



**Australian Government**

**Cotton Research and  
Development Corporation**

Annual, Progress and Final  
Reports

**Part 1 - Summary Details**

**REPORTS**

Please use your TAB key to complete Parts 1 & 2.

**CRDC Project Number:** DAQ123C

**Annual Report:**  Due 30-September

**Progress Report:**  Due 31-January

**Final Report:**  Due 30-September  
(or within 3 months of completion of project)

**Project Title:** Best weed management strategies for dryland cropping systems with cotton

**Project Commencement Date:** 01/07/02      **Project Completion Date:** 30/06/05

**Research Program:** 3 Crop Protection

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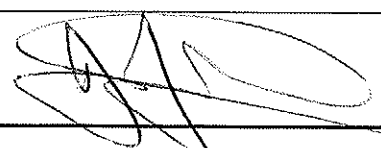
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A/EM PLANT SCIENCE

## ***Part 3.3 – Final Reports***

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### **1. Outline the background to the project.**

A 1-year scoping study (phase I) was initiated in July 2001 following negotiations with CRDC, Cotton CRC and Weeds CRC, as a prelude to a joint project on weeds in dryland cotton systems. This scoping study determined the dominant and difficult-to-control weeds in dryland cropping systems with cotton, identified the farming practices leading to these weed problems, evaluated economic impact of weeds in these systems, and developed a new research proposal for better management of these identified weeds (phase II).

The scoping study involved a postal survey to dryland cotton growers, meetings with selected growers, and a field survey of weeds in each component of the rotations on selected farms. The project team reviewed the mail survey information on the main weed problems. Ten growers were interviewed for more detailed information on their weed management practices, and monitoring of weeds in sorghum, summer fallow and dryland cotton was conducted in these growers' paddocks.

The scoping study provided a great deal of information about the various farming practices and issues facing growers in terms of weed management. After analysing the data collected in the scoping study, the following research and development issues were evident:

#### Weed issues

- Main weeds were bladder ketmia, sowthistle, caltrop, summer grasses (liverseed and barnyard), and black bindweed
- Weed spectrum was very diverse
- Weed spectrum differed considerably between cropping zones
- Some emerging weed problems such as fleabane, which then became a major weed problem with the next few years.

#### Herbicide technology issues

- There was an over reliance on glyphosate for weed control in summer and winter fallows
- There was an over reliance on post emergence herbicides in winter cereals for weed control
- Residual herbicides may have role in controlling late flushes and still maintain rotation flexibility
- Weed control in sorghum was heavily dependant on atrazine, but it is variable in effectiveness
- Water volumes being applied were too low for consistent effective weed control
- Many growers delayed spraying fallow fields when weeds first germinate and try to control the second flush with the one herbicide application, and thus creating difficult-to-control weeds
- There appeared to be considerable variability in the efficacy of the herbicides used in a number of the cropping and fallow phases. This may be due to water volumes being used, the size of the weeds when sprayed or incorrect application of herbicides
- Our database has a huge amount of information on all herbicides and mixtures used on each weed in different crops and fallows, as well as rates of application and levels of control achieved

### Integrated weed management issues

- An overall integrated weed management plan was lacking for these dryland production systems
- There appeared to be a general lack of understanding of the importance of preventing seed set on surviving weeds
- Crop competition as a weed control option appeared to be poorly understood, with many growers sowing at low densities and allowing weeds to germinate, competing for valuable moisture resources
- Residual winter weeds were setting seed and contributing to weed problems in subsequent fallows and crops.
- Summer crops were sown on wide row spacing and growers tolerate weeds in the skip row without recognising the value of controlling those weeds to prevent replenishment of the seed bank
- Weed control in maize and sunflowers tended to be poor, contributing to weed problems in other components of the rotation
- There appeared to be an imbalance in weed management inputs for dryland cotton compared with the rotational crops.

