Cotton Catchment Communities CRC

# FINAL REPORT

## *Part 1 - Summary Details*

**Cotton CRC Project Number:** 3.02.11

**Project Title:** A historical geography of cotton farming in NSW and Qld: adaptation and adoption

**Project Commencement Date:** 1/3/2010 **Project Completion Date:** 31/3/2012

**Cotton CRC Program:** 3 – Community

## *Part 2 – Contact Details*


**Administrator:** Rebecca Cross

**Organisation:** University of New South Wales

**Postal Address:** Biological Sciences Building, University of NSW, NSW 2052

**Ph:** 0405707756 **E-mail:** ra.cross@yahoo.com

**Principal Researcher:** Wendy S. Shaw, Project Leader

**Researcher:** Danielle Drozdzewski

**Research Assistants:** Rebecca Cross, Peta Wolifson

**Organisation:** University of New South Wales (UNSW)

**Postal Address:** Biological Sciences Building, University of NSW, NSW 2052

**Ph:** 02 93853715 m.0415128103 **E-mail:** w.shaw@unsw.edu.au

**Supervisor:** Wendy S. Shaw (Principal Researcher)


**Signature of Research Provider Representative:**

## *Part 3 – IP and In-kind*

Since the November 2011 6 monthly report, please outline the additional IP and in-kind that has been generated in the project.

1. Intellectual Property developed within the project.
Journal articles, reports, books (including chapters in edited collections) and other published materials/outputs will be the property of the University of New South Wales.

2. Project In-kind – Growers,Ginners and Consultants
1.5 hours: Spray-tech Aviation - 1.5 hours
1.5 hours: Guy Roth - 1 hour (plus 30min survey)
2 hours: Pate & Mike Carberry - 1.5 hours (plus Andrew Carberry for 30mins)
1.5 hours: John Watson - 1 hour (plus 30min survey)
2.5 hours: David Montgomery - 2 hours (plus 30 min survey)
1.5 hours: Sandy Munro - 1 hour(plus 30 min survey)
2 hours: Rob & Fleur Thompson - 1.5 hours(plus 30 min survey)
1.5 hours: Fiona Anderson - 1 hour(plus 30 min survey)
1.5 hours: Peter Gregg Snr - 1.5 hours
1.5 hours: Geoff Brownlie - 1 hour(plus 30 min survey)
1 hour: Mark Noble - 1 hour
1 hour: Jon-Maree Baker - 1 hour
1 hour: David Revell - 1 hour
1.5 hours: Vicki Tuck - 1 hour(plus 30 min survey)
2 hours: Scott & Jo McCallum - 1.5 hours(plus 30 min survey)
1.5 hours: Brian Kinsey - 1 hour(plus 30 min survey)
40 mins: Rob Tuck - 40 mins
40 mins: Joanne Grainger - 40 mins
40 mins: Ross Burnett - 40 mins
1 hour: Alan Williams - 1 hour
5 hours: Jean and Paul Kahl - 2 hours (plus perhaps 1 hour for help provided throughout the project) (plus 2 hours with re-interview)
3.5 hours: Brian Hearn - 2 hours (plus 1 hour with re-interview)(plus 30 min survey)
3 hours: Frank & Norma Hadley - 1.5 hours (plus 1.5 hours with re-interview)
1.5 hours: James Kahl - 1.5 hours
1.5 hours: Vic Melbourne - 1 hour (plus 30mins re-interview)
1.5 hours: Dave Anthony - 1 hour (plus 1 hour re-interview) (plus initial time with helping with contacts 30mins)
40mins: Tom & Bob Wilson - 40 mins
2hours 10mins: Ken and Susie Arnott - 1 hour (plus 40 mins with re-interview)(plus 30 min survey)
40mins: Dick Estens - 40mins
3 hours and 10mins: Ian & Wanda Dunnet - 1 hour (plus 40mins re-interview) (plus 1.5 hours help with history)

30mins: Anna Thompson - 30mins
40mins: Michael Smith - 40 mins
1.5 hours: Stephen Warden - 1 hour(plus 30 min survey)
1 hour 10mins: Nick Goodhew - 40mins(plus 30 min survey)
40mins: Paolo Carazzini - 40mins
1 hour 10mins: St John Kent - 40mins(plus 30 min survey)

***Part 4 – Final Report***

# 1 Background

This project documents a historical geography of the adaptations by the Australian cotton industry, and its communities, to changes over time. This report focuses on the major challenges faced by the cotton industry and documents the recollections of members of the cotton communities about the strategies deployed to overcome these challenges, from the 1960s onwards. Many challenges, and strategies adopted to overcome them, are unique to this agricultural sector. These have shaped the 'modern' or current Australian cotton industry, since the 1960s.

'Adaptation' and 'adoption' are keys terms used in academic, industry and government related Research and Development literatures (including policy documents). Adaptation and adoption are themes that reoccur in discussions about the unique status of Australian agriculture, particularly its capacity to adapt to increasingly complex and uncertain socio-cultural, economic and environmental conditions. The cotton industry has a fast-paced history of development in Australia, particularly from the 1960s onwards. This was due, in part, to the restrictive US Farms Bills that persuaded Californian growers to adapt their methods of intensive irrigated production to Australian conditions (Hearn, 1996). In the Australian context, pioneer growers and researchers developed an industry based on a capacity to adapt to local conditions, and adopt new technologies which:

> 'over the next 30 years expanded dramatically, and in the course of 15 years Australia swung from being an importer of cotton to the world's 4th largest exporter … cotton ranks third in Australia in value as an export crop' (Hearn, 1996: 1).

Cotton farming communities have had to change cotton-growing methods in response to a raft of environmental, social and political interventions – each viewed by many of the respondents who completed surveys and/or interviews for this research, as significant challenges. In response to these challenges, innovative and coordinated solutions developed by cotton growers have then been adopted industry-wide. Specific challenges associated with Australian cotton growing conditions range from extreme natural events, major changes in water policy, pest and weed issues, environmental audits, technological changes, (including genetically

modified cotton) (Cotton CRC, 2007), and socio-cultural changes (Merrill and Pigram, 1984). To address such challenges the industry has adapted existing technologies and resources, as well as developed new ones; for example progress made in pest management strategies and the introduction of Integrated Pest Management (Fitt, 1994).

This research project aimed to fill a gap in cotton-related research by documenting a range of experiences of adaptation and adoption in the cotton industry/community using social research methods. To operationalise, a team of researchers collated some of the experiences of as many cotton community members as possible within the constraints of the project, using survey and interview methodologies, and retrieval of artefacts and memorabilia. The details were collated and then presented to cotton communities as an educational DVD. The 'oral histories' gathered through in-depth interviews are snapshots of the industry, as remembered by its members rather than a definitive summary of the industry.

# 2 Objectives

| Objectives: | Extent to which the objectives have been achieved: |
|---|---|
| 1. To identify how have farmers have adapted to cotton-growing in Australian conditions, over time and, how have cotton communities adapted over time. | Some of the major challenges experienced by cotton growers / communities are detailed in **Section 5** of this report |
| 2. To document the strategies that farmers have used, in living memory, to adapt to:<br>-Australian conditions<br>-changing technologies<br>-changing expectations in the wider community<br>-a 'greener' expectation of Australian agricultural practice<br>-climate change policies<br>-the Federal Governments water license 'buy-back' scheme<br>-other issues raised by cotton farmers / communities | This objective was achieved by identifying, detailing and documenting the major strategies deployed to respond to the challenges |
| 3. To identify and document case studies based on contacts made in 2. | Four in-depth case studies were conducted about the cotton industry |
| 4. To produce consumable outputs to disseminate historical geography of Murray-Darling basin – for farmers and cotton | The outputs include: six-monthly reports, this research report and a DVD documentary based on |

| | |
|---|---|
| producing communities, and a wider audience. | interviews, memorabilia and other visual data collated for this research project. Publications forthcoming |

# 3 Methods

To capture the main challenges and subsequent strategies implemented in the modern cotton-growing era, a mixed methods social research approach was employed. This methodology involved, first, the compilation of a full review of existing literatures (refer to Appendix A) to identify the documented industry challenges, adaptations and adoptions to provide direction for development of the survey / interview schedule. Then, quantitative and qualitative primary data sources were collated using survey and in-depth interviewing techniques, with the view to create a social historical geography of cotton's history of adaptation and adoption. This mixed methods approach was utilised to produce a 'critical-realist' view, which recognises both participant diversity and that the 'underlying structures are complex and may be different from the observable events and discourses to which they give rise' (Winchester, 1996: 119).

### *3.1 Survey Development*

An initial literature review helped identify key moments in the cotton industry, which were included in the survey. These moments were included to capture both industry and grower perspectives on adaptation, for example, to changes in the supply of water, and industry adoption of, for instance, new varieties at those times. The survey (Appendix B, 1) used both closed and open-ended questions to capture quantitative and qualitative data, and used a range of questions to follow on from previous industry surveys by Cotton Consultants Australia (2008).

