GHD

Cotton Research and Development Corporation

Second Australian Cotton Industry Environmental Audit

August 2003

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1. Executive Summary

1.1 The Big Picture

The main cotton production areas in Australia occur in northern NSW through to central Queensland. Normally, over 400,000 hectares of land is under cultivation for cotton, producing about three million bales of cotton each year. Australia has the world's highest yield of cotton in terms of production per hectare. The Australian cotton industry has expanded over the last decade (with cotton production more than doubling from 1995 to 2001). Ninety percent of cotton is exported, with cotton being the third largest crop exported from Australia. The value of production amounts to approximately $1.5 billion annually.

An independent environmental audit of the Australian cotton industry was first conducted in 1991. The aims of the inaugural audit were to assess the environmental impacts of the cotton industry, determine how such impacts could be reduced and how environmental performance could be improved.

The Cotton Research and Development Corporation commissioned this second environmental audit of the Australian cotton industry to assess the industry's response to the previous audit recommendations, identify the environmental issues currently facing the industry, and to recommend strategies and priorities to further improve the cotton industry's environmental management practices.

The Australian cotton industry has been subject to intensive environmental scrutiny, which, in part, was triggered by events such as fish kills from pesticides and, about five years ago, pesticide residues found in beef exports. There are ongoing concerns with the intensive use of pesticides and perceived high water use. As a result of these incidents and concerns, the cotton industry has developed and implemented a wide range of improvements in its operations and environmental management practices.

These improvements have been implemented over the last twelve years, since the inaugural environmental audit in 1991, however, the most significant and far-reaching environmental improvements have been implemented over the last five years.

There has been considerable investment by the industry into research and implementation to achieve long-term environmental outcomes. Some of the key areas of improvement have been:

- Formulating and implementing a Best Management Practices (BMP) approach to cotton farming and environmental management. The BMP program has been a driving factor for the improved environmental management observed on cotton farms;
- Ongoing increases in water use efficiency, which have resulted in lower quantities of water applied per unit of production;
- Improved pest management, including less reliance on pesticides, through the adoption and implementation of Integrated Pest Management strategies of which the use of genetically modified cotton crops is a key component;
- Improved spray application to more effectively target spray placement and minimise off-target drift;
- Introduction of increased chemical container recycling to reduce disposal in landfills;
- Improved land management through minimising erosion, identifying and managing salinity and reduced 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); and
- Conducting a strong research, extension and development program. This has resulted in identification of environmental issues and introduction of improved management practices in pesticide use, pest management, water use, vegetation and land management, waste recycling and disposal, wildlife management and biodiversity.

Although the cotton industry has vastly improved since the 1991 audit was conducted, there are still areas where significant environmental improvements could be achieved. The main environmental issues facing the cotton industry and opportunities for improved performance are in:

- Water management;
- Pest management and pesticide use; and
- Waste management.

Whilst there have been improvements in land and vegetation management and Occupational Health & Safety, there are still improvements that may be achieved in these areas.

1.2 Implementation of 1991 Audit Recommendations

One of the aims of the current audit was to assess the cotton industry's response to the previous 1991 audit recommendations. The 1991 audit included recommendations under the broad headings of Pesticide Use, Land Use, Water Use and Cotton Processing. The broad strategic issues identified in the 1991 audit have been addressed and the industry's performance is summarised below:

- There were no recommendations that have not been implemented (rated as a non compliance). Of the 44 applicable recommendations for cotton farms, high compliance has been achieved for 75%. Partial compliance was achieved for 20% of recommendations, and only 5% of recommendations were rated as low compliance.
- **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.
- **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.
- **Water Use**: a high level of compliance was achieved for all recommendations including those concerning water conservation, tailwater and stormwater management, research and monitoring.
- **Cotton Processing**: a high level of compliance was achieved for recommendations with respect to availability of personal protective equipment, noise exposure reduction, accident reporting and waste management. A lower level of compliance was found for dust abatement and monitoring, employee education, noise monitoring and health & safety audits.

Note that due to changes in legislation, improved technology and changes to operating procedures, not all the recommendations made in 1991 remained valid. Also, the cotton industry had no direct control over a number

of the 1991 recommendations, such as changes to legislation. In such cases, if the intent of the recommendation has been met by some other means, other than that recommended, then compliance was assessed as met.

1.3 Stakeholder opinions and concerns

A survey of stakeholders was conducted to ascertain opinions on the environmental performance of the Australian cotton industry and to identify areas of current environmental concern. The main areas where stakeholders agreed that environmental improvements have been made were the implementation of the cotton industry Best Management Practices (BMP) manual and general reduction in pesticide usage.

The main areas of perceived environmental concern for local, state and federal government were excess water usage by the cotton industry, reduced environmental flows in rivers, groundwater depletion, water allocations to irrigators and fish kills. It should be noted that these are concerns for agricultural industries in general, not just the cotton industry. Not all of these concerns were supported by available data, for example, there have been few fish kill incidents in recent years that potentially have been caused by pesticides.

The main areas of environmental concern for community and environmental groups were water allocations, groundwater depletion and the presence/ absence of wildlife corridors. This was followed by concerns about environmental flows, salinity, groundwater quality, spray drift and river water quality.

Two workshops were also held, including environmental, community and industry personnel. There was general consensus from stakeholders at the workshops that the area of prime importance is the desired environmental outcomes for whole catchments. Once these desired outcomes are established, then cotton growers can identify the on-farm practices that might best achieve those outcomes. All activities in the catchment should be considered in an integrated way, not just cotton. It should be noted that cotton growing only accounts for about 1-5% of the catchment area in cotton growing districts. The workshop identified that the top two environmental priorities for the cotton industry to address were water management, followed by pesticide usage.

1.4 Key findings from the audit

Cotton Farms

Environmental management: One of the most significant environmental improvements in the Australian cotton industry is the development and implementation of a Best Management Practices (BMP) program. The Best Management Practices program indicates a high level of stewardship by the cotton industry. The BMP manual is an excellent tool for systematic and detailed evaluation of environmental issues and implementation of continuous improvement action plans. The audit identified a direct link between the areas of improvement observed on the properties and the BMP modules available to the growers at the time of the audit. Farms that had undertaken their second BMP audit showed real improvements in environmental management, and the auditing process provided a benchmark to indicate that progress had been made. It was observed that farms practicing BMP generally had better environmental management practices, as well as superior documentation and records management.

The BMP audits were found to give a good assessment of the environmental farm practices currently covered by the BMP manual.

As well as the BMP program, considerable progress has been made on developing and implementing the components of an Environmental Management System in the cotton industry.

However, the BMP guidelines have not been fully implemented at all farms. Participation in the BMP program and ongoing BMP and industry auditing will ensure that the industry standard is lifted. In order to effectively monitor environmental improvements and transparency in the cotton industry, more frequent external audits are required.

Key environmental performance indicators, by which the performance of the cotton industry as a whole, and at individual farms can be objectively assessed, need to be developed by the cotton industry.

Water management: Ongoing improvements are being made in applying water efficiently to cotton fields, including extensive water use efficiency research and implementation. All of the irrigated farms inspected are pursuing, or are investigating, methods to maximise applied water use efficiency and minimise water application losses. Good practices were observed to minimise water storage and transmission losses. However, there does not appear to be equivalent attention to addressing the issue of minimising water losses during storage and distribution around the farm. Most farmers were not aware of how much water was lost through evaporation and/or leakage and water balances had not been conducted.

There are a number of farms in Queensland, particularly in Government established irrigation areas, that do not have adequate tailwater collection return systems.

Stormwater retention and reuse has improved at most irrigated farms, although documentation and engineering assessments of stormwater management was often poor. Dryland farmers do not have the facilities or capacity to capture stormwater runoff from *all* areas of their farms that may be used for a range of crops, including cotton, that have been sprayed with pesticides. As a result, pesticides may be washed into local watercourses during storm events.

There have been numerous water quality monitoring programs in different cotton growing districts over the last twelve years since the 1991 audit. Overall findings indicate that the residual concentrations of pesticides have declined in waterways, for pesticides used by the cotton industry.

Pest management: There has been a high adoption by growers of Integrated Pest Management (IPM) practices, including use of more selective and less toxic chemicals, growing of genetically modified cotton, non-chemical pest controls and changed farm practices to reduce habitat for pests. The application of IPM principles has resulted in the reduction of pesticide spraying requirements in the period since the first audit. There has also been a major change in the types of pesticides used, with greater reliance on short-residual and/or more selective pesticides. There has been strong adherence to the Insecticide Resistance Management Strategy. There have also been a number of incremental improvements in spray drift management by growers, aerial sprayers and groundrig operators.

Further implementation of Integrated Pest Management strategies should continue to achieve reductions in pesticide use by growers.

Pesticide management: There have been numerous improvements in the management of spray drift of pesticides since the inaugural environmental audit. These include: changed pesticide application practices; weather monitoring during spraying and the use of on-farm weather stations; use of Pesticide Application

Management Plans; improved spray records; production of detailed farm maps identifying sensitive areas; accreditation of sprayers; and ongoing research.

Pesticide Application Management Plans have been developed and implemented. However, such plans could be expanded to cover all of the chemicals used, and to be more effective, some farm maps could be shown in more detail.

The storage and handling of pesticides was generally satisfactory. Implementation of Best Management Practices has greatly improved the storage and handling of pesticides since the 1991 environmental audit. However, there were many minor BMP practices not implemented on approximately one third of farms inspected such as lack of signage, ventilation, full bunding, security, emergency plans, Material Safety Data Sheets and licensing.

Although there have been many improvements in pesticide management practices, there is a declining but still a significant number of complaints in cotton growing areas about spray activities, including health affects, crop damage from herbicides and impact on flora and fauna. Although not all complaints are cotton related, it is evident that some growers still need to improve spray practices.

The number of fish kills from pesticides and prosecutions for pesticide related issues has decreased significantly since the last audit.

Other chemicals: It was noted that most storages of other chemicals, such as fuels and oils, do not comply with Australian Standards and management practices need improvement. The recently released BMP module on the storage and handling of petrochemicals should enable growers to check against best practices and improve their storages.

Waste management: The cotton industry has increased its use of reusable and recyclable containers. There has been a reduction of chemical containers disposed of in landfills due to the drumMUSTER container collection system. However, it was noted by some growers that drumMUSTER failed to deliver adequate services in certain areas, due to a lack of regular services or insufficient notice of collection times. It was also noted that not all chemicals and pesticides commonly used on farms were covered by the drumMUSTER program so growers have to dispose of some containers by alternative means. Some farmers were observed to still use on-farm tips for chemical container disposal and, in general on-farm tips were not well managed.

Storage and disposal of workshop wastes was typical of agricultural enterprises and was not always satisfactory. Evaporation pits, for disposal of chemical container washouts, did not all meet the industry's BMP requirements.

Land management: The cotton industry, as a whole, demonstrated increased awareness of sustainable development and biodiversity on farms. There have been improvements in the management of cotton stubble, erosion, soil structure and condition, as part of implementing sustainable farming practices.

Salinity is only a concern in some cotton growing areas and there are continuing salinity investigations, testing, mapping and improved management in most potential problem areas.

Vegetation management: It was noted that most growers are retaining native vegetation and/or participating in tree planting programs. Approximately 20% of farms inspected had retained over 100 hectares of native (or regenerated) land area. Land clearing is still occurring, but mainly on previously cleared grazing land or crop land. Riparian zones were not always well managed (in common with other agricultural industries) and guidelines are currently being produced to assist growers to manage these areas.

Wildlife: Wetlands and water storages can contribute to biodiversity conservation on farms. A number of farms have incorporated artificial wetlands and features to encourage wildlife. A range of waterbird species were observed by the auditors on farms in, or adjacent to, water storages. Bird abundance can be used as an indicator of broad environmental health or as an indicator of biodiversity in cotton growing areas.

A number of farmers maintain a population of fish, yabbies and mussels in water storages for harvesting. Populations of aquatic fauna in farm dams can provide a good indicator of any contamination from spray-drift or from tailwater runoff.

Research projects are currently being conducted to retain, manage and enhance biodiversity on farms.

Air emissions: Growers have utilised retention of wheat stubble, growing winter crops, rotational summer crops and mulching to minimise dust. Tree belts around the perimeter of farms were also observed, which can act as windbreaks and help to reduce wind-blown dust leaving the site. The practice of burning cotton crop residues on site has been phased out with most growers using the residue as mulch on the farm except where Fusarium wilt has necessitated the burning of residues for disease control. Currently there are no accurate figures on the quantity of greenhouse gases being produced by cotton farms, however, investigations are being conducted.

Energy: Energy usage records are kept but unit energy use is not tracked. The energy requirements of producing cotton would benefit from further research and investigation.

Occupational Health and Safety: There was wide variation in the standard of OH&S practices across farms, with larger farms leading the way in implementing adequate management systems. There appeared to be greater progress made towards good OH&S practices on farms which had implemented BMP guidelines. A number of farmers are currently addressing OH&S issues and improved practices were observed. However, not all farms employed these good practices.

Education and information transfer: There has been a strong and focussed research program on issues that affect environmental management at cotton farms and information transfer to growers appears satisfactory. However, results of research and improved environmental practices do not appear to reach the public, particularly in non-traditional cotton growing areas.

Excellent management information packages have been developed, such as CottonLOGIC, to aid cotton growers with farm management activities, including environmental management. New training programs have also been developed which will help to improve the knowledge of growers and industry personnel on environmental issues and best practices. The services provided by extension officers/ support personnel are widely valued by growers and appears to be one of the most cost effective ways of ensuring that BMPs are implemented with vigour and rigour.

Genetically modified cotton: The cotton industry conducted extensive trials on genetically modified cotton prior to its introduction, including effects on non-target species, gene escape/ potential to outcross with native cottons, potential weediness, changes in status of minor pests and resistance. In response to potential problems, the cotton industry introduced a planting cap, a resistance management plan and weed resistance management practices. Research in the seven years since the introduction of genetically modified cotton indicates that pesticide usage has been significantly reduced by over 50% (averaged over 7 years for the target pests).

Cotton processors – gins

Dust: Of the seven gins inspected, all had dust collection and removal facilities and available monitoring results indicated better performance compared to 1991, however, improvements can still be achieved. Dust controls for external areas at the gins inspected appeared adequate.

Noise: The gins have introduced a number of engineering and operating controls to reduce environmental and occupational noise. Environmental noise monitoring has been conducted at gins located near sensitive areas. The other gins were located in remote areas, so environmental noise monitoring was not considered necessary.

Water management: Of the gins inspected, only one had a holding pond to retain silt and trash in stormwater runoff to prevent pollution. The same gin was the only one that had a separate area for holding modules from farms potentially affected with Fusarium wilt, which could isolate stormwater runoff if required. There is a disease control issue with recycling stormwater from the module yard onto adjacent cotton farms. Not all gins have installed a truck washdown area for disease control.

Most, but not all, gins have introduced some water minimisation and reuse measures.

Poor practices were noted at two areas used by transport contractors for chain lubrication. These areas had a high potential for pollution of stormwater, groundwater or soil.

Dangerous goods: Chemicals were generally stored in an acceptable manner. A number of minor poor environmental practices were observed at some gins, including a lack of inventory of dangerous goods kept on site and dangerous goods location maps, lack of bunding, Material Safety Data Sheets, spill kits, emergency plans, ventilation and signage.

Waste management: Ongoing investigations are being carried out on composting of gin trash, pesticides detected in trash, and control of diseases in composted trash. The cotton industry has developed a policy of not providing gin trash to livestock as feed and cotton trash has not been sold or provided to cattle producers since the 1994 Helix contamination incident.

Poor management of on-site waste tips was observed. Transport spillage of cotton was also observed along access roads to gins in one area.

Energy: The gins had undertaken a number of engineering and operational measures to minimise energy use and recover heat. Investigations have also been undertaken to reuse waste cotton trash for heat and electricity generation. None of the gins inspected had established their greenhouse gas emission levels.

Best Management Practices: There is currently no BMP manual for cotton gins, similar to that for cotton farms. A number of the larger gins have established some environmental management procedures that operate within quality and operation systems, but they do not currently cover all environmental aspects.

Occupational Health and Safety: The gins had all made improvements in recent years to safety. The larger gins lead the way in terms of improved OH&S practices and documentation. Some of the smaller gins lag behind in terms of meeting the new OH&S requirements.

An investigation is currently being conducted by NSW WorkCover and the Queensland Department of Industrial Relations to assess OH&S management in gins. Preliminary results indicate that the gins rated well against other agricultural sector industries such as feedlots, wineries, packing sheds and forest harvesting.

Occupational noise monitoring has not been conducted at all gins (3 out of 7 inspected). The ongoing use of compressed air for internal dust control does not represent best practice.

Cotton processors – seed processors

There are currently two cotton seed processors in Australia: one large older plant; and one smaller, relatively new plant. Due to the differences between each plant, each was reported separately and no general conclusions were drawn.

The environmental and OH&S issues associated with the cotton seed processing plants are typical of industrial plants and do not reflect the performance of the cotton industry as a whole. Hence it was recommended that the seed processors should not be included in future Australian cotton industry audits, but should conduct their own routine, independent, environmental and safety audits.

2. Introduction

2.1 Background

The main cotton production areas in Australia occur in northern NSW through to central Queensland, with approximately three-quarters of cotton growing areas located in NSW. Over 400,000 hectares of land was under cultivation for cotton in the 2001-2002 growing season, producing over three million bales of cotton. The area planted for cotton dropped in the 2002-2003 season due to severe drought conditions across Australia.

Major cotton production regions of Australia

Australia has the world's highest yield of cotton in terms of production per hectare. The Australian cotton industry has expanded over the last decade (with cotton production more than doubling from 1995 to 2001).

Cotton is the third largest crop exported from Australia. The cotton crop is a major contributor to the Australian economy, with the value of production amounting to approximately $1.5 billion per year. Ninety percent of cotton is exported, with Indonesia and Japan being the biggest export destinations for Australian cotton.

Cotton industry audits

The first environmental audit of the Australian cotton industry was conducted in 1991. This was a landmark audit in that it was the first environmental audit attempted by an agricultural industry in Australia. The audit evaluated environmental aspects of cotton production and developed a series of recommendations to improve environmental performance and reduce environmental impacts.

Since the 1991 audit, there have been significant improvements in managing environmental risks, including the implementation of the audit recommendations and formulation of a Best Management Practices program for the Australian cotton growers.

Over the past twelve years, there have also been major changes to environmental legislation (for example, water, pesticide and waste legislation) in both NSW and Queensland, which have had a significant impact on the cotton industry.

> The Australian cotton industry has undertaken a second environmental audit, twelve years after the inaugural audit to assess its performance and identify areas for further improvement.

This second audit of the Australian cotton industry was funded by the Cotton Research and Development Corporation (CRDC) and was conducted by GHD Pty Ltd (GHD). The GHD audit team and the industry reference panel are listed in Appendix C.

2.2 Purpose

The terms of reference for the Australian Cotton Industry Second Environmental Audit are to:

- Assess the cotton industry's response to the previous audit recommendations;
- Assess the environmental issues currently facing the industry;
- Assess current industry action in light of the first audit;
- Review core information and data to provide a basis for identifying significance to the cotton industry; and
- Recommend strategies and priorities to further improve the cotton industry's environmental management, within existing legislative requirements.

3. Methodology

3.1 Scope of work

The scope of this environmental audit covers all environmental aspects of cotton industry operations including farm land clearing and preparation, planting and harvesting, farm management, pesticide and fertiliser application, cotton ginning and seed preparation.

3.2 Overall methodology

The project encompassed the following main elements:

- Project inception meeting with CRDC;
- Review relevant environmental documentation, best practice guidelines, previous audits and action plan;
- Survey and interview relevant stakeholders;
- Inspections of a selection of sites, including farms, cotton gins and seed processing facilities;
- Identification of environmental risks and liabilities; and
- Preparation of a report for CRDC encompassing the audit findings.

Project inception

A project inception meeting was conducted in Narrabri in October 2002. The purpose of the meeting was to establish lines of communication; obtain readily available information and details of further information that may be available; obtain stakeholder contact details; discuss selection criteria for sites to be visited; and to confirm the project timetable.

Review existing site information

A literature review of environmental management issues in the Australian cotton industry was conducted. The purpose of the literature review was to:

- Identify areas of environmental concern from stakeholders (farmers, cotton industry, government, community and environmental groups);
- Assess how environmental and general management practices have improved since the 1991 audit;
- Identify areas where environmental practices could be improved within the industry;
- Assess recent research in the cotton industry and how this has (or may in the future) lead to positive environmental outcomes;
- Identify potential environmental benchmarks that could be used to monitor environmental performance of the cotton industry as a whole and for individual farms;
- Collect and collate quantitative data to establish environmental performance benchmarks;
- Obtain information to verify that the 1991 audit recommendations have been implemented;

- Identify new and emerging issues that may have an environmental impact on the cotton industry (such as genetically modified organisms); and
- Evaluate the impact of recent legislative changes on cotton industry environmental issues (such as new pesticide regulations and water allocation plans).

Information on environmental management and performance, including CRDC library resources which were reviewed, are listed in Appendix E.

Conduct survey, interviews and workshops

The purpose of this stage was to ascertain stakeholder views on current environmental performance of the cotton industry, as a whole, as well as particular areas of concern. A structured survey questionnaire was developed and sent to a range of individuals and stakeholder groups. The survey was also widely advertised in environmental and cotton industry newsletters and publications over a three month period. The structured survey was followed up by telephone interviews. Two workshops were held, one in Sydney and the other in Toowoomba. The workshops invited participants from environmental groups, government departments and industry members. The survey, interviews and workshops assessed whether environmental best practices were being followed (or perceived as being followed) and areas where improvements can be made. The results were compared to findings during the site inspections.

GHD contacted a broad cross-section of stakeholders, including industry organizations (Cotton Research and Development Corporation, Cotton Australia, Australia Cotton Cooperative Research Centre), individual small and large cotton growers, regional growers associations, cotton gins and cotton seed processors, aerial sprayers, environmental groups, community groups, local councils, Environment Protection Authorities in NSW and Queensland, state government departments of agriculture, land and water conservation and work cover authorities. CRDC provided valuable assistance in identifying stakeholder groups.

Conduct site inspections

Facility inspections were undertaken to ensure that the environmental aspects of selected sites were identified and to gain a full understanding of environmental compliance, practices, procedures, performance and management issues. All site audits were conducted by Senior Environmental Auditors accredited by the Quality Society of Australasia (QSA). The QSA accreditation program ensures that auditors meet the international standard for environmental auditors (ISO 14012: 1996, *Guidelines for environmental auditing – Qualification criteria for environmental auditors*).

The audits assessed current environmental performance, whether best practice guidelines are being implemented, whether the detailed recommendations of the 1991 audit have been met, and opportunities for improvement. Environmental issues at each stage of the cotton cycle were reviewed.

Preparation of report

A draft report was prepared and submitted to CRDC for review and comment. The draft report was presented to the CRDC at Narrabri. A final report was submitted to CRDC after receiving comments on the draft.

3.3 Site selection criteria

Cotton farms

A selection of cotton farms was inspected to obtain a picture of environmental performance of the cotton industry as a whole. Site selection criteria were developed by GHD and CRDC, based on the following:

- At least thirty farms inspected across a number of growing districts;
- Representation from major cotton growing districts to identify regional-specific issues;
- Approximately 70% of cotton production located in NSW (based on 70% of cotton growing areas are currently in NSW and 30% in Queensland);
- A selection of large and small farms represented;
- A selection of farms which have, and have not been, audited to Best Management Practices (BMP) guidelines; and
- A selection of dryland and irrigated farms, with water sourced from rivers, bores or schemes.

Site visits were staggered over the period of the project (October 2002 to March 2003) to cover planting and growing activities.

Cotton farms visited are summarised in Table 1.

State	Growing district	Number of farms
NSW	Bourke	1
	Lower Namoi	5
	Upper Namoi	2
	Gwydir	4
	Macquarie	5
	Menindee	1
	Border Rivers	2
	Total NSW	**20**
Queensland	Emerald	2
	Theodore	2
	Darling Downs	3
	St George/ Dirranbandi	3
	Border Rivers	2
	Total Queensland	**12**

Table 1 Summary of cotton farms inspected by growing district and state

Details of the farms visited are summarised below:

- 63% of farms were in NSW;
- Farm size ranged from 1,500 – 80,000 hectares (total farm area);
- Cotton planted in the 2002-2003 season ranged from nil to 2,200 hectares;

- Four farms inspected were dryland farms;
- Of the irrigated farms, twenty extracted water directly from the river and eight were part of an irrigation scheme. Seven farms also used groundwater; and
- Ten farms had not been audited to BMP guidelines, eleven farms had undertaken their first BMP audit and eleven had undertaken a second or third BMP audit.

Note: only thirteen farms were inspected in the 1991 audit, mainly in the Emerald region.

Cotton processing plants

Currently there are 40 cotton gins in NSW and Queensland. Seven gins were inspected, representing 18% of the industry. Gins were located across NSW and Queensland, from central NSW to Emerald. Gin sites inspected ranged from 5 – 37 years old, with capacities of 35,000 – 200,000 bales per annum, and represented a range of old and new technology.

Two cotton seed processors were also inspected, representing 100% of the industry.

Other sites

Three aerial spraying operations were inspected in NSW and Queensland. These included chemical storage and loading facilities, associated maintenance facilities, and general aerodrome operations. An inspection was also performed at a Council waste facility that accepted pesticide containers (via the drumMUSTER program) and other farm waste including waste oils.

4. Findings from 2002 Audit – cotton farms

4.1 General

A range of environmental management practices were observed during the cotton farm site inspections. Improvements since the 1991 environmental audit and good environmental practices are summarised below, as well as areas that require further improvements. The consistency of good practices across the cotton farms inspected, and conversely poor or questionable practices, were examined.

Limitations

The findings of the audit were based on information from various sources (interviews with farm owners/ managers and staff, BMP manual records, farm records, WorkCover licences, and environmental monitoring reports). For time and logistical reasons, it was necessary to select cotton farm employees for interview and was not always possible to cross-check all information provided.

GHD inspected a wide cross-section of farms, as described in Section 3.3. Most of the growers who agreed to participate in the audit were actively following Best Management Practices, consistent with those documented in the Australian Cotton Industry BMP manual. Ten out of 32 growers who participated had not undergone any BMP audits. Therefore, growers actively applying Best Management Practices were better represented in the sample pool selected for inspection as part of the audit program.

4.2 Cotton farm compliance with 1991 audit recommendations

Sixty nine (69) environmental and occupational health and safety recommendations were made in the inaugural environmental audit of the Australian cotton industry. The 1991 audit recommendations and the cotton industry's response are tabulated in Appendix H. Findings of this audit and evidence that the recommendations have been implemented are also detailed in Appendix H.

Note that due to changes in legislation, improved technology and changes to operating procedures, not all the recommendations made in 1991 are still valid. As an example, the 1991 audit recommended that environmental monitoring records be kept for 30 years. This is not a statutory requirement, as records are currently only required to be kept for four years in NSW. If the intent of the recommendation has been met by some other means, other than that recommended, then compliance has been assessed as met.

Implementation of recommendations is summarised below in Table 2. There were no recommendations which have not been implemented (rated as a non compliance).

Of the 44 applicable recommendations for cotton farms, high compliance has been achieved for 75%. Partial compliance was achieved for 20% of recommendations, and only 5% of recommendations were rated as low compliance. Recommendations from 1991 which have not been fully addressed (and are still relevant) are discussed in Section 4.4 onwards.

Recommendations	Number
Total number of recommendations	69
Cotton farm recommendations	49
◗ Environmental	◗ 44
◗ OH&S	◗ 5
High compliance	33
Partial compliance	9
Low compliance	2
Non compliance	0
Not applicable	5

Table 2: Summary of compliance with 1991 audit recommendations for cotton farms

A number of general recommendations were made in the 1991 audit, such as changes to planning and environmental legislation. The cotton industry has no direct control over these issues, so recommendations have been listed as "not applicable". The five not applicable recommendations related to: changes to pesticide legislation; planning controls and zoning of new cotton farms; water allocations to wetlands; maintenance of long-term health data bases; and planting of tree lines around rural communities.

4.3 Stakeholder concerns

A survey of stakeholders was conducted to ascertain opinions on the environmental performance of the Australian cotton industry. Background information, the survey questionnaire and survey results are detailed in Appendix F. In addition to the survey, two workshops were held to further discuss how the environmental performance of the cotton industry could be improved and priorities for action. The workshop notes are included in Appendix G. The results of the survey and workshops are summarised below.

The main areas where stakeholders agreed that environmental improvements have been made were the implementation of the cotton industry Best Management Practices guidelines and general reduction in pesticide usage. The main areas of current environmental concern are given below.

Cotton industry	Government	Community
Water allocations	Excess water usage	Water allocations
Environmental flows	Environmental flows	Groundwater depletion
Spread of weeds/ diseases	Groundwater depletion	Wildlife corridors
Groundwater depletion	Water allocations	Environmental flows, salinity, groundwater quality, spray drift and river water quality
Spray drift	Fish kills	

Table 3: Major environmental concerns of stakeholders on the performance of the cotton industry

The main areas of perceived environmental concern for local, state and federal government organisations were excess water usage by the cotton industry, reduced environmental flows in rivers, groundwater

depletion, water allocations to irrigators and fish kills. It should be noted that these are concerns for all agricultural industries, not just the cotton industry. Not all of these concerns were supported by available data, for example, there have been few fish kill incidents in recent years that potentially have been caused by pesticides.

The community (including environmental and community groups, concerned citizens, neighbours of cotton growers) are more concerned about a greater number of environmental issues than the cotton industry and local, state and federal government. The main areas of environmental concern for community and environmental groups were water allocations, groundwater depletion and the presence/ absence of wildlife corridors. This was followed by concerns about environmental flows, salinity, groundwater quality, spray drift and river water quality.

Of the survey respondents 79% indicated that most, but not all, of their environmental concerns were being addressed by the cotton industry. The majority of stakeholders (64%) felt that the cotton industry communicated openly, but not necessarily effectively, with the public.

Two workshops were also held, including environmental, community and industry personnel. There was general consensus from stakeholders at the workshops that the area of prime importance is the desired environmental outcomes for whole catchments. Once these desired outcomes are established, then cotton growers can identify the on-farm practices that might achieve those outcomes. All activities in the catchment should be considered, not just cotton growing. (It should be noted that cotton growing only accounts for about 1-5% of the catchment in cotton growing areas.) The top environmental priorities for the cotton industry to address were noted in the workshops to be water management, followed by pesticide usage. The outcomes of the surveys, workshops and consultation were used to direct the audit inspections to ensure that stakeholder concerns were addressed.

4.4 Environmental management

4.4.1 Best Management Practices Program

Improved practices

One of the most significant environmental improvements in the Australian cotton industry is the development and implementation of a Best Management Practices (BMP) program. The Australian cotton industry Best Management Practices program comprises the following:

- A Best Management Practices Manual. The manual gives guidelines on best practices for the application of pesticides, storage and handling of pesticides, integrated pest management, storage and handling of petrochemicals, farm design and management, and farm hygiene. A draft section on land and water management has also been produced. The manual also includes self-assessment worksheets, risk assessment worksheets and allows for development of action/ improvement plans; and
- An audit program for assessing compliance of individual growers against the BMP guidelines.

The BMP program commenced in May 1999. Audits have been conducted on approximately 267 farms, representing 20% of the cotton growers in the industry and 45% of the cotton area grown in 2001-2002 (Holloway & Roth 2003).

The Australian Cotton Industry Best Management Practices Manual

The Best Management Practices program is considered to be an excellent tool for ensuring that cotton growers consider environmental aspects systematically and in detail. It also ensures that areas in which there are shortcomings are addressed through action plans, which are resulting in the gradual improvement of farm practices.

This audit found that those growers using the BMP manual usually had better practices than those not yet taking part in the BMP audit process. This does not imply that non-BMP farms all had poor practices, just that BMP participating growers had more thoroughly assessed the environmental impacts of their activities, had put in place plans for improvement, had generally implemented the action plans and had demonstrated a commitment to continual improvement.

Farms which had undertaken their second BMP audit showed real improvements in environmental management, and the auditing process provided a benchmark to indicate that progress had been made.

There was a direct link between the areas of improvement observed on the properties and the BMP modules available to the growers at the time of the audit.

Areas of improvement noted during the audit included:

- Risk assessment, identification of farm hazards and controls;
- Farm design and management, including minimising potential for erosion and stormwater management;
- Farm hygiene;
- Integrated pest management; and
- Storage and handling of pesticides and application of pesticides.

It was evident that the practices outlined in the BMP manual also gave good guidance for whole farm management for mixed product farms.

Growers who had undertaken an audit had developed action plans to address a wide range of deficiencies. The auditors checked the progress of a selection of the action plan(s) – most were completed or in progress. However, implementation of some plans had been delayed due to lack of income (due to drought).

It was also observed that farms practicing BMP generally had superior records management in terms of:

- Degree of documentation of procedures;
- Development of environmental policies;
- Stormwater management plans;
- Pesticide Application Management Plans;
- Monitoring records;
- Documentation of improvement programs; and
- Evidence that improvements had been carried out.

The quality and thoroughness of the documentation was also generally better than at non-BMP farms.

There also appeared to be a flow-on to Occupational Health and Safety (OH&S) issues – BMP farms tended to have better OH&S practices and documentation of these practices.

A previous survey has been conducted of growers to determine the impact of the BMP audits (Holloway & Roth 2003). The majority of growers indicated that they had benefited from the audit and their understanding of the BMP process had increased. Perceived benefits were assistance with record keeping, identification of areas which may have been overlooked, an impetus for action, increased awareness of areas requiring improvements, and an external objective opinion of farm practices.

Areas for improvement

The BMP guidelines have not been fully implemented at all farms. Based on the audit inspections and discussions with industry personnel, the uptake of BMP on smaller, mixed-crop farms or dryland farms has not reached the current levels achieved across larger irrigated farms.

> ***Recommendation 1:*** It is recommended that Cotton Australia continue to encourage cotton growers to adopt the BMP system. A target should be set by the cotton industry to have most irrigated growers undertaking the initial BMP audit by the end of year 2004.

4.4.2 Environmental Audits

Improved practices

The BMP program includes detailed, independent BMP audits of individual farms.

Farm practices were independently reviewed during this audit prior to accessing the farms' BMP audit reports. The findings from GHD personnel were similar in most instances to the BMP audit findings. The BMP audits were found to be thorough, accurate and give a good assessment of the environmental farm practices currently covered by the BMP manual. The BMP audit objectively assesses that "best practices" are actually being adopted.

The BMP audits are conducted by independent environmental auditors with cotton industry knowledge. This ensures a good understanding of industry issues and practices, as well as knowledge of environmental issues and requirements.

Areas for improvement

The inaugural industry wide audit was conducted in 1991. There have been many changes and improvements in industry practices, as well as legislative changes since the initial audit.

This is the second industry-wide independent audit. Twelve years have elapsed since the initial audit. In order to effectively monitor environmental improvements in the cotton industry, more frequent audits should be undertaken, say every five years, or if there are major changes to environmental legislation and cotton industry practices. Many of the recommendations made in the 1991 audit are no longer valid due to changes in environmental and health and safety legislation, improved technology and changes to operating procedures.

This audit and the previous audit were undertaken over a limited time frame during the cotton growing season so not all activities, such as harvesting, were observed during the site visits.

Recommendation 2: It is recommended that the cotton industry:

- Organise for an independent cotton industry audit to be conducted more regularly, say at least every 5 years; and
- 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.

4.4.3 Environmental Management Systems

Improved practices

In 1991, no cotton farms had developed an Environmental Management System (EMS). Considerable progress has been made on developing and implementing the components of an EMS in the cotton industry. The development and implementation of Environmental Management Systems is good practice but is not required under legislation, nor an industry standard.

An EMS is a structured system for managing environmental aspects and impacts, managing risk, preventing pollution and ensuring compliance with environmental legislation. (The BMP manual mainly covers the operational control aspects of an EMS, as well as legal requirements).

There is only one cotton grower who has developed a certified Environmental Management System (EMS), and it is understood that accreditation has lapsed (due to lack of perceived commercial benefits), in favour of adopting the BMP approach. The BMP manual and audit process has gained wide acceptance from within the cotton industry.

One of the aerial operators inspected had a certified EMS and another was is the process of developing an EMS, consistent with the international EMS standard ISO 14001.

It was noted that some growers, from larger farms, had developed components of an EMS including an Environment Policy and procedures for pesticide use, fuel use, land clearing, waste management, water and stormwater management, complaints handling, as well as emergency procedures and occupational health and safety strategies. One grower was in the process of developing an EMS as a tool for managing the implementation of BMP. Another of the larger growers visited is currently developing an EMS.

Case study: One larger farm was in the process of developing a "Sustainability Plan" at the time of the site inspections. The plan was being developed, and addressed issues including:

- Surveys of flood plain and riparian zones;
- Ecological monitoring;
- Protection of waterways (through buffer zones, stock access control, vehicle movement control etc);
- Identification of historic landfills;
- Rehabilitation of designated areas; and
- Salinity.

BMP and a Salinity Management Plan were included as components of the Sustainability Plan. A systematic implementation plan prioritising initiatives and actions also forms part of the plan.

The cotton industry is currently looking at the issues involved in expanding the BMP manual and ensuring that it retains its overall current approach and is also consistent with the relevant EMS principles. Further modules are anticipated to be developed for the BMP manual to cover other environmental impacts of farm activities, such as salinity, biodiversity, native vegetation, water quality and water management. Other sections of an EMS (such as development of a whole farm environment policy, documenting existing operational procedures, document control requirements, environmental training and emergency procedures) would also need to be addressed to evolve the BMP program into a working EMS.

The CRDC in conjunction with the Murray Darling Basin Commission is currently investigating the general appropriateness of implementing an EMS on cotton farms. Ten farms are participating in the trial project.

Work is also being conducted on interfacing the cotton BMP with systems used in other agricultural sectors, such as the "Cattlecare" program. ("Cattlecare" is the cattle industry's independently audited quality assurance program). Seventeen cotton farms inspected also ran cattle in adjacent areas of the farm, two had sheep/ fat lambs and two had aquaculture operations.

4.4.4 Environmental performance indicators

Improved practices

The previous 1991 audit did not establish environmental performance indicators, by which the performance of the cotton industry as a whole, and at individual farms, could be objectively assessed. Quantitative environmental performance data for the cotton industry was not reported.

A great deal of research and environmental monitoring has been conducted since the last audit on all aspects of environmental performance. Data is now available to track past and present environmental performance and allow the cotton industry to set targets for continuous improvement.

Areas for improvement

In order to evaluate the environmental performance of the cotton industry, environmental performance indicators should be established for the industry as a whole, as well as for individual farms. This will allow environmental performance improvements to be quantitatively tracked and compared in future industry-wide audits. A number of key social, environmental and economic indicators have been suggested for measuring

the sustainability of cotton production systems (Roth 2003) including chemical use, water quality, water use, river health, soil health, biodiversity and compliance with industry codes and BMP.

The survey conducted of stakeholders opinion on the cotton industry asked for suggestions of appropriate environmental performance indicators. Some suggested indicators are included below (not all the suggested indicators could be quantitatively evaluated).

Issue	Suggested quantitative performance indicator	Units
Water	Total water use by the cotton industry	GL/a
	Total water input on farm	ML/ha
	Crop water use efficiency	Bales/ ML
	Irrigation water efficiency	%
Pesticides	Total quantity of pesticide used	kg/a of active ingredient
	Average number of pesticide applications	Number
	Endosulfan (or other pesticide) levels exceeding water quality guidelines	% of samples
	Fish kills attributable to cotton pesticides	Number per year
	Odour and spray drift complaints	Complaints per year
Land management	Salinity problems	% of growers experiencing problems
Waste management	Chemical containers returned for recycling (to drumMUSTER)	%

Table 4: Suggested environmental performance indicators for the cotton industry

The survey of stakeholders indicated that communication with the public could be improved. Industry reporting of environmental performance to the public is recommended on a regular basis.