This project (phase II) focussed on 5 key summer weeds (fleabane, bladder ketmia, barnyard grass, liverseed grass, and sowthistle) in dryland cropping systems with cotton. Both chemical and non-chemical options were investigated to reduce survivors of these key weeds, so that there is minimal replenishment of the seed-bank. Ultimately, lower weed pressure in the 'weak link' of the rotations would result in better weed management across the whole cropping system, particularly in dryland cotton.

## **2. List the project objectives and the extent to which these have been achieved.**

The primary aim of this project was to improve management of the key summer weeds identified in the scoping study, such as fleabane, bladder ketmia, barnyard grass, liverseed grass, and sowthistle in dryland cropping systems with cotton.

The primary aim was achieved by:

- In-depth studies of seed persistence and emergence
- Effective management of fleabane in crops and fallow
- Effective management of sowthistle and bladder in fallow
- Improved control of summer grasses and bladder ketmia in sorghum using herbicides
- Improved weed control in sorghum using crop competition

## **3. Detail the methodology and justify the methodology used.**

The project team used a systems approach to investigate better weed management options for problem weeds in dryland cotton cropping system. The rationale for the systems approach was to achieve better and more consistent control of problem weeds in all the rotational components, including crops and fallows preceding cotton, thereby reducing the replenishment of the soil seedbank for these weeds, and reducing weed impacts on the following cotton crop.

Better weed management practices have been developed through using chemical and non-chemical options, integrating smart and safe use of residual and knockdown herbicides, and competitive crops.

The research consisted of 5 key components, tackling weed ecology and population management, options for better weed control with herbicides in wheat, sorghum and fallows, and non-chemical options for weed control in sorghum. The trials were conducted at both central Queensland (CQ) and southern Queensland (SQ) to cover differences in environments, rotations, and weed biotypes.

#### Dynamics of weed seeds in soil seed-bank

In-ground pot studies investigated seed persistence and emergence patterns of 2 (CQ) and 5 (SQ) key summer weeds in different soils, burial depths, and environments. These studies will need to continue for an additional 1-2 years, when buried seeds will be exhumed at specified intervals, and the extracted seeds subjected to germination and tetrazolium test to determine seed viability, dormancy and persistence. Weather stations collect data on soil temperature and moisture at the burial depths. Seed persistence, emergence and weather data will be used to construct a simple decision support tool to assess the long-term impact of different management tools on the weed population in following crops in phase III.

#### Effective management of fleabane in crops and fallows

Fleabane has become one of the most difficult-to-control weeds in the northern grain region in the last few years. In response to this weed problem, the project team organised a national workshop on fleabane in February 2004 to collate and synthesise the research data, develop best bet management options, and identify research priorities. So far, four field trials in crops and winter fallow have been completed on improved fleabane control in SQ, and two more trials on fleabane management in wheat and sorghum are still underway. A draft management guide on fleabane management has been completed.

#### Effective management of summer broadleaf weeds in fallow

Two trials investigated impact of in-crop and fallow herbicides on control of sowthistle and bladder ketmia in early summer fallow following a wheat crop in SQ. Two collaborative trials evaluated the effectiveness of a range of herbicide treatments on sowthistle control in winter and summer fallows in SQ.

#### Improved control of summer grasses and bladder ketmia in sorghum using herbicides

Four trials across were conducted to improve atrazine control efficacy on summer grasses and bladder ketmia in sorghum in SQ (2) and CQ (2). Ten atrazine-based herbicide treatments were compared, including atrazine with and without metolachlor, fluroxypyr, and bromoxynil. Impacts of different application times, with and without mechanical and rain incorporation, were also assessed. The residual effects of these herbicides on following cotton crop emergence and growth were also investigated in the field by re-sowing the same trial site with cotton in CQ, and in glasshouse bioassays by using intact soil cores collected from experimental plots in SQ.

#### Improved weed control in sorghum using crop

Seven field experiments were carried out in both CQ and SQ to improve sorghum competition against weeds, thereby reducing the reliance on herbicides, preventing the replenishment of new seeds to the soil seed-bank, and reducing the impacts of weeds on crop yield. These trials investigated the influence of different sorghum cultivars, seeding rates, and row configurations on weed survival, weed suppression, and seed production.

