Natural resource management: Achieving more through partnerships

Natural resource management and minimising the impact of cotton production on the environment are important issues for the Australian cotton industry. The industry is proactively recognising and responding to many of the environmental challenges that face today's agricultural industries. The timeline of natural resource management outcomes in the Australian cotton industry illustrates the challenges and achievements of the industry since the early 1990s.

In 1991, the first environmental audit of an agricultural industry in Australia was conducted on the Australian cotton industry. Since this time there has been considerable research investment and effort by the industry to achieve long-term environmental outcomes. A second environmental audit commissioned by Cotton Research and Development Corporation (CRDC) in 2003 confirmed industry-wide improvements.

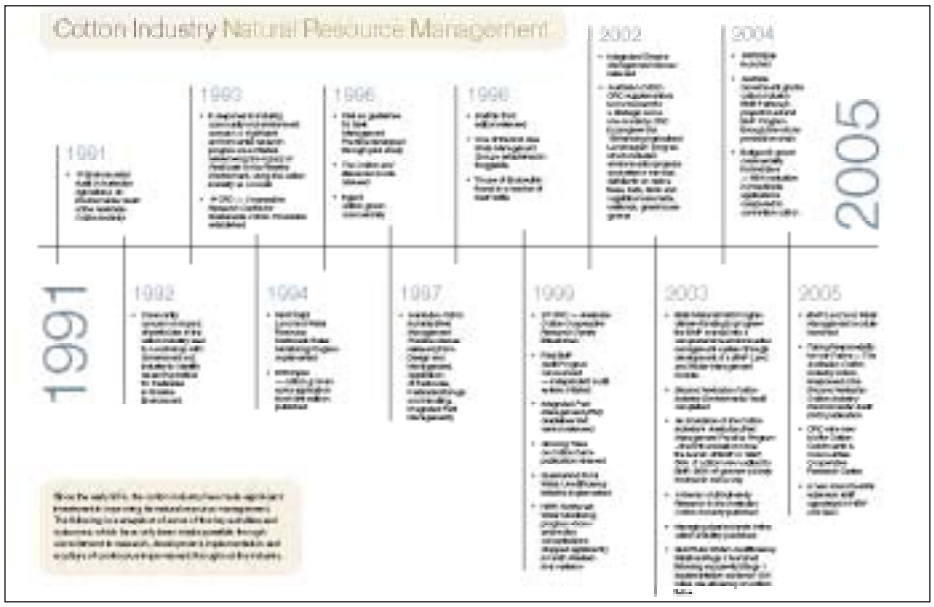
Despite the many environmental improvements made since the 1991 audit, the industry acknowledges that the 2003 audit identified some areas requiring further work. There has been significant investment by the industry in natural resource management over recent years, with the Australian Cotton Cooperative Research Centre (CRC) investing $1.5 million and CRDC investing over $1 million in 2004–05.

The industry recently launched the new Best Management Practices (BMP) Land and Water Management module, thereby placing the industry in a good position to face the challenges of natural resource management in 2005 and beyond.

Philip Russell, Chief Executive Officer of Cotton Australia, considers natural resource management to be at the forefront of agriculture and something that we must all take responsibility for.

"We believe industries should be proactive in identifying and managing practical solutions to assist members at a property level deal with managing their natural resources. We see it as vital to link landholders to solutions at a sub- and catchment level."

The cotton industry's proactive approach to addressing environmental issues has put it in good stead to form



The cotton industry NRM timeline.

partnerships with key natural resource management bodies in both Queensland and New South Wales. Cotton is grown commercially in areas supported by Fitzroy Basin Association, Queensland Murray Darling Committee, Condamine Alliance, Namoi Catchment Management Authority (CMA), Central West CMA, Lachlan CMA, Western CMA and Border Rivers-Gwydir CMA.