The survey deployed for this research used qualifying questions that directed different groups to different sections (eg for industry only, for community only, for both). The themes used to group survey questions were:

- General and Historical questions
- Geographical cotton community satisfaction
- Environmental management
- Information sources
- The future of cotton growing

### *3.2 Survey Distribution*

Multiple methods of survey distribution were utilised to maximise the response rate:

- The eight-page paper version of the survey was mailed (with the aid of the Cotton CRC member networks) to subscribers of the Spotlight Magazine Winter Issue (2010) with a reply-paid envelope. Approximately 2,000 surveys

were distributed in this way to both current and ex-growers and industry related personnel.
- The paper version of the survey was also emailed to key grower contacts collected during preliminary discussions with Cotton CRC staff.
- A handout including the survey was also made available at the 'Sustaining Rural Communities' Conference in Narrabri (2011).
- Concurrent to this mail-out, an online version of the survey was devised and a web link was also advertised within the Spotlight magazine Winter Issue (2011) and advertised within the Cotton CRC e-newsletter (June, 2011).

Despite using multiple distribution methods and snowballing techniques, the survey return rate was only four percent over four months (88 completed surveys). The respondents all replied via post or email. No online surveys were completed.

The survey included an invitation to participate in a follow up in-depth interview, and/or to contribute cotton memorabilia to the project (which would be returned upon completion). Of the 88 survey respondents, 40 indicated they were willing to be interviewed (a very high response rate). At interview, several respondents provided material memorabilia.

### *3.3 Interviews*

Participants were sourced from the survey responses and through Cotton CRC contacts. The Cotton CRC suggested people of importance in the industry, for example early pioneers of the modern cotton industry and long-term ex industry personnel. Three interviewing fieldtrips were made to NSW and QLD, with further interviews conducted with contacts in Sydney and Newcastle.

- August 2011 - Namoi Valley / Gwydir Valley / MacIntyre Valley / Darling Downs (Wendy Shaw, Rebecca Cross)
- October 2011 - Namoi Valley (Peta Wolifson, Rebecca Cross)
- October 2011 - Macquarie Valley (Danielle Drozdzewski, Rebecca Cross)

A total of 34 interviews were carried out face to face and were recorded using either a voice recorder or a video camera depending on participant preference. Another 8 key interviewees who were not available for a face-to-face interview were interviewed and recorded via telephone. **Forty-two in-depth interviews** were collected.

Examples of the memorabilia collected from various interviewees included: photos, documents, letters, videos and other historical data. This rich historical and visual data helped inform the discussion and provided qualitative depth to the overall historical context of the project.

Interviews were conducted using a semi-structured approach[1] to add layers of detail to the survey themes and provide nuanced explorations of individual experiences / histories. Themes for interviews were:

- Personal history of involvement in cotton
- Cotton community history and social involvement
- Adaptation and Adoption in relation to :
    - Pests
    - Water
    - Varieties
    - Equipment
    - Environmental issues
    - Economic issues
- Industry involvement/interaction and policy development
- Concerns for future adaptation and adoption

### *3.4 Data Analysis*

Quantitative (statistical) survey data were coded and analysed using the statistical analysis package (SPSS) to determine trends. The low response rate (below ten percent) meant that the quantitative results were not statistically significant to represent the whole cotton growing population. However, after theme building and coding, the qualitative results proved to be useful for informing and providing foundation to the themes used during the in-depth interviews.

The complexity of the interview transcripts meant that manual coding was preferable (rather than using NVivo or similar software package). The depth of information in the interviews provided detailed contexts and verbal (oral) histories, which produced undeniable 'evidence' of a capacity to adapt, and examples of the uptake and adoption of new practices and technologies. The project objectives were then addressed by the use of 'writing as analysis' through the collation of this 'evidence' into a narrative. This method is often used in qualitative and interpretative research projects (cf Winchester, 1996). The variety of sources provided a 'thickened description' about a process, or event:

> '[A thickened description] attempts to make sense of the complex layers or dimensions of meaning in cultural rituals by describing them in detail from many points of view … [which can include] the interpretation of iconography and symbolic imagery in … artefacts' (Robinson, 1999: 474).

This evidence, therefore, is not a list of 'facts' as such, nor does it corroborate or refute existing details or documents / literatures. Rather, this project is a collation of

[1] Two types of interviews are commonly conducted in ethnographic fieldwork: 'structured' and 'unstructured' (cf Winchester 1996). This research has used a method that includes the freedom of expression of an unstructured interview, but provided prompt themes as required, thereby adding some (semi) structure.

stories about the experiences of those involved in the cotton industry, including the recollections of some with experiences from the advent of the modern cotton industry, in the 1960s. Section 4 (Results and Discussion) combines this 'data' into a set of narratives about the historical geographies of the modern (post 1960s) Australian cotton industry.

Using interview materials, and the associated memorabilia, an educational DVD on adaptation and change – to the industry and associated communities, has also been produced.

# 4 Results and Discussion

### 4.1 *Introduction*

This section responds to the objectives (see section 2): it identifies the key challenges and strategies deployed to address these in the context of Australia's cotton growing environment. Socio-cultural and geographical challenges, pest and weed challenges, water challenges and challenges yet to be encountered, characterise this highly specialised agricultural industry. The industry has proved to be adept at adaptation. The following discussion focuses on the data provided during in-depth interviews, case studies and collation of memorabilia. The 'oral histories', supported with visual artefacts, such as photographs, were based on the recordings of recollections of memories and experiences by members of the cotton community. This provided such a rich data field that the survey statistics (which are summarised in Appendix B, 2) were deemed to be contextual only, and less than statistically significant. The qualitative field produced detail that enabled the identification of some of the main trends in challenges and mitigation strategies deployed to ensure the endurance of cotton growing in Australia. Following the qualitative method of ethnographic 'writing as analysis', interview-respondent commentaries are woven into the text.

(See Appendix C for maps of survey and interview respondent distributions.)

### *4.2 Challenge 1: Geographical and Socio-cultural Challenges*

The primary geographical and socio-cultural challenges that were identified as shaping the modern cotton industry in Australia have been: (i) integrating cultures – farming and American approaches to business; (ii) overcoming inefficiencies in harvest transport; (iii) ensuring stable economic growth; (iv) developing and maintaining community connections; and (v) forging researcher relationships with growers. These challenges have meant that whole communities have changed their behaviours over short periods. This capacity to change -- the rapid rate of adoption and adaptation -- was identified as the main reason for the industry's survival. Key players have co-operated to meet challenges as they arise. Collaboration among key players – growers, researchers, and seed, equipment and chemical suppliers – as well as innovation, were identified as the industry's strengths. The following

sections detail prominent examples of geographical and socio-cultural challenges identified by interview respondents, and the main strategies deployed to address these. It also identifies that ongoing change and adaptation to change has become culturally embedded within the cotton industry.

### *4.2(i) Integrating (Farming) Cultures*

The main social challenge to the modern pioneering cotton growers was community acceptance of a new culture of farming practice. An Australian national identity carved out of early colonialism and associated agricultural practices resulted in a distinctive rural culture centred on the traditions of beef, sheep and wheat farming (Powell, 2005). In the early days of modern cotton farming, irrigation development was such a new concept in Australian farming that one interview respondent reflected 'I didn't know what irrigation was, I thought it was something like corrugated iron!' (Interview respondent 24). Using irrigation to grow cotton crops was a foreign concept and required radical changes to farming landscapes: 'windmills [were] pulled down, wells filled in, fences pulled down, trees pushed over and all [of which] … didn't go down too well with the traditional graziers' (Interview respondent 19). The scale of these early changes meant that many local community members viewed cotton as a threat, an unknown that could unsettle traditional farming communities and lifestyles, in the early 1960s. One established grower commented:

> People were … self-satisfied in their achievements district-wise in cattle and sheep and wheat [farming] and any threat to change [was taken] …very seriously, everybody stood in the road [ie against] of cotton developing (Interview respondent 30).

Another farmer commented: 'The poor farmers around here didn't know whether to start growing cotton or sell and get out or stick around' (Interview respondent 6). The introduction of cotton farming to these Australian rural communities was described as an 'uncomfortable shift … [there was an initial] bad reaction to spread of cotton [lasting] 2-3 years, then it would die down … then cotton would spread to the next valley…'(Interview respondent 38).

Another challenge to farmers at that time was the arrival of North American migrants who were involved in pioneering this new phase of cotton growing in Australia. This meant that existing community members faced not only a new farming style but also a different culture associated with cotton growing (Merrill & Pigram 1984). As one grower commented '[there was] this impression that Americans came to change everything' (Interview respondent 38). Another community respondent in the Narrabri region explained, 'it was glamorous, foreigners were coming … they had a very positive influence [in school] especially on public speaking … they caused the upswing of the protestant religion … [and] brought a new dimension' (Interview respondent 24). Some community members were less enthusiastic about 'the yanks' (Interview respondent 24) but efforts were made to bring the two cultures together to enhance community spirit. The Namoi

Shire officially welcomed the Americans, and other community events included the Cotton Ball at Narrabri and Carnival day at Wee Waa (Interview respondent 7, Interview respondent 13).

Some community members viewed cotton growing as an opportunity for community growth and revitalisation. Traditional family farms that had converted to cotton production did so for a range of reasons, one being 'improving income and lifestyle' (Interview respondent 19) and for some cotton was welcomed as something new, 'everything you did with cotton was exciting' (Interview respondent 5). This group of Australian and American cotton farming pioneers (in the 1960s) were widely viewed as a foundation of the modern cotton industry and its success. This group were characterised by ingenuity (Interview respondent 1) and described by one long-term researcher as 'the most dynamic farmers in the world' (Interview respondent 17). Other local businesses were revitalised at that time.