#### 4. Detail and discuss the results including the statistical analysis of results.

##### Dynamics of weed seeds in soil seed-bank

In-ground pot studies have generated important information on seedling emergence patterns and seed persistence.

Each weed species had distinct patterns of emergence after seed burial:

- Barnyard grass had staggered patterns of emergence, mostly from mid spring to summer
- Liverseed grass emerged predominantly in one major flush in mid spring
- Bladder ketmia had low level (<6%) but staggered patterns of emergence from mid spring to early autumn
- Sowthistle also had staggered patterns of emergence, but emerged all year round with major emergence from mid spring to summer
- Soil types had significant effects on fleabane emergence. No fleabane emerged in heavy black soil, while a major flush emerged in late June 2005 in pots with the light soil.

Burial depths had significant effect on seed emergence:

- Very few seedlings emerged (<1%) from 10 cm burial depth for 4 of the 5 weeds studied, except for liverseed grass which had 16% emergence at 10 cm soil depth during 26 months of burial
- Barnyard grass, fleabane, bladder ketmia, and sowthistle emerged predominately from soil surface, while liverseed grass emerged mainly from 5 cm burial depth.

Persistence differed substantially between different species:

- Less than 10% remained of barnyard grass, liverseed grass, fleabane and sowthistle after 18 months of burial.
- However, more than 50% of bladder ketmia seed persisted under same conditions.

Burial depths had significant effect on seed persistence:

- Burial depths affected significantly seed persistence for 4 of the 5 weeds studied. Seeds of liverseed grass, bladder ketmia, fleabane and sowthistle had greater persistence, when buried at deeper soil layer (10 cm) compared to the 0-2 cm burial depth. In contrast, persistence of barnyard grass was similar (5-7%) irrespective of burial depth after 18 months of burial.

##### Effective management of fleabane in crops and fallows

- Fallows

Winter fallow trials with post emergent knockdown and residual herbicides showed that glyphosate, Sprayseed or paraquat alone were generally ineffective on fleabane. Better weed control was achieved with glyphosate mixed with metsulfuron (Ally), 2,4-D, picloram + 2,4-D (Tordon 75D), atrazine or triclopyr + picloram (Grazon DS). The most effective treatment was a split application of glyphosate + 2,4-D (Surpass) followed by paraquat + diquat (Sprayseed) or paraquat (double knockdown). Addition of the residual herbicide atrazine to glyphosate provided good residual control in the following flushes for 4-5 months.

Timeliness of herbicide application and good spray coverage was crucial on fleabane control.

- Wheat

Preplant fallow spray of chlorsulfuron (Glean) provided excellent full season control of fleabane (>90%) in early fallow and wheat. Post-emergence treatment of Ally was also effective, achieving 80% control. Addition of picloram + MCPA (Tordon 242) or follow-up application of 2,4-D amine improved the control efficacy to 85-90%.

After harvest treatment of two-way mix (glyphosate + Surpass) or three-way mix (glyphosate + Surpass + Ally) was very effective to control weed survivors, although better control was achieved with the three-way mix.

- Sorghum

Preplant fallow spray of atrazine at 4L/ha was very effective in providing seasonal long control, when the treatment was applied within several days of rain to incorporate the herbicide. Preplant treatments of glyphosate mixed with Surpass or dicamba, or followed by Sprayseed also provided effective control on fleabane. Control efficacy was improved further by the follow-up application of atrazine at planting.

Fleabane was highly competitive. Uncontrolled fleabane at a density of 14 plants/m<sup>2</sup> caused 67% yield reduction in the untreated plots, even though the mature fleabane plants were removed at 2 months after planting. If the fleabane plants were kept uncontrolled for the whole season, sorghum plants would have died.

