

FINAL REPORT

DAQ00170

GRDC Grower Solutions for Central Queensland

PROJECT DETAILS

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PROJECT TITLE: GRDC GROWER SOLUTIONS FOR CENTRAL QUEENSLAND

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Summary

This project, DAQ00170 (2011-2015) addressed the key short-term, seasonal and in-crop production constraints (priorities) of grain growers in Central Queensland (CQ), particularly in relation to managing grass weeds, soil nutrients and other emerging issues. The project used a structured development and extension approach involving on-farm field trials, field walks, biannual district-level grower meetings and extension products to promote grower adoption of best practice. The project's activities contributed to statistically significant practice change in all target areas and culminated in the delivery of a comprehensive feathertop Rhodes (FTR) grass management package to the grains industry in CQ.

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Conclusions

The type and frequency of grower and agronomist issues addressed by the project over its operating period and benchmarking survey data collected in 2011 and again in 2014 on-farm practices and grower and industry attitudes showed definitively that stubble cover, weed management and soil nutrient management were the major drivers for cropping decisions in CQ.

The project has significantly influenced adoption of best practice in several aspects of integrated weed management (IWM), including managing weeds at the most appropriate stage(s) and the use of most appropriate speed of spray application, nozzle and pressure settings to match the weed, crop or phase and environmental conditions. Delivery of the FTR management best practice manual in 2014 has given the CQ grains industry more locally validated options for grass weed management and a strategic framework within which to deploy these options. The project can take significant credit for the impact (severity) of FTR decreasing between the 2011 and 2014 benchmarking surveys. However, growers are increasingly aware of the magnitude of the FTR problem and the need for ongoing extension to promote greater adoption of best practice has now been clearly identified.

The project's data indicate significant evolution in usage, and implicit understanding, of herbicides, herbicide groups and appropriate use patterns. Since 2011, significantly more growers are now using a broader array of herbicides from different groups, e.g. K, A, L, H and B. The use of the double-knock tactic has increased significantly between surveys; this represents an important outcome for IWM in CQ, but more extension is needed on this subject. Herbicide use data collectively show significant increases in the use of herbicides (in-crop and fallow residuals) and the use of cultural practices, particularly various tillage practices, crop rotations and others such as burning between years. Increased usage of cultural practices reflects the perception of increased difficulty in controlling weeds with herbicides in zero-till systems.

The project has significantly influenced adoption of best practice in crop rotation and macronutrient deficiency management. On-farm trials conducted by the project have demonstrated clearly that significant productivity gains are possible by correctly identifying and remediating phosphorus (P) deficiency with application of P fertiliser into the sub-soil (15-20cm) under optimal growing conditions, i.e. when water and other nutrients, particularly nitrogen (N), are not limiting. This result can be extrapolated to potassium (K) on the basis of findings from other nutrient response research currently underway in CQ. The trial data also demonstrate that when there is insufficient fallow rain to replenish any lost soil moisture due to deep fertiliser application (ripping effect), the following crop can be significantly impacted. There was clear evidence of

uncertainty with regard to the outcomes of nutrient application to pulse crops. This suggests the need for on-going development work in CQ to build the capability and capacity of grain growers for on-farm diagnostics and trials.

The project's overall impact through trial work, supported by extension and communication activities to disseminate the latest results, is also evident from the benchmarking data, which show that with respect to sources of information, a highly significant increase in the use of departmental extension as a source between surveys is evident.

Recommendations

A research, development and extension (RD&E) gap analysis for CQ was conducted as part of the contractual requirements of this project. A brief summary of the findings of this analysis is presented here. A more comprehensive report on the findings was submitted to the GRDC in June 2015.

Over the analysis period, the vast bulk of production issues was related to weed management, soil nutrient management and agronomy. A second tier of issues grouped under disease management, technology and insect management is also clearly evident. The predominance of weed management is reflective of the past economic importance of key grass weed species in CQ, particularly FTR and sweet summer grass (SSG) in the first half of the analysis period. Weed management will continue to be very important, but the largest productivity gains are likely to be in the subject areas of soil nutrient management and agronomy, followed closely by technological advances. A relatively high priority rating for extension warrants special mention due to the importance of extension activities in underpinning adoption and practice change.