Recommendation 3: It is recommended in respect of environmental performance that the cotton industry:

- 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; and
- Publish a regular environmental performance report for cotton farms, with results validated by an external expert.

4.5 Water use and management

4.5.1 Introduction

The year 2002 has been the fourth driest year since 1900 for Australia as a whole, with the highest average maximum temperature on record (Bureau of Meteorology 2003). There has been widespread and prolonged drought across Australia including the cotton growing districts in NSW and Queensland. The drought has brought the issue of water usage into sharp focus. The cotton industry is perceived by the community as an excessively high water user, to the detriment of environmental flows and downstream users.

Photo 1: The Darling River reduced to a series of shallow ponds due to the drought

Total water use by the cotton industry amounted to 2,314 GL in 1996/97, accounting for 15.5% of total water use for all irrigated land uses (National Land & Water Resources Audit, 2002). The dairy industry was the largest water user, accounting for almost 40% of water use.

Benchmark data are shown below and indicate that water use by the cotton industry is comparable to other irrigated agriculture, with a water use of 7ML/ha for cotton, fruit, dairy and sugar cane. Cotton has a comparatively high economic efficiency ($452/ML compared to the average return of $193/ha for all irrigated land uses).

Land use	Water returns $/ML	Total water use GL	Per cent of total water use %	Water use ML/ha
Vegetables	1295	392	2.6	3
Fruit	1276	665	4.4	7
Tobacco	985	17	0.1	4
Grapes	600	781	5.2	8
Tree nuts	507	140	0.9	6
Cotton	452	2 314	15.5	7
Coarse grains	116	518	3.5	3
Dairy	94	5 902	39.5	7
Peanuts	90	25	0.2	3
Hay	54	20	0 1	4
Rice	31	1 696	11.3	11
Legumes	24	33	0.2	3
Sheep	23	37	0 1	4
Sugar cane	21	1 195	8.0	7
Beef	14	1080	7.2	4
Oilseeds	10	85	0.6	3
Cereals	-9	87	0.6	3
All irrigated land uses	**193**	**14 959**	**100.0**	**7**

* Derived from estimates of mean water use per land use type in each region

Annual returns and intensity of water use (Source: National Land & Water Resources Audit 2002)

4.5.2 Water storage and transmission

Improved practices

Water losses are important issues. Good practices observed to minimise water storage and transmission losses, included:

- Growers maintained a minimum amount of water in storages to minimise evaporation losses;
- Use of deep storages where possible to minimise the surface/volume ratio;
- Compartmentalising large water storages to reduce evaporation losses;
- Installing volume gauges in storages so that quantities can be more accurately tracked;
- Where possible, storing water allocations in the local dam until they are required, not in on-site storages;
- Pumping waters direct from the source onto the irrigation areas;
- Some farmers have lined their water storages with bentonite, clay or other liners to minimise leakage; and
- Others have conducted electromagnetic surveys to detect areas of potential leakage in water storages as well as conducting geophysical analysis for leak testing. However, not all farmers had conducted permeability testing when their storage ponds were constructed.

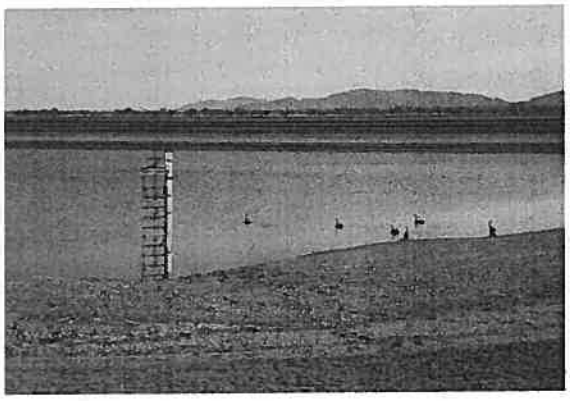


Photo 2: Volume indicator in storage pond

Areas for improvement

The good practices described above were not evident at all farms. At least eight irrigated farms were observed to use single shallow (<4m water depth) water storages with large surface areas, which result in higher evaporative losses. (Note that there are limits on the maximum water storage wall heights. In NSW storages greater than 15m high or that have a significant or high hazard rating are prescribed by the Dams Safety Committee of NSW. In Queensland, storages greater then 8m high and greater than 500ML storage are automatically "referable" by the Dams Safety Section of the Department of Natural Resources and Mines).

Water storages of up to 3800ML were observed, with multiple storages on larger farms. Surface areas of storages were often 50-100 hectares, with high evaporative losses.

More than half of the individual farmers visited did not appear to give much attention to addressing the issue of minimising water storage and transmission losses. The general consensus was that these issues are expensive to rectify and would not be addressed in the short term.

Smaller growers had not conducted water balances across the farm. Most farmers were not aware of how much water was lost through evaporation and/or leakage. However, estimates by one grower in NSW was that up to 30% of his water allocation was lost via evaporation. Growers should be encouraged to calculate the volume of water lost through evaporation from their water storages and distribution channels. The corresponding economic loss should also be determined. This may motivate growers to change practices or install features to minimise water losses.

Photo 3: Typical large surface area water storage

Photo 4: High evaporative losses from distribution channels

Levels in water storages had not been surveyed at the majority of farms inspected (approximately 80% of irrigated farms).

Distribution and tailwater return channels were observed to be of the shallow, open trench type, which can also result in high evaporative losses. On-farm transfer channels over 5km in length from the river offtake to the cotton fields/ water storage area were observed.

Storages and distribution channels were not always lined or leak tested, leading to leakage losses (and potential salinity problems). Trees were observed in water storages, which may also result in water penetration through clay base layers.

The DLWC conduct leak testing on scheme delivery channels, via piezometers. However, the use of piezometers to measure water leakage from on-farm channels and/ or storages was not widespread.

Note that the 1991 audit concluded that there was little scope for reducing the major element of water wastage (that is, evaporative losses). The auditors do not agree, although it is recognised that some solutions may be costly.

Recommendation 4: It is recommended that:

- Deeper water storages (which maximise the depth to storage ratio) be installed for new storages to minimise evaporative losses, where it is economically practical;
- Existing water storages be reviewed for rectification works to transform them into multi-cell, deeper ponds;
- Growers be encouraged to calculate the volume of water lost (and corresponding economic loss) through evaporation from their water storages and distribution channels; and
- Lining and leak testing of water storages and distribution channels should be encouraged.

4.5.3 Water application

Improved practices

Groundwater and surface water quality were routinely measured at the larger farms. This is becoming increasingly common as the farm's agronomist monitors what is being applied to the crop. (Very few small farms inspected conducted routine water quality testing due to the cost). Typically, conductivity, nutrients, pH and a range of cations and anions were monitored.

All of the irrigated farms inspected are pursuing, or are investigating, methods to maximise applied water use efficiency and minimise water application losses.

Significant effort is being made to ensure that water is used efficiently on the fields. A range of water use minimisation initiatives were noted at the irrigated farms inspected. These included:

- Some form of irrigation scheduling based on soil moisture to minimise water usage (using neutron or capacitance probes), to avoid over-watering and to minimise tailwater runoff (few farms inspected rely solely on visual inspections to schedule irrigation);
- Full tailwater collection and recirculation;
- Use of laser-levelled fields to ensure even water distribution across the field and prevent waterlogging;
- Use of weirs in distribution channels to ensure an even head of water across the field;
- Installation of more efficient equipment, such as low-pressure nozzles in centre-pivot overhead irrigation equipment, or drip irrigation systems;
- Increasing the flow of water to the fields (without causing erosion) such as by doubling the number of siphons or increasing the grade of the field or pumping water onto fields, to prevent waterlogging and minimise deep drainage;
- Only applying water down every second furrow to reduce waterlogging in heavy clay soil;
- Use of electromagnetic surveys to identify deep draining soils, which can then be remediated;
- Measuring the moisture content throughout the soil profile which may not be available to the crop, and monitoring deep drainage using moisture probes;
- Retention of wheat stubble to improve water infiltration in heavy clays, and to minimise initial watering requirements;
- Use of meters in delivery channels and tail water drains to monitor water distribution and return;
- Participating in Water Use Efficiency trials and benchmarking water usage around the farm;
- Selecting crop species that require less water;
- Planting in skip rows (that is, only planting every second row) when water availability is limited;
- Pulling up siphons well before water flows into the tail drain;
- Reducing irrigation in times of drought (stressing early and late in the season) without damaging the crop;
- Managing the crop to harvest quickly to save one round of irrigation; and
- Participation in the Waterwise Irrigation Management Course (in NSW only). Farmers undertaking training appeared to be more aware of water use and efficiency issues and have commenced trials of different application methods on their farms. Participation in these courses should be encouraged.

Water allocations and cost of irrigation water are contributing to the increasing adoption of water use efficiency measures in an effort to maintain margins over the longer term. This was particularly topical this season due to the drought conditions and impacts on allocation volumes.

Photo 5: Irrigation water trials

Photo 6: Drip irrigation system

Two of the farms surveyed had well established drip irrigation systems in service on a number of fields. Site personnel confirmed that these fields were typically more efficient in water usage than other fields (furrow irrigation) on the properties. Farmers with drip irrigation systems confirmed that there is a substantial maintenance requirement on the drip reticulation systems and filters but this is far outweighed by the lower maintenance and operating costs associated with the lack of head and tail canals, operation of siphons, waterlogging problems and erosion control. As the water is applied with greater accuracy, the operators can also apply minerals, nutrients and other additives to the cotton by incorporating the prescribed dose in the irrigation water. Overall, operators of drip irrigation systems indicated that drip irrigation was far more efficient and less onerous to manage than a furrow irrigation system.

The key factor that prevents its rapid up-take is capital cost. Operators believe that in the longer term, investment in drip irrigation is recoupable and recognise the significant environmental benefit of improved water use efficiency. However, there is a high degree of commercial risk associated with such a significant up-front investment, which will not yield immediate financial returns.

Irrespective of the irrigation method, most growers visited had not quantitatively measured water use on their farms or savings made by changed practices.

Water

"You cannot manage it if you do not measure it"

The often repeated catchcry

4.5.4 Water use and management research

Improved practices

Recent water allocation reforms are likely to promote more attention to the issue of water use efficiency. Limited water availability encourages growers to use their allocation efficiently.

Economic analysis indicates that the top 20% of growers (those that achieved the highest farm operating profit) have greater water efficiency than the average grower (Boyce 2001). The top performing growers used 0.5 ML less water per hectare.

The Queensland Government Rural Water Use Efficiency (WUE) Initiative has been investigating water use efficiency on cotton farms. Stated aims of the Rural WUE program are to increase irrigation efficiency by at least 10% and have at least 70% of growers adopt BMP guidelines for irrigation. Participation in the Cotton and Grains Adoption Program is estimated at greater than 75% of growers. Cotton and Grains irrigators have invested $3.5 - $3.6 million, with a Government contribution of $1.5 million to the program. The target of 10% WUE increase is being achieved and in many cases exceeded. One grower was reported as achieving a WUE of 2.9 bales/ML, whilst saving over 1 ML/ha of water. Around 78% of irrigated growers have adopted the BMP guidelines (Qld NRM website). The BMP guidelines for water use are currently under development.

The Queensland Rural WUE program has funding to support R&D proposals to reduce evaporation from irrigation storages. This is an important component of farm WUE. The call for proposals is in conjunction with the National Centre for Engineering in Agriculture. The primary focus of projects will be to demonstrate the physical and economic viability of a range of water management concepts on the farm.

Growers generally expressed high regard for the Queensland Rural WUE program and the practical outcomes in various regions. This was reflected in the growers' participation in, and knowledge of, local research initiatives. The future and funding of the Rural WUE Initiative beyond December 2003 has not been confirmed.

Crop water use efficiency on irrigated cotton farms in Australia was recently investigated (Tennakoon 2000). Production and water use data were obtained from twenty five cotton farms and over 200 fields representing the six largest production areas, which produces over 80% of the annual crop in order to estimate evapotranspiration (ET), irrigation efficiency (IE) and crop water use efficiency (CWUE). Water balances indicated the average farm level irrigation efficiency was 57%, with a high variability (37 – 68%) in irrigation efficiency at different valleys as well as at different farms. There is opportunity to improve efficiency at most farms.

Up until the recent past, there has been a lack of agreement on the definition of (and how to measure) the components of the water balance, and how to define Crop Water Use Efficiency (CWUE). Water balance studies have been fragmented and research and extension projects have been uncoordinated (ACCRC/CDRC May 2000). Investigations have now determined consistent definitions and methods for measuring water use efficiency and standardised on-farm record keeping (Hood 2002).

Research is being undertaken to help irrigators improve their profitability and sustainability by either producing more with the water they have or by using less water to maintain their current productivity. A number of recent and current studies compared different irrigation methods to evaluate water savings and water use efficiency.

Recent studies have been undertaken on furrow versus drip irrigation (surface and sub-surface) and use of "sock" systems to prevent surface crusting. Low pressure overhead systems, predominantly centre-pivot systems, have also been investigated (Kelly 2002, NCEA 2000). There is a trade-off for some systems – water usage may decrease but energy requirements may increase.

In addition, growers inspected were conducting their own water efficiency trials, such as comparing conventional channels and siphon system versus "pipe through bank" system, to reduce tailwater. Others

were investigating the use of "Flexiflumes" (essentially a flexible hose with holes set to furrow spacing) versus siphon systems.

Floating covers for evaporation control are being trialled at a number of farms, but were not observed during this audit. Covers are currently prohibitively expensive. Use of large diameter (0.8m) reinforced hoses for transferring pumped water around the farm is also being investigated to reduce losses from the distribution system. Investigations are also proposed into increasing the water storage efficiency of constructed wetlands by using vegetative cover and protection from wind.

Investigations are also being conducted on breeding varieties with better water use efficiency to help boost yields for dryland growers and give irrigated cotton growers better yields when water supply is limited (ACCRC undated).

Recommendation 5: In regard to improving water use efficiency, it is recommended that:

- Growers be encouraged to assess where their losses are and to quantitatively measure their water usage and losses;
- Participation of growers in water and irrigation management courses be encouraged;
- The cotton industry continue field investigations for improving application methods and increasing water use efficiency; and
- 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 NSW.

4.5.5 Tailwater management

Improved practices

Tailwater is the excess irrigation water collected from the cotton field. All irrigated cotton farms in NSW must have tailwater collection and return systems in order to obtain a water licence. Tailwater systems are designed to prevent possible off-site contamination by water containing pesticides, nutrients or sediment. The release of tailwater to watercourses is an offence under the NSW Clean Waters Act and NSW POEO Act.

Audits of tailwater systems were conducted by NSW Department of Land & Water Resources (now DIPNR) in the Macquarie Valley in 1988-1993 (Cooper 1995), which resulted in rectification of most tailwater problem sites in NSW.

All of the irrigated cotton farms inspected had tailwater systems, however, the adequacy or capacity of these systems was not investigated as part of this audit. The operators interviewed recognised the importance of retaining all their tailwater from a water resource and a pollution control perspective.

A search of the NSW EPA and Australian Legal Information Institute web sites and Cotton Australia files indicated that there has only been one prosecution in the last ten years of a grower for failure to retain tailwater on their farm: in 1996 at Mullaley a grower allowed tailwater to enter Cox's Creek where high levels of endosulfan were detected.

NSW EPA complaint records for 1998 - 2002 (for Gunnedah, Moree and Narrabri) indicate that there has only been one complaint with respect to tailwater – one person complained that the banks on the return channel on their neighbour's farm had broken, allowing potentially pesticide-contaminated water to enter their property. This incident did not lead to a prosecution.

Remediation systems, such as artificial wetlands, for pesticides in tailwater are currently being investigated. Enzymes have been found that will degrade pesticides in tailwater that is contaminated with organophosphates, carbaryl, endosulfan, endosulfan sulfate and a number of synthetic pyrethroids. Field trials have been conducted.

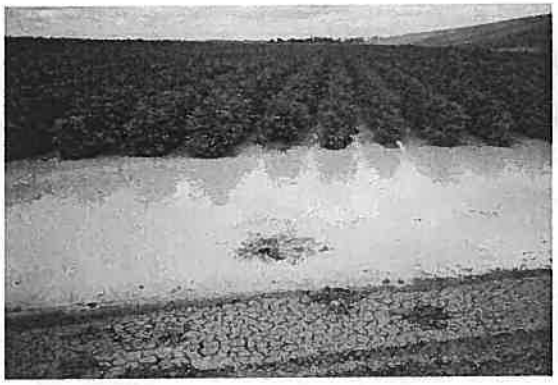


Photo 7: Tailwater collection system

Areas for improvement

The auditors were advised during discussions with industry personnel that there are still some older farms in Queensland that do not have tailwater systems (these were not inspected during the audit). Some farms in the Theodore Valley Irrigation Area that have irrigation waters supplied via collective irrigation channels are limited in their ability to capture and recirculate tailwater due to current channel infrastructure design. It is understood that these were old Queensland Government-designed irrigation schemes that didn't cater for tailwater capture.

Recommendation 6: 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.

4.5.6 Stormwater management

Improved practices

Studies have shown that the main transport mechanisms for pesticides from farms are via stormwater runoff, followed by spray drift. Not all farms have been designed to retain all stormwater runoff on their properties. Even for farms with stormwater retention facilities, contaminated stormwater or tailwater may be released to the environment during major storm events.

In 1995/96 there were approximately 30% of cotton farms in the Upper Namoi valley that were incapable of effectively containing pesticides on farm after moderate falls of rain (DLWC 1996). This situation has improved significantly with all NSW and most Queensland growers inspected having stormwater retention facilities.

Many growers had complex stormwater management strategies and capability to pump between major storages, allow water to backflow in supply and tail channels, flood fallow fields and direct excess runoff to surge areas in order to retain the maximum amount of stormwater. Stormwater could then be directed back to the distribution channels or water storage ponds. Growers rate their systems as capable of retaining 25mm of rainfall as a minimum (and some up to 150mm – considered a major storm) depending on the storage levels and available capacity at the commencement of the storm event. A number of growers claimed their systems would achieve zero release in any storm event.

Photo 8: Stormwater collection pond

In flood-prone areas, it was noted that growers had created levee banks around their farms. At these farms, all stormwater would be retained on site.

Growers with designated "blowout" points had directed the excess stormwater to blowout onto on-farm fields and/or away from rivers and creeks. Stormwater was designed to pass through vegetated areas (crops or grassed areas) to remove silt, nutrients and some pesticides prior to reaching nearby watercourses.

During site inspections and documentation review, two examples of Irrigation and Drainage Management Plans were observed. These were being prepared by irrigators in NSW for submission to DLWC in 2003.

Areas for improvement

None of the growers visited tested their stormwater quality for pH, conductivity or residual pesticides.

Whilst most growers had devised physical on-the-ground strategies to retain the maximum amount of potentially contaminated stormwater with the infrastructure available, stormwater management plans were often poorly documented. For some of those plans that were documented, there was little evidence to suggest that the infrastructure available was designed or engineered to control major storm events. The value of the stormwater plans (and confidence of the regulators) would be significantly enhanced by having the systems capacity professionally rated.

Recommendation 7: It is recommended that reviews be undertaken of the stormwater management systems that would specifically identify:

- 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; and
- Improvements to increase the capacity of the runoff retained.

Three dryland farms were inspected as part of the audit, across a number of growing areas. Some of the growers had established systems to capture stormwater runoff from certain fields. However, dryland farmers do not have the facilities or capacity to capture stormwater runoff from *all* areas of their farms that may be used for a range of crops, including cotton, which have been sprayed with pesticides. As a result, pesticides may be washed into local watercourses during even minor storm events. There are legal requirements which govern the amount of stormwater runoff that can be captured in a farm dam.

A number of dryland farmers only grow cotton intermittently, when climatic and market conditions are favourable. These growers could not economically justify the instalment of adequate stormwater capture systems on farms that may only grow cotton periodically (DLWC 1996).

Recommendation 8: It is recommended that 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.

4.5.7 Water quality

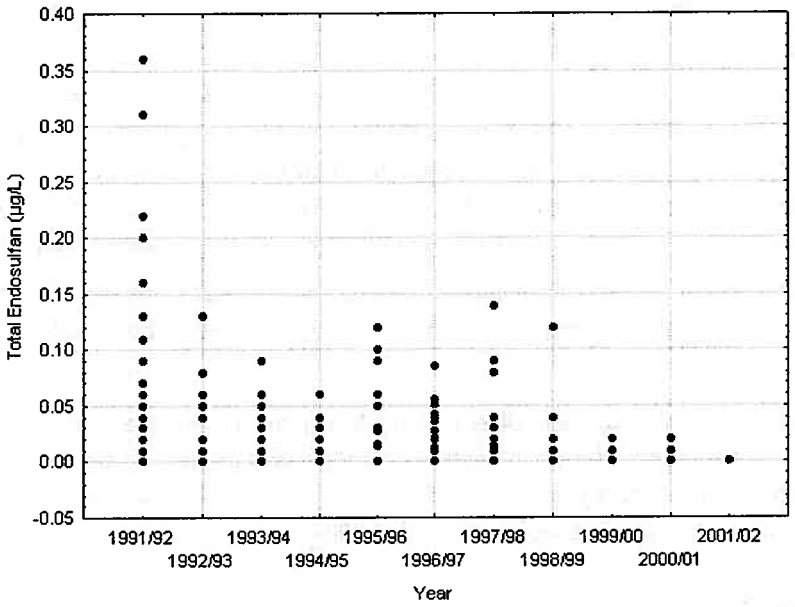
Improvements in surface water quality

There have been numerous water quality monitoring programs in different cotton growing districts over the last twelve years since the 1991 audit. These have been carried out by Catchment Management Committees, state government authorities, irrigators and concerned groups. Studies were conducted in response to concerns about the impact of irrigated agriculture on the river systems, perceived declining water quality, pesticide contamination and fish kills, and algal blooms. Overall conclusions indicate that levels of pesticides used by the cotton industry have declined in waterways.

Some of the water quality studies are briefly summarised below. (The scope of this audit did not include a comprehensive review of all water quality investigations).

- NSW DLWC surface water quality program in central and north west NSW (Gwydir, Namoi, Macintyre, Bourke and Macquarie growing areas). The program was established in response to concerns from rural communities and the cotton industry about the impact of irrigated agriculture on the areas' river systems. The data provides an indicator for measuring the long-term impact of cotton and dryland agriculture on the surface water systems and for measuring improvements achieved by the industry in reducing their impacts on the environment. Monitoring has been undertaken at 22-29 sites since 1991 for flow, nutrients, pesticides, and physical-chemical parameters. Macroinvertebrates are also monitored.

During recent testing (DLWC 2001), no samples exceeded the drinking water health values for pesticides. Generally it was found that the number of times that "trigger" values were exceeded for pesticide chemicals, such as endosulfan and chlorpyrifos, were fewer than in previous years. It is believed that this is correlated to the low pest pressure experienced during the season (and therefore the reduced number of pesticide applications) as well as improved Integrated Pest Management, use of Ingard cotton and implementation of BMP.



Endosulfan levels in the Namoi River, Narrabri, 1991-2002 (Source: DLWC 2002)

In the case of endosulfan, there has been a real decrease across all areas. The decrease in detected environmental levels was attributed to low pest pressure, a high level of education regarding industry best practice, Integrated Pest Management, availability of alternative pesticides and a restriction on the use of endosulfan.

Herbicides are still a problem in riverine areas, although it is acknowledged that large amounts of herbicide are used by all cropping industries.

> The DLWC recommended that "The best management practices adopted by the cotton industry must be made applicable to the whole agricultural sector to address the rise of chemicals such as diuron, fluometuron, metolachlor and prometryn, which have all risen sharply over the last decade".

- NSW DLWC has conducted riverine condition assessments of various catchments, including the Gwydir and Macintyre catchment areas.
- ACCRC has recently funded water quality studies upstream, within and downstream of the Gwydir irrigation area as well as on-farm water quality. One of the aims of the study is to determine inputs of salts and nutrients to the Gwydir valley watercourses.

- Studies conducted by Catchment Management Associations of individual catchments. Water quality data in the Border Rivers Catchment (Macintyre Valley growing area) has been analysed for the period 1990-99 (McGloin 2001). Results indicate that electrical conductivity was not at detrimental levels but turbidity exceeded guideline levels at some locations and other areas indicated increasing trends for turbidity.
- Condamine Balonne Basin, (St George – Dirranbandi and Darling Downs growing areas) from 1993 – 2001. Total endosulfan concentrations decreased to zero in 1999-2000 coinciding with restrictions on use and changes to the label for application. However, prometryn and metolachlor detections significantly increased from 1993-2001.
- Experimental constructed wetlands have been established at two farms, via a Cotton CRC/ NHT funded project, with the aim of investigating their potential to remediate irrigation runoff (which may contain pesticides, nutrients and soil pathogens). Clean-up of tailwater will reduce risks to the ecosystem in the event of site runoff during storm events. Funding is being sought to extend the program to measure pesticide degradation and to monitor a range of other potential environmental benefits.
- A Waterwatch program that involves farmers participating in water sampling and quality testing of waterways adjacent to their properties is planned. Growers visited in the Emerald area were ready to participate.

Another improvement is that Catchment Blueprints or Management Plans are being established by Catchment Management Boards for catchments in cotton growing areas. The Blueprints identify baseline water quality data as well as quality targets for each catchment. For example, targets have been set for electrical conductivity in the Namoi Catchment (DLWC 2002).

Groundwater quality

There has been limited public reporting of groundwater quality in cotton growing areas. Some examples include:

- Seven out of eight bores installed in the Condamine Balonne basin had no pesticides detected in the bores. High levels of metolachlor were detected in one bore at Dalby (CBWC 2002); and
- In NSW, the DLWC has conducted routine groundwater quality and depth monitoring, including at bores on, and adjacent to, cotton farms. Growers participating in the audit indicated that there was little feedback of any results or implications to the growers. The NSW DLWC should be encouraged to provide feedback on groundwater results in NSW cotton regions and implications to the growers.

4.6 Pest management

4.6.1 Integrated Pest Management

Improved practices

The Australian cotton industry has developed a major focus of reducing dependence on synthetic pesticides and recognising the importance of natural processes for insect control. Insects are controlled by implementation of an Integrated Pest Management (IPM) strategy. The IPM strategy integrates a system of non-chemical pest control measures with appropriate use of pesticides. The use of broad-spectrum synthetic pesticides is seen as a last resort.

The farms inspected were all using some, if not all, of the IPM practices listed below. All growers must be encouraged to continue to use IPM practices to reduce the number of chemical sprays and impact on the environment.

IPM practices noted at cotton farms included:

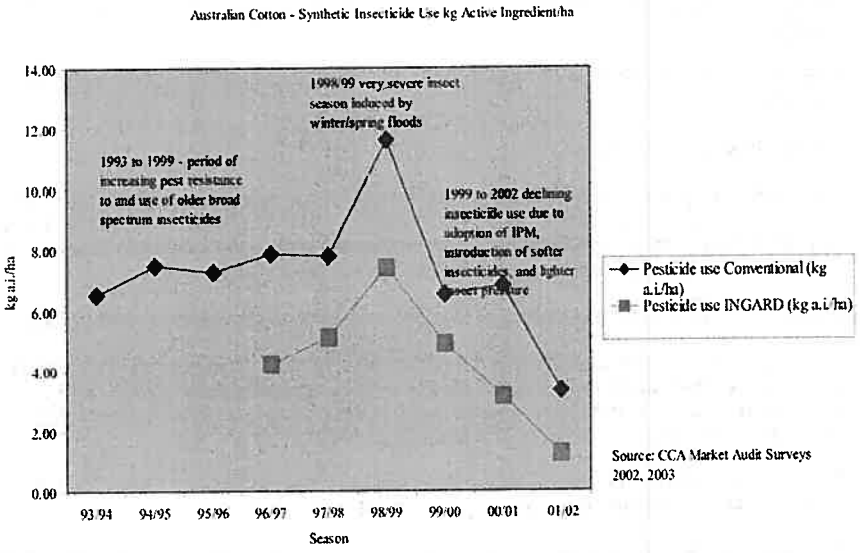
- Growing transgenic cotton varieties (Ingard), with built-in protection against pests. There has been a strong adoption by growers of these new varieties. For the 2002/03 season, up to 30% of the cotton crop can be Ingard;
- Use of non-chemical control methods, such as mechanical destruction/ field cultivation of overwintering heliothis pupae ("pupae busting");
- Changed farming practices, such as planting cotton into standing wheat stubble, which may result in decreased pressure from heliothis;
- Use of biological virus sprays;
- Use of selective pesticides, that is, those that do not harm beneficial predators or the environment, whilst targeting heliothis or other key pests. Growers reported that use of selective chemicals resulted in fewer sprays per season and lower risk of resistance to pesticides developing. One farmer commented that the sole use of selective/less toxic pesticides cost more per hectare and gave less effective pest control (and hence lower yields);
- Use of pesticides which break down quickly after application to reduce the overall pesticide load on the environment;
- Avoidance of "hard" chemicals early in the season (that is, broad-spectrum pesticides such as pyrethroids and organophosphates which have a high impact on predatory beneficial species). A number of farmers had made the decision to avoid using synthetic pyrethroids altogether and/or to avoid using endosulfan where they were located adjacent to sensitive areas such as grazing properties or Travelling Stock Routes;
- Planting of trap crops. The purpose is to attract moths to the trap crop, instead of the cotton crop, where they are killed by virus sprays. Growers inspected were debating the benefits of this method;
- Monitoring and promotion of the activity of beneficial insects and spiders, which attack cotton pests;
- Use of food sprays to encourage beneficial insects into the cotton field;
- Use of refuge crops, which are not subject to the normal spray regime and can harbour beneficials. Strips of lucerne and other crops were observed – these also acted as buffer zones between sensitive areas;
- Management of rotational crops (to harbour beneficial insects or act as a trap crop);
- Practicing good weed control to reduce alternative hosts for pests;
- Close monitoring of the crop, 2-3 times per week, to reduce unnecessary spraying;
- Accepting some pest damage to crops before spraying. Higher thresholds for crop damage and pest numbers were set before spraying pesticides;
- Varying the pesticides used to avoid insecticide resistance;
- Joining with neighbouring growers in an Area Wide Management (AWM) group to control pests in a coordinated manner on an area level. AWM groups have been established in various areas to assist with the regional application of IPM measures including coordination of pesticides applied in the region. Membership includes growers, spray contractors, crop consultants, and local QDPI/ Department of Agriculture and Cotton Australia representatives

Growers following the IPM strategy used combinations of all of the above techniques and avoided reliance on any one method.

Growers commented that the application of IPM principles has resulted in the reduction of pesticide (insecticide) spraying requirements in the period since the first environmental audit. Growers across a number of districts confirmed a reduction in the number of pesticide sprays (0-4 sprays per season) for transgenic cotton/ IPM practices, compared to 6-12 sprays for conventional cotton.

Case study: One well established and successful property inspected demonstrated a particular commitment to IPM principles. The grower is progressively promoting crop nutrition and soil health, together with other IPM principles, to significantly reduce the use of hard chemicals. A number of trial fields, growing conventional cotton without hard chemicals, are maintained. The grower has operated these trials for four years with continuing improvement and success.

The total quantity of pesticide used has declined significantly in recent years, due to the adoption of Integrated Pest Management and the use of alternative pesticides. This is illustrated in the graph below.



Synthetic insecticide use has decreased (Pyke 2003)

Investigations and research are continuing of non-chemical pest controls, such as the use of biological control agents, growth regulators, heliothis egg parasitoids, use of spray oils to deter heliothes from laying eggs on the crop and breeding programs for mass release of beneficials such as assassin bugs which attack heliothes. This is just some of the research occurring into improving pest management.

Further implementation of Integrated Pest Management strategies should continue to achieve reduction of pesticide use by growers.

Areas for improvement

Discussions with growers and industry personnel indicated that some farmers, who only grow cotton intermittently, may not be keeping abreast of IPM practices and may not realise the full impacts of their pest management spraying regime and use of pesticides on neighbouring farmers.

"Bug checkers" and consultants used a number of different forms for recording information from field checks. It was noted that beneficial insects were not routinely recorded by some consultants. Bug checkers/ consultants should be encouraged to record beneficial insects if they don't already do so (in accordance with the Cotton Consultants Australia Operational Guidelines for field inspections).

Recommendation 9: It is recommended that farmers, such as grain growers who only grow cotton intermittently, be encouraged via training, information and visits by extension officers to keep abreast of IPM practices.

Recommendation 10: It is recommended that "bug checkers"/ consultants be encouraged to record beneficial insects if they don't already do so.

4.6.2 Insecticide resistance

Improved practices

Helicoverpa armigera has developed resistance to pyrethroids, carbamates, endosulfan and is beginning to develop resistance to organophosphates (ACCRC 1999). The Insecticide Resistance Management Strategy (IRMS) has been developed to avoid chemical resistance problems developing. The IRMS is revised each year and aims to reduce the survival and selection of resistant pests by rotating chemical groups, using strict windows for application of pesticide groups and avoiding sequential use of the same chemicals. To ensure compliance with the strategy, growers wanting to use insecticides outside of those specified in the IRMS have to make a written request to the Transgenic Insecticide Management Strategy committee.

There was a strong awareness of and adherence to the IRMS at the farms inspected. Spot checks of spray records indicated that pesticides were sprayed during the correct time periods. Spot checks were also made of spraying the same chemical sequentially on a field as per the IRMS.

Two farmers reported that they adhere to the IRMS as closely as possible, however, there have been circumstances on their farms where they have opted to contravene the IRMS. The contravention usually occurred because a spray was delayed or a crop was under heavy attack, hence, substances were applied outside the allowable windows. These farmers believed that it was not practical to have a firm cut-off date for specific chemicals and that many other factors such as weather and bug life cycles would influence the effectiveness of this strategy. It was reported that *"The bugs don't know what the date is!"*

Vigilance in this area must be maintained.

Recommendation 11: It is recommended that comprehensive checks of spray records continue to be conducted during Best Management Practice audits as a means of measuring compliance with the Insecticide Resistance Management Strategy (IRMS). In addition, education or further strategies should target those farmers that do not adhere to the IRMS.

4.7 Pesticide Management

4.7.1 Spray drift management

There have been numerous improvements in the management of spray drift of pesticides since the inaugural environmental audit. These include changed pesticide application practices, weather monitoring during

spraying and the use of on-farm weather stations, use of Pesticide Application Management Plans, improved spray records, production of detailed farm maps identifying sensitive areas, accreditation of sprayers and ongoing research. These are discussed below.

Research

Ongoing research has been conducted on spray application methods to manage and minimise spray drift. CRDC has provided extensive funding for research to improve pesticide application performance and to mitigate spray drift. Some recent projects have included: the optimisation of large droplet placement technology for aerial application of insecticides in cotton; the potential for long distance endosulfan drift; improved pesticide application performance; development of guidelines for ground based spray applications; enhancing access to climate and weather data; laboratory and field evaluations of different nozzle types; use of electrostatic nozzles on aircraft and helicopters; and evaluation of mineral oils for cotton IPM. These projects have resulted in changed practices (described below) and minimisation of spray drift.

Other research since the first environmental audit has included:

- NSW DLWC conducted a detailed review of environmental practices of cotton farmers in the Macquarie Valley in 1994/95 and in the Namoi Valley in 1995/96 (DLWC 1996) aimed at reducing environmental contamination by pesticides;
- The biological impact of cotton pesticides was investigated in detail (LWRRDC 1996) in an attempt to bring together various lines of conflicting evidence on the ecological impact of cotton pesticides in Australian rivers. The chemicals of most concern were identified and ongoing research recommended;
- Extensive research on pesticide movement and fate and the impact of pesticides in the environment was conducted in the 1990s (LWRRDC 1998). Guidelines were also developed for improved management practices for minimising spray drift;
- The 'Cotton Model' for minimising the impact of pesticides on the riverine environment (Cox Inall Communications, on behalf of LWRRDC, 1998) was developed in response to mounting community concern with the intensive use of pesticides in the cotton industry and their impact on riverine health. The Cotton Model involved extensive field research to assess the fate and transport of pesticides and their impact on the riverine environment;
- The research data described above assisted the cotton industry in the development of Best Management Practices to enable implementation of practical, cost effective and sustainable farm management practices;
- A review of the available information and progress on pesticide application in the cotton industry was recently conducted (Parkin 2001), with improvements in aerial and ground application methods noted; and
- A Centre for Pesticide Application and Safety was established at The University of Queensland, specialising in application technology and environmental issues. A state-of-the-art wind tunnel has been established for investigating pesticide application effects.

Changed pesticide application practices

Improved practices

Cotton farmers, aerial operators and groundrig operators visited during the audit were acutely aware of spray drift management issues. There has been a change in practices over the last decade to reduce spray drift including the practices listed in Table 5.

General practices	Groundrig operators	Aerial operators
Techniques developed (as part of Best Management Practices) to minimise spray drift include: ◗ Developing Pesticide Application Management Plans; ◗ Establishing communications with neighbours before and during spraying; ◗ Only applying pesticides during appropriate weather conditions and monitoring and recording weather conditions during application; ◗ Observing buffer zones; ◗ Spraying at night during low wind conditions to minimise off-target spray movement and volatilisation of pesticides; ◗ Using different forms of chemicals, such as endosulfan EC instead of the (now banned) ULV; ◗ Trials with fluorescent dyes on ground rig and aerial sprayers to optimise pesticides application and reduce residual chemicals; ◗ Maintaining remnant vegetation and the planting of transgenic cotton (with reduced spraying requirements) was noted on boundary areas of properties with adjacent sensitive areas, such as rivers and creeks, main roads, travelling stock routes, neighbouring houses and areas of natural vegetation. This practice minimises spray drift off the properties.	Ground application has increased in significance since 1999 and now forms a major sector of pesticide application. Techniques developed for ground rigs include: ◗ Use of inter-row and over-row shielded sprayers; ◗ Using nozzles with a low drift potential and using different droplet sizes for different chemicals; ◗ Using different heights/ speed/ pressure of applications to suit the chemical applied; ◗ GPS tracking of groundrig spray patterns and concentrations; ◗ Using a "beeline" system to achieve accurate ground-rig application (no overlap or excess chemicals)	Techniques developed for aerial operators include: ◗ Avoidance of off-target spray drift by the use of correct equipment by trained and licensed operators; ◗ Having someone on site observing each application; ◗ All farmers advised that there is at least one responsible person on the ground at all times monitoring wind and spray drift during aerial spraying. This person is in contact with the aerial sprayer at all times, usually via two way radio; ◗ Large Droplet Placement technique; ◗ Improving spray patterns; ◗ Improving aircraft nozzle configurations; ◗ Use of lower booms to reduce drift; ◗ Use of GPS guidance system for precision applications; and ◗ Use of Satloc system which maps out the entire flight path and application area. In addition, aerial operators have developed written protocols for aerial applications. One of the operators inspected had implemented an accredited EMS, another was in the process of developing an EMS.

Table 5: Changed pesticide application practices in the cotton industry

Weather monitoring during spraying

Improved practices

Weather monitoring is conducted during spray applications at all the farms inspected. A number of growers have permanent weather stations at properties, or else use portable systems (hand held or mounted on the ground rig). Larger stations used both permanent and portable weather monitoring devices. Windsocks are also used to monitor local wind variations.

Photo 9: Typical weather station at a cotton farm

A notable feature across a number of cotton growing valleys has been the establishment of a network of weather stations funded by growers and aerial spray operators. Real-time data gathered from these weather stations can be accessed by growers and sprayers via phone on demand. Recorded historical data from the stations is also available.

Where the farm was some distance from the aerial spray operator, the spray operator would make contact with the farm to get a local weather report before departure. On some properties, the aerial sprayer would make direct contact with the weather station by telephone to access real-time local data.

Spot checks of spray records were made to confirm that weather conditions were monitored and recorded. Records at all farms were satisfactory, with over 90% of growers recording weather conditions throughout the pesticide application. The NSW Pesticide Amendment (Records) Regulation 2001 requires a record of weather conditions before the application and if weather conditions change.

Pesticide Application Management Plans (PAMP)

Improved practices

Farmers applied systematic and documented processes for the management of pesticide spraying.

