
Cotton Growing Practices

2015-16

Findings of CRDC's survey
of Cotton Growers

Roth Rural for the
Cotton Research and
Development Corporation





Australian Government
Cotton Research and
Development Corporation



Cotton Growing Practices

2015-16

**Findings of CRDC's survey
of Cotton Growers**

**Roth Rural for the
Cotton Research and
Development Corporation**



Summary

The Cotton Practices Surveys are undertaken for the Cotton Research and Development Corporation (CRDC) to gather information about farming practices, the adoption of research and opportunities to improve cotton research and development. This survey has focussed on the strategies used to consider seasonal conditions in cotton management, historical mining exploration wells and perceptions of cotton research and development.

This survey related to both the 2014-15 cotton season and the start of the 2015-16 season. Both of these seasons had limited water in many regions. Growing conditions for many regions in 2014-15 were close to ideal where irrigation water was available with sunny days, no excessive heat events and a dry finish.

Responses were received from 239 cotton growers, a 30% response rate. Responses represented 35% of the irrigated and 16% of the raingrown (dryland) cotton production area in 2014-15.

Highlights of the findings presented in this report include:

The 2014-15 Cotton Crop

- » The 2014-15 season achieved some exceptionally high yields (average 12.8 bales/ha, with individual fields yielding up to 18 bales/ha). Respondents attributed these high yields to a mix of weather and management, including:
 - Weather conditions – water, sun, dry finish, no prolonged heat events;
 - Timing – irrigations, rainfall events, earliness;
 - Water management;
 - Fertiliser;
 - Ground preparation;
 - Attention to detail;
 - Fields without verticillium wilt.
- » Quality discounts were reported by 59% of irrigated crops, 58% of partially irrigated and 64% of raingrown crops. Discounts were on average \$13/bale on irrigated cotton, \$26/bale on partially irrigated and \$19/bale on raingrown cotton.
- » Reported costs of production ranged from \$200/ha for raingrown conventional cotton to \$5,700/ha for irrigated cotton. Reported costs of production were on average:
 - Irrigated cotton: \$3,123/ha
 - Partially irrigated cotton: \$1,656 /ha
 - Raingrown: \$948/ha.

Raingrown (Dryland) cotton

- » 61% of respondents have produced raingrown cotton in some seasons.
- » 74% of raingrown cotton farms also produced irrigated cotton.
- » Stored soil moisture, previous crop history and prices are the factors most commonly influencing decisions around planting raingrown cotton.

Seasonal management

- » Stored water and soil moisture is more significant than seasonal outlook in determining the area of cotton grown.
- » Seasonal outlook has some influence on fertiliser rates, crop inputs and the area grown for some respondents.
- » A range of different approaches were used in managing limited water with some growers planting only the area they had enough water to fully irrigate, some stretching water over a larger area and relying on in-season rainfall and others using a mix of strategies on different fields.
- » Changes in 2015-16 cotton management compared with 2014-15 were most commonly related to planting configuration to adapt to limited water, time of planting and nutrition.

Managing limited water in 2015-16

Both raingrown and irrigated growers used a range of strategies for managing limited water, including:

- » Planting configuration including skip row in irrigation and double skip in raingrown;
- » Reduced irrigation area, concentrating on more water efficient fields;
- » Planted later (19% of respondents), planted earlier (8%), some farms did some of each.
- » For irrigated cotton in 2015-16:
 - 59% of respondents planted only the area they had enough water to fully irrigate;
 - 22% planted some fields that receive full irrigation and some semi-irrigated;
 - 15% did not have enough water for full irrigation of all planted fields at the time of planting. (1.1% of the total planted area was abandoned due to lack of water).
- » Irrigation timing, monitoring and scheduling;
- » Manage for earliness to reduce water demand;
- » Stubble cover;
- » Grow more winter crop and other crops;
- » Nutrition strategies;
- » Flexible staffing arrangements.

Replant and damaged cotton 2015-16

- » A third of respondents had either replanted or abandoned some cotton in 2015-16.
- » 11% of the total green hectares planted in 2015-16 were replanted or abandoned.
- » Poor plant stand was the main reason for replanting, particularly in Central Queensland. Lack of water, hail and herbicide drift were the other major causes.

Mining exploration wells

- » Drilling for mining exploration had occurred on or near 27% of respondents' properties.

Research priorities

- » Priorities were spread across the full scope of cotton research and development.
- » The highest priorities were: varieties and plant breeding; cotton disease management; biotechnology and insect resistance management, cotton nutrition, herbicide resistance management and irrigation management and water use efficiency.
- » Verticillium wilt and other seedling diseases were raised repeatedly as a key issue.
- » A number of suggestions were made relating to people development, crop production, soil health, machinery technology, cotton physiology and future research.