In the nutrient management subject area, a high priority for CQ growers is the continuation of the basic research on P, K and sulphur (S) which the GRDC is currently funding, followed by more development or extension activities, particularly local on-farm trials, to supplement greater awareness of soil nutrient and fertility decline issues on their farms. This follows from the success of the CQ Grower Solutions project in showcasing elements of research outputs from other GRDC funded programs, e.g. the Nutrient Management Initiative (NMI) project. Other nutrients, S being the foremost among them, follow closely behind in the priority ranking, indicative of significant gaps in the current grower and agronomist level of understanding of their successful deployment in fertiliser programs to address perceived nutrient deficiencies.

From an agronomy perspective, the call for new varieties that are specifically adapted to CQ production systems and growing conditions is a long standing one. Management of stubble at planting is a problem that continues to grow in importance. Experienced agronomists and some of the best grain growers in CQ claim that the current industry practice in relation to crop layouts (not suitable for modern, high yielding varieties) and un-even plant stands are significant causes of unrealised yield potential. The rising cost of all fertilisers, particularly N, is a significant and ever increasing cost of production that will make low-cost alternative sources of N a very high priority for the future.

Increased training or guidance on the use of residual herbicides, in conjunction with other tactics such as crop rotation programs and tillage, is a high priority for CQ. A knowledge gap in relation to local (CQ specific) plant back and crop safety data for most residual herbicides has been long considered a high priority for future investment. A lack of options and/or guidelines for effective control of weeds, particularly grasses FTR and SSG, along fence lines, paddock edges and other non-cropped areas is viewed as a significant development or extension gap and a weakness of IWM strategies that allow the weed species in question to rapidly recolonise treated areas. While FTR and SSG continue to be important economic considerations, sow (milk) thistle, Mexican poppy and fleabane, to some extent, are increasingly prevalent in cropping areas and are perceived to be hard-to-kill weeds.

Outcomes

The expected outcome of the project was more profitable and environmentally sustainable grain production in CQ. The degree to which the project's activities resulted in and/or contributed to economic, environmental and social outcomes was measured by quantifying practice change in relation to the two most critical subject areas for CQ, namely weed and soil nutrient management.

Economic outcomes: Benchmarking data collected by the project show that prior to 2014, the control of grass weeds (primarily FTR), was costing 45% of CQ grain growers \$10-\$30/ha and another 45% of growers more than \$30/ha each year, over and above the traditional costs of weed control in their farming systems. The delivery of a regionally tested and validated package of strategic and tactical management options for controlling hard-to-kill grass weeds in late 2014 will result in

significant future cost savings due to more effective control, lower weed pressure, better fallow and in-crop water use efficiencies and higher yields. Trials conducted by the project have shown that significant yield increases are possible by correctly identifying and remediating sub-soil macronutrient deficiencies, particularly P, under optimal growing conditions. Trial data show that when water and other nutrients, including N, were not limiting, deep P application increased yields by 35% and generated additional income of \$230.44/ha, a profit of \$92.76/ha, a return on investment (ROI) of 1.7:1 for applied P in the first year, with increased yield responses expected for another 4-5 years. Legume-cereal rotation trials have clearly demonstrated the potential for reducing reliance on N fertiliser as a result of increased yield of wheat following chickpeas, equivalent to 20-40kg of N/ha in CQ cropping systems where water availability is not a limiting factor.

Environmental outcomes: Benchmarking data indicate a 10% increase in soil testing and the frequency of testing which, in turn, is indicative of better matching of fertiliser inputs to soil deficiencies and crop requirements, and therefore less potential off-farm movement of nutrient inputs. By the end of 2014, there were more growers (21%) targeting younger, more susceptible, weed stages; increased (20-30%) use of larger droplets; significant increase (20-30%) in the diversity of herbicide groups used, and a 21% increase in the use of double-knocking to control FTR and other grass weeds. This practice change will result in significant environmental benefits from lower off-target movement and significantly lower herbicide usage.

