resulting in lower fuel use through the following:

- the introduction of Bt cotton and improved integrated pest management has reduced the number of spray applications required,
- adoption of minimum tillage for crop rotations which has reduced cultivation;
- innovations in picking, baling and handling through the self-propelled picker and round baler has resulted in major increases in harvesting productivity and reduced machinery operation; and
- more fuel efficient machinery (e.g. tractors and pumps) being purchased by growers and contractors.

In the case of greenhouse gas emissions (GHG), research and development and adoption is still at an early stage. With the implementation of the Clean Energy Futures Package, including the Carbon Farming Initiative, and the carbon tax on 1 July 2012, GHG emissions will increasingly be a priority RD&E and implementation issue for all of agriculture, including cotton. Strategic plans and investments by the industry's organisations has acknowledged this and put in place strategies and actions.

Cotton growing is a small contributor to agricultural GHG emissions and the industry has explored, and where feasible implemented, different opportunities for the management and reduction of emissions. These include: improved fertiliser management; increasing soil carbon; planting vegetation in farm corridors, riparian zones and on areas of less productive land and composting using cotton trash and manure; achieving improved fuel efficiency through more fuel-efficient machinery performance and exploring bio-fuel use; purchasing more fuel efficient machinery and equipment; reducing frequency of operations in spraying, tillage and harvesting; and reducing methane emission by preventing waterlogging where feasible.

Cotton is generally grown in areas that are susceptible to climate change in the form of reduced rainfall and higher temperatures with associated higher evaporation. The industry has given priority to climate change in its RD&E strategies over an extended period of time. Cotton Australia's Strategic Plan addresses climate change and the participation of the cotton industry in the carbon economy.

Progress has been made by the industry in the following areas:

- development of the NutriLOGIC system for optimising soil nutrition and minimising over fertilisation leading to nitrous oxide emissions;
- improving cotton growing practices in response to increased climate variability;
- undertaking plant breeding and research into changed farming systems to take advantage of increased temperatures, to manage increased water stress and to respond to elevated atmospheric carbon dioxide levels; and
- improving water use efficiency to provide savings in allocations that can be used during droughts of increasing frequency and intensity.

Section 5: The emerging drivers of improved environmental performance

5.1 Introduction

The previous sections of this report analysis how the industry has changed on-farm production and environmental management to reduce the impact of cotton growing. As noted previously in this report at the time of the First and Second Environmental Audits incidents relating to pesticide use triggered adverse publicity and the risk of government regulatory action. This resulted in strong industry research and development efforts with targeted extension through the BMP program. Major improvements were subsequently made by farmers in reducing the impact of cotton growing on the environment, particularly through a large reduction in pesticide use and improved water management.

This report notes a significantly changed context in how the industry now faces its environmental management challenges. The operating environment for the industry is now much more complex and demanding in terms of:

- competitiveness and market expectations;
- profitability margins;
- regulatory requirements;
- government expectations through public policy;
- environmental and natural resource management programs operating at regional and landscape scales;
- pressures on Murray Darling Basin water resources; and
- public expectations for good environmental and social stewardship.

The relentless pressures for growers achieving productivity and profitability increases in the face of declining in the terms of trade for cotton lies at the forefront of industry thinking as does the industry's reputation for environmental stewardship.

The CRDC Chair has noted that *'For cotton to successfully compete for the available land & water resources we need to be closer to the technical needs of our customers'*. He also stated that global demand for food, fibre and energy means there will be *'more competition for our land and water to grow a wider range of crops. We need a farming system that is flexible to producing a wide range of crops without antagonism and with complementarity'*.

The flexibility of the cotton farming system became a key aspect of the CRDC Strategic R&D Plan 2008-13. The goals of the plan are to:

1. Add value to the Australian Cotton industry with premium products operating in improved routes to market;

2. (Advance) cotton in a highly productive farming system with improved environmental performance; and
3. (Continue) a culture of innovation and learning.

The term of this plan is nearing its completion date and the industry is looking towards future directions. The industry, therefore, has to address its future RD&E agenda against its increasingly complex operating environment.

The Vision2029 aspirations set the goal posts for future performance and an Australian cotton industry that is a:

Differentiated producer – world leading supplier of elite quality cotton that is highly sought after in premium market segments;

Responsible producer – supplier of the most environmentally and socially responsible cotton on the globe;

Tough industry – resilient and equipped for future challenges;

Successful industry – exciting new levels of performance that transform productivity and profitability of every sector of the industry;

Respected industry – an industry recognised and valued by the wider community for its contribution to fibre and food needs of the world; and

Capable industry – an industry that retains, attracts and develops highly capable people.

In terms of environmental stewardship, the industry can move into a future with a background of assessing its environmental performance over two decades, building a knowledge base through research in the past decade provides data to benchmark its performance and provides science-based best practices for growers to adopt. It is fortunate for the industry's further growth and prosperity, that the drivers for productivity and profitability increases are also the key drivers for environmental improvement. Achieving efficiencies in water, chemical and energy use reduces costs and contributes to increasing productivity and profitability, but also contributes to reducing the impact of cotton growing on the environment.

This report finds that the emerging drivers for further improvements in the environmental performance of cotton growing over the next decade are centring around: the influence of public policy and programs; the requirement for flexible and adaptive farming systems to meet productivity and profitability challenges and changing climate; international retailer, consumer and value chain market drivers for environmental sustainability; and Australian public opinion industry and business performance in terms of environmental and social stewardship.

The need for flexible and adaptive farming systems has been discussed previously in this report. Similarly, the central role of Australian Government policies and programs has been discussed in this report under water and land management; and energy efficiency, greenhouse gas emissions and climate change. These key policies and programs include: Clean Energy Future package, phase 2 of Caring for our Country for 2013-18, the Murray Darling Basin Plan (when it is approved and implemented), and the continuation of the continuation of the National Water Initiative reforms and Water for the Future programs.

This section addresses the market drivers for environmental sustainability and the need for the industry to improve its reputation in Australia and maintain its 'social licence to farm'.

5.1 Market drivers for environmental sustainability

The influence of international retailers, consumers and environmental groups

A key driver for improved environmental performance today is the influence of consumers and major retailers. Consolidation of industries, integration of value chains and the advance of information technology all combine to place retailers in an increasingly powerful position to influence suppliers. Key international retailers have strong corporate social responsibility agendas and are setting sustainable cotton targets. The evidence is that environmental interest groups, consumers and the wider public are engaging directly with retailers to influence these companies to improve and demonstrate sustainability through the value chain including farmers.

In response, there is now a critical momentum with major retailers to take action and ensure their corporate social responsibility plans and targets are in place to reflect and demonstrate their environmental and ethical credentials. For the cotton industry, the Better Cotton Initiative (BCI) provides clear evidence of the significance of the strategic shift for cotton supply chain firms. Major retailers have set explicit and public targets for sourcing sustainable produced cotton.

The implication for Australia is that even though Australian cotton is produced to high environmental standards relative to most other countries, retailers and consumers are going to drive change through global cotton production systems in the next decade and beyond. The Australian industry needs to be actively engaged with initiatives such as the Better Cotton Initiative and relevant international forums to ensure that performance indicators sought by the value chain are feasible and useful for Australian growers.

Better Cotton Initiative

The Better Cotton Initiative was founded in 2005 by the Adidas Group, Gap Inc., H&M, ICCO, IFAP, IFC, IKEA, Organic Exchange, Oxfam, PAN UK, and the World Wildlife Fund (WWF).

The Initiative has defined Better Cotton as being produced by farmers who:

- Minimize the harmful impact of crop protection practices;
- Use water efficiently and care for the availability of water;
- Care for the health of the soil;
- Conserve natural habitats;
- Care for and preserve the quality of the fibre; and
- Promote decent work.

BCI describes its endeavours as initiating global change in the mass market with long-term benefits for the environment, farmers and other people dependent on cotton for their livelihood according to its website.³

The following major retailers have set the following targets for their use of cotton.

Table 14: Major retailers and targets for their use of cotton

IKEA	100 per cent Better Cotton use by 2015 Current estimated cotton use about 210,000 MT
Levi Strauss	20 per cent of the cotton used in jeans to be Better Cotton by 2015
Adidas	100 per cent Better Cotton use by 2018
H&M	By 2020, all cotton products made from sustainable sources (Better Cotton, organic, recycled) Current cotton use estimated at over 200,000 MT
M&S	25 per cent of cotton from sustainable sources by 2015
Walmart	Walmart U.S. is intent on procuring cotton from more socially and environmentally sustainable sources

Source: Sustainable cotton targets of various retailers and brands sourced from websites.

Governments are also setting policies around the supply of products from sustainable agriculture. For example, the UK Government (Department for Environment Food and Rural Affairs) has a Sustainable Clothing Action Plan that includes:

- Improving Environmental Performance across the supply chain;
- Consumption trends and behaviour;
- Awareness, media, education and networks;
- Creating market drivers; and
- Traceability across the supply chain (ethics, trade and environment).

The Plan is aimed at the development of a tool that will allow brands and retailers to determine their environmental footprint from raw material to consumer use and disposal. The process starts by determining their annual fibre consumption which is translated into energy, water and carbon use.

5.2 Maintenance of the ‘social licence to farm’.

A major CSIRO publication, *Defending the Social Licence of Farming: Issues, Challenges and New Directions for Agriculture* (Williams and Martin –Eds, 2011) with authors from Australia, the US, Europe and Iceland contend that:

“Farmers are increasingly expected to demonstrate their social and environmental responsibility as a pre-condition to being allowed to carry out their preferred farming and commercial practices.” In Australia, it is suggested that: “issues including climate variability,

³ http://wwf.panda.org/wwf_news/?169863/Better-cotton-threading-its-way-towards-global-markets

water scarcity, animal welfare and declining biodiversity have led to increasing demands on farmers to conduct and communicate their farming practices so as to protect their ‘social licence to farm.’

The authors also contend that:

“As resources become scarce and society’s expectations more diverse and demanding, farming can expect that social licence issues will become both more difficult and more important. The old models of response, largely focused on defensive positions, will often be insufficient to protect the interests of both farmers and the community.”

Instead the authors advocate innovation and proactive policies to defend the social licence of the farm sector.

Roth (2011) provides a chapter, *Retaining the social licence: the Australian cotton industry case study* and argues that the cotton industry is one that has successfully retained a social licence and has addressed consumer perceptions through the use of proactive approaches. This section of the report looks at the evidence of the industry successfully presenting itself as environmentally responsible to the Australian community.

Australian community perceptions of cotton growing

The Australian cotton industry through Vision2029 has stated that achievement of its aspirational characteristics depends on how the industry is perceived by every link of the value chain⁴, by consumers and by the wider community.

This Third Environmental Assessment therefore conducted some qualitative research on community perceptions of cotton growing. This research was undertaken to complement previous studies and sought to investigate how the Australian cotton industry’s environmental performance is perceived by the general community, how the changes and improvements made in the cotton industry over the previous decade are perceived by the general community, and what the community believes the cotton industry needs to improve to become even more environmentally friendly.

Community focus groups had been conducted in 2003, 2005 and 2007 to assess the community’s attitudes and perceptions of the cotton industry in Australia, and to ascertain areas of environmental concern.

The industry’s qualitative research over the years on the community’s attitude towards the cotton industry has varied. In the 1990s, the perception was quite negative, but in recent times it has become more neutral. Whilst cotton growers have made numerous changes to their production practices which have substantially reduced the industry’s environmental impact, some of the stigma attached to cotton growing from earlier years remains particularly in the areas of chemical and water use.

⁴ Described as comprising seed and chemical distributors, growers, consultants, researchers, pickers, truckers, ginnerers, classers, merchants, spinners and brand owners (Vision2029: What is the future of the Australian Cotton Industry).

Overview of previous research:

Stollznaw (1997): Qualitative investigation of community attitudes towards cotton growing

In the Stollznaw research, the highest level of environmental concern was related to the use and application of chemicals causing damage to the surrounding environment. The aerial application of chemical spray and amount of pesticides and herbicides used was viewed very negatively. This was followed by concerns relating to excessive water use and the degradation of water quality in nearby rivers and wetlands.

The community considered cotton growing was the least environmentally friendly of all agricultural industries and it had the least respect. Furthermore, individuals that had some connection to the cotton industry identified the same level of concern about the impact of the cotton industry on the environment as individuals not involved in the industry.

GHD (2003): The Second Australian Cotton Industry Environmental Audit

During the second environmental audit a survey was administered to three independent groups, the cotton industry, government agencies and to individuals in the community not involved in the cotton industry to further assess the community's attitudes towards the cotton industry in Australia.

The audit found that water use and the depletion of ground water sources were of most concern in relation to cotton production. Concern about chemical use remained high and related to aerial spraying and spray drift, chemical residue in soils and water pollution as the result of chemical use. This was followed by concerns for the retention of wildlife corridors and environmental flows for rivers and wetlands. Land clearing and soil erosion were also identified as issues of environmental concern. Another finding was that there was a proportion of the community that was now concerned about the lack of information available about the environmental impact of the cotton industry.

Roy Morgan (2005): Attitudinal research into the cotton industry

This research encompassed individuals from cities, regional centres and cotton communities. Its purpose was to provide a broader look at the community's perceptions of, and attitudes towards the cotton industry in Australia.

Similar to the second environmental audit, this research found that water use and water shortages were identified as the key environmental concern across all sectors. Other environmental issues identified depended on where the individual lived, for instance air pollution was a key issue identified by city respondents, whilst chemical use was the key issue for individuals from cotton communities.

In line with the Stollznaw research in 1997, individuals still believed that the cotton industry had the highest environmental impact, highest chemical and water use, and least concern for the environment than any other agricultural industries, including cattle, sheep for wool and meat, and rice.

Whilst city, regional centre and cotton communities identified similar environmental concerns, the attitudes held towards the cotton community varied between these groups, with individuals in the cotton community having the most positive view on the cotton industry, while city respondents were more likely to have the least knowledge of and have no opinion of the cotton industry.

The main reasons driving a positive opinion of the industry in cotton communities were the perceptions that the industry makes a major contribution to the Australian and regional economies, and created jobs for residents. For city dwellers, positive perceptions of the cotton industry related to the end product such as garments.

The main drivers behind a negative opinion of the cotton industry were related to the perceived high impact the cotton industry has on the environment and these included high levels of water consumption and the application of excessive and dangerous chemicals.

This research also found that there had been a positive shift in attitudes within cotton communities over time, but the attitudes held by individuals in the city and regional centres had remained the same.

Groups with neutral attitudes were seen to have little information and interest in the cotton industry. Many city and regional dwellers were unable to comment, as they did not have an opinion on the issues.

The low awareness of the cotton industry as a whole by individuals from cities and regional centres also applied to awareness of the BMP program. In comparison, cotton community residents had greater awareness.

Awareness of specific facts about cotton production was also low in city and regional centre dwellers and higher for individuals in cotton communities. However, even individuals within cotton communities had a low awareness of the innovation and improvements made by growers to increase water use efficiency and decrease chemical use.

When individuals were asked to identify key areas that would most change their opinion of the cotton industry they nominated research and development to reduce use of chemicals and increase water use efficiency.

The research investigated community perceptions toward the use of genetically modified cotton being grown. Many individuals stated that whilst they would be against the use of genetic modification for food production, they would be open to the use of genetic modification for the production of fibre. However, when the individuals who disagreed with the use of genetically modified crops were told that it decreased the use of pesticides by 75 per cent or more, many city and regional residents were found to be more likely to change their initial opinion. This was less likely to occur for city dwellers.

Gavin Anderson (GA) research (2007): Cotton Australia qualitative focus groups

This research was conducted to measure the public's perceptions of the cotton industry and water use. Ten focus groups were held in metropolitan and regional areas. Information was gathered on the awareness, knowledge and perceptions participants of the cotton industry. This was followed by an in-depth examination of how individual's gathered their information and what type of information campaigns would be most successful in generating a positive perception of the cotton industry.

In line with previous research of community perceptions, GA found there was low awareness of cotton production. The majority of participants did not think cotton production was an important issue, although they considered water shortages and water use as the top issues facing Australia.

Similarly, there was little to no awareness about cotton as an agricultural industry, with awareness in cities being much lower than that in regional centres. Furthermore, many participants believed that cotton was a relatively new small agricultural industry in Australia and rating it far below wheat, beef, dairy, wool and vegetables as a major agricultural industry. Many of the participants in the focus groups believed that the majority of cotton farms in Australia were large and foreign owned and identified Cubbie Station as being quite typical of cotton farms.

Despite this low level of awareness and knowledge of the cotton industry, there remained a concern about water and chemical use.

While the use of GM cotton varieties are generally accepted in the industry, the Gavin Anderson (GA) study *Attitudinal Research in the Cotton Industry* (2007) found community perceptions of genetically modified crops tend to be negative with an overemphasis on possible dangers. The study concluded that when members of the public were interviewed about this topic, the general view tended to be a sense of fear. The report found that the use of terminology such as 'genetically modified' makes most members of the community uncomfortable, fuelling a perception that 'as a result of genetic modification of crops, a "super bug" will be created, or we will be going down the "cane toad" path again.'

The study also found a lack of communication about GM crops and concluded that: 'People know very little about what genetically modified cotton really means, and without this knowledge comes fear and discomfort.' Transparency was cited as an important aspect of communication and the study found that people would become more comfortable with the idea of genetic modification if they were made to feel that there has been sufficient research done prior to introduction as was the case for GM cotton varieties.

The cotton industry conducted extensive trials on transgenic cotton prior to its introduction, including effects on: non-target species, gene escape, the potential to outcross with native cottons, potential weediness, changes in status of minor pests, and resistance. It was the first major Australian agriculture industry to move successfully to the commercial use of biotechnology. Along with Roundup Ready® varieties resistant to the herbicide glyphosate, these transgenic cotton varieties have contributed to substantially reduced pesticide use, improved profitability and reduced worker exposure to chemicals.

On the whole the GA research found that there was a neutral to mildly negative perception of the cotton industry held by community members, with most perceptions being based on little to no knowledge and being loosely held.

Following the distribution of an information sheet on the cotton industry, many respondents shifted to a more positive view of cotton production. A chart outlining actual water use in relation to other industries was identified as being particularly helpful, with many participants stating they were previously unaware of where the cotton industry sat in relation to other agricultural industries in water use.

One factor that affected whether the information would sway the respondents opinion was whether the information source was credible or not. The main sources of information, which were identified for both groups, were ABC radio and news, regional newspapers, state metropolitan dailies, as well as local radio.

The following key messages were identified as being the most useful in motivating support for the industry:

- 'Australian cotton is the lifeblood of many regional communities creating jobs and supporting local economies';
- 'Australia has the most water efficient cotton farmers in the world, allowing them to produce three times the global average on the same resources'; and
- 'Drought has hit the cotton farmers as bad as everyone else'.

Furthermore, many individuals stated that whilst they were not that interested in the cotton industry at the start of the focus group as it did not affect them on a day-to-day basis, they reported that they would be interested in hearing more about the industry and that it was something that they 'should' know more about.

However, while campaigns based on these messages were likely to motivate individuals to a more positive attitude towards the cotton industry, many people raised the view that it would not be a good idea for the cotton industry to run a public education campaign. They considered the industry should 'stay below the radar', especially in relation to water use in view of the then severe drought.

2012 community focus groups:

A small market research study was included as part of the environmental assessment to complement existing research described above.

Media Consumption

The findings suggest there is a significant change occurring in the way in which those with a serious interest in news and current affairs source information.

The participants considered that news is about '*what's in your face*' especially topics of particular interest (human rights, women's issues, the environment, etc.) and those which relate to people's sense of values such as fairness, sustainability, respect for others.

Most participants conceded that once an issue fades from the media, they are unlikely to follow-up. Indeed, the conversation disturbed a number of participants by highlighting that they tended to lose interest and failed to follow stories to their conclusion.

There is considerable cynicism regarding traditional media such as newspapers, TV news and current affairs. The newspapers are seen to be biased and some have strong political stances.

Participants believed they need to review several sources to gain a more reliable perspective on stories. They like on-line news, especially when comments are included as these provide insights from people with some knowledge and help ascertain the verisimilitude of the story or view being presented.

Participants stated that the news on commercial TV is very trivial with sport dominating, many commercial breaks and a bias towards 'celebrity gossip'.

Most participants (irrespective of age) felt they had too little time to depend on traditional news and were increasingly relying on more immediate and mobile sources such as 'apps' from the newspapers and new services including such as Yahoo news and Google news. Some were also using Google alerts to signal stories about topics of interest.

The immediacy with which news and information is sought was highlighted during one focus group when a question was raised about the size of Australian agriculture. A participant reached for his mobile phone and made a quick search. Before the discussion of that point had concluded, he was able to quote a percentage of GDP attributable to agriculture. These people want news and information *instantly* – where and when they want it. Rather than newspapers and TV, they were increasingly checking stories during the day on-line (when at work or using a computer) and via their phone at other times.

Saturday papers are liked for the range of sections (arts, travel and more in-depth stories). A few participants record TV news and view this later, though this involves fast forwarding to stories of interest. Stories or topics of particular interest were often the basis of an Internet search to find complementary reports and further information. A number of these metropolitan residents in both age groups said they enjoyed the regional segments on TV.

Perceptions of Australian Agriculture

When asked for some spontaneous impressions of Australian agriculture, participants conceded they knew little about the sector and it was hard for city people to understand industries that were quite distant from their experience. The first and main things that came to mind were:

- Subsidies;
- Not much has changed;
- A sense of agriculture continuing as it always had with large, broad-acre farming by families who had been on the land for generations. Little was understood about the innovation and change that had taken place;
- Hard luck stories: There was a sense of the media having two types of regional stories – those covering droughts and other natural disasters or 'hard luck stories' which were the human or emotional side of the natural disasters. These were about families that had been on properties for generations struggling to survive or having to sell their land. Overall, these created a sense of inefficiency 'flogging a dead horse' and trying (often unsuccessfully) to use poor soil or areas with insufficient water. Even worse, there was a sense of environmental damage – clearing vast tracts of land and destroying ecosystems, stripping soils and polluting with fertilisers and chemicals.