#### Effective management of summer broadleaf weeds in fallow

Glean and Ally mixed with Tordon 242 or 2,4-D applied in wheat provided substantial benefits in control of sowthistle and bladder ketmia in the following summer fallow. This is likely due to persistence of chlorsulfuron and metsulfuron residues as well as reduction of weed seed-bank following effective in-crop weed control.

#### Improved control of summer grasses and bladder ketmia in sorghum using herbicides

The main findings of the 4 trials on improving atrazine efficacy in SQ and CQ are summarised below.

- Bladder ketmia and other broadleaves

Bladder ketmia and other broadleaf weeds were controlled effectively (97-100%) with a range of atrazine treatments either alone (pre-planting or at-planting) or in mixtures at lower rates with metolachlor (Dual Gold), fluroxypyr (Starane) and bromoxynil (Bromicide 200). In one trial, atrazine efficacy improved with mechanical incorporation at planting.

- Liverseed grass

Liverseed grass was controlled consistently well (89-100%) with atrazine + Dual Gold. As there was good rain incorporation in both trials, mechanical incorporation at planting did not improve control. However, if limited rain after herbicide application is likely, mechanical incorporation should be carried out to improve efficacy. Atrazine alone was not effective even at higher rates and with mechanical incorporation, particularly with high weed pressure in wet seasons.

- Barnyard grass and other summer grasses

Pre-plant atrazine alone was effective on summer grasses when good rainfall was received after application (90%). Mechanical incorporation at sowing improved control up to 100%, likely due to the cultivation controlling newly emerging weeds.

Treatments of atrazine + Dual Gold at a range of rates applied at planting were very effective on barnyard grass and other summer grasses as long as good rainfall incorporation was obtained after application. When there was limited rain after herbicide application, mechanical incorporation improved grass control from 78% to 100%.

Efficacy of atrazine applied at planting was variable. It was highly effective when incorporated mechanically or with follow-up rain when weed pressure was low to moderate.

However, this treatment was less effective in wet seasons with high weed pressure, such as 50 barnyard grass plants per square metre.

- Sorghum yield reduction by summer weeds

Uncontrolled weeds caused an average of 14% yield reduction, but ranged from 0% to 34%. Yield loss was greater with high weed pressure and low-moderate in-crop rain.

- Re-cropping with cotton

In the 2003 CQ trial, the atrazine residues had no effect on cotton growth or yield when sown 12 months after the application of the atrazine treatments. This is currently being investigated in the 2004 trials as well.

#### Improved weed control in sorghum using crop

Seven field experiments investigated the impact of sorghum cultivars, row spacings, and seeding rates on competitiveness against weeds. Results showed that all these agronomic factors had a major impact on weed growth, indicating that weed management can be improved using crop competitiveness. This research identified more competitive cultivars, such as Goldrush and Buster, and combined with higher population, increased suppression of weed seed production by 2-3 fold, which would have a major reduction in replenishment of the soil seed-bank from uncontrolled weeds by herbicides. Increasing row spacing from solid to single skip increased weed seed production by 60% and to double skip by 80%. This indicates that weed management needs to be fine-tuned for the wide row configurations to minimise substantial replenishment of the soil seed-bank.

A TECHNICAL REPORT OUTLINING MORE DETAILED RESEARCH RESULTS WILL BE SUBMITTED TO CRDC.

#### **5. Provide a conclusion as to research outcomes compared with objectives. What are the “take home messages”?**

The seed-bank studies showed that each weed species has distinct patterns of emergence and persistence. Barnyard grass, fleabane, bladder ketmia, and sowthistle predominately emerged from soil surface, while liverseed grass emerged mainly from 5 cm burial depth. Liverseed grass emerged in one major flush, whereas bladder ketmia and barnyard grass showed staggered emergence throughout the spring and summer, and sowthistle emerged all year round. Weed seeds persisted longer in the deeper soil than in the soil surface.