Social outcomes: The project can claim significant industry development and capacity building through its program of development and extension activities (January 2011 - June 2015), which were attended by 1,850 growers, agronomists and agribusiness professionals. The project delivered 60 grower information meetings, 21 field walks, eight workshops and one best practice manual on managing FTR.

Achievements/Benefits

Background:

DAQ00170 was designed to address key, long-standing production constraints (strategic component) as well as short-term, seasonal and in-crop issues (reactive component) within CQ grain production systems. The project operated in eight cropping districts across CQ, namely, Kilcummin, Clermont, Capella, Gindie, Rolleston, Duaringa, Biloela and Moura. The project's key objectives were (1) to collect, clarify and prioritise grower issues, and (2) to conduct targeted and locally responsive on-farm trial and demonstration activities in response to locally identified issues, coupled with appropriate extension methodology, to deliver practical solutions and facilitate practice change within a 1-3 year timeframe.

For reporting purposes, the project's D&E activities were grouped under headings of weed management, soil nutrition and emerging or other issues. These thematic classifications were a reflection of the pre-determined subject areas nominated in the project specification and the broad subject areas that grower-nominated issues tended to be aggregated under. Trials and related extension activities were located in as many of the cropping districts as was practically feasible, depending on the subject or topic and locational criteria. Biannual grower information meetings (dissemination of trial results) were conducted in each of the eight cropping districts.

Priorities addressed and major activities undertaken in 2011:

(a) Weeds management priorities:

- o Efficacy of Group A double knocks (Group A herbicide followed by paraquat[#]) in fallow on FTR,
- o Efficacy of residual and knockdown herbicides on FTR in-crop and in fallows,
- o Improve adoption of best practice in spray application for grass weed management.

(b) Soil nutrient management priorities:

- o What is the residual N and overall system benefit of chickpeas to a following wheat crop in CQ grain production systems?
- o What is the most effective way to address K deficiency in the soil with fertiliser?
- o On-ground support for GRDC funded NMI project (M. Bell, University of Queensland (UQ)) activities in CQ (crop x nutrient response curves)

(c) Emerging/other issues:

- o Effective options for desiccating the mungbean variety Crystal^d
- o Is there a yield response in mungbeans to added N fertiliser?

(d) Quantify attitude and practice change in CQ under each of the main thematic areas of the project.

Justification: FTR was the single most important production constraint for grain cropping in CQ and was also becoming

increasingly prevalent in parts of southern Queensland (Qld). Prior to 2011, there were only a couple of herbicidal products registered for use on FTR and none that were deemed commercially effective. At a joint meeting of the GRDC funded Grower Solutions groups and the *Chloris* species working group in Brisbane (April 2011), it was determined that a high IWM priority for the GRDC Northern Grains Region was the development, validation and legalisation of effective herbicidal options for hard-to-kill weeds, including FTR. Accordingly, a CQ project priority was the generation and collation of local efficacy data on herbicide products and use patterns for residual and knockdown control of grass weeds. The trial data generated would support the GRDC funded 'Pathways to Registration' project, which was leading industry efforts to develop legal spray options for weed management through the Category 25 pathway of the Australian Pesticide and Veterinary Medicines Authority (APVMA).

CQ grain growers were interested in the residual soil N and general system benefits of chickpeas to following cereal crops based on the results of similar work done in other areas. The rotational benefits assessment was designed as two staggered sets of four trials, each scheduled to run over two winter cropping seasons and generate data from a range of soil type, farming system and environmental conditions. Assessment of crop responses to K fertilisers was identified as a priority following reports of K deficiencies in a number of CQ chickpea crops in 2009 and 2010. Mungbean desiccation and responses to added fertiliser were identified as priorities following anecdotal reports from the Dawson-Callide Valley in 2010 that mungbean growers were experiencing difficulty in desiccating Crystal and crops grown with added N fertiliser were out-yielding crops without additional N. On-ground support for the NMI project trials on managing soil macronutrient deficiencies was identified as a key activity in the DAQ00170 project specification.