Participants did not have knowledge of the changes that have taken place across Australian agriculture in the past decade. There was a general assumption that some techniques had improved and there had been advances in technology (e.g. better strains of wheat or other crops, which was something school children were taught about concerning research by CSIRO). However, balancing

this and contributing to the image of little change and diminishing competitiveness was the belief that food imports had increased.

Innovation or the use of technology is perceived as adopting genetically modified crops and this raised concerns. Some also thought there had been changes (i.e. a reduction) in the use of chemicals (including many being banned) due to the risks created for people.

There was no knowledge or awareness of the changes and improvements in environmental performance of Australian agriculture, though most assumed something would have happened in a decade, especially given the occurrence and duration of the drought. If anything, there was a concern that farmers would have used water at the expense of the environment. Innovation and improved environmental performance was often thought to arise because of public pressure or media scrutiny. *"They sporadically find solutions when they are forced to..."*

Perceptions of Cotton Growing

Participants conceded they knew little about the cotton growing industry and struggled to discuss the various topics raised by the moderator. Cotton growing has a low media profile – *'it is not in your face'*. *"It has been 'off the air' for a while. I'm not up-to-date..."*

Instead, two other issues have recently attracted participants' attention. The first is the treatment of cattle in Indonesian abattoirs that emerged in 2011. The other is the 'price war' between Coles and Woolworths. Their concern was this is unfairly impacting on primary producers and affronting people's sense of fairness.

Generally the participants felt cotton was a niche crop that did not make a significant contribution to the Australian economy. None could estimate the number of people employed in cotton growing. Importantly, there were comments about never seeing clothing, which stated 'Australian grown cotton' in the way, the 'Woolmark' identified garments made with Australian wool.

There was a sense of cotton being a crop requiring a warm climate and most guessed or assumed it was grown in northern Australia, especially Queensland. There continues to be a vague notion of cotton (like rice) requiring vast amounts of water and being an unsuitable crop for dry Australian conditions. There was also some residual image of cotton production diverting scarce water resources during the drought and exacerbating the impact on other farmers and the environment.

Cotton was still thought to require extensive use of pesticides and other chemicals. Whilst accepting they did not know many details, there was some negativity in participants' impression of cotton growing in Australia. They did not have a sense of cotton growing having changed or being up-to-date. There was little sense of change or improvement and there continues to be an image of excessive water and chemical use and a detrimental effect upon the environment.

Impressions of grain crops were a little better. There was a sense of grain being a larger and more important crop. People also felt there had been more 'development' work with 'strains' that required less chemicals and water.

Horticulture was also seen in a more positive light. The rise of organic produce and farmers' markets suggested innovation and more sustainable practices to the participants. TV cooking shows often showcased boutique producers introducing new varieties and sustainable practices, which

helped, create a more positive image. Produce was consumed locally in contrast to cotton, which is never seen by city residents.

The idea of an environmental assessment of cotton growing was considered a good idea and a number of participants expressed interest in learning about the findings.

During the focus groups, a range of newspaper articles about cotton growing was shown to participants. Several were press releases and these articles raised the ire of participants who immediately assumed they were biased and little more than free advertising for a vested interest. As such, the articles highlighted the importance of information being seen to be reliable and unimpeachable and ideally independent.

An article titled, '*It could be country's largest cotton crop*' (Western Advocate 12 August 2011, page 7), engaged participants and generated some surprise and curiosity especially the fact that growers had achieved a record crop and were part of an expanding rather than a contracting industry). They were also surprised that cotton was grown so far south. References to 'the lowest environmental footprint' and 'slashed chemical use' were unexpected and generally pleasing, though participants were a little cynical and questioning. They wanted 'real data' and measurements from a credible source.

Another article titled, '*New cotton experiment*' (Northern Downs News 11 August 2011, page 10), generated interest in studies and experiments being conducted to reduce the water consumed in growing cotton. However, the article was thought to have too much on the process rather than relevant outcomes, i.e. how much water was being saved. It was also thought to use too much technical language or jargon.

Developing a communications strategy for metropolitan areas

Regarding how the industry should develop a communications strategy to inform the metropolitan community about the Australian cotton industry, the findings from these focus groups suggest:

- Information needs to be 'significant news', i.e. developments or insights that are worthy of attention as part of general news and not merely 'propaganda' for the industry. However, these need to be relatively short and easily understood, i.e. written for the layperson with little jargon and technical terms.
- Information and details need to be credible and demonstrable. Respondents were wary and cynical about details that were vague and open to challenge. A '90 per cent reduction in chemical use' led to questions about the remaining 10 per cent. The participants asked what volume does it comprise, what sort of chemicals continue to be used, and what damage has been done to the environment over the years prior to the reduction.
- In terms of messages, from these focus groups the following ranking emerged:
 - Claims of reduced water consumption resonated with participants. However, as noted above, the message needs to be about a significant reduction. Additionally, the volume of water that continues to be used cannot be open to criticism or leave the reader concerned.

- Reduced chemical use also engaged participants, though there are still concerns about the chemicals that continue to be used.
- An environmental assessment of the industry attracted considerable attention. There was interest in a comprehensive review rather than selectively choosing positive stories. It also implied a more modern and accountable approach. However, the assessment needs credibility and be beyond criticism, i.e. conducted by impartial and authoritative personnel.
- Whilst innovation and change created interest among some participants, it needed a 'surprising' element to warrant consideration, e.g. *'the cotton industry is not what you think...it has changed dramatically...'*

2012 media analysis:

A media analysis was carried out to identify the publicly reported perceptions surrounding the cotton industry as found in the media, and to document any changes in the stories being written about the cotton industry over the past two years.

The main finding of the media analysis was that there was little coverage of cotton issues or news either in print media or on radio or TV. The most commonly reported topics were about crop yields, major flooding and the Cubby station's sale. The articles released that related to the environmental impact of the cotton industry were centred on genetic modification (GM) technology, chemical use, spray drift and water use.

Articles on the use of GM technology in the cotton industry were about how GM cotton can result in decreased reliance on chemicals and water and, therefore, improve the environmental performance of cotton growing. More specifically articles addressed how the development of a new variety of cotton has led to reductions in pesticide use by 85 per cent over the previous 15 years.

Use of chemicals and their application on cotton farms figured prominently in articles that were written about the cotton industry. This included advice to farmers to be aware of the chemicals they are using and their application strategies. There were a number of reports of cotton crops and water bodies being affected by spray drift from neighbouring farms. Other articles reported on the problems associated with weed resistance as the result of 'overuse' of herbicides.

The consumption of water by the cotton industry was another subject of interest with one article suggesting that water use was a major issue in which the cotton industry would have to overcome to ensure its future as a core agricultural industry in Australia. There were few articles about the improvements that are being made in the cotton industry.

The article that attracted most interest through follow up comments was about a national survey of year 6 and 10 students by the Australian Council for Educational Research that found three-quarters of Australian children in their final year of primary school believe cotton socks come from animals. In addition more than 40 per cent of students in Year 10 thought cotton came from an animal.

The Primary Industries Education Foundation commissioned the research in which 900 rural and urban students were surveyed from 61 schools across the states over almost four months to October 2011.

The survey also found that about a third of respondents thought wildlife could not survive on farmed land.

Cotton Australia reports that it is looking to commission further market research to assess stakeholder views, particularly politicians, about the cotton industry. The industry's education and communication programs also gather market information. In the education area Cotton Australia has joined the Primary Industries Education Foundation (PIEF). Its vision is: 'An Australian community which understands and values its primary industries'. PIEF commissions work to track the perceptions of agriculture held by school children and teachers. Cotton Australia has recently developed a social media policy and uses these tools to communicate with stakeholders and the community.

Perceptions of growers and stakeholders of emerging environmental issues

The *Cotton Grower Environmental Performance Survey 2012* found that water use efficiency, pesticide/herbicide use and managing spray drift continue to be rated by growers as the top three environmental priorities for the future (*Figure 11*).

Efficiency is an underlying theme in the use of water, chemicals, fuel, and energy. Reduced emissions of greenhouse gases (GHG) was also identified as an emerging issue rather than an achievement to date, but only by 4 per cent of growers as a top three issue. Use of genetically modified (GM) cotton varieties was less prominent as an issue, but was accompanied by comments about the need to stop GM cotton plants growing outside planted fields. Only a few growers appear to be concerned that other stakeholders might object to the use of GM cotton.

Emerging resistance of pests (weeds and insects) to the available pesticides was evident, as was concern that Round Up Ready varieties might over time become more vulnerable. Concern about pesticides also reflected the risks of spray drift spreading to neighbours and producing adverse reactions.

Few growers rate some issues such as the protection or planting of native vegetation and the protection of riparian areas as top three environmental issues. Similarly, few rated as a top three environmental issue the industry's reputation, or the need to defend and communicate the industry's achievements.

Some growers offer deeply felt objections to government legislation or regulation that they saw as ill-considered interference, but this response came only from a few. Similarly a small number rate the effects of coal mining and/or coal seam gas extraction as a top three priority but responses indicated that this was an emerging issue.

As with the reported achievements and their own future plans, the primary focus is on issues that have implications for profitability and long term financial viability, with the industry's 'social license to operate' being a secondary issue in terms of priorities.

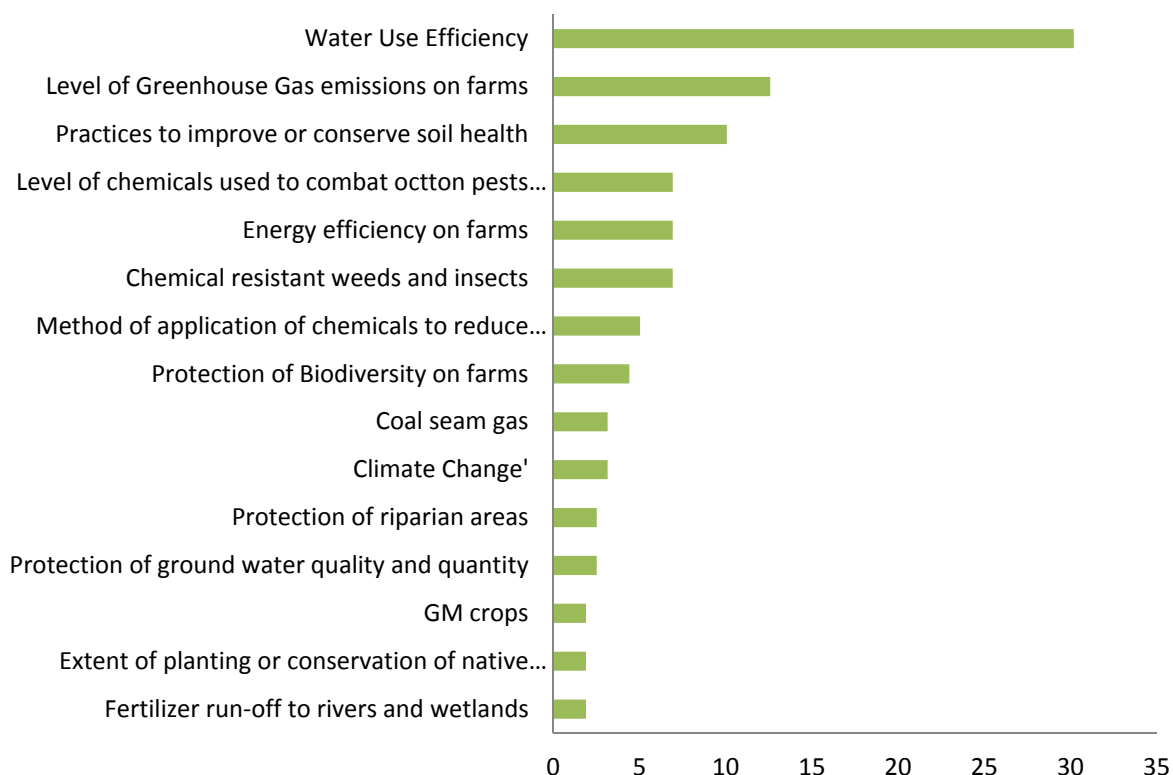
Putting these replies together with the reported achievements and plans for further improvement, it is clear that growers are proud of what the industry achieved to reduce its environmental impact, while concentrating most on the changes that also have potential financial benefits.

Stakeholders

Stakeholders were asked to nominate the three main environmental issues they believe the industry needs to act on today. Amongst respondents, water use was ranked as the first main issue, energy efficiency as the second main issue and soil health as the third main issue. Spray drift and energy efficiency also rated prominently.

When asked what environmental issues they see as becoming important over the next three to five years in terms of impacting on cotton growing, water was again ranked by most as the first main issue and again by those as the second main issue by those that ranked something else as the first main issue. Energy use, carbon emissions and coal seam gas extraction were rated prominently.

Figure 22: Stakeholder perceptions on future environmental priorities for the industry



Source: Cotton Stakeholder Environmental Performance Survey 2012.

Conclusions and recommendations

As noted in this section, in the past decade a significant strategic shift has been occurring in the drivers for improving environmental performance in the cotton industry. At the time of the previous environmental audits, environmental incidents that triggered adverse publicity and the risk of government regulatory action resulted in strong industry research and development efforts with targeted extension through the BMP program. The industry had to demonstrate to environmental and industry regulators that it was acting to overcome practices that impacted on the environment. Major improvements were subsequently made by farmers in reducing the impact of cotton growing on the environment.

This report finds that the emerging drivers of further improvements are international retailer, consumer and value chain marketing and actions for environmental sustainability; the industry's reputation in Australia and maintenance of its 'social licence to farm'. The industry now needs to demonstrate to markets and the community through objective assessment and 'hard' data that it is complying with practices that minimise its impact on the environment. In this respect it needs to overcome lingering perceptions of poor environmental practice. Previous market research and the small study undertaken for this report show that community perceptions of the cotton industry's environmental performance are outdated and affect the industry's reputation.

Recommendation:

It is recommended 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.

The rationale for this recommendation is that the industry competes in a global market. Key international retailers which operate in that market have strong corporate social responsibility agendas and are setting sustainable cotton targets. This is being partly driven by environmental interest groups, consumers and the wider public directly engaging retailers to influence those companies to improve and demonstrate sustainability through the value chain including on farms. The industry also needs to be engaged with retailers and consumers to both understand their positions and to have influence in the setting of sustainability targets to ensure that they are reasonable and practical in commercial terms..

'Social licence to farm'

A key emerging driver of improved on-farm environmental practices is the industry's reputation in Australia and the maintenance of its 'social licence to farm'. Previous market research and the small study undertaken for this report show that community perceptions of the cotton industry's environmental performance are outdated and affect the industry's reputation.

Cotton was not a subject of great interest to participants in the 2012 focus groups and they conceded they knew little about the contemporary cotton growing industry in Australia. Nevertheless, there appears to be a residual image of cotton growing as being poorly suited to Australia and environmentally inappropriate given the perception of high water and chemical usage. Participants had no real idea of the innovations or changes that had been taking place in Australian agriculture per se, and cotton growing in particular. Their interest in an industry or issue is piqued by reports of excessive, unfair or damaging events.

Notwithstanding these points, a broad range of topics including rural affairs, agriculture and cotton growing in Australia engaged participants. There were comments about enjoying reading about rural affairs such as in a recent issue of the Regional Express Airlines' inflight magazine.

There was interest in:

- Learning of some of the innovations and changes that have been occurring in agriculture and cotton growing.

- The environmental assessment of the cotton industry. Participants wanted to know about the study, its timing, the personnel involved in its preparation and how it could be accessed.

Importantly, the participants felt that any news about cotton growing in Australia needs to be disseminated in a modern form to reach the maximum audience.

These findings suggest:

- There is a need to go beyond the traditional channels of major media.
- The industry needs to have its data and point-of-view instantly accessible where and when the community requires information.
- Websites need to appear close to the top of lists generated by search engines and contain 'quick facts' pages that can be easily accessed on computers and smart phones.

Recommendation:

It is recommended 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.

The rationale for this recommendation is that the industry needs to be armed with sophisticated market research information to influence the perceptions of consumers, the community, politicians, government officials and environmental groups. The information gathering and media world is change rapidly and the industry needs to keep abreast so that its voice is heard and it is able to substantiate its performance. It is acknowledged that Cotton Australia is intending to commission further market research on perceptions of Australian cotton growing.

Bibliography

AFPRG (2006), '*CREATING OUR FUTURE: agriculture and food policy for the next generation*', Report by the Agriculture and Food Policy Reference Group to the Minister for Agriculture, Fisheries and Forestry.

Agrifood Awareness Australia Ltd (2009), *GM Cotton in Australia: A Resource Guide*. Kingston A.C.T. Available from: <http://www.afa.com.au/resource_guides/Resource_Cotton2.pdf>

Australian Bureau of Statistics (2012), '*Completing the Picture - Environmental Accounting in Practice*' ABS 4628.0.55.001, May 2012

Australian Government (2012), '*Rural Research and Development Policy Statement*', Department of Agriculture, Fisheries and Forestry, Canberra.

Australian Government Bureau of Meteorology (2004), '*Weather for Pesticide Spraying*', viewed 3rd August 2012, <www.bom.gov.au/info/leaflets/Pesticide-Spraying.pdf>

Australian Government National Water Commission (2011), *Biennial Assessment of the National Water Initiative*. ACT, Australia.

Australian National Resource Atlas (2009), *Agriculture, Cotton Industry, Australia*. Australian Government, Available from <http://www.anra.gov.au/topics/agriculture/cotton/index.html#main_envch>

Australia Natural Resources Atlas (ANRA) (2009), *Benchmarking Rural Industries' Practices and Productivity Performance and Review of Industries' Capacity to Change*. Australian Government. Available from: <http://www.anra.gov.au/topics/agriculture/cotton/index.html#main_envch>

Australian Pesticide and Veterinary Medicines Authority (2012), Canberra, viewed 3rd August 2012, <<http://www.lib.monash.edu.au/tutorials/citing/harvard-websites.html>>

BMP Accreditation, CCA BMP LWA Benchmarking, 2006

Chapagain, A.K., Hoekstra, A.Y., Savenije, H.H.G. and Gautam. R. (2005), *The Water Footprint of Cotton Consumption: An Assessment of the Impact of Worldwide Consumption of Cotton Products on the Water Resources in the Cotton Producing Countries*. Ecological Economics 60. Elsevier B.V. pp. 186 – 203.

Cotton Sector Research Development and Extension, Final Strategy, June 2011

Cotton Research and Development Corporation (2005), *Taking responsibility for our future: The Australian Cotton Industries Action Response to the second Australian cotton industry environmental audit 2003*. CRDC, Narrabri, Australia.

Commonwealth Scientific and Industrial Research Organisation (2007), *Bollgard® II – the latest GM cotton*. Available from: <<http://www.csiro.au/files/files/pjr8.pdf>>

Constable, G. Llewellyn, D. Wilson, L. and Stiller, W (2011), *An Industry Transformed: The impact of GM technology on Australian cotton production*, Farm Policy Journal, Vol. 8 No. 1, Autumn Quarter 2011, pp 23-41

Cotton Australia (2011), 'BMP Cotton – The Australian Cotton Industry's Pesticide Application Management Plan 2010/11', viewed 3rd August 2012, <http://cottonaustralia.com.au/uploads/resources/Pesticide_Application_Management_Plan_Template_2010-11.pdf>

Cotton Australia (2012), *Cotton Matters – 12 January 2012*. Cotton Australia News. Available from: <<http://www.cottonaustralia.com.au/news/view.aspx?id=777>>

Cotton Australia (2009), *Cotton Australia: Strategic Plan 2009 – 2013*. Available from: <http://www.cottonaustralia.com.au/ca/strategic-plan/2009-13_Cotton_Australia_Strategic_Plan.pdf>

Cotton Australia (2011), *New Growers Checklist 2011*. Available from <http://cottonaustralia.com.au/uploads/resources/Cotton_Australia_New_Grower_Kit_2011.pdf>

Cotton Catchment Communities CRC (2011), *Australian Cotton Producers Manual 2011*. Narrabri, Australia. Available from: <http://www.cottoncrc.org.au/industry/Publications/Australian_Cotton_Production_Manual>

Cotton CRC Development and Delivery Team (2012), 'Cotton Pest Management Guide 2011-12', viewed 3rd August 2012, <http://www.cottoncrc.org.au/industry/Publications/Cotton_Pest_Management_Guide_2011_12>

Cotton Incorporated (2012), *Monthly Economic Letter: U.S. and Global Market Fundamentals* [internet], Available from: <<http://www.cottoninc.com/MarketInformation/MonthlyEconomicLetter/>>

Cotton Map 2011/12, 'Susceptible Crop Awareness Map', viewed 3rd August 2012, <www.cottonmap.com.au/>

Cotton Research and Development Corporation (2010), *How is myBMP Different?* [internet], Available from: <https://www.mybmp.com.au/What_is_different.aspx#Growers>

Crop Consultants Australia Inc. (2012), viewed 3rd August 2012, <www.cropconsultants.com.au/>

De Blecout, M., Lahr, J. and van den Brink P.J. (2010), *Pesticide use in cotton in Australia, Brazil, India, Turkey, & USA*. Alterra, Wageningen. Available from: http://www.icac.org/seep/documents/reports/2010_alterra_report.pdf

Department of Agriculture and Food, Growing GM cotton in WA, Fact Sheet, January 2010

Donnelly, D., Mercer R., Dickson J. and Wu E. (2009), *Australia's Farming Future Final Market Research Report: Understanding Behaviours, Attitudes, and Preferences Relating to Climate Change*. Prepared by Instinct and Reason. Surrey Hills NSW.

Emergent Futures Pty Ltd (2010), *Cotton Industry Vision 2029 – Final Report*. Melbourne VIC.