Perceptions of research and CRDC

- » 99.6% of respondents are aware of CRDC.
- » 70.2% understand fairly well or very well what CRDC does.
- » 88% indicated that overall they are supportive of CRDC's research and investments.
- » CRDC's perceived strengths were in investing in cotton R&D.

Many thanks to the growers who have provided their information through this survey, making it possible to prepare this industry wide report. We hope you find the collated industry information of interest.

CONTENTS

Summary	2
Background	
Survey Design, Distribution and Response	6
Survey Design.....	6
Survey Timing.....	6
Survey Distribution.....	6
Survey Response.....	7
Seasonal Conditions and Influences	8
Findings	
Managing for Seasonal Conditions	9
Cotton Production Area.....	9
Planting Raingrown (Dryland) Cotton.....	11
Management to Optimise Yield for Seasonal Conditions.....	12
Managing Limited Water.....	20
Seasonal Outlook and Decision Making.....	24
Management of High Yielding Cotton.....	25
2014-15 Season Results	26
Yields.....	26
Quality.....	28
Irrigation Efficiency.....	28
Costs of Production.....	29
Replant and Abandoned Cotton 2015-16	30
Mining Exploration Wells	32
Cotton Research	34
Research Priorities and Grower Input To CRDC.....	37
CRDC Strategic Plan Statements.....	41
Other Comments.....	44
Preferences for Survey Reporting	44
Appendix: Survey Questions	45

List of Tables

Table 1	Proportion of cotton grown in 2013-14 represented in the survey.....	8
Table 2	Management strategies for the high yield potential in 2014-15.....	13
Table 3	Changes to cotton management in 2015-16 compared with 2014-15	17
Table 4	Strategies for managing seasonal conditions and limited water in irrigated or raingrown cotton.....	21
Table 5	Strategies of growers with fields yielding 16.5 bales/ha or above	25
Table 6	Cotton yields, quality and irrigation use in each region, 2014-15	26
Table 7	Average costs of production by region	29
Table 8	Replanted and abandoned cotton 2015-16, by region.....	30
Table 9	Reasons for replanting or abandoning 2015-16 cotton	31
Table 10	Number of farms with mining exploration drilling and number of wells	32
Table 11	Comments about mining exploration drilling wells.....	33
Table 12	Net positive rating of CRDC performance.....	35
Table 13	Priority areas of investment	39
Table 14	Description of 'other' and comments on research investment allocation	40
Table 15	Other comments.....	44

List of Figures

Figure 1	Response rate by region.....	7
Figure 2	Proportion of cropping land planted to cotton over 4 seasons.....	9
Figure 3	Proportion of land in each region developed for irrigation planted to cotton over 4 seasons.....	10
Figure 4	Proportion of land in each region developed for raingrown cropping planted to cotton over 4 seasons.....	10
Figure 5	Proportion of respondents growing dryland cotton	11
Figure 6	Factors most influencing decisions about planting raingrown cotton.....	11
Figure 7	Factors limiting yield in 2014-15, by region	16
Figure 8	Strategies used for managing limited water in irrigated cotton in 2015-16.....	20
Figure 9	Impact of seasonal outlook on cotton farming decisions.....	24
Figure 10	Yields and quality of irrigated cotton 2014-15	27
Figure 11	Yields and quality of partially irrigated cotton (up to 3 irrigations) 2014-15.....	27
Figure 12	Yields and quality of raingrown cotton 2014-15.....	27
Figure 13	Quality discounts on 2014-15 cotton by region.....	28
Figure 14	Average cotton production cost vs target yield 2014-15.....	29
Figure 15	Level of understanding of what CRDC does	34
Figure 16	Understanding of what CRDC does, by region.....	34
Figure 17	Level of overall support for CRDC research investment and activities	35
Figure 18	Perceptions of CRDC's performance in investing RD&E.....	36
Figure 19	Perceptions of CRDC's performance in communicating with growers and listening about R&D	36
Figure 20	Perceptions of CRDC's performance in working collaboratively	36
Figure 21	Ways of having input to CRDC about research	37
Figure 22	Reasons for not having input to CRDC about research.....	37
Figure 23	Avenues used for giving input to CRDC about research, by region.....	37
Figure 24	Proportion of respondents suggesting each level of investment in areas of Cotton RD&E.....	38
Figure 25	Views about cotton profitability, % respondents compared over time	41
Figure 26	Views on aspects of the Australian cotton industry, % respondents over time.....	42
Figure 27	Views on cotton industry RD&E, % respondents compared over time	42
Figure 28	Views on cotton research communication, % respondents over time	43

Background

The Cotton Research and Development Corporation (CRDC) undertakes an annual survey of cotton growers to gather information about farming practices and growers' views on research, development and extension. This information helps to inform CRDC about the benefits of the research it invests in. Change in industry practice can be quantified by comparing information across the surveys conducted over the past 20 years.