Dick Browne, Chairman of Condamine Alliance, a supporting partner in the new Cotton Catchment Community Cooperative Research Centre (CCC CRC), believes "the cotton industry is well positioned to deliver natural resource management out-

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Natural resource management projects in the cotton industry

Soils	
Diversity of VAM fungi in soil health	Stella Loke
*Maintaining profitability and soil quality in cotton farming systems	Nilantha Hulugalle, NSW DPI
Development of measures of soil health	Peter McGee, U Syd
Sequestration of carbon below ground in cotton fields by arbuscular mycorrhizal fungi and cotton roots	Leonie Whiffens, U Syd
Maintaining a functional soil system for improved cotton production	Damien Field, U Syd

Weeds	
Phyla canescens — Lippia	*Matt Macdonald, UNE*
Development of sustainable integrated weed management strategies for use with low input cotton systems	*Ian Taylor, NSW DPI*

Genetically modified cotton	
Rhizosphere biological functions as influenced by GM cotton	Oliver Knox, CSIRO
Environmental impacts of genetically modified cotton on soil biological processes — effects of farming systems	Vadakkatu Gupta, CSIRO
A community evaluation of GM crops in the cotton industry in Australia	*Wendy Russell, U Wollongong*

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Water	
Precision placement of irrigation water with LEPA for Centre Pivots and Lateral Moves	Joseph Foley, NCEA
Hydrological impacts of irrigation in the Bourke district	Sam Buchanan, U Syd
Development of a decision support system for water allocation in the Gwydir and Namoi valleys	Rebecca Letcher, ANU
Development of a decision support system for water allocation in the Gwydir and Namoi Valleys	Karen Ivkovic, ANU
*Quantifying deep drainage using lysimetry	Anthony Ringrose-Voase, CSIRO
*Development of a field method for measuring deep drainage potential	Alex McBratney, U Syd
*Understanding and developing effective knowledge management systems	Graham Harris, QDPI&F
Drivers for the ecological condition of dryland rivers in northern NSW	Annie Vander Meulan, UNE
Measuring the influence of water quality on drainage through irrigated cotton soils	Des McGarry, QNR&M
Hydrologic and geophysical characterisation of palaeo-channels in north New South Wales	Chris Vanag, U Syd

Salinity	
***Understanding salinity threat in irrigated cotton growing areas of Australia: Phase IV — Interpretation/Extension**	John Triantafilis, U Syd/U NSW

Sodicity	
Characterising soil structural stability and form of sodic soil used for cotton production	Simon Speirs, U Syd
The impact of sodicity on cotton cropping systems	Kylie Dodd

Pesticides	
Management of risk for chemicals used in cotton production	Angus Crossan, U Syd
Environmental benefits of on-farm wetlands	*Michael Rose, U Syd*

Ecosystems	
*Valuation of ecosystem services relevant to cotton production in the Gwydir catchment	Francis Karanja, UNE
Ecosystem Services — The economic and ecological implications of catchment targets in the central west, border rivers and Gwydir	Nick Reid, UNE

Vegetation	
***Role of native vegetation in harbouring beneficial insects and reducing insect pest damage**	Ingrid Rencken, UNE
Determination of current biodiversity values of remnant vegetation on cotton farms in the lower Macquarie River catchment	Trudy Green, UNE
Impacts of cotton defoliants on native trees	Adam Downey, UNE
Biodiversity in tree plantings on cotton farms	Rhiannon Smith, UNE

Fertiliser management	
***Reducing losses of nitrogen from cotton rotation systems — assessing greenhouse gas emissions in cotton**	Peter Grace, CRC Greenhouse

Biodiversity	
Recording, analysing and mapping of biodiversity in cotton areas of the Emerald Irrigation Area	Bill Wilkinson, QNR&M
Aquatic biodiversity and the ecological value of ring-tank water storages on cotton farms	Susan Lutton, CRC Freshwater Ecology
*Insectivorous bats, irrigated cotton, native vegetation remnants and intensive production landscapes	Leah MacKinnon, U Syd

comes through its BMP program, and it can be a model for other agricultural industries. We are developing partnership projects that will deal with a wide range of natural resource management issues."

Jim McDonald, Chairman of the Namoi CMA, acknowledges the contribution of the cotton industry to the economic and social fabric of the Namoi catchment and the efforts made by the industry with respect to natural resources management issues. Jim is confident that the industry and CMA can work together to further enhance natural resource management outcomes.

"Cotton growers have recognised that there are still some activities that could be improved and this provides an opportunity for a strong partnership between the industry stakeholders and the Namoi CMA to work together on improving natural resources in the Valley," Jim said.