Environment, Climate Change and Water ('DECCW'), and NSW Farmers' Association (2007), 'Spray Sense: Safe and Effective Use of Farm Chemicals', *Reducing Herbicide Drift*, viewed 3rd August 2012, <www.grdc.com.au/director/events/factsheets>

Environment, Climate Change and Water ('DECCW'), and NSW Farmers' Association (2007), 'Spray Sense: Safe and Effective Use of Farm Chemicals', *Rig selection, Nozzle Information, Spray Quality,*

Calibration, viewed 3rd August 2012,
<<http://www.dpi.nsw.gov.au/agriculture/farm/chemicals/general/>>

Environment, Climate Change and Water ('DECCW'), and NSW Farmers' Association (2007), 'Spray Sense: Safe and Effective Use of Farm Chemicals', *Spray Drift Factsheet*, viewed 3rd August 2012, <www2.dpi.qld.gov.au/extra/pdf/fieldcrops/sprayright2005.pdf>

GHD (2011), *Cotton Grower Practices – 2011 Survey*. GHD Pty Ltd. Hassall with the Cotton CRC Development and Delivery team.

Gunningham, N., (2004) Cotton, Health and Environment: A Case Study of Self-Regulation, *The Australasian Journal of Natural Resources Law and Policy* [Vol. 9, No.2, 2004]

Hassall and Associates Pty Ltd (2006), *Evaluation of the Australian Cotton Industry's BMP Process*. Report prepared for Cotton Australia and Cotton Research and Development Corporation, Brisbane.

Huang, J., Hu, R., Fan., Pray, C.E. and Rozelle, S (2003), Bt cotton benefits, costs and impacts in China. *The Journal of Agrobiotechnological Management and Economics*. Available from: <<http://www.agbioforum.org/v5n4/v5n4a04-huang.htm>>

Inovact Consulting (2010a), *Raising National Water Standards Program Strategic Evaluation Plan 2009-2012*, Inovact, Canberra

Inovact Consulting (2010b), *Raising National Water Standards Program: Mid Term Evaluation Report*, Inovact, Canberra

Inovact Consulting (2011a), *Community Skills Knowledge and Engagement in Regional NRM: Drivers of Performance & Developing Australian Government Investment strategy*, Inovact, Canberra

Inovact Consulting (2011b), *Community Skills Knowledge and Engagement in regional NRM: Case studies of organisational performance*, Inovact, Canberra

Inovact Consulting (2011c), *Community Skills Knowledge and Engagement in regional NRM: National staff and stakeholder survey report*, Inovact, Canberra

Inovact Consulting (2011d), *The Adaptive Capacity and Resilience of Australia's Water Management Regime: Impact of the National Water Initiative*, Inovact, Canberra

Inovact Consulting (2011e), *Developing the Productivity and Efficiency of Water Use: Assessment of the Impact of the National Water Initiative*, Inovact, Canberra

Inovact Consulting (2011f), *Raising National Water Standards Program: Stage 2 Evaluation Report*, Inovact, Canberra

Institute for Sustainable Resources (2012), 'Cotton Greenhouse Gas Calculator', viewed 3rd August 2012, <<http://www.isr.qut.edu.au/tools/index.jsp>>

Institute for Sustainable Resources, Queensland University of Technology (2009), *Life Cycle Assessment of a 100 % Australian-Cotton T-Shirt*. Brisbane QLD. CDRC

International Programs. U.S. Census Bureau. (n.d) *World Population: 1950-2050*. International Data Base, available from:
<<http://www.census.gov/population/international/data/idb/worldpopgraph.php>>

International Trade Centre (2012a), *Trends in Mill use Fibre*. Available from
<<http://www.intracen.org/cotton-guide/The-World-Cotton-Market/Trends-in-mill-use-of-fibre/>>

Kauter G, Downes S, Pyke B, (2009), 'A snapshot of the Cotton Australia TIMS Committee in 2009', *The Australian Cotton Grower*, April- May 2009, pp 8-11.

Khan, S.R, Qureshi, M. S., Khan, S. R. and Khwaja, M. A. (2006), *The costs and benefits of compliance with international environmental standards: Pakistan case study*. International Institute for Sustainable development; Manitoba, Canada. Available from
<http://www.iisd.org/tkn/pdf/tkn_pakistan_standards_sum.pdf>

Lovett S, Price P & Lovett J, (2003), *Managing Riparian Lands in the Cotton Industry*, Cotton Research and Development Corporation.

Maas, Susan, Allen, Stephen, and Weir, Duncan, (Australian Cotton Industry Development & Delivery Team) 2012, 'Cotton Symptoms Guide: The Guide to Symptoms of Diseases and Disorders in Australian Cotton', 1st Edition.

Macarthur Agribusiness (2004), *Evaluation of the Australian Cotton Industry Best Management Practices Program*. Brisbane QLD.

Martin, P. and Williams, J. (2011), *Defending the Social Licence of Farming: Issues, Challenges, and New Directions for Agriculture*. CSIRO Publishing. Collingwood VIC. 2011.

McRae, D. Roth, G. and Bange, M. (2007), *Climate Change in Cotton Catchment Communities, A Scoping Study Report for the Australian Greenhouse Office, Cotton Catchment Communities Cooperative Research Centre, Narrabri, New South Wales*.

Milroy, S.P. Bange, M.P. and Hearn, A.B. (2003), *Row configuration in rainfed cotton systems: modification of the OZCOT simulation model*, CSIRO Narrabri, New South Wales.

Monsanto (2011), *A guide to dryland cotton 2011/2012*. Available from:
<http://www.monsanto.com.au/_pdfs/a_guide_to_dryland_cotton.pdf>

Monsanto and Cotton Seed Distributors (2011/12), 'Guide to Dryland Cotton, 2011/12', viewed 3rd August 2012, <http://www.monsanto.com.au/_pdfs/a_guide_to_dryland_cotton.pdf>

Morgan, R. (2004), *Attitudinal Research into the Cotton Industry: Qualitative Report*. Prepared by Roy Morgan Research. Sydney NSW.

MyBMP (n.d) *How is myBMP Different?* [internet] Available from:
<https://www.mybmp.com.au/What_is_different.aspx#Growers>

NSW Farmers (2012), 'Agricultural Chemicals', viewed 3rd August 2012,
<www.nswfarmers.org.au/policy_committees/ag_chemicals>

NSW Government (2012), 'Farm management', viewed 3rd August 2012,
<www.dpi.nsw.gov.au/agriculture/farm>

NSW Government (2012), 'Keeping Records of Pesticide Use', viewed 3rd August 2012,
<www.environment.nsw.gov.au/pesticides/pestrecords.htm>

NSW Dept. of Environment and Conservation (2012), 'Pesticides Record Keeping Form', viewed 3rd August 2012, <www.environment.nsw.gov.au/resources/pesticides/pesticidesrkform.pdf>

NSW Dept. of Environment, Climate Change and Water (2012 a), 'Chemicals and Pesticides', viewed 3rd August 2012, <<http://www.environment.nsw.gov.au/pesticides/index.htm>>

NSW Dept. of Environment, Climate Change and Water (2012 b), 'Training', viewed 3rd August 2012, <<http://www.environment.nsw.gov.au/pesticides/training.htm>>

Oeko-Text Institutes (n.d) Oeko-Tex Certification [internet], Available from: <http://www.oeko-tex.com/OekoTex100_PUBLIC/content4.asp?area=hauptmenue&site=zertifizierung&cls=02>

OECD (2008), OECD Guidelines for Multinational Enterprises [Internet], Available from <[http://www.oesorichtlijnen.nl/wp-content/uploads/Kenniscentrum/Sector per cent20informatie/Textiel per cent20International per cent20Overview per cent20CSR.pdf](http://www.oesorichtlijnen.nl/wp-content/uploads/Kenniscentrum/Sector%20per%20informatie/Textiel%20per%20International%20Overview%20CSR.pdf)>

Queensland Department of Environment and Resource Management 2012, 'SILO Climate Data', viewed 3rd August 2012, <www.bom.gov.au/silo/>

RIRDC (1999), *Growing Trees on Cotton Farms: A Guide to Assist Cotton Farmers to Decide How, When, Where and Why to Plant Trees*. Rural Industries Research and Development Corporation, Barton, ACT, Australia.

Roth, G. (2010), *Economic, Environmental, and Social Sustainability Indicators of the Australian Cotton Industry*. Cotton Research and Development Corporation, Narrabri, NSW.

The World Bank (2012) *World Development Indicators*, Available from <http://data.worldbank.org/data-catalog/world-development-indicators?cid=GPD_WDI>

Trahair, S., M. Pignatelli, and C. Owen (2003), *Second Australian Cotton Industry Environmental Audit*. Cotton Research and Development Corporation (CRDC). GHD Pty Ltd. Chatswood NSW.

Office of the Chief Economist, World Agricultural Outlook Board, U.S. Department of Agriculture, Available from <http://www.usda.gov/oce/>

Syngenta (2010), 'Decision Support', viewed 3rd August 2012,
<<http://www.environment.nsw.gov.au/pesticides/training.htm>>

United States Department of Agriculture (2011), *USDA Agricultural projections to 2020*, Available from
http://www.usda.gov/oce/commodity/archive_projections/USDAAGriculturalProjections2020.pdf

United States Department of Commerce (2012) *International Data Base, world Population 1950-2050*, Available from
<<http://www.census.gov/population/international/data/idb/worldpopgraph.php>>

Williams, Sandra, Lewis, Wilson, and Vogel, Stacey, (Australian Cotton Industry Development & Delivery Team) 2011, 'Pest and Beneficials in Australian Cotton Landscapes Guide', 1st edition, viewed on 3rd August 2012,
<http://www.cottoncrc.org.au/industry/Publications/Pests_and_Beneficials/Cotton_Insect_Pest_and_Beneficial_Guide>

Women in Cotton Network (2011), *NRM Survey of the Australian cotton industry 2010–2011 Feedback Report*

World Wildlife Fund (2009), *Better cotton threading its way towards global markets*. Available from
<http://wwf.panda.org/wwf_news/?169863/Better-cotton-threading-its-way-towards-global-markets>

Van Yperen, M. (2006), *Corporate Social Responsibility in the textile Industry, International Overview*. Available from: <[http://www.oesorichtlijnen.nl/wp-content/uploads/Kenniscentrum/Sector%20informatie/Textiel %20International %20Overview %20CSR.pdf](http://www.oesorichtlijnen.nl/wp-content/uploads/Kenniscentrum/Sector%20informatie/Textiel%20International%20Overview%20CSR.pdf)>

Abbreviations

a.i.	active ingredient
b	billion
BCI	Better Cotton Initiative
BMP	Best Management Practice
Bt	<i>Bacillus thuringiensis</i>
CA	Cotton Australia
CATI	Computer Aided Telephone Interviews
CCCCRC	Cotton Catchment Communities CRC
CFI	Carbon Farming Initiative
CRDC	Cotton Research and Development Corporation
CSG	Coal Seam Gas
CWUI	Crop Water Use Index
GDP	Gross Domestic Product
GL	Gigalitre
GHG	Greenhouse Gas
GM	Genetically modified
GPWUI	Gross Production Water Use Index
ha	Hectare/s
IPM	Integrated Pest Management
IWUI	Irrigation Water Use Index
kg	kilogram
km	kilometre/s
KPI	Key Performance Indicator
m	million
MDB	Murray Darling Basin
MDBA	Murray Darling Basin Authority
ML	Megalitre
NRM	Natural Resource Management
NWC	National Water Commission
NWI	National Water Initiative
OECD	Organisation for Economic Cooperation and Development
OH&S	Occupational Health and Safety
PIERD Act	Primary Industries and Energy Research and Development Act, 1989
PISC	Primary Industries Standing Committee
RD&E	Research, Development and Extension
USDA	United States Department of Agriculture
VET	Vocational Education and Training
WFIE	Whole Farm Irrigation Efficiency Index

Appendix 1: Cotton Grower Environmental Performance Survey 2012

Methodology

The Cotton Grower survey was devised to cover the key environmental issues faced by cotton growers, improvements in farm practices made by growers since 2003 and views on emerging environmental issues. Those interviewed were either currently or recently growing cotton or had other involvement in the cotton growing industry. A total of 150 computer aided telephone interviews averaging just less than 25 minutes were conducted between 26 March and the 10th of April 2012.

The sample was obtained by calling individuals listed in the CRDC's database along with a separate listing of the officials (Chair, Secretary, Treasurer) of regional cotton grower associations. The database provided usable contact names and phone numbers for 401 potential interviewees, including association officials (most of whom also were growers) and some who proved on contact to be suppliers or consultants. Many farms had more than one contact listed, while some contacts were listed for more than one farm.

Three of the 150 interviewed had grown cotton recently (2009 or later) but not in the current year. A few of the individuals interviewed were not growers, and instead were suppliers of goods or services to the industry and one official of a regional association who was not currently growing cotton. However, 13 of the 14 association officials that were interviewed were growers.

The database provided information on whether the contact was recorded as having registered with a log in and password on the CRDC's myBMP (Best Management Practice) website designed to provide essential information for the industry on Information Resources and Risk Management to assist improvement of grower practices. Many of these were designed to reduce the environmental impact of cotton growing through better management of water, agricultural chemicals (pesticides and fertilizers), land and natural streams and the native wildlife and vegetation that use it, and to reduce production of greenhouse gases.

Sample Characteristics

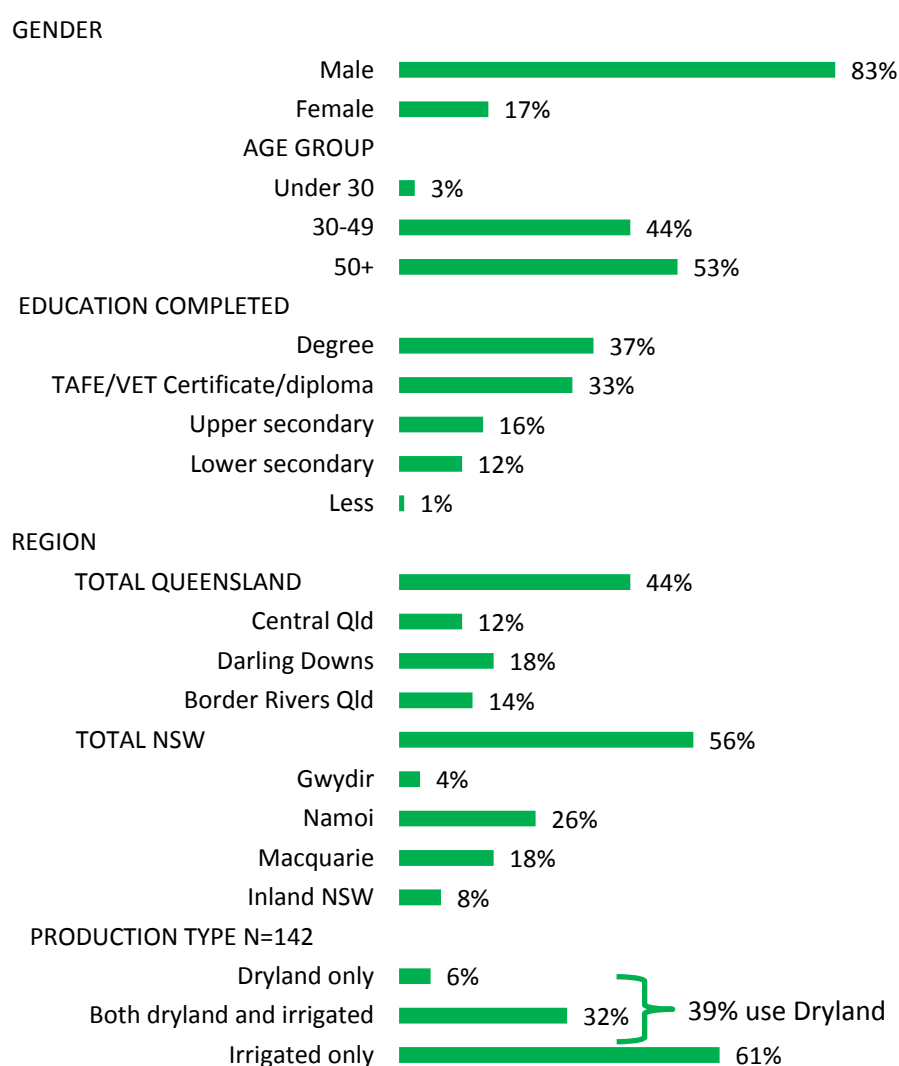
Growers in all the growing regions of Australia were surveyed. A small number of growers in the database were identified as operating in areas that are relatively new for cotton growing. However, despite intensive effort only three growers were interviewed from these locations.

Nearly all the current growers interviewed (95 per cent) were also involved in other forms of agricultural production as well as growing cotton, and only seven (5 per cent) were growing cotton

exclusively. Additionally, most of the growers had first grown cotton before 2003 (85 per cent) with only 15 per cent having started growing recently.

Many of the site users who were interviewed were not recorded in the database as registered users of the site. Only 14 of those interviewed were recorded as registered with the myBMP website.

Figure 23: Personal characteristics of cotton growers interviewed



Source: Cotton Grower Environmental Performance Survey 2012

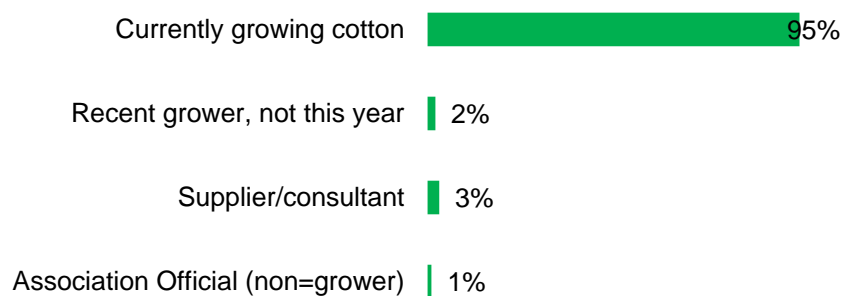
Key characteristics of the sample:

- Nearly all respondents were currently growing cotton
- Most respondents were male
- About half were aged 50 or more and very few aged under 30

- Of those interviewed 56 per cent (N=84) were located in NSW and 44 per cent (N=66) in Queensland
- Some interviews were conducted in every growing region. However, very few were interviewed from the Bourke (N=2) and the McIntyre /Mungindi (N=5) regions because there were relatively few contacts in those regions.
- For analysis the regions were re-classified to group together as follows:
 - NSW Regions
 - Gwydir River
 - Namoi
 - Macquarie
 - Inland NSW (Bourke, Lachlan, Murrumbidgee, Menindee)
 - QLD Regions
 - Central Queensland
 - Darling Downs
 - Border Rivers Queensland (St George, Dirranbandi, McIntyre Valley)
- The bulk of the sample came from the NSW regions of Namoi (N=39) and Macquarie (N=27), and the Queensland Darling Downs (N=27), Border Rivers Queensland (N=21) and Central Queensland(N=18) regions.

While only one respondent was an association official who was not a grower, in total 14 association officials were interviewed (9 per cent of the total sample). The graph below demonstrates the distribution of industry involvement of the cotton growers that were interviewed.

Figure 24: Distribution of grower involvement in the cotton industry



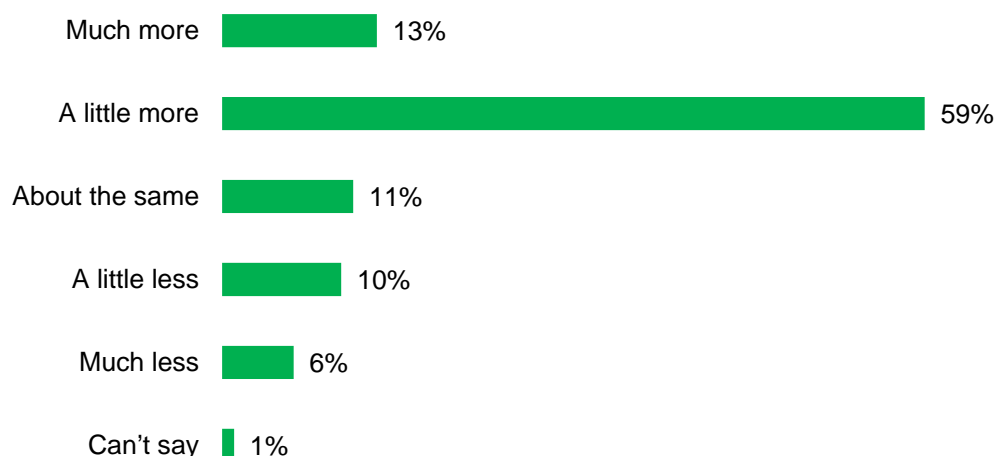
Source: Cotton Grower Environmental Performance Survey 2012

Perceptions of Industry Environmental Performance

Those currently producing other crops or livestock as well as cotton (N=135) were asked about the relative environmental impact of cotton growing compared to other forms of agricultural production.

As shown in the graph below, most believed that the impact of cotton growing was greater than the impact of other forms of production they were involved in (72 per cent), while only one in five believed that the impact of cotton growing was less than from other forms of production (21 per cent).

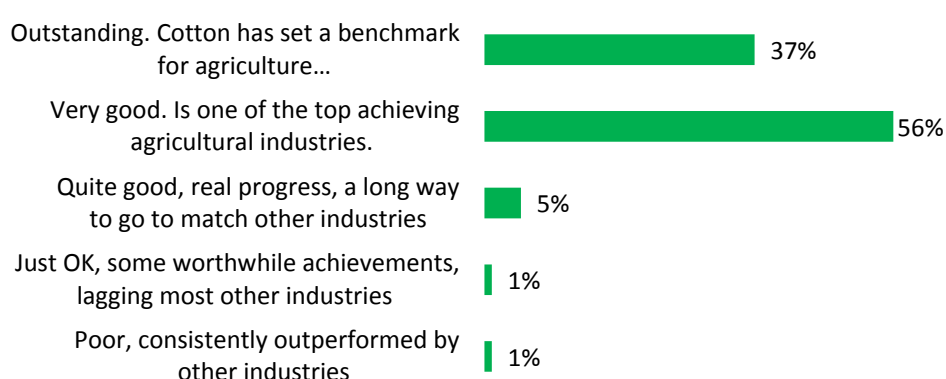
Figure 25: Cotton crop's impact on the environment in comparison to other crops and livestock



Source: Cotton Grower Environmental Performance Survey 2012

However, when asked to rate the performance of the cotton growing industry in reducing its environmental impact compared to other agricultural industries, most indicated this was outstanding or very good (93 per cent), as shown in the graph below.