Each of the previous surveys included core annual questions and then 3 to 4 focus themes to investigate specific aspects of the farming system. For example, previous themes have included nutrition, soils, biotechnology stewardship, weed management, irrigation, energy, emissions, workforce, harvesting, riparian areas and communications. These themes are revisited again to monitor change. For example, nutrition was investigated in 2006 and 2007 and again in 2011 and 2013 – the paired years used to distinguish differences over a longer period vs differences between seasons.

Survey design, distribution and response

The Cotton Practices Survey is guided by CRDC with input from Cotton Australia, researchers and others.

Survey design

The 2015-16 Cotton Practices Survey included the core set of annual questions that have been repeated in each survey. These questions gathered respondents' demographics (region, farm area) and information specific to the season (yields, quality, area of cotton).

Further survey themes and questions were developed in collaboration with CRDC, Cotton Australia and researchers working in the theme areas. The CRDC Board also reviewed questions specific to CRDC performance. CRDC's policy is for CRDC funded research to incorporate survey questions into this survey where appropriate.

The overall survey program is guided by CRDC's Monitoring and Evaluation Framework and supplemented by research questions relevant to the seasonal conditions. This survey gathered mid-term assessment of growers' views of CRDC's performance against the Strategic R&D Plan 2013-2018.

The record yields of 2014-15 and unusual seasonal conditions of both 2014-15 and the start of the 2015-16 seasons prompted the investigation of how cotton management is adapted to suit seasonal conditions. These questions were developed with CRDC and reviewed by Cotton Australia and CSIRO's Dr Mike Bange. Questions on mining exploration wells were added at the request of Cotton Australia to aid some research, and the questions designed with Dr Bryce Kelly, UNSW.

"Partially irrigated" cotton was added as a category this year alongside Raingrown (Dryland) and Irrigated cotton. This was included due to the increasing occurrence of partially irrigated cotton crops (a result of both limited water and changes to Monsanto's royalty models).

Questions were pilot tested with both dryland and irrigated growers and refined before distribution.

Survey timing

Surveys have usually been conducted in winter, focussing specifically on the preceding crop. This survey was conducted in February 2016 to investigate how growers had managed seasonal conditions and planting decisions across two seasons. It also allowed us to gather timely information about replant and abandoned crops. The delayed timing was also to avoid overlap with other surveys for CRDC in winter-spring of 2015.

Survey distribution

This was the first Cotton Practices Survey to be conducted almost entirely online. An email link was circulated by CRDC to the 447 farms who had their email registered with CRDC. A postcard inviting participation was mailed to all growers registered with CRDC. Links to the survey were included in Cotton Australia and CottonInfo e-newsletters and were circulated by Regional Delivery Officers and other contacts. Following the initial response period the project team phoned and emailed growers to encourage greater participation - some of these were completed on paper and entered into the online system.

Overall the online survey system received a lower fully completed response (prompted and unprompted) as compared with the hard copy surveys conducted in previous years, but a higher response rate when including partial replies.

Survey response

The response rate can be considered both in terms of the number of farms responding (Figure 1) and the area of cotton in 2014-15 (Table 1). Note however that some respondents did not grow cotton in 2014-15. Response rate was:

- » 239 responses (177 completed, 62 partially completed, excluding an additional 51 responses that completed less than 4 questions), representing:
 - 30% of the 792 farms registered with CRDC
 - 51% of the 467 farms with valid email addresses.
- » 60,584 ha irrigated, 4,665ha partially irrigated and 5,505 ha raingrown cotton. This is equivalent to:
 - 35% of irrigated cotton for 2014-15
 - 16% of raingrown cotton crop for 2014-15.

Responses were received from both irrigated and raingrown (dryland) growers:

- » 89% of respondents grow irrigated cotton, 39% with no raingrown (dryland) cotton
- » 61% grow dryland cotton (28% whenever possible, 33% sometimes).