The information on seed-bank dynamics indicates that weed management plans need to be tailored for each main weed species. It is important to keep weed seeds, apart from liverseed grass, near the soil surface to promote more rapid loss of seeds from the seed-bank. It is particularly important to prevent seed production on any survivors of bladder ketmia, as seed will persist for many years, much longer than for the summer grasses and wind-blown seed of sowthistle and fleabane. Data collected will be used in developing a decision support tool on the seed-bank dynamics of these weeds to predict the long-term impacts of different management tactics on weed populations in following crops and fallows.

Our field research demonstrated clearly that difficult-to-control weeds, such as fleabane, can be effectively and relatively simply managed by focussing on population management rather than the reactive approach. Successful control of fleabane was achieved by diligent monitoring weed emergence, controlling small weeds, target weeds in crop, and using combination of knockdown and residual herbicides, their mixes, and crop competition. The

management guide for managing fleabane in fallows, wheat and sorghum is ready to be distributed to key agricultural consultants and growers for further comments before wider distribution. More research is needed for the fallows and cotton components of the rotation.

Weed control in sorghum using atrazine is often variable particularly for grasses. However, control can be enhanced greatly by integrating smart use of residual herbicides, mixes and crop competition. Atrazine was best applied as close as possible prior to the planting rain or earlier fallow rain to incorporate the herbicide into the zone of germinating weeds. As well, a shallow mechanical soil disturbance at sowing improved weed control for both pre-plant and at-planting applications. For paddocks infested with either mostly liverseed grass or dense grass populations, mixes of Dual Gold and atrazine provided much better grass control than atrazine applied alone at higher rates. In addition, crop competition, using more competitive sorghum cultivars, higher seeding rates, and 1m row spacing, reduced weed seed production on survivors by up to 4-fold, thus greatly minimising replenishment of seed-bank.

**6. Detail how your research has addressed the Corporation's three Outputs - Economic, Environmental and Social?**

Economic

The economic analysis in the scoping study estimated costs of weeds in dryland cotton systems to be \$341/ha of dryland cotton, \$93/ha of sorghum, \$37/ha of wheat, and \$35/ha of fallow. Agronomists estimated that costs of weed control in fallows infested with fleabane have doubled in recent years, and zero tillage was threatened by this difficult-to-control weed. The new weed strategies developed from this project should reduce the economic impact of weeds in the long-term and enable growers to continue with zero-tilled systems.

Environmental

The project has shown that the strategic approach to weed population management will result in paddocks with lower weed pressure and subsequent reduced use of herbicides.

**7. Provide a summary of the project ensuring the following areas are addressed:**

- a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.)**

Not applicable.

- b) other information developed from research (eg discoveries in methodology, equipment design, etc.)**

Not applicable.

- c) are changes to the Intellectual Property register required?**

No. All research information is available to the general public.

**8. Detail a plan for the activities or other steps that may be taken:**

- (a) to further develop or to exploit the project technology.**

Management guides are currently been developed for improved control of problem weeds, such as fleabane, bladder ketmia, summer grasses and sowthistle, in different components of the cropping system. They will be published and widely distributed.

The impact of the residual herbicides on following dryland cotton will be assessed by glasshouse bioassays, using intact soil cores collected from experimental plots, in the new project.

New field experiments will also investigate best-bet treatments for fleabane, bladder ketmia and summer grass control in summer fallow and cotton phases of the rotation. Selection of treatments will be based on industry consultation.

A simple seedbank model will be constructed for selected weeds, such as summer grasses, based on data generated in the above experiments in the new project. The model will be used to predict the impact of various management options in different parts of the rotation on weed seedbank and potential weed problems in the future.

**(b) for the future presentation and dissemination of the project outcomes.**

Project outcomes will be further delivered through the use of various forms of printed media, websites, by giving additional presentations conferences and industry forums, as well as organising specific workshops with growers and agronomists.

Management guides for the key summer weeds, fleabane, bladder ketmia, barnyard grass, liverseed grass, and sowthistle, will be published as brochures and articles on websites, making them widely available to the industry.