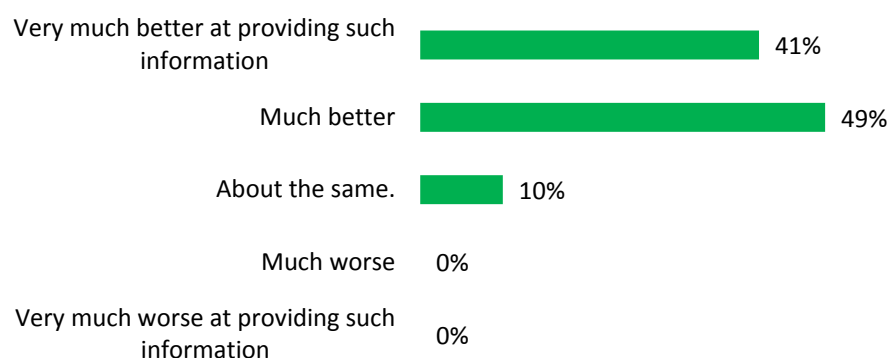
Figure 26: Grower perceptions on industry performance in improving environmental impacts



Source: Cotton Grower Environmental Performance Survey 2012

These growers also considered that the industry's performance in providing information about how to reduce the environmental impact of its production was better than in other agricultural industries (90 per cent) with none believing it to be worse.

Figure 27: Grower perceptions on industry performance in providing information

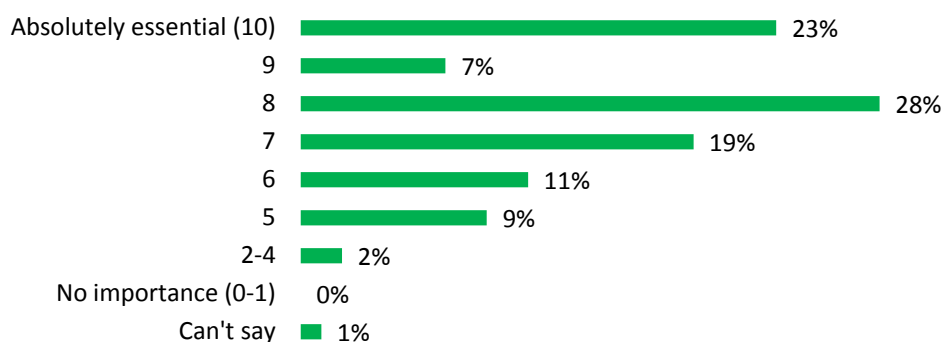


Source: Cotton Grower Environmental Performance Survey 2012

Despite this positive view of the industry's efforts, 83 per cent believed that more needed to be done to influence the views of other stakeholders about the industry's environmental impact. It appears these growers do not believe the industry's efforts have been recognised.

The issue is seen as important. When rated on a ten point scale, 27 per cent believed that improving environmental performance was absolutely essential, and 58 per cent rated it at 8 to 10 on a zero to 10 scale; none gave a rating below 2, and only 2 per cent a rating below 5.

Figure 28: Grower perceptions on the importance of improving environmental performance

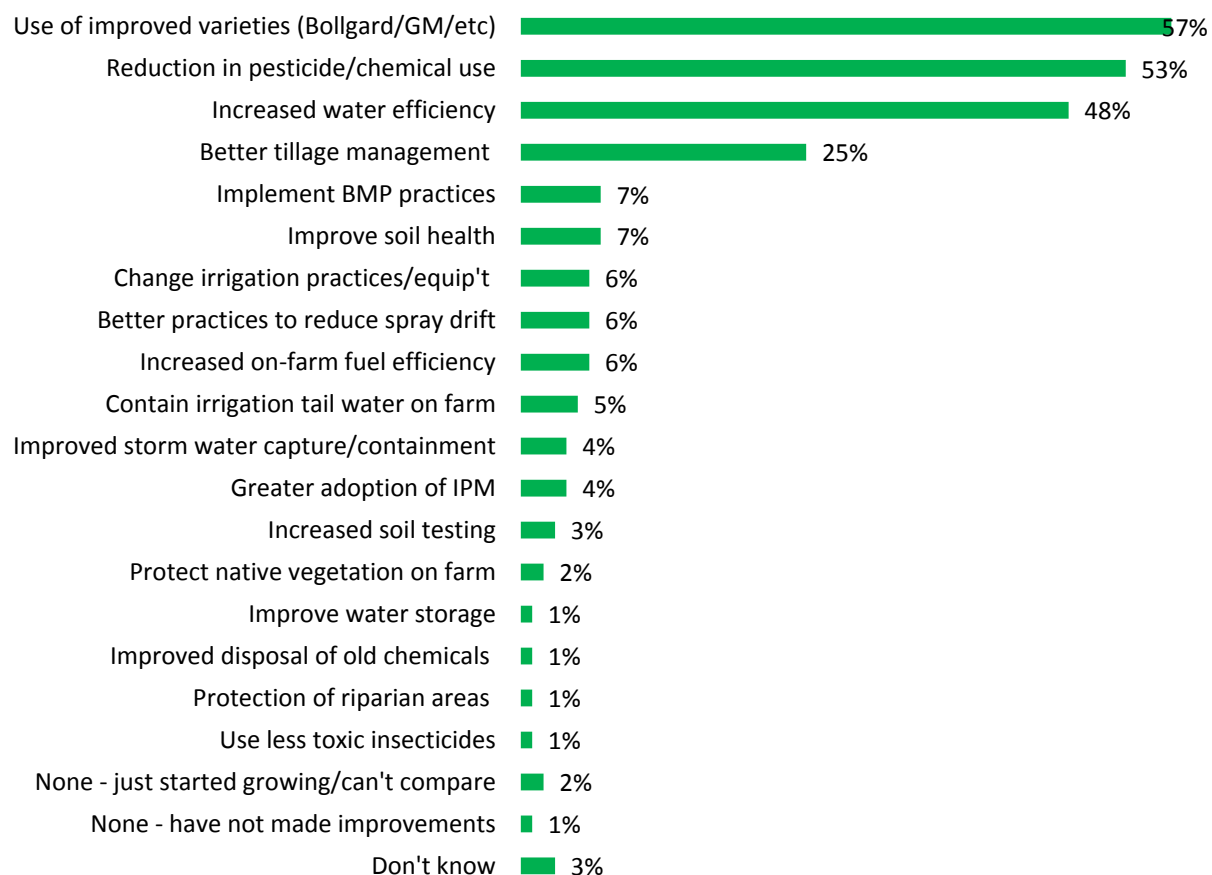


Source: Cotton Grower Environmental Performance Survey 2012

Nature of Improvements Made

When asked what improvements they had made to reduce the environmental impact of their own cotton growing since 2003, the 141 growers who felt able to answer replied as shown below.

Figure 29: Grower perceptions on their own improvements in reducing environmental impacts of cotton



Source: Cotton Grower Environmental Performance Survey 2012

Three types of improvement accounted for the bulk of those reported:

- Use of improved cotton varieties (with most specifically mentioning Bollgard or GM cotton)
- Reduced use of chemicals (reduced insecticide use and reduced fertiliser use were specifically mentioned by some respondents), often in conjunction with introduction of improved varieties that are genetically modified to be resistant to Boll moth attack or are “round UP ready”
- Improved water efficiency, also often associated with introduction of improved varieties of cotton

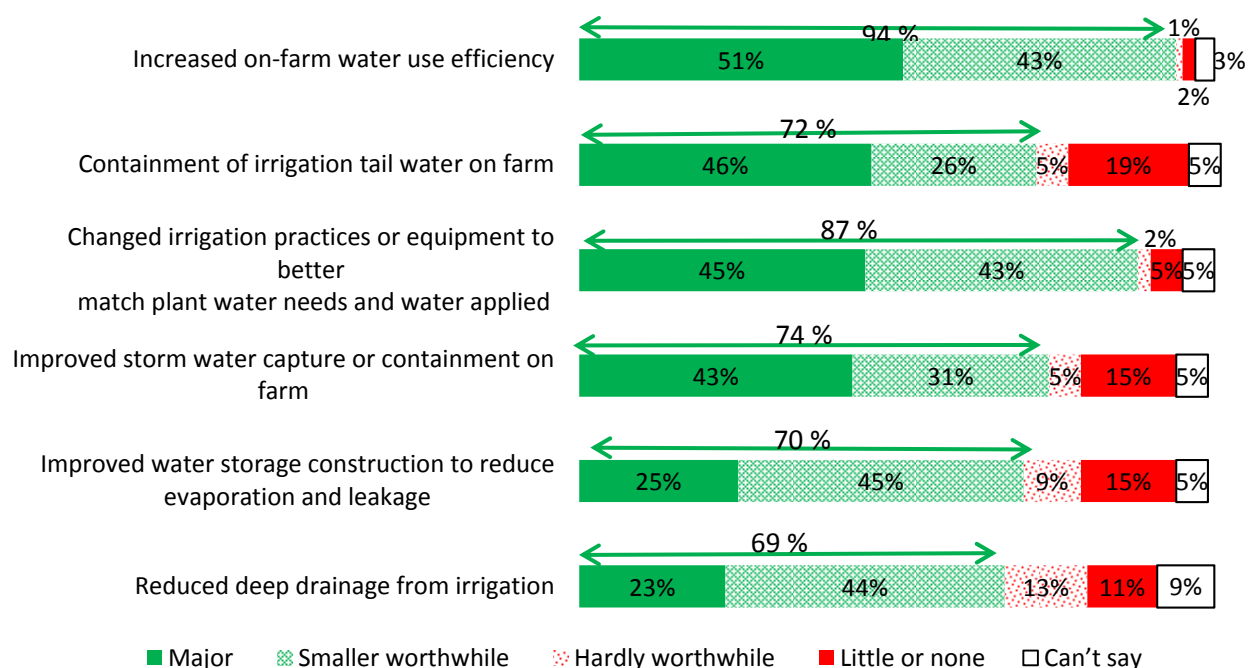
Better tillage management that reduces soil disturbance, reduces compaction of soil, or leaves stubble in the ground was also reported by 25 per cent.

Some volunteered a range of new practices from mulching and retention of stubble, to carbon sequestration and planned crop rotation with the aim of improving soil quality.

However, the overwhelming focus in replies to this question was on the new cotton varieties and the consequences for chemical and water use.

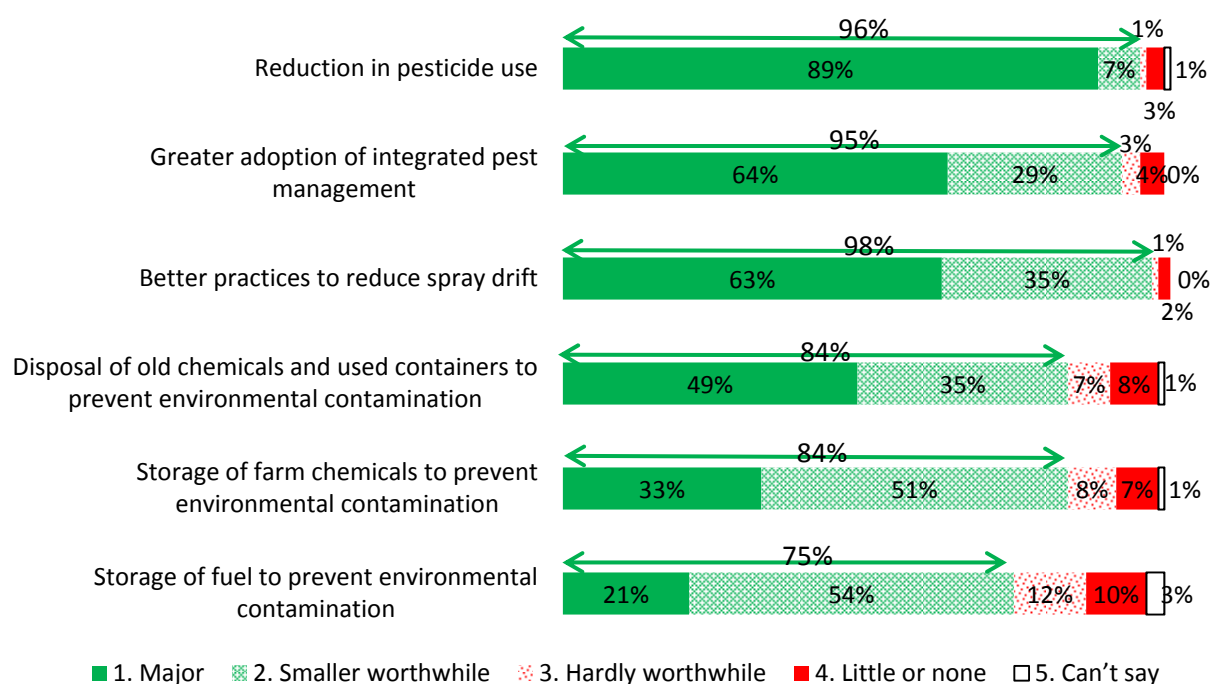
Respondents were asked to rate a number of statements about different specific improvements that have been made by the industry since 2003 covering aspects of water management, management of chemicals, land management, and management of greenhouse gas production and energy use.

Figure 30: Grower perceptions on improvements in water management



Source: Cotton Grower Environmental Performance Survey 2012

Figure 31: Grower perceptions on improvements in chemical management

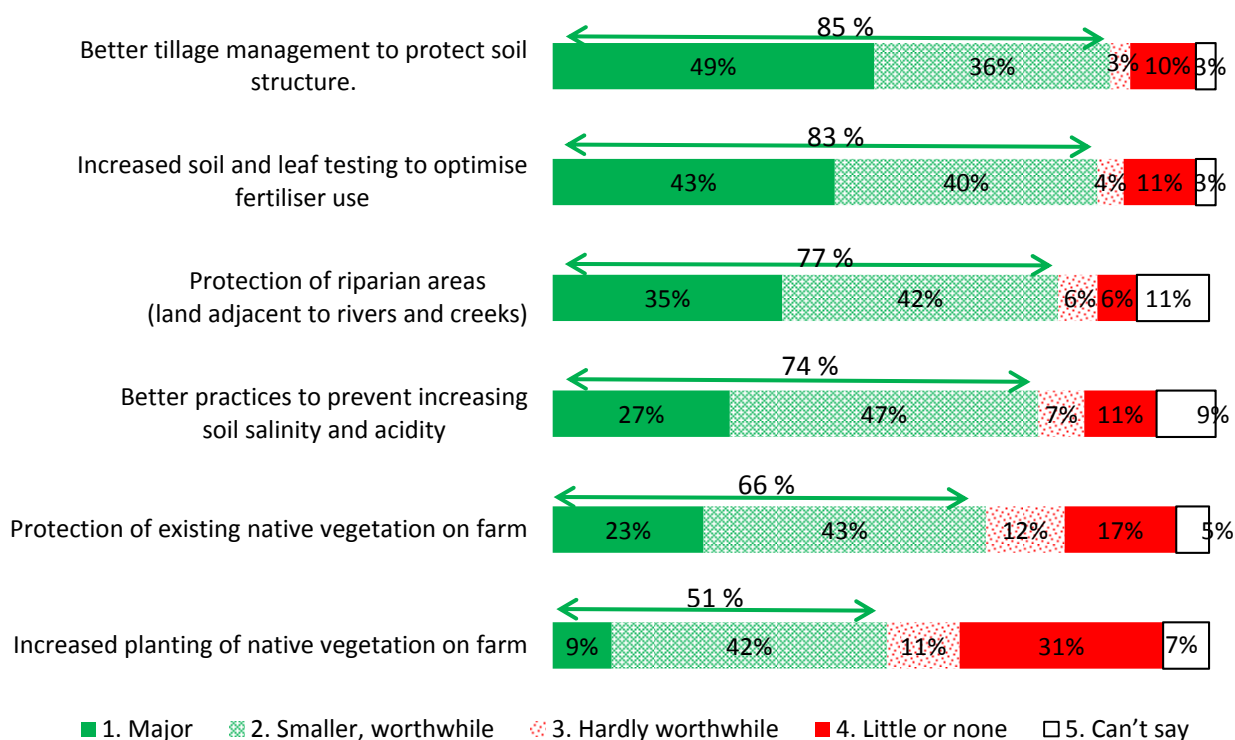


Source: Cotton Grower Environmental Performance Survey 2012

Large majorities believed that major improvements have been made in some aspects of water management and management of chemicals. The graphs above show the areas where they believe that the greatest impacts have been achieved.

Ratings of improvement in land management were not quite as positive, as can be seen in the graph below with improved tillage and optimising fertiliser use most likely to be seen as major.

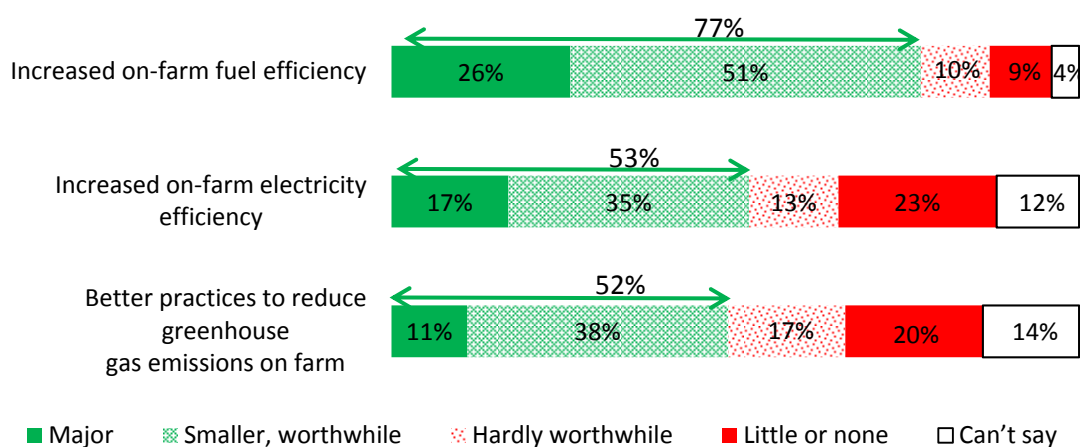
Figure 32: Grower perceptions on improvements in land management



Source: Cotton Grower Environmental Performance Survey 2012

Efficiency in use of fuel and electricity, and practices to reduce greenhouse gas emissions from farming activity were among the areas where fewest believed that major improvements have been achieved.

Figure 33: Grower perceptions of improvements in greenhouse gas emissions



Source: Cotton Grower Environmental Performance Survey 2012

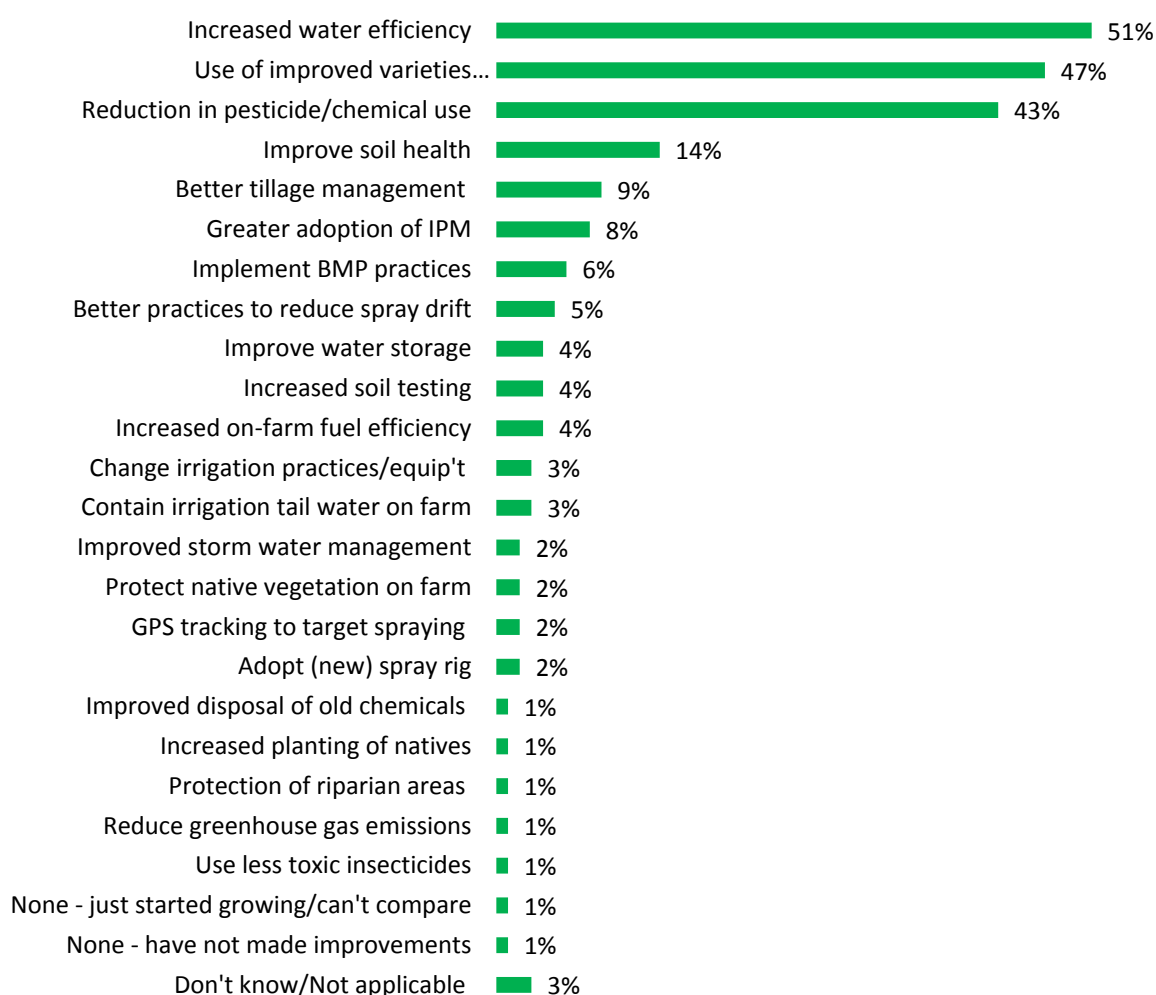
At least half those giving ratings believed that at least worthwhile improvements have been achieved in every area probed.