Most growers were routinely using some form of a PAMP. All farms visited, except two, had established PAMPs. These varied in detail from simple farm maps with neighbour notifications to detailed written procedures (for whole farms or individual fields) and comprehensive records of agreements with neighbours/spray operators (both aerial and groundrig) and cotton consultants. A PAMP template was produced by Cotton Australia (Cotton Australia 2001).

During the site inspections, the sharing of best practice information and documentation was noted in several growing areas, where the Cotton Australia Grower Services Manager had a 'best practice' PAMP supplied by a local farmer. This PAMP was used as a demonstration for other farmers who were developing or improving their existing PAMPs.

Areas for improvement

Approximately one third of growers visited had PAMPs that only covered endosulfan sprays. The rest had extended the PAMP to cover all pesticide sprays. Growers should be encouraged to extend the PAMP to cover all pesticides and herbicides used.

A spot check of EPA complaint records for the period 1998-2002 for Gunnedah, Moree and Narrabri (EPA 2002) indicate that there were seven specific complaints from neighbours of cotton farms regarding lack of notification of spraying activities. Although neighbour notification is only strictly required for endosulfan (it is required by the endosulfan label and hence a legislative requirement), it would be advisable, in the interests of neighbourly harmony and courtesy, to notify neighbours of all sprays. This may result in fewer complaints in the future. A number of cotton farmers who practice notification for all sprays indicated improved neighbour relations, even though workload may increase (most growers had multiple neighbours, with one grower having 16 neighbours). It is important to have good communications with neighbours and record keeping of notifications.

There was a reluctance of some grazing neighbours to sign off on the PAMP. Where sign-off cannot be achieved, it is recommended that the farm map, contact details and location of the cotton fields for the season be sent to the neighbour.

It was also noted that several growers had not updated their PAMPs since the initial spray management plan produced in 1999 (this was noted during site inspections and in BMP audits). It is recommended that PAMPs be reviewed and updated each season to identify any changed practices, new neighbours and different areas planted to cotton.

Deficiencies in implementing the PAMP (noted in this audit and recent BMP audits) included lack of pre-season agreements with contract groundrig operators, neighbours not signing off on agreements, lack of notification of neighbours for some endosulfan spray applications, records of spray orders not always matching spray confirmations, lack of routine weather monitoring records and lack of calibration of weather monitoring equipment.

Recommendation 12: It is recommended that the following Pesticide Application Management Plan (PAMP) actions be taken:

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

Spray records

Improved practices

Almost all growers (approximately 90%) used pre-printed spray logbooks. The rest used their own customised forms. All growers visited kept good records of all pesticides used throughout the growing season, spray orders and spray confirmations. Full details of pesticide applications were kept, including chemical name, date, application method, applicator, area treated, quantity used, wind speed and direction (as required under the recent NSW Pesticide Amendment (Records) Regulation 2001).

Some aerial operators have a Satloc system which maps the entire flight path of the aerial spray job. This is useful information if there are any complaints regarding the areas sprayed or spray drift issues.

It was noted that AusQual had conducted independent spot check audits of spray records of endosulfan use at four of the farms inspected in NSW over the last three years, with satisfactory results.

Farm Maps

Improved practices

Most farm maps observed (approximately 75%) were in considerable detail showing sensitive areas. Some farm maps were accompanied by a specific list of instructions to aerial sprayers for spraying specific fields, for example, "Spraying not permitted in a north-easterly wind (due to sensitive area) or during school bus hours".

Areas for improvement

However, some maps (approximately one quarter of those observed) failed to identify areas sensitive to spraying. A number of farmers pointed out that houses and other sensitive areas were shown on the maps, however, these should be clearly labelled as sensitive and buffer zones clearly marked. Other farmers noted that the aerial sprayer had been spraying the property for many years and that they were familiar with all surrounding sensitive areas. Despite the familiarity of contractors with the farms, the onus is on the farmer to provide accurate and up-to-date information to contractors relating to sensitive areas surrounding the farms.

Recommendation 13: It is recommended that 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.

Accreditation of Sprayers

Improved practices

The majority of farmers used AAAA-accredited aerial sprayers and were able to produce copies of AAAA accreditation certificates. The remainder believed their sprayers were accredited but their accreditation certificate was not attached to the Pesticide Application Management Plan.

The AAAA has made a commitment to regulators to make the "Spraysafe" program more accountable and effective. AAAA has negotiated with a range of independent bodies to undertake audits of "Spraysafe" accredited operators.

Areas for improvement

The ground rig operators do not currently have an accreditation system, however, the majority of contract sprayers were members of the Groundrig Operators Association. The Association advised the auditors that it is investigating a competency-based assessment criteria for groundrig operators. Hence, future membership will provide assurance on the competency of the operators and the equipment.

> ***Recommendation 14:*** It is recommended that the Groundrig Operators Association develop competency-based assessment procedures for its members to provide assurance on the competency of the operators and the equipment.

Calibration of Equipment

Improved practices

All farmers rely on the aerial sprayer to provide properly calibrated spray equipment to ensure correct application rates are applied. AAAA accreditation provides them with third party assurance in this regard.

Computerisation of ground spray rig equipment has reduced manual calibration requirements. Growers with this type of equipment were able to detail their verification techniques. Most of these techniques involved calculating volumes applied and spray areas during spraying.

Areas for improvement

Many farmers undertake simple jar tests on ground rig equipment to check the calibration of the sprays. Some farmers rely totally on the competence of the operator.

Recent inspections by industry consultants indicated that individual cotton and grain farmers, as well as contract sprayers, had difficulty in accurately calibrating their spray equipment, including new computerised spray equipment (pers. Com. B Pyke, CRDC).

4.7.2 Storage and handling of pesticides

Improved practices

The storage and handling of pesticides was generally satisfactory. Pesticides were observed to be mostly stored in designated and lockable storage areas and were generally best practice. Implementation of Best Management Practices has greatly improved the storage and handling of pesticides since the 1991 environmental audit.

Shipping containers were commonly adapted for use for pesticide storage, generally providing adequate spill protection and security. Metal plates were welded across the front of the containers to provide a bunded area. (However, the ability of the bund to capture 25% of the storage contents was not always established.)

Photo 10: Bund installed within a shipping container

Photo 11: Non-complying chemical store - no bunding, signage or ventilation.

The shipping containers were usually raised above ground level. Raising the containers minimises lifting required when transferring chemicals between the storage shed and vehicles. It also assists in collection of any spills by allowing drainage lines to be installed, to direct spills to a container located under the shipping containers.

Ventilation of shipping containers was generally suitable, for odours and temperature, at approximately 85% of the sites inspected. Thermally insulated containers were often used, and these proved effective in maintaining lower internal temperatures. Storage sheds/ containers were observed to be painted white or of reflective metal and sited in the shade where possible, such as along the eastern side of a workshop, to minimise internal temperatures (as per the requirements of AS2507). A number of farmers had also removed the solid container doors and replaced them with grated steel doors for improved ventilation whilst maintaining security.

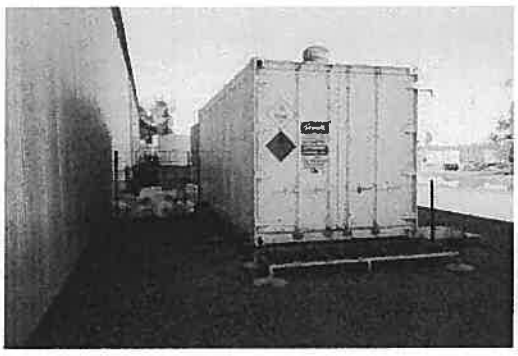


Photo 12: Shipping container used effectively as a pesticide store

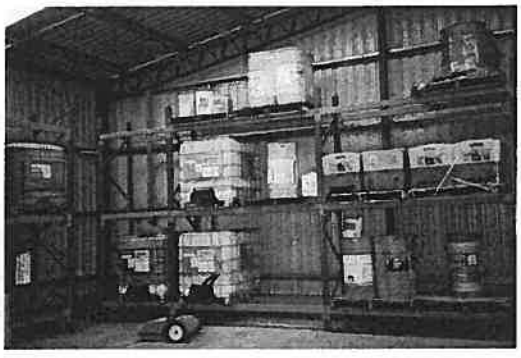


Photo 13: Good storage of pesticides

A number of properties also had recently purpose designed storage sheds usually of light metal frame and cladding construction, with a concrete floors and bund. These sheds were generally observed be adequate in size, with provision for good compartmentalisation of materials stored and adequate ventilation and signage. These storage sheds were usually accompanied by a mixing platform. One property collected all waste/wash waters from the (under cover) platform into wastewater tanks and reused the water for mixing chemical or off-site disposal as deemed appropriate.

Infrastructure for effective capture of spills or potentially contaminated stormwater was observed at the majority of farms. Consideration of required infrastructure for suitable handling and storage of chemicals is critical during the concept and design stages of facilities. Retrofitting of such drainage and other infrastructure can be difficult and expensive.

Most growers sought to reduce the quantity of pesticides stored on site by minimising stock levels, only ordering as required, returning unused chemicals to the supplier and sending unwanted old chemicals to the ChemCollect or Chemclear programs.

Areas for improvement

In some instances, however, storage of chemicals required improved management. It was observed that there were many minor BMP practices not implemented on approximately 30% of farms inspected such as lack of signage, ventilation, full bunding, security, emergency plans, Material Safety Data Sheets and licensing.

Photo 14: Poor storage of chemicals in open unbunded area

Photo 15: Uninsulated, dark colour, shipping container used to contain pesticides. Internal temperatures may be excessively high.

Observations of areas requiring improvement included:

- Some of the shipping containers used as pesticide stores had wooden floors, which are not appropriate as spilled chemicals may seep into the wood or penetrate the gaps. Two sites visited had wooden floors;
- Ventilation of shipping containers was not always adequate, for odours or for temperature. Strong odours were noted on entry to at least five of the storage areas, indicating spills or leaks. Single skin containers, especially those that are a dark colour can reach excessively high temperatures in summer and may result in liberation of pesticides from containers. Improved roof and low-level vents are required for adequate ventilation of these storage areas;
- Incompatible chemicals were not always segregated;
- Pesticides were not always stored within the designated bunded areas or were not stored within the bund the correct distance away from the bund walls (for example: stacking of chemicals on pallets against a kerb-height bund wall would not capture leaks or spillages and does not satisfy AS2507 requirements to store containers "at least 600mm from the inner crest of the bund wall");
- An old machinery shed was converted into a lockable store with bunding. However on this occasion, the storage was over crowded and containers could easily fall from the bunded troughs onto the earth floor;
- At least four pesticide storage areas were not adequately locked/ secured during the site inspections. There were opportunities noted to increase security controls in some chemical storages. This is

particularly important at facilities that store larger quantities of chemicals, such as those associated with aerial operators;

- First aid kits and spill kits were not always available close to the pesticide store;
- At two sites, drainage from the mixing area was observed to flow onto a bare adjacent area, not into a properly constructed evaporation pit;
- One grower stored pesticides in the open, on bare ground, with no security, signage or bunding. The grower had an action plan to upgrade to a proper store;
- Spill capture and drainage could be improved. At one property, while other aspects of storage were best practice, closure of the sump drain was not possible at the time of inspection. Any spillage would be able to escape via the sump drain line. A valve or similar mechanism should be fitted to allow the drain to be closed;
- Another property had a large bunded area for bulky-bin containers. This area was not covered and was also used as a mixing platform. The bund drained directly to an evaporation pit which was observed to contain a diluted milky substance (estimated >200L) that could not be identified at the time of the inspection; and
- Three farms inspected had small stocks of old chemicals with labels faded or peeling off. Old chemicals should be removed off site and disposed of correctly.

Recommendation 15: It is recommended that pesticide storage be improved by checking against "best practices" outlined in the Best Management Practice manual and implementing the following, where required:

- Growers establish, by measurement, that bunding in pesticide stores can retain 25% of the storage contents;
- Wooden floors, or other porous materials, should 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;
- Pesticides be stored within the designated bunded 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; and
- Old chemicals be removed off site and disposed of correctly.

Purchase and inventory of pesticides

Improved practices

The quantity of pesticides held on site was minimised at most farms by practicing an "order as you go'" policy, where chemicals were delivered as they were required. This was practiced by most farm managers who were a reasonably close distance to suppliers. This approach allows a degree of risk transfer and minimisation of costs associated with establishing larger storage facilities. This approach should be encouraged for those farmers within a reasonable distance from chemical suppliers. Other farmers advised that they tended to purchase their chemicals in bulk at the start of the season.

All farmers interviewed purchase chemicals in returnable containers where available, as a preference. The advantages reported by farmers were:

- More cost effective in bulk;
- Safer decanting of substances; and
- Easier disposal of containers to suppliers.

At least five of the properties visited maintained a running inventory of all chemicals in stock. These properties required all chemicals to be signed out of storage. The benefit of this practice is that the total quantity of chemicals on site at any time is known, in case of an emergency such as a fire. An inventory of pesticides was not usually maintained during the season by the other growers. It was generally the responsibility for one or two personnel on the site to manage chemicals and they usually monitor levels of stocks.

> ***Recommendation 16:*** It is recommended that 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.

Emergency Plan

Improved practices

Approximately 30% of the growers had an emergency plan to manage issues associated with chemical spills or contamination on the site. The majority of the growers felt that it was common sense. Spill kits and first aid kits were generally provided, and communications lines were simple – usually to one manager. Emergency plans were observed on some, but not all, of the larger properties.

Areas for improvement

Emergency procedures were sometimes displayed on the internal wall of storage sheds, which would not be practical if there was a fire or chemical spillage.

> ***Recommendation 17:*** It is recommended that to improve emergency procedures:
>
> - All growers develop an Emergency Plan suitable to their size of operation; and
> - Clear emergency procedures be displayed outside the storage shed, with back-up copies at the site office. Emergency procedures should also be legible from a distance.

Material Safety Data Sheets

Improved practices

All growers visited, except two, had Material Safety Data Sheets (MSDS) for the chemicals used on site. This is a large improvement since the 1991 audit.

Some growers with internet access were aware of websites where MSDSs were available, and accessed these sites as required. Links to a guide to websites that offer MSDSs without a fee could be useful to include on the CRDC and Cotton Australia websites.

Areas for improvement

A number of farmers had large folders of MSDS which were issued by Cotton Australia several years ago, for a comprehensive range of chemicals. However, many of these chemicals are not used by farmers. It was also noted that some growers did not have MSDS for some of the newer chemicals used such as "Affirm" or "Steward", or for fertiliser such as anhydrous ammonia, which is a toxic and corrosive gas.

Growers generally did not have MSDS for chemicals applied by aerial operators or contract groundrig operators. All farm workers should have access to information about the chemicals used in their working environment, even if they don't have to handle the chemicals directly themselves.

Recommendation 18: It is recommended that in regard to Material Safety Data Sheets (MSDSs):

- Growers maintain a folder for the chemicals they actually use, so details can be readily accessed if there is an accident or environmental incident;
- Growers remove MSDSs for chemicals they do not use;
- Growers check that they have complete and most up-to-date MSDS for each chemical on an annual basis;
- MSDSs be made available to farm workers for all chemicals used on site, even if they don't have to handle the chemicals directly themselves; and
- Include links to a guide to websites that offer MSDSs on the CRDC and Cotton Australia websites.

Licensing

Areas for improvement

There was a lack of awareness of the quantities of pesticides kept on site that required a Dangerous Goods licence in NSW, although quantities are stated in the BMP manual. At least seven farms visited in NSW, quantities of chemicals kept on site would require a licence. Currently, up to 1000L of pesticides (Class 6.1, Packing Group III) can be stored without a licence, or 100L of Class 6.1 Packing Group II. Licensing requirements in NSW are currently under review and licences may not be required in the future for farm quantities of dangerous goods. Once legislation in NSW is amended, growers should check whether licensing is required. If licensing is still required, growers should determine the maximum quantities of each Class and Packing Group of chemicals held on site and apply for a dangerous goods licence if threshold quantities are exceeded.

No farms visited in Queensland had storage practices or held quantities of pesticides that would require licensing under the Queensland *Environmental Protection Act 1994* or the *Dangerous Goods Safety Management Act 2001*.

Signage

Improved practices

Most pesticide storage areas had some signage at around 90% of the farms inspected. Where signage was lacking, a number of growers had identified this in their BMP action plans.

Areas for improvement

Signage was not always correct or complete. For example, signs indicated dangerous goods Class 3 (flammable liquids) and Class 6 (poison) but did not indicate Class 5 (oxidising agents) or Class 8 (corrosive liquids) where these were stored in pesticide stores. Incorrect signage was not always picked up in BMP audits.

It was also noted that two farmers had printed their own signs, which were starting to fade and required replacement (the durability of signs was not in accordance with AS1216).

Recommendation 19: It is recommended in regard to signage that:

- Growers check that they have the correct signage for the type of dangerous goods stored on site; and
- Signs should be replaced if they are faded.

4.8 Environmental incidents related to pesticides

Major environmental incidents related to cotton pesticides occurred in 1994 when Helix residues were found in cattle and in1998 when endosulfan residues were detected in beef exports.

Endosulfan contamination was detected in a beef shipment to Korea. Subsequently, endosulfan residues were found in other export meat. Monitoring during the previous two seasons had not resulted in detections of residues. This incident resulted in the accelerated implementation of BMP. Also in response to this incident, the National Registration Authority prescribed new, stricter conditions for using endosulfan.

Case study: Helix residues found in beef exports. The pesticide Helix (chlorfluazuron, CFZ), was sprayed on cotton crops in NSW and Queensland during the 1994 growing season. Due to a drought, with cattle feed in short supply, 30,000 tonnes of cotton trash containing residues of CFZ was fed to cattle as a drought supplement.

In late 1994, the NSW Department of Agriculture issued a fact sheet regarding CFZ residues accumulating in the fat of the cattle. Cattle farmers lost export sales due to CFZ contamination. Cotton growers voluntarily stopped using Helix.

The primary concerns raised by the community were the issues of spray drift, residue in soil, concern that the chemical would be passed through cattle to milk, and fear in the community that they were eating contaminated meat (Pesticide Action Network website).

The industry response to this was voluntary withdrawal of the chemical and industry recommended no more cotton trash feeding to cattle.

4.8.1 Complaints

It would be fair to say that there is an acrimonious relationship between neighbouring farmers and cotton growers in some areas with respect to spray drift issues. There have been a number of real and vexacious complaints to the EPA. The EPA has found that some of these complaints were unsubstantiated or that there was insufficient evidence to prosecute. However, there are still a large number of complaints each year regarding chemical spray impacts and odours.

A spot check was undertaken of the NSW EPA complaints register for spray complaints between 1998/99 to 2001/02 seasons in the Gunnedah, Moree and Narrabri areas. Over the four seasons, there were 318 complaints – over 95% of the complaints were concerned with spray issues (for all crops, not just cotton). Complaints are summarised below:

Season	Number of complaints [a]
1998/1999	127
1999/2000	58
2000/2001	95
2001/2002	23

Table 6: Summary of complaint numbers in selected NSW cotton districts (Source: EPA 2003)

Note (a): One complainant may be responsible for multiple complaints. Also one incident may have resulted in multiple complaints. Complaints may not be substantiated in all cases. Not all of the complaints were related to cotton.

The complaints were concerned with spray activities, but were not necessarily all cotton related. The majority of complaints related to aerial spraying activities. The total number of complaints appears to fluctuate, but have declined from 1998/99. The increase in number of complaints in 2000/01 may be due to increased awareness of the local community of environmental issues and avenues of registering complaints, as well as better reporting arrangements. The decreased number of complaints in 2001/02 may be due to lower pest pressure and/or adoption of Integrated Pest Management practices, PAMPs and Best Management Practices and hence reduced spray activities.

Growers taking part in the audit have anecdotally reported a general improvement in relationships with their neighbours since the introduction of the pre-season agreements for the application of pesticides. Growers believe that this mechanism has assisted them to communicate measures taken to reduce the impact of spray-drift and impact on neighbouring properties. This in turn should deliver reduced complaints over time.

Complaints could generally be split into four categories: health affects, damage to crops, flora and fauna concerns and other general complaints. A summary of the complaints (NSW EPA register for 1998-2002 for selected cotton districts) is provided below in Table 7.

Health Affects	Crop damage	Flora/Fauna	Other
Common health complaints included various combinations of the following: breathing and respiratory difficulties; headaches, severe headaches; nausea; sore, burning, stinging, itchy or watering eyes; sore or burning throat; dry throat and nostrils; dizziness. Less common health affects, sometimes combined with more common health affects summarised above, included: asthma attacks, dry mouth, aching ears, numbness in mouth/ lips/ tongue, sinus problems, choking from strong fumes, raspy voice, swollen or stinging face, skin irritation, tightness in chest, coughing, migraine, affects on nervous system, pins and needles/tingling in tongue and nose, bad taste in mouth. Many people complained of strong chemical or burning odours when cotton was being sprayed. Several people phoned to request information about long term health affects. Many of those were primarily concerned about their children. Several people indicated that they would like to know what chemicals were being used near their houses/properties.	Several people complained of lucerne wilting or dying; 150 acres of cotton damaged by spray of hormone product; 20-30 trees on property lost leaves from spray drift, pepper trees and garden shrubs dead; Peppercorn trees and olive trees badly affected by overspray; $50,000 of lucerne badly affected; and Fruit trees affected.	Complaints received relating to negative affects to flora/fauna after spraying of pesticides, included Trees along the road dying; Garden plants wilting after neighbour sprayed cotton; Six trees killed after neighbour sprayed cotton; Several beekeepers complained of dead and dying bees; one resident noted a lot of dead bees on her outdoor furniture after spraying in her area; Crayfish in dams dying; Hundreds of dead and dying carp and other fish in the Gingham River, near Gwydir River; Two separate incidents of fish kills in Moomin Ck; Several people commented that their cattle had been contaminated with endosulfans; Several people commented that they were concerned for their cattle after noticing spray drift entering their properties.	Many people complained of pesticide odour/spray drifting into houses, sometimes through air conditioning units, forcing them to lock all doors and windows, turn off air conditioning, and not go outside; Many people complained about operators spraying in strong wind/ inappropriate weather conditions; A few people complained that their neighbours had not notified them prior to aerial spraying; A couple of people complained that workers in fields had been sprayed by aerial operators who were spraying other fields; One lady claimed to have been sprayed when in her own yard; One person complained of unsafe use, storage and disposal of chemicals on their neighbour's property; Two people complained about overspray landing on their cars while they were driving on road; Two people given a 'Round-up' spraying job by a cotton and spray-rig contractor came home with burning eyes and skin and running nose. Caller complained that directions and safety gear were inadequate; One person expressed concern about the possibility of aerial pesticide spray depositing into water tanks on roofs of houses.

Table 7: Summary of NSW EPA complaints register, for selected cotton districts, relating to pesticide spray practices

The majority of growers inspected were practicing good spray management techniques. Although the number of complaints is declining, the significant number still received by the NSW EPA indicate that there may be poor performers in the industry and their actions can bring the whole industry into disrepute. (It must be noted that there may be multiple calls from individuals recorded; lack of investigations by the EPA to substantiate all complaints; and currently there is no differentiation made by the NSW EPA between complaints made specifically regarding cotton, and those concerning spray activities on other crops. However, most of the complainants specifically mentioned cotton.)

An issue associated with complaint compilation in Queensland is that complaints are not always directed to the EPA. Anecdotal evidence suggested that complaints are directed to:

- Local councils;
- Department of Primary Industries,
- Department of Health; and
- Cotton Australia and other extension officers.

> ***Recommendation 20:*** It is recommended that:
>
> - Complaints from all cotton growing areas be collated on an annual basis, analysed and used as a performance indicator; and
> - 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.

There is some disparity in spray management practices conducted by other agricultural sectors, which do not have rigorous guidelines for spray applications. Some cotton growers have reported being affected (crop damage, loss of beneficials) by sprays from adjacent, non-cotton farms. In one recent incident, it was reported that spray drift of the pesticide 2,4-D from a neighbouring wheat/cotton farm caused widespread cotton damage. There have been a number of other recurring problems with cotton being damaged by herbicides. New legislation requiring reporting of all pesticide uses may help to track problems with pesticides from non-cotton farms.

4.8.2 Prosecutions

There have been few prosecutions in relation to poor spray practices in the last ten years.

None of the farmers inspected reported receiving any fines, penalties and/or environmental improvement notices from local or state authorities. This was confirmed by industry personnel, searches of legal databases, EPA information and media articles. Available information indicates that there has only been one recent prosecution: on 19 February 2000 an aerial spray pilot applied a mixture of insecticides on a property near Mullaley, NSW. Two people were working at the property at the time drilling a water bore. Spray drift made contact with their eyes and skin, causing acute symptoms. (Penalty $2,250)

4.8.3 Odours

The growers inspected reported few complaints with respect to odours in recent years, mainly from improved practices such as:

- Use of deodorizer whenever odorous chemicals are used;
- Avoiding or minimising the use of odorous chemicals (such as profenofos); and
- Establishing pre-season communications with neighbours regarding areas planted to cotton and areas to be sprayed.

However, the EPA receives a substantial number of complaints each year relating to odour – refer to Table 7 above.

The use of weather stations to monitor wind conditions during spraying operations is recognised as a useful initiative to address spray drift and odour issues. Beyond providing data to minimise potential for spray drift during operations, historical records of conditions can be reviewed to determine links between spraying events and reported odour and spray drift complaints or issues.

4.8.4 Fish kills

NSW Fisheries maintains a database of incidents where dead fish are observed in waterways (fish kills) in NSW, with records dating back to the 1970s. Over the last 20 years, no cause was determined for 47% of the fish kills reported (Lugg 2000). Where a cause could be traced, the main causes were low dissolved oxygen levels (14%), pesticide/ chemical pollution (8%), acidic runoff (4%), high or low temperatures (3%) and sewage pollution (3%). Not all the pesticide incidents were related to the cotton industry.

The 1991 audit of the cotton industry reported there was a reasonably high incidence of fish kills in the late 1980s, some of which were directly attributable to the cotton industry. From the 1985/86 season to the 1990/91 season (that is, prior to the last cotton industry audit) there were 67 reported fish kills of which the majority were possibly from spray drift, not all cotton related, or tailwater runoff from cotton farms (LWRRDC 1996). Since the last industry audit in 1991, there have been fewer reported incidences of fish kills attributable to cotton industry activities. From the 1991/92 to 1994/95 seasons, there were 15 reported fish kills. Not all of these were due to cotton pesticides – some were due to discharges from sewage treatment plants, ash run-off after bushfires or other causes of oxygen deprivation.

NSW Fisheries records indicate that from the 1995/96 to 2001/02 seasons, there were 26 fish kill incidents in the Macintyre, Moonie, Gwydir and Namoi River Basins. Of these, eight were due to unknown causes, three were possibly due to pesticides and the remainder were mainly attributed to low dissolved oxygen or cold water stress. Not all of the fish kills were investigated.

It is clear from the NSW Fisheries records that the number of fish kills from pesticides have been reduced since the 1991 audit, due to changed industry practices. During this audit it was noted that a fish kill incident occurred adjacent to the Theodore Irrigation Area in 1997. The auditor was advised that a large number of operational changes had been implemented since the incident to prevent re-occurrence.

Fish kill incidents in cotton growing areas have been widely reported. Poor past practices which have resulted in fish kills, odour complaints, and health effects remain in the collective public memory for a long time. It is difficult to change such perceptions and attitudes, despite changed practices in the cotton industry and improvements in farm activities which have reduced environmental impacts.

4.8.5 Access of cattle

There was some concern with access of cattle onto cotton farms, as they may consume crops which have been sprayed, or drink on-farm tailwater which may contain pesticides. This situation may occur where property fences have not been maintained, particularly along Travelling Stock Routes. The auditors were advised by cotton industry personnel of incidences of cattle straying onto cotton farms. The auditors observed two instances of cattle on cotton fields – one on a farm inspected and one during travels around the cotton valleys.

The auditors understand that it is the legal responsibility of the drover/ grazier to ensure that cattle do not stray onto other property. However, if wandering beef cattle become contaminated with pesticides, it could be argued that the cotton grower was in breach of their duty of care if fence-lines are not maintained. This has not yet been tested in court.

> ***Recommendation 21:*** It is recommended that access of cattle be restricted by adequate boundary fencing for cotton farms adjacent to Travelling Stock Routes or graziers. The state of fence-lines should be evaluated in the BMP self assessment worksheets, Land Management module.

4.8.6 Health effects

A study on the health and safety risks associated with cotton production conducted by the Australian Agricultural Health Unit (Brown et al 1997) indicated that chemicals were associated with only 6 out of 269 accidents/ injuries.

A National Farm Injury Data Centre report (Franklin et al 2001) indicated that 3.1% of injuries on cotton farms were associated with "long term contact with chemicals or substances". (The information was based on compensated injury/ disease data for people employed in the Queensland cotton industry between July 1992 and June 1999).

A review was recently undertaken by the Australian Academy of Technological Sciences & Engineering of pesticide use in Australia (Radcliffe 2002). The report addressed current trends, particularly since 1994-5, in the use and methods of application of pesticides and the impact of pesticides and their residues on community health and on the environment. Adverse health effects experienced by workers due to pesticide exposure were reported, however, data does not differentiate between effects from cotton pesticide practices and other industries' pesticide practices.

Currently there is no complete, nation wide reporting system that provides an indication of the number of cases of pesticide related health effects experienced by workers using pesticides in Australia. Similarly little information is available on chronic or long-term effects of pesticides in Australia. A number of follow-up studies of workers previously exposed to pesticides are, however, being undertaken.

Pesticide exposure in the community is monitored by the National Residue Survey of pesticides in food, the Australian Total Diet Survey and rainwater tank surveys. The levels of pesticides identified in surveys of food eaten are well below the statutory limits and pose no health risks (AATSE 2002).

Workers and the general public may be exposed during spray activities. Short-term health problems such as nausea, stinging eyes, headaches have been reported (refer to Table 7). These symptoms may be more severe in sensitive individuals.

There have been articles in the media regarding health effects of pesticides (for example, "Copping a Spray", SMH, 18/1/03). However, health statistics collated by AATSE in 2002 do not reflect the levels quoted in the SMH article.

The auditors do not have further recommendations to supplement those already made in the AATSE study.

4.9 Other chemicals

The following sections (4.9 and 4.10) relate to most agricultural activities, not just to the cotton industry, and have been included for completeness. The main chemicals used on farms, apart from pesticides, were petrochemicals (fuels and oils) and fertilisers.

Improved practices

Improved practices since the 1991 environmental audit included:

- A new section of the BMP manual on the "Storage and Handling of Petrochemicals" was distributed to growers in January 2003;
- Most growers had prepared an inventory of the pesticides used on site and held corresponding MSDSs;
- A number of growers have taken the initiative and commenced a program of bunding all fuel tanks on their properties, commencing with those tanks most likely to impact on waters if spillage occurred;
- At larger farms, diesel tanks were located in bunded areas (earthen, concrete-lined or brick bunds) and
- Oil storage was generally noted to be undercover, on sealed areas where spills could be controlled.

A notable initiative observed on one Queensland farm was the supply of oil in large custom-made, reusable, heavy-duty steel containers. These containers have been designed to allow handling with forklifts. These containers minimise the generation of waste 205 litre drums and their robust construction minimises the potential for spillage caused by failure of containers.

Farm personnel indicated that they had sought additional guidance on how to improve the management of chemicals and fuels. The recently produced "Storage and Handling of Petrochemicals" BMP module should assist growers to self check and improve their storages.

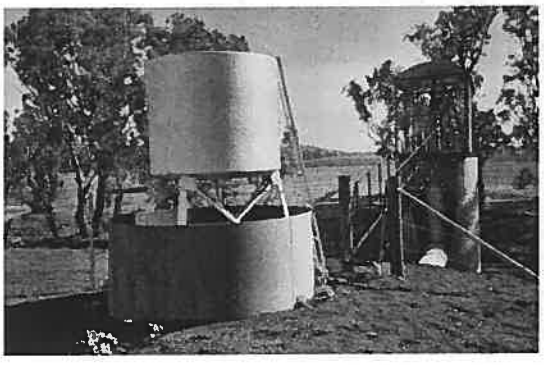


Photo 16: Bunding around diesel tank on creek bank

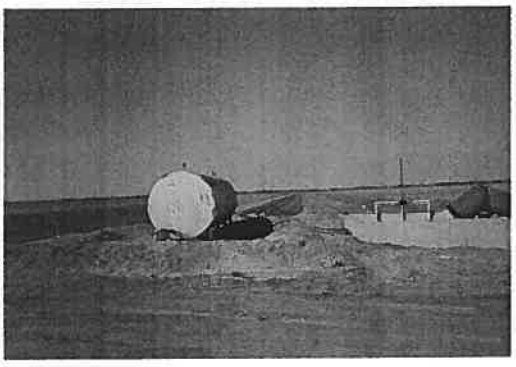


Photo 17: Earthen bunding around diesel tank adjacent to water distribution channel meets Australian Standards

Photo 18: Oil in custom-made reusable heavy-duty steel containers

Areas for improvement are discussed in the individual sections below.

4.9.1 Inventory

Chemical inventories did not include all the chemicals stored and used on site such as diesel, petrol, paints, solvents, kerosene, anhydrous ammonia, LPG, welding gases, oils and greases. MSDSs were not available for all these chemicals. Employers must ensure that MSDS are readily accessible to any employee who could be exposed to the substance. This is a legislative requirement under the NSW Occupational Health and Safety (Hazardous Substances) Regulation and the Queensland Workplace Health and Safety Regulation 1997– farms are not exempt.

Farm maps normally indicated the pesticide store but not storage areas for fuels and chemicals (such as anhydrous ammonia fertiliser, which is classified as a dangerous good).

Recommendation 22: It is recommended in respect of other (non-pesticide) chemicals that:

- Chemical inventories be expanded to cover all the chemicals and fuels used on site, and corresponding up-to-date MSDS be obtained; and
- 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.

4.9.2 Licensing

There was a lack of awareness of the quantities of fertilisers and fuels kept on site that required a Dangerous Goods licence. At some farms visited in NSW, threshold quantities were exceeded and, therefore, a licence is required. For example, at one farm 50,000L diesel was stored in an above-ground tank, which would require a dangerous goods licence from WorkCover. Licence requirements are briefly mentioned in the BMP manual.

Recommendation 23: It is recommended that in NSW, 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.

4.9.3 Diesel storage

Most farms visited continue to use above ground, elevated diesel storage tanks with no bunding. In many cases, diesel storage does not comply with current Australian Standards, the NSW Dangerous Goods Regulation and/or the Queensland Dangerous Goods Safety Management Regulation 2001. Large storages, up to 50,000L were also unbunded. Minor spillage and staining was noted around the majority of diesel storage tanks. Some growers reported diesel spills of up to 1000L, which were absorbed onto the ground and allowed to degrade naturally.

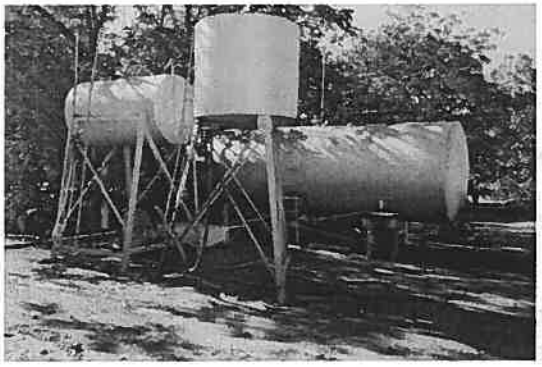


Photo 19: Lack of bunding or other protection measures around diesel and petrol tanks

Photo 20: Bund is too close to tank

AS1940 categorises diesel storages under 10,000L stored outdoors as a 'minor storage'. For minor storages on open land, AS1940 Section 2.3 (d) requires that '*a potential flow of spillage is prevented from reaching a ..... watercourse or property boundary by such means as the use of a natural ground slope, or the provision of a diversion channel, kerb or bund*'. BMP guidelines state that Queensland farmers are exempt from AS1940.

Diesel-driven pumps were primarily used for water pumping on irrigated farms. Diesel storage tanks, located adjacent to water pumps along rivers or creeks, were not generally bunded. Any leaks from pumps and storage tanks would flow to the creek, which represents a high risk of harm to the environment. On-farm diesel tanks were also not generally bunded, so spills could flow to the water distribution channels and contaminate the supply. Some of the diesel tanks may also be located in flood prone areas.

Photo 21: Lack of bunding around fuel storage adjacent river

At larger farms, with bunded diesel tanks, removal of water collecting in bunds may be a problem as there were sometimes no pump-out facilities available.

It was noted that a number of bunds observed have design faults that should be rectified prior to construction of additional bunds, to provide greater protection to the environment. This includes the bund walls do not intersect a 60^0 line from the top of the tanks to ensure that fuel/ chemical cannot discharge over the top of the wall (requirement of AS1940).

A number of bund walls were constructed of cement besser blocks. This is allowed under AS1940. However, the auditors observed at five fuel compounds that fuel spills had not been cleaned up quickly and fuel had bled through the porous blocks.

There was a lack of fire extinguishers or other protection measures around fuel tanks and this should be rectified. AS1940 sets out the requirements for fire protection facilities. There was also a lack of emergency procedures to cover fuel spills and fire. Emergency procedures, which have been developed for pesticide storage areas, should be extended to cover petrochemical storage and handling.

Diesel storage areas often did not have appropriate (or any) signage. In one case a 50,000L diesel tank was incorrectly labelled as petrol.

Underground fuel storage tanks were uncommon, but at least one that was greater than twenty years old was noted. The condition of the tank was unknown. It is recommended that when installing new tanks, aboveground diesel tanks should be installed in preference to underground tanks. Tank integrity testing using an experienced pressure-testing contractor may also be considered for tanks greater than twenty years old. A number of above-ground tanks were noted to be rusting, so tank integrity testing should be considered.

Recommendation 24: It is recommended in regard to diesel storage that:

- 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 tank;
- Fire extinguishers or other protection measures be provided around large, permanent diesel tanks, in accordance with AS1940;
- Emergency procedures should cover petrochemical storage and handling;
- Growers need to ensure that signage is correct on all fuel installations (guidelines are given in the BMP manual);
- Aboveground diesel tanks be installed in preference to underground tanks; and
- Conduct tank integrity testing for underground tanks greater than twenty years old and rusting or damaged above-ground tanks.

4.9.4 Petrol storage

Petrol was stored at the majority of farms. Poor practices observed included:

- Petrol storage areas often did not have appropriate signage, either on aboveground tanks or around fuel dispensing areas;
- Above ground storage tanks did not have any bunding or means of preventing a spillage from escaping to a watercourse;
- Fuel dispensers were not locked and/or tanks were not kept in a secure area;
- Old and rusting tanks were observed; and
- There was a lack of tank integrity testing or reconciliation of fuel records for underground tanks to determine if there were fuel losses by leakage.

At least two of the farms inspected are known to have old underground petrol tanks, which have not been correctly decommissioned. The two growers indicated that they were not aware of the requirements for decommissioning. The BMP manual only briefly covers what to do with abandoned tanks and further guidance would be valuable to growers.

Recommendation 25: It is recommended in regard to petrol storage that:

- 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; and
- Tanks requiring decommissioning be pumped out and gas freed, then either dug up, crushed and tipped at an approved site of filled with an inert substance such as sand in accordance with (AS1940, WorkCover and API Guidelines).

4.9.5 Oil storage

Oils are classified as combustible materials. Under AS1940, up to 5000L of oils in farm workshops and 10,000L in outdoor areas are considered as "minor storage". There is no strict requirement to bund the storage, however, provision must be made to prevent any spillages from reaching a watercourse or property boundary. Under both Queensland and NSW legislation, it is an offence to pollute waters. The NSW POEO Act also states that it is an offence to cause a substance to leak or spill in a manner that harms or is likely to harm the environment. Therefore, growers need to assess the environmental risk of their oil storage areas and provide appropriate protection measures.

Storage conditions for oils varied between the farms inspected. At a number of storage areas, oil drums were stored on the dirt floor of a shed (one deliberately to absorb spills onto the ground rather than staining concrete areas). Oil was also observed stored in unbunded, unsealed, external areas. One storage was observed in a tin shed with wooden floors – it is not appropriate to store combustible materials on wooden floors. Also, oil could leak through gaps between floorboards.