Achievements: In the first 12 months, the project conducted nine small-plot herbicide efficacy trials, five on-farm (paddock scale) herbicide efficacy demonstrations were developed and effected in collaboration with regional private agronomists (105 attendees - growers and agribusiness professionals), five spray application best practice workshops conducted in collaboration with Bill Gordon (201 attendees - growers, spray applicators and agronomists), 11 nutrient management trials and two mungbean pre-harvest desiccation trials.

A benchmarking survey targeting all CQ growers and agribusinesses was conducted in November and December 2010. A total of 71 responses from individual farming enterprises and agribusiness to 49 questions covering practices and information relating to general farming, soil fertility, pulses within the system and weed management were received.

Priorities addressed and major activities undertaken in 2012:

(a) Weeds management priorities:

- o How to maximise efficacy of Group A double knocks (Group A herbicide followed by paraquat) in fallow.
- o Strategies to achieve consistent efficacy from residual herbicides.
- o Strategies to achieve consistent efficacy from paraquat in a double-knock tactic for annual grass weeds.
- o Management options for Mexican poppy in chickpeas and fleabane.

(b) Soil nutrient management priorities:

- o What is the residual N and overall system benefit of chickpeas to a following wheat crop in CQ grain production systems?
- o What is the most effective way to address K deficiency in the soil with fertiliser?
- o On-ground support for GRDC funded NMI project (M. Bell, University of Queensland (UQ)) activities in CQ (crop x nutrient response curves).

(c) Emerging/other issues:

- o Effective options for desiccating the mungbean Crystal.

Justification: Highly variable results following the use of the double-knock technique on grass weeds such as FTR by different spray applicators across the CQ region called into question the usefulness of this technique, which was recognised by the research establishment as being critical for effective weed control and proactive resistance management. Thus, development of a strategic framework to maximise the efficacy of double-knocking became a high priority for effective IWM. Grower interest in ameliorating K deficiencies through the strategic application of fertilisers continued to build in response to positive results from trials in the previous season and emerging research results from the NMI project.

Achievements: In this 12 month period, the project conducted 13 small-plot trials knock-down and residual herbicide efficacy, four macronutrient deficiency management trials in support of the NMI project, eight chickpea-wheat rotation trials and one mungbean pre-harvest desiccation trial. In the 18 months to December 2012, the project successfully compiled the bulk of the efficacy and use pattern data on Group A herbicide double-knocks to control FTR (and to a lesser extent SSG), which were

subsequently used by the 'Pathways to Registration' project to secure regulatory approval for the use of Group A herbicides on FTR in fallow.

Priorities addressed and major activities undertaken in 2013:

(a) Weeds management priorities:

- o Best bet chemical, mechanical and cultural control options for management of grass weeds in CQ.
- o What chemicals are cost effective in controlling broadleaf weeds, particularly fleabane and Mexican poppy, in chickpeas?
- o Alternative(s) to paraquat, in a double-knock strategy with Group A or Group M herbicides for grass weed (FTR and SSG) control.
- o How can the paraquat double-knock be made to work properly and consistently for FTR, SSG and other grasses?

(b) Soil nutrient management priorities:

- o What is the residual N and overall system benefit of chickpeas to a following wheat crop in CQ grain production systems?
- o Fertiliser application strategy (product, rate, timing, placement) to overcome soil deficiencies in P, K and S.

Justification: Partly in response to the continuing high weed pressure from FTR in grain paddocks and the extension efforts of the project to promote an IWM approach, diversification of control tactics to include cultural and non-chemical control options was recognised by CQ grain growers as a high priority. Increased detection of deficiencies in P, and in some instances S, and new results from the NMI project were the drivers for heightened grower interest in developing a holistic approach to the characterisation and amelioration of macronutrients N, P, K and S.