When asked to rate how concerned they were about specific environmental issues, water allocations and management stood out clearly above the other issues prompted. Many recognised use of nitrogen fertilizers and efficiency of power and fuel use as priorities, followed by pesticide application and tillage management. Biodiversity and greenhouse gas emissions were much less widely accorded high priority.

These replies to the prompted actions align quite well with the answers volunteered without prompting. The unprompted replies were, however, more specific in nominating the introduction of improved varieties of cotton as the means by which both reduced chemical use and improved water efficiency had been achieved.

When asked to volunteer what improvements they believed had been made generally in their region, the replies were similar to those given when asked about improvements they had personally made, as shown by the graph below.

Figure 34: Grower perceptions on regional improvements in reducing environmental impacts of cotton

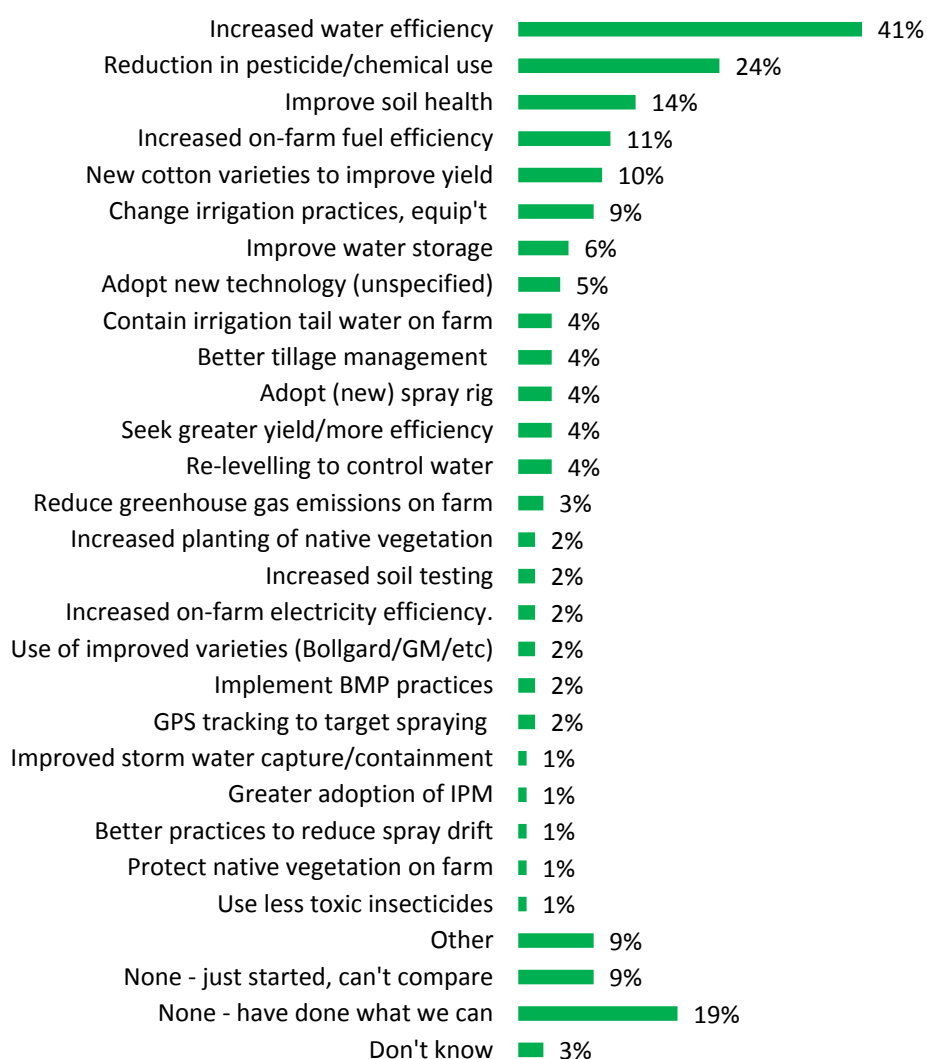


Source: Cotton Grower Environmental Performance Survey 2012

Mentions of action to improve soil health were more common in replies to this question, while mentions of improved tillage practices were less common. Again the three dominant replies were the introduction of new cotton varieties, reduced chemical use and improved water efficiency.

Perceptions about what more could be done to reduce the environmental impact of cotton growing were more varied, with a substantial group indicating they had done as much as they could, or that further improvements required improved technology (with some mentioning further improvements in pest resistance or drought tolerance).

Figure 35: Grower perceptions on further improvements to be made



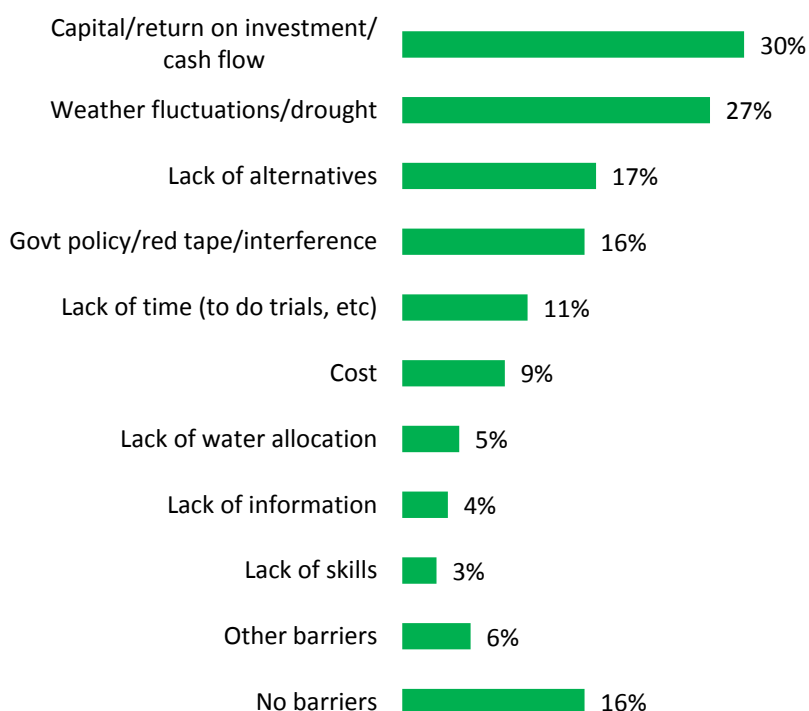
Source: Cotton Grower Environmental Performance Survey 2012

Action to improve soil health and increased fuel or energy efficiency were more prominent among actions to make further improvements than in what had been already done.

When asked what (if anything) had been a barrier to them achieving reduced environmental impact from their cotton growing, financial considerations clearly dominated. This was often linked to mention of the long term drought or to the recent two successive seasons with floods.

For some (9 per cent), the answer was simply “cost”, but most put the financial issue in terms of having the required capital, being able to see a worthwhile return on investment, or lacking the cash flow to support adoption of improved practices (30 per cent). The following graph shows the distribution of replies after these were categorised.

Figure 36: Grower perceptions of barriers to their own improvement

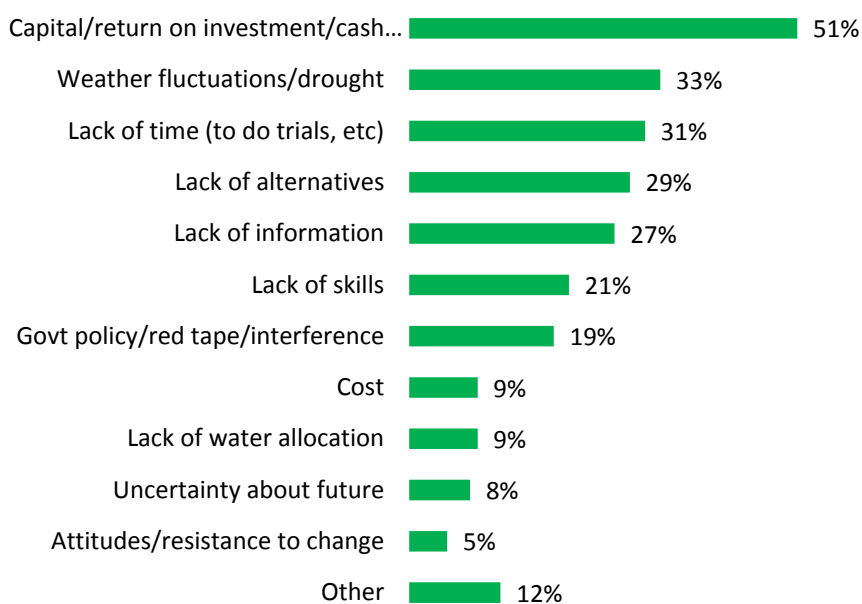


Source: Cotton Grower Environmental Performance Survey 2012

Some (16 per cent) volunteered that there were no barriers.

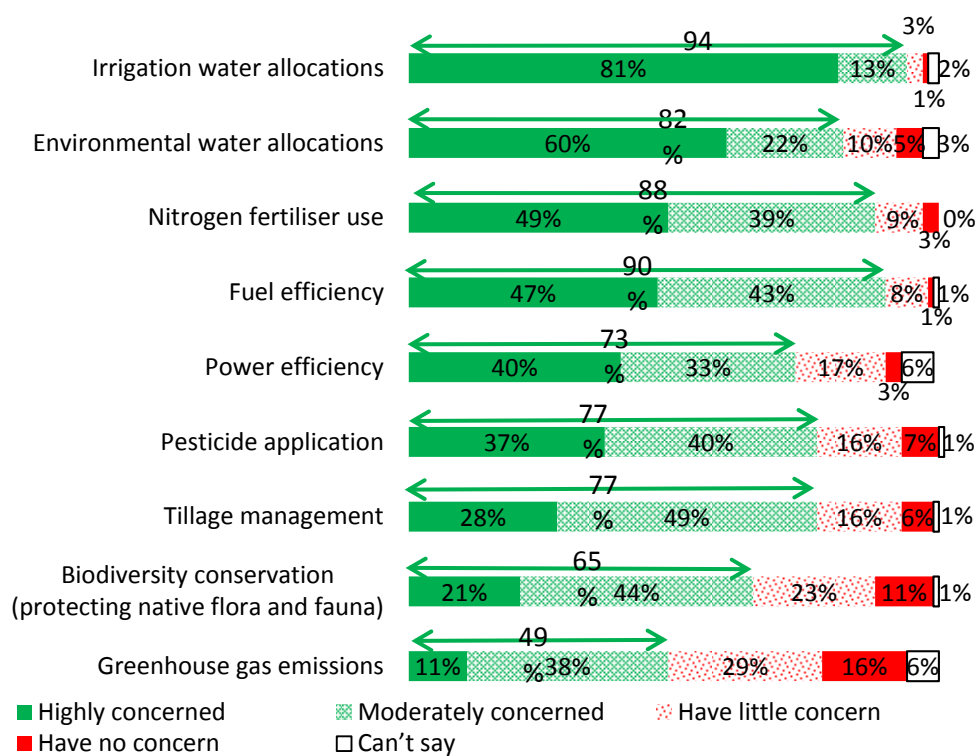
Perceived barriers to action across their region concentrated even more strongly on financial issues, with weather problems, lack of time, and perceived lack of alternatives or of necessary information also being relatively common replies. More mentioned lack of skill (21 per cent) as a regional barrier than had done so as a personal barrier (3 per cent). It is perhaps easier to volunteer this about others in general than to admit one's own lack of required skill.

Figure 37: Grower perceptions on barriers to regional improvements



Source: Cotton Grower Environmental Performance Survey 2012

Figure 38: Grower concerns in terms of environmental issues



Source: Cotton Grower Survey 2011

Priority here clearly goes to those aspects that have the greatest implications for the survival and profitability of the cotton growing enterprise – water, fertiliser and fuel use. These align with the areas where the growers believe more has already been done to reduce impacts.

Most believed that more needs to be done to influence other stakeholders, including public opinion (83 per cent). A range of actions were volunteered by those who believed more action was needed, led by educating the general public and/or children about what cotton growers have already done, and generally improved communication, publicity or promotion. Actively lobbying governments with the facts about the industry's efforts, awareness raising and meeting to communicate with key audiences were also mentioned. One specific issue mentioned was disseminating factual information about the benefits of GM cotton varieties, along with factual reporting of innovations by the industry. However, when pressed another 17 per cent believed that nothing more could be done to improve perceptions of the industry, or were unable to make a suggestion (total 20 per cent). The following graph summarises the frequency of replies grouped into categories developed to summarise the replies given.

Figure 39: Grower perceptions of actions to take to influence stakeholders



Source: Cotton Grower Environmental Performance Survey 2012

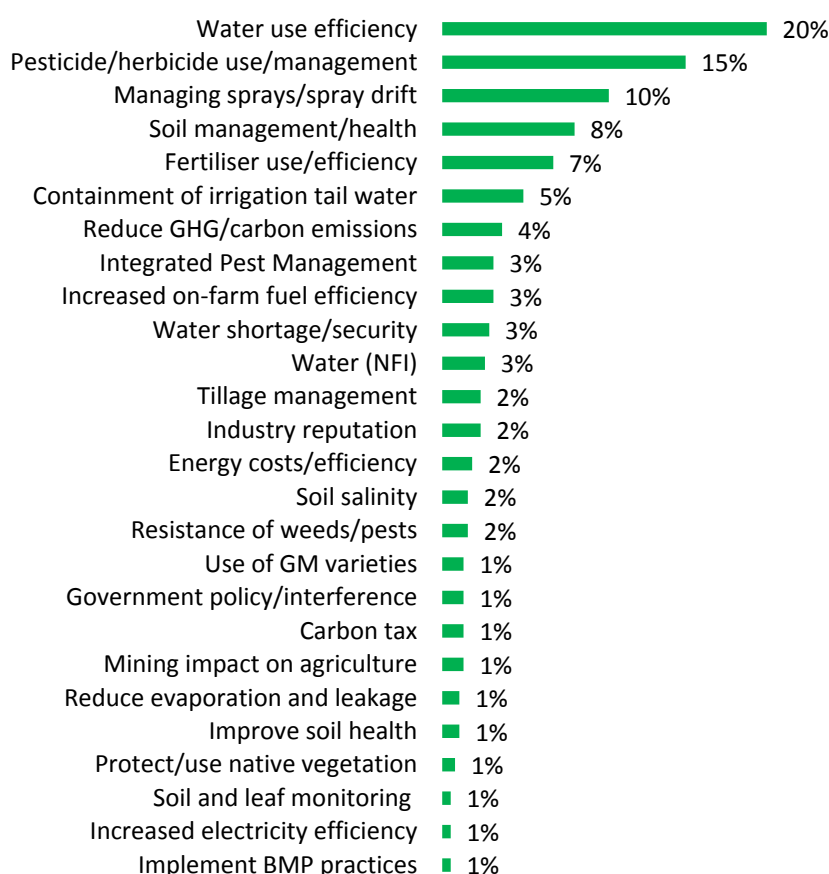
Top environmental priorities today

The growers were asked to nominate their own top three environmental priorities for the industry today. Some nominated only one, and others nominated more than three. The graph below simply

Inovact Consulting

reports for each category the percentage of those asked the question who gave a reply that fell into the category. Categories were largely aligned with the prompted list of achievements, but have been reworded to reflect the lower level of detail given by these verbatim replies. A number of other categories (such as use of GM cotton) have been added to capture as accurately as possible the full range of replies.

Figure 40: Grower perceptions on the top environmental priorities



Source: Cotton Grower Environmental Performance Survey 2012

Efficiency is an underlying theme behind several categories – in use of water, chemicals, fuel, and energy. Water supply was mentioned by some, and those who simply stated “Water” with no further information might have been thinking of supply rather than efficient use. Reduced emissions of greenhouse gases (GHG) and carbon was more often mentioned here than in the reports of actual achievements to date, but only by 4 per cent. Use of genetically modified varieties was also less prominent, and was often accompanied by comments about the need to stop the seeds spreading GM cotton outside the planted fields. Only a few appeared concerned that other stakeholders might object to the use of GM cotton. Emerging resistance of pests (weeds and insects) to the available pesticides was evident, as was concern that the pest-resistant “roundup ready” GM varieties might over time become more vulnerable. Concern about pesticides also reflected the risks

of the material spreading to neighbours and producing adverse reactions, reflected in the concern about spraying and spray drift.

The very low levels of nomination of some issues are also noteworthy, including protection or planting of native vegetation, and protection of riparian areas, (mentioned by so few it is not shown on the graph). Industry reputation, or the need to defend and communicate the industry's achievements was mentioned, but only by a few. A few offered trenchant and clearly deeply felt objections to government legislation or regulation that they saw as ill-considered interference – but this came only from a few. Had we asked about general, rather than environmental, priorities, this might well have been volunteered by a larger proportion of the sample. Similarly, the small number who expressed concern about the effects of coal mining and/or coal seam gas extraction might have been larger if the question had been phrased more broadly.

As with the reported achievements and their own future plans, the primary focus is on issues that have implications for profitability and long term financial viability, with the industry's "social license to operate" being a secondary theme.

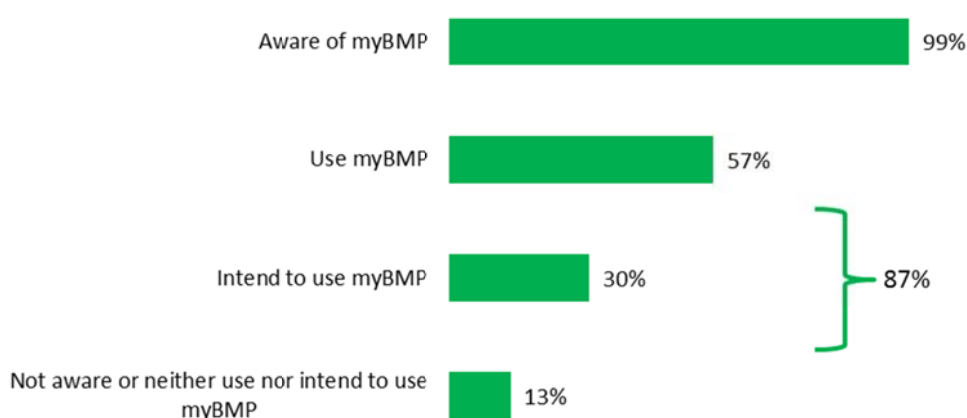
Putting these replies together with the reported achievements and plans for further improvement, it appears that these growers are proud of what the industry has done to reduce its environmental impact, while concentrating most on the changes that also have potential financial benefits both for themselves and for the industry.

The myBMP program

The myBMP program was designed to improve cotton growing practices in general and to achieve environmental improvements in the process.

As shown in the graph below, the program name is almost universally recognised (99 per cent). Just over half the respondents report using the myBMP website and most either do so or report that they intend to do so in future (87 per cent). Only 13 per cent are not aware or neither use nor intend to use the website.

Figure 41: Cotton growers' awareness and use of myBMP



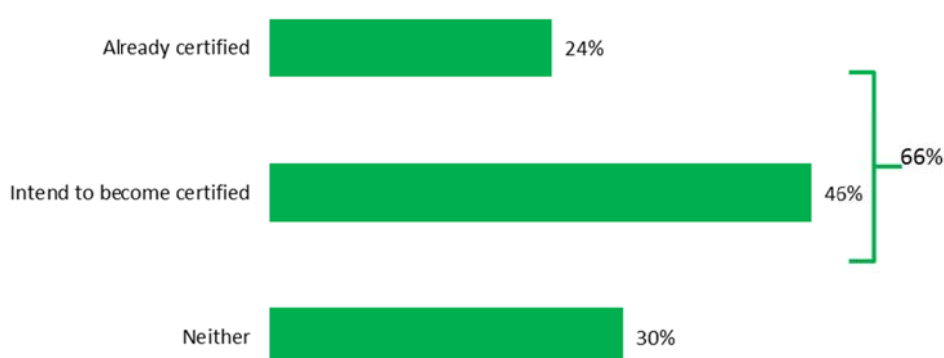
Inovact Consulting

Source: Cotton Grower Environmental Performance Survey 2012

Certification of cotton production as meeting the myBMP standards is much more demanding than simply drawing on information from the program. However, 70 per cent of the growers surveyed reported are either already certified (24 per cent) or intend to become certified (46 per cent).

As mentioned in discussing sample characteristics, only 14 respondents were drawn from those who were recorded on the data base as registered users of the myBMP website. Less than half of these described themselves as site users (6/14) while 59 per cent (79/134) of those not identified as registered users said they used the site. Only 2 of the 14 said they were myBMP Certified, while 32 of the other respondents (24 per cent) reported they were certified.