Two papers are scheduled this year for submission to a scientific journal, and 2 articles in rural magazines. The team will also present research outcomes at the 5<sup>th</sup> Australian Sorghum Conference, 13<sup>th</sup> Australian Cotton Conference, and 15<sup>th</sup> Australian Weeds Conference.

**(c) for future research.**

Management strategies will be developed for sustainable use of glyphosate with the introduction of glyphosate-tolerant cotton in dryland cotton and grain cropping systems in the new project. Glyphosate-based treatments will be compared with alternatives for effectiveness in weed control in different components of the rotation. This information will be used to develop options to minimise the risk of weeds developing glyphosate resistance in both conventional dryland cropping systems and those with glyphosate-tolerant cotton. This will be done in consultation with the industry and resistance committees.

**9. List the publications arising from the research project and/or a publication plan.**

*Refereed Journals*

Walker SR, Taylor IN, Milne G, Osten VA, Hoque Z, Farquharson RJ (2005) A survey of management and economic impact of weeds in dryland cotton cropping systems of sub-tropical Australia. *Australian Journal of Experimental Agriculture*, **45** (1) 79-91.

2 papers on impacts of sorghum cultivar, row spacing and density on weed management are planned to be submitted to *Weed Science* in November 2005.

*Conference Papers*

Walker S, Osten V, Taylor I, and Sullivan A (2002). Weeds in systems with dryland cotton – a scoping study. *In Proceedings 13th Australian Weeds Conference, Perth*, pp. 731.

Walker SR, Taylor IN, Milne G, Osten VA, Hoque Z, & Farquharson RJ (2004) A survey of weeds in dryland cotton cropping systems of sub-tropical Australia 1. Management

practices and effectiveness. *In Proceedings 12<sup>th</sup> Australian Cotton Conference, Gold Coast.*

Hoque Z, Farquharson RJ, Taylor IN, Walker SR, B McCorkell, & R Jones (2004) A survey of weeds in dryland cotton cropping systems of sub-tropical Australia 2. Economic cost of weeds. *In Proceedings 12<sup>th</sup> Australian Cotton Conference, Gold Coast.*

Wu H & Walker S (2004) Managing fleabane in dryland cotton farming systems. *In Proceedings 12<sup>th</sup> Australian Cotton Conference, Gold Coast.*

Wu H, Walker S, Osten V, Taylor I, & Sindel B (2004) Emergence and persistence of barnyard grass (*Echinochloa colona*) and its management options in sorghum. *In Proceedings 14<sup>th</sup> Australian Weeds Conference, Wagga Wagga.*

Walker S, Osten V, Wu H, & Taylor I (2004) Weed management in grain sorghum – current practices and new research in Australia. *In Proceedings 4<sup>th</sup> International Weed Science Congress, Durban, South Africa.*

#### *Grower Magazines and Articles*

Wu H (July 2003) A scoping study on weed issues and their economic impact in dryland cropping systems with cotton. *In 'Weedwatch', Weeds CRC Newsletter.*

Wu H (September 2003) Biology of barnyard grass. *In 'Northern Herbicide Resistance Reporter'.*

Walker S, Widderick M & Wu H (March 2004) Proceedings of fleabane workshop. *In [www.weeds.crc.org.au/publications/wshop\\_proceedings.html](http://www.weeds.crc.org.au/publications/wshop_proceedings.html)*

Walker S (April 2004) New weed the bane of dryland farmers. *In 'Rural Weekly'.*

Wu H (March 2004) Fleabane biology and its control. *In 'Northern Herbicide Resistance Reporter'.*

Walker S & Wu H (April 2004) Managing fleabane. *In [www.dpi.qld.gov.au](http://www.dpi.qld.gov.au)*

Walker S & Taylor I (August 2004) Weed control weak links in dryland cotton cropping systems. *In 'The Australian Cottongrower'.*

Wu H & Walker S (October 2004) Flaxleaf fleabane, a difficult-to-control weed in dryland cropping systems associated with zero-tillage. *In 'The Australian Cottongrower'.*