Photo 22: Oil drums stored in workshop on dirt floor

Recommendation 26: 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.

4.10 Waste management

4.10.1 Container disposal

Improved practices

During the 1991 audit it was noted that disposal of empty chemical containers was not adequate, with most containers buried on site. Improved practices include the provision of the drumMUSTER container recycling program and use of reusable containers.

DrumMUSTER is a national scheme, introduced across Australia in 1999, for the collection and recycling of non-returnable containers. Clean containers carrying a drumMUSTER sticker can be taken to a collection point arranged by the local council. Some larger growers have arranged for drumMUSTER to collect non-recyclable containers directly from their property.

Over 3 million non-returnable crop and veterinary chemical containers have been collected since the program was launched in 1999. In NSW for 2001-2002, 29% of drums were returned in NSW and 17% in Queensland. 2% of the drums were rejected by drumMUSTER, due to damage or lack of cleaning (drumMUSTER 2002). The largest number of drums within Australia was collected in the Moree Plains Shire area (91,744 containers, equivalent to 203 tonnes of waste recycled) for 2001-2002.

Farms inspected used a range of reusable chemical and pesticide containers, "envirodrums" and bulkiboxes, as well as solid chemicals in plastic-lined cardboard boxes. Clean triple-rinsed containers were returned to the supplier where possible, or taken to a drumMUSTER collection point.

The majority of farmers indicated that they would prefer chemicals to be available in reusable containers. The availability of these containers was generally determined by the manufacturers and sometimes suppliers. The industry should work closely with chemical manufacturers and suppliers to maximise the availability of chemicals in reusable containers.

Returnable containers were readily observed on the properties inspected. Non-reusable containers were also observed. The farmers report that these cannot be avoided as:

- Many chemicals are only available in disposable containers; and
- Operationally, smaller containers are better suited to activities on site (such as field mixing of chemicals for ground rig operators) or due to the quantities required.

Non-reusable pesticide containers were generally removed from site via the drumMUSTER program where possible. Where drumMUSTER services were not adequate, growers have fenced off areas to store the containers and periodically took the clean containers to a local council operated landfill or continue to stockpile them until a viable off-site disposal becomes available.

Clean (triple-rinsed) herbicide drums were quite commonly used as floats for trash screens around irrigation pumps and as markers on several farms.

Areas for improvement

It was noted by growers that drumMUSTER failed to deliver adequate services in some areas, such as in the Macquarie and Namoi Valleys, due to a lack of regular services or insufficient notice of collection times. It was also noted that not all chemicals and pesticides commonly used on farms were covered by the drumMUSTER program (such as "Hot Up" spray adjuvant and "Biopest paraffin oil"). Therefore, farmers have to dispose of some containers by alternative means.

Old, dirty or damaged containers may not be accepted by drumMUSTER and were observed (at approximately 40% of the farms visited) stockpiled on site or in on-farm tips.

Photo 23: Old & damaged containers awaiting disposal

Photo 24: Good storage of empty containers in cages

Prior to drumMUSTER, containers were disposed of primarily by burial on farm or at a shire tip (DLWC 1996, 1997). At least four of the growers visited continue to dispose of containers in tips on their property, however, the auditors were advised that all containers are triple rinsed before disposal. One grower advised that disposal on-site is the only viable option due to the remoteness of the property. Another grower disposes of containers on the property as this the most practical option – the grower has tried drumMUSTER but was not satisfied with the service and did not consider it to be a viable option. Another had traditionally disposed of containers at the farm tip for many years. Two growers indicated that they crushed drums/containers and burned wastes to reduce volume.

Cardboard boxes from solid chemicals were generally burnt on-site. Incineration of wastes is not acceptable.

Recommendation 27: It is recommended in regard to waste pesticide containers that:

- The cotton industry work closely with chemical manufacturers and suppliers to maximise the availability of chemicals in reusable containers;
- Growers be discouraged from burying containers on site by providing alternative means of disposal, if viable. DrumMUSTER should be encouraged to provide regular services to cotton growing areas and to provide adequate notification of services;
- Growers ensure that containers are adequately cleaned and sent to drumMUSTER as soon as possible so that they do not accumulate on sites; and
- BMP audits include a check of evidence that chemical containers have been returned to drumMUSTER.

4.10.2 Workshop wastes

Improved practices

Most farmers advised that waste oils were periodically collected by waste oil recycling companies for reprocessing, either direct from the farm or a central collection point, such as a garage/ mechanical workshop at the local town. Some farms in more remote locations had stockpiled minor volumes of waste oils.

It was noted that a central Queensland council landfill had developed a purpose-designed area for diversion and collection of waste oils, therefore providing another option for management of waste oils.

Clean 200L steel drums were used for storage of parts in workshops or as garbage bins. Smaller 20L oil drums were disposed of at local Council tips or on farm tips.

One grower had, as part of a BMP action plan, intentions to upgrade the waste storage area including full enclosure and bunding.

Only larger workshops had parts washing facilities which use solvents. The wash unit supplier was responsible for collection and disposal of spent solvent.

Scrap metal wastes that could be recycled included pipework, sheet metal, wire, car bodies and clean 200L drums. These wastes were observed stockpiled on site (awaiting infrequent collection).

Areas for improvement

Storage and disposal of workshop wastes was typical of agricultural enterprises and was not always satisfactory. Waste oil collection areas were generally unbunded and showed evidence of past spillage and soil contamination. Waste oil drums were observed to be unlabelled, rusting or otherwise in poor condition at some farms. Spill kits were not always available.

It was not clear from site inspections and interviews how all farmers disposed of waste oil. At least one farmer admitted to dumping waste oil at the local Council tip. Waste oil was used at two farms around power poles for termite protection and at another for dust control on roads. These practices result in land contamination and potential water pollution and must be avoided.

Poor management of spent oil filters was noted at one farm, with oil leaking onto the adjacent ground.

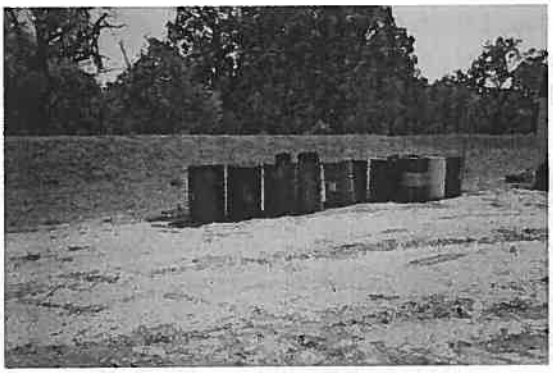


Photo 25: Waste oil stored unbunded in open

Photo 26: Waste oil collection tank

Batteries were stored at some farms awaiting disposal (via charity collection systems). Battery recycling facilities are limited in some areas and it is unknown how batteries are disposed of. These were often stored adjacent to workshops in exposed and unbunded areas. Batteries can leak acids and should be stored in bunded areas.

NSW and Queensland country areas are not well serviced for recyclable materials generated on farms, such as glass and paper, and hence these are not commonly recycled.

Recommendation 28: It is recommended in regard to workshop wastes that:

- Waste oil be collected and sent for reprocessing. Waste oil must not be dumped at landfills or used for dust suppression or termite protection;
- In more remote areas, farmers could coordinate a periodic oil collection with a recycling contractor, where an oil collection vehicle could visit a number of farms when an agreed volume of waste oil was available for collection;
- Waste oils/ oil filters be stored as for fresh oils in appropriately bunded, covered, ventilated areas, with correct signage and spill kit; and
- Old batteries and scrap metal be recycled wherever possible, with the former stored in bunded areas, while awaiting disposal.

4.10.3 Evaporation pits

Improved practices

Wherever possible, pesticide containers were triple rinsed, with rinse waters directed into the spray tanks and then sprayed onto crops with the bulk of the spray. Where this was not possible, or at bulk chemical use areas, evaporation pits were commonly used for disposal of washings from pesticide containers.

Most pits were fenced, secured and had appropriate signage.

Areas for improvement

Evaporation pits were observed to be mostly unlined. Where pits had been lined with on-site clays, the permeability of the pond had not been tested. Therefore, there is no certainty for most sites that rinse water is

not leaking from the pond and causing contamination. Lining of all evaporation ponds with a thick plastic liner over a clay base is recommended. The cost of an adequate liner is negligible compared to the potential future cost of any remediation activities. Guidelines for the disposal of pesticide residues in evaporation pits are included in the BMP manual.

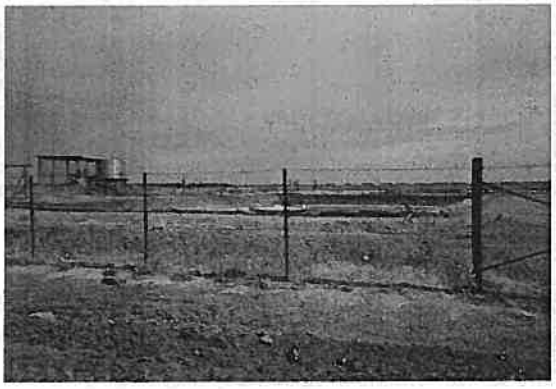


Photo 27: Securely fenced and lined evaporation pit

Photo 28: Fenced, unlined evaporation pit

Photo 29: Unfenced, unlined evaporation pit

Photo 30: Unfenced, unlined evaporation pit containing milky substances

Seven farms were observed with evaporation pits. Five of the farms did not meet the industry's BMP requirements - there was either a lack of fencing or signage, and/or unlocked gates.

A number of farmers had container washout areas, which drained uncontrolled onto adjacent areas. One grower had a sealed wash area for container washouts that couldn't be practically rinsed into the bulk spray tanks during a spray run. This drained to a vegetated area away from waterways or drainage areas.

Recommendation 29: It is recommended in regard to evaporation pits that:

- All wastewater, from chemical washout areas, drains to a controlled area, such as an evaporation pit;
- Evaporation ponds be sealed (such as with a thick plastic liner over a clay base); and
- All pits be securely fenced, kept locked and have appropriate signage.

4.10.4 On farm tips

This section relates to most agricultural industries which have on farm tips, not just to the cotton industry, and has been included for completeness. On farm tips are used for the disposal of inert and solid wastes generated on the farm.

The NSW POEO Act allows for the disposal of up to 5000 tonnes per year of solid/ inert waste on farms in unlicensed landfills. Farm tips are not directly covered by the Queensland Environmental Protection Act as they don't meet the threshold of 50 tonnes per year for an environmental licence. Irrespective of whether a tip needs a licence, farmers need to ensure that tip sites do not cause water pollution (surface and groundwater) or air pollution from burning of wastes.

Photo 31: On farm tip includes herbicide containers and steel drums

Photo 32: On farm tip with recyclable materials near a watercourse

Improved practices

The use of on farm tips for all waste types was observed to be less prevalent than noted in the 1991 audit. Most tips were used for disposal of inert and solid wastes only and were not used for disposal of pesticide containers (exceptions are noted below). The auditors did not observe the disposal of any containers of solid or liquid pesticides in farm tips. Tips were generally located in suitable locations, except for those areas noted below.

Areas for improvement

On farm tips are still being used for the disposal of chemical containers and other wastes at some sites. Observed poor practices were:

- On farm tips were not always clay lined;
- Records were not kept of what is disposed;
- One farm had constructed a water storage pond around an old tip site – exposed wastes were visible in the dry storage pond;
- Tips were observed to be located close to creeks and rivers, in flood-prone areas or in water surge/collection areas at four sites;
- Old chemical containers, oil drums and oil filters were observed in tips;
- Wastes in tip sites were sometimes burnt or incinerated;
- The locations of tip sites were rarely shown on site maps; and

- One tip has been in use for over 50 years.

A wide range of readily recyclable materials was observed in farm tips including scrap metal, corrugated iron, wire and car bodies. Building wastes, which could be reused for erosion control around embankments, were also observed at farm tips.

> ***Recommendation 30:*** It is recommended that guidelines be provided via the BMP manual for siting, design and operation of tip sites. These should be based on existing established guidelines such as the NSW EPA guidelines "Environmental Guidelines: Solid Waste Landfills" (1996).

4.11 Land management

Effective land management is a key component to sustainable cotton production and to ensure that potential environmental impacts are minimised.

The cotton industry has invested considerable research into minimising erosion, avoiding soil compaction, ensuring good soil structure and nutrition, and management of potential salinity problems in cotton growing areas. The results of research have been implemented across the industry and improved practices were evident at the farms inspected during the audit.

In addition, guidelines for sustainable land management for the cotton industry have been produced. (A land and water module of the BMP manual is currently in draft form, which provides practical natural resource management guidance to farmers.)

4.11.1 Sustainable development

The cotton industry is developing a comprehensive natural resource management program in order to ensure the sustainability of the industry. Currently, trials are being conducted at ten cotton farms to identify natural resource management issues relevant to cotton farms and to assess how management practices contribute to the achievement of catchment objectives.

There has been recent debate regarding rewarding farmers for environmental stewardship, that is, compensating farmers for actions taken over and above their legal requirements. The Wentworth Group of prominent scientists have stated that landholders who take additional environmental precautions, such as encouraging conservation of remnant vegetation, should be compensated for those services (Williams 2003). The cotton industry has been recently actively addressing land management issues, and some form of financial encouragement may enhance the uptake of Best Management Practices.

4.11.2 Stubble management

Improved practices

The majority of growers inspected indicated that cotton stubble was normally slashed and incorporated into soil. This is confirmed by the cotton industry benchmark survey (ACCRC/CRDC 2002). Others practiced pulling out the stubble, mulching and then incorporating into soil. No farms visited indicated that they pulled, raked and burnt cotton stubble.

Cotton farmers formerly allowed grazing on cotton stubble. However, since the Helix scare where beef cattle grazing on stubble or fed cotton trash were found to have persistent pesticide residues, grazing has ceased.

Areas for improvement

"Rake and burn" is still being used in some areas. The cotton industry benchmark survey (ACCRC/CRDC 2002) indicates that: 8% of growers use this technique, predominantly in the Macintyre, Darling Downs and Balonne areas; 64% slash and incorporate cotton stubble; while 31% pull, mulch and incorporate.

4.11.3 Erosion

Improved practices

Growers use a number of means of controlling erosion in water delivery and tailwater collection channels, including use of rocks, concrete blocks, recycled concrete/ bricks from demolitions, tractor/ car tyres and the use of concrete sills in drains to prevent silt being washed from fields to distribution channels.

Erosion in the channels was minimised by using low grades and slow water velocities.

Erosion around water storage areas was controlled using grassed embankments or vegetation such as reeds and water plants (although there was a lack of grass or vegetation noted in some areas due to the drought).

Farms in flood-prone areas were surrounded by levee banks to minimise damage and erosion problems.

Erosion in the cotton fields was controlled by using laser-levelled fields (common practice), zero or minimum till, planting direct into wheat stubble, and prevention of stormwater run-on to fields using contour banks. Of the farms visited, soil erosion from fields is not a significant problem.

Potential erosion problems appear to be adequately managed at the majority of farms.

Photo 33: Concrete headwalls for erosion control

Photo 34: Concrete sills on drainage channels to prevent soil wash-off from fields

Photo 35: Recycled building materials used around irrigation channels to minimise erosion

Areas for improvement

Severe degradation of irrigation channels was observed on one farm where cattle had gained access to the cotton fields. The sides and base of the channel were churned up from the cattle. (Note that the presence of large numbers of kangaroos and emus observed at five cotton farms, probably trying to access water during the drought, did not appear to cause significant damage to the channels or field areas.)

On a small number of farms (5 out of 28 irrigated farms), considerable erosion (wave marks, slumping and rills) was noted in some distribution channels.

4.11.4 Soil compaction and condition

Improved practices

Ensuring good soil structure is a key to sustainable farming practices. Measures observed on farms to minimise soil compaction included:

- Use of zero or minimum till normally, by maintaining permanent beds;
- Planting rotation crops such as wheat;
- Controlled traffic (limiting compaction to set tracks);
- Avoiding traffic on wet soils;
- Using crop rotations, to penetrate compacted layers of soil and improve soil structure;
- Use of Roundup Ready cotton (resulting in fewer passes for herbicide spraying and less cultivation, hence less compaction); and
- Use of SOILpak for managing soil condition.

The cotton industry benchmark survey (ACCRC/CRDC 2002) confirmed these practices were used.

Measures used on the cotton farms to improve soil condition included:

- Routine physical checks of soil structural condition;
- Annual soil tests on irrigated paddocks for nutrients, and appropriate fertiliser use;
- Soil conditioning with gypsum or lime;
- Planting nitrogen-fixing rotation crops; and

- Incorporation/ mulching of trash into soil to improve the organic content.

Growers generally relied on the advice of qualified agronomists regarding soil compaction and condition, and generally well managed on the farms inspected. The majority of growers interviewed were aware of measures to be taken to minimise soil compaction.

Soil spatial prediction modelling and mapping techniques have been recently investigated and improved (Odeh & McBratney 2000). Work has been undertaken to produce a soil database for the cotton growing regions in eastern Australia (McBratney 2000, Odeh et al 2002). Soil information has been mapped to enable planning of land utilisation in accordance with its capacity and to allow growers to improve farming practices. Organic carbon, total nitrogen and phosphorus, pH, conductivity, clay content and other parameters have been measured and mapped. GIS maps have been produced for the three main valleys where cotton is produced – the Macintyre, Gwydir and Lower Namoi. The information can result in improvements to farming practices and on-farm management decisions. Information collated and entered in GIS format can aid in total land management.

4.11.5 Salinity

In the Murray-Darling Basin area, inefficient irrigation practices have resulted in the creation of perched water tables, waterlogging, rising water tables and salt mobilisation. Point source salinisation and water logging are evident in irrigated cotton-growing districts in the lower Macquarie Valley near Trangie, Upper Namoi south of Gunnedah, lower Macintyre Valley west of Goondiwindi and at Bourke near the Darling River (Triantafilis 2001).

The common cause of degradation is deep drainage or excessive groundwater recharge, resulting in the mobilisation of salts from rising water tables. Soil salinity problems can also arise from the application of poor quality saline water.

The cotton industry benchmark survey (ACCRC/CRDC 2002) indicated that 12% of growers had a problem with salinity (mainly in the Macintyre, Macquarie, Emerald and upper Namoi areas) and 6% with rising water tables (mainly in the Dawson Callide region).

Improved practices

Extensive research has been conducted on understanding, measuring and mapping the salinity threat in irrigated cotton growing areas (Odeh et al 1998, Triantafilis 2001). Electromagnetic sensing systems and soil surveys have been conducted in each of the major cotton-growing areas of the lower Namoi, Macquarie and Gwydir valleys in NSW and the Macintyre valley in Queensland. Of the districts studied, Bourke contained the largest amounts of soluble salts within the top seven metres, followed by Gunnedah, Trangie, and Warren, then Toobeah, Ashley and Wee Waa (Triantafilis 2001).

Maps which show the areas of greatest risk of excessively deep drainage have been produced for the lower Gwydir and Macquarie valleys. These maps can be used to assist growers in siting (or relocating) water storages and distribution channels.

Salinity Hazard Maps were developed by the Queensland Department of Natural Resources and Mines in 2002 to identify areas with potential to develop salinity problems in the longer term unless land management changes are made. These maps were based on characteristics of landscapes and were not intended to replace on-ground, local or site-specific environmental impact assessments. However, some areas

surrounding St George, Dirranbandi, Goondiwindi and Emerald were identified as possessing moderate-high and high salinity hazard.

Photo 36: Area affected by salt scalds

Most farms inspected conducted annual soil tests of irrigated cotton fields, including for salinity. On some farms, electromagnetic sensing surveys had been conducted to detect the extent of soil salinisation. Routine monitoring of groundwater levels (every quarter) via piezometers were conducted across a farm in the Macquarie area. A farm in the Dirranbandi area had commissioned consultants to develop a detailed salinity management plan. Plan development was underway at the time of the farm visit. Part of the investigation phase of the plan involved the installation of 21 piezometers to gather groundwater data. However, on-farm testing of salinity indicators was not extensive in all potential problem districts.

It was noted that one smaller grower had purchased a conductivity meter for testing salt levels in irrigation water.

Areas for improvement

Applied water can pick up salts as it travels across the fields. Evaporation in storages can also contribute to elevated salt levels. In general, there was a lack of water quality testing for conductivity (salinity) and sodicity for irrigation water. Even on larger farms, routine testing of applied water was not common. It is recommended that routine conductivity tests be conducted at farms where there is potential for salinity problems.

During the audit, salt scalds were only noted on one farm where a leaking reservoir had affected approximately a 50 metre wide strip along adjacent cotton fields. A high water table was noted at two other farms, which resulted from a leaking off-site irrigation scheme channel, however, the channels have now been remediated.

> ***Recommendation 31:*** It is recommended that on-farm testing of salinity indicators, including routine conductivity tests of irrigation water, be increased in potential salinity problem districts.

4.11.6 Contaminated Land

Historical use of some farms has resulted in areas of potentially contaminated land. These uses are generally limited to cattle and sheep dip sites, chemical storage areas and old landfills. The areas of some larger Queensland farms have been expanded over time with the purchase of additional adjacent and/or local properties. This can result in a number of these sites occurring on individual farms.

Improved practices

One farm in NSW had an old sheep dip site cleaned up, but testing was not undertaken. One farm in Queensland had fenced off a known cattle-dip site to prevent access.

Growers who had potentially contaminated areas were aware of the locations, although sites were not documented.

Areas for improvement

None of the growers interviewed with potentially contaminated sites had undertaken contamination testing of the area.

> ***Recommendation 32:*** It is recommended that guidelines be provided via the BMP manual for the identification and management of potentially contaminated sites.

4.12 Vegetation management

4.12.1 Land clearing

Broad-scale clearing of remnant vegetation can have a significant impact on the sustainability of a property and may result in the loss of habitat, loss of native mammals, birds and reptiles, as well as contribute to soil loss, erosion and salinity problems.

Generally cotton farms only account for approximately 1-5% of the catchment area, across all cotton valleys. For example, in the Namoi catchment, dryland and irrigated cotton occupy 3.1% of the catchment, compared with 30.3% of the catchment land area used for cropping and cultivation (Namoi CMB 2003). Cotton farms range from fully cultivated to farms that have retained considerable areas of native vegetation.

In NSW, landclearing is controlled by the Native Vegetation Act (1997) and in Queensland by the Vegetation Management Act (2000).

Improved practices

Clearing activities on farms inspected in Queensland ranged from no clearing, to clearing of regrowth, to recent clearing of areas of remnant vegetation. Two out of twelve properties visited in Queensland had cleared 200 hectares for "land management" and 500 hectares for establishment of a new farm in the past 10 years.

Broadscale landclearing in NSW cotton districts is less prevalent than Queensland, however, clearing of remnant vegetation remains a concern in NSW. The majority of NSW farms inspected had not cleared any land over the past 10 years. On one property, 125 hectares was being allowed to return to bushland. A number of farms inspected in NSW had cleared some areas (up to two hectares per year, as allowed under

permit). One farm had cleared up to 120 hectares in the past 10 years. However, the growers reported that these areas were already heavily affected by previous clearing, grazing and other agricultural activities.

Most farmers (over 80%) had retained pockets of vegetation on their farms along roadways, around farm houses, adjacent to creeklines, farm borders and some areas which were not viable for farming. The vegetated areas, on most of the farms inspected, were small (less than one hectare) and the areas were sometimes in isolation. The areas contribute to visual amenity, shade, wind breaks, protection of riparian zones, spray drift buffers and/or maintenance of beneficial insects. The long term viability of small isolated pockets of native vegetation is reduced compared to larger linked corridors.

At approximately 20% of the 32 farms visited, growers had retained considerable areas of native vegetation, for example: 230 hectares (representing 15% of the farm area); 500 ha on another property (also 15%); and over 1000 hectares on one farm. Personnel at another farm advised that a target had been established for vegetation retention of 40% of farm area by the completion of planned farm development.

One farm had established a series of native vegetation corridors specifically for the purpose of facilitating native animal access to a natural lagoon and bushland. These corridors were fenced to prevent access to cattle.

One grower had an area of approximately 125 hectares dedicated as a Wildlife Refuge in conjunction with NSW NPWS. Out of the 32 farms visited, none had entered into Voluntary Conservation Agreements (or equivalent) for areas of remnant vegetation. A new tax incentive was announced by the Minister for the Environment and Heritage in March 2003 to entitle landholders interested in managing and conserving their land to tax incentives when joining a voluntary conservation agreement with state and local government agencies. The aim of this plan is to encourage people to enter into conservation agreements.

Native vegetation observed on farms generally appeared to be in a relatively healthy condition, given the widespread drought conditions.

There have been a limited number of studies on the effect of spray drift on native vegetation. One study (NSW Forestry, 1999) concluded that there was no physical evidence to support that spray drift from cotton defoliants had a significant impact on native vegetation adjacent to or within cotton growing areas.

Available data on terrestrial and aquatic vegetation in cotton growing areas has been summarised in a biodiversity research study (Reid et al, 2003). The study found that biodiversity of vegetation in cotton areas is important for soil health, natural pest control, prevention of soil erosion, water filtration and maintenance of groundwater levels.

Maps of broad vegetation categories and landuse have been produced as part of the cotton biodiversity investigations (Roth 2003).

Areas for improvement

It was observed that some areas of natural vegetation were heavily infested with weeds, such as boxthorn and burrs, which degrade the value of the area. Cattle had been allowed direct access to other areas of natural vegetation, particularly this season where stock has been desperate for feed during the recent drought.

Photo 37: Retention of native vegetation

Photo 38: Remnant vegetation around a cotton field

4.12.2 Tree planting

Improved practices

Most growers (over 60%) had undertaken limited tree planting around farms, particularly along roadways and farm borders and some along watercourses for bank stabilisation. Trees have also been planted to act as a visual screen around the farm. However, tree planting was not extensive on most farms visited (growers indicated that less than a few hundred trees had been planted).

Exceptions were: extensive tree planting observed on a Dawson Valley property (6,000 trees) in partnership with a local Landcare group and Department of Primary Industries; 2000 trees planted at Narrabri; and 4500 trees at a cotton farm at Warren.

Two cotton growers visited in Central Queensland were active members of local Landcare groups. Associated activities included tree planting and visits by school groups. Of the 32 farms visited across all cotton growing areas, thirteen growers participated in Landcare or other environmental/ catchment groups, with at least seven taking part in local tree planting projects, as well as on-farm tree planting. The current Chair of Landcare Australia is a cotton grower. The auditors were advised that the Macquarie growers were active members of Landcare.

Benefits of tree planting reported by farmers included environmental and other factors such as:

- Better bird habitat – birds using trees for nesting and food (insects and nectar);
- Effective drift buffers for adjacent graziers/ farmers/ towns;
- Control of waterlogging/ rising water tables;
- Protection/ restoration of river banks;
- Provision of shade for livestock;
- Visual amenity, particularly in flat cotton growing areas;
- Provides a good marker for the property for aerial sprayers; and
- Provision of wind breaks and reduced wind-blown dust.

A guide specifically on growing trees on cotton farms has been developed (RIRDC et al 1999). This guide covers: ways in which trees on cotton farms can provide benefits; the how, where and when of planting trees; the types of species that will grow in specific regions; and case studies of what worked or did not work from farmers' own experiences.

Recommendation 33: It is recommended in respect to vegetation management that:

- 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;
- Cotton growers be encouraged to retain and manage native vegetation on farms, consistent with relevant catchment-specific plans where available; and
- Cotton growers be encouraged to plant trees and native vegetation on farms.

4.12.3 Riparian zones

The density of riparian vegetation varies in different cotton growing areas. For example, riparian vegetation in the upper Namoi valley is extremely sparse compared to the lower Namoi (DLWC 1996, L&WA 2002). In the Gwydir Valley, west of the Newell Highway, timber cover in riparian zones is <3% (DLWC, 1997).

The majority of cotton farms inspected had cotton fields within a hundred metres of creeks or rivers. Data collected by the DLWC indicated that 50% of farms in the Macquarie Valley and 48% in the Upper Namoi had cotton fields within 300 metres of waterways (DLWC 1996). However, 69% of non-cotton farms were located within 300 metres of waterways. In the Gwydir valley, 48% of cotton irrigators had fields within 100 metres of a river or creek, compared to 40% in the Macquarie Valley and 30% in the Upper Namoi (DLWC 1997).

Improved practices

Discussions with growers and observations indicated that riparian zones on or adjacent to farms were generally managed by:

- Growing cotton away from the riparian areas;
- Growing Ingard cotton in buffer strips near creeks/sensitive areas;
- Preventing spraying near the riparian zones;
- Fencing off eroded areas and restricting cattle access;
- Encouraging grass cover on eroded embankments; and
- Control and removal of weeds.

An auditor was advised by personnel at one Queensland farm that part of their management plan included a commitment to providing a minimum 150 metre buffer of vegetation between all farmed areas and waterways, and rehabilitation of designated areas.

Guidelines for the management of riparian zones on cotton farms are currently being developed by Land and Water Australia and the CRDC. The guidelines cover management of stock, rehabilitation of lands and stabilisation of waterways, nutrient and sediment traps, weed control, use of agricultural chemicals adjacent

to riparian lands, management of farm runoff and river off-take facilities. These guidelines contain case studies, which will provide a resource for growers to effectively manage and improve riparian lands.

Areas for improvement

The improved practices described above were not observed on all farms with riparian lands.

Infestations of willows in some areas had choked rivers, altered the river alignment and caused severe erosion on opposite embankments. Erosion from past clearing practices was also evident along some creek lines, adjacent to or running through cotton farms.

It was noted that cattle were allowed access to riparian areas to eat vegetation on at least four farms. This was generally allowed due to the drought and the extreme shortage of feed and the auditors were advised that this was not a normal practice. However, a number of growers allow cattle agistment on their farms, or run their own cattle (17 farms inspected), and some allow uncontrolled access to creeks and rivers.

Growers also allowed access to riparian zones and rivers for stock watering, and no provision was observed for off-stream watering at the farms inspected. Whilst direct access to creeks/rivers is a common grazing practice, cattle access resulted in degradation of embankments, sedimentation in waterways, overgrazing of vegetation, introduction of weeds, and cow manure entering waterways. Access of livestock to rivers and creeks should be managed to prevent erosion and degradation of stream banks, avoid damage to vegetation and riparian habitat, and prevent pollution of watercourses.

Recommendation 34: It is recommended in respect to riparian zone management that:

- Access of livestock to rivers and creeks should be managed to prevent erosion and degradation of stream banks, avoid damage to vegetation and riparian habitat, and prevent pollution of watercourses; and
- Growers with riparian areas on their farms should be encouraged to follow best practice guidelines for management of riparian zones, such as those currently being produced by CRDC.

4.13 Wildlife

Improved practices

Wetlands and water storages can contribute to biodiversity conservation on farms. In this season of widespread drought across all growing areas, artificial wetlands and water storages on cotton farms function as a significant local water source for birds and local fauna.

A range of waterbird species were observed by the auditors on farms in or adjacent to water storages (a variety of ducks, swans, egrets, pelicans, cormorants and herons). Other birds observed included magpies, currawongs and herds of emus in western areas. Species lists had not been compiled for the farms visited in NSW or Queensland. However, some growers were keen to commence a bird survey and had gathered bird identification materials. Growers should be encouraged to keep records of bird species, if they have the resources and skills to do so.

A number of farms across several growing areas were observed to have incorporated artificial wetlands for stormwater/ tailwater storage. At other farms, features to encourage wildlife were incorporated into water storages such as provision of deeper areas, maintaining minimum water levels specifically for water birds,

creation of vegetated stands in the storage, retention of old/dead trees with hollows adjacent to storages, retention of pockets of nearby native vegetation, and promotion of reed growth along embankments. Trees were observed in water storages, which provide habitat for birds – until they die due to waterlogging and fall over. Vegetation has been retained in some water storage areas specifically for use as habitat areas.

Photo 39: Abundant bird life observed in this pond

Photo 40: This water storage does not incorporate any features for attracting waterbirds

Two farms inspected maintained a population of fish, yabbies and mussels in ponds for harvesting. One other farm visited on the Darling Downs had established a significant aquaculture operation, including custom-designed fish pens located within an existing water storage, and supporting infrastructure. The operation was supported by systematic water quality and fish tissue sampling and testing. Populations of aquatic fauna in farm storages can provide a good indicator of contamination from spray-drift or from tailwater runoff. However, the escape of non-native aquatic fauna from water storages due to overtopping during storm conditions must be avoided.

Riparian zones can contribute significantly to maintaining wildlife and biodiversity in cotton growing areas. This audit did not assess wildlife/ biodiversity in riparian zones.

A large number of kangaroos, wallabies and emus were observed on eight farms, possibly seeking water during the drought conditions. Kangaroos were noted at one farm in covered culverts and water distribution pipes, seeking shade. One grower indicated that emus were common on the farm during previous seasons. Other animals were not observed during the limited time on each site.

Some of the research into wildlife on or near cotton farms is described below: There have been numerous isolated studies on fauna and these have been collated and summarised in the Biodiversity Research study (Reid et al, 2003). Available information on the biodiversity of fauna in cotton growing regions (mammals, birds, reptiles, amphibians, fish and invertebrates) have been summarised.

Baseline studies of waterbird abundance in storages have been conducted in the Lower Gwydir Valley (Jarman & Montgomery 2002). Twenty three surveys of 19 on-farm wetlands on nine cotton farms were conducted in 1999 –2001. Bird abundance can be used as an indicator of broad environmental health or as an indicator of biodiversity in cotton growing areas. Over 42,000 birds were counted, representing 45 species. On-farm storages cover 120 km^2 (1.13% of the landscape) and comprise 45% of the total area of natural and artificial wetlands in the Lower Gwydir Valley. However, the study concluded that the on-farm wetlands/ water storages probably only support 1-5% of the Valley's waterbird community. On-farm storages could contribute substantially more than they do now to conservation of a diverse waterbird community.

Funding is currently being sought by the Australian Cotton CRC to support a study of waterbird-related biodiversity values of on-farm wetlands and storages. The outcomes from the study would be a booklet that can be used by growers to evaluate the biodiversity value of their storages/ wetlands for waterbirds and suggestions for improving those values (as recommended above). Opportunities for, and impediments to, implementing habitat-enhancement techniques would also be reviewed. Ultimately, the findings from the study could be incorporated into the BMP manual Land and Water Management module.

A cotton farm with a heavily timbered riparian zone on the banks of the Macintyre River has been investigated as part of the Birds Atlas survey: 68 species have been recorded in seven surveys, averaging 21 species each. The area was rated of high conservation value. The growers have implemented a number of controls for the riparian area.

Environmental condition surveys have been conducted in the Lower Balonne cotton growing districts, commissioned by St George and Dirranbandi irrigators group, Smartrivers (SKM 2000, Benson 2002). The initial project (SKM 2000) included riparian zones in the scope of the surveys.

Bird surveys have also been conducted in cotton growing districts, along Travelling Stock Routes (Freudenberger & Drew 2001). The study found that Travelling Stock Routes were of high conservation value for birds, due to their large size, connectivity and vegetation diversity. A number of the farms inspected during this audit were located adjacent to Travelling Stock Routes.

Research projects are currently being conducted to retain, manage and enhance biodiversity on farms (CRDC 2003).

The CSIRO has conducted a pilot study of bats in and around cotton fields (CSIRO 2003). Eight species of small insectivore bats were detected and identified near cotton. The pilot study showed moth avoidance of bats – both reduced moth flight, and increased fast moth flight when a bat call was detected. Bats may be an important factor in the control of Helicoverpa moths. Some farmers have erected artificial bat houses to provide roosting places. Other farms, which preserve old stands of native vegetation, particularly with tree hollows, have more bats.

Recommendation 35: It is recommended in respect to wildlife that:

- 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;
- More vegetated 'islands' be designed into new ponds (or constructed in existing water storages when low – like this season) for waterbird habitat;
- Further projects on waterbird-related biodiversity values of on-farm wetlands and storages be conducted; and
- Further studies on biodiversity of other species on cotton farms should be conducted.

4.14 Air emissions

There were severe dust storms experienced in agricultural areas in eastern NSW and southern-central Queensland in October-November 2002. The Bureau of Meteorology estimated the dust storm at between 1500 and 1800km long, up to 400km wide and 6km high. The El Nino weather pattern, which has led to drought conditions in Australia, was also associated with higher wind speeds, helping to mobilise the dust.

Farming areas from Orange in southern NSW to Central Queensland were affected by the storm. It was estimated that up to 10 million tonnes of topsoil were lost during the dust storms (Cotton World News 2003). The removal of topsoil and fertile matter by such storms exposes the subsoil, which is not only less fertile but also less capable of absorbing moisture. Some cotton growing districts were affected by these severe dust storms.

Over 85% of cotton is grown on grey, brown or black cracking clays (QDPI 2002). Clay soils in cotton growing areas were observed to form a hard, cracking surface and were not inherently dusty, unless disturbed. Even fallow fields, which were bone dry with substantial wind gusts, were not observed to generate dust. However, if the fields were being worked by machinery, large quantities of dust were liberated. Traffic on access roads around the cotton fields also generated dust.

Improved practices

Growers have utilised retention of wheat stubble, growing winter crops, rotational summer crops and mulching to minimise dust. Tree belts around the perimeter of farms were also observed, which would act as windbreaks and help to reduce wind-blown dust leaving the site.

The practice of burning cotton mulch on site has been largely phased out with most growers interviewed using the material as mulch on the farm.

From the NSW EPA records over four cotton seasons (for Moree, Narrabri and Gunnedah areas) only two people complained about smoke from burning of household wastes or burning of crop stubble (the records do not differentiate between cotton, wheat or cereal crop stubble).

The main type of greenhouse gas from cotton growing is from nitrous oxide emissions, from oxidising fertiliser. Secondary sources of greenhouse gases from cotton farms are from the use of fuels and electricity, burning of trash and land clearing. A recent study (AFFA undated) indicated that the cotton industry could reduce emissions significantly by being more efficient in its fertiliser use. Currently there are no accurate figures on the quantity of greenhouse gases being produced by the Australian cotton industry. The CRDC and ACCRC are currently investigating benchmarking greenhouse gases from cotton farming with the Greenhouse Accounting CRC.

Areas for improvement

A number of cotton growers, in common with other farmers, continue to burn household rubbish at their on-site tips. Several farms had general waste tips where a whole range of farm wastes were burnt, which may cause air pollution.

The presence of Fusarium wilt has necessitated the burning of mulch for disease control, which again may cause pollution.

4.15 Energy

The main forms of energy used on farms are electricity and diesel. Electricity records are readily available from invoices. Diesel records are also closely tracked to avoid wastage, and because of the government diesel fuel rebate scheme requirements. Unit energy use (kW per bale) is not tracked.

The energy requirements of producing cotton do not appear to have been effectively addressed. Comparisons of life cycle energy requirements of cotton against synthetic fibres (derived from petrochemicals or wood pulp) or other natural fibres have not been investigated. A complete life cycle assessment of cotton, including energy use and waste generation, may assist in illustrating the long term sustainability of natural fibres such as cotton.

Recommendation 36: It is recommended in respect to energy management that:

- 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.

4.16 Occupational Health and Safety

Agriculture is rated as the second most dangerous occupation in Australia, with only the mining industry being above it. The cost of farmer injury within the cotton industry was found to be almost triple that of other farmers, such as sheep, pig and dairy cattle farmers, based on a farm survey conducted in 1996 in Queensland (Brown et al 1997). The National Farm Injury Data Centre found that most injuries on cotton farms are associated with machinery and equipment maintenance (Franklin et al 2001).

Improved practices

A manual for managing cotton farm safety has been recently developed (Farmsafe 2002). The manual provides comprehensive checklists for identifying hazards, induction information for workers and contractors, registers for training and farm injuries, as well as specific guidance notes for cotton picking safety.

There was wide variation in the standard of OH&S practices across farms and implementation of the Managing Cotton Farm Safety Manual, with larger farms leading the way in OH&S management systems. A number of farmers are currently addressing OH&S issues.