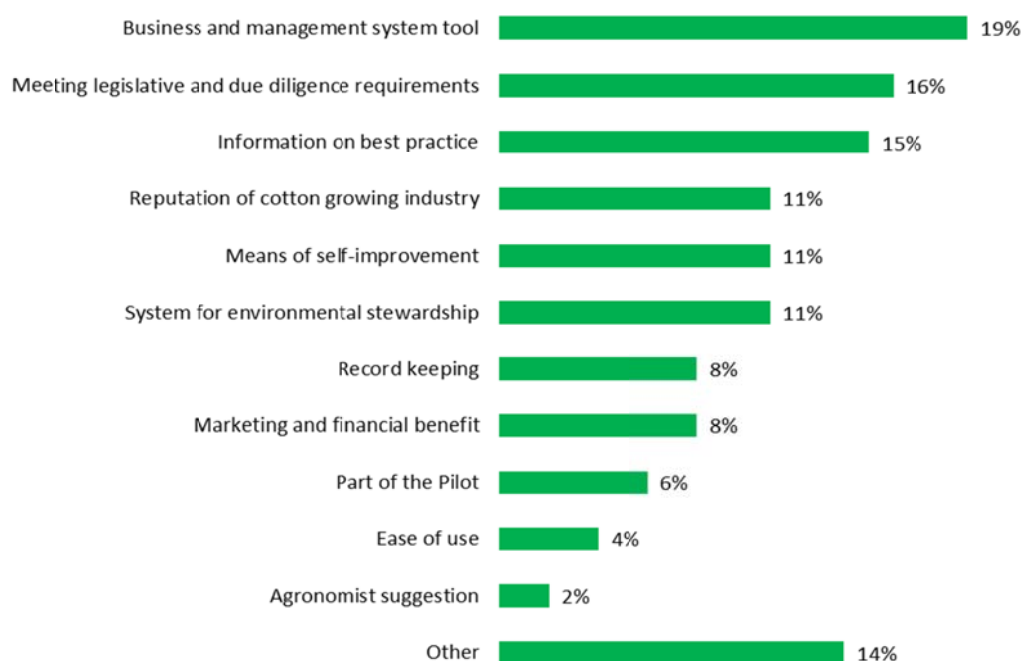
Figure 42: Cotton grower myBMP certification



Source: Cotton Grower Environmental Performance Survey 2012

When asked to identify what attracted them to use of the myBMP site or to seek certification, the 85 who were using, certified or intending to become certified identified a range of possible benefits. These were categorised and are summarised in the following graph.

Figure 43: Attractions to using myBMP

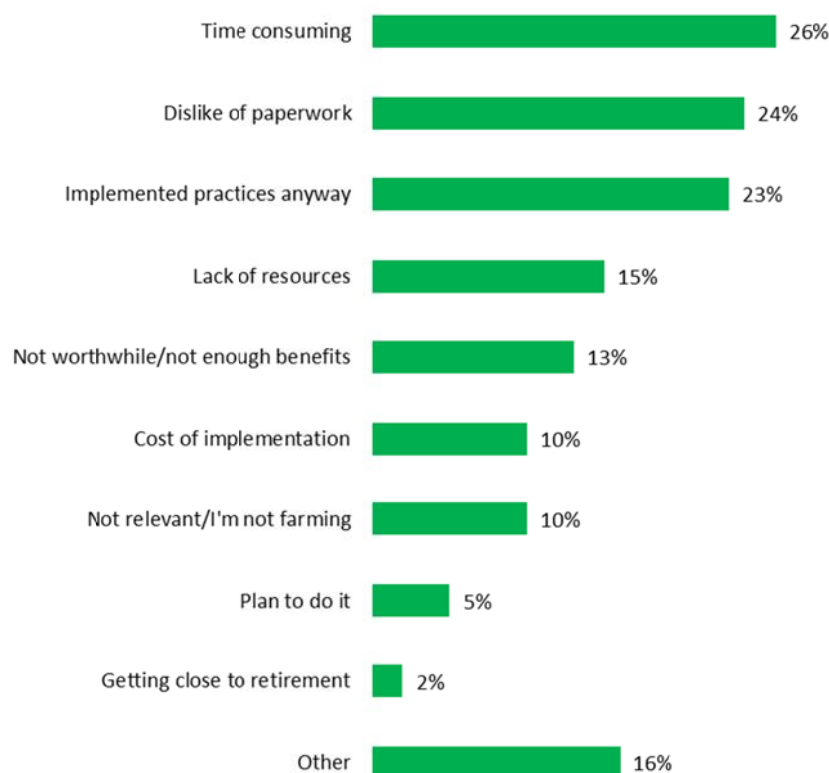


Source: Cotton Grower Environmental Performance Survey 2012

Some benefits focus on myBMP supporting better management of their cotton growing as a business or providing information on best practice. A substantial group nominated support in meeting legislative requirements and environmental regulations. Other saw the benefits in terms of improved industry acceptance and reputation in the wider community.

When asked about barriers to adoption, those who had not indicated that they use the myBMP site or have or intend to become certified focussed on resource issues rather than lack of perceived benefits.

Figure 44: Barriers to using myBMP



Source: Cotton Grower Environmental Performance Survey 2012

Reasons given included dislike of paperwork or believing there was too much paperwork involved, the time required, other lack of resources and cost issues accounted for many of the replies. Some claimed they had adopted myBMP practices, but did not see the added value of the effort required to become formally certified. A few volunteered they still had plans to adopt certification (although they had not said so when explicitly asked). Only 13 per cent denied there would be benefits or said the benefits would be insufficient. Greater support and ease of adoption appear to be critical for achieving increased penetration of myBMP certification.

Appendix 2: Cotton Stakeholder Environmental Performance Survey 2012

Methodology

An online survey was devised to evaluate the attitudes of industry stakeholders towards the key environmental issues faced by the cotton industry. The key objectives of the stakeholder survey were to assess stakeholders' views on the progress of the cotton growing industry in meeting environmental challenges; to assess the environmental issues currently facing the industry from stakeholders' perspectives; and to identify the environmental issues that the industry is likely to face in the future (next 3-5 years).

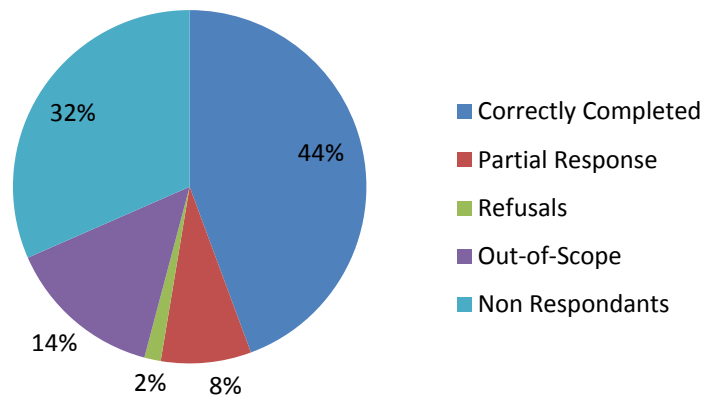
The survey was meant to gauge not only the perceived highlights, shortcomings and supporting evidence of the industry's progress in improving environmental progress, but also perceptions of urgency for further action, barriers, and priority issues for the future.

would really like to know who is truly external to the industry in these responses. E.g. there are lots of government respondents but a number are within the industry. For CA this is important, especially given we use it as a defensive doc to policy makers (therefore to be credible in these circles this needs to have a good portion of external responses (otherwise could be seen as industry saying how good we think we are). Can't change the portions now, so to manage would be helpful to know this portion/breakdown if possible.

Sample Characteristics

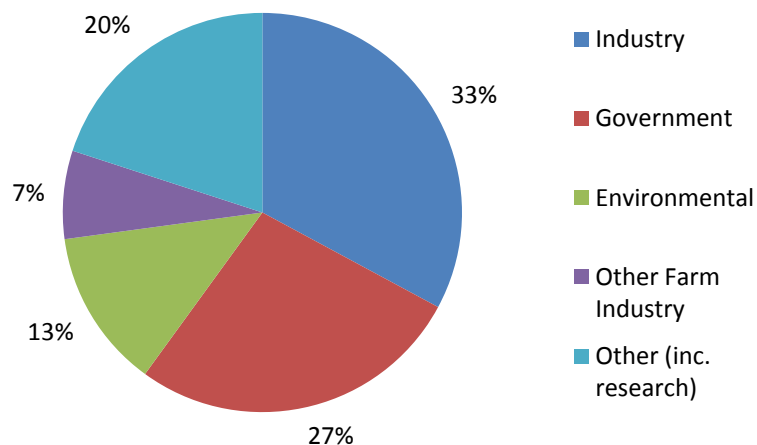
A total of 133 stakeholders, identified by the Cotton Research and Development Corporation, were emailed invitations to complete the online survey. There were a total of 70 responses out of the 133 stakeholders that were contacted by email, resulting in a response rate of 53 per cent.

Figure 45: Sample and response rate



Source: Cotton Stakeholder Environmental Performance Survey 2012

Figure 46: Stakeholder classification and distribution



Source: Cotton Stakeholder Environmental Performance Survey 2012

Key characteristics of the sample:

- 64 per cent were males;
- 59 per cent were aged 50+, while the other 49 per cent were aged between 30 and 49;
- 33 per cent were classified as environmental actors (such as catchment management authorities or natural resource management organisations; and local, national, and/or international non-government organisations;

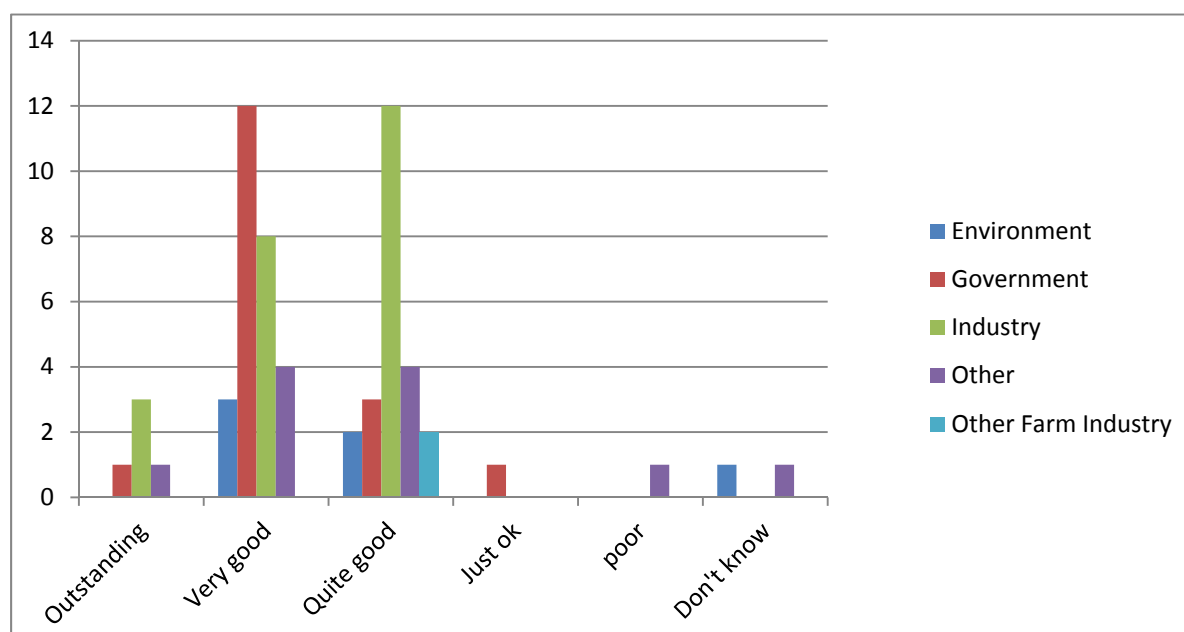
- 27 per cent were classified as governmental actors (such as Australian government departments, state government departments or agencies, intergovernmental departments, etc.)
- 13 per cent were classified as industry actors (such as cotton grower organisations, cotton industry organisations (non-grower), water organisations, merchants, etc.)
- 7 per cent were classified as other farm industries (such as Grain Producers Australia, Cattle Council of Australia, Queensland Farmers Federation, CANEGROWERS, and Rice Growers Association of Australia)
- 20 per cent were classified as other, including research (such as government research organisations, private research organisations, universities, etc.)

Perceptions of Industry Performance

When stakeholders were asked how they would rate the cotton industry's overall performance, a large proportion rated the cotton industry's performance as quite good or very good, with few respondents rating performance to be below just ok. Most individuals identified the industry's performance to be very good.

The distribution of level of the cotton industry's performance selected by each type of stakeholder group can be seen on the graph.

Figure 47: Stakeholder perceptions of industry's overall performance



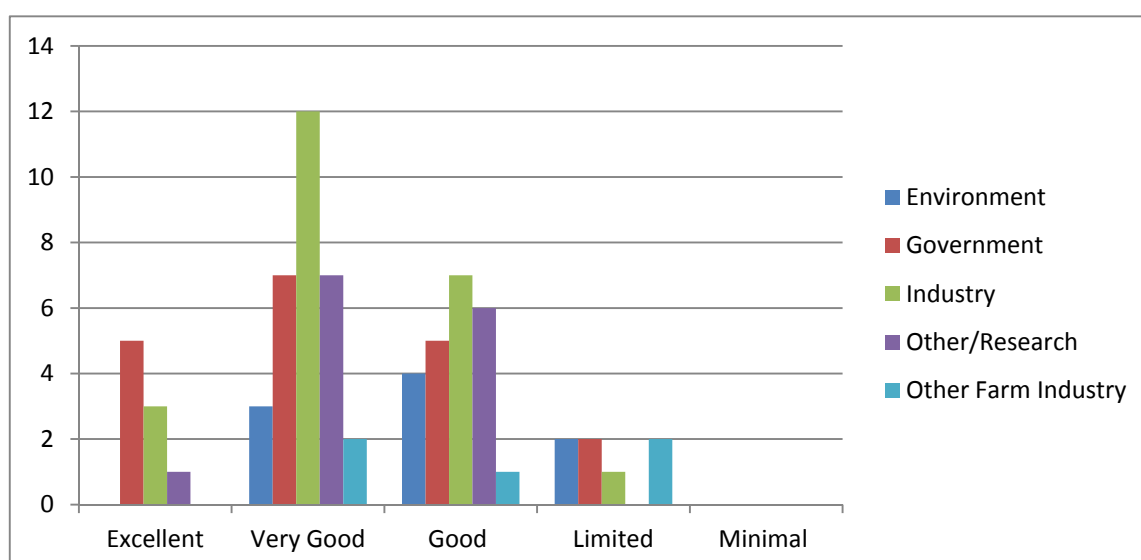
Source: Cotton Stakeholder Environmental Performance Survey 2012

Stakeholders were asked to describe their level of awareness of farming practices of the cotton growing industry based on their organisation's involvement in the industry. A large proportion claimed a good to excellent level of awareness of farming practices, with very few respondents

identifying themselves as having limited awareness, and no respondents identifying as having minimal awareness.

Results suggest that most stakeholders identified by the Steering Committee were familiar with the industry, enabling them to be adequately informed in answering the survey.

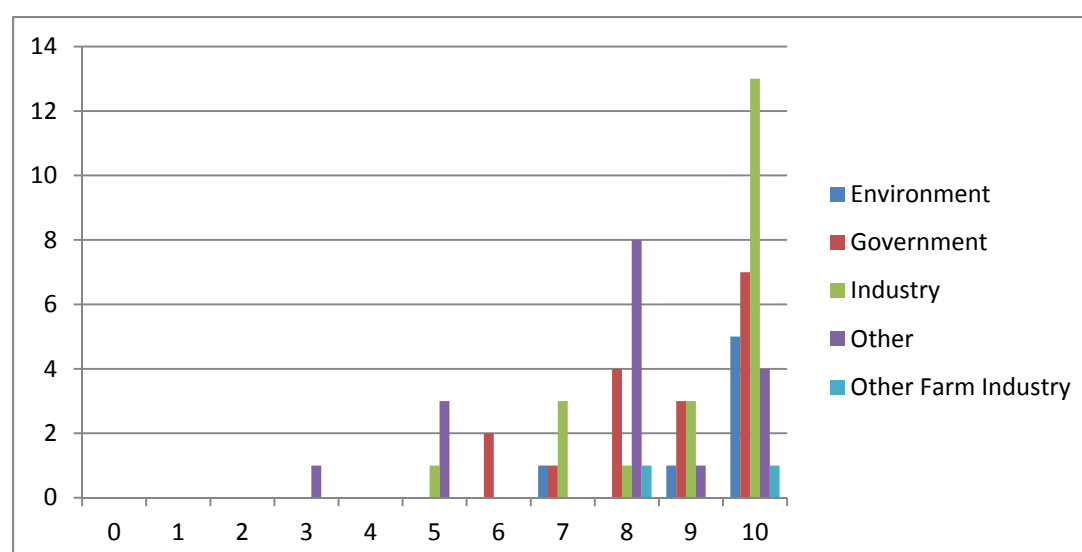
Figure 48: Stakeholders' level of awareness of farming practices



Source: Cotton Stakeholder Environmental Performance Survey 2012

Stakeholders were also asked if they found any importance in the industry taking more action to inform governments, the general community, and other sectors on the environmental performance of cotton farming. A large proportion of the stakeholders find it important for the cotton industry to take more action to inform governments, the general public, and other sectors on the environmental performance of cotton farming. The majority of stakeholders ranked this importance to be from 8 to 10, with few ranking this importance to be below 7.

Figure 49: Stakeholders' perceptions on importance of the industry informing others on environmental performance

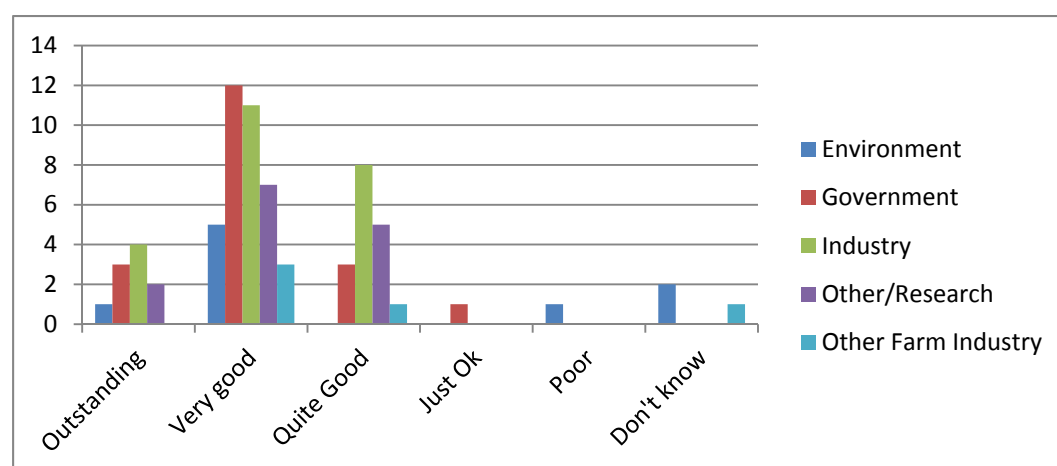


Source: Cotton Stakeholder Environmental Performance Survey 2012

When asked to assess the overall performance of the cotton industry in reducing the environmental impact of cotton growing over the past 10 years, A large proportion rated overall performance to be a quite good to outstanding, with very few respondents (all from environmental groups) rating performance to be below just ok. Most individuals identified the industry's performance to be quite good and very good.

Results suggest that the stakeholders feel that over the past 10 years good progress has been made to reduce environmental impact of cotton growing. A highlight is the positive response from government respondents.

Figure 50: Stakeholders' perceptions on the overall performance of the industry in reducing the environmental impact of cotton

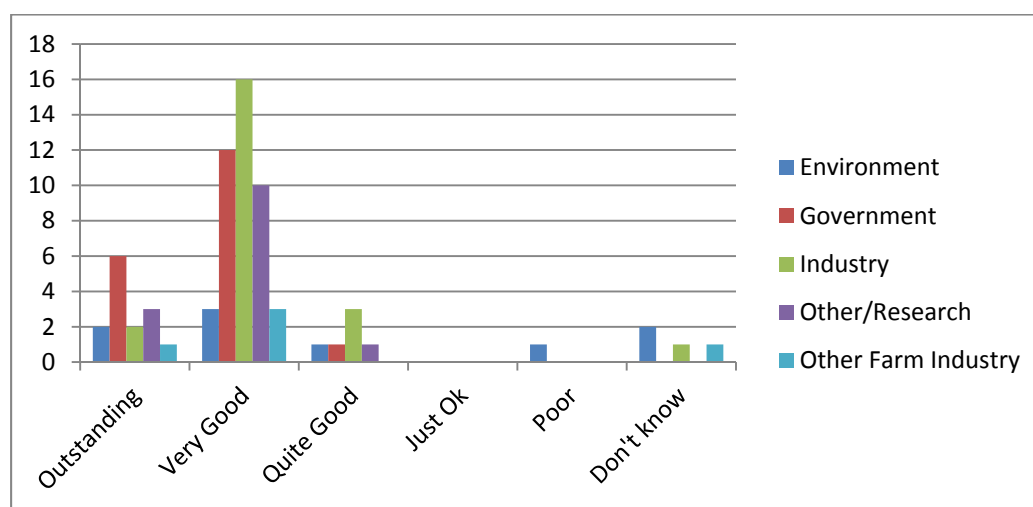


Source: Cotton Stakeholder Environmental Performance Survey 2012

Relative to other agricultural industries, a large proportion of stakeholders rated the overall performance of the cotton industry over the past 10 years to be a very good to outstanding, with very few respondents rating performance to be below quite good relative to other industries. Most individuals identified the industry's performance relative to other industries to be very good.

Results suggest that the stakeholders feel that over the past 10 years very good progress has been made to reduce environmental impact of cotton growing relative to other industries. Highlights are positive responses from government, other industry and environmental respondents.

