a guide for irrigation management in cotton and grain farming systems
WATERpak – a guide for irrigation management in cotton and grain farming systems
The 2013 edition of WaterPAK is a compilation of the latest best practice management information for water management on Australian cotton farms. Water is the major limiting factor for cotton production in Australia and efficient water management is paramount for cotton growers to achieve high yields and profits in a sustainable way. Making good water management decisions is no simple task for growers who operate in a complex environment of unpredictable climate, variable soil type and evolving water policy.

In the face of these challenges the cotton industry has improved its efficiency of turning water into bales of cotton by 40 per cent over the last 10 years and growers are equally ambitious for future improvements. This edition of WATERpak provides growers and consultants with the best available information from research to assist them make further improvements in water use efficiency and water management more broadly. WATERpak is a supporting information resource for the cotton industry’s Best Management Practice program myBMP.

CRDC and the industry have long recognised the connection between more efficient water use and improvements in environmental outcomes on farms. New goals for both are guiding cotton industry investment in research and development concerning water and water use. These goals will be facilitated through the turning of knowledge into practise on every farm where growers reap the value every season from improvements to system design and management, the selection and adoption of new technologies, a management focus on the water needs of cotton plants and a better understanding of how to respond to a variable climate.

Keeping step with research, included in this edition are new chapters looking at tools and information for decision making, irrigation system selection, storages and channels, pumps, fertigation, and management decisions in limited water use situations as well as a new section dedicated to irrigation management of grain crops.

WATERpak has now been designed to be read electronically on tablets and notebooks, with links to other on-line information sources so further information can be readily accessed. As new research comes to hand, this is further developed by the Cotton Industry Development and Delivery Program and its team of specialists. WATERpak will be regularly updated and distributed electronically to growers and their advisors.

Like its predecessor, this publication of WATERpak demonstrates that the Australian cotton industry is taking its responsibility for wisely managing the use of water resources seriously. Equally it demonstrates the capacity of our world leading industry researchers, development and delivery personnel. Well done.

Bruce Finney
Executive Director, CRDC
# Table of Contents

About this publication  
Acknowledgements  

## Section 1  Concepts for efficient irrigation

1.1 Farm planning, WATERpak and myBMP  
1.2 Water use efficiency, benchmarking and water budgeting  
1.3 Water use efficiency in the Australian cotton industry  
1.4 Understanding deep drainage  
1.5 Deep drainage under irrigated cotton in Australia: a review  
1.6 Managing storages and channels  
1.7 Metering  
1.8 Pumps  
1.9 Using PAM in irrigated cotton  

## Section 2  Irrigation management

2.1 Irrigation scheduling  
2.2 Crop and management decisions in limited water situations  
2.3 Irrigation decision support tools  
2.4 Plant water status measurement  
2.5 Managing soils for irrigation  
2.6 Soil imaging  
2.7 Calibrating soil water monitoring devices  
2.8 Evapotranspiration  
2.9 Using automatic weather stations  
2.10 Irrigation salinity and water quality  

## Section 3  Irrigation management of cotton

3.1 Cotton growth responses to water stress  
3.2 Managing irrigated cotton agronomy  
3.3 Managing irrigation of cotton with limited water  
3.4 Impact of waterlogging on cotton  
3.5 Irrigation and cotton disease interactions
### Section 4  Irrigation management of grain crops

<table>
<thead>
<tr>
<th>subsection</th>
<th>Crop</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Irrigated wheat</td>
<td>290</td>
</tr>
<tr>
<td>4.2</td>
<td>Irrigated sorghum</td>
<td>298</td>
</tr>
<tr>
<td>4.3</td>
<td>Irrigated corn</td>
<td>205</td>
</tr>
<tr>
<td>4.4</td>
<td>Irrigated chickpeas</td>
<td>312</td>
</tr>
<tr>
<td>4.5</td>
<td>Irrigated soybeans</td>
<td>219</td>
</tr>
<tr>
<td>4.6</td>
<td>Irrigated mungbeans</td>
<td>326</td>
</tr>
<tr>
<td>4.7</td>
<td>Irrigated barley</td>
<td>333</td>
</tr>
</tbody>
</table>

### Section 5  Irrigation systems

<table>
<thead>
<tr>
<th>subsection</th>
<th>System</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Selecting an irrigation system</td>
<td>341</td>
</tr>
<tr>
<td>5.2</td>
<td>Developing a surface irrigation system</td>
<td>355</td>
</tr>
<tr>
<td>5.3</td>
<td>Surface irrigation performance and operation</td>
<td>365</td>
</tr>
<tr>
<td>5.4</td>
<td>Bankless channel irrigation systems</td>
<td>388</td>
</tr>
<tr>
<td>5.5</td>
<td>Centre pivot and lateral move systems</td>
<td>392</td>
</tr>
<tr>
<td>5.6</td>
<td>Drip irrigation: design, installation and management</td>
<td>426</td>
</tr>
<tr>
<td>5.7</td>
<td>Fertigation</td>
<td>441</td>
</tr>
</tbody>
</table>