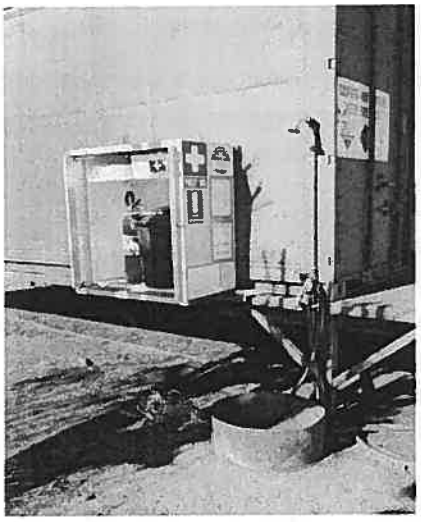


Photo 41: First aid kit, fire extinguisher, safety shower, signage at pesticide store

Photo 42: Inside chemical storage shed showing lifting hoist, emergency contacts, safety signage and procedures

Good practices observed were:

- Up to date chemical accreditation of all employees handling chemicals on the farm;
- Guarding of moving parts of irrigation pumps and providing cages around large pumps;
- Use of whiteboards to indicate fields that had been recently sprayed and re-entry periods;
- Use of chemical loading systems that reduce or eliminate contact between the handler and the pesticide;
- Use of closed-loop spray systems on ground rigs which minimises spillage and exposure risks;
- Permanently carrying a box containing Personal Protective Equipment, basic first aid kit, laminated emergency procedure guides and a set of MSDS in each work vehicle;
- Displaying multiple copies of emergency procedures at storage areas, workshops and offices;
- Development of Safe Operating Procedures for all equipment and field activities (such as the use of irrigation pumps, workshop activities, spot spraying);
- Development of OH&S policies, procedures and site induction packages;
- Formal site induction, with sign off required by permanent and casual workers and contractors;
- Routine independent safety audits by external consultants at some corporate farms;
- Development of emergency plans and procedures;
- Senior First Aid training of selected employees;
- Use of disposable overalls for personnel handling pesticides;
- Washing machines provided on site for laundering of contaminated work clothes, where required;
- Development of site specific Farm Safety Checklist;
- Several farms had their fuel storages audited by the fuel supplier for compliance with OH&S requirements;

- Channels marked with flags and/or barricades at critical points to prevent vehicle entry;
- Restricted speed limits and traffic hazard warning signs around farms;
- Wearing seat belts at all times in vehicles on the farm; and
- Production of OH&S manuals.

For tasks designated as hazardous, such as application of pesticides, one grower required each worker to read and sign a safe work method statement at the commencement of the activity. The form also acted as a request for consumable PPE necessary to undertake the task. Records of all hazardous activities undertaken on the farm included records of personnel who undertook the activities and precautions taken during that task.

Areas for improvement

Not all farms employed these good practices. There appeared to be greater progress made towards good OH&S practices, implementation of the Managing Cotton Farm Safety Manual and the requirements of the NSW OH&S Regulation (2000) on farms which had implemented BMP guidelines and larger farms.

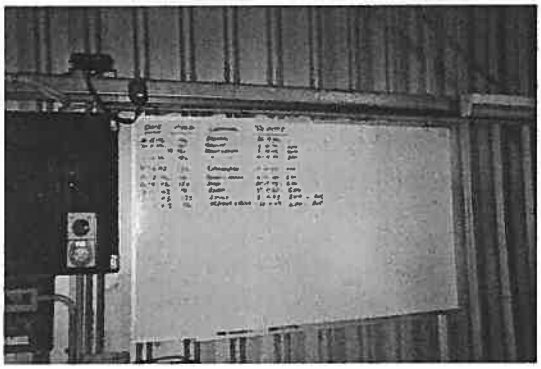


Photo 43: Use of whiteboards to indicate fields that had been recently sprayed and re-entry periods

Other observations noted included:

- Overalls were not always worn when handling chemicals, as some of the ground spray rigs were designed as a closed loop system and the spillage/exposure risk was considered minimal. The protection offered by overalls was questioned by a number of growers, as they maintained the fabric absorbed minor spills and resulted in prolonged exposure to chemicals as slightly contaminated overalls were often worn until an activity was completed;
- Some growers advised that bug checkers/ consultants were advised in writing that long pants were recommended in the field. These checkers were observed as not always wearing long pants. Farmers advised that as they were independent consultants, they believed the recommendation was enough, and did not consider it was their responsibility to police the consultants.

4.17 Education/ information transfer

4.17.1 Research

The cotton industry has had a strong research program focussed on environmental improvements in the areas of best management practices, insect management, soil and water, as well as environmental benefits realised from research in farming systems and plant breeding.

Research programs and direction are evaluated on an annual basis to assess relevance to industry and stakeholder needs. The process for evaluating research programs is transparent and accountable and appears adequate to address current and foreseeable environmental concerns. A number of areas have been identified for further research by CRDC, ACCRC and others, for example, developing a holistic understanding of the processes driving a healthy soil system and further irrigation efficiency projects.

As well as general research, a large number of research projects relevant to local areas, such as Central Queensland, are currently being conducted. Many of these projects focus on state of the local/regional environment, and environmental management issues, practices and opportunities for the industry. Grower involvement is encouraged in a number of these projects, notably the Waterwatch project, involving water quality monitoring and data collection.

The auditors noted that, in general, the growers visited were willing to adapt the latest research to their farms where possible, were enthusiastic to trial new techniques and quick to change their practices to comply with Best Management Practices. This may be because of the younger age of growers/ farm managers/ agronomists compared with other agricultural sectors, as well as education, availability of research information and a high level of computer literacy.

4.17.2 Information transfer

Technology and research transfer is a major component of the activities of the ACCRC and other cotton related research bodies. A number of methods of disseminating results of many of the research projects and environmental studies to growers, agronomists and consultants are available. These include:

- Regular newsletters and publications:
  - 'Cotton Tales' (weekly, ACCRC);
  - Cotton Australia Activities & Issues (fortnightly);
  - 'Cotton Insight' (monthly, Darling Downs Cotton Growers Inc);
  - CRC information updates;
- Cotton Trial and Yearbook (ACCRC/DPI) for Central Queensland, Macquarie, Lower Namoi, Gwydir and Macintyre;
- National Cotton Extension Team (comprising Industry Development Officers, State Agriculture Department District Agronomists, CRDC and Australian Cotton CRC researchers and Water Use Efficiency Officers);
- Cotton Australia Grower Services Managers, for implementation of BMP;
- Industry organisations (eg Emerald Chemical Liaison Group, Integrated Pest Management Groups meetings, Cotton Consultants Association meetings, Area Wide Management groups);
- Meetings, conferences, workshops and field days;

- Written information such as brochures, manuals, pocket guides, information packs, conference proceedings;
- Information included on web sites;
- and
- Audio tapes. These have been produced on pesticide application to assist workers with low level reading skills (CBWC, 2002).

It was also noted that Cotton Australia policy advisors provide legislation updates and associated information to growers via newsletters and during farm visits. Given evolving legislation applicable to growers, systematic provision of this information is considered valuable.

The variety of methods for information transfer appears satisfactory. During the site visits, it appeared that growers had access to the available information and were using it. However, a number of farmers commented that they were overwhelmed by the quantity of information now available and did not have the time to assimilate most of it. The one-on-one approach of the Grower Services Managers and IDOs appeared to be an effective way of transferring information relevant to a particular grower and encouraging the adoption and implementation of improved environmental practices.

A survey conducted by ACCRC (Christiansen & Price 2002) indicated that cotton growers had a high level of awareness of the resources available, had copies of key materials such as the IPM guidelines and IRMS, and regularly used the resources. Over 90% of industry personnel have access to the internet, but the majority still prefer printed material. The survey indicated that a significant percentage (10-20% in some regions) of growers were not aware that some of these resources are available, let alone using them.

Results of research and improved environmental practices do not seem to reach the public, particularly in non-traditional cotton growing areas. Information has recently been conveyed to the public via the Cotton Australia Discovery Centre at Darling Harbour, NSW, and the Australian Cotton Exhibition Centre at Narrabri, NSW, which was opened in 2001.

Management information packages

Management information packages have been developed by industry bodies, such as the following:

- CottonLOGIC (Cotton CRC,CSIRO) for cotton crop management, particularly for managing insects, pests and crop nutrition. The software was made available in 1998 and has been used by over 1000 growers. It incorporates previous systems of EntomoLOGIC, a pest management decision support system and NutriLOGIC which covers cotton nutrition issues and improved fertiliser management;
- Weedpak for weed management (Cotton CRC, CRDC);
- Integrated Disease Management (Cotton CRC, CRDC);
- SOILpak for cotton growers. This is a best practice soil management manual for the Australian cotton industry, designed to assist growers to develop successful soil management strategies. Use of the manual may result in environmental improvements including improved soil structure, avoidance/ reduction of waterlogging, avoiding salinity, minimising erosion, minimising pesticide migration, and/ or increasing water use efficiency; and
- Other management information packages include MACHINEpak (CRDC, NCEA) which describes the machinery available for land preparation, and SPRAYpak (CRDC Cotton CRC), which describes spray application methods. Growers visited were generally aware of the packages and used one or more.

Education

New training programs have been developed recently which will help to educate growers and industry personnel on environmental issues and best practices. Some of these courses include:

- Integrated Pest Management short course introduced in 2001;
- Workshops on SOILpak;
- Best Management Practices training workshops in 1999;
- Waterwise irrigation management courses; and
- The Cotton CRC/ University of New England has developed a Cotton Production Course. Sustainable cotton production and environmental management are core features of the program.

Support personnel

The enthusiasm and knowledge of individual support personnel, such as Grower Services Managers (GSM) and Industry Development Officers (IDO), seems to be reflected in the uptake of best management practices in different areas. The influence of support personnel on BMP uptake may also be impacted by the support personnel to grower ratio within some areas, with a designated support officer being able to better service a smaller number of growers. The uptake of BMP can also be influenced by the type of farming within individual areas assigned to support personnel, with observations suggesting greater uptake rates in areas with a higher proportion of larger, irrigated farms. Regardless, the services provided by the support personnel are widely valued by growers. The employment of GSMs and IDOs is considered money well spent – one of the most cost effective ways of ensuring that BMPs are implemented with vigour and rigour.

CCA members are encouraged to promote the BMP program to their grower clients.

Technology transfer and extension for 2001-2002 from CRDC (employment of IDOs and extension officers) accounted for 8% of the operating budget of $12.6M.

Cotton Australia contributes to the investment of people on the ground for BMP implementation.

Recommendation 37: It is recommended in respect of education and information transfer that:

- Growers be made aware of and encouraged to participate in further environmental educational courses with an emphasis on implementing best management practices and the specific needs of their farms (such as soil and water management courses); and
- CRDC and Cotton Australia give priority to funding field personnel for the introduction of the BMP Land and Water Management module, as this appears to be a most effective means of information transfer and encouraging the uptake of best management practices.

4.18 Genetically modified cotton

The Australian cotton industry is the only major agricultural user of transgenic technology in Australia. In 2002/03 an estimated 60% of the Australian crop was planted to transgenic varieties ("Ingard" and "Roundup Ready"). The use of this technology has resulted in significant reductions to pesticide use.

Bt Cotton – Ingard®

Ingard® cotton varieties carry a gene from Monsanto, which codes for a protein toxin commonly referred to as Bt. The gene originated from a common soil bacterium. The Bt protein is toxic to a narrow range of insects, including the two major pests of cotton in Australia (*Helicoverpa armigera* and *H. punctigera*). Bt is not toxic to mammals.

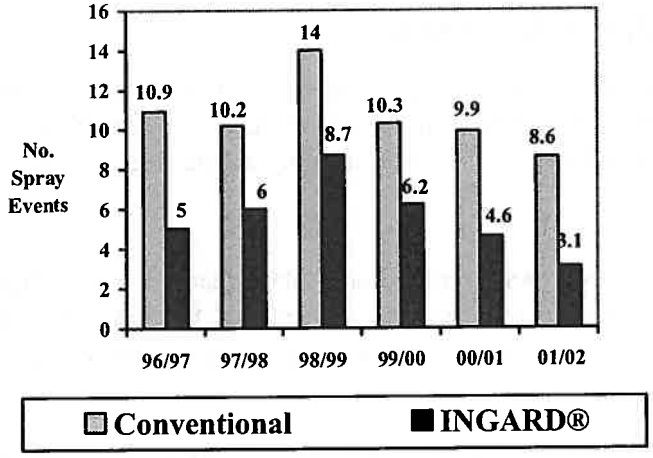
Prior to release, Ingard cotton had to satisfy a range of regulatory requirements on environmental impact including effects on non-target species, gene escape/ potential to outcross with native cottons, potential weediness, changes in status of minor pests and resistance to the Bt protein (Fitt 2003). None of these studies showed Ingard cotton posed any significant risks to the environment. The potential for targeted pests to develop resistance (immunity) to the Bt protein in Ingard cotton was recognised as a risk before it was approved for release. Consequently, cotton growers who plant Ingard must comply with a resistance management plan as part of the licence agreement they sign with Monsanto. Since 1995, the CRDC has provided annual funding to monitor pest populations for resistance to Bt. To date no significant changes have been detected suggesting the resistance management strategies adopted by the industry have worked (Pyke 2003a).

Ingard has been grown in Australia since the 1996/97 season for seven consecutive seasons. The area planted in 2001-02 was 125,000 ha, representing 30% of the total area planted to cotton (Pyke 2003). A cap has been placed on the planting of Ingard at no more than 30% of the total cotton area and will remain in place until Bollgard®II cotton (described below) fully replaces Ingard in 2004/05.

When compared to conventional (non-transgenic cotton) Ingard has allowed cotton growers to reduce the use of insecticides by and average of 50% (over seven years).

Since the introduction of genetically modified cotton (Ingard) in the 1996-97 season, an investigation has been undertaken each year to examine differences in pesticide application and economic performance for comparative Ingard and conventional crops. The 2000/2001 season results (Doyle et al 2002) across all cotton growing valleys, found that the average number of pesticide applications for Ingard was down 54% on those for conventional crops (4.6 applications compared to 9.9 on average). For comparable fields in 2000/2001, 82% show an economic benefit from the Ingard crop. Economic benefits will encourage growers to use genetically modified cotton. For the 2001/2002 season, the number of sprays on conventional crops across all valleys was 8.6 while Ingard cotton was sprayed 3.1 times on average (Doyle et al 2003). Similar significant reductions in the total number of pesticide sprays were measured for previous years.

The graph below indicates the average number of pesticide sprays for conventional cotton compared to Ingard cotton. There was a reduction in pesticide use for Ingard cotton for each season, from 38% in 1998/99 to 64% in 2001/02 (Pyke 2003).



Comparison of the Average Number of Spray Events in INGARD and Conventional Cotton over Six Seasons (Source: Pyke 2003)

Transgenic cotton was planted on most farms inspected during the audit. It was observed that transgenic cotton was commonly planted in boundary areas. This approach was designed to minimise spray drift moving off the property due to reduced pesticide application events/requirements of the transgenic cotton.

The most common reasons given by growers during site inspections for using Ingard cotton were to reduce chemical applications in environmentally sensitive areas, reduce reliance on chemicals, reduce the number of sprays and meet IPM requirements. A survey conducted over the 2001/02 season indicated that environmental benefits, insect management/ IPM benefits and economic/ yield benefits were equal reasons for growing Ingard cotton (Pyke 2003).

Two gene Bt Cotton - Bollgard II

A transgenic cotton with two Bt genes (Bollgard II) should become available commercially in the 2003/04 season. Bollgard II is more effective than Ingard on pest species and should be much more difficult for these pests to develop resistance. Bollgard II is therefore expected to be made available without a planting cap and could potentially be planted on well over 50% of the Australian cotton area from 2004/05 onwards. It is expected to reduce pesticide use by cotton growers significantly.

Roundup Ready ® Cotton

"Roundup ready" is a genetically modified cotton, which is resistant to the glyphosate herbicide Roundup. This allows the cotton crop to be directly sprayed with Roundup (a non-residual herbicide) to control weeds. Roundup Ready cotton has been rapidly adopted by the cotton industry, since it was introduced in 2000, because it provides a new tool for improving weed management costs and flexibility as well as reducing the use of soil applied residual herbicides. In 2002/03, an estimated 45% of the cotton planted in Australia carried the Roundup Ready gene.

One of the main concerns of the public with other genetically modified crops is the potential for "super weeds" to develop which are resistant to herbicides. Roundup Ready cotton requires cotton growers to sign a licence agreement with Monsanto to access the technology. Part of that agreement requires weeds in fields treated with glyphosate to be surveyed after treatment and if weeds have escaped control to ensure they are controlled by a means other than glyphosate (cultivation, hand chipping or a different herbicide). This

approach is expected to reduce the chances of weeds becoming resistant to glyphosate or for weeds that are more tolerant of glyphosate becoming dominant weeds.

The potential for Roundup Ready cotton to become a weed in its own right is not high because cotton is not a weedy species. Despite being grown for many years in the river valleys in north-western NSW, central and southern inland Queensland, cotton plants are not often found beside roadways or along streams or rivers. Consequently, unless self seeded or "volunteer" cotton plants are treated with glyphosate and thus selected over normal plants, Roundup Ready cotton is not expected to become a weed. Roundup Ready cotton volunteers are much more likely to establish on cotton farms where soil conditions are favourable for establishment and seed populations are highest. If treated with glyphosate under these circumstances Roundup Ready cotton can be expected to create some problems. In response to potential problems, the cotton industry has developed weed resistance management practices, including the management of volunteer Roundup Ready plants by a range of potential options – hand chipping, cultivation and non-glyphosate herbicides. Research on alternative herbicides for the control of seedling volunteer cotton has been conducted, which indicates that alternative herbicides are effective (Roberts 2002). Advice is available to the cotton industry in the new publication, WEEDpak (ACCRC 2002).

The introduction of Roundup Ready cotton has the benefit of reducing the amount of residual herbicide used as well as reducing the reliance on manual chipping for weed removal (less exposure to chemicals).

There have been reports by the growers visited that mistakes have been made in spraying Roundup onto non-Roundup Ready cotton, resulting in loss of the crop.

It was noted on a number of properties where Roundup Ready cotton has been planted that cotton bushes were growing in the tailwater canals and some fallow fields. One grower advised that some cotton in the tail water canals and fallow fields is Roundup Ready cotton. Despite his efforts to chemically destroy the plants, these plants have become weeds as they are resilient to Roundup and other harder herbicides that have been tried. The grower advised that he was unaware of how to destroy unwanted plants, apart from manually removing them.

5. Findings from 2002 Audit – cotton processing

5.1 Cotton gin audits

5.1.1 Site inspections

Currently there are 40 cotton gins in NSW and Queensland. Seven gins were inspected: five in NSW and two in Queensland, from central NSW to Emerald. (During the 1991 audit, there were 21 ginning facilities in operation and six inspections were undertaken).

Gin sites inspected ranged from 5 – 37 years old, with capacities of 35,000 – 200,000 bales per annum. The gins were inspected between December 2002 and February 2003. None of the gins were operational during the site inspections and much of the equipment was dismantled for maintenance and cleaning operations. Gin personnel interviewed included gin managers, environmental officers and core operations/ maintenance personnel.

The audit included environmental and occupational health and safety issues. The main OH&S issues are the control of noise and dust. The main environmental issues are the emissions of dust and noise, potential stormwater pollution and the disposal of trash.

5.1.2 Cotton ginning

Modules of cotton are transported from the farms to a cotton gin and stored in a yard area prior to processing. The cotton gins are located in the same farming areas where cotton is grown. One gin inspected was located adjacent the cotton farm, and the other six were in rural locations.

The gin is comprised of equipment to:

- Initially clean the cotton by removing sticks, rocks and green bolls;
- Dry the cotton to a moisture level of around 6-7%;
- Further remove leaf trash, sticks, stalks and dirt;
- Separate the fibres from the seed in the gin stand;
- Further clean the lint to remove any remaining trash; and
- Compress the cotton into a bale. The bales are then transported to a spinning mill.

The process is controlled from a centralised console room, where operators can observe the machinery. Cotton gins run for about 100 days a year, 24 hours a day, seven days per week, to gin the cotton. The gins employ temporary and casual staff during the ginning season.

Cotton seed was stockpiled and either sold as: contracted fuzzy seed for pure seed production; to seed processors (primarily for crushing to produce cottonseed oil); or sold for stockfeed. A higher proportion was sold for domestic stockfeed during the 2002/03 season due to the lack of other sources of stock feed and the high prices paid for seed.

Mote produced at the gins was baled and sold for low-grade cotton uses, such as the production of mops or paper. Mote is the small, loose fibres separated from the lint.

5.2 Air emissions

5.2.1 Licensing

Dust generated from the various stages of the ginning process is discharged via fabric filters and/ or cyclones. Gin dust consists of cotton fibres and other organic and mineral impurities. Gin dust can present a health hazard to workers and nearby communities and an atmospheric pollution hazard.

Gins that process above 30,000 tonnes/ annum are required to have a licence under the Protection of the Environment Operations (POEO) Act in NSW. However, gins that process lower quantities have also been issued with licences. Typically, NSW EPA licences for gins do not currently specify limits for dust emissions, just that "the premises must be maintained in a condition which minimises or prevents the emission of dust from the premises". Gins need to comply with the Clean Air (Plant and Equipment) Regulation under the POEO Act – at present this is under review by the EPA in consultation with industry groups. The Australian Cotton Ginners Association has been asked to submit a proposal, which is requesting exemptions and provisions for gins.

In Queensland, an Environmental Authority (that is, an environmental licence) issued by the Environmental Protection Agency is not required for the operation of a cotton gin. Dust emissions that create nuisance to neighbours can trigger statutory procedures under the Qld *Environmental Protection Regulation 1998*.

5.2.2 Gin air emissions

Improved practices

The 1991 audit indicated that some of the older gins had no provision for dust collection and removal or had simple cyclone systems. Only newer or upgraded gins were fitted with fabric filters. A particulate standard of 250 mg/m^3 applied at the time.

Of the seven gins inspected, all had dust collection and removal facilities and available monitoring results indicated better performance than in 1991. Four gins had cyclones for dust extraction (this is not the most effective means of dust control, although it is cost effective). Monitoring data reviewed for the gins using only cyclones indicated that dust levels exceeded a level of 100 mg/m^3 on occasions. Three gins had cyclones plus fabric filters, and monitoring data reviewed during the audit indicated that dust emission levels less than 100 mg/m^3 were achieved.

Monitoring of dust levels was not specified in the licence conditions for the gins. A number of larger gins had undertaken random assessments of Total Suspended Particulates (TSP) and respirable dust (PM10). One large gin conducted routine annual particulate matter testing, with results submitted to the NSW EPA, to enable the EPA to review dust emissions from cotton gins in NSW.

Dust controls for external areas at the gins inspected appeared adequate. Dust abatement practices included:

- Dust emissions from module storage pads and internal access roads have been minimised at gins by compacting pad surfaces and providing a layer of gravel or crushed rock;

- During operations, spraying roads using a water cart is undertaken to minimise dust generation;
- At one gin, dust abatement measures included the purchase of a neighbouring residence and relocation of the residents who were affected by traffic-generated dust from the module yard and internal roads;
- One gin had planted trees (and retained natural vegetation) around the site perimeter and in between module yards to minimise wind-blown dust;
- Enclosed, or semi-enclosed sheds, are used for seed storage to protect it from the weather. This also minimises windblown dust; and
- Watering of cotton trash stockpiles has also been introduced to minimise dust.

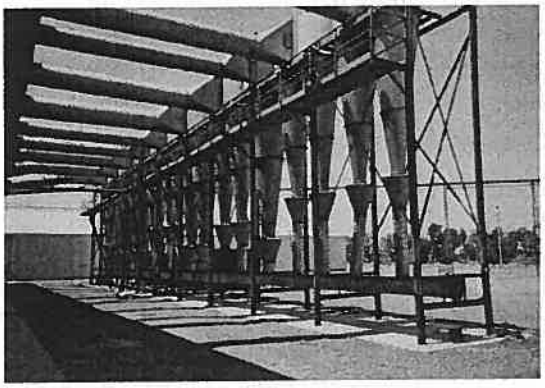


Photo 44: Typical arrangement of open top dust cyclones

Photo 45: Dust extraction and transfer system

At one gin, there have been complaints regarding dust generated on unsealed public roads, which provide access to the gin. Although not actually the responsibility of the gin, gin management have conducted or organised watering of roads to minimise dust on approach roads and have lobbied the local Council to seal the road.

The NSW EPA complaints register for the Gunnedah, Moree and Narrabri areas indicated that there was only one complaint regarding air emissions from gins between 1998/99 to 2001/02 seasons.

Photo 46: Enclosed shed used for seed storage minimises wind-blown dust

Areas for improvement

None of the gins had permanent meters fitted to the discharge point(s) to measure dust emissions. This is due to the expense of monitoring from multiple discharge points from the open-topped cyclones.

The auditors were not aware of gins with dust deposition gauges, which measure overall dust levels from the site. In the interests of good neighbour relations, monitoring of dust at the site boundary in sensitive areas or near residences could be considered.

Gin personnel advised that the occurrence of fires in module yards or in cotton trash stockpiles were not uncommon at the gins inspected. Fires have been controlled by bulldozing the module/trash and burying, letting the fire burn out (with inherent smoke pollution problems) or by using fire fighting water.

Recommendation 38: It is recommended in respect to environmental dust emissions that:

- Monthly dust deposition readings could be conducted at the site boundary, during the ginning season, for gins located near residences or other sensitive receptors; and
- Gins be encouraged to plant trees around the site perimeter to reduce wind-blown dust and for visual amenity.

5.3 Noise

Improved practices

In the 1991 audit, data presented indicated that disturbance from external noise emissions (environmental noise) would be likely at neighbours within one kilometre from a gin.

A number of recent improvements have been introduced at the gins inspected, to reduce both environmental and occupational noise levels. Observations and good practices noted included:

- Noise baffles to redirect noise away from residences;
- Sound-proofing on walls;
- Shielding around external equipment (such as fans) to contain noise;
- Moving equipment away from sensitive areas, such as relocating pumps to the side of the building away from residences;
- Provision of silencers on the seed blower and cyclones;
- Enclosing and providing sound insulation at noisy areas, such as the bale press area;
- Provision of sound-proofed console rooms;
- Replacement of equipment for production purposes, with quieter equipment;
- Modification of bale lowering procedure, so that bales don't bang;
- Replacement of steel blocks with nylon blocks on bale chains;
- Restricting entry of personnel to high noise areas;
- Ensuring adequate door closure to noisy areas;
- Relocating noisy equipment away from the main work areas of gin personnel;

- Rotation of personnel to work in different areas (mainly required to reduce fatigue); and
- Thermal insulation of lint ductwork has also resulted in reduced noise.

Environmental noise monitoring has recently been conducted around the site perimeter and nearby sensitive residences at three of the gins inspected. The other gins were located in remote areas, so environmental noise monitoring was not considered necessary. Most gins inspected were not located near residences and were not subject to noise complaints.

Areas for improvement

Of the seven gins inspected, there were only two noise issues at one site, located near a town:

- Monitoring indicated that night-time noise criterion were exceeded and recommendations were made for noise shielding of ancillary equipment and seed blowers; and
- Noise complaints were also received at the gin from neighbours, regarding the reversing beeper on a truck.

Photo 47: Cotton gins are generally sited in isolated areas, so noise and dust do not cause problems

5.4 Water management

5.4.1 Water use

Water is not used in the gin for processing. Minor quantities are used for amenities, the humidifiers, dust suppression on roadways, truck washdown areas and for keeping cotton trash moist (to aid in composting and to prevent self-combustion). Fire-fighting water was also stored at all gins inspected in tanks or ponds.

Water and stormwater management at gins was not covered in the 1991 audit.

Improved practices

Three of the gins inspected have recently installed truck washdown areas for disease management. In these facilities, trucks are pressure-blasted with water containing "Farmcleanse" to control the spread of cotton diseases. Water from these washdown areas is generally directed to an initial concrete pit for collection of silt,

then to an evaporation pond or trench. Ponds/ trenches relied on the natural clay content of soils in the area for water retention.

Since most pits and ponds have only recently been installed, sludge has not yet been removed from these areas. Sludge from the collection pit and evaporation ponds may contain contaminants and should be analysed prior to any off-site disposal.

Recommendation 39: It is recommended in respect to gin washdown areas that:

- A washdown area be installed at all gins, which receive cotton from potentially disease-affected cotton areas; and
- An assessment be conducted to determine if there is a potential for contamination from disposal of the sludge from washdown pits/ ponds – sludge from a number of gins should be analysed for diseases.

5.4.2 Water use minimisation

Improved practices

Some gins had incorporated water minimisation facilities and practices, including:

- Stormwater run-off from yard areas was collected and reused for on-site dust control and tree watering;
- Rainwater from large roofed areas was collected for use on site. The "first flush" was generally discarded as it contained too much dust and silt. (A number of gins do not collect rainwater as the roofed areas pick up too much dust);
- At one gin, roof water was collected for use as fire-fighting water and for irrigation;
- Greywater (from showers and kitchen areas) was collected separately at one gin and recycled for tree watering; and
- One gin treated all wastewater from amenities in a package treatment plant and recycled water onto gardens.

Areas for improvement

One gin reported a problem with the capacity of its septic tanks. Due to the naturally-occurring clay soils at the site, the septic system cannot cope with the volume of wastewater generated from the amenities when the full workforce is present at the site. Ponding of sewage occurs in a depression near the septic system, and in wet weather the sewage can contaminate stormwater runoff across the site. This may pose both a significant environmental and public health risk.

Recommendation 40: It is recommended in respect to gin water use that:

- Water use minimisation measures be implemented at all gins; and
- Gravel-lined absorption trenches or other means of disposal be considered for septic tank effluent, where ponding is a problem.

5.4.3 Stormwater

Improved practices

Stormwater from module yards may be polluted with silt, cotton/ cotton trash and possibly pesticides. One gin inspected directed stormwater to a holding pond (temporary water storage area), designed to remove gross solids and settle out silt. A considerable volume of stormwater could also be retained in the stormwater channels around the site.

The same gin had a separate area for holding modules from farms potentially affected with Fusarium wilt. Stormwater runoff from this area could be isolated if required.

NSW EPA Environmental Protection Licences state that samples of stormwater runoff should be tested for a range of parameters including suspended solids, nutrients and organochlorine/ organophosphate pesticides. (Note that not all licences are consistent and some do not currently have this requirement). There have been few rainfall runoff events in recent years. However, the limited results reviewed during this audit from three gins in NSW indicated: no detectable pesticides; conductivity and pH levels were generally acceptable; high nutrient levels were recorded at two gins (there was no data to indicate the source of the nutrients); and high suspended solids concentrations were noted in only one stormwater runoff sample (>2200 mg/L).

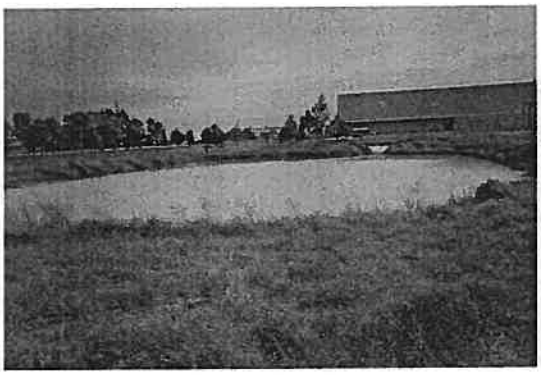


Photo 48: The catch pond settles silt in stormwater run-off from the module and bale yards.

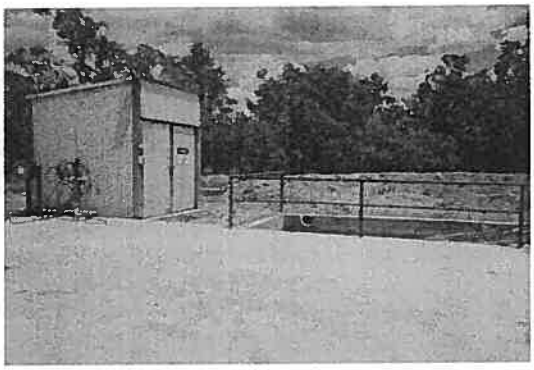


Photo 49: Truck washdown pad and evaporation pond (recently installed)

Areas for improvement

Of the gins inspected, six did not have any holding ponds or trash screens for stormwater runoff – two flowed to the local Council road reserve, one to a local creek, and three to a nearby cotton grower's water distribution system. It is not a specific licence requirement to install holding ponds/ trash screens, however, there is the general requirement not to pollute waters under both NSW and Queensland environmental legislation. Silt runoff is considered to be pollution under the legislation. The risk to the environment is dependent on the location of the gin and the proximity to sensitive areas such as rivers, creeks or town stormwater drains.

There is a disease control issue with recycling stormwater from the module yard onto adjacent cotton farms. Water/ soil-borne bacteria and fungi may be transferred from infected cotton modules to the stormwater system.

At one gin, the transport contractor used an area for vehicle maintenance, storage of fuels and lubrication of chains. The chain lubrication area (which uses a recycled vegetable oil) represents a risk of pollution of stormwater during a rain event, as the open lubrication trough can overflow. Housekeeping in this area was poor (refer to photo below).

A second gin has a designated area used to lubricate chains for its transport contractor. The area was not sealed, bunded or roofed, and heavy oil staining of the hardstand was evident. The oils used for lubrication are waste oils from a nearby mechanical workshop. Activities in this area have the potential to pollute stormwater and cause significant contamination of the land.

Recommendation 41: It is recommended in respect to gin stormwater management that:

- Holding ponds (temporary water storage ponds) be installed, where practical, at site drainage points to capture silt and gross solids, particularly in environmentally sensitive areas;
- Trash screens could be considered at discharge points to screen cotton and trash from stormwater prior to release;
- Provision be made to isolate stormwater from around module yards that may store modules potentially affected with Fusarium wilt;
- For disease control purposes, stormwater should be directed away from adjacent cotton farms or disinfected prior to use; and
- Where appropriate, gins develop a hydrocarbon management policy and facilities to prevent potential stormwater, groundwater or land contamination, such as at the chain lubrication area.

Photo 50: Open chain lubrication trough

5.5 Dangerous goods

Improved practices

Chemicals commonly kept at the gins included gas for heating (natural gas, LPG or butane) and diesel. Minor quantities of oils, lubricants, paints, solvents, welding gases and cleaning compounds were kept for maintenance and cleaning purposes. Chemicals were generally stored in an acceptable manner, except for the areas noted below in "Areas for improvement".

Insecticide and herbicide spraying was generally undertaken by contractors and chemicals were not stored on site. Where herbicide was used by site personnel, only minor quantities were held on gin sites at any given time.

Larger gins had developed purchasing policies regarding all dangerous goods and chemicals used on site. All materials have to undergo a hazard and safety assessment and be pre-approved prior to use on site. A list of approved chemicals was kept on site at these gins, or made available via corporate intranet services. One company with multiple gins uses a single purchasing point for all of its gins.

Areas for improvement

A number of poor practices were observed at some gins:

- In general, there was no inventory of dangerous goods kept on site;
- Material Safety Data Sheets were not available for all the materials used at all of the gins;
- Unbunded diesel tanks were used;
- Suitable spill kits were not always in place;
- No systematic process operated for the ongoing assessment of the integrity of one underground fuel tank;
- Emergency plans for fires and spills had not been developed at all sites. There was also a lack of maps to indicate the location of dangerous goods stores or tanks;
- Inadequate ventilation of flammable/ combustible stores; and
- Lack of signage (none, incomplete or faded) at dangerous goods stores and tanks.

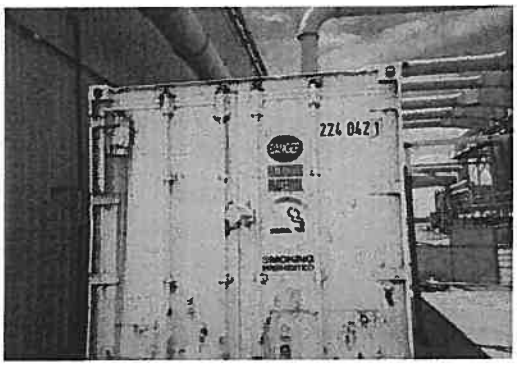


Photo 51: Incorrect signage at a flammable goods storage area (signs faded and Class 3 diamond missing)

Recommendation 42: It is recommended in respect to dangerous goods storage at gins that:

- Gin management check all dangerous goods storage areas against regulatory requirements, including Australian Standards; and
- Gins consider developing a purchasing policy to screen and approve the types of chemicals and dangerous goods used on site.

5.6 Waste management

5.6.1 Cotton trash

Cotton trash comprises leaves, stalks, other vegetable matter and impurities separated from the cotton fibre in the gin. Approximately 7-10% of the overall weight of material harvested from the cotton field ends up as cotton trash.

Improved practices

At gins inspected, cotton trash was either stockpiled and composted on site, stockpiled at another site or transported to local farms for composting and utilisation as organic matter. Composted trash was sometimes used at the gin site for landscaping purposes. A number of gins reported that local farmers would take variable quantities of trash off site for use on their (non-cotton) farms.

Photo 52: Large scale composting of cotton trash

The CRDC has been conducting a monitoring program of gin trash, in conjunction with the NSW EPA. The results of this monitoring have been provided to the EPA, which is reviewing the data. The EPA is also reviewing the waste management legislation and will determine the waste classification of cotton trash. (Currently, guidelines have not been established for concentrations in wastes of most of the pesticides commonly used in the cotton industry. The pesticides are not currently listed in waste classification guidelines (NSW EPA 1999 or Chemical Control Orders).

The monitoring program analysed gin trash for 29 pesticide chemicals used in cotton production from three gins (Crossan & Kennedy, 2003). Preliminary results from the study indicate that residues were found for 13 chemicals, and the levels detected for most of the residues were in the low range, just above the limits of detection. Average concentrations of ten replicate composite samples of chlorpyrifos, bifenthrin, cypermethrin, indoxacarb, profenofos and propargite were detected in fresh trash above 1mg/kg. Both fresh and aged trash was tested, with concentrations of residues lower in the older trash.

At one of the gins inspected, which did not take part in the study described above, fresh and aged trash (2-3 years old) had been analysed for a range of pesticides, including trace elements, pH, conductivity, organochlorine and organophosphate pesticides and triazine herbicides. Trace amounts of pesticides, at currently acceptable levels, were detected in fresh and aged trash.

The cotton industry has a policy of not providing gin trash to livestock as feed. Cotton trash has not been sold or provided to cattle producers since the 1994 Helix contamination incident. (Note that the 1991 audit

indicated that there were "few environmental problems associated with the disposal of trash. There is no data to suggest that ginning trash is contaminated with pesticide residue levels warranting concern although conclusive evidence is lacking").

Areas for improvement

Gin management reported that trash had been buried at some sites (or offsite) in the past. Trash has been disposed of off-site without adequate records of quantities disposed or disposal location, and without written agreements with the end user. In light of past problems with consumption of trash by cattle and potential ongoing contamination with pesticides, gin managers should ensure that all off-site use can be accountable.

It is recognised that gin trash may be contaminated with Fusarium wilt. Management at one large gin inspected in NSW indicated that the temperature reached in the composting heap was not always sufficient to kill *Fusarium*. This is posing a problem for the industry, as the trash cannot be spread back onto farms and the NSW EPA does not allow it to be burnt. Research has shown that maintaining elevated temperatures in the windrows appears very effective at destroying the activity of plant pathogens such as *Fusarium* as well as most weed seeds (Pittaway 2000).

Trash samples were found at one of the gins inspected to have elevated salt levels (in fresh and aged trash), which would be of concern if applied to farm land at high application rates and/or on a regular basis. This needs further research and testing to determine if it is a problem or just an isolated incident.