Figure 51: Stakeholder perceptions of the cotton industry's environmental performance relative to other agricultural industries



Source: Cotton Stakeholder Environmental Performance Survey 2012

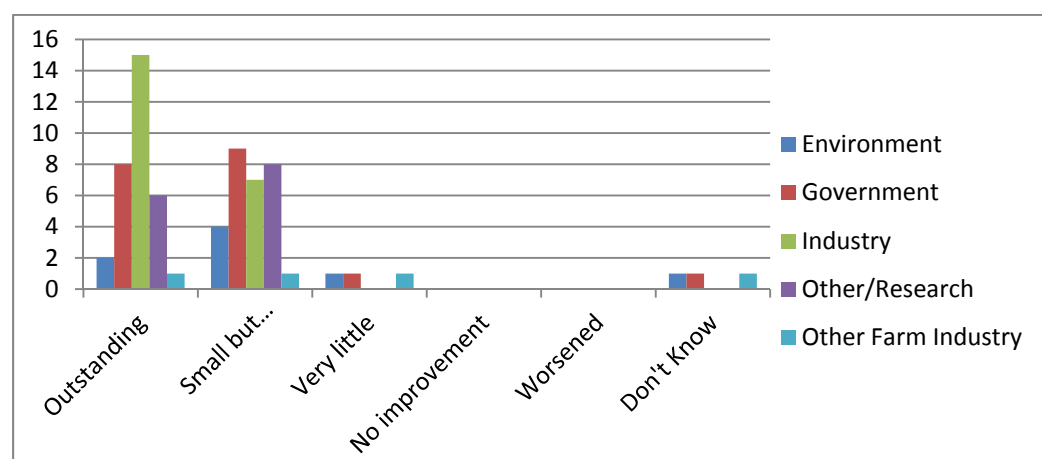
Nature of Improvements Made

Stakeholders across all groups agree with the growers that the industry has made either outstanding improvements or smaller, but worthwhile improvements in water use efficiency and in a related issue of protection of groundwater quantity and quality over the past decade.

Most respondents identified the industry's water-use efficiency to be a small but worthwhile improvement or an outstanding improvement. Very few respondents rated water use efficiency to be below very little improvement, and no respondents claimed water-use efficiency has worsened.

Results suggest that the stakeholders feel that environmental impacts of cotton growing have been reduced by worthwhile to outstanding improvements in water-use efficiency.

Figure 52: Stakeholder perceptions on water-use efficiency

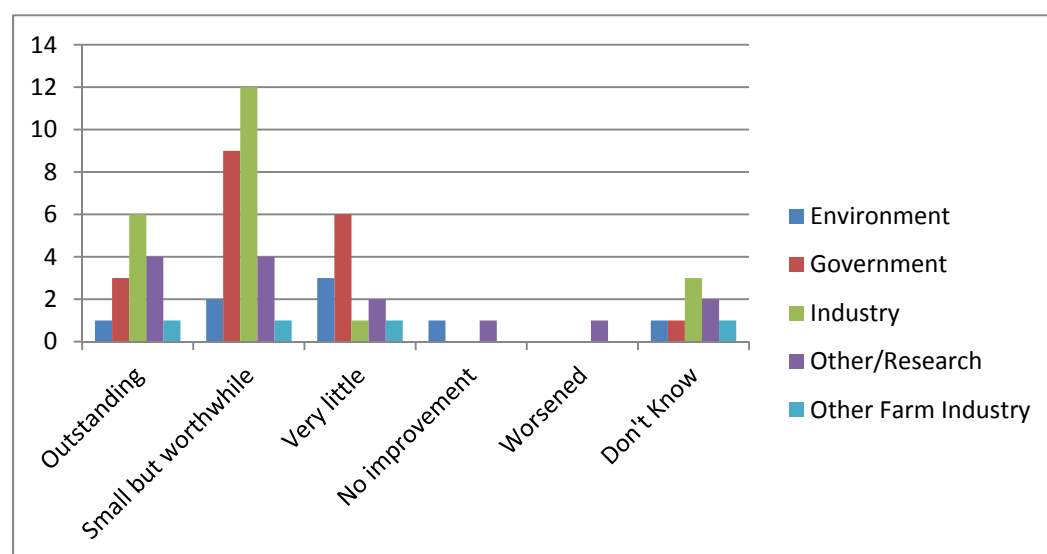


Source: Cotton Stakeholder Environmental Performance Survey 2012

In terms of the protection of ground water quantity and quality, A large proportion rated the reduction of an impact on ground water quantity and quality to be a very little to outstanding, with few respondents rating the reduction to be below no improvement. Most individuals identified the industry's reduction of impact on water-use to be very little or outstanding.

Results suggest that the stakeholders find that the environmental impacts on ground water quantity and quality have been noticeably but only slightly reduced.

Figure 53: Stakeholder perceptions on protection of ground (underground) water quantity and quality



Source: Cotton Stakeholder Environmental Performance Survey 2012

Like water use and management, 42 per cent of stakeholders identified factors relating to chemical use and application as core environmental issues. These factors include pesticide/chemical fertiliser use, spray drift, insect and weed resistance, regulation, and chemical application.

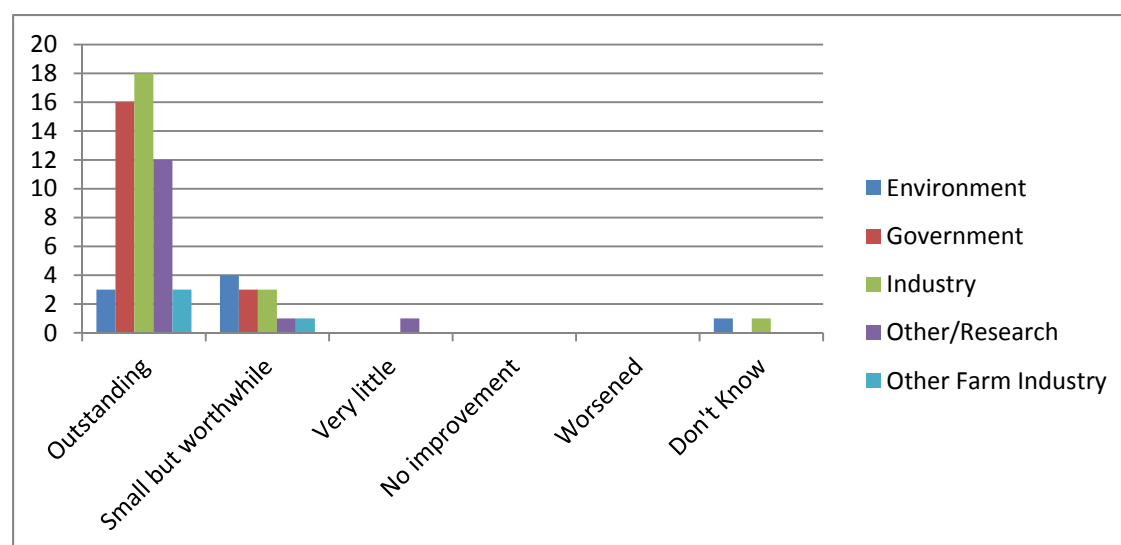
Similarly, most stakeholders rated growers' performance in more effectively managing spray drift as outstanding or achieving worthwhile improvements, although a smaller proportion rated this as outstanding compared with the reduction in the use of pesticides.

Level of chemicals used to combat cotton pests and diseases

The survey results show a majority of stakeholders across all groups apart from environmental groups rated reductions in the use of pesticides as an outstanding improvement over the past decade. Environmental groups rated the performance of the industry as outstanding or achieving smaller but worthwhile improvement. Government and industry stakeholders were prominent in rating the performance as outstanding.

Results suggest that the stakeholders feel that there has been a significant decrease in the level of chemicals used to combat pests over the past 10 years.

Figure 54: Stakeholder perceptions on improvements in the level of chemicals used to combat cotton pests and disease

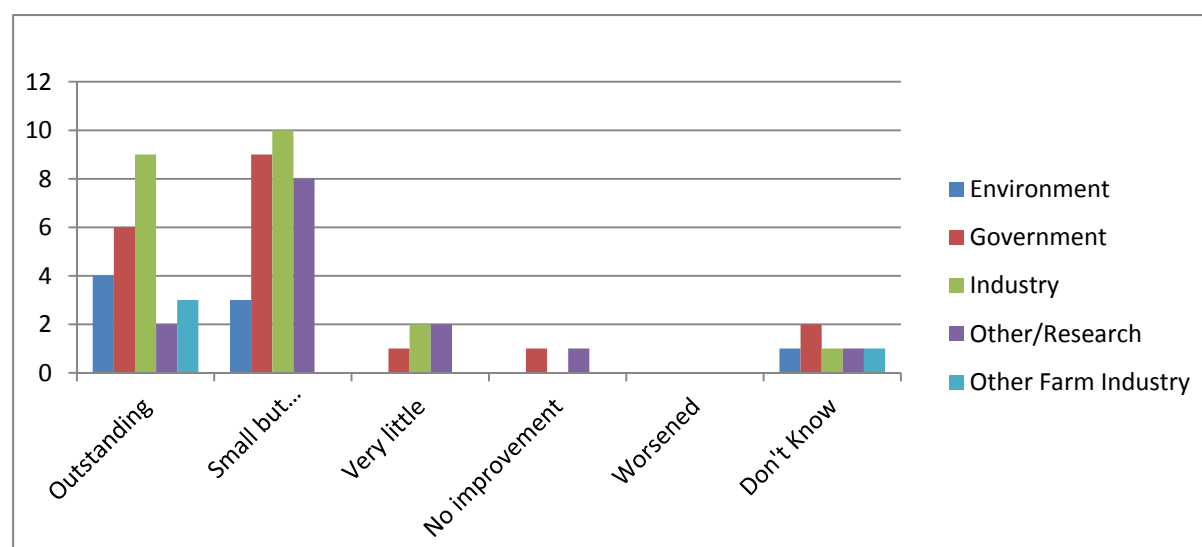


Source: Cotton Stakeholder Environmental Performance Survey 2012

Method of application of chemicals to reduce spray drift

Compared with the level of chemicals used, in the case of spray drift, there were fewer stakeholders rating the performance as outstanding and more rating the improvement as smaller but worthwhile. However, the majority of stakeholders across all groups, except research and non-specified groups rated the industry's performance as outstanding or as achieving smaller but worthwhile improvement. Again, industry and government stakeholders were prominent in rating performance in the top two categories. There were some government, industry and research stakeholders who considered there had been very little or no improvement. Respondents from other farm industry organisations rated the cotton industry's performance highly.

Figure 55: Stakeholder perceptions on improvements in the method of application of chemicals to reduce spray drift



Source: Cotton Stakeholder Environmental Performance Survey 2012

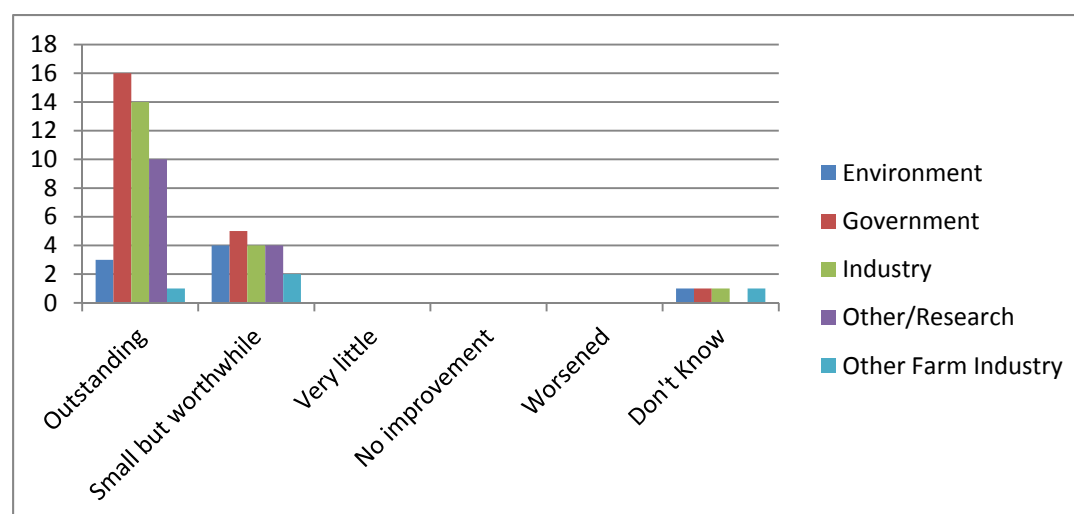
Chemical run-off to rivers and wetlands

The survey results show that the majority of stakeholders also rated the prevention of chemical run-off to rivers and wetlands as an outstanding or achieving a smaller but worthwhile improvement. Government, industry and research and other stakeholders were prominent in rating the industry's performance as outstanding.

A large proportion rated the reduction of the impact of pesticides to be a small but worthwhile to outstanding, with no respondents rating reduction to be below very little. Most individuals identified the industry's reduction of impact on water-use to be outstanding.

Results suggest that the stakeholders feel that environmental impacts of pesticides have been reduced quite dramatically.

Figure 56: Stakeholder perceptions in improvements in pesticide or other chemical run-off to rivers and wetlands

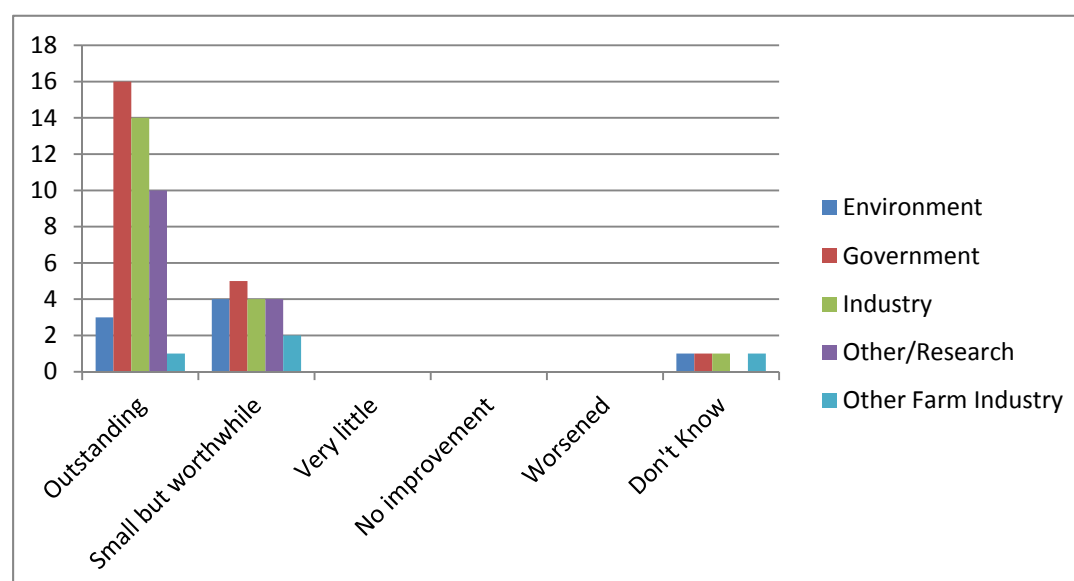


Source: Cotton Stakeholder Environmental Performance Survey 2012

Fertilizer Run-off to rivers and wetlands

The survey results show that the stakeholders across all groups were largely split between those that rated the improvement by the industry as outstanding or smaller but worthwhile improvement.

Figure 57: Stakeholder perceptions of improvements in pesticides or other chemical run-off to rivers and wetlands



Source: Cotton Stakeholder Environmental Performance Survey 2012

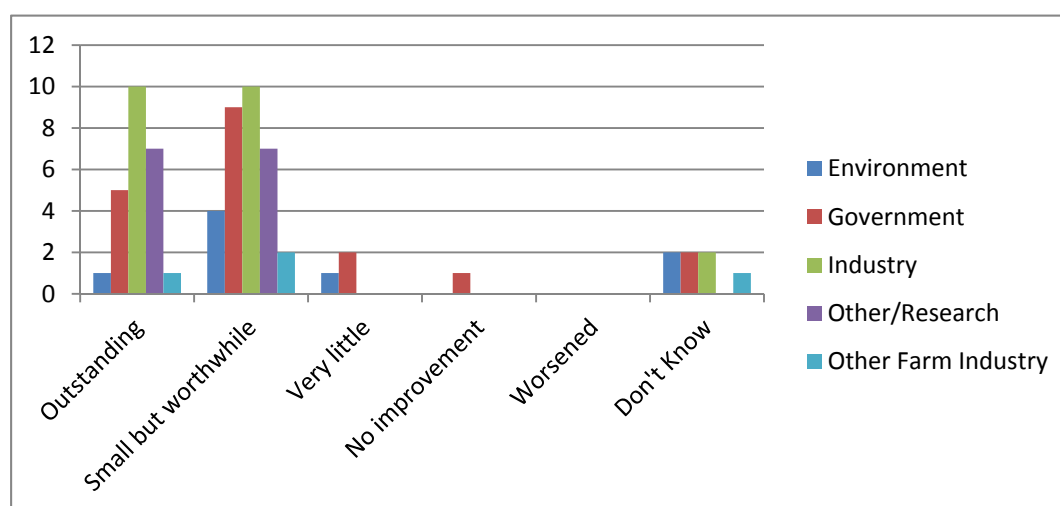
Protection of groundwater water quality and quantity from chemical infiltration due to spraying and storage practices

The survey results show that stakeholders tended to rate the industry's performance as having achieved smaller but worthwhile improvements, but there was a significant proportion of government

officials who considered very little improvement had been achieved. A large proportion rated the reduction of the impact of fertiliser run-off to be a small but worthwhile to outstanding, with few respondents rating the reduction to be below very little, and no respondents claiming that fertiliser run-off has worsened. Most individuals identified the industry's reduction of impact on water-use to be small but worthwhile or outstanding.

Results suggest that the stakeholders feel that environmental impacts of fertiliser run-off have been noticeably reduced.

Figure 58: Stakeholder perceptions on improvements in fertiliser run-off to rivers and wetlands



Source: Cotton Stakeholder Environmental Performance Survey 2012

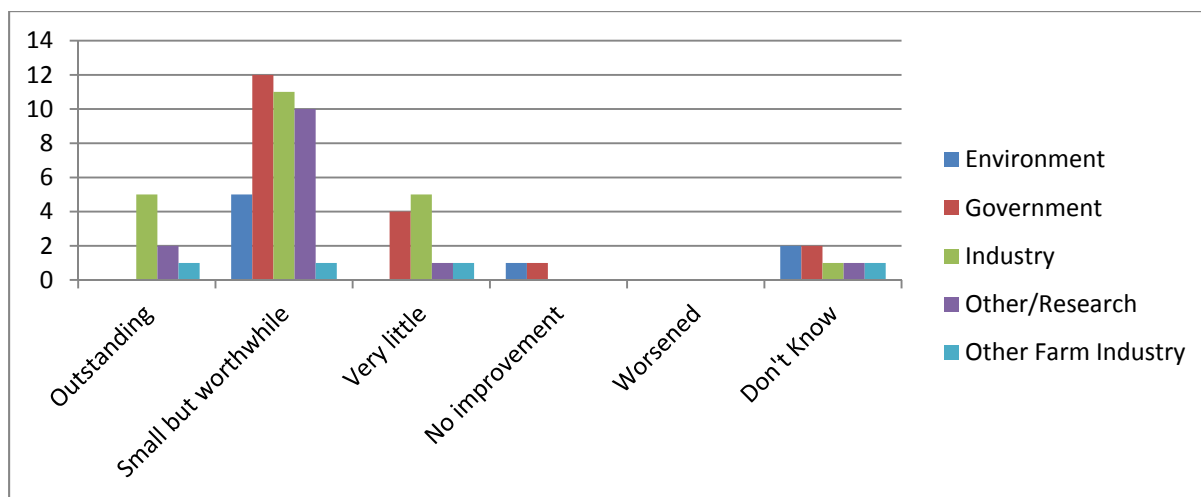
Ratings of improvement in land management were not quite as positive as perceived by growers, although improved tillage and optimising fertiliser use were seen by stakeholders as major achievements.

Extent of planting or conservation of native vegetation on farms

When asked about the extent of the industry's activities in planting or conservation of native vegetation on farms, A large proportion rated conservation of native vegetation to be small but worthwhile, with some respondents rating conservation to be below very little or outstanding, and no respondents claiming the it has worsened. Most individuals identified the industry's conservation practises to be small but worthwhile.

Results suggest that the stakeholders find conservation practises to be noticeably effective, but only minimally.

Figure 59: Stakeholder perceptions of improvements in the extent of planting or conservation of native vegetation on farms



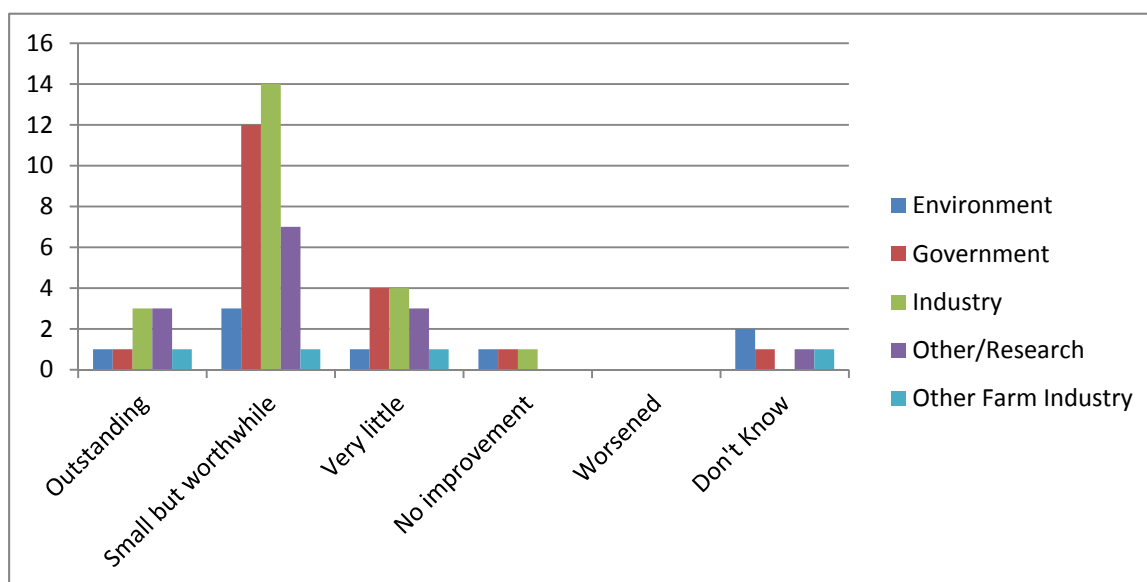
Source: Cotton Stakeholder Environmental Performance Survey 2012

Protection of biodiversity (native flora and fauna) on farms

Similarly, a large proportion rated protection of biodiversity to be small but worthwhile, with some respondents rating biodiversity to be below very little or outstanding, and no respondents claiming it has worsened. Most individuals identified the industry's protective practises to be small but worthwhile.