NRM RESEARCH IN THE COTTON INDUSTRY

The Australian Cotton CRC will cease operation on June 30, 2005 and will be replaced by the new Cotton Catchment Community CRC (CCC CRC). Dallas Gibb and Nick Reid have been joint program leaders of the Australian Cotton CRC's 'Enhancing the Agricultural Environment' program. The objective of this program has been to minimise the environmental impacts of cotton farming and enhance the agricultural environment. The program has focused on:

- Water quality, bioremediation of pesticides and wetlands;
- Deep drainage and irrigation salinity;
- Increasing awareness of native vegetation and its importance to farm systems;
- Biodiversity and the value of ecosystem services; and,
- Benchmarking greenhouse gas emissions and management strategies.

Natural Resource Management research is a key element of the new CCC CRC. Around $20 million over seven years (20 per cent of the CCC CRC's budget) will be allocated to important issues to the cotton industry and the catchments where cotton is grown. This expenditure will be boosted by inputs from a number of catchment management authorities and regional bodies.

Research in the new Cotton Catchment Communities CRC will focus on:

- River flow management;
- Groundwater management and connec-

tivity with surface water;
- On-farm water storages;
- Terrestrial biodiversity and ecosystems services;
- Property and catchment planning tools; and,
- Indicators and monitoring of environmental health.

Dallas Gibb said: "The new CCC CRC is a great vehicle for NRM research and development because it will provide a framework for partnerships between all the players in NRM from policy makers through to individual growers. Some of these include Cotton Australia, CRDC, ACGRA, NSW and Queensland catchment management groups, government agencies, cotton marketers and private investors.

"Partnerships allow greater focus of research activities so that the lag phase between research outcomes and adoption is reduced. This has been exemplified by the adoption of integrated pest management strategies by growers that has reduced pesticide levels in the riverine environment by 90 per cent, delivering direct water quality benefits for the environment.

"A key focus for the CCC CRC will not only be in delivering new research outcomes in NRM, but more significantly evaluating the economic and social impacts of adopting new technologies and practice in NRM.

An on-farm water storage at Emerald (©IAWM).

"This is how the CRC program 'Catchment' links to the 'Community' and 'Farm' programs," Dallas said.

Bruce Pyke, General Manager — Research and Extension with CRDC, said the industry has invested heavily in developing Best Management Practices and in knowledge delivery systems that will enhance adoption.

"This is one of the great strengths we have," he says. It should help us to address the gap that we currently have between what is perceived as government top-down catchment approaches to natural resource management, and the need for more inclusive industry-owned bottom up approaches such as BMP. It also gives us an opportunity to provide information and confidence that will allow growers to contribute and address catchment outcomes," Bruce said.

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THE ENVIRONMENTAL EXTENSION TEAM — WHO'S WHO?

The industry has established an environmental focus team that forms part of the Cotton CRC Extension Group. This team is responsible for delivering natural resource and environmental technical skills and information to cotton growers.

Located in various cotton growing regions, they work closely with local growers, Cotton Australia Grower Service Managers and cotton consultants to develop relevant extension activities. Some of the key activities the team will focus on over the next 12 months include:

- Assisting with technical delivery of the new BMP Land and Water Management module;
- Supplying technical information on vegetation management and assessment;
- Supporting enhanced riverine management;
- Extending findings from environmental research projects supported by the cotton industry; and,
- Assisting landholders in the preparation of environmental funding applications.

Regional environmental extension projects conducted by the Cotton CRC are funded in partnerships with:

- Department of Agriculture, Forestry and Fisheries providing the Environmental Specialist and an Environmental Extension Officer;
- The Queensland Government AGSIP program conducted by DPI&F, NR&M and the Environmental Protection Agency (EPA) providing two Environmental Extension Officers; and,
- Namoi Catchment CMA providing a Natural Resource Officer.

Cotton CRC partners including CRDC and the Queensland and NSW Departments of Primary Industries support these projects. The projects link directly to the Cotton Australia BMP program and involve collaboration with regional natural resource management bodies.

If you are interested in more detail on any of the projects outlined or the environmental focus team activities please contact one of the team members.

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CURRENT RESEARCH PROJECTS

Currently there are 37 environmental research projects addressing a range of issues funded by Cotton CRC and CRDC. The projects and the key researcher associated with each project are listed in the tables earlier in this story.