Recommendation 43: It is recommended in respect to management of cotton trash that:

- Records be kept of all trash disposed of off-site (receiver, location, quantity, date);
- Written contractual agreements be developed for all off-site disposal. Farmers should not be allowed to take trash for unaccounted use on their farms;
- A consistent suite of tests be established for testing of cotton trash; and
- Routine monitoring of trash be conducted for pesticides, salt levels, nutrients and diseases to ensure that composted trash is a suitable material for reuse. Cotton trash should preferably be kept on site until results indicate that offsite reuse is acceptable.

5.6.2 Other wastes

Improved practices

Small quantities of mixed wastes were generated from workshop, office and amenities areas. These were disposed of commercially when the gin was sited near a town. Some gins had their own on-site waste tip.

Spare parts and old equipment were stored on some sites for possible reuse or recycling for scrap metal. Waste oil from workshop areas was collected for recycling. At the seven gins inspected waste oil was disposed of in a satisfactory manner. (The 1991 audit indicated that it was a common, although unacceptable, practice to minimise the dust on access roads by wetting the road with waste oil).

Generally, wastes were stored and managed adequately, except for one site, noted below.

Areas for improvement

One tip located at a gin in NSW was observed to be poorly managed, with a large quantity of recyclable materials and wastes generated from off-site dumped at the tip. This does not meet the NSW government's policy of maximum conservation of resources by reusing and recycling materials where possible.

General housekeeping in the area of this tip was poor and presented a potential risk of stormwater contamination.

> ***Recommendation 44:*** It is recommended that gin managers ensure that on-site waste tips are properly maintained.

5.6.3 Transport spillage

Improved practices

Since the 1991 audit, covering of cotton modules with tarpaulins and the use of enclosed module trucks has been introduced. These practices minimise the potential for transport spillage of cotton.

Areas for improvement

Substantial quantities of cotton were noted along roadside verges in one particular cotton district. In one area, cotton piles were observed adjacent to waterways - this has the potential for pollution of waters and does not give a good visual impression of the cotton industry.

Adequate covering of loads is the responsibility of the transport contractor. However, gin management could refuse to accept incoming modules if they are not sufficiently covered.

Transport spillage (litter) generated from inadequate covering of loads is an offence. In most cases, the local Council would be the responsible prosecuting authority and Council rangers could be encouraged to conduct spot checks and issue fines for loads that are not adequately covered.

> ***Recommendation 45:*** It is recommended in respect to transport spillage that the cotton industry improve the management of transporting cotton modules to the gin.

Photo 53: Cotton spillage near a major river.

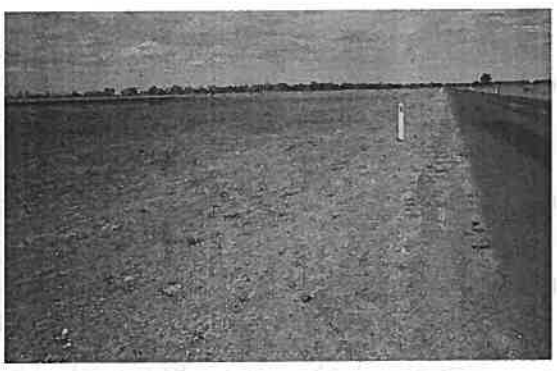


Photo 54: Extensive spillage of cotton, near a gin, along a public road.

5.7 Energy management

Improved practices

Large quantities of gas and electricity are used for operation of equipment. Energy use is regularly monitored and tracked as energy use per bale produced. For large ginning companies, energy use figures are benchmarked against the other gins, as well as previous years' figures. Total energy use depends upon the moisture content of the cotton and there does not appear to be much scope for overall large-scale energy reduction.

Some of the measures undertaken to reduce energy usage at the gins visited include:

- Lagging of all lint and hot ductwork;
- Improved flow controls and dampeners for hot air;
- Investigations into directly burning trash to preheat the hot air;
- Investigations of gasification of cotton trash to produce a hot gas for heating purposes;
- Harvesting radiant heat from ductwork and feeding it into the heaters to improve their efficiency;
- Elimination of non-essential gin equipment;
- Installation of new more energy-efficient equipment (larger capacity, faster machinery that is more efficient);
- Reduction of air flow rate, which has resulted in lower gas requirements for heating the air, and a decrease in fan motor size which has resulted in electricity savings;
- Assessing lighting needs and modifying usage patterns; and
- Energy conservation awareness training.

It is the auditors' understanding that a number of gins have investigated burning or gasification of cotton trash, but that no gins have installed such facilities to date. One of the gins inspected has undertaken a detailed technical review of a plant to process cotton waste into energy.

Power factor correction has been undertaken at most gins to minimise costs.

None of the gins inspected had established their greenhouse gas emission levels or determined greenhouse reductions from the implementation of energy saving measures described above.

5.8 Best Management Practices

Improved practices

Of the gins inspected, the following good environmental management practices were noted:

- Larger gins had developed standard environmental checklists and conducted internal environmental assessments on a non-routine basis;
- Three of the gins inspected had undertaken environmental audits of their sites. Audits were internal or conducted by external consultants, conducted on a non-routine basis;
- A number of the larger gins have established some environmental management procedures that operate within quality and operation systems (but they do not currently cover all environmental aspects);

- One gin inspected had developed an Environmental Management Plan for the site;
- One large gin was currently developing an Integrated Management System encompassing quality, safety and environment; and
- Four gins had developed environmental management and monitoring procedures.

Areas for improvement

None of the cotton gins inspected had developed an Environmental Management System.

It was noted that out of the seven gins inspected, two gins had not established any written environmental procedures.

There is currently no BMP manual for cotton gins, similar to that for cotton farms. The industry standard management guidelines could include:

- Dust control from module storage, internal roadways, cotton ginning, trash stockpiles and storage, seed storage and handling;
- Dust monitoring (TSP, PM10, dust deposition);
- Noise control measures;
- Water minimisation measures;
- On-site sewage treatment;
- Stormwater management and controls;
- Management of chemicals and fuels;
- Cotton trash handling;
- Energy minimisation techniques;
- Greenhouse gas calculations;
- Environmental protection licence compliance; and
- Environmental management plans.

Recommendation 46: It is recommended in respect to environmental management at cotton gins that:

- A minimum industry standard guide for cotton gins be produced;
- Standard environmental checklists be developed to allow gins to conduct internal environmental audits; and
- External environmental audits be considered on a routine basis at gin sites, irrespective of size.

5.9 Occupational Health and Safety

Improved practices

A joint "Cross Border Gin Project" is currently being conducted by NSW WorkCover and the Queensland Department of Industrial Relations (DIR) to assess OH&S management in gins (WorkCover/ DIR 2002). An initial self-audit survey has been conducted, which covered eleven key areas including: legal obligations; OH&S management systems; risk management; workplace consultation; training; plant and vehicles; record keeping; contractors; visitor safeguards; work environment; and hazardous and chemical substances. The survey has been followed up by site inspections by WorkCover and DIR, which found that the self-audit results were reasonably accurate. Further site inspections will be conducted during the ginning season. The results of the survey and inspections will be used to target areas for improvement. A Code of Practice, advisory notes and/or training packages may result.

Similar surveys have been conducted for other agricultural sector industries such as feedlots, wineries, packing sheds and forest harvesting. The auditors were advised by DIR that the gins rated well against these industries.

The site inspections and interviews confirmed that cotton gins are gradually progressing towards the new OH&S requirements and standards. The larger gins lead the way in terms of improved OH&S practices and documentation.

Several of the larger gins inspected have extensive safety management systems operating and have taken part in a recognised safety management system program (such as the NSCA 5 Star program) and have been independently assessed against the program criteria. Two of the gins inspected had achieved a high rating.

All the gins inspected had gradually improved safety around the plant in the last few years in line with new OH&S requirements. Some examples of improvements included provision of covers for moving machinery, installation of new equipment, windows in lint cleaner equipment to observe fires, improvements to catwalks and platforms including provision of kickboards and improved railings at stairwells, manual handling improvements, guards on bale strap cutters, and installation of interlock systems.

Appropriate personal protective equipment (PPE) was observed at the gins. Gin management advised that wearing of PPE was rigorously enforced. Some gins had dismissal policies relating to PPE infringements. It was reported that gin personnel routinely wear dust masks in designated areas and/or for performing designated operations. Gin management advised that compliance with wearing hearing protection was rigorously checked.

Sampling has been conducted at a limited number of gins for exposure to respirable dust particles. Larger gins have conducted routine OH&S surveys of dust.

The 1991 audit found that internal (occupational) noise levels were a significant problem, with many gin employees exposed to high noise levels in excess of those set down in prevailing regulations. Few facilities in 1991 had any type of records on noise levels and exposures. Occupational noise levels have been measured at four of the gins inspected during this audit. Noise monitoring has been carried out on a routine basis, or if there have been changes to equipment or procedures. Noise exposures exceeded 90 dBA for some workers/

work areas. Occupational noise was controlled using a combination of operational and engineering controls, described in Section 5.3, and using hearing protection.

Noise maps had been produced at two of the gins inspected to identify high noise areas. Noise maps were displayed at key points around the gins.

Documentation of safety issues has also been undertaken. Observations included:

- Documentation of hazard and risk assessments;
- Development of improvement plans in response to the results of risk assessments;
- Development of induction procedures for permanent staff, casual and contract personnel;
- Production of safety guidelines for site visitors,
- Development and implementation of training programs and competency assessments;
- Identification of confined spaces and documentation of confined space entry procedures;
- Development and documentation of Work Instructions and procedures, such as lock-out procedures;
- Development of internal safety checklists;
- Fatigue management policy; and
- Improved document management systems and record keeping.

Formal training packages for cotton ginners have been developed by the Australian Cotton Ginners Association in partnership with TAFE, with the first graduates in 2001. One of the objectives of the course is to improve safety.

The auditors were advised that the Australian Cotton Ginners Association had established an OH&S sub-committee and addressed a number of issues, including un-tarping of cotton modules (working at height), wearing reflective vests at night in module yards and site security.

The larger gins undertook routine internal site inspections during the maintenance period and during the ginning season. External audits by independent OH&S consultants, as well as OH&S training, were conducted.

Most of the seven gins reported receiving improvement notices from NSW WorkCover or DIR Queensland. One gin reported having received a fine in the last few years. The gin responded positively to the incident by employing a full time safety officer, developing and installing a comprehensive guarding policy, developing a safety improvement plan, introducing safe work practice policies and procedures and undertaking risk assessments.

Areas for improvement

Some of the smaller gins lag behind in terms of meeting the new OH&S requirements. For a number of gins, documentation of safety procedures is still being undertaken.

Site inspections conducted as part of the Cross Border Gin Project resulted in approximately 12-15 improvement notices per gin relating to a range of issues from documentation and administrative procedures, to faulty electrical wiring and unguarded outside machinery. The main areas requiring improvement include control of contract personnel and transport contractors, confined space procedures and identification of

confined spaces, lack of emergency procedures practice and documentation (pers. comm. R Alford/ G Vincent).

Health assessments (hearing and lung function tests) varied for the gins. At smaller gins, no assessments were undertaken. Larger gins conducted health assessments on an annual or pre-employment basis, depending on whether the employee was employed on a permanent, casual or contract basis.

Floors and equipment surfaces are cleaned continuously during the ginning season using vacuum systems, compressed air and manual sweeping, with compressed air and manual sweeping being the most common cleaning methods. Compressed air merely blows the dust to another area – there is no positive removal of dust. The ongoing use of compressed air for internal dust control does not represent good practice and is not acceptable in most other industries. Vacuum systems for removal of dust are preferred from an OH&S perspective to ensure positive dust removal. The Australian Cotton Ginners Association advised that vacuum systems were trialled but were not successful or practical.

Overall, there was a lack of internal self-inspection safety checks and external OH&S audits for the smaller gins. It is understood that there has been a push to employ an OH&S consultant to service a number of small gins, but this has not eventuated.

Recommendation 47: It is recommended in respect to Occupational Health and Safety practices at gins that:

- Gins investigate better dust control systems, rather than blowing dust with compressed air;
- Gins produce noise maps to identify high noise areas for internal and external areas;
- Routine OH&S noise monitoring be undertaken at all gins;
- Gins be encouraged to take part in an accredited safety program in order to improve OH&S practices and documentation of procedures; and
- A general self-audit checklist be developed for the smaller gins (which do not have their own OH&S specialists).

Photo 55: Safety Information Board in the main meeting place for gin personnel.

5.10 Cotton seed processing audits

There are currently two cotton seed processors in Australia, both located in NSW. Both sites were inspected as part of the audit. The findings were based on a limited spot check of the plant, with minimal review of documentation. The seed processing plants were not in operation during the site visits and much of the equipment was dismantled for maintenance and cleaning purposes.

In the seed processing plants, the different types of pure seed are stored in segregated areas prior to processing. Impurities such as sticks are removed from the seed. The small fuzzy lint fibres are then removed from the seed using acid. The seeds are tested for germination and vigour, and seed meeting the required standards is then coated with a fungicide and insecticide to protect both the seed and seedlings from diseases and pests. A coloured dye is also added to differentiate the different seed varieties.

The environmental and OH&S issues associated with the cotton seed processing plants are typical of industrial plants and do not reflect the performance of the cotton industry as a whole.

The findings and recommendations have been reported separately to the two cotton seed processing companies involved in the audit.

> ***Recommendation 48:*** It is recommended that the seed processors not be included in future Australian cotton industry environmental audits and that the cotton seed processing plants conduct their own routine, independent, environmental and safety audits.

5.11 Cotton processor compliance with 1991 audit recommendations

The 1991 audit recommendations and the cotton industry's response are tabulated in Appendix H. Findings of this audit and evidence that the recommendations have been implemented are also detailed in the Appendix.

Implementation of recommendations is summarised below.

Recommendations	Number
Total number of recommendations	69
Cotton processor recommendations	20
◗ Environmental	◗ 10
◗ OH&S	◗ 10
High compliance	10
Partial compliance	8
Low compliance	1
Non compliance	1

Table 8: Summary of compliance with 1991 audit recommendations for cotton processors

Recommendations from 1991 which have not been fully addressed (and are still relevant) have been discussed in the previous sections.

High compliance was met for 50% of the recommendations, with a further 40% of recommendations partially implemented. There was only one recommendation rated as having low compliance regarding use of

compressed air instead of vacuum systems. The one non-compliance was with respect to a specific waste management issue at a cotton seed processor.

(Note: Recommendations 63 and 65 – 69 inclusive from the 1991 audit related to specific issues at a cotton seed processor. Compliance with these recommendations has been reported separately.)

6. Conclusions and Recommendations

6.1 Conclusions

The Australian cotton industry has been subject to intensive environmental scrutiny which, in part, was triggered by events such as fish kills from pesticides and pesticide residues (Helix and endosulfan) found in beef exports around five years ago. There are ongoing concerns with the intensive use of pesticides and perceived high water use. As a result of these incidents and concerns, the industry has developed a wide range of improvements, which it has implemented over the last twelve years since the inaugural environmental audit. The most significant and far-reaching improvements to environmental practices have been implemented over the last five years.

Although the cotton industry has vastly improved since the 1991 audit was conducted, there are still areas where significant environmental improvements could be achieved.

There have been a broad range of environmental improvements at cotton farms, with many ongoing incremental improvements. The key areas of improvement have been:

- Formulating and implementing a Best Management Practices approach to cotton farm and environmental management;
- Improving water use efficiency;
- Adoption and implementation of Integrated Pest Management strategies;
- Development and adoption of many management tools which have resulted in environmentally positive outcomes; and
- Conducting a strong research and development program.

6.2 Summary of recommendations

A number of recommendations have been made throughout the report and are summarised below. The key recommendations are highlighted and reflect the primary concerns of stakeholders and/or represent areas of significant risk to the environment or health and safety.

A large number of the specific recommendations, made below, are already covered by the Australian Cotton Industry Best Management Practices manual. However, the BMP guidelines have not been fully implemented at all farms. Participation in the BMP program and ongoing auditing will ensure that the industry standard is lifted.

No.	Recommendation
Cotton farms	
	Environmental management
1	It is recommended that Cotton Australia continue to encourage cotton growers to adopt the BMP system. A target should be set by the cotton industry to have most irrigated growers undertaking the initial BMP audit by the end of year 2004.

No.	Recommendation
2	It is recommended that the cotton industry: ◗ Organise for an independent cotton industry audit to be conducted more regularly, say at least every 5 years; and ◗ 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.
3	It is recommended in respect of environmental performance that the cotton industry: ◗ 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; and ◗ Publish a regular environmental performance report for cotton farms, with results validated by an external expert.
	Water use and management
4	It is recommended that: ◗ 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; ◗ Existing water storages be reviewed for rectification works to transform them into multi-cell, deeper ponds; ◗ Growers be encouraged to calculate the volume of water lost (and corresponding economic loss) through evaporation from their water storages and distribution channels; and ◗ Lining and leak testing of water storages and distribution channels be encouraged.
5	In regard to improving water use efficiency, it is recommended that: ◗ Growers be encouraged to assess where their losses are and to quantitatively measure their water usage and losses; ◗ Participation of growers in water and irrigation management courses be encouraged; ◗ The cotton industry continue field investigations for improving application methods and increasing water use efficiency; and ◗ 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 NSW.
6	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.
7	It is recommended that reviews be undertaken of the stormwater management systems that would specifically identify: ◗ 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; and ◗ Improvements to increase the capacity of the runoff retained.
8	It is recommended that 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.

No.	Recommendation
	Pest management
9	It is recommended that farmers, such as grain growers who only grow cotton intermittently, be encouraged via training, information and visits by extension officers to keep abreast of IPM practices.
10	It is recommended that "bug checkers"/ consultants be encouraged to record beneficial insects if they don't already do so.
11	It is recommended that comprehensive checks of spray records continue to be conducted during Best Management Practice audits as a means of measuring compliance with the Insecticide Resistance Management Strategy (IRMS). In addition, education or further strategies should target those farmers that do not adhere to the IRMS.
	Pesticide management
12	It is recommended that the following Pesticide Application Management Plan (PAMP) actions be taken: ◗ Growers be encouraged to extend the PAMP to cover all pesticides and herbicides used; ◗ In the interests of neighbourly harmony and courtesy, growers notify neighbours of all sprays, if requested by the neighbours; ◗ 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; ◗ PAMPs be reviewed and updated each season to identify any changed practices, new neighbours and communication to neighbours of different areas planted to cotton; ◗ Checks of PAMPs continue to be conducted, during BMP audits, as a means of checking the effectiveness of the PAMP; and ◗ 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).
13	It is recommended that 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.
14	It is recommended that the Groundrig Operators Association develop competency-based assessment procedures for its members to provide assurance on the competency of the operators and the equipment.
15	It is recommended that pesticide storage be improved by checking against "best practices" outlined in the Best Management Practice manual and implementing the following, where required: ◗ 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;

No.	Recommendation
	◗ Pesticides be stored within the designated bunded 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; and ◗ Old chemicals be removed off site and disposed of correctly.
16	It is recommended that 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.
17	It is recommended that to improve emergency procedures: ◗ All growers develop an Emergency Plan suitable to their size of operation; and ◗ Clear emergency procedures be displayed outside the storage shed, with back-up copies at the site office. Emergency procedures should also be legible from a distance.
18	It is recommended that in regard to Material Safety Data Sheets (MSDSs): ◗ Growers maintain a folder for the chemicals they actually use, so details can be readily accessed if there is an accident or environmental incident; ◗ Growers remove MSDSs for chemicals they do not use; ◗ Growers check that they have complete and most up-to-date MSDS for each chemical on an annual basis; ◗ MSDSs be made available to farm workers for all chemicals used on site, even if they don't have to handle the chemicals directly themselves; and ◗ Include links to a guide to websites that offer MSDSs on the CRDC and Cotton Australia websites.
19	It is recommended in regard to signage that: ◗ Growers check that they have the correct signage for the type of dangerous goods stored on site; and ◗ Signs be replaced if they are faded.
20	It is recommended that: ◗ Complaints from all cotton growing areas be collated on an annual basis, analysed and used as a performance indicator; and ◗ 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.
21	It is recommended that access of cattle be restricted by adequate boundary fencing for cotton farms adjacent to Travelling Stock Routes or graziers. The state of fence-lines should be evaluated in the BMP self assessment worksheets, Land Management module.
	Other chemicals

No.	Recommendation
22	It is recommended in respect of other (non-pesticide) chemicals that: ◗ Chemical inventories be expanded to cover all the chemicals and fuels used on site, and corresponding up-to-date MSDS should be obtained; and ◗ 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.
23	It is recommended that in NSW, 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.
24	It is recommended in regard to diesel storage that: ◗ 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 tank; ◗ Fire extinguishers or other protection measures be provided around large, permanent diesel tanks, in accordance with AS1940; ◗ Emergency procedures cover petrochemical storage and handling; ◗ Growers need to ensure that signage is correct on all fuel installations (guidelines are given in the BMP manual); ◗ Aboveground diesel tanks be installed in preference to underground tanks; and ◗ Conduct tank integrity testing for underground tanks greater than twenty years old and rusting or damaged above-ground tanks.
25	It is recommended in regard to petrol storage that: ◗ 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; and ◗ Tanks requiring decommissioning be pumped out and gas freed, then either dug up, crushed and tipped at an approved site of filled with an inert substance such as sand in accordance with (AS1940, WorkCover and API Guidelines).
26	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.
	Waste management
27	It is recommended in regard to waste pesticide containers that: ◗ The cotton industry work closely with chemical manufacturers and suppliers to maximise the availability of chemicals in reusable containers;

No.	Recommendation
	◗ Growers be discouraged from burying containers on site by providing alternative means of disposal, if viable. DrumMUSTER should be encouraged to provide regular services to cotton growing areas and to provide adequate notification of services; ◗ Growers ensure that containers are adequately cleaned and sent to drumMUSTER as soon as possible so that they do not accumulate on sites; and ◗ BMP audits include a check of evidence that chemical containers have been returned to drumMUSTER.
28	It is recommended in regard to workshop wastes that: ◗ Waste oil be collected and sent for reprocessing. Waste oil must not be dumped at landfills or used for dust suppression or termite protection; ◗ In more remote areas, farmers could coordinate a periodic oil collection with a recycling contractor, where an oil collection vehicle could visit a number of farms when an agreed volume of waste oil was available for collection; ◗ Waste oils/ oil filters be stored as for fresh oils in appropriately bunded, covered, ventilated areas, with correct signage and spill kit; and ◗ Old batteries and scrap metal be recycled wherever possible, with the former stored in bunded areas, while awaiting disposal.
29	It is recommended in regard to evaporation pits that: ◗ All wastewater, from chemical washout areas, drains to a controlled area, such as an evaporation pit; ◗ Evaporation ponds be sealed (such as with a thick plastic liner over a clay base); and ◗ All pits be securely fenced, kept locked and have appropriate signage.
30	It is recommended that guidelines be provided via the BMP manual for siting, design and operation of tip sites. These should be based on existing established guidelines such as the NSW EPA guidelines "Environmental Guidelines: Solid Waste Landfills" (1996).
	Land management
31	It is recommended that on-farm testing of salinity indicators, including routine conductivity tests of irrigation water, be increased in potential salinity problem districts.
32	It is recommended that guidelines be provided via the BMP manual for the identification and management of potentially contaminated sites.
	Vegetation management
33	It is recommended in respect to vegetation management that: ◗ 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; ◗ Cotton growers be encouraged to retain and manage native vegetation on farms; and ◗ Cotton growers be encouraged to plant trees and native vegetation on farms.
34	It is recommended in respect to riparian zone management that:

No.	Recommendation
	◗ 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; and ◗ 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.
	Wildlife
35	It is recommended in respect to wildlife that: ◗ 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; ◗ More vegetated 'islands' be designed into new ponds (or constructed in existing water storages when low – like this season) for waterbird habitat; ◗ Further projects on waterbird-related biodiversity values of on-farm wetlands and storages be conducted; and ◗ Further studies on biodiversity of other species on cotton farms should be conducted.
	Energy
36	It is recommended in respect to energy management that: ◗ 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.
	Education/ information transfer
37	It is recommended in respect of education and information transfer that: ◗ Growers be made aware of and encouraged to participate in further environmental educational courses with an emphasis on implementing best management practices and the specific needs of their farms (such as soil and water management courses); and ◗ CRDC and Cotton Australia give priority to funding field personnel for the introduction of the BMP Land and Water Management module, as this appears to be a most effective means of information transfer and encouraging the uptake of best management practices.
Cotton processing - gins	
	Air emissions
38	It is recommended in respect to environmental dust emissions that: ◗ Monthly dust deposition readings could be conducted at the site boundary, during the ginning season, for gins located near residences or other sensitive receptors; and ◗ Gins be encouraged to plant trees around the site perimeter to reduce wind-blown dust and for visual amenity.
	Water management
39	It is recommended in respect to gin washdown areas that: ◗ A washdown area be installed at all gins, which receive cotton from potentially disease-affected cotton areas; and

No.	Recommendation
	◗ An assessment be conducted to determine if there is a potential for contamination from disposal of the sludge from washdown pits/ ponds – sludge from a number of gins should be analysed for diseases.
40	It is recommended in respect to gin water use that: ◗ Water use minimisation measures be implemented at all gins; and ◗ Gravel-lined absorption trenches or other means of disposal be considered for septic tank effluent, where ponding is a problem.
41	It is recommended in respect to gin stormwater management that: ◗ Holding ponds (temporary water storage ponds) be installed, where practical, at site drainage points to capture silt and gross solids, particularly in environmentally sensitive areas; ◗ Trash screens could be considered at discharge points to screen cotton and trash from stormwater prior to release; ◗ Provision be made to isolate stormwater from around module yards that may store modules potentially affected with Fusarium wilt; ◗ For disease control purposes, stormwater should be directed away from adjacent cotton farms or disinfected prior to use; and ◗ Where appropriate, gins develop a hydrocarbon management policy and facilities to prevent potential stormwater, groundwater or land contamination, such as at the chain lubrication area.
	Dangerous goods
42	It is recommended in respect to dangerous goods storage at gins that: ◗ Gin management check all dangerous goods storage areas against regulatory requirements, including Australian Standards; and ◗ Gins consider developing a purchasing policy to screen and approve the types of chemicals and dangerous goods used on site.
	Waste management
43	It is recommended in respect to management of cotton trash that: ◗ Records be kept of all trash disposed of off-site (receiver, location, quantity, date); ◗ Written contractual agreements be developed for all off-site disposal. Farmers should not be allowed to take trash for unaccounted use on their farms; ◗ A consistent suite of tests be established for testing of cotton trash; and ◗ Routine monitoring of trash be conducted for pesticides, salt levels, nutrients and diseases to ensure that composted trash is a suitable material for reuse. Cotton trash should preferably be kept on site until results indicate that offsite reuse is acceptable.
44	It is recommended that gin managers ensure that on-site waste tips are properly maintained.
45	It is recommended in respect to transport spillage that the cotton industry improve the management of transporting cotton modules to the gin.

No.	Recommendation
	Best management practices
46	It is recommended in respect to environmental management at cotton gins that: ◗ A minimum industry standard guide for cotton gins be produced; ◗ Standard environmental checklists be developed to allow gins to conduct internal environmental audits; and ◗ External environmental audits be considered on a routine basis at gin sites, irrespective of size.
	Occupational Health and Safety
47	It is recommended in respect to Occupational Health and Safety practices at gins that: ◗ Gins investigate better dust control systems, rather than blowing dust with compressed air; ◗ Gins produce noise maps to identify high noise areas for internal and external areas; ◗ Routine OH&S noise monitoring be undertaken at all gins; ◗ Gins be encouraged to take part in an accredited safety program in order to improve OH&S practices and documentation of procedures; and ◗ A general self-audit checklist be developed for the smaller gins (which do not have their own OH&S specialists).
Cotton processing – seed processors	
48	It is recommended that the seed processors not be included in future Australian cotton industry environmental audits and that the cotton seed processing plants conduct their own routine, independent, environmental and safety audits.

Appendix A

List of abbreviations

Abbreviation	Definition
AAAA	Aerial Agricultural Association of Australia
AATSE	Australian Academy of Technological Sciences and Engineering
ACAHS	Australian Centre for Agricultural Health and Safety
ACCRC	Australian Cotton Cooperative Research Centre
ACF	Australian Cotton Foundation (now Cotton Australia)
ACGRA	Australian Cotton Growers Research Association
AFFA	Department of Agriculture, Fisheries and Forestry - Australia
ANZECC	Australia & New Zealand Environment Conservation Council
API	Australian Petroleum Institute
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standard
AVCA	Agricultural and Veterinarian Chemicals Association of Australia
AWA	Australian Water Association
AWM	Area Wide Management
BDI	Beneficial Disruption Index
BMP	Best Management Practices
CA	Cotton Australia
CBWC	Condamine Balonne Water Committee
CCA	Cotton Consultants Australia
CFZ	Chlorfluazuron
CMB	Catchment Management Board
CMN	Conservation Management Network
CNWRWQP	Central & North West Regions Water Quality Program
CRDC	Cotton Research and Development Corporation
CSD	Cotton Seed Distributors Ltd
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWUE	Crop water use efficiency
DIPNR	Department of Infrastructure, Planning and Natural Resources
DIR	Department of Industrial Relations (Qld)
DLWC	Department of Land and Water Conservation (NSW)
DPI	Department of Primary Industries (Qld)
EC	Emulsifiable Concentrate
EDO	Environmental Defenders Office

Abbreviation	Definition
EPA	Environment Protection Authority
ET	evapotranspiration
GHD	GHD Pty Ltd
GIS	Geographical Information System
GL	Gigalitre
GMO	Genetically modified organism
GOA	Groundrig Operators Association
GPS	Global Positioning System
GRDC	Grains Research & Development Corporation
GSM	Grower Services Manager
IDO	Industry Development Officer
IE	Irrigation efficiency
IPM	Integrated Pest Management
IRMS	Insecticide Resistance Management Strategy
L	Litre
L&WA	Land and Water Audit
LDP	Large Droplet Placement
LWRRDC	Land and Water Resources Research and Development Corporation
MDBC	Murray-Darling Basin Commission
mg/m^3	Milligrams per cubic metre
ML	Megalitre
MSDS	Material Safety Data Sheet
NCEA	National Centre for Engineering in Agriculture
NPV	Nuclear Polyhedrosis Virus
NPWS	National Parks and Wildlife Service
NSCA	National Safety Council of Australia
PAMP	Pesticide Application Management Plan
PAN	Pesticides Action Network
PM10	Particles less than 10 microns
POEO	Protection of the Environment Operations
PPE	Personal Protective Equipment
OH&S	Occupational Health and Safety
RIRDC	Rural Industries Research and Development Corporation
SKM	Sinclair Knight Mertz

Abbreviation	Definition
TAFE	Technical and Further Education
TSP	Total Suspended Particulates
ULV	Ultra Low Volume
VCA	Voluntary Conservation Agreement
WUE	Water Use Efficiency

Table 9: List of abbreviations (Appendix A)

Appendix B

Glossary

Term	Definition
Action Guideline Level	Concentration level established by NHMRC/ ARMCANZ which may trigger surveillance
Adjuvant	An agent added to a substance to increase its effectiveness
ai	Active ingredient
Area Wide Management group	A group of cotton growers (from 3-12 growers) who co-ordinate integrated pest management on a regional basis
Bale	Unit of ginned cotton weighing 227 kilograms of lint
Benchmark	Criterion by which to measure something – a reference point
Beneficials	Insects that are beneficial to the cotton crop eg: insects that prey on caterpillars
Best Management Practices	Practices that have been identified as the best way to carry out a particular process
"Bollgard II" ® cotton	Two-gene cotton which uses the gene in Inguard cotton plus another which produces a different form of the Bt toxin.
Bt	Bacillus thuringiensis Bacterium that manufactures toxic crystals which selectively kills certain caterpillars. Does not kill spiders or other insects and is non-toxic to the environment and to the food chain.
Conservation Management Networks	Conservation Management Networks are designed to help to coordinate the protection and ongoing management of remnant vegetation and to support the owners and managers of the remnants. A Conservation Management Network (CMN) is a network of remnants, their owners or managers, and other interested individuals. A CMN usually focuses on one ecological community, such as grassy woodland in a particular region, wetlands of a river system, or a particular forest type.
CottonLOGIC	A computer-based decision support tool to help growers record and analyse information on insect pressures, fertiliser use, pesticide applications, field operations, water management and water use efficiency.
Crop water use Efficiency	The amount of cotton lint produced per unit of water used as evapotranspiration.
Evapotranspiration	Water that passes from the leaves of plants to the air plus water evaporated from the surface of the plants and soil.
Endosulfan	Organochlorine insecticide, which has been extensively used in the past on cotton for the control of heliothis larvae, thrips, aphids and mirids. Endosulfan is highly toxic to aquatic organisms. Endosulfan absorbed by foliage degrades quickly, with a half life of 3-4 days. In soil, a biological oxidation product endosulfan sulphate can form, which has a half life of 110 days.
Environmental flow	River flows produced by releasing dam water to simulate, maintain or repair natural flow patterns.
Farm Water Use Efficiency	The amount of water used by the crop in evapotranspiration expressed as a proportion of the total water input to the farm.
Genetically modified organism	The modification of a micro-organism, plant or animal by inserting a modified gene or gene from another variety or species, generally to improve disease resistance or improve growth.
Heliothis	Moth species. The caterpillars of two species are major cotton pests in Australia and can quickly devastate crops if not controlled.
Helix	Trade name of pesticide chlorfluazuron (CFZ), sold by ICI Australia.
Industry Development Officer	Officer acting as a link between the research organizations and growers. IDOs provide information and advice, facilitate Area Wide Management groups, organise field days, as well as conduct local trials of new techniques and cotton varieties.
"Ingard" ® cotton	Brand name of transgenic cotton carrying the Bt gene, which gives built in protection against the heliothis caterpillar (licensed by Monsanto)
Insecticide Resistance	The IRM Strategy sets the limits on which insecticides can be used and when they can be used in

Term	Definition
Management Strategy	different growing valleys.
Integrated Pest Management	Is an approach to pest control which recognises that maximum control of pests is likely to require several methods used in concert, including using cultural, biological, mechanical and chemical control methods.
Lint	Cotton fibre
Metolachlor	Selective herbicide of the chloroacetanilide group. Used on cotton for the control of annual grasses and broad leaf weeds.
Module	Large container into which cotton is transferred following harvesting, to allow for transportation to cotton gin.
Offset buffer zone	During aerial application of pesticides, a portion of the target crop is left untreated on the downwind side. The untreated area is then treated when weather conditions change and are favourable, or can be treated with a different pesticide.
Pesticide	Chemicals used as insecticides, herbicides, growth regulators, defoliants, conditioners and dessicants
PM10	Particles less than 10 um diameter, commonly referred to as inspirable dust
Prometryn	Selective, systemic herbicide of the triazine group. Used on cotton for the control of annual grasses and broad leaf weeds.
"Roundup Ready" ® cotton	Brand name of transgenic cotton carrying a gene which gives built in protection against the herbicide Roundup.
Refuge crops	Refuge crops, such as sorghum, lucerne or soybean are grown to allow populations of heliothis to breed without selection pressures. Refuge crops are required to be grown with transgenic cotton. Refuge crops are not subject to the normal spray regime and can harbour beneficials.
Transgenic cotton	Cotton crop that has been subject to gene transfer, genetically modified species.
Trap crops	Crop planted alongside cotton designed to lure heliothis into them, where they are then destroyed. Soybean, chickpea, maize, pigeon peas, sorghum, etc, may be used as trap crops. Efficiency of the trap crop depends on the season.
Trigger value	Concentration level below which there is a low risk of adverse effects on the environment. When the concentration level is reached, this should "trigger" further investigations, such as more intensive monitoring or characterisation of risk.
Voluntary Conservation Agreement	These are voluntary, joint agreements between a landholder (private land owners, a local council, or a person leasing land from the Government) and the local or state government, which allows landholders to conserve the natural, cultural and/or scientific values of an area of land. It is intended to provide permanent protection for the special features of an area, eg: to conserve remnant native bushland. Each VCA is: voluntary; ownership remains with the land owner; does not restrict future sale of land; is an individual agreement.
Wildlife Refuge	Wildlife Refuges are a voluntary agreement between a landholder and the National Parks and Wildlife Service. The Wildlife Refuge lasts only as long as the land holder wishes, but while it is in place it provides legal protection for the land.

Table 10: Glossary of Terms (Appendix B)

Appendix C

Audit team & Reference Group

The GHD environmental audit team taking part in this study are listed below:

Team Member	Title	GHD office	Role
Ian Garrard	Environment Manager	Sydney	Project Director
Ross Woodward	Principal Environmental Scientist	Sydney	Peer review
Sue Trahair	Senior Environmental Auditor	Sydney	Project Manager and site auditor
Maurice Pignatelli	Senior Environmental Auditor	Sydney	Site Auditor
Chris Owen	Senior Environmental Auditor	Brisbane	Site Auditor
Bruce Markey	Principal Chemist	Sydney	Toxicology
Carolyn Pettigrew	Consultation Specialist	Sydney	Consultation and workshop
Andrew Batts	Consultation Specialist	Brisbane	Consultation and workshop
Kylie Fitzpatrick	Environmental scientist	Sydney	Consultation and survey
Alison Packwood	Environmental scientist	Sydney	Research, site visit programming
Nicholas Digges	Environmental engineer	Sydney	Research

Table 11: GHD Environmental audit team (Appendix C)

The Cotton Industry Second Environmental Audit Reference Group are listed below:

Name	Position	Organisation
Guy Roth	Research Program Manager	Cotton Research and Development Corporation
Dr Gary Fitt	Chief Executive Officer	Australian Cotton Cooperative Research Centre
Allan Williams	Executive Officer	Australian Cotton Growers Research Organisation
Rachel Holloway	Research Program Co-ordinator	Cotton Research and Development Corporation
Bruce Pyke	Research and Extension Manager	Cotton Research and Development Corporation
Peter Cone	Advisor - Technical	Cotton Australia
Prof. Ron Harris	Cotton Research and Development Corporation External Peer Reviewer	Professor Emeritus (University of Guelph)

Table 12: Cotton Industry Second Environmental Audit Reference Group (Appendix C)

Appendix D

Site Visits

State	Growing district	Number of farms
NSW	Namoi	5
	Upper Namoi	2
	Bourke	1
	Macquarie	5
	Hillston (Menindee)	1
	Gwydir	4
	Macintyre (Border Rivers)	2
Queensland	Emerald	2
	Theodore	2
	Darling Downs	3
	St George	2
	Dirranbandi	1
	Macintyre (Border Rivers)	2

Table 13: Site visits – cotton farms (Appendix D)

State	Location
Cotton gins	
NSW	Hilston
	North Bourke
	Warren
	Merah North
	Narrabri
Queensland	Emerald
	Dalby
Cotton seed processors	
NSW	Narromine
	Wee Waa

Table 14: Site visits – cotton processors (Appendix D)

Appendix E

Literature reviewed

E.1 Publications

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Williams, J., (February 2003) "Challenging our Water Myths" National Parks Journal, pp 10-11

WorkCover NSW and Queensland DIR (November 2002) "Joint Cross Border Cotton Gin Project 2002/2003, Consolidated Analysis, Mail Survey"

E.2 Web sites reviewed

Organisation	Website	Information
Aerial Agricultural Association of Australia (AAAA)	www.aerialag.com.au	◗ Background to and current operations and initiatives of the AAAA
Australian Bureau of Statistics	www.abs.gov.au/ausstats	◗ Water account for Australia
Australian Cotton Cooperative Research Centre	www.cotton.crc.org.au	◗ Information about and links to industry organizations and local growers associations ◗ Technical/ research papers ◗ IPM Short Course
Australian Legal Information Institute	www.austlii.edu.au	◗ Prosecutions relating to the cotton industry
Australian Natural Resources Atlas	www.environment.gov.au/atlas	◗ Data summaries and maps of natural resources data
Commonwealth Bureau of Meteorology	www.bom.gov.au	◗ Annual Australian Climate Summary 2002
Cotton Australia	www.cottonaustralia.com.au	
Cotton Seed Distributors	www.csd.net.au	◗ GM cotton trials
Cotton Research and Development Corporation	www.crdc.com.au	◗ Current research projects ◗
Cotton World News	www.cottonworld.com.au	◗ Cotton industry information and news updates

Organisation	Website	Information
Department of Land and Water Conservation, NSW	www.dlwc.nsw.gov.au	◗ Catchment Management Boards ◗ Draft Catchment Blueprints ◗ Draft Regional Vegetation Management Plans ◗ Draft Water Sharing Plans
Department of Industrial Relations, Workplace Health & Safety, Qld	www.whs.qld.gov.au	◗ Agricultural sector audits
Department of Natural Resources & Mines. Qld	www.nrm.qld.gov.au/slats www.nrm.qld.gov.au/rwue/ www.nrm.qld.gov.au/salinity	◗ Land cover change in Qld ◗ Rural Water Use Efficiency Initiative ◗ Salinity Hazard Mapping
Environment Protection Authority, NSW	www.epa.nsw.gov.au	◗ Environmental licences for cotton gins ◗ Penalties and fines
Jones Air	www.jonesair.com.au	◗ Company information ◗ Company ISO 14001 EMS overview
NSW Fisheries	www.fisheries.nsw.gov.au	◗ Fish kill database
Pesticide Action Network (PAN) UK	www.pan-uk.org/pestnews	◗ Claims against ICI Australia in relation to the Helix incident
Smartrivers	www.smartrivers.com	◗ St George and Dirranbandi irrigators group
University of New England	www.une.edu.au/agronomy/cotton	◗ Cotton Production Course
University of Queensland	www.uq.edu.au	◗ Current research projects ◗ Centre for Pesticide Application and Safety
World Wide Fund for Nature	www.wwf.org.au/downloads	◗ NSW land clearing report ◗ Land clearing in Qld

Table 15: Web sites reviewed (Appendix E)

E.3 Videos and presentations reviewed

Australian Greenhouse Office, Martin Teasdale, "Greenhouse Challenge and Cotton", presentation

Roth,G, "Irrigation of Cotton" presentation, CRDC

CSIRO, 1993 "Caterpillars and Cotton" video

WorkCover & Department of Industrial Relations "Cotton Ginning Industry Project" 7/11/02, presentation

Appendix F

Cotton Industry Stakeholder Survey

APPENDIX F – COTTON INDUSTRY STAKEHOLDER SURVEY

F.1 Purpose

The purpose of the questionnaire and phone survey was to ascertain stakeholder views on current environmental performance of the cotton industry as a whole and for particular areas of concern. The survey and interviews assessed whether environmental best practices were generally being followed (or were perceived as being followed) and whether it was perceived that environmental improvements have been made in the twelve years since the previous audit. The survey also identified areas where it was perceived that improvements still need to be made.