Results suggest that the stakeholders find biodiversity practises to be noticeably effective, but only minimally

Figure 60: Stakeholder perceptions of improvements in protection of biodiversity (native flora and fauna) on farms



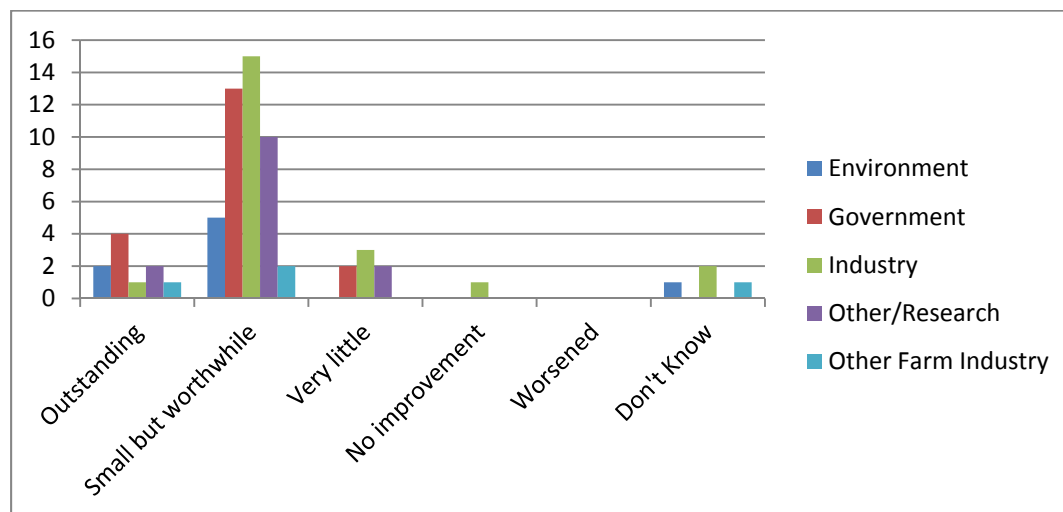
Source: Cotton Stakeholder Environmental Performance Survey 2012

Protection of riparian areas

There were similar results for the protection of riparian areas, with a large proportion rated protection of riparian areas to be small but worthwhile, with few respondents rating biodiversity to be below very little or outstanding, and no respondents claiming it has worsened. Most individuals identified the industry's protective practises to be small but worthwhile.

Results suggest that the stakeholders find protective practises towards riparian areas to be noticeably effective, but only minimally.

Figure 61: Stakeholder perceptions on improvements in the protection of riparian areas



Source: Cotton Stakeholder Environmental Performance Survey 2012

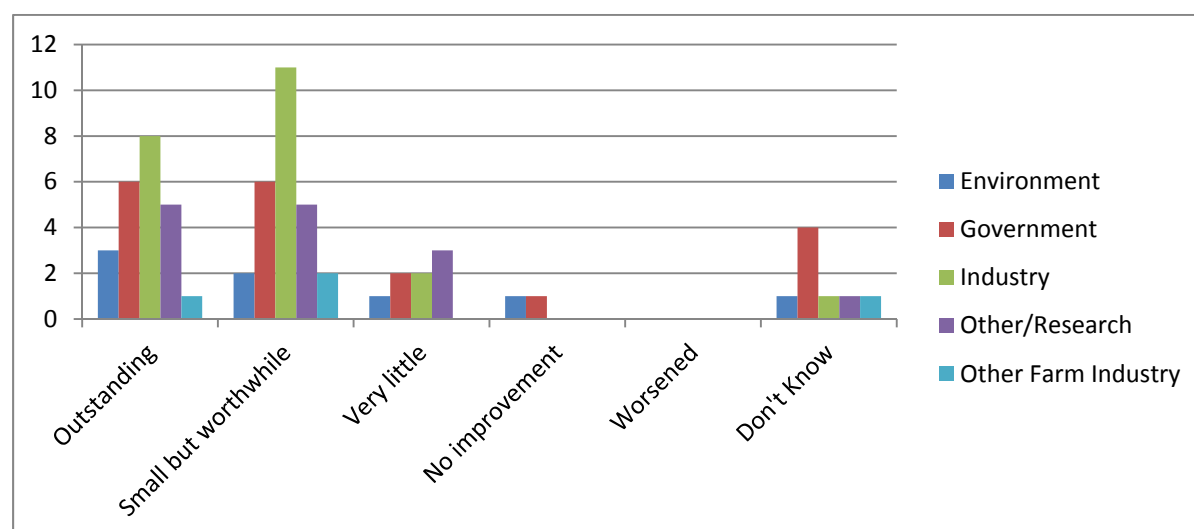
Practices to conserve or improve soil health

Perceptions on practices to improve soil health were more positive with more respondents rating the improvements as outstanding or worthwhile. In this respect, cotton industry stakeholders stood out. Practices mentioned included preventing soil structure breakdown; preventing increasing salinity, acidity and sodicity; avoiding excessive nitrogen use and increasing soil carbon.

A large proportion of stakeholders rated protection of soil health to be small but worthwhile or outstanding, with few respondents rating protection to be below very little, and no respondents claiming it has worsened. Most individuals identified the industry's protective practises to be small but worthwhile or outstanding.

Results suggest that the stakeholders find soil health protection to be noticeably more effective over the past 10 years.

Figure 62: Stakeholder perceptions of improvements in practises to conserve or improve soil health



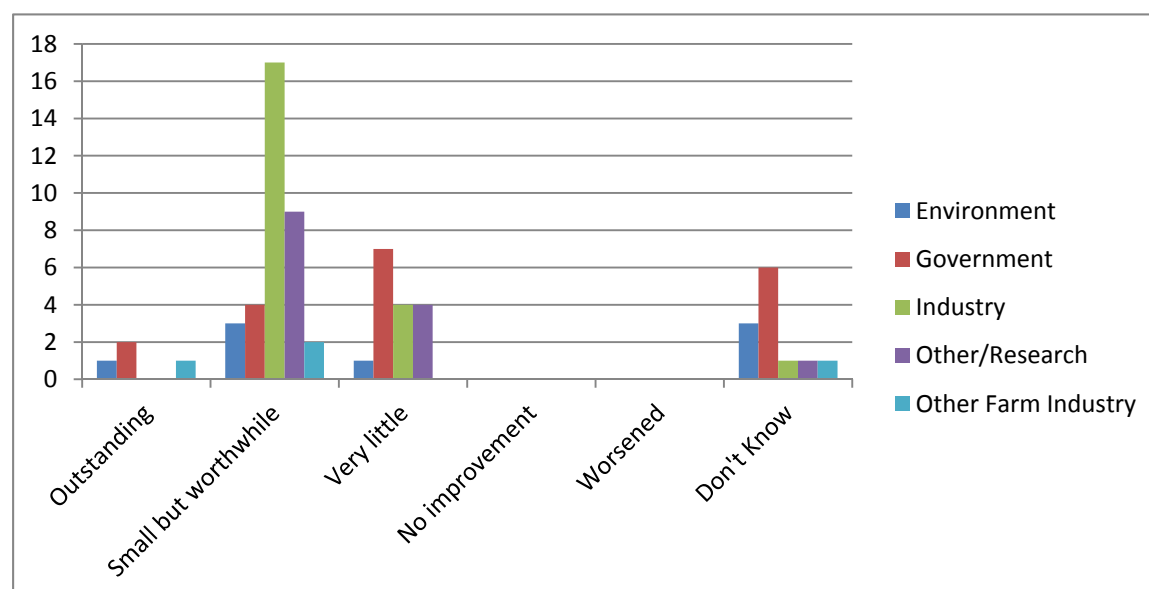
Source: Cotton Stakeholder Environmental Performance Survey 2012

Energy Efficiency on farms

When stakeholders were asked about the industry's actions towards energy efficiency on farms, a large proportion rated energy efficiency changes to be small but worthwhile, with few respondents rating protection to be very little or outstanding, and no respondents rating below no improvement. Most individuals identified the industry's energy efficiency to be small but worthwhile.

Results suggest that the stakeholders find attempts to increase energy efficiency on farms have been noticeable, but only minimally.

Figure 63: Stakeholder perceptions of energy efficiency on cotton farms



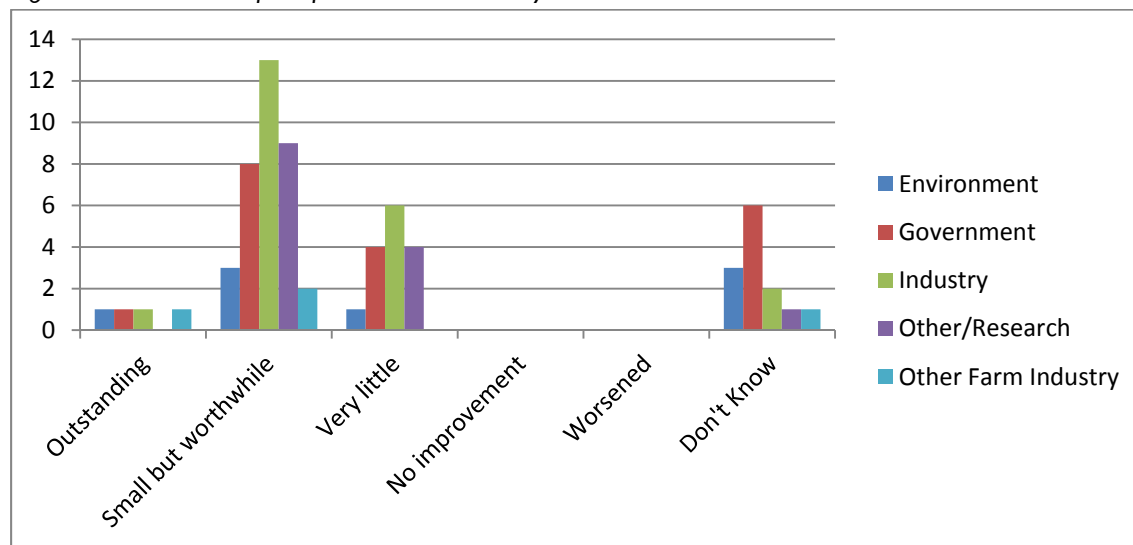
Source: Cotton Stakeholder Environmental Performance Survey 2012

Fuel Efficiency on farms

A large proportion rated fuel efficiency changes to be small but worthwhile, with few respondents rating protection to be very little or outstanding, and no respondents rating below no improvement. Some respondents also weren't aware of fuel efficiency practises on cotton farms. Most individuals identified the industry's fuel efficiency practises to be small but worthwhile.

Results suggest that the stakeholders find attempts to increase fuel efficiency on farms have been noticeable, but only minimally. Results also suggest that many do not have enough awareness of fuel efficiency practises on farms.

Figure 64: Stakeholder perception on fuel efficiency on farms



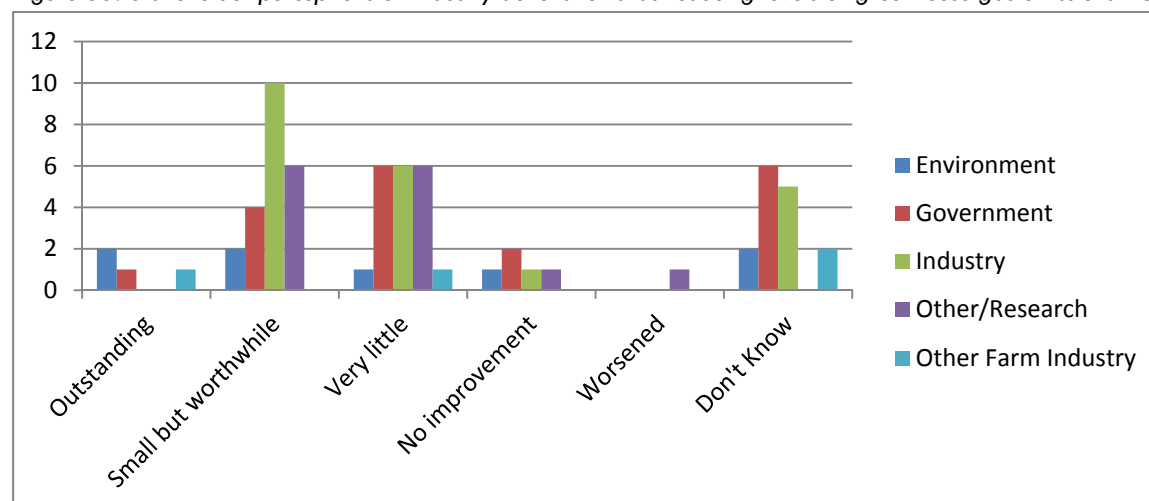
Source: Cotton Stakeholder Environmental Performance Survey 2012

Levels of greenhouse gas emissions from cotton farms

A large proportion of stakeholders rated industry activities towards decreasing the level of greenhouse emissions to be small but worthwhile or very little, with few respondents rating levels to be below no improvement. Some respondents weren't aware of levels of greenhouse gas emissions on cotton farms. Most individuals identified the industry's fuel efficiency practises to be small but worthwhile or very little.

Results suggest that the stakeholders find attempts to decrease levels of greenhouse gas emissions on farms have been noticeable, but only minimally. Results also suggest that many do not have enough awareness of levels of greenhouse gas emissions.

Figure 65: Stakeholder perceptions on industry actions towards reducing levels of greenhouse gas emissions from farms



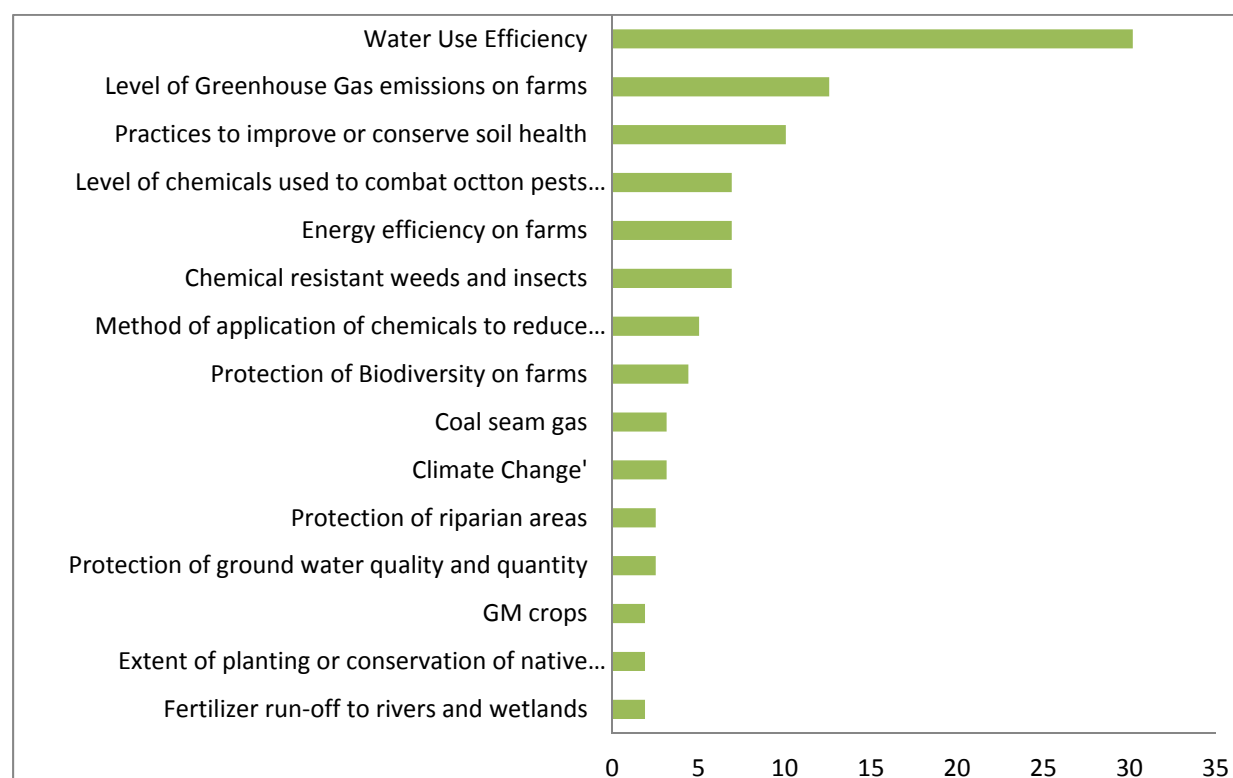
Source: Cotton Stakeholder Environmental Performance Survey 2012

Top environmental priorities today

Stakeholders were asked to nominate the three main environmental issues they believe the industry needs to act on today. Amongst respondents, water use was ranked as the first main issue, energy efficiency as the second main issue and soil health as the third main issue. Spray drift and energy efficiency also rated prominently.

When asked what environmental issues they see as becoming important over the next three to five years in terms of impacting on cotton growing, water was again ranked by most as the first main issue and again by those as the second main issue by those that ranked something else as the first main issue. Energy use, carbon emissions and coal seam gas extraction were rated prominently.

Figure 66: Stakeholder perceptions on future environmental priorities for the industry



Source: Cotton Stakeholder Environmental Performance Survey 2012

When stakeholders were asked to identify key environment issues threatening the cotton industry, 78 per cent of the total respondents identified factors relating to water as core environmental issues, identifying factors including water quality, water use, ground water quality, water conservation, water efficiency, water security, water availability, water management, and irrigation.

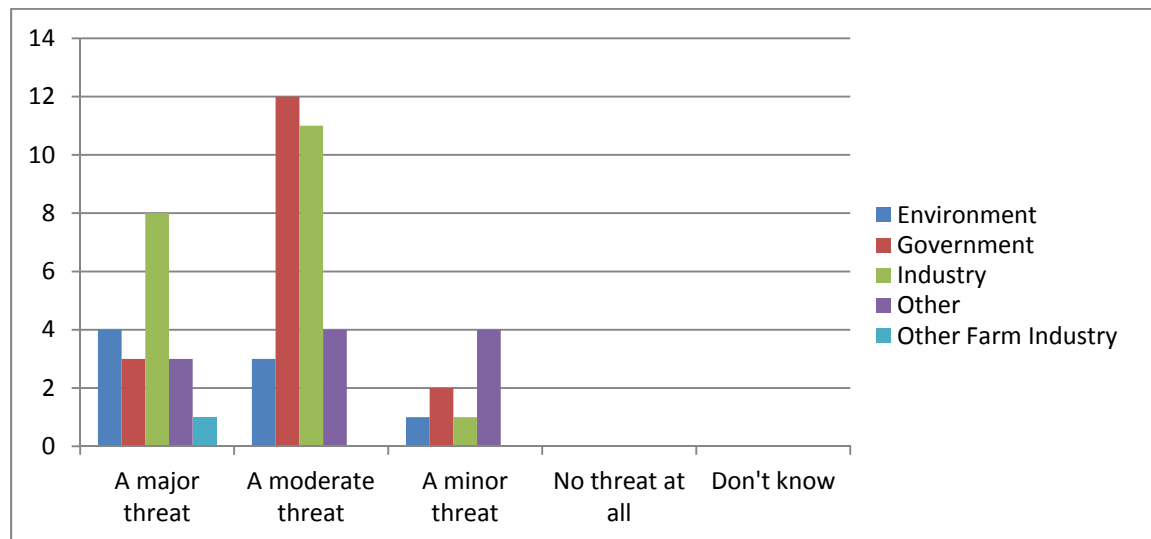
- 76 per cent of the total respondents identified factors relating to soil as core environmental issues, identifying factors such as soil conservation, soil health, acid soils, soil salinization, excess nitrogen, soil structure, use of land, soil compaction, and soil carbon.
- 42 per cent of the total respondents identified factors relating to chemical application and use as core environmental issues, identifying factors such as spray drift, pesticide/ herbicide/ fertiliser use, resistance, regulation, and chemical application.
- 40 per cent of the total respondents identified factors relating to climate impact and energy use/efficiency as core environmental issues, identifying factors such as carbon emissions, greenhouse gases, climate change, fuel efficiency, carbon tax, sustainability, energy conservation, energy costs.

- 36 per cent of the total respondents identified factors relating to the protection of the surrounding environment, identifying factors such as river water quality, nutrient runoff, riparian land management, biodiversity/biosecurity.

28 per cent of the total respondents identified other environmental factors, identifying factors such as mining, the BMP program, GM, land security, social license to grow cotton, coal seam, and low employment.

When stakeholders were asked if the industry faces a threat to its future if it does not take further action on its environmental performance, a large proportion of stakeholders feel that the cotton industry faces a moderate to major threat to its future if it does not take further action on its environmental performance. Few respondents found there to be a minor threat, and no respondents believed that there is no threat at all.

Figure 67: Stakeholder perceptions on the implications of a lack of action on the industry's future



Source: Cotton Stakeholder Environmental Performance Survey 2012

Respondents rated the cotton industry's environmental performance as very good, but were clear that it is still important to take more action in the key environmental areas, suggesting that no action would result in a moderate-major threat to the industry.