### Section 6  Catchment-scale impacts

<table>
<thead>
<tr>
<th>subsection</th>
<th>Impact</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Catchment water quality and cotton: northern NSW case study</td>
<td>452</td>
</tr>
<tr>
<td>6.2</td>
<td>Water quality in the Gwydir Valley watercourses</td>
<td>460</td>
</tr>
<tr>
<td>6.3</td>
<td>Water quality in Queensland catchments and the cotton industry</td>
<td>468</td>
</tr>
</tbody>
</table>

### Section 7  Glossary

<table>
<thead>
<tr>
<th>subsection</th>
<th>Glossary</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Glossary</td>
<td>476</td>
</tr>
<tr>
<td>7.2</td>
<td>Acronyms</td>
<td>479</td>
</tr>
</tbody>
</table>

### Section 8  Attachments

<table>
<thead>
<tr>
<th>subsection</th>
<th>Attached</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Siphon flow rates</td>
<td>481</td>
</tr>
</tbody>
</table>
About this publication

Water is the major limiting factor of cotton and grain production in Australia and efficient water management is paramount for cotton and grain growers to achieve high yields and profits. An unpredictable climate coupled with a range of soil types forces farmers to make management decisions in a complex and variable environment.

The challenge for irrigators is to find the balance between the higher costs of improved water use efficiency and environmental stewardship and the maintenance of farm profits.

WATERpak provides technical information and practical advice to help irrigators improve irrigation practices, minimise environmental impacts and increase farm profits from irrigated cotton crops.

For the first time, WATERpak brings together in one place the many years of irrigation research conducted by a variety of organisations in the Australian cotton and grains industries.

The easiest gains to improve farm water use efficiency are within the field: minimisation of tailwater losses, drainage and the potential improvement in yield through the reduction of waterlogging effects. Put simplistically, by ‘applying the right amount of water at the right time in the right place’.

Harder to achieve but very significant in terms of water use efficiency, gains exist in the control of evaporative and seepage losses from storages and channels. This is where most water is lost on broadacre irrigation farms and it is essential that researchers and growers combine forces to address evaporation, seepage and drainage losses.

This third edition of WATERpak brings together best practice for irrigation management in the cotton and grains industries, whether as part of an integrated farming system or as separate enterprises.

WATERpak and myBMP

The Cotton Industry’s myBMP Program prioritises issues for attention, provides a process of identifying the potential management risks and provides action plans to help manage those risks and improve farm performance.

WATERpak provides detailed technical and practical advice that supports the practices covered in the water module of myBMP. Individual myBMP practices provide links directly to the relevant WATERpak resources and a more detailed explanation of these links is included in WATERpak Chapter 1.1.

Another companion resource is SOILpak for cotton growers, generally referred to simply as SOILpak in this publication.
Acknowledgements

Thanks to the WATERpak update committee that worked on the third edition in 2012:
David Wigginton, DW Consulting Services
Rose Brodrick, CSIRO
Graham Harris, DAFF Queensland
Mike Bange, CSIRO
Janelle Montgomery, NSWDPI
Rod Jackson, NSWDPI
Jim Wark, Cotton Australia
Tracey Leven, CRDC
Jane Trindall, CRDC

Thanks to the original WATERpak committee:
Helen Dugdale, Cotton Research and Development Corporation
Graham Harris, formerly of Queensland Department of Primary Industries and Fisheries
Steve Milroy, CSIRO Plant Industry
James Neilsen, CSIRO Plant Industry
Dirk Richards, CSIRO Plant Industry
Guy Roth, Australian Cotton CRC
David Wigginton, formerly of Queensland Department of Primary Industries and Fisheries
David Williams, NSW Department of Primary Industries

Thanks too for the other contributors to this publication:
All topic authors for their input and expertise.
The partners of the Australian Cotton CRC, specifically, the Cotton Research and Development Corporation for funding its compilation and printing.
Dr Helen Fairweather, Technical Specialist (Water Use Efficiency),
NSW Department of Primary Industries, Dubbo
Dr Phil Goyne, Queensland Department of Primary Industries and Fisheries
Stefan Henggeler, Integra Management Systems, Narrabri NSW
David Larsen, Australian Cotton CRC & NSW Department of Primary Industries
Olivia Parker, Queensland Department of Primary Industries and Fisheries
Dr Siva Sivapalan, Lecturer in Irrigation Agronomy,
Charles Sturt University, Wagga Wagga
Elizabeth Tout, Cotton Research and Development Corporation
Pat Weldon, Senior Technical Officer (Water Use Efficiency),
NSW Department of Primary Industries, Dubbo

For more information
Cotton Research & Development Corporation
PO Box 282, Narrabri NSW 2390
Phone: 02 6792 4088    Fax: 02 6792 4400
Web: www.crdc.com.au