Achievements: In this 12 month period, the project conducted 26 herbicide efficacy and cultural control trials relevant to different crop and phase options, including fallow, prior to sorghum and in-crop (wheat, chickpeas), and herbicide groups (residual and knock-down chemistry). This work program has generated a substantial, locally generated data set, which growers can use to develop confidence in the applicability and efficacy of various weed control options under a range of resource base, production practice and environmental condition scenarios prevalent in the various cropping districts of the region. Completion of eight chickpea-wheat rotation trials this year marked the completion of the legume-cereal rotation assessment priority commenced in 2011. Over a three year period, the project completed two rounds of assessment (16 trials), which conclusively showed the potential yield benefits (equivalent to 20-40kg of N/ha applied as bag fertiliser) as well as other potential system benefits to wheat grown after chickpeas.

Priorities addressed and major activities undertaken in 2014 and 2015:

(a) Weeds management priorities:

- o Need for better understanding and greater awareness of residual herbicide damage in chickpea.
- o Alternatives to Group A herbicides (e.g. Verdict[®]#) for knockdown control of FTR grass.
- o More R&D on non-chemical methods of weed control, including microwaves, fire and steam.

(b) Soil nutrient management priorities:

- o Fertiliser application strategy (product, rate, timing, placement) to overcome soil macronutrient deficiencies (P, K, S).

(c) Quantify attitude and practice change in CQ under each of the main thematic areas of the project.

(d) On-farm technological innovation in machinery.

Justification: The program of activities from January 2014 to June 2015 included continuing trials to address IWM priorities carried over from 2013 on the double-knock and non-chemical control tactics, and new activities to address the underlying causes of residual herbicide damage in chickpeas. The increasingly frequent detections of P, K and S deficiencies across the CQ region were now viewed as unquestionably the most important constraint on production and profitability of grain

farming in CQ. Demonstrations and extension (bus tour) of innovations in farm machinery were voted among the top priorities in 2014.

Achievements: The project conducted 10 herbicide efficacy trials this year. A CROP FACTS newsletter edition on minimising herbicide damage in chickpeas was developed and disseminated to the grains industry in early 2014. A series of eight workshops on broadleaf weed best management practice (BMP) were developed and delivered by Mark Congreve (ICAN Pty Ltd) in 2014. CQ data generated by the project and data from other research/development groups on the efficacy of various herbicide options for controlling FTR were integrated into a new management guide that was delivered to the grains industry at the end of 2014. An on-farm diagnostic fertiliser response trial protocol was developed and implemented on 10 sites (farms) across CQ where P, K or S deficiency has previously been identified. The results of these trials generated a high level of interest and helped to maintain macronutrient development and extension (D&E) as a top priority to the end of the project (June 2015). A second Grower Practices benchmarking survey of 98 CQ growers and agribusinesses representing approx. 169,000ha in early 2014, revealed significant practice change across the main operating themes of the project, namely weed management and soil nutrient management. A bus tour looking at innovative technology adoption across the northern and southern highlands in June 2015 was attended by 60 growers and 20 industry representatives from cropping districts across CQ including Biloela, Wowan, Theodore, Baralaba, Rolleston, Gindie, Emerald, Capella, Kilcummin and Dysart. Industry feedback indicates that the tour was instrumental in influencing a number of growers to invest in new farm machinery.

Major outputs and outcomes

Highlights of the project's outputs and outcomes include:

- (a) A highly successful information extension and communication program.
- (b) Development of significant capability and confidence across CQ cropping districts in the development and implementation of grass weed control strategies.
- (c) Development and delivery of a comprehensive FTR management framework and user manual .
- (d) Development and testing of an heuristic, on-farm trials based framework to address macronutrient deficiencies for use by growers and agronomists.

Additional information

Technical user manual - Integrated Weed Management (IWM) of feathertop Rhodes grass 2014.