Projects in regular font are funded through CRDC and those in italics are Cotton CRC funded. An asterisk (*) denotes a joint CRDC/Cotton CRC project. The four projects in bold are described in more detail in the following articles. A further two projects are also described.

UNDERSTANDING THE SALINITY THREAT IN IRRIGATED COTTON GROWING AREAS

Dr John Triantafilis, University of Sydney/Cotton CRC

The Cotton Research and Development Corporation, the Cooperative Research Centre (CRC) for Sustainable Cotton Production and the Australian Cotton CRC funded a series of projects entitled "Understanding the salinity threat in the irrigated cotton growing areas of Australia". The projects will help cotton growers understand the causes and best management options for fields affected by isolated instances of point source salinisation and waterlogging.

The mobile EM Sensing System (MESS) operating in the Namoi Valley.

Phase 1 — Preliminary investigations

A scoping study to determine if Electromagnetic (EM) induction technology could be used to map subsoil salt stored naturally in the heavy cracking clays of the lower Namoi valley. The project found that various EM instruments (EM38, EM31 and EM34) would be useful for mapping subsoil salt layers at the field and farm scale.

Phase 2 — Methods and techniques

This developed more rapid field and district scale methods and techniques for collecting EM data. In collaboration with the National Centre for Engineering in Agriculture (University of Southern Queensland) a mobile EM Sensing System (MESS) was developed for field scale investigations.

Phase 3 — Implementation and management

This phase determined if the technology could also be applied at field and district levels in other cotton growing districts. Joint Natural Heritage Trust/Cotton CRC projects were undertaken with a number of community groups in the following areas:

- Macintyre River Valley (Border Rivers Food and Fibre);
- Lower Gwydir Valley (Gwydir Valley Irrigators Association);
- Upper and lower Namoi Valley (Upper and lower Namoi Valley Water Users Associations);
- Macquarie Valley (Macquarie2100); and,
- Bourke District (Bourke Irrigators Association).

Maps have been produced which show:

- The potential salinity hazard of irrigation salinisation as a consequence of irrigating with progressively saline water in the lower Namoi valley;
- Clay content and deep drainage risk in the lower Macquarie and Gwydir valleys; and,
- Location of subsurface saline material in the Bourke Irrigation district.

Phase 4 — Interpretation and extension

A web-based Geographical Information System (GIS) that landholders, policy analysts, extension officers, consultants and others can use in decision-making and project proposals will be developed. Currently data from the lower Macquarie, Macintyre and Darling River valleys is being incorporated into GIS format.

The projects were based at the University of Sydney and the Australian Cotton Research Institute, Narrabri. Dr John Triantafilis led the research projects with contributions from University of Sydney students and staff employed through CRDC, CRC and Natural Heritage Trust (NHT) grants. The research will continue at the University of New South Wales as part of a Natural Heritage Trust — Nationally Competitive Component grant.

ENVIRONMENTAL BENEFIT OF WETLANDS ON COTTON FARMS

Michael Rose, Dr Angus Crossan and Prof. Ivan Kennedy, The University of Sydney/Cotton CRC

Small changes in the management of tailwater channels and storages can have a large impact on the habitat value of cotton farms. Research funded by the Cotton CRC will provide cotton growers with guidelines and tools to ensure clean irrigation tailwater for use by native plants and animals. Three biological methods of removing pesticide from water are being investigated:

- Phytoremediation — removal of pesticides by holding water in vegetated areas such as artificial wetlands;
- Microbial bioremediation — microbial breakdown of pesticides; and,
- Biofiltration — filtering water through biological material such as wood chips and biofilms on basalt gravel to remove pesticides.

Each method reduces the amount of pesticide relative to that found in the untreated tailwater. Practical ways to incorporate these methods at a farm scale are under investigation.

Conclusion

The ultimate goal would be to link clean wetland corridors along the floodplain with each other, as well as linking them with other habitat vegetation along and away from the floodplain. In this way, the

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Pilot-scale basalt gravel biofiltration channel.

quality of our scarce water resources are not compromised, and agriculture and the natural environment can coexist.