Whether or not the arrival of the American farmers can be viewed as a main catalyst to the advent of the modern cotton industry remains unclear – and somewhat controversial – but, one respondent did state that '[the Americans] were like a tsunami of change in the way business was done … they were brash … and powered everything on' (Interview respondent 24). One of the American pioneers pointed out that: 'anti-cotton [sentiments] came when we were successful … to start with they all wanted us to succeed then others started to grow [cotton] and jealousy came when [our] success came' (Interview respondent 7). This sentiment changed as more farmers began to switch from traditional farming practices to cotton growing, which was in many cases an economic decision. Poor economic circumstances occurred 'as terms of trade declined in the beef industry and the costs of land increased with the irrigated industry, [so] there was a need to keep up [and therefore grow cotton, which was more profitable]' (Interview respondent 10).

### *4.2(ii) Overcoming Inefficiencies in Harvest Transport*

Harvest transport has been a key challenge faced by the industry, particularly the remoteness of farms and distances required for cartage, the equipment required and the inefficiencies in the associated processes. When the Americans began farming '[cotton was picked] entirely by machine, and dumped on a tarp on the ground, then packed into a woolpack by hand, then put onto a truck and sent by railroad up to Brisbane…[this was] a very expensive [and inefficient] way to do it' (Interview respondent 7). Next, trailers were used to transport picked cotton from the farm to the QLD gins, for new growers in NSW and southern QLD this meant many kilometres of travel, with high costs and a high risk of water/rain damage to the cotton (Interview respondent 14). Traditional farming communities viewed this method of transportation negatively. Cotton growers were viewed to be litterers, 'spilling cotton in the main street' (Interview respondent 13). The industry response to this challenge was to change cotton transportation equipment:

> When i first got into the industry we were leaving the cotton at harvest in trailers and getting into palettes which was a precursor to modules - so you'd build a module over this palette-type structure that was used like a sled to pull onto the back of the truck until they worked out the chain-bed concept to build them on the ground and pick them up. That was another major revelation in the industry, to grow cotton you could be miles away and it was quite feasible to grow it and transport it to the gin and that made a big difference (Interview respondent 16).

The **pallet-less modules** increased efficiencies (Interview respondent 14). Most recently, the introduction of round bale equipment has provided a clear example of the rapid adoption and uptake of technology within the cotton industry. According to two respondents:

> You know the picking technology is a huge leap forward, these round bailing pickers now. They're all around me … next door has one. That's a huge leap forward. I mean we used to have teams of backpackers here, and have a lot of fun or a lot of dramas, depending on how it was going (Interview respondent 35).

> About 30% of the cotton ginned this year was in round so that's our first year of rounds here but next year we're looking possibly 60% - some of the gins in Queensland this year ginned 100% rounds so take up [has] been big – and you can see the advantages for the farmer – John Deere's come in and said use this machine – it eliminates your tractors, module builders, ground crew, chaser pins … and your operators, to back to one picker and have someone help wrap in plastic every now and then (Interview respondent 18).

Changes in transportation occurred with the opening of new gins and changes in ginning technology (Interview respondent 13). The Namoi Co-op and Auscott were the first two gins in NSW and they aided in providing ginning competition as well as transport efficiency due to their localisation. These gins, and the QLD Marketing Board, were also the three marketers of cotton and played a large part in the economic development of the industry. Other gins have come and gone over time but some perceived that the three big players have had the strongest influence in forging a cotton industry (Interview respondent 5, Interview respondent 13).

***CASE STUDY 1: Stabilising Economic Growth - Auscott Pty. Ltd.***

Auscott has played a critical role in the development of the cotton industry. It was financially involved in the first crop produced by US pioneers in 1962 and in early government lobbying efforts (Interview respondent 6). Auscott was bought out by J.G. Boswell, a Californian parent company, in 1963. Auscott grew, ginned and marketed their own cotton, and then offered ginning services to neighbours 'at a price' (Interview respondent 1). Throughout Auscott's history, it has maintained relations with growers, industry and the local community, and has aided in stabilising aspects of the cotton industry's local economic growth. Business arrangements between Auscott and individual growers meant that costs, research, information and marketing were shared, according to several growers:

- Many tried to market themselves, and many were unsuccessful … the most successful were those staying with the pool [Auscott] (Interview respondent 1).

- We saw their techniques of irrigation development [as] pretty spot on and me, and a few others, modelled our development on Auscott and we've copied them or kept an eye on them ever since and they don't mind … they bent over backwards to help us sometimes (Interview respondent 19).

- They [Auscott] were fantastic, you know they took all these new growers under their wing and helped them grow cotton and took them around and showed them what to do and how to do it … so they were pretty instigative getting cotton going (Interview respondent 33).

Business relationships were also maintained by Auscott with other industry players as explained by an industry respondent:

- We regularly go to other peoples gins and [there is] no issue with QLD cotton and Namoi cotton guys coming down here, I mean we traditionally trip around to see other people's ideas (Interview respondent 18).

Auscott have also maintained a role in the local community as well with one respondent who stated:

- It was in the paper, Auscott will be having a party, the grand opening, [they] invited the town and half the town was out here … and it was just beer, it was unheard of, the size of the party, huge steaks as much as you could eat, no-one had seen anything like it (Interview respondent 18).

- Local scholarships are a way of keeping Auscott in the community eye … they are a pretty good corporate citizen (Interview respondent 18).

Auscott now has operations in three cotton-growing valleys – the Namoi, Macquarie and Gwydir valleys. The presence of this corporation with such strong economic backing, a forward thinking and innovative outset (Interview respondent 1), a direct connection with the US, and a community orientated ethos, impacted positively on the rate of growth in cotton production and stabilisation of the industry (Interview respondent 6).

### *4.2(iii) Maintaining Community Connections*

The maintenance of community connections within and between cotton communities across QLD and NSW has proved to be a geographic and social challenge to the Australian cotton industry. The low numbers of regular growers, and the sporadic nature of newcomers to each cotton-growing region has meant that relations between communities has been essential for the maintenance of the cotton industry.

The wealth and prosperity associated with cotton helped revitalise local businesses (Interview respondent 11) and embedded cotton into the socio-economic fabric of many communities. As one grower explained:

> Even people in Dubbo – now they just want the cotton industry to go great because it all effects the whole town … the motels, the restaurants, buying houses in town, cars the whole lot … it's all associated (Interview respondent 27).

A culture of sharing ideas and strategies, of sharing information to disseminate amongst local growers, has ensured good working relationships between communities. Two growers commented on the origin of these relationships:

> Because [the] industry was started by US people talking back to the other side of globe [and we wanted to] know what was happening … they had a willingness to share the info whereas my Scottish/Irish ancestry tended to keep it under the hat … [we] didn't even tell neighbours how much rain you had or you'd fib to him (Interview respondent 10).

> It was very cooperative … [US growers] lent machinery to us and we lent expertise on weeds (Interview respondent 13).

Sharing ideas led to the development of support networks, which have became key to the introduction of new farmers to cotton growing. This was particularly the case with those who had been vocally opposed to the industry in the early days (Interview respondent 26). A lack of market competition between growers was also cited as a defining factor in building relationships, as one grower noted:

> The [cotton] industry is pretty good … it all jumps and helps out each other. So we had plenty of support … and that's mainly because cotton industry doesn't compete against itself … so you are not trying to sell a product and compete with your neighbour like the cereal industry (Interview respondent 33).

However, there have still been challenges with the coordination of wider community and industry desires, as one grower explained:

> [There is] no recognition of what's happened with aerial spraying industry … if [the cotton industry] could do without it they would [have] and they [the wider community] shouldn't have been like that … [it has] come at huge cost to a lot of people (Interview respondent 11).

Local and American growers pioneered the post 1960s cotton industry in Australia. The resultant 'cotton communities' have adopted a culture of sharing knowledge, research outcomes and ideas more generally. The organisation of conferences assisted in the formalisation of knowledge sharing (see Case Study 2).

### *4.2(iv) Forging Researcher Relationships with Growers*

In the early stages of the modern cotton industry, growers and researchers needed to work together regardless of the tyranny of distance (across northwestern NSW and southern QLD), and the challenging task of adapting cropping practices to Australian conditions. The development of unusually close relationships between researchers and growers is a defining characteristic of the Australian cotton industry and is, in many ways, a model for change for other agricultural industries.

The Australian Cotton Growers' Research Association (ACGRA) was one of the first bodies formed in the 1970s in response to pest resistance issues. ACGRA led research that 'focused on address[ing] industry needs and problems through a voluntary self-levying system to help fund that type of work' (Interview respondent 1). Self-funded research has been integral to grower/research relations – a collaboration that has been particularly fruitful for adaptation. Cooperation rather than competition hinged on various requirements, including the need to cross-reference grower trials and results in the industry's early stages. This co-operation helped to foster a participatory relationship on the ground between scientists, agronomists, consultants and growers that continues to this day. Growers participated in trials, experimentation and data collection; several respondents reflected on this relationship with agri-companies as well as researchers:

> We used to joke and say it [the cotton crop] used to look like a field day site with all the bloody flags around it. So there was plenty of research going on from all fields, chemical companies and government departments (Interview respondent 35).

> The industry really pushed the limits of technology. Researchers could see the benefits of it, the potential … [that] kept growers interested in the progress of the researcher (Interview respondent 4).