The results of the survey were compared to current industry data and practices, as well as findings and observations made during the site inspections.

The results of the surveys are evaluated in Section F.4 and summarised in Section 4.3 of the main report.

F.2 Methodology

Initially, previous surveys of the cotton industry were examined as part of the literature review. Findings of previous studies and surveys are summarised in F.3.

Results were used to help formulate a questionnaire/ phone survey. The questionnaire is included at section F.5. The questionnaire was reviewed by CRDC prior to distribution.

The questionnaire was sent to the organisations listed in an industry database, prepared by CRDC, in early November 2002. The questionnaire was also placed on the CRDC and GHD website, along with background information on the project.

The project and survey were widely advertised in cotton industry and the environmental publications listed below:

Publication	Publisher	Format	Frequency
AWA Water News	AWA news@awa.asn.au	Email newsletter to AWA members	Weekly
WME email news	Waste Management & Environment Media Pty Ltd	Email newsletter - free	Weekly
EDO NSW Bulletin	Environmental Defenders Office Ltd (NSW) edonsw@nsw.edo.org.au	Email newsletter - free	Weekly
EnviroInfo	Hallmark Editions lawninfo@lawnmedia.com.au	Email newsletter - free	Fortnightly
eba newsletter	Environment Business Australia eba@environmentbusiness.com.au	Email newsletter to members	Monthly
"Water"	Australian Water Association	Monthly magazine	Monthly

Table 16: Advertising of survey questionnaire (Appendix F)

Follow-up telephone surveys were conducted with organisations who had not submitted a written response.

F.3 Previous studies and surveys

Cotton farmers

A "Cotton Industry Benchmark Survey" was conducted in 1996 and again in 2000. The 1996 survey indicated the following areas of environmental concern:

- Soils: pupae control; soil compaction; erosion control;
- Cotton stubble management: trash entering tail water; pull, rake & burn method;
- Spray drift reduction;
- Water use efficiency; and
- Insect management.

Source: ACCRC/ CRDC, August 2000, "Cotton Industry Benchmark Survey: An Analysis of the Australian Cotton Industry", CRDC Occasional Papers: Extension.

The 2000 survey results have not yet been published.

Community attitudes

A major research program was conducted in 1995 in country NSW and Sydney by Stollznow Research Pty Ltd. The results of the 1995 survey were used to prepare various community communications campaigns involving advertising to raise the profile of the cotton industry, which were run in 1996 and 1997. In 1997, a three-part program was developed and conducted by Stollznow Research Pty Ltd to assess the effect of the advertising and to reassess community attitudes in the country. The three stages of the program included a phone survey, in depth discussion groups regarding the major issues raised during the survey, and a review of attitudes of cotton industry employees. The results of the Stollznow survey relevant to this audit are summarised below.

617 interviews were conducted across five different communities in Queensland and NSW cotton growing areas via phone. 46% of respondents to the survey felt that there should be no modification to the environment, or that only minor modification was acceptable. 35% of respondents felt that any industry affecting the environment should ensure that the environment is sustainable.

Of 168 unprompted responses, the main areas of environmental concern raised by respondents were:

- pollution as a result of the use of chemical sprays (33);
- aerial application of these sprays (33);
- degradation of river water (21);
- excessive water usage (12);
- degradation of the land (11);
- degradation of groundwater (9);
- land clearing (8); and
- community health issues (including asthma, hay fever, headaches, allergies) (7).

Overall, the majority of unprompted concerns relate to chemicals and their application, followed by water usage issues, then land care issues, and finally community health issues.

One part of the survey related to the level of respect respondents had for the cotton industry. It was noted that people with the highest level of concern regarding environmental issues had the least respect for the cotton industry. It was also noted that people associated with the cotton industry generally had the same range and level of concerns as those who were not engaged in the cotton industry.

Respondents were asked to rate their level of concern for 15 specific environmental issues put to them. The level of concern, from highest to lowest, were: Chemical usage; Spray drift; Aerial spraying; Pesticide usage; River water quality; Groundwater quality; Community health; Residue in soil; Herbicide usage; Soil erosion; Effect on wildlife; Land clearing; Irrigation practices; Overstocking; and Local subdivisions. As with the unprompted responses, the highest level of concern relates to chemical usage and application, followed by water issues, then community health issues. The levels of concern about these issues were equal between country people and city people.

Respondents were asked to comment on their perception of the level of environmental concern felt by various industries. Each individual (including cotton growers) felt that they were more concerned with the environment than anyone else. The cotton industry rated quite low when compared to Landcare (which was seen to have a high level of concern for the environment) and other conservation groups, but reasonably well when compared to other industries such as mining and cattle farming.

The cotton industry rated relatively poorly in actually caring for the environment, slightly above the state government.

Source: Stollznow Research Pty Ltd, April 1997 "Investigation and monitoring of community attitudes toward the cotton industry in country areas", prepared for Cotton Australia Ltd.

Following the presentation of the results of the survey, discussed above, a qualitative follow-up was undertaken. Seven discussion groups were held in four geographic areas.

It was stated that the overriding central issue remains community health, although in the previous study this did not appear as the main issue. Concerns were the possible short and long-term effects on community health resulting from the perceived heavy use of cotton chemicals and their method of application, and include spray drift and residue in soil and water (river water, groundwater and tank water). Other major issues discussed included water usage (conflicts with other users) and land clearing in some cotton growing areas.

In addition to concerns raised in the survey, concerns raised during discussions included:

- It was felt that there was not enough detailed information on how far chemicals drifted;
- Fish kills, along with the possibility of chemicals leaching into underground water supplies;
- Bt cotton – generally perceived as a positive with regard to reduced chemical use, however concerns were raised as it 'kills bugs', and may therefore alter the overall ecological balance.
- The Helix 'contaminated beef' issue – it was generally felt that Helix was not the major health risk that it was perceived to be;
- It was felt that irrigation licenses have been over-issued, and that allocations need to be reduced to lead to more equitable distribution of water amongst those who need to use it. Cotton farmers are seen as having greater access to water in some areas to the detriment of others;
- Animal habitats are destroyed by farming;
- The Department of Natural Resources is blamed for not having paid a great deal of attention to pre-planning in the area of water allocation;

- Some farmers are illegally pumping water;
- People become more afraid of things if they don't know the facts, for example, people don't realise that the pesticides used in the cotton industry are the same as what they put on their roses or vegetable gardens;
- Clearing of land in areas which should not be cleared (along rivers, on slopes) leading to degradation of land was raised as a problem;
- Salinity – the problem is becoming greater every year;
- Community health including short term (asthma, nose bleeds) and long-term (genetic, cancer);
- Shortage of objective information – eg. How much chemical is actually in the land, and what the life of that chemical is;
- Lack of education about things such as recycling water;
- The farmers feel that they are not really represented by anyone, including industry bodies.

Source: Stollznow Research Pty Ltd, June 1997 "Qualitative investigation of community attitudes toward cotton growing", prepared for Cotton Australia Ltd.

F.4 Results of the current survey

F4.1 Respondents (Question 1)

Sixty responses were received. Respondents were classified into one of three categories:

- *Cotton industry*, including cotton farmers, cotton ginners, seed processors, industries serving the cotton industry (eg. aerial pesticide applicators, cotton consultants, irrigation consultants) - 32 responses;
- *Government* agencies (local, state and federal) - 17 responses; and
- *The community*, including environmental and community groups, concerned citizens, neighbours to cotton growers, Landcare - 11 responses.

F.4.2 Areas of environmental improvements (Question 2)

Respondents were asked to state whether or not they agreed that a range of environmental improvements had been made in the cotton industry. Responses ranged from 'strongly agree' to 'strongly disagree'.

Between 40-50% of respondents **strongly agreed** that the following environmental improvements had been made:

- Implementation of the Australian Cotton Industry Best Management Practices manual (47%)
- General reduction in pesticide usage (43%)
- Reduced pesticide use due to use of genetically modified cotton (43%).

Over 50% of respondents **agreed** that the following environmental improvements had been made:

- Improved disposal of old chemicals and chemical drums (60%)
- More information provided to the community on environmental issues (58%)
- More vegetation or crops planted around farms as buffers from pesticide application (56%)
- Improved irrigation practices and water use efficiency (54%)

- Improved measures to minimise effects of pesticide drift (52%)
- Improved attitude of the cotton industry to the environment (52%)

A smaller proportion of respondents **agreed** that were tighter legislative pesticide controls (49%), that there had been an improvement in tailwater management (49%), a general reduction in pesticide usage (48%), improvement in river water quality/lower pollution (47%), improvement in aerial spraying application to cotton crops (43%), lowers levels of odours and dusts (44%), implementation of the Australian Cotton Industry Best Management Practices manual (42%) and reduced pesticide use due to use of genetically modified cotton (42%).

Those who **disagreed** or **strongly disagreed** that the various improvements had been made were in the minority, with the highest proportion of respondents to disagree being 25%, who disagreed that more plants had been planted around cotton farms as wildlife corridors.

The responses to this question generally indicate that a large proportion of respondents either agree or strongly agree that each of the listed environmental improvements have been made.

F.4.3 Level of concern regarding environmental issues (Question 4)

Respondents were asked to rate their level of concern regarding various environmental issues faced by the cotton industry as high, moderate, low, or no concern. Respondents were also given the opportunity to state any additional concerns they had.

The responses from each category were assessed separately, in order to assess how the level of concern for various issues is influenced by different backgrounds. The results are discussed below.

Cotton industry

A large proportion of respondents from the cotton industry were **highly concerned** about:

- The distribution of water/water allocations (72%),
- Environmental flows and the spread of weeds and diseases (50%),
- Depletion of groundwater (43%).

A large proportion of respondents from the cotton industry were **moderately concerned** about:

- Aerial spraying of chemicals/spray drift (65%), and
- Water pollution as a result of chemical use (56%).

A smaller proportion was moderately concerned about land clearing (44%), provision/retention of wildlife corridors (43%), the attitude of the cotton industry towards caring for the environment (42%), salinity (42%), community health (41%), land degradation/salinity (41%), and disposal of chemical drums (40%).

Government

A high proportion of respondents from government agencies were **highly concerned** about:

- Excessive water extraction/usage and environmental flows (65%),
- Depletion of groundwater supplies, distribution of water/water allocations (62%),
- Fish kills (59%),

A smaller proportion was highly concerned about the spread of weeds and diseases (44%), community health (38%) and salinity (38%).

A high proportion of respondents from government agencies were **moderately concerned** about:

- Aerial spraying of chemicals/spray drift (88%),
- Water pollution as a result of chemical use (76%),
- Land degradation – salinity (65%),
- Contamination or degradation of groundwater quality (59%),
- Provision/retention of wildlife corridors (56%),
- Degradation of river water quality (53%),
- Land degradation – erosion, retention of remnant vegetation (50%),
- The attitude of the cotton industry toward caring for the environment.

A smaller proportion was moderately concerned about reuse/reticulation of water (44%), effects on wildlife (44%), greenhouse gas issues (40%) and the lack of information on the environmental impacts of the cotton industry (40%).

The community

A large proportion of those fitting into this category were **highly concerned** about the majority of issues:

- Distribution of water/water allocations and depletion of groundwater (82%),
- Provision/retention of wildlife corridors (80%),
- Environmental flows, salinity, contamination or degradation of groundwater quality, aerial spraying of chemicals/spray drift, degradation of river water quality (73%),
- Land clearing (70%),
- Fish kills, chemical residues in soils, land degradation, water pollution as a result of chemical use, excessive water usage/extraction, retention of remnant vegetation (64%),
- Biodiversity, disposal of old chemicals (60%)
- Land contamination, effect on wildlife, the attitude of the cotton industry toward caring for the environment (55%); and
- Community health (50%).

A smaller proportion was highly concerned about the spread of weeds and diseases (45.5%), disposal of chemical drums (45.5%), and ground application of pesticides (40%).

A large proportion of the community were **moderately concerned** about:

- Land degradation – erosion (60%),
- Lack of information on environmental impacts of the industry (55%).

A smaller proportion was moderately concerned about land contamination (46%), effect on wildlife (46%), and community health (40%).

Discussion

The responses to this question indicate that the highest levels of concern for the highest number of issues are felt by those not directly involved in the cotton industry. Those in the cotton industry are highly concerned about the fewest issues.

Each group was highly concerned about the distribution of water/water allocations, and environmental flows. It is possible that the context in which the different groups are highly concerned about these issues are different. For example, those from the cotton industry may be concerned about how the distribution of water affects farm productivity, and may be concerned about how environmental flows are low due to drought, and may affect their water allocation. On the other hand, the community groups may be concerned about how distribution of water and low environmental flows may harm the environment.

Other issues which a high proportion of respondents in each of the groups commonly felt high to moderately concerned about included the spread of weeds and diseases, aerial spraying of chemicals/spray drift, and water pollution as a result of chemical use.

Additional concerns raised by respondents included:

- Occupational health and safety;
- The ability of the media to portray the cotton industry in bad terms;
- The impact of inappropriate Government policies on the industry;
- That the cotton industry does not do enough to correct misperceptions held by the public;
- The potential problems associated with genetically modified cotton (eg. super weeds);
- The impacts are not unique to the cotton industry, other industries also have these impacts on the environment; and
- Improvement needed in the level of support for growers who are addressing all the right environmental legislation and practices in order for them to remain positive and profitable. A lot of farmers are in a productivity/profit bind and are generally being as environmentally friendly as they can be.

F4.3 Do you feel your concerns are being addressed by the cotton industry (Question 5)?

79% of respondents indicated that their concerns were being addressed by the cotton industry. Several respondents answered 'yes and no', indicating that some but not all of their concerns were being addressed, and listed concerns they had that were not being adequately addressed.

Issues that people feel are not being adequately addressed are summarised below:

- There are still a lot of growers not involved in the BMP program. It was felt that more pressure should be put on them to become involved. There is a definite need to market the benefits of being involved in the program. It was also suggested that other farming groups should be encouraged to participate in similar schemes;
- Several people felt that many of the listed issues had been addressed to a degree, but not to the required level and not by everybody;
- "...the issue of inefficient use of water and the failure to return empty chemical drums should be better dealt with. Farmers should have to show evidence of chemical drum return as part of their audits (i.e. receipts from DrumMuster or retailer)";

- Flora and fauna issues are not being adequately addressed;
- Government agencies do not police/enforce the tighter legislative controls adequately (on pesticide use, land clearing, etc) due to lack of funding/staff;
- One respondent felt that the only way to address his concerns would be to ban the expansion of cotton farming, outlaw genetically modified cotton, and to use labour intensive not pesticide intensive farming methods;
- Understanding and managing soil is not given enough of a priority;
- Need more of a research focus on biodiversity, and how it can benefit the cotton industry (eg. beneficial insects);
- One person felt that not enough research had been done on greenhouse gases in the cotton industry;
- There needs to be an understanding that many of the environmental impacts are due to inappropriate government policy and lack of substantial and accurate science to support the policy. [This comment was related to the issue of water allocations]

The question goes on to ask who should address their concerns. It was suggested by several respondents that a collaboration of all relevant stakeholders was required to address environmental concerns, so that everyone involved has input, and there is a commitment by all to recognise that there are shared responsibilities in dealing with environmental aspects of the industry. One aerial operator indicated that they would like to be involved in the 'deliberations' by the cotton industry regarding environmental improvement, but had never been invited to do so.

Others suggested that issues could be resolved by the cotton industry in consultation with relevant government agencies, and that agencies such as DLWC and NSW Agriculture should be in a more advisory than regulatory role. It was also suggested that the government could address concerns by increasing staff numbers and funding organizations responsible for enforcing legislation.

Another suggestion was that further linkages with organisations such as catchment groups and Landcare groups would be useful.

F4.4 Do you feel that the cotton industry communicates with the public openly and effectively (Question 6)?

Of the respondents that answered this question, 64% felt that the cotton industry communicates openly and effectively with the public. Some people answered 'yes and no', with one person suggesting that the industry made information available if people were willing to read it, and therefore communication was open but not effective.

The theme of the comments varies widely. Some feel that the industry has not made enough of an effort to inform the public of the environmental improvements that have been made.

Others feel that the industry only communicates the good news stories and covers up the bad news, and that this has lead to suspicion in the community. Some feel that the lack of communication from the cotton industry has lead to the spread of misinformation.

Some respondents felt that open and effective communication had been achieved through community groups that have been formed specifically to help information transfer between the cotton industry and community, and through school education days about the cotton industry.

Others feel that it is necessary to improve the public perception of the cotton industry, but that it is difficult to sufficiently resource media/education activities, particularly outside of rural areas. Furthermore, it is felt that it is difficult to publicise positive news, but that bad news is easily publicised, and the effect of bad news can far outweigh the effect of good news. It was suggested that grower groups needed to establish a working relationship with the media to help communications between the cotton industry and general public.

Communication from the cotton industry alone is often perceived to be defensive, therefore it was felt that another method is needed to get the correct message into the media and the community. One respondent suggested that a collaborative team approach is needed to communicate cotton issues. They feel that the cotton industry and other social representatives speaking together about the good and bad issues facing the industry could achieve effective communication.

Another issue that was addressed was that of communication within the cotton industry. One comment is provided below:

> *"..... my main concern is that growers are paying their levy and then wondering how this is of benefit to them. Without a marketing plan, coinciding with a communication plan and consistent communication with growers, ... much of the research dollars seems to be tucked away with researchers that never sees the light of day except for the cotton conference proceedings. The website is a start but how much does a "mum and dad" grower know about the web and how to find relevant research that applies to their cotton farm. Overall I would rate the communication the highest on the list of importance and fund it accordingly, much of the environmental research is being done but no* [one] *sees it! Dissatisfied customers paying their levy wondering what benefit they get. Coordination of research and being able to access growers that have adopted the research to benefit their operation will be a key to showing other growers how individual research can have long term environmental benefit, the "triple bottom line" in grower language....."*

Several other respondents mentioned that the cotton extension officers in their region did a very good job of keeping them informed, and one commented that communication within the cotton industry was much better than communication between the cotton industry and the general public.

F.5 Questionnaire

All information from this questionnaire will be treated confidentially

1. What is your association with the cotton industry? (Tick more than one box, if applicable)

	Cotton industry organization		Environmental group, and if so, please name:
	Education, Researcher		Community group, and if so, please name:
	Cotton farmer		Local council, and if so, please name:
	Grazier or neighbour to cotton farmer		Other government body (federal, state) and if so, please name:
	Cotton industry services (aerial applicator, ground rig operator, chemical supplier, cotton consultant, cotton gin, cotton seed processor, etc)		Concerned citizen – city resident
	Landcare group		Concerned citizen – regional/ country resident
	Downstream water irrigator		Other (please specify):

2. Environmental improvements have occurred in the cotton industry in the last ten years. Please state whether you agree that improvements have been made in the following areas:

Area	I agree that environmental improvements have been made				
	Strongly agree	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
Implementation of the Australian Cotton Industry Best Management Practices manual					
General reduction in pesticide usage					
Reduced pesticide use by using genetically modified cotton					
Tighter legislative pesticide controls					
Improved aerial spraying application to cotton crops					
Improved measures to minimise effects of pesticide drift					
Improved disposal of old chemicals and chemical drums					
Lower levels of odours and/or dust					
Improved irrigation practices and water use efficiency					
Improved river water quality/ lower pollution					
Improvement in tail water management					
Reduction in incidence of fish kills					
Improved groundwater quality					
Improved land clearing practices					
More trees planted around cotton farms as wildlife corridors					
More vegetation or crops planted around cotton farms as buffers from pesticide application					

Area	I agree that environmental improvements have been made				
	Strongly agree	**Agree**	**Don't know**	**Disagree**	**Strongly disagree**
Improved attitude of the cotton industry to the environment					
More information provided to the community on environmental issues					
Other (please state):					
No improvements					

3. Have you visited a cotton farm in the last few years?

☐ Frequently ☐ Infrequently (< 2 times) ☐ Not in the last 3 years ☐ Never visited a cotton farm

4. In your opinion, what do you consider to be the major environmental issues currently facing the cotton industry, and how would you rate your level of concern regarding that issue?

Issue	Level of Concern				Comments
	High	Moderate	Low	No concern	
Water Water pollution as a result of use of chemicals (pesticides, fertilisers)					
Degradation of river water quality					
Excessive water extraction/ usage					
Distribution of water/ water allocations					
Environmental flows					
Reuse/ reticulation					
Salinity					
Contamination or degradation of groundwater quality					
Depletion of groundwater					
Pesticides Aerial spraying of chemicals, spray drift					
Ground application of pesticides					
Wastes Disposal of chemical drums					
Disposal of old chemicals					
Land Land clearing					

Issue	Level of Concern				Comments
	High	Moderate	Low	No concern	
Land degradation - erosion					
Land degradation - salinity					
Soil compaction					
Chemical residues in soil					
Land contamination					
Air Odours					
Dust					
Flora and fauna Effect on wildlife					
Biodiversity					
Fish kills					
Spread of weeds and diseases					
Retention of remnant vegetation					
Provision/ retention of wildlife corridors					
Other issues Community health					
Use of genetically modified cotton					
Greenhouse gas issues					
Cotton industry attitude towards caring for the environment					
Lack of information on environmental impacts of the industry					
Other					

Please list any additional concerns and comments you have:

.....

.....

.....

.....

.....

5. Do you feel that your concerns are currently being addressed by the cotton industry?

☐ Yes ☐ No

If not, how do you think they should be addressed and by whom (eg. Individual farmers, government, industry bodies)?

.....

.....

6. Do you feel that the cotton industry communicates with the public openly and effectively?

☐ Yes ☐ No

Why / Why not?

.....

.....

.....

7. Do you have any environmental data or reports that could assist us in our assessment of environmental issues faced by the cotton industry?

☐ Yes ☐ No

Please list and advise name and contact phone number.

.....

.....

.....

8. What types of benchmarks do you think might be used to rate the performance of the cotton industry? We would like your suggestions of how the environmental performance of the industry could be measured (some examples would include: water use per hectare; endosulfan levels in rivers; the number of cotton farms that have been audited as complying with Best Management Practices)

.....

.....

.....

.....

9. Would you like to participate in a workshop where you can discuss in more detail issues of environmental concern? Workshops may be held in NSW or Queensland (depending on response). If you would like to participate in a workshop, please provide name, organisation and contact phone number.

☐ Yes ☐ No

.....

.....

Thank you for taking the time to participate in this study. Please email, post (no postage stamp required) or fax the completed questionnaire to:

Kylie Fitzpatrick

GHD Pty Ltd, Reply Paid 65079, 10 Bond Street, Sydney, NSW, 2000

Fax: 02 9239 7193 Phone: 02 9239 7222

Email: kfitzpatrick@ghd.com.au

Appendix G

Workshop notes

G.1 Introduction

Workshops were held in Sydney on 11 March 2003 and in Toowoomba 12 March 2003. The aim of the workshops was to identify:

- Areas where the industry needs to improve;
- Strategies for improvement;
- Priorities; and
- Measuring the environmental performance of the cotton industry.

The workshops were primarily targeted at involving environmental, community and government groups to ensure their areas of concern were being addressed.

An outline of the cotton industry survey and preliminary audit findings was presented to workshop participants to generate discussion. The Sydney workshop was facilitated by Sue Trahair and Carolyn Pettigrew and the Toowoomba workshop by Chris Owen and Andrew Batts from GHD.

G.2 Environmental performance

In addition to focusing on cotton industry-specific issues, the workshop groups were interested in discussing the audit in the context of wider catchment or landscape management and agricultural practices. This was because cotton is only part of the picture, but also identifying desired environmental outcomes helps determine the most important on-farm practices that achieve those outcomes.

There was general agreement that implementation of Best Management Practices by cotton growers had contributed to significant improvements and should be acknowledged.

The discussions are summarised in the following points:

- Need to look at the environmental outcomes you want to achieve then work backwards;
- Audits focus on process rather than outcomes;
- Audits/BMP should be linked to catchment performance/ river health;
- Increasing involvement and maintaining active involvement in BMP will be a challenge in the longer term;
- Are we targeting the right areas for catchment improvements? For example, a small grower with very good practices may have negligible impact on catchment health. Should be targeting larger growers for which a small improvement on their farms may result in a bigger impact on catchment health;
- Main performance parameter is catchment health. In some areas, where cotton is the predominant activity, the cotton industry will have a major impact. In others areas, where cotton growing may only account for 30% of the agricultural activities, changes on farms will have a less overall impact in catchment health;
- Main concerns for catchment health are water usage for irrigation (and how this affects environmental flows), pesticides and sediment loads to rivers during storm conditions. Stormwater runoff is a very important consideration;
- General need for a vision for rivers and communities – the community should be stating what is the acceptable river health in their community – shared vision of agriculture with community;

- Use Catchment Blueprints – what is appropriate in each area, and where it is acceptable to grow cotton in that catchment;
- Use downstream wetland health as a parameter in determining catchment health;
- Need to define long-term sustainability and environmental performance. Use a 50 year time frame;
- Environmental monitoring has improved in part because an "industry has grown up" and measures various parameters. Need for an "industry" to develop environmental performance standards/measures relevant to catchment health;
- Air monitoring programs for pesticides could be expanded, with results available for access by community and other stakeholders;
- Environmental operational performance measures could include pesticide usage rates per product outputs;
- Audit a "snapshot" – those audited were volunteers, therefore, may not be a true indication of overall practice; and
- 25 growers produce over 33 percent of crop. The impact of the management practices on these farms is very significant to catchments and industry performance.

The following points were raised as issues pertinent to the industry but were not raised in the survey/ audit:

- Funding of research;
- Economic payback for environmental improvements;
- Generally "younger" profile of farmers – more open to change than other agricultural sectors;
- Structural reform of the industry can provide optimal environmental outcomes (eg removal of redundant weirs); and
- Chemical handling and usage in other industry and government operations requires more focus in cotton growing regions.

G.3 Areas requiring improvement and strategies

General

- Cotton industry is taking the lead in sustainability. Should be industry lead, not by regulatory authorities. Other associations (eg: irrigation association) are also looking at sustainability;
- Form partnerships with conservation and community groups, although some groups will have nothing to do with the cotton industry. Some organisations understand the issues from farmers' perspective as well;
- Encourage further partnerships between growers and scientific and academic bodies;
- Report on environmental data;
- Audit focus has been on farm not catchment;
- As a minimum, must ensure cotton industry is complying with all laws and legal requirements;
- Branding of cotton: BMP-grown cotton is favoured by consumers, but not prepared to pay a higher price. Currently no differentiation of product on basis of using BMP or having an EMS;
- Life cycle assessment required of BMP-grown cotton versus non-BMP.

Water

- Look at using less water overall, not just increasing on-farm efficiency;
- Further investigate alternative irrigation practices;
- Stop handing out water allocations;
- Improve investigation and prosecution processes for unlicensed water harvesting;
- Look at less waste of water, especially water delivery systems and on-farm storage. Long delivery schemes lead to high losses;
- Better management of channels – line or realign channels/ lengths with high water loss;
- Store in smaller, deeper (more expensive) storages;
- Further investigate deep drainage issues associated with irrigation to provide a better understanding of links to salinity hazards and inefficient use of water;
- Water pricing will drive change over time.
- Campaign for funding extension of the Queensland Government Rural Water Use Efficiency Initiative, or similar programs

Pesticides

- Rely on registration of pesticides and label warnings for protection of wildlife;
- Positive use of digital GPS in spraying practice (aerial and on-ground);
- Integrated pest management to reduce a number of applications and incorporate use of soft chemicals (potentially more expensive but positive environmental outcomes);
- Pest spectrum has changed;
- Incorporate use of genetically modified cotton – fewer insecticides (positive) but more herbicides (negative).
- Require all contract ground rig operators to be accredited with Groundrig Operators Association.

Petrochemicals

- Lack of awareness of regulations and storage requirements eg bunding and location of equipment;
- Regulations not widely addressed at farm level – regulatory authorities have not focussed on farms;
- Information/ education for farmers as to regulations required (not expensive to address by and large).

Wastes

- Chemcollect not continuing;
- Improvements – "just in time" purchases therefore fewer old drums lying around;
- Reuse incorporated in buy back schemes for unwanted chemicals– waste avoided;
- DrumMuster very positive program – better management required;
- Compost guidelines – do they or should they cover cotton trash (for reuse on cotton farms or elsewhere)?;
- Gin trash – disposal/reuse policy/regulatory issue that needs to be addressed by statutory bodies.

Land Management

- What constitutes a sustainable use of land (what is the baseline)?;
- What is acceptable environmental impact and who decides what's acceptable?;
- Ask question of whole catchment communities (and other stakeholders) – whole communities working together;
- EMS benefits industry (long term gain) but not to individual farmers in short term financially;
- Fertilisers cause build up of solids – assessment of management practices required.

Vegetation & Wildlife

- Need to measure lethal and sublethal effects of pesticides on wildlife. Fish kills (lethal impacts) not good as an indicator of overall health;
- Establish a monitoring protocol for sentinel species (non migratory) as "biomarkers" for impact of softer chemicals (eg terrestrial vertebrates such as dunnarts and other small mammals, as well as birds);
- Management of buffer zones and water storage as they are key sites for habitat;
- Growers need to be aware of and involved in vegetation/habitat mapping and the importance of whole farm management to protect habitat – made aware of potential benefits of managing property for wildlife;
- Improved access by growers to maps which illustrate local and regional areas of high biodiversity value would assist in farm planning;
- Focus on farms is usually on habitat management not on individual species;
- Emphasise to growers protection of riparian zone vegetation. Applies to where cotton is 100% of the crop and on mixed farms;
- More focus is generally required on habitat and nature conservation in wetland areas and the impact of dam construction, water extraction levels and environmental flows on these;
- Advocate policy of protecting areas on cotton farms for public good;
- There were concerns raised regarding the potential impacts of genetically modified crops on other species, particularly transfer of pesticide-resistant genes into weed species.

Communication

- Better complaint handling and coordination between agencies is required in Queensland. A more consistent, transparent and systematic protocol, with feedback to complainants would be beneficial;
- Further communication of industry environmental management initiatives to the wider community would be beneficial for the industry;
- Further communication with communities and individuals regarding pesticide spray practices and chemicals used would assist in greater clarity of issues for all parties;
- The communication of research results and outputs by CRDC was seen as effective, though further communication initiatives, such as increased face-to-face discussions/presentations would be helpful for growers;
- Increased liaison with other rural industries regarding chemical application would provide benefits for the cotton industries.

Best Management Practices

- Encourage the establishment of basic BMP standards across other agricultural industries;
- Uptake and implementation of BMP still has improvement potential.

Occupational Health and Safety

- There is an inconsistent approach to OH&S across the industry, with gins generally more advanced in this area than farms;
- Improvements are required at many farms;
- User-friendly tools with an agricultural focus are required. Farms particularly require this.

G.4 Priorities

Each of the workshop participants were asked to rank their top three priorities of environmental and related issues that needed to be addressed. In summary the ranking and priority of concern were:

Area	Sydney		Toowoomba	
	Ranking	Priority	Ranking	Priority
Wildlife	3,3,3	Equal 5	3	Equal 7
Vegetation	2,2,3	Equal 3	1,3	4
Land management	2,3	Equal 5		8
Water Management	1,1,1,1,1,1,1,2	1	1,1,1,1,1,2,2	1
Pesticides	1,1,2,2,2,3	2	1,1,2,2,2,2,2	2
Petrochemicals			3,	Equal 7
Wastes	2,3,2	Equal 3	2	6
Occupational health & safety			1,3,3	Equal 3
Communication (with external stakeholders and within the industry)			3,3,3,2	Equal 3
Participation in BMP			3	Equal 7

No. 1 = top priority

Appendix H

1991 Audit Recommendations

Audit Recommendations in 1991, Proposed Actions, and Findings in 2002 - 03.

One of the aims of this audit was to assess the cotton industry's response to the previous 1991 audit recommendations. The 1991 audit included recommendations under the broad headings of Pesticide Use, Land Use, Water Use and Cotton Processing.

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 disposal and recycling of pesticide containers.

Land Use: a high level of compliance was achieved with respect to soil compaction and erosion. 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, impact assessment,.

Water Use: a high level of compliance was achieved for all recommendations including those concerning water conservation, tailwater and stormwater management, research and monitoring.

Cotton Processing: a high level of compliance was achieved with respect to PPE availability, noise exposure reduction, accident reporting and waste management. A lower level of compliance was found for dust abatement and monitoring, employee education, noise monitoring and health & safety audits.