The future

The researchers are looking for growers in other valleys to host further research into on-farm wetlands for beneficial insect refuge, waterbird habitat and biodiversity in general. The two current field sites are located in the Namoi Valley — Mollee, Wee Waa (collaborator Phillip Norrie) and Auscott, Narrabri (collaborator Ben Stephens).

THE ROLE OF NATIVE VEGETATION IN HARBOURING BENEFICIAL INSECTS AND REDUCING PEST DAMAGE IN COTTON

Ingrid Renken, University of New England/Cotton CRC

Over the past 10 years the value of beneficial insects and the contribution they make towards pest control within IPM have been recognised. There has been much research carried out on these insects but where do these heliothis-eating predators live and where do they lay their eggs? Ingrid Renken from the University of New England has dedicated her PhD to investigating the spatial and seasonal fluxes of populations of beneficial insects on several kinds of non-crop vegetation in a cotton growing district.

Methods

The work was conducted in a cotton producing area of the Namoi valley as it had a number of distinct non-crop vegetation types within a two kilometre radius of each other and adjoining cotton properties. Planted native windbreak, riverine trees, travelling stock route, pastures and dryland lucerne were suction sampled from July to January for three years.

Irrigated cotton, turnip weed and irrigated wheat were also sampled. Adult predators, larvae and nymphs were recorded. Presence of larvae indicated that beneficial insects were using the vegetation as potential egg laying sites.

For beneficial insects to be effective in cotton they need to be present early in the cotton growing season and so the sampling effort was focused on late winter and early spring.

TABLE 1: Location of target species beneficial insects during winter and early spring

	Lucerne	Pasture	Stock route	Windbreak
Red and Blue beetle	High	Not found	Medium	High
Green lacewing	Not found	Not found	Not found	High
Brown lacewing	High	Low	Medium	Medium
Variegated ladybird	High	Not found	Low	Low
Minute 2-spot	High	Not found	Medium	Low
Damsel bug	High	Low	High	Low

TABLE 2: Where larval stages of predation were collected

	Lucerne	Pasture	Stock route	Windbreak
Lady Bird Larvae	High	Low	Medium	
Lacewing Larvae	Low	Low		High
Damsel Bug nymphs	Low	High	Medium	

Results

Beneficial insects were present in all the vegetation types sampled. Table 1 shows where the target species beneficial insects were found during the winter and early spring sampling.

Table 2 shows where larval stages of the predators were collected, indicating that this vegetation is important in the predator life cycle.

Management opportunities

Vegetation surrounding cotton fields is valuable to cotton producers. Grasses on the traveling stock route had higher predator numbers but are very susceptible to drought. Although native trees have lower predator numbers, they act as a reservoir to ameliorate the impact of drought. It is important to maintain a variety of vegetation types if you want a suite of generalist predators.

Adult brown lacewing (actual size 10 mm).

REDUCING LOSSES OF NITROGEN AND GREENHOUSE GASES FROM COTTON ROTATION SYSTEMS

Dr Peter Grace, Queensland University of Technology and Dr Ian Rochester, CSIRO,

Background

The principal greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Tillage disrupts soil aggregates and promotes the degradation of soil organic matter and the production of CO_2 with an overall loss of carbon from the soil. Soil carbon is critical for maintaining soil structural stability and is an indicator of soil fertility.

CH_4 is produced when soils are water-

Measuring greenhouse gas emissions with gas chromatographs

logged for excessive periods of time. N_2O is produced on degradation of organic and mineral sources of nitrogen fertiliser. One molecule of N_2O has the effect of over 300 molecules of CO_2 in contributing to global warming. N_2O emissions also indicate increased losses of other nitrogen gases to the atmosphere once fertilisers are applied.

Method

Continuous monitoring gas analysis equipment measures greenhouse gas emissions, including nitrous oxide, which is released from mineral (fertiliser) and organic (legume) nitrogen sources. Preliminary data confirms earlier observations that the amount of N_2O released is highly dependent on the source of available nitrogen.

Early season emissions from a non-fertilised cotton crop that had been preceded by vetch are approximately one-third the magnitude of emissions from a cotton crop that had received 140 kg N per hectare.

Outcomes

The project will suggest best management practices to reduce carbon and nitrogen losses and emissions of greenhouse gases from cotton systems. Reduced or no-tillage and the consistent return of crop residues to the soil will promote an increase in carbon and nitrogen stores, as well as slow release sources of nitrogen.