> [The industry fostered an] innovative culture of people … farmers, agronomists, researchers … there was a culture across the industry of sharing and trying new ways (Interview respondent 3).

> Grower involvement in research sets the industry apart [from others, in terms of] participation in decision-making and funding of research as represented by the cotton research awards (Interview respondent 39).

The establishment of research stations also helped to forge linkages and sustained working relations between growers and the industry more broadly. For example, the Myall Vale Research site within the Namoi community facilitated a cross-disciplinary approach to research, with a full complement of research staff. This has ensured that local adaptation and adoption challenges have been met (Interview respondent 3, Interview respondent 8, Interview respondent 16, Interview respondent 21, Interview respondent 24). Long-term relationships between growers and corporations were developed (Interview respondent 21), as one grower commented: 'it was a dynamic, bubbling industry and we were all young. I look around now and I see all the same faces, we're all just a bit slower, fatter and greyer (Interviewee respondent 35). An ex-corporate respondent explained, 'there was a bond … particularly between researchers and growers' (Interview respondent 1), and a sense of family and community was instilled (Interview respondent 22). Similarly, a scientist commented on the importance of grower/researcher linkages, 'that's the reason why we stay in the industry for a long time. The feeling that you [are] doing a good thing … [and] are [a] part of something' (Interview respondent 17).

The primary cottonseed supply company in Australia was also established within this cooperative and coordinated atmosphere. Cotton Seed Distributers (CSD) became the 'first good joint cross-industry arrangement … it paid good dividends and consolidated seed distribution … it was also a catalyst for forming the Australian Cotton Foundation and Cotton Australia' (Interview respondent 1). CSD also forged a close working relationship with growers and research alike, as reported by one grower, 'CSD selected growers to grow particular fields [of cotton] and they selected and packaged seed and worked with CSIRO on breeding programs' (Interview respondent 5).

The building of these relationships within the industry has been essential to focussing research and implementing coordinated strategies of adaptation across cotton communities. The level of grower involvement has developed shared understandings within the research culture and has led to the rapid uptake and adoption of new ideas and technologies, which have been critical to the success of cotton in Australia (Interview respondent 4).

***CASE STUDY 2: Forging Relationships - Cotton Conferences***

Cotton conferences in Australia have been an instrument used to overcome geographical and social challenges by bringing communities together, sharing ideas and research, and uniting growers. The ACGRA instigated the first Australian Cotton Conference:

> I think 1982 was the first one we had in a bit of a tin shed in Goondiwindi … and it was a research forum really, quite a few growers came to it. [In] 1984, we had it in Toowoomba at USQ and it was a little bit bigger but again research focused and then we moved to the Gold Coast. But up until the early 90s, it was still very much a research-focused conference. It was run by ACGRA and they tried to maintain that (Interview respondent 16).

Conferences became a showcase of local research and began to attract nearly 30 percent of the industry, and became a key resource particularly for both 'early adopters' and prospective growers (Interview respondent 1). They were also used to address industry-wide matters, as one industry representative recalls, 'I remember attending a cotton conference sometime in the 80s [where] the theme was 'can we still keep growing cotton at less than $200/bale?'' (Interview respondent 16). The social interactions facilitated by the conferences also strengthened networks within the industry as described by one scientist:

> The cotton conference is a good one because it brings everyone in the cotton industry – research, consultants, marketing, chippers and everyone together in the one place. So to me that's the place you socialise, know each other and talk about issues. So that's more the significance of the conference, and if we have developed things that other growers haven't heard about, they will hear about it at the conference and they will know who the researcher is and then talk to the researcher … this is good, you become friends (Interview respondent 17).

Conferences also attracted international researchers and eventually the World Cotton Research Conference was born out of the Australian conference culture (Interview respondent 1). Australia's cotton conferences are another example of an industry ready to adapt to change and adopt strategies to address change.

### *4.3 Challenge 2: Pests and Weeds*

Pests and weeds have presented an ongoing challenge in the development and viability of the cotton industry in Australia. With the introduction of transgenic cotton and its subsequent overarching use within the industry, pesticide use has declined. Other issues, particularly surrounding water management, have subsequently come to the fore. However, pests and weeds did presented significant challenges to the industry, and some of the most significant requirements for adaptation, and adoption of new practices and technologies. For example, Integrated Pest Management (IPM) continues to evolve with ongoing research, development, and forms a central part of the industry's Best Management Practice (BMP). An entomologist summarised the broad change this way:

> Pest management has changed dramatically from basically a heavily pesticide-reliant system to now with Bollgard II we're not really spraying for Helicoverpa very much at all … [E]ven though we're still managing some pests … we've made a huge leap forward (Interview respondent 21).

#### *4.3(i) Early Challenges*

Early cotton growing utilised the existing Empire variety, which came to Australia with the First Fleet. As a variety not bred for Australian conditions, pest damage was frequent and yields stagnated at around one bale to the acre. The US growers who pioneered the modern industry in the Namoi Valley introduced Delta Pine varieties, and others, but continued to struggle with Australian pests and weeds. Reflecting on these problems, one pioneer has stated:

> For many years we used Delta Pine variety and would bring in better varieties from the States … Heliothis was our biggest, worst problem for cotton here … we were spraying virtually every week with DDT (Interview respondent 7).

As Australian farmers began to grow cotton, often at the expense of other agricultural production, new pest and weed challenges continued to evolve. One Australian pioneering grower described some of the initial difficulties with the new crop:

> As far as the agronomy was concerned I had no idea at all, we didn't know anything about Heliothis or the other insects that were about then … and fertility and variety and all that sort of thing was completely different to what we were used to (Interview respondent 19).

The unprecedented prevalence of Helicoverpa in the early years 'led the industry into a trap [and that] was the overuse of pesticides' (Interview respondent 1), with particular use of one chemical group that included DDT. This pest issue led to the collapse of cotton growing in the Ord River (see case study 3), but also, importantly, alerted the industry to the threat of pesticide resistance. The industry response, and strategies deployed for resistance management (see section 4.3(iv)), heralded the beginnings of highly co-ordinated approaches that were to follow. As one respondent commented:

> The researchers quickly worked out a rotation use of pesticides to … manage resistance … in the mid 70s. The industry very quickly attuned itself to looking to research to provide answers and … being extremely quick to adopt that new technology. And that's where cotton differed from any other agricultural industry. Because they'd been through that period of hurt in the early 70s, they knew how important it was to very quickly adapt to new technologies (Interview respondent 1).

The ban of DDT in 1987 (Australian Government 1997) is still controversial in the cotton industry. DDT was replaced by various chemicals, over time, many of which were fraught with their own controversies. Two respondents noted that these included the decimation of populations of birds, fish and livestock (Interview respondent 11, Interview respondent 23).

Animosity towards the cotton industry was most often a result of pest management issues. Most notably, the use of aerial spraying and the much reported fish kills caused by Endosulfan drift demonised the cotton industry. One grower reflected that concerns were often justified:

> You did [have to defend yourself] when you were spraying. And you don't blame people for that too, particularly with some of the chemicals (Interview respondent 23).

The extent of the controversy, and concern within the industry itself resulted in the cotton industry pioneering a self-imposed environmental audit, and development of Best Management Practice (BMP) guidelines. As one respondent recalled:

> [The cotton industry] was forced [to implement BMP] because it was a sizeable user of agricultural chemicals [and] it had created some mishaps that did generate a lot of public attention … There were practices that were just not sustainable, not acceptable and didn't reflect responsible attitudes (Interview respondent 1).

***CASE STUDY 3: Pest resistance - The collapse of cotton growing in the Ord***

In 1960, the Ord River pilot farm was established because of water availability and the long, dry winters of the Kimberley region. One ex-industry respondent described this origins of the scheme this way:

> The engineers had found the perfect dam site. Never in the history of human endeavour could so much water be contained by such a small dam wall … so they started growing cotton (Interview respondent 2).

The isolation of the Ord, which initially attracted one cotton grower's (Interview respondent 23) sense of adventure, proved to be one of the greatest challenges for cotton farmers. As one of the first five farmers, respondent 2 left after nine years and reflected on reasons for this:

> We realised after being up there for the first 8 years [that] it wasn't as good as we thought. If you're producing that far away you've got very expensive costs … We just weren't making any money (Interview respondent 23).

CSIRO scientists, who would later move their plant breeding operations to Narrabri, were based at the research station in the Ord when *Helicoverpa armigera* developed resistance to DDT in the 1970s. Cotton growing in the Ord subsequently collapsed. One pioneer grower recalled the pest problem:

> They [the scientists] realised … it wasn't going to be plain sailing. [Cotton] yielded very well but even in those first couple of years we knew … the native vegetation was supplying us with a Heliothis problem. It got to the point where you could put on all the DDT you liked it couldn't stop them … we were putting on 20 sprays … the economics fell right out of it (Interview respondent 23).

Moreover, one scientist recalled how other agronomic research in the Ord was abandoned in the face of the *Helicoverpa* problem, and regretted the situation that unfolded:

> I still am deeply ashamed. I think CSIRO pulled out prematurely … It was cowardice under enemy fire. Heliothis said 'Boo!' and everyone ran away except the growers. And I felt for the growers that we'd really let [them] down – both Commonwealth and State governments (Interview respondent 2).