Note that due to changes in legislation, improved technology and changes to operating procedures, not all the recommendations made in 1991 are still valid. If the intent of the recommendation has been met by some other means, other than that recommended, then compliance has been assessed as met. Where the cotton industry has no direct control over an issue, recommendations have been listed as "not applicable"

The assessment of compliance was based on the following:

High compliance:	All or most requirements of the recommendation have been met
Partial compliance:	Key requirements of the recommendation have been met by a limited section of the industry
Low compliance:	Key requirements of the recommendation have not been met but achievements regarding compliance have been demonstrated
Non compliance:	The requirements of the recommendation have not been met
Not applicable	The cotton industry does not have direct control over the issue

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
	Recommendations Concerning Pesticide Use			
1	Poor performers amongst aerial operators and growers should be reformed or removed from the industry. This should be primarily achieved by industry (ACF, AAAA and AVCA) education programmes and peer pressure.	The Australian Cotton Foundation (ACF) (now Cotton Australia) supports the self-regulatory accreditation programmes of the Agricultural and Veterinary Chemicals Association and the Aerial Agriculture Association of Australia.	High compliance	"Operation Spray Safe" is an initiative of the AAAA, which aims to educate and train both agricultural pilots and ground staff, provide an accreditation program for aircraft operators, and educate farmers. A revised edition of the "Pilots and Operators Manual" was completed in May 1998 to educate agricultural pilots on the products they are applying and their fate in the crop and environment. Pilots are examined on their knowledge, and issued a Certificate of Approval on successful completion of the examination. A "Chemical Handling Manual for Agricultural Aviation", May 1998, supported by training videos, was also produced as part of "Operation Spray Safe". NSW and Qld require agricultural pilots to hold an Agricultural Chemical License or Rating. This involves an examination conducted by the AAAA and accepted by regulatory authorities such as Department of Primary Industries (Qld) and Environment Protection Authority (NSW). Observations during the audits indicated that: ◗ the majority of growers use AAAA accredited operators; and ◗ the majority of growers or consultants handling pesticides had appropriate ChemCert certificates.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
		The ACF will, through the rural industry training schemes, assist to provide specialized education programmes for growers. Industry peer pressure in conjunction with growers associations will be used to improve overall performance of the industry.	High compliance	Cotton grower education programs have been conducted on BMP by Cotton Australia. Integrated Pest Management training programs conducted by the Cotton CRC have been developed recently. Observations made during the audits indicated that a number of cotton farmers had recently undertaken specialist courses such as "Waterwise irrigation management course", "Rural Leadership Program", and the UNE "Cotton Production Course". Larger and/or corporate farms are operated/ managed by trained agronomists. Smaller growers utilise consultants who are members of Cotton Consultants Australia. CCA impose minimum entry and ongoing training requirements on its members.
2	AAAA should continue to exert pressure on all operators to join and become accredited.	The ACF has lobbied state governments to require AAAA's accreditation before agricultural rating is issued on pilot's licence. The ACF will continue to lobby and support this recommendation.	High compliance	AAAA accreditation is still not compulsory, however a large proportion of aerial operators (75% of operators, controlling 90% of aircraft in use) are members of the AAAA.
3	The ACF should encourage its members to use AAAA accredited aerial operators.	The ACF will encourage growers to use AAAA's accredited aerial operators.	High compliance	The BMP manual encourages use of AAAA accredited operators. Observations made during the audits indicated that the majority of growers audited used AAAA accredited operators. Most growers had copies of the AAAA Spraysafe Accreditation certificate or EPA Aircraft (Pesticide Applicator) Licence as part of the PAMP.
4	Regulatory authorities should maintain tighter control of pesticide use as a disincentive against poor standards.	Tougher chemical and environmental control legislation is expected to be enacted in NSW and Queensland in early 1992.	Not applicable, however compliance has been met by changes to legislation	NSW - The Pesticides Act 1999, administered by the NSW EPA, replaced the Pesticides Act 1978. The new Act aims to reduce the risks associated with the use of pesticides to human health, the environment, property, industry and trade. Tighter controls on record keeping were introduced with the Pesticides Amendment (Records) Regulation 2001, which came into force 31 July 2002. Other relevant legal Acts and Regulations, which have an impact on the control of pesticides include: Protection of the Environment Operations Act 1997, Dangerous Goods Act 1975 and Dangerous Goods Regulation 1999, OH&S Act 1983, OH&S (Hazardous Substances) Regulation 1996, and the Code of practice for the safe use and storage of chemicals in agriculture 1998.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
				QLD – The Chemical Usage (Agricultural and Veterinary) Control Act 1988 regulates use of pesticides in Queensland. The Environmental Protection Act 1994 regulates activities which may cause environmental harm, and Environmental Code of Practice for Agriculture outlines how farmers can comply with the Act. Other relevant legislation includes Environmental Protection (Waste Management) Regulation 2000, Health (Drugs and Poisons) Regulation 1996, Workplace Health and Safety (Miscellaneous) Regulation 1995, Workplace Health and Safety Act 1995, Workplace Health and Safety Regulation 1997, and "The storage and use of chemicals at rural workplaces industry code of practice".
5	More monitoring of spray drift in populated areas is required. Air monitoring should be introduced in a small number of key sites (eg Wee Waa, Moree). Methods used should be comparable with those currently used in Emerald.	The Mungindi Cotton Growers Association will pilot a monitoring program for season 1991/92 in conjunction with the ACF and Department of Water Resources. The ACF will pressure both state governments to implement sophisticated monitoring programmes similar to those in place in Emerald.	High Compliance	A health study was conducted in Emerald went over a 12 month period – conducted by QLD Dept of Health over the 1990/91 growing season. Specific long term regional monitoring programs were not established. CRDC advised that after the first audit, Emerald had a person dedicated to spray drift monitoring. It is noted that numerous spray drift monitoring studies have been conducted, comparing spray drift from aerial and ground applications. Drift profiles indicated off-target movement of 50m for both applications under very low (stable) wind conditions (ACCRC 1999). The CRDC funded a study last year to research the "Multiple pesticide and odorous degradation product air monitoring in an urban centre surrounded by intensive cotton production" The co-funding partners are Cotton Australia, Therapeutic Goods Administration of Department of Health and Aged Care and the National Registration Authority. The study has been extended due to drought and lack of insect pressure, and is to be completed April 2004. Spray drift management procedures and use of buffer zones have been incorporated into BMP guidelines and PAMPs. In addition, extensive weather stations have been installed, so that every cotton farm is within 20km of a weather station to monitor conditions during spraying. In addition, all large farms and most smaller family farms inspected have installed their own on-site weather stations. The growers and aerial spray operators can access real-time data remotely.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
6	Tank mixing of several chemicals to be simultaneously applied should not be carried out without firm guidance on the compatibility of the products concerned. Commonly required mixtures should be identified and research conducted to confirm their compatibility.	The ACF will continue to ensure with the assistance of the AAAA's and cotton consultants that growers only use chemicals according to strict guidance and use regulation.	High compliance	Chemical product labels, MSDS and technical data from the supplier provide information on compatibility of chemicals. Interviews with growers and aerial operators indicated that product labels were carefully followed for each product mix. In addition, the BMP manual provides some instructions as to the mixing of pesticides, and recommends that staff involved in handling and use of pesticides should be appropriately trained through courses such as ChemCert. Observations made during the audits indicated that the majority of workers who handled chemicals at the cotton farms had undertaken the Agsafe/Farmcare Farm Chemical User Training Program "Certificate Chemical Handling Storage Transport" or equivalent. AAAA released an updated version of a "Chemical Handling Manual for Agricultural Aviation" in 1998. Ground support staff are examined on their knowledge of this manual.
7	Chemical handlers should be provided with and use proper protective equipment including full overalls.	The laws in both states currently require provision of protective equipment. The ACF will immediately concentrate on upgrading its education program in the area of occupational health and safety to include this. The ACF has joined the Rural Industry Training Council and will use this forum to obtain better education and compliance.	High compliance	Both NSW and Qld have updated legislation covering Workplace Health and Safety. The BMP manual addresses the need for OH&S principles to be applied, and recommends that all staff involved in handling and use of pesticides should be appropriately trained through courses such as ChemCert or SMARTchem. The Rural Training Council of Australia offers a Cotton Production training package, which includes a unit on OHS. Site observations indicated that the majority of cotton farms had appropriate personnel protective equipment (including full face shield, respirator, dust masks, gloves and disposable overalls) available at the on-farm chemical store. Closed chemical mixing systems and enclosed cabs for spray vehicles (with air-conditioning and carbon filters), that ensure less exposure to chemicals than in 1991, were also observed The effective use of this equipment was not assessed during the inspections, however the growers advise that safety requirements are strictly adhered to by personnel handing pesticides.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
8	Field workers such as bug checkers and chippers should also wear appropriate clothing, including long trousers and shirt sleeves.	The ACF has upgraded its chipper health and safety brochure and had added a poster which will be distributed throughout cotton growing regions in November, 1991 and continue each year.	High compliance	A number of growers have developed policies and guidelines for OH&S requirements for contractors. These include requirements for field workers to wear appropriate clothing. Growers reported however, that it was difficult to enforce this requirement and long trousers and shirt sleeves were not always worn. The intent of the recommendation was to avoid dermal contact of workers with sprayed cotton. Adherence to minimal re-entry periods after spraying (as stated on product labels) would meet this requirement. This is discussed further under the findings for *Recommendation 16 (1991)*. New OH&S requirements indicate that a risk management approach should be undertaken, to examine risks of all factors including contact with pesticides, sun exposure and heat stress in order to determine appropriate protective clothing. Wearing of long trousers and shirt sleeves as recommended in 1991 may not always be appropriate. In addition, research has been conducted on pesticide exposure and risk assessments. CRDC advised that there has been a specific study on Endosulfan Worker Exposure (confidential report, not sighted by the auditors), which is currently being assessed by the National Occupational Health and Safety Council. The work was completed by the Australian Centre for Agricultural Health and Safety.
9	Employers should provide laundry facilities at the place of work for the washing of pesticide contaminated work clothes.	The ACF will undertake to ensure all growers are made aware of this recommendation and encourage its adoption.	High compliance	The intent of the recommendation was to reduce employee exposure to pesticides. The majority of farms did not provide laundry facilities for its workers. It is noted however, that disposable overalls are often used by chemical handlers on larger farms and by contract groundrig operators, which meets the intent of the recommendation. Laundry facilities were available to workers at a number of farms. Smaller family farms use home laundry facilities – potentially pesticide-contaminated clothing is washed separately.
10	Aerial spraying should remain as the current best method as it has many advantages over boom spraying. These include: fewer operators required and thus less occupational exposure to pesticides, easier control by regulatory authorities and less soil compaction.	The proposed industry action does not meet this recommendation. See below.		Overall, there has been a trend away from aerial applications since 1991. Ground application has increased in significance since 1999, particularly for dryland cotton. Even on larger farms, up to 70-80% of applications are currently undertaken by groundrig. A number of smaller farms favour ground rig operation to minimise spray drift, limit the number of workers handling chemicals and keep tight controls on chemicals used. Aerial application is only used when access by a ground rig is not available, mainly due to wet soils or crop closure.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
		The cotton industry through its research arms – CRDC and ACGRA - are funding new equipment designs to improve ground spraying and improved application technology for ground and aerial spraying.	High compliance	Techniques developed (as part of the BMP Manual) to minimise spray drift and/or decrease occupational exposure (for groundrig or aerial application) include: developing Pesticide Application Management Plans; establishing communications with neighbours before and during spraying; only applying pesticides during appropriate weather conditions; monitoring and recording weather conditions during application; ensuring workers handling chemicals are appropriately trained; observing minimum re-entry periods after spraying; observing buffer zones; and adoption of Integrated Pest Management to minimise overall pesticide use. Techniques developed for *aerial operators* include: avoidance of off-target spray drift by the use of correct equipment by trained and licensed operators; only applying during favourable weather conditions; having someone on site observing each application; communication with ground controller to avoid workers in the area to be sprayed; Large Droplet Placement technique; improving spray patterns; and improved aircraft nozzle configurations. Techniques developed for *ground rigs* include: use of inter-row and over-row shielded sprayers; spraying at night during low wind conditions to minimise off-target spray movement; using band spraying to reduce pesticide usage; selection of nozzles with a low drift potential; using different droplet sizes for different chemicals; using recommended heights/ speed/ pressure; using lower pressure/ higher volume sprays (to get better penetration and hence lower use); use of automatic rate controllers to ensure accurate (and minimum) chemical use; GPS tracking of groundrig spray patterns and concentrations; and development of "Spray Application Guidelines for Groundrig Operators". The Groundrig Operators Association is currently developing a Code of Practice and documentation of best procedures. Soil compaction from ground rigs has not been found to be a problem, since designated wheel tracks are used. Groundrigs are now designed as purpose-built vehicles, as opposed to heavy tractors which have been adapted as spray vehicles.
11	New farms should be designed with aerial spraying in mind so that potential spray drift problems are avoided.	The ACF has in conjunction with local growers associations begun to address whole farm design and farm plans. The industry is working to minimise the potential for drift by controlling application.	High compliance	The BMP Manual gives guidance on the need for buffer zones to be used to catch drift from applications, and guidelines on how to develop a farm map before pesticide application to help identify sensitive areas and hazards. Site observations of farm maps indicated that appropriate buffer zones were identified for aerial spraying. Practices identified in the findings for *Recommendation 10 (1991)* indicate other measures used to minimise spray drift.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
12	Rural communities surrounded by cotton farms should plant tree-lines as biological buffers. Species should be chosen to maximise effectiveness as barrier to spray drift.	The ACF is assisting the NSW Department of Agriculture and Department of Planning to develop strategic plans for buffers or drift barriers. The program is underway. The CRDC is funding a research program directed to biological buffers at Queensland University Gatton Campus.	Not applicable	The cotton industry cannot dictate the actions of local communities. Rural communities surrounded by cotton farms have not planted tree-lines as biological buffers. Case studies indicated that planting trees on farms provided greater drift capture than planting tree lines around towns (RIRDC/ CRDC 1999). See findings for *Recommendation 13 (1991).*
13	Cotton farmers should plant tree lines around their own properties (with due allowance for the safety of crop spraying aircraft) to limit the drift of spray off the property.	The ACF will encourage cotton growers to implement this recommendation.	High compliance	A guide "Growing trees on cotton farms" 1999, has been developed by the Rural Industries Research & Development Corporation. The guide covers tree line planting specifically for spray drift buffers. The BMP Manual provides some information on vegetative buffer zones on cotton farms. Site observations indicate that tree lines are not planted extensively around cotton farms. Tree lines were often planted for visual effects (along roads). On some farms, trees were planted for shade maintenance of beneficial insects, as well as for controlling spray drift. The intent of the recommendation was to limit the drift of spray off the property. Spray drift has been tackled through the implementation of BMP, specifically spraying under correct weather conditions, selection of pesticides and application methods. Tree line buffers are a secondary drift management method.
14	Planning authorities should exert controls to ensure that new housing is sensibly zoned in relation to existing cotton farms to avoid potential spray drift problems. Zoning of new cotton farms should similarly take account of existing residential development.	The ACF will lobby the government to address this issue. A planning edict issued in Queensland as well as the NSW Department of Planning Rural/Urban Interface Committee are attempting to address and solve this issue.	Not applicable	The cotton industry has no direct control over planning issues. Queensland and NSW state governments have not promulgated controls on siting of cotton farms in designated rural areas. Zoning of rural areas is up to individual local Councils and any application for rezoning would be considered on its individual merits. Permitted uses are specified by Councils in their Local Environment Plans. There are no overarching mechanisms in place which guide local councils on planning the interface between the cotton industry and residents.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
15	Doctors/health workers should be encouraged to maintain long-term databases on incidence of cancers, asthma and allergies in cotton growing areas.	The ACF has agreed to assist in funding a rural medical practitioners' education programme and the CRDC is funding a health monitoring and data/statistics collection programme. The ACF will continue to lobby governments to improve overall rural health monitoring.	Not applicable, however, the recommendation is being met by others	The cotton industry has no direct control over health databases, however, it has participated in health studies. CRDC advised that ACF set up a Cotton Industry Medical Undergraduate Scholarship after the first audit. The Gwydir Cotton Growers Association has taken over the fund raising of the scholarship. A comprehensive review of "Pesticide use in Australia" was undertaken in 2002 by the Australian Academy of Technological Sciences and Engineering. The report addressed, amongst other issues, the impact of pesticides and their residues on community health. (The last major review of pesticides in Australia was the July 1990 Report of the Senate Select Committee on Agricultural and Veterinary Chemicals, chaired by Senator Mal Colston). The report indicated that there is *no information on chronic (long term) effects* of pesticides in Australia, but a number of studies are in progress. The report recommended that "Consideration should be given to developing a system of formal reporting of worker's exposure to pesticides, including the establishment of an Adverse Health Effects Register that records all acute health effects definitively shown to arise from pesticide use". There is currently a joint program with seven Research & Development Corporations (Cotton RDC is one of these) to coordinate the above type of information - the National Farm Injury Data Centre.
16	Chemical companies should provide information on the minimum re-entry periods which should be observed after crops are sprayed for all products.	The ACF will undertake to disseminate to growers more detailed information on re-entry periods. The results of 'chipper' exposure monitoring, supported by the cotton industry, will be used to adjust this re-entry information if necessary.	High compliance	Material Safety Data Sheets (MSDS), product information sheets and product labels provide information regarding the nature of various pesticides and appropriate re-entry periods. Re-entry periods are summarised for common pesticides in the annual "Cotton Pest Management Guide" from NSW Agriculture/ Australian Cotton CRC. Cotton consultants also advise growers on re-entry periods. Records and systems in place indicate that re-entry periods are regularly applied and enforced although these can be difficult to enforce on larger farms.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
17	Pesticides likely to produce strong, drifting odours should be avoided in areas where their use could lead to public nuisance.	The cotton industry is pressuring chemical companies to research the deodorizing of farm chemicals and will encourage growers to try alternative management techniques where cotton is in close proximity to residential areas.	Partial compliance	A number of new, low odour products have been developed and are used by cotton growers. Growers report avoiding use of odorous chemicals, such as "Curacon", and/or using an odour-masking agent. The trend by growers is to use less insecticides overall through implementing Integrated Pest Management and participating in Area Wide Management groups. In addition, the BMP Manual provides guidelines for controlling spray drift, and minimising odour problems. These guidelines are implemented by the growers via the BMP program. Interviews with cotton growers indicated minimal complaints about odours from neighbouring properties. It is noted however that a review of EPA complaint records indicated that there have been numerous complaints regarding odours in recent years. It is not always possible to distinguish between complaints made by a number of people or one individual, or whether complaints were from spraying cotton crops or other agricultural crops. However, the number of odour complaints specifically mentioning cotton in different areas and on different occasions, indicate that odours are causing public nuisance. It is evident that improvements in odour control need to continue. As noted in 5 above, the CRDC funded a study last year to research the "Multiple pesticide and odorous degradation product air monitoring in an urban centre surrounded by intensive cotton production".
18	Research into integrated pest management techniques should be continued and encouraged. This can help to avoid problems of pesticide resistance and contribute to a reduction in the quantities of pesticide used.	The cotton industry through the ACGRA and the CRDC will continue to research integrated pest management.	High compliance	Integrated Pest Management (IPM) has been the subject of extensive research by CSIRO, CRDC, Australian Cotton CRC, Qld DPI, and various universities and is the subject of continuing research. A number of growing valleys practice IPM and have Area Wide Management groups (approximately 40 groups). The BMP Manual includes a section on how to implement IPM. Detailed information on IPM practices can be found in ENTOpak, and the Cotton Pest Management Guide. The Cotton CRC also offers an IPM short course.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
19	Continued observance of the Pyrethroid Strategy is essential in order to continue to avoid pesticide resistance undermining current ability to control pests with available products.	The CRDC, ACGRA, ACF will continue to encourage all growers to observe the Pyrethroid Strategy. To date, all growers have complied with this strategy.	High compliance	The Pyrethroid Strategy for insecticide resistance has expanded to cover a broad range of other chemicals. The Insecticide Resistance Management Strategy is set out in the Cotton Pest Management Guide for different growing areas. Spot checks of adherence to the strategy were made during the audit by comparing a sample of spray records against the IRMS. A high level of compliance was found. Detailed checks of compliance with the IRMS are undertaken during BMP audits. Audit reports reviewed indicated that a high level of compliance was found. The IRMS has not been followed on occasions due to extreme pest pressures, when all reasonable attempts to apply alternative methods have not worked. In these cases, some growers have made a written submission to TIMS for consideration.
20	Research into all aspects of pesticide resistance should be maintained and encouraged.	The CRDC has recently commissioned research projects to address this issue.	High compliance	Pesticide resistance continues to be the subject of research. There has been extensive pesticide resistance research since the 1991 audit. The CRDC coordinates research on monitoring pesticide resistance in a range of cotton pests of approximately $1 million annually.
21	Aerial operators should be encouraged to purchase turbine engined aircraft when current piston-engined aircraft are due for replacement. In areas where noise complaints are frequent, the immediate replacement of piston-engined aircraft should be considered.	The ACF will draw this to the attention of the AAAA's. However turbine engined aircraft cannot be safely used on small areas in some cases.	High Compliance	Aerial operators interviewed indicated that turbine powered engines are currently used. No piston-operated engines are used in cotton growing areas. The numbers of planes and operations have decreased, as there has been a move away from aerial spraying to groundrig operation. In 1999, there were less than 300 agricultural aircraft in Australia, across all agricultural sectors. Growers visited had no recent reported incidences of noise complaints. This is reflected in the EPA complaint records. The NSW EPA complaints register for cotton related complaints between the 1998/99 and 2001/02 seasons in the Gunnedah, Moree and Narrabri areas indicated that there was only one complaint about noise from aerial operators.
22	All pesticides and herbicides should be stored under lock and key and preferably under cover.	The ACF will address this matter through its planned education program for the cotton industry.	High compliance	The BMP Manual provides guidelines for appropriate storage facilities and locations for pesticides. Site observations at cotton farms indicated that pesticides were normally kept in lockable sheds. However, there were some exceptions, with some chemicals observed in unlocked sheds or stored out in the open.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
23	Pesticides storages should have adequate storage space for the quantities of chemical to be kept, have proper bunding, segregation of different products and security controls.	The cotton industry and aerial operators will undertake to ensure that storages comply with legislation and safety regulations.	High compliance	The BMP Manual provides guidelines for appropriate storage facilities and locations for pesticides. In addition there is the need to comply with government regulations regarding pesticide storage and handling. Site observations at cotton farms indicated that pesticides were kept in secure, bunded chemical storage areas. Different types of chemicals were segregated where possible. Safety equipment and fire extinguishers were observed. Areas requiring improvement included ventilation of storage areas, bunding of storages, signage and security. Site observations at aerial operators facilities indicated that pesticides were kept at secure premises, with adequate bunding/ spill control and segregation.
24	Chemical storage and handling needs improving. ACF, AVCA and AAAA should have a strong education policy to ensure that growers and aerial operators are aware of the correct procedures.	ACF, AVCA and AAAA's will continue to address this issue in the rural training and education programs planned for the cotton industry.	High compliance	Correct chemical storage and handling are adequately addressed in the BMP Manual. BMP training is also conducted. It was observed that growers implementing BMP generally had better chemical storage facilities and handling practices. Those growers not participating in BMP generally had poorer storage facilities. Personnel handling chemicals were ChemCert certified. A "Managing Cotton Farm Safety Manual" was produced for industry in early 2002. Cotton farm safety training courses are also conducted (by Farmsafe Australia) on occupational health and safety issues and risk management. As an initiative of the AAAA, a "Chemical Handling Manual for Agricultural Aviation" and two supporting videos were released in 1998. Operators are instructed how to train ground support staff in correct chemical handling techniques, who are then examined on their knowledge.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
25	Proper facilities should be provided for the disposal of pesticide containers. The ACF should lobby government to achieve this.	The ACF will continue to pressure state and federal governments to find a rapid solution to crippling and unworkable legislation preventing acceptable disposal. The ACF will continue to pressure the chemical industry for assistance with a solution.	Partial compliance	The BMP Manual states that clean containers should be returned to the supplier where possible. If they cannot be, they should be taken to a drumMUSTER collection point. Pesticide containers were removed from site via the drumMUSTER program where possible. However, it was noted that drumMUSTER does not deliver adequate services in some areas or adequate notification that there would be a collection. It was also noted that not all chemicals and pesticides commonly used on farms were covered by the drumMUSTER program. Old, rusty and/or damaged containers are also not serviced by drumMUSTER. On some properties, chemical containers continue to stockpile, or the growers opt for disposal by burial on-site. Containers were usually placed in enclosures on the properties. However, stray insecticide/ herbicide containers were observed at some farms.
26	The industry as a whole including chemical manufacturers, aerial operators and growers should work together to increase the proportion of chemicals supplied in bulk or in re-usable containers.	The industry is moving toward greater bulk handling facilities and the ACF will continue to encourage this.	High compliance	The BMP Manual comments on the need to buy pesticides in returnable, recyclable or soluble packaging, or to buy pesticides from suppliers who provide product recovery programs. Site observations indicated that where possible, pesticides were purchased in reusable containers, in bulk "envirodrums" or bulkiboxes, in containers covered by the drumMUSTER program, in solid form and/or in plastic-lined cardboard boxes. Not all chemicals are available in these forms.
27	The industry as a whole should also seek ways to increase the proportion of steel drums which are recycled instead of buried.	The ACF will where possible, encourage the recycling of steel drums which can be safely reused. The AVCA draft protocol on container management should be used where possible to allow recycling of steel drums.	Partial compliance	Steel drums were observed awaiting collection at some farms. However, many cotton growing areas are not adequately serviced by recyclers. Clean 200L (non-pesticides) steel drums were reused for rubbish disposal or for storage of parts in workshops, which is acceptable. Steel drums (crushed and whole) were observed at a number of on-farm tips.
28	The use of empty pesticide containers for secondary purposes such as trash cans should be completely avoided.	The ACF will undertake to continually bring this issue to the attention of all industry participants.	High compliance	The BMP manual states that empty pesticide containers should not be used for secondary purposes. Interviews with growers indicated that pesticides containers were not used for non-suitable secondary purposes. During site visits, no observations were made of empty pesticide containers used as garbage cans. Triple-rinsed herbicide (Roundup) containers were often observed used as floats for trash retention in water delivery channels.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
29	Where burial of pesticide containers on-site is the only option, growers and aerial operators should ensure that tips are managed to the highest possible standard. Detailed records should be kept of the location and contents of pits.	The ACF will encourage grower associations to assist with this campaign to provide better management of tips and burial pits.	Low compliance	The BMP provides guidelines on the construction of disposal pits, and growers are advised to keep records of the location of the pit. On site disposal of chemical containers was observed at a number of farms. The tip sites were in unlined pits/ gullies. One farm kept records of disposal and had marked the pit on the map. Overall, on-farm tips were not managed to a high standard. It is noted that if the drum MUSTER service were to improve, some growers that currently bury their containers would stockpile them for collection.
30	Evaporation pits should only be dug on sites where adequate testing has ensured that the ground is impermeable. Ideally evaporation pits should be lined.	The ACF will disseminate information on the construction of evaporation pits to all growers and industry personnel.	Low compliance	The BMP Manual provides guidelines on the construction of evaporation pits. Not all pits observed during the audit were lined. Soil testing records were not available for all pits – instead, growers had relied on the general clay soils of the area and site observations of water holding capacity. Poorly designed evaporation pits have the potential to present significant land contamination issues in the future.
31	Evaporation pits should be securely fenced and signed to prevent people or animals accidentally entering them.	The ACF will draw this issue to the attention of the industry and through grower associations encourage compliance.	Partial compliance	Six evaporation pits were observed at the 32 farms. Five of the pits were observed to either lack fencing, be unlocked or lack appropriate warning signs. Only one of the pits fully complied.
	Recommendations Concerning Land Use			
32	The ACF should develop an environmental policy or code of good practice on land acquisition. This should not only detail where the new cotton farming developments should be encouraged (and where they should not be), but should also cover aspects such as the layout and design of newly established cotton farms and their proximity to residential areas and sensitive wildlife habitats.	The ACF in conjunction with the CRDC and ACGRA will formulate a policy and disseminate to all industry participants.	Partial compliance	A general cotton industry code of good practice on land acquisition has not been produced. Guidance on where new cotton farming developments should be encouraged has not been produced. Layout and design principles, including buffer zones, are covered in the BMP manual and other cotton industry publications. Cotton Australia has produced an Environmental Policy.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
33	Land use changes involving the cotton industry should be documented in detail. A database should be established to include details of previous land uses (and, in cases where land ceases to be used for cotton, subsequent land uses), details of adjacent land uses and information on natural/semi-natural habitats present on the land before and after the change.	The ACF will lobby the relevant government departments to establish a database on landuse involving the cotton industry.	Partial compliance	GIS data is now available to track landuse changes and vegetation clearing. Details are summarised in the National Land & Water Resources Audit (NHT 2002).The Qld Statewide Land and Trees study project was founded in 1995 as a major vegetation monitoring initiative to investigate the overall woody vegetation cover and report on the previously unquantified extent of land clearing in Queensland. In NSW, current vegetative cover of various districts is mapped in Regional Vegetation Management Plans. Mapping of vegetation has commenced in cotton growing areas as part of biodiversity studies.
34	Growers who wish to develop large areas for growing cotton where this could give rise to significant environmental impacts should be encouraged to undertake an independent environmental assessment of the proposals.	The ACF will recommend to growers that it will be in their best interests to undertake independent environmental assessments of large development proposals in light of impending legislation in NSW and Queensland.	Partial compliance	The 1991 recommendation was and continues to be above existing legal requirements. There is no regulatory requirement to undertake an environmental assessment of cotton areas. Cotton farms are not classified as designated developments in NSW and do not require an Environmental Impact Statement or Statement of Environmental Effects. Planning NSW has not developed any guidelines for cotton farms. Similarly in Qld, there are no specific planning triggers that would require an environmental impact assessment. No guidelines have been produced by the cotton industry as to when independent environmental assessments are recommended and the scope of these assessments. The auditors only observed two environmental assessments – one for a proposed development of an irrigation area on an existing cotton farm and one for a cotton farm adjacent to a sensitive area. There is a requirement to produce an irrigation/ drainage management plan for irrigated farms. This has a brief environmental component. Significant extensions to irrigated areas, and potential environmental impacts would be considered in the irrigation/ drainage management plan.
35	Where it is compatible with their overall farming operations, growers should be encouraged to retain areas of natural vegetation on their farms to encourage wildlife.	Natural vegetation which encourages wildlife is a feature already on many cotton farms. The cotton industry will encourage growers to implement this where possible.	Partial compliance	Site observations indicated that most growers had retained some natural vegetation or had re-planted native vegetation (up to 25% was reported). However, natural vegetation areas on most farms were relatively small. Retention and planting were undertaken for a number of purposes including provision of shade for stock and shade around houses, visual impacts, spray drift buffers, and protection of riparian zones, not solely for encouragement of wildlife.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
36	Growers should be encouraged to incorporate features to promote wildlife in water storage lagoons insofar as this is compatible with the primary function of the lagoons.	The ACF will encourage growers to implement where possible in consultation with government wildlife authorities.	Partial compliance	Site observations indicated that birds extensively used water storage areas. Water storage lagoons and dams were sometimes the only local water sources during drought conditions. Observations in a number of growing districts indicated a wide variety of birds using farm dams (pelicans, black swans, ibis, various ducks, egrets, shags and magpies). Interviews with growers indicated that wildlife was encouraged. Trees, reeds and man-made islands were observed in and around storage dams. However, not all farms had incorporated features to promote wildlife. A number of growers have stocked various fish, yabbies and mussels in farm dams.
37	The practice of good agricultural methods to minimise problems of soil compaction and erosion should be encouraged.	The CRDC are continually funding major research programmes to minimise and ultimately eliminate soil compaction and erosion. Extension programs to convey research information to growers will continue.	High compliance	The BMP manual provides guidelines on practises to minimise runoff and erosion. The draft land and water management module provides information regarding soil compaction. Extensive research on soil compaction and erosion has been undertaken over the last 12 years. Soil compaction and erosion were not observed to be problems at the cotton farms visited, although heavy siltation in the tail drains of one property was observed.
38	Landcare groups should be promoted. This is an effective way of disseminating information, putting pressure on poor performers and liaising with the local community. Both the number and status of cotton farming Landcare groups should be increased and their activities promoted.	The cotton industry has been involved with Landcare groups since its inception. The ACF will encourage continued participation and use some Landcare grants already obtained and used by cotton growers as models for the rest of the industry.	High compliance	Interviews with growers during the audit indicated a low participation rate with Landcare groups active in cotton growing areas. There are several growers and valleys involved in Landcare groups such as at Myall Vale, Macquarie, Boggabilla and Emerald. The intent of the recommendation was to promote dissemination of information, put pressure on poor performers and liaise with the local community. This has been met by mechanisms other than involvement with Landcare, such as Area Wide Management Groups, National Heritage Trust projects and catchment management groups. Growers have initiated and undertaken their own projects, such as tree planting and creek embankment stabilisation.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
	Recommendations concerning Water Use			
39	The water requirements of important wetlands should be recognised by the water authorities in their allocation of waters.	The ACF will encourage NSW Water Resources to continue their wetlands program and lobby Queensland to undertake a similar project in conjunction with environment authorities.	Not applicable, but compliance has been met	The cotton industry does not control water allocations. New water allocations take into account environmental flows and the requirements of important wetlands.
40	Research into methods of cotton growing which could reduce water requirements (eg. Use of short season varieties, better scheduling of irrigations, improved soil management) should be encouraged.	The CRDC is funding ongoing major research programs on plant breeding and soil management. The industry is supporting a program devised by Dr Peter Cull using the Neutron Probe to better schedule irrigation.	High compliance	Extensive research has been conducted over the past eleven years aimed at reducing water requirements, including: use of different varieties of cotton; use of soil moisture probes (neutron probes and capacitance probes) to schedule irrigation based on soil moisture conditions; and different application techniques.
41	The rate of depletion of groundwater reserves should be monitored.	The ACF will encourage the Water Resources Commission to continue a monitoring program of groundwater reserves.	High compliance	Investigations and monitoring of groundwater resources in cotton growing areas is undertaken by DLWC, research organisations and universities).
42	All tail-water should be recycled. Both peer pressure amongst farmers and government inspections should be pursued to encourage the worst performers to improve their performance.	The ACF strongly supports this policy and is continuing a program in conjunction with grower associations to conduct 'on-farm' discussions to reach consensus decisions and provide solutions to tail-water containment. Queensland and NSW legislation is currently addressing this issue.	High compliance	Recirculation of tailwater is a condition of a surface water irrigator's licence in NSW. Site visits and interviews indicated that all farms inspected in NSW had adequate tailwater collection systems. There are some older cotton farms in QLD where tailwater is not captured or recycled.
43	At least the first flush of stormwater run-off should also be withheld and the water storage capacity on cotton farms should include allowance for this.	The cotton industry supported and participated in an Irrigation Association of Australia workshop on surface run-off from cotton farms in July 1991. This document will form the basis for joint ACF, CRDC and Water Resources research to determine first flush levels for incorporation into legislation.	High compliance	Site inspections, interviews and review of documentation indicated that most growers had facilities to capture as much surface runoff as possible from their sites. The majority of growers advised that they would be able to retain the first flush. Dryland farmers do not generally have the facilities to capture stormwater run-off from all cotton fields.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
44	Studies should be conducted to provide realistic guidelines as to how to calculate the size of this first flush. The cotton industry should commission appropriate studies.	The cotton industry has already commissioned this study.	High compliance	The BMP manual indicates capture and retention of at least the first 15mm of runoff during wet weather from fields that have been recently sprayed. Farms inspected could meet this requirement.
45	In areas such as Emerald, where the entire irrigation scheme was set up without provision for tail-water recycling, growers should set and work towards a realistic date for complete reticulation of tail-waters.	The ACF has been instrumental in assisting with the development of Queensland Department of Environment and Heritage guidelines for government irrigation systems.	High compliance	Site observations indicated that tailwater systems had been installed. However, there are still some older cotton farms in Qld where tailwater is not captured or recycled.
46	Research into the impact of pesticide contamination on population levels of fish and other aquatic wildlife would be useful.	The CRDC is currently funding 3 research projects which examine impact of pesticide contamination on fish and aquatic wildlife. A number of chemical companies are also funding similar projects.	High compliance	There have been a number of studies on the impact of pesticides on the environment, which satisfy this recommendation. Studies are summarised in the AATSE document "Pesticide use in Australia", 2002. The study concluded that monitoring has been ad hoc and there is "little known of the effects of pesticides on Australian species in their natural habitats". Ongoing monitoring and research on the impacts of pesticides is being conducted. The work by DLWC (Central & North West water quality program) has been scaled back, as it is very expensive and the pesticides monitored over the past 10 years have shown to be declining.
47	Fish kill incidents should be promptly investigated by the responsible authorities to a set of specified criteria. This will provide a disincentive against illicit tail-water releases and help identify any other causes of catastrophic mortality.	The ACF supports prompt investigations of fish kills by government authorities with sampling done only by trained government employees.	High compliance	The NSW EPA, NSW Fisheries or Qld DPI investigates fish kill incidents. NSW Fisheries have produced guidelines for assessing fish kill incidents. Despite prompt investigations, definitive causes of fish kills cannot always be established.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
48	Groundwater supplies should be monitored for signs of contamination by pesticides or nitrate.	Recent extensive ground water contamination monitoring was completed by Department of Water Resources in the Namoi region. 23 sample sites were chosen because they were known to be associated with heavy chemical use in the past. No contamination was found. The cotton industry will encourage continuous monitoring across all growing regions.	High compliance	Where groundwater was used for irrigation, quality was measured for a number of parameters including pH and major cations and anions. However, groundwater quality was not routinely measured by the farmer or by the DLWC (in NSW) for contamination. Groundwater contamination studies have been conducted in a number of cotton growing areas.
49	The use of billabongs for water storage should be discouraged.	The ACF will raise this issue with government authorities and participate in formulation of policy in determining a definition of and continued use of billabongs.	High compliance	Site observations indicated that natural billabongs were not used.
Recommendations Concerning Cotton Processing				
50	Dust abatement systems (i.e. fabric filters) should be fitted on all ginning sites. Obscuration meters should be fitted to the fabric filter outlets with visual and audible alarms and recording charts. The system will require regular maintenance schedule. Monitoring records should be kept for at least 30 years.	The cotton processors will incorporate the audit recommendations into their overall schedules for gin upgrade and maintenance.	Partial compliance	Site observations indicated that the gins mainly use cyclones for dust extraction, sometimes with fabric filters for selected parts of the gin. Obscuration meters on outlets with visual and audible alarms and recording charts were not used at any of the gins inspected as there are a number of outlet points from multi-cyclone dust extraction systems. Instead, checks of dust emissions are undertaken on a semi-routine basis. Environment Protection Licences for cotton gins in NSW are not all consistent. However, they all require minimisation or prevention of the emission of dust and nominate points for the monitoring of environmental dust. Most larger gins had undertaken environmental dust monitoring. Smaller gins had not undertaken any environmental dust measurements. Only the large gins undertake routine annual monitoring, due to the expense. Environmental dust monitoring records are not required to be kept for 30 years. The NSW EPA only requires monitoring records to be retained for 4 years.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
51	Annual lung function tests should be carried out on all permanent staff. The records should be kept by the company for at least 30 years.	Most gins are now carrying out lung function tests and will continue to do so.	Partial compliance	Discussions with management indicated that pre-employment and annual lung function tests are undertaken for most of the larger gins, but not for all the smaller gins. Under the new OH&S legislation, the decision to undertake lung function tests is not mandatory, but based on the results of a risk assessment. Not all gins have undertaken an adequate risk assessment to determine whether lung function tests are justified.
52	Plant layout should be such that air entering the gin building should be from a clean area and suction points/doors/exit ports should not be located near areas of high dust levels. Also layout should allow employees to proceed from the outside to rest and lunch rooms without having to traverse through the ginning area.	While awaiting the results of this audit, processors have been preparing to upgrade occupational health and safety standards and improve management of plant and equipment.	High compliance	Site observations indicated that plant layouts were adequate for gins.
53	Floors and equipment surfaces should be vacuumed down frequently during a shift; use of compressed air for clearing dust from surfaces should be discontinued.	The ACF to recommend to processors for implementation.	Low compliance	Discussions with management indicated that compressed air blowing was preferred over vacuuming.
54	Doors of enclosed console room should be kept shut.	The ACF to recommend to processors for implementation.	High compliance	Site observations indicated that air-conditioned, sound-proofed console rooms were used with automatic door closers.
55	All indoor personnel should use respiratory protection (class L disposable masks). Note that the masks offer adequate protection only if used correctly.	The ACF to recommend to processors for implementation.	High compliance	Site observations indicated that disposable masks were available for personnel. Improvements to equipment design and equipment enclosures means that not all indoor areas require a dust mask to be worn.
56	A program of employee education should be undertaken to emphasise the risks of dust inhalation and to demonstrate the best practicable means for reducing dust levels and for avoiding excessive particle inhalation.	Individual processors are spending millions of dollars a year on dust and noise abatement. Results of the audit will broaden and upgrade ongoing worker education schemes.	Partial compliance	Larger gins had established employee induction programs (for permanent and casual employees), including dust risks and controls. Smaller gins had not documented procedures but were currently developing guidelines.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
57	Employee exposure to noise in gins and seed processing plant should [be] reduced. Methods used should include: Engineering Control: Isolate noise and minimise the employee contact with the noisy environment (eg work from "quiet rooms") Isolate fan room Consider controls on individual pieces of equipment Regular maintenance to minimise vibration Administrative Controls: (Rotate staff so that individual workers are not exposed to high noise levels continuously for long periods). Personal Protection: provision of ear muffs and plugs. This strategy should be considered only after engineering and administrative solutions have proved insufficient.	The ACF to recommend to processors to upgrade and expand programmes to prevent noise exposure.	High compliance	Site observations, interviews and documents reviewed indicated that noise exposure had been reduced through various engineering and operational controls, as well as wearing personnel protective equipment.
58	Regular monitoring of noise levels should be undertaken.	Most processors are now monitoring. Audit recommendations will be incorporated into gin programmes.	Partial compliance	Larger gins had undertaken occupational and environmental noise monitoring. However, not all gins had conducted monitoring.
59	Annual hearing tests should be carried out on all permanent staff.	ACF to recommend to processors for implementation in view of impending workplace legislation.	Partial compliance	Discussions with management indicated that pre-employment and annual hearing tests are undertaken for most of the larger gins, but not for all the smaller gins. Under the new OH&S legislation, the decision to undertake hearing tests is not mandatory, but based on the results of a risk assessment. Not all gins have undertaken an adequate risk assessment to determine whether hearing tests are justified.

	Recommendations from 1991 Audit	Proposed Industry Action in 1991	Compliance	Finding/ comments
60	In-house health and safety audits should be undertaken at all cotton processing facilities. This should include a review of previous accidents and of current safety procedures.	ACF to recommend to processors for implementation in view of impending workplace legislation.	Partial compliance	The larger gins undertake routine internal and external safety audits, using in-house specialists or external consultants. Implementation of corrective actions resulting from audits was observed, such as machine guarding, improvements to walkways, improved manual handling devices, change of bale strapping cutters, to name a few. Not all gins currently have health and safety audits.
61	Accident Books should be maintained at all processing facilities. Information such as the nature of the injury, part of body involved, where accident occurred, date, time, person to whom accident was reported, lost time, activity undertaken when accident occurred, other people or vehicles involved, etc, should be recorded.	ACF to recommend to processors for implementation in view of impending workplace legislation.	High compliance	This is a NSW WorkCover and QDIR requirement. Gins inspected kept accident record books, which cover all the information required.
62	More appropriate methods of reducing road dust at gins such as damping down with water or laying down a permanent road surface should be considered. The spreading of waste oil for this purpose should be ceased.	A program to address this issue will be undertaken by processors.	High compliance	Site observations indicated gravel or crushed rock was used in the module yard storage areas. Water carts were available for dust suppression. Spreading of waste oil on unsealed surfaces is not allowed under NSW or Qld legislation. Gin managers advised that waste oil, or other chemicals, were not used for dust suppression at any of the gins inspected. There was no evidence of oil staining at any of the gin module storage yards or service roads.
64	The uncontrolled burning of trash should be avoided.	In NSW legislation pending prohibits the burning of gin trash. Both Queensland and NSW ginners prefer to allow natural composting to occur.	High compliance	Site observations indicated that gin trash was generally composted and stockpiled or used at selected farms. Burning of gin or seed processing trash is not allowed under the NSW or Qld legislation. NSW Environment Protection Licences for cotton gins specifically state "There must be no incineration or burning of any waste at the premises". One of the seed processing plants had an incineration facility, which appeared to have been in recent use. The auditor was advised that incineration was no longer practiced on site.

Note: Recommendations 63 and 65 – 69 inclusive related to specific issues at a cotton seed processor. Compliance with these recommendations has been reported separately.

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 ISBN:1 876354 90 9

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft	S Trahair, M Pignatelli, C Owen	R Woodward		I Garrard		
Final	S Trahair	I Garrard		I Garrard		
Final v2	S Trahair	A Packwood		I Garrard		19/8/03