Application of research

Agricultural practices that maximise

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nitrogen and water use efficiency and increase soil organic matter stores will also reduce greenhouse gas emissions and provide win-win situations for cotton growers in terms of economic and environmental sustainability.

Soil and region specific BMPs are being developed to reduce greenhouse gas emissions and ensure N losses are minimised for maximum return. Landscape level impacts include reductions in nitrogen that may be leached or transported into rivers or lakes.

This project is funded by Cotton Research and Development Corporation, Australian Greenhouse Office, Greenhouse CRC and Cotton CRC.

INTEGRATED AREA WIDE MANAGEMENT — "THE EMERALD MODEL"

Ian Rankin and Bill Wilkinson, QNR&M

The Integrated Area Wide Management (IAWM) project provides information, support and processes that assist production and environmental outcomes. Growers, consultants and NRM groups gather information. IAWM provides training and support and integrates this information into a database that participants can contribute to and use at property and landscape scales.

Growers can provide summarised landscape-scale data collected with scientific rigour to agencies and NRM bodies to enable more informed decision-making. Confidentiality and intellectual property rights are maintained and a grower reference panel approves information for distribution.

Water sampling after a storm event (©IAWM).

IAWM was initiated in 1999, and the pilot project started in 2002 as a joint initiative between growers, CRDC, Cotton Australia, NR&M, QDPI&F and 4T Consultants P/L.

Growers

The Emerald pilot has developed a comprehensive GIS database including:

- Base natural resource (for example, soils and topography) datasets;
- Land use/sub-catchment boundaries;
- Urban and rural water quality;
- Birds and macroinvertebrates;
- Pest information; and,
- Vegetation types.

The IAWM project has developed a water quality course and field manual and is currently developing a local bird field manual. These tools reduce the cost, time and resources growers need to commit to property planning. The IAWM project provides information and support for the Cotton BMP Land & Water Management module.

IAWM has also been used to improve area wide management of pest insects such as Helicoverpa spp. and silverleaf white fly.

Communities

IAWM works with rural industry to reduce community concerns about environmental impact of agriculture. In one example, IAWM data identified the source of turbid water in a drain as an on-farm erosion problem and IAWM staff worked with the community and growers to discuss and rectify the problem and minimise the risk of future occurrences.

Government

IAWM has collaborated with NR&M, Sunwater and growers to identify and quantify seepage problems with the supply channel. As a result, Sunwater has initiated a program to line a portion of the channel. IAWM will continue to monitor improvements and impacts.

Conclusion

The IAWM approach has assisted growers to better understand and respond to NRM issues at both property and landscape scale. The success of this project has lead to further funds being invested to trial the IAWM approach in other cotton areas.

WATERBIRDS AND IRRIGATION STORAGES IN THE LOWER GWYDIR

Peter Jarman and Janelle Montgomery, University of New England/Cotton CRC

On-farm storages present a golden opportunity for the cotton industry to contribute to biodiversity conservation — perhaps at little cost to profitability. If characteristics of some on-farm wetlands could be modified without unacceptably reducing their usefulness for irrigation then the widely dispersed system of on-farm wetlands could further contribute to the conservation of a diverse waterbird community.

Methods

Surveys were undertaken of 19 on-farm wetlands on nine cotton farms in the Gwydir valley between September 1999 and July 2001. The number of birds present on each wetland, bird species and any signs of breeding together with wetland characteristics were recorded.

Findings

Waterbirds occurred more regularly, and in greatest densities, on on-farm wetlands that are structurally diverse, contain trees in the water, and have established aquatic vegetation or at least a seed bank from which such vegetation can grow. They are least likely to occur on wetlands that are uniform in depth, and that lack trees or islands and aquatic vegetation. Water level will also impact on breeding behaviour with rapid draw-down potentially disrupting breeding events.

Management options

Cotton farmers could modify water storages and water use to enhance their ability to provide a suitable habitat for waterbirds. Many cotton farms have multiple storages so if one storage per farm were modified to encourage birds, the resultant spread of waterbird habitat across the landscape and through time could be beneficial.

The project was funded by the Gwydir Valley Irrigators Association and Natural Heritage Trust.

A well-vegetated on-farm water storage on a Gwydir cotton property.