The pest challenges at the Ord River site marked a key turning point; it highlighted the issue of pesticide resistance and the industry's need for Integrated Pest Management (IPM) (see case study 4). While there is a current Resistance Management Plan for the Ord as a 'new' cotton growing area, one of the former scientists involved (Interview respondent 37) believes that any success with cotton growing at the Ord will only be with 3-gene transgenic cotton (see section 4.3.4), and social issues with the area's isolation will continue to pose difficulties.

### *4.3(ii) Australian Varieties*

Selective plant breeding was also a strategy deployed to overcome pest and weed challenges. The introduction of cotton varieties bred to suit Australian conditions were vital to the success of the industry and provided the most significant yield increases prior to transgenic cotton. Dr Norm Thompson's involvement was well recognised, for instance:

> Dr Norm Thompson … with the purpose of getting insect resistant cotton, brought seeds and varieties from all over the world … Under his program the local varieties outshined the imported varieties. The plant breeding here now leads the world (Interview respondent 7).

Introduction of okra-leaf varieties, which were resistant to Helicoverpa and varieties resistant to bacterial blight and verticillium, were notable moments for the industry. A grower with decades of experience spoke of the breeding program's contribution as a strategy for pest and weed resistance, and Dr Norm Thompson's role:

> One of the biggest things has been the improvement in varieties since Norm Thompson started to develop Australian varieties … One of the main breakthroughs was verticillium resistance because verticillium was one of the main things that held our yields back in the 60s and 70s. [When] we put Norm's varieties in, it increased our yield by a bale to the acre … and that was one of the biggest boosts we got prior to Bollgard [II and] Roundup Ready … Norm was the man that kept our industry going here early on … and we're just lucky we had him (Interview respondent 19).

### *4.3(iii) Best Management Practice (BMP)*

A BMP program was established in response to concerns about the impacts of pesticide use on the riverine environment. An interview respondent, who had been involved in the development of the original BMP program, commented:

> It was the right thing at the right time. There was an Endosulfan contamination of beef cattle that happened during the development stage of the BMP manual … which provided a very real rationale as to why this was important to the industry and it wasn't just a theoretical problem … but this was something that was genuinely an issue (Interview respondent 39).

In its early years, the program dealt with concerns about human and environmental impacts of pesticide use. Since then, a broader strategy to address the impacts of other aspects of agronomic management has been introduced.

***CASE STUDY 4: Pest adaptation strategies - Integrated Pest Management (IPM)***

Integrated Pest Management (IPM) within Australia's modern cotton industry has changed remarkably, reflecting the industry's advances in research and development around pests. Alongside a number of other developments in the

industry, the introduction of transgenic cotton has had the most significant impact on IPM. One scientist explained how the perception of IPM has undergone vast changes:

> We've got a much clearer picture of what we think integrated pest management is these days ... [Back in 1985] it was … interpreted basically as not spraying very much at all, tolerating lots of damage [and] getting low yields ... [now there are] better tools … the transgenics, but also the insecticides … that are more selective, so they let the beneficial insects survive as well as providing good control of the target pests … IPM is … not so much about getting high yields as getting profit … and if you can do that by spraying less [then] that's the way to go (Interview respondent 21).

Early attempts at IPM lacked the scientific tools to achieve successful outcomes industry-wide. As pesticide resistance problems and the negative public perceptions surrounding cotton worsened into the 1990s, there was an industry consensus for action and pest management strategies were examined more closely. As a scientist recalled:

> That really came to a head about 1998 where we had a very wet winter, loads and loads of weeds, massive pest problems and very high spray numbers (Interview respondent 21).

At this time, CSIRO scientists organised a meeting with other leading researchers, consultants and growers and developed a blueprint for on-farm IPM covering an annual period, based on the industry's existing tools and knowledge (Interview respondent 17). These guidelines focused on pest management and associated agronomic management. A scientist explained the timeliness of this meeting:

> By us getting together and putting [IPM] in a really practical context … [the result] was something that the extension people could focus on [as] the message to get out to industry … more selective, more IPM-compatible insecticides became available and that meant they could actually spray Helicoverpa without being as disruptive. [Ingard] was capped to 30% of the area ... but because it controlled Helicoverpa quite well for part of the year it became a bit of a safe test bed for people to try some IPM tactics on (Interview respondent 21).

The industry's changes to IPM have been described as a 'journey' that farmers, consultants and scientists have gone on together (Interview respondent 17). The collaborative character that had become well entrenched in Australia's cotton industry meant that on-farm sampling was integral to the acceptance and adoption of IPM tools and protocols.

The industry's shift from conventional to transgenic cotton was a pivotal turning point for IPM. Before transgenic cotton, many believed that IPM had failed to deliver on its intended goals. 'No-one was willing … [whereas now] people are doing it without knowing it's IPM!' (Interview respondent 37). A former scientist explains:

> For years and years people were playing around with all these things … And here this one technology comes along: Bt cotton and it is IPM in a bag. But it also allowed better IPM to come in as well. People could actually *do* IPM now instead of just talking about it or doing it on the research farm (Interview respondent 37).

Developments in IPM have continued, and now form a vital component of the industry's environmental Best Management Practice (BMP). The collaborated efforts of the cotton industry's research and development are subject to increased accessibility through new technologies. The computerised Decision Support System, CottonLOGIC, was designed to assist with IPM and is now accessible via smart phone and tablet applications (Interview respondent 4). Cotton growers can literally carry knowledge data(bases) into the field and input their own pest data. The speedy development and application of such technologies within the cotton industry exemplifies the pro-activeness of the industry to adopt technologies for improved efficiencies.

### *4.3(iv) Transgenic Cotton*

The uptake of transgenic, Roundup Ready cotton in Australia has led to a drastic reduction in the use of insecticides and herbicides. Paired with BMP, this reduction has seen community concerns regarding pesticides in cotton shift from pesticide management to other concerns, such as water management. According to one respondent, complaints to the NSW Department of Primary Industry regarding spraying have declined '100 percent' (Interview respondent 3).

Introduced in 1997, Ingard was a single gene Bt cotton that was capped at 30 percent use. However, a lack of testing industry-wide meant that the intended outcome of the product – to be Helicoverpa resistant – generally failed. A respondent recalled the product roll out and the industry's focus on resistance using Bt genes:

> It was the introduction of what was potentially going to be a silver bullet and the small area work certainly showed that the technology worked but as soon as it got to a larger scale [it failed] … but there was a period of denial around that … That's where some of the work started around looking at … resistance to Bt (Interview respondent 22).

The introduction of the second Bt gene into Australian seed with Bollgard II delivered greater reliability, as one respondent noted 'Bollgard II was actually going to deliver what Ingard was supposed to deliver in the first instance' (Interview respondent 22). Another respondent explained:

> When we had 2-gene cotton it changed over within two seasons … 2-gene cotton is much more durable [provides more protection] in terms of resistance management. The likelihood of [pest resistance] is much less with 2 genes than one, and is much less with 3 than 2 and so on (Interview respondent 37).

- *Resistance Management Strategies*

  Prior to the introduction of strains of cotton genetically modified to be resistance to, for example, Helicoverpa, a main problem was the development of resistance to insecticides by insect pests. The industry's Resistance Management Strategies prior to Bollgard II had focused on structuring the use of pesticides throughout the season. A former scientist explained:

  > They're controlling aphids now with a lot softer chemicals than they did in those days … they have less impact on the beneficials, and that's part of the resistance management strategy … to rotate those soft chemicals so you don't lose those … products to resistance (Interview respondent 37).

  These strategies have inevitably introduced new issues to be addressed. For example, there was controversy around the 'pupae busting' program:

  > We brought in the pupae-busting program … in the mid '80s, in the Pyrethroid resistance program … but the problem was it goes against best practice in terms of minimum till … you can't kill pupae … by not disturbing the soil. You've got to do it, so that's always been a sticking point (Interview respondent 37).

  Whilst resistance management for conventional insecticides still exists it is largely, as one respondent put it 'on … a backburner [for] Heliothis', they suggest that 'it's still important for white flies [and] sucking pests that aren't controlled by … transgenic crops at the moment' (Interview respondent 37).

  However, the achievements of resistance management for conventional cotton appeared to have improved the chances of the uptake of transgenic cotton by cotton growers:

  > The successful uptake of the Bt transgenic resistance management strategy was largely on the back of the successful Pyrethroid resistance management work we'd done (Interview respondent 37).

  Members of this relatively young industry have participated in and therefore remember first-hand many of the strategic measures that have improved cotton growing in Australia. The result is that growers generally appreciate the significance of strategies proposed by researchers. In the Resistance Management Strategy for Bt cotton, a former scientist explained:

  > The refuge requirements [are] a nuisance … but [the growers] do them because of the history of the cotton industry knowing that if you don't [adapt and adopt new methods] you're … going to end up … back to spraying and all the problems: environmental issues, health, occupational health and safety issues, all those things we got away from will come back (Interview respondent 37).

  Another respondent provided another perspective:

  > You don't want [some cotton growers] to contaminate their neighbour's farm, so there's a degree of care that goes with that. Everyone thinks it's all about 'oh, welcome to the club', well it's also a bit of risk management from an industry perspective. That's why

> we're happy … to make sure those new growers have got a go-to [attitude] around this and that they're aware of the risks of what they're dealing with (Interview respondent 22).