Wu H & Walker S (November 2004) Flaxleaf fleabane, a difficult-to-control weed in dryland cropping systems associated with zero-tillage. *In 'The Australian Grain'.*

Wu H, Osten VA, Walker SR, Taylor IN (2005) Management of summer grasses and broadleaf weeds in sorghum (to be submitted to *The Australian Grain* in December)

#### **10. Have you developed any online resources and what is the website address?**

Taylor I & Walker S (2002) Final Report: A scoping study on weed issues and their economic impact in dryland cropping systems with cotton. The full report is available on the Cotton CRC and Weeds CRC websites,

<http://cotton.crc.org.au/Publicat/Weeds/index.htm> and

[http://www.weeds.crc.org.au/publications/other\\_products.html](http://www.weeds.crc.org.au/publications/other_products.html)

Walker S, Widderick M & Wu H (March 2004) Proceedings of fleabane workshop. *In [www.weeds.crc.org.au/publications/wshop\\_proceedings.html](http://www.weeds.crc.org.au/publications/wshop_proceedings.html)*

Walker S & Wu H (April 2004) Managing fleabane. *In [www.dpi.qld.gov.au](http://www.dpi.qld.gov.au).*

**11. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. Where possible include a statement of the costs and potential benefits to the Australian cotton industry or the Australian community.**

Weeds in dryland cotton systems are estimated to cost the industry approximately \$20 million annually due to control costs and yield losses from residual weeds (Walker *et al.* 2004). Potential development of herbicide resistance, particularly for glyphosate, is likely to greatly increase the economic loss due to weeds.

Research information and best weed management practices derived from the project will be readily available to growers for improved management of their main weeds in cropping systems with dryland cotton, particularly for fleabane, bladder ketmia, summer grasses, and sowthistle. Economic data on the impact of these weeds and the new control options will also assist growers in making their weed management decisions. Adoption of these management strategies will ultimately result in reduced production costs, increased yields, and reduced risk of developing herbicide resistance. These aspects will apply to the whole area of dryland cotton production in Queensland and New South Wales.

The project team aims to measure the successes of this research by requesting feed-back from the participants at our workshops and Industry Development Officers on the level of adoption of the new management technology and improved weed control. This will be compared with data from the initial scoping study.

#### ***Part 4 – Final Report Executive Summary***

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A one-year scoping study determined and prioritised the important weed issues of cropping systems with dryland cotton (DAQ117C). The study was commissioned and funded jointly by CRDC, Cotton CRC, GRDC and Weeds CRC in 2001-02. After consulting widely with growers, the project team produced a report that bench-marked the weed flora and management practices used in dryland cotton cropping systems. This report is published on the Cotton and Weeds CRC websites, and has been summarised in various conference papers and a paper was published in the Australian Journal of Experimental Agriculture. The main findings were that the weed flora was diverse, cropping systems complex, and weeds had a major financial and economical impact. Many of the common weeds were not controlled adequately or consistently in all parts of the rotation. Weed control was highly reliant on glyphosate in fallows and on atrazine in sorghum, but a diverse range of herbicides and mixes were used in cotton. Few non-chemical control options were used, and residual weeds often resulted in significant replenishment of the seed-bank. The report highlighted that fleabane was an emerging weed issue with the potential to become a major problem, which has eventuated since the scoping study.

The current project (DAQ123C), also funded jointly by CRDC, Cotton CRC, GRDC and Weeds CRC, focused on improved management of 5 key summer weeds, bladder ketmia, sowthistle, fleabane, barnyard grass and liverseed grass. The approach was to strategically manage these weeds, with a particular emphasis on developing better control practices for the weak-links of the rotations, and reducing replenishment of the soil seed-bank, which will reduce the economic impact of weeds in the long-term. The project team has made substantial progress on studying the biology of these weeds, devising specific control tactics for fleabane in wheat, sorghum and fallows, better herbicide efficacy for bladder ketmia, sowthistle, barnyard grass and liverseed grass in sorghum and fallows, and manipulating sorghum agronomy for improved competition against weeds.