- *Roundup Ready Cotton and weed management*
  Roundup Ready Bt cotton has completely changed weed management in the modern cotton industry. In the past, cotton growers would employ workers for cotton weed chipping: 'It used to be part of the culture. Cotton chippers were in town … they were itinerants' (Interview respondent 24). Roundup Ready Cotton therefore greatly affected the dynamics and efficiencies of cotton management, including eliminating the need to employ weed chippers (as required). A pioneer grower reflected on the change, including the difficulties in finding suitable herbicides:

  > [Roundup ready cotton] has totally changed the industry … There are many, many weeds that are similar enough to cotton that there wasn't any chemical to kill them … but with Roundup now it's just so easy (Interview respondent 7).

Research and development into pest and weed management has demonstrated again that members of the Australian cotton industry have the ability to adapt and respond to enhance the success of the industry. Responses have occurred as issues arise, and also pre-emptively. This bodes will for the resolution of concerns that may arise in the future.

### *4.4 Challenge 3: Restrictions and access to water*

Cotton farmers and the industry more broadly have had to develop and adapt their businesses and technologies to changing policies of water supply and licensing, as well as be responsive and prepared for the whims of the Australian climate. Restrictions and access to water supply has presented the Australian cotton community with significant challenges, particularly during the modern cotton era.

#### *4.4(i) Early Challenges:*

Irrigation development during the second half of the 20th Century was extensive in Australia. Both Federal and State governments were heavily involved in dam construction, water distribution systems, the development of irrigation schemes, and encouragement of farmer investment in irrigation for crop production (Cotton Australia, 2008). In the 1960s, irrigated cotton farming became the foundations for a viable industry in Australia. Broad scale irrigation became a reality by securing water sources. Dams were constructed in inland areas of NSW and QLD. During the 1960s and 1970s, these dams paved the way for the resurgence in cotton growing in Australia, and a move away from 'dryland' or 'rain-fed' cotton to irrigated cotton (Henzell, 2007). Dams were constructed in river valleys. For example, the Keepit dam in the Namoi Valley and the Burrendong Dam in the Macquarie Valley. These

enabled the establishment of irrigation-based cotton communities. This was of particular importance in the Narromine and Warren Shires – where annual precipitation levels were lower than in other cotton growing areas across NSW and QLD. Dam construction saw the 'significant expansion' of cotton crops during the 1980s and 1990s in these regions (MDBA, 2010: 1059).

As a high value annual crop, the production levels of cotton have been adapted to the availability of water annually. Cotton is an opportunistic crop: when water is plentiful, it yields the highest value return for investment. This profitable return makes cotton a lucrative crop – 'we're all saving our water for … [a] crop of cotton. Nothing else can match it for making money' (Interview respondent 27). 'Cotton generally returns more per megalitre than any other crop, contributes $1.5 billion a year in export earnings and employ[ing] 10,000 Australians' (Cotton Australian, 2012).

During the 1980s and 90s, many traditional croppers and graziers were drawn into the cotton industry because of the returns on investment. This was particularly the case with the over allocation of water licenses along the Murray-Darling river system. As one farmer contended,

> 20 to 30 percent of enterprise or farmers in this valley that became cotton growers ... really had no intention of becoming cotton growers ... [they] were forced to [because they] had water licenses ... and it was one of the few remaining profitable crops (Interview respondent 26).

Water has been both cotton's 'limiting factor' (Interview respondent 20) and its drawcard. As one grower asserted, 'it … depends on water ... [we have a] full allocation this year [2011], enough water to grow [cotton] so taking advantage of it' (Interview respondent 27). However, water reform is independent of natural events. For instance, the two most significant changes in water reform were the separation of land title and water access entitlements and the water sharing processes initiated by the Council of Australian Governments, (COAG) in 1994. Human factors have influence water reform -- such as the building of dams, water licensing and water-buy back schemes, as well as environmental constraints such as flood and drought. In particular, drought has severely affected cotton production – with impacts on local economic growth. As one respondent observed, cotton production fell so severely over the past decade that many farmers left the cotton industry, particularly in 2004 to 2005 and 2007 to 2008 (Cotton Australia, 2008; Interview respondent 25).

River regulation in the form of flood mitigation schemes, responded to large flooding events such as the Namoi floods in 1971. Such mitigation has reduced the incidence and extent of flooding. One long-time grower recalled that during the 1971 flood, aerial photography was used to map the extent of flood channels and was the start of a 'flood mitigation scheme, [that] while met with … resistance ... got … going, and a lot of work [was] done' (Interview respondent 1). The control of the

water supply, particularly in the form of mitigation against environmental factors, has been implemented to sustain the productivity of cotton communities.

### *4.4(ii) Industry adaptation strategies*

The development of strategies for water use efficiency, in tandem with wider industry developments, have seen 'continuing growth and productivity' despite a reduction in the total water [available, and] required' (MDBA, 2010: 1078). Indeed, the tight-knit and productive relationship between cotton farmers, and research and industry bodies, was overwhelmingly identified by respondents as advantageous to cotton communities. It has also proved to be a distinct strategy for dealing with water supply and efficiency. One respondent commented that, 'growers identified [water as a limiting factor … water was becoming a … strong focus … there were lots of [research] projects to do with water' (Interview respondent 20).

Water efficiency emerged as a prominent theme of discussions about water challenges, with farmers and the industry more broadly. Restrictions to water supply, initiated by the water license buy back and the 10-year drought, forced many cotton communities to look at new innovative ways to use water more efficiently, particularly for growing cotton. A respondent argued that the water reform process has continually pushed farmers 'to remain profitable, to either keep increasing yield[s], or reducing inputs' – it has *forced* farmers to continually assess their water efficiency (Interview respondent 20). Similarly, another respondent commented that the combined impact of research and application has improved on-farm water use efficiency by 40 percent in the last 10 years (Interview respondent 3). Farmers supported these views; one farmer argued that the drought forced them to 'run a more frugal business' and that despite the hard times, there has been 'a lot of really positive outcomes' in learning how to 'streamline your business' and cut your overheads back (Interview respondent 25).

Other water-use efficiency strategies were developed through collaborative research by growers and the wider cotton industry. Examples of such collaborations have included, the use of specifically Australian varieties of cotton (section 4.3(ii)) and Best Management Practices (BMP) (section 4.3(iv); Land and Water Modules and WATERPak (Roth, 2011). A respondent noted that collaborative research practice (see also section 4.2(iv)) have had positive outcomes for cotton communities because:

> If the government was raising the bureaucratic process of water reform the growers were quickly able to identify what research was needed and put that in place to demonstrate that their practices were efficient (Interview respondent 20).

### *4.4(iii) Farming adaptation strategies*

Strategies deployed by cotton farmers to overcome water supply issues include, dryland cropping, crop rotation, and irrigation equipment changes including sub-surface and drip irrigation, levee and farm design development. The respondents

interviewed for this research have trialled then used different combinations of these strategies. The key elements of these discussions are detailed below.

- *Dryland cropping*
  Dryland has presented a viable alternative to irrigated cotton because of cotton's 'strong, foraging tap root system', which 'actively explores the soil profile for moisture' (The Australian Cotton Grower, 2009: 20). A respondent affirmed that, 'cotton really suits it [dryland cropping] because it's such a good forager' (Interview respondent 26). While dryland cotton was a popular crop in the late 1990s, prolonged drought during the first decade of this century saw a decline in areas under dryland cropping (The Australian Cotton Grower, 2009). Dryland cropping was also seen as an alternative to irrigated cotton when growers were implicated in the buyback of water licenses. Some farmers have identified dryland cropping as an alternative, viable and productive strategy for managing diminishing water allocations, and drought. As an opportunistic crop, dryland cotton is also increasingly an option for farmers with high and/or near to full water allocation, and often limited natural rainfall.

- *Crop rotation*
  For the majority of cotton community members interviewed, the drought simply meant that they did not grow cotton, or planted only one or two crops between 2001 and 2009. Because cotton is an opportunistic crop, it is grown in combination with other – usually less water intensive – crops such as lupins, sorghum and chickpeas. However, 'none of these alternative enterprises [have] the same return as from cotton' (MDBA, 2010). This was recognised by most respondents: 'we've been growing wheat and canola on our cotton fields because we've had no [water]' (Interview respondent 27). The same grower commented, 'there won't be any corn in [this season] because you can't make the money out of corn, [or] irrigated wheat' (Interview respondent 27).

- *Irrigation equipment changes*
  A number of changes to irrigation systems were cited as strategies for improving water efficiency and in some cases, for mitigating soil compaction problems caused by the use of heavy equipment. These changes ranged from adjusting farm design and introducing levees following the introduction of irrigated cotton in the 1970s, to more recent implementation of sub-surface and drip irrigation. As irrigated cotton returns higher yields, and higher rates of employment, than dryland varieties (MDBA, 2010), it has important for growers and the industry more broadly to improve 'in-field water use efficiency' (Interview respondent 20). Drip irrigation represented an albeit expensive improvement in water use efficiency. Traditional methods of flood irrigation used furrows, which were less expensive. One respondent commented that:

> The government spent more on improving infrastructure to grow cotton through drip irrigation and overhead sprinklers, where we can save 20% water [but] with our drip [system] we're saving 50% water (Interview respondent 27).

Another new technology introduced to improve efficiency has been overhead lateral move irrigators. Those seeking more innovative approaches to water use were prompted not only by decreases in water allocation through drought, but also through the buyback of groundwater licenses, as one farmer noted:

> We looked at alternate sources of irrigation and that's when we started to move to a linear move, which means lateral move irrigators, pressurised watering ... We set up one farm with two 750 metre long lateral move irrigators ... we reduced our water usage by about 30 percent (Interview respondent 33).

Another respondent concurred on the efficiency of the overhead lateral movers. This respondent was prompted to invest in the technology because of their small water (general security) license, which left them vulnerable to purchasing water on the temporary market – a source not available during the drought. They commented:

> For that reason, we invested about five years ago in an overhead lateral-move irrigator. We converted about 146 ha of flood irrigated land to overhead irrigation and that's been fantastic because it's automated many [hectares] and it's given us a tremendous water saving (Interview respondent 26).

The primary response during interviews to questions about water use efficiency and irrigation equipment changes was that continual reassessment of water usage resulting from various restrictions has prompted cotton community members to look at innovative ways to improve water usage and associated farm design.

### 4.5 Challenge 4: Future Challenges

The future challenges likely to impact on the Australian cotton industry relate to new dimensions of the existing socio-cultural and geographical challenges, pest and weed, and water issues. These include the development and spread of coal seam gas mining, the advent of corporate farming, pest and weed resistance issues, future water policies and availability, and expansion of the cotton industry.

#### *4.5(i) Coal Seam Gas Mining*

The increasing presence of coal seam gas (CSG) mining within cotton growing landscapes is presenting ongoing challenges to cotton communities. The temporary workforce associated with the mining industry has had an impact on local rural businesses and influenced the challenge of securing skilled local labour. This concern was expressed by a respondent who identified problems:

> 'Particularly with hiring casual staff; one of the things you're seeing [is mining] pushing up wages, [and] you struggle to compete with the wages … one of the other things you're seeing around town is accommodation prices – they get higher … [when we are] trying to bring seasonal staff in, we do get backpackers and that sort of thing come into town and they go whoa! The prices are huge - $400 a week for a cabin in a caravan park!' (Interviewee respondent 18).

CSG is also a concern to local farmers and agriculturalists more broadly, who are apprehensive about the increasing challenges of aquifer management and local water security. One respondent explained this uncertainty: 'I mean nobody knows what's happening with the water. That's a huge concern, because by the time they stuff it up they'll be gone' (Interviewee respondent 35). The long-term challenge is 'that we'd still like to be here in 50, 60, 100 years' time and mining won't be, it'll probably be gone in 50 years time and there'll be a lot of holes in the ground' (Interview respondent 4).

In attempting to adapt to this challenge and the potential unknown impacts of mining, there is a need for dialogue and negotiation with this industry (Interview respondent 1). Strategies suggested for local adaptation include finding innovative ways to make financial gains out of mining through, for example, labour sharing schemes (Interviewee respondent 5), and proposals for joint industry research: 'we were talking about partnering with the CSG operators … to put some sort of partnership in place and look at how this human resource is managed' (Interviewee respondent 22).

### *4.5(ii) Corporate farming*

Another looming potential challenge to the cotton industry is the maintenance of family farming units. Exacerbating this potential is the increasing *average* age of growers – which is now believed to be approximately 50 years (Interview respondent 27, Interview respondent 30). The cost-price squeeze in agricultural sectors has impacted on smaller farming units, with a consequent growth of more corporate players with cash reserves to buy up and consolidate farming lands. Concerns about the future of farming were expressed thus:

> Farms will get bigger and bigger [due to] economies of scale – one farmer's been buying up his neighbours as they come up for sale (Interview respondent 4).

> When they lose this generation of family owned farms, they'll lose wealth of knowledge and determination regarding food production … [it will be a] decline in favour of corporate farms funded by super funds (Interviewee respondent 10).

### *4.5(iii) Pest and Weed Resistance Issues*

Future pest and weed resistance issues present a challenge to the future success of the cotton industry. GM cotton now underpins the entire industry and there are concerns related specifically to the effectiveness of Round-up ready cotton as explained by some respondents:

> Big problem with growing continuous Roundup Ready [cotton variety] is that you can build up resistance to the Roundup but probably the worst immediate thing is that you've got Roundup Ready seedlings coming through … [because] so much cotton does fall on the ground (Interviewee respondent 14).

> I've got reservations about the roundup over all the Australian industries, not so much cotton but I think we're gonna muck it up somehow, [we are] using too much, [and there are] plenty of resistant weeds out there (Interview respondent 8).

Concerns have also been raised in terms of Bollgard's ability to cope with future pest resistance issues: 'resistance [has been] detected … it's all low level and going up and down but it's something you don't take your eyes off either' (Interviewee respondent 4). Further future challenges of resistance will also relate to secondary pests and weeds, as one respondent contended 'there will always be a pest of the year' (Interviewee respondent 4).

### *4.5(iv) Water Security*

With water being seen as the limiting factor to cotton growth (Interview respondent 20, Interview respondent 26), the future availability of this resource and continued negotiation with other water-users is generally regarded to be a key challenge to the future of the cotton industry. The latest Murray Darling Basin Commission (MDBC) plans have not been well received in local communities, as coordination of water use between stakeholders and potential impacts were not seen as being well defined (Interview respondent 22). One respondent referred to negative wider public perceptions associated with water-use and were echoed throughout the community:

> We feel so frustrated out here … the concept that we're still raping the rivers, it's mind blowing that people get these ideas … but if they know what would happen to all the communities in this area on this river if irrigation's gone, it will effectively just wipe out the town (Interview respondent 18).

Water efficiency was also the main response to questions about climate change, with 'cotton farmers … [are] trying to be more efficient financially and sustainably rather than responding [per se] to 'climate change'' (Interview respondent 3).

### *4.5(v) Expansion of the Industry*

Expansion of the cotton industry presents challenges to understandings about the ways the industry is currently coordinated. As one respondent noted, '[it is] becoming more diverse, geographically …. people don't know each other as well [and won't] as industry expands' (Interview 8). There are also serious implications with new growers joining this highly specialised industry, particularly, it is feared, because of the responsibilities associated with the use of GM technology and adherence to industry standards: 'if [newcomers] are talking about growing cotton you don't want them to do the wrong thing (Interview respondent 22).

Further expansion challenges were related to the opening up new cotton growing areas, such as the Burdekin in QLD. The following respondent explains the range of context specific challenges:

> [Expansion] will involve large growers and 'corporates' in the Ord River and North Queensland … the Burdekin is another area … but technically you can't go there unless you've got three gene cotton for insect control, and then you've got all the social issues of setting up a new industry in a pioneer place, where people don't want you (Interviewee respondent 37).

In responding to these complex challenges, the cotton industry's track record of high rates of adoption and adaptation discussed in this report will be essential to its survival. This will require ongoing cooperation between growers, research organisations and the industry more generally – in other words, whole cotton communities. Locally tailored strategies will also be required to combat increasing rural uncertainties and instabilities.

# 5 Outcomes

The Australian cotton industry has demonstrated its ability to adapt to changing social, environmental and economic conditions through the development of strategies and their adoption as well as the uptake of new technologies. This adaptive strength has resulted in an unprecedented expansion of the industry. This growth of the industry over time, including the geographic spread of cotton farms, an increasing number of growers and changes to the industry's research and development bodies has also, somewhat paradoxically, threatened to diminish the strong collaborative character that has made it so unique within Australian agriculture. While loss of industry-wide collaboration is inevitable to some degree, knowledge of some of the key outcomes of the collaboration to this date (as documented in this report), will allow the industry to identify some of its successes and failures in order to address future social, economic and environmental challenges and to enhance the flexibility and resilience of cotton communities.

The outcomes of this report respond to its stated objectives as follows:

**Objective 1**: To identify how farmers have adapted to cotton-growing in Australian conditions over time and how cotton communities have adapted over time:

**Expected outcomes (scientific):** Production of knowledge base about the historical geography of cotton farming/communities in Murray-Darling Basin, and their adaptive capacities in the face of continual change

**Expected industry / applied outcomes:** Enhanced community awareness of cotton growing communities

In response: four overarching challenges, and ways of meeting these challenges, were drawn from primary data. They were:

- Geographical and Socio-cultural challenges faced by cotton farming;
- Pests and Weeds;
- Water supply; and
- Future challenges.

This document, six monthly reports and the forthcoming educational DVD and publications represent the 'knowledge base'. Distribution of the DVD is expected to enhance community awareness, as will subsequent publicity.

Within these sections of this report, the strategies deployed to address the issues listed below (Objective 2) were documented to establish some of the ways that farmers / farming communities and the cotton industry more generally, have adapted to cotton growing in Australian conditions.

**Objective 2**: To document the strategies that farmers have used, in living memory, to adapt to:

- Australian conditions
- Changing technologies
- Changing expectations in the wider community
- A 'greener' expectation of Australian agricultural practice
- Climate change policies
- The Federal Government's water license 'buy-back' scheme
- Other issues raised by cotton farmers and cotton communities

**Expected outcomes (scientific):** More specific understandings of the *culture of adaptive capacity* in the context of Australian cotton growing

**Expected industry / applied outcomes:** Production of knowledge about the history of adaptability and innovations – and its implications for current needs to be adaptive and innovative; knowledge about the importance of this industry to its communities.