Advances have been made in understanding the dormancy, germination requirements, emergence patterns and persistence of the 5 key weeds through the 3 long-term seed-bank experiments. These weed species differed markedly in their emergence patterns. Barnyard grass, fleabane, bladder ketmia, and sowthistle emerged predominately from soil surface, while liverseed grass emerged mainly from 5 cm burial depth. Liverseed grass emerged in one major flush, whereas bladder ketmia and barnyard grass showed staggered emergence throughout spring and summer, and sowthistle emerged all year round. Percentage of weeds seed surviving in surface soil after 2 years was negligible for sowthistle, 2-5% for barnyard grass, liverseed grass and fleabane, but over 50% for bladder ketmia. However, a higher percentage of viable seeds was found in deeper soil. These trials will continue for additional 1-2 years.

The project invested a large effort into researching better management of fleabane, a difficult-to-control weed in dryland cropping systems with cotton. A number of very effective in-crop treatments that achieved 95-100% control were identified, based on use of preplant fallow application of atrazine prior to sorghum, and preplant chlorsulfuron or post-emergent metsulfuron mixes in wheat. These residual herbicides provided good residual control of the following flushes for 4-8 months. In fallows, timeliness of herbicide application and using mixes were crucial. Glyphosate control efficacy reduced from 88% for weeds 5cm in diameter to 13% for weeds 10cm diameter or larger. Better weed control was achieved with several herbicide mixtures, such as glyphosate mixed with Ally, 2,4-D, Tordon 75D, atrazine or Grazon DS. As well, double knockdown application of glyphosate followed by Sprayseed or paraquat was highly effective and consistent. Management strategies will be published in a brochure and websites, and distributed widely to agricultural consultants and growers. The strategies are based strategic population management using combinations of knockdown and residual herbicides, herbicide mixes, crop competition, and targeting smaller and more susceptible weeds.

Four field experiments identified a number of glyphosate-based treatments and alternatives for highly effective control (95-100%) of sowthistle and bladder ketmia in fallows.

Techniques to improve control of summer grasses and bladder ketmia in sorghum were investigated. The most effective treatments were atrazine applied pre-plant in late winter fallow incorporated with rain and atrazine + metolachlor mechanically incorporated at sowing. Atrazine alone at sowing was not consistent for grass control, particularly for high weed pressure situations. In contrast, most atrazine-based treatments were successful for effective bladder ketmia control.

The residual effects of these atrazine based treatments are being evaluated on cotton. Re-cropping cotton into the 2003 central Queensland experiment showed that the herbicides residues had no adverse affects on cotton emergence, growth and yield after one year of herbicide application. More in-depth studies on cotton sensitivity to atrazine and other residual herbicides are in progress following the 2004 experiments in central and southern Queensland.

Seven field experiments investigated options to improve weed control in sorghum using crop competition to suppress weed growth and seed production. This has important implications for long-term weed control resulting from less replenishment of seed-bank. Results showed that increased crop seeding rate reduced weed seed production by 25-30%. Also, there were large differences in sorghum cultivars' ability to suppress weed seed production. Bonus and Goldrush reduced weed seed production by 30-40% compared with other cultivars under

identical growing conditions. Row spacing also had major impact on weed seed production, with 80% more weed seeds produced in double skip row configuration compared with 1 m row spacing. These results from both central and southern Queensland showed consistently that weed management can be improved based on the choice of more competitive sorghum cultivar, narrow row spacing, and high planting rates.

The project team, in collaboration with the University of New England, obtained funding from the Weeds CRC for a PhD scholarship on “Morphological and molecular characterisation of barnyard grass species in Australia and implications for weed management”. The PhD student, Michelle Keenan, commenced her study in late 2004. This PhD study will compliment this project, contributing to development of better management packages for summer weeds in dryland cropping systems with cotton.

The team has been very active in delivering research results to growers, advisers and researchers via 35 publications and presentations in refereed journals, international and national conference proceedings, grower magazines, field days and industry forums.