The strategies deployed by farmers and the wider cotton communities / industry were documented under the major challenges identified under Objective 1, above. Some of the key strategies and *cultures of adaptive capacity* documented were:

- Identification of a culture of cooperation and sharing, this has led to:
- Conferences and other early industry collaboration to allow the effectiveness of subsequent strategies for adaptation
- Overcoming inefficiencies in harvest practice through the adoption of new technologies
- The development of Australian cotton varieties in response to yield and pest challenges

- The development of Best Management Practice guidelines and a 'greener' expectation of Australian agricultural practice.
- Changes to water reform in response to environmental concerns and changing community expectations.
- A capacity to continue the demonstrated adaptive capacity into the future – with some constraints, identified in Section '4.5 Challenge 4: Future Challenges'

**Objective 3**: To identify and document case studies based on contacts made in 2. Four case studies were selected for discussion in this document as key strategies of the industry in response to the challenges identified in objective 2. They are:

- Stabilising Economic Growth: Auscott Pty. Ltd.
- Forging Relationships: Cotton Conferences
- Pest Resistance: The collapse of cotton growing in the Ord
- Pest Adaptation Strategies: Integrated Pest Management

**Objective 4**: To produce consumable outputs to disseminate historical geography of the Murray-Darling basin[2] – for farmers and cotton producing communities, and a wider audience

- This report provides a written documentation of adaptation and adoption in the Australian cotton industry. By recording the memories and knowledge of a wide variety of cotton community stakeholders, including growers, scientists, consultants and community members, this report provides a historical geography for the use of the enduring Australian cotton industry. This report may also be of practical use to other agricultural industries in Australia as an example of the successes of pro-active research and development and industry cohesiveness in the face of a myriad of social, economic and environmental challenges.
- The second consumable output of this research is the production of a DVD documentary. Alongside the above outcomes, this will serve to record the histories and stories of some of the key figures in pioneering the Australian cotton industry and those who played other key roles in responding to the industry's significant challenges, and the achievements in adaptation and adoption.

In addition to responding to these objectives, this report has identified a number of areas for further research through its identification of a number of key, future challenges. New research into the following areas should be welcomed by the cotton industry:

- The impacts of Coal Seam Gas Mining on cotton communities
- Generational change in the cotton industry and the impact of corporate farms on cotton communities

[2] The extent to which the Murray-Darling basis was represented was restricted by respondent location

- Potential social and economic impacts of resistance to Bt genes in the cotton industry
- Strategies to address public perceptions around water usage in the cotton industry
- Strategies to maintain research and development extension mechanisms within an expanding Australian cotton industry.

There are no changes to the Intellectual Property register required.

# 6 Conclusion

This research has documented details gathered in surveying a wide range of cotton community members, and interviewing more than forty industry participants – some of whom were present at the beginning of the modern industry (post 1960s). Using personal recollections, it identified that Australia's modern cotton industry has built on a foundation of cotton community cooperation, and ongoing *cultures of adaptive capacity.* As a relatively young agricultural sector, modern cotton growing in Australia did not follow the pattern of previous more conventional agricultural pursuits, such as grazing, or wheat and sheep farming. This capacity to adapt, and adopt new methods has not, however, been without controversy and the cotton industry has faced criticism about, for example, the use of chemicals such as DDT, aerial spraying and water use, and most recently, the use of genetically modified varieties. However, this has proved to be a resilient industry which, notwithstanding a new set of challenges, appears to capable of facing challenges as they arise.

This research project has also captured some of the characters associated with one of Australia's most successful, yet possibly misunderstood agricultural sectors through the production of an educational DVD, a documentary.

***Extension Opportunities***

1. Detail a plan for the activities or other steps that may be taken:
   (a) to further develop or to exploit the project technology: with the assistance of 'Papermoose productions' the educational DVD will be pitched to ABC TV, who have expressed interest in pursuing some of its themes for further publicity (tba).
   (b) for the future presentation and dissemination of the project outcomes: Work has commenced on writing journal and other publications (see also a)).
   (c) for future research: once the DVD has reached the various audiences -- cotton communities / industry more broadly, opportunities to pursue further interviews, to 'thicken (the existing) narrative' will be welcomed, and included in future publications, media productions (see also a)).

***Publications***

9. A. Publications: Journal articles based on this report will be submitted to scholarly journals, including – *Geographical Research* and *Journal of Agricultural and Rural Geography*

   B. The online survey might attract respondents once the documentary DVD has reached various audiences – if reactivated, the website address is: https://www.surveys.unsw.edu.au/survey/155266/aa0442f2/. It will also be uploaded on Dr Wendy Shaw's UNSW webpage and participants will be invited to complete the survey at the DVD launch.

**References:**


Australian Cotton Grower (2009) Dryland cotton makes comeback for summer cropping rotations, *Australian Cotton Grower* (Aug/Sept 2009), Cotton Seed Distributors CSD, Wee Waa, NSW

Australian Government, Department of the Environment, Water, Heritage and the Arts (1997) Some previous uses of organochlorine pesticides in Australia, *Scheduled Wastes Fact Sheet Number 4 February 1997*, www.environment.gov.au/settlements/publications/chemicals/scheduled-waste/ocpfactsheet4.html (accessed 17/1/2012)

Cotton Australia (2008) *Environment/Water/History of Irrigation*. http://www.cottonaustralia.com.au/environment/water/history/(Accessed 22/5/2010)

Cotton Australia (2012) *History of irrigation*, www.cottonaustralia.com.au/environment/water/history/ (Accessed 17/01/2012)

Cotton Consultants Australia (2008) *2008 Grower Feedback Report*, by Western Research Institute, Bathurst, NSW

Cotton Cooperative Research Centre (CRC), (2007) *History of Australian Cotton*, www.cottoncrc.org.au/content/Communities/Cotton_Info/History_of_Australian_Cotton.aspx (Accessed 22/5/2010)

Fitt, G. (1994) Cotton pest management: Part 3. An Australian perspective, *Annual Review of Entomology*, 39: 543-562

Hearn, B. (1996) *An Agronomist's Odyssey*, talk given at 'Science with Its Sleeves Rolled Up', unpublished

Henzell, T. (2007) *Australian Agriculture: Its History and Challenges*, CSIRO Publishing, Collingwood, VIC, Australia

Merrill, P.J. & Pigram, J.J. (1984) American involvement in the Australian cotton growing industry, 1962-1972, *Australian Geographer*, 16(2): 127-133

Murray Darling Basin Commission MDBC (2010) *Guide to the Propose Basin Plan*, Appendix C - Irrigation District Community Profiles, Macquarie community profile, www.mdba.gov.au/bpkid/guide/ (Accessed 17/01/2012)

Powell, J.M. (2005) Environment-identity convergences in Australia 1880-1950, in *(Dis)Placing Empire: Renegotiating British Colonial Geographies* (Ed. Proudfoot, L.J. and Roche, M.M.) Ashgate Publishing, Hampshire, UK

Robinson G.M. (1999) *Methods and Techniques in Human Geography*, John Wiley and Sons, Sussex

Roth, G. (2011) Towards sustainable and profitable water use in the Australian cotton industry, Cotton Catchment Communities CRC, www.**cotton**crc.org.au/files/77927ba2-a65a-4975.../CRCWatRe.pdf (Accessed 17/01/2012)

Winchester, H.P.M. (1996) Ethical issues in interviewing as a research methodology in human geography, *Australian Geographer*, 2(1): 117-113

## *Part 5 – Final Report Executive Summary*

This research project is a documentation of a historical geography of the adaptations to changes over time, amongst cotton communities across Australia. It has focused on the major challenges faced by the modern Australian cotton industry (1960s onwards), and strategies deployed to meet the challenges. Adaptation and adoption were the keys themes of this research project – the Australian cotton industry has a fast-paced history of development in Australia, and needed to be capable of rapid change. Cotton growers, associated research and development agencies, and cotton communities more broadly, have built an industry based on a capacity to adapt to local conditions, and test and adopt new technologies, as appropriate. Although not always a smooth journey, the adaptive capacity of the Australian cotton industry is notable, particularly from the early days of the modern industry. Although relatively new, Australia's cotton industry is now a world leader.

The main challenges faced by cotton farming communities, that have driven and enhanced adaptation and adoption capacities include: a range from extreme natural events, major changes in water policy, pest and weed issues, environmental concerns, rapid changes in technology (including genetically modified cotton) (Cotton CRC, 2007) and socio-cultural challenges (Merrill and Pigram, 1984). Socio-cultural challenges include adapting and integrating farming cultures, overcoming inefficiencies in harvest transport, maintaining community connections, forging researcher relationships with growers. A raft of foreseeable challenges include the vagaries of mining, particularly Coal Seam Gas mining, ongoing concerns about water and pests/weeds, and the uptake of new technologies, and the increasing corporatisation of cotton growing.

The research used social science data generation techniques and a mixed methods format, including survey data generation, in-depth interviews and the inclusion of historical memorabilia, such as newspaper clippings and photos. The recollections of many of the industry's key players provided the bulk of the data, and provided material (video-recorded) for the production of a documentary DVD, which premiered at Narrabri, in New South Wales, in March 2012. This research is a starting point for future social research on the cotton industry in Australia.

For more information contact:
Dr Wendy Shaw, University of New South Wales, Australia
T: +61-2-93853715 E: w.shaw@unsw.edu.au or
Rebecca Cross, T: +61405707756 E: ra.cross@yahoo.com