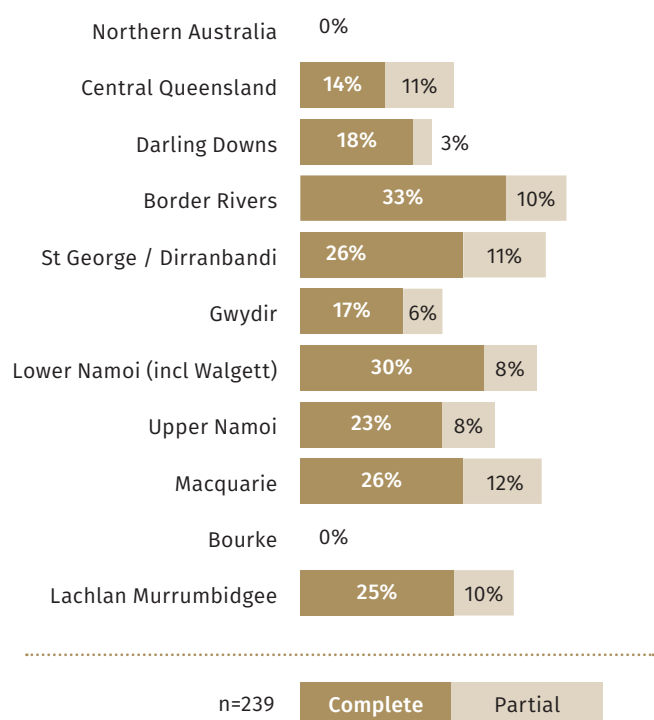
A number of questions in the survey were relevant to all growers, regardless of whether they had grown cotton in the current season. Of the growers who responded:

- » 82% were growing cotton in 2015-16.
- » 6% had most recently grown cotton in 2014-15.
- » 9% had most recently grown cotton in 2013-14.
- » 3% had last grown cotton in 2012-13 or earlier.

The response rate from each region is shown in Figure 1. Follow up calls had been targeted towards a 20% response from each region. However, on reviewing the responses, it was evident that a number of farms had the region miscoded in the CRDC database.

Figure 1

Response rate by region



Response Total	Number of farms*	Number of responses
Central Queensland	80	20
Darling Downs	174	39
Border Rivers	48	20
St George / Dirranbandi	35	13
Gwydir	104	24
Lower Namoi	119	45
Upper Namoi	73	24
Macquarie	89	35
Bourke	4	0
Southern NSW	60	21

* Includes all farms registered with CRDC and any additional added through survey, regions adjusted based on growers' responses

For this report St George, Dirranbandi and Border Rivers regions have been aggregated as 'Macintyre-Balonne'. Gwydir and the Lower and Upper Namoi regions are combined as 'Northern NSW'.

Table 1

Proportion of cotton grown in 2013-14 represented in the survey

	Irrigated Cotton			Raingrown Cotton	
	Area in survey (field ha)		% of area grown*	Area in survey (field ha)	% of area grown*
	Irrigated	Partially Irrigated			
Industry Total	60,584	4,665	35%	5,505	16%
Central Queensland	4,529	1,500	43%	120	n/a
Darling Downs	2,152	1,445	19%	1,270	26%
Macintyre - Balonne	11,870	0	34%	570	19%
Northern NSW	24,103	1,620	46%	3,515	14%
Macquarie	4,438	100	47%	30	4%
Southern NSW	13,491	0	26%	0	n/a

* Compared with industry total reported in the Cotton Yearbook. Field hectares are calculated using a 1.5 conversion where required from green hectares

Seasonal conditions and influences

Irrigation water allocations in both the 2014-15 and 2015-16 seasons were limited in many regions, resulting in reduced areas of cotton. Weather conditions for the 2014-15 season were favourable for most farms with moderate temperatures, no major heat events, plenty of sunlight and a dry finish. Some exceptional yields were achieved.

Two commercial factors may have influenced planting decisions and use of limited irrigation water in 2015-16:

- » Monsanto changed their genetic trait licence policy, allowing growers to split their farm to select either the end point royalty or the per hectare royalty model on different fields. This made it a viable option to plant both dryland, partially irrigated and irrigated cotton on the one farm.
- » CSD had a 'no pick, no pay' offer for dryland cotton. For any dryland cotton that was not harvested this season CSD undertook to provide free seed for next season.

Findings

Unless otherwise defined, graphs indicate the proportion of respondents giving each response.

Managing for seasonal conditions

This survey sought to understand how cotton growers vary decisions to suit seasonal conditions and the management decisions that contributed to high yields.

Cotton production area

To understand the fit of cotton within the farming enterprises we asked respondents to list the total area developed for each irrigated and dryland cropping on their farm and the “typical” area grown to cotton in a good year. Across all respondents in a good year:

- » 55% of the total area developed for irrigation is typically grown to irrigated cotton;
- » 17% of the total area developed for dryland cropping is typically planted to raingrown cotton.

On average across the industry over the past four years, this ‘typical’ pattern occurred in 2013 and for irrigated cotton in 2014, but the 2014-15 and 2015-16 years saw a reduced cotton area, reflecting the dry seasonal conditions and limited water allocations (Figure 2). This pattern has varied by region as illustrated in Figure 3 for irrigated cotton and Figure 4 for raingrown cotton. Note that these figures are varied also by differences in which growers have responded to the survey in each year.

Figure 2

Proportion of cropping land planted to cotton over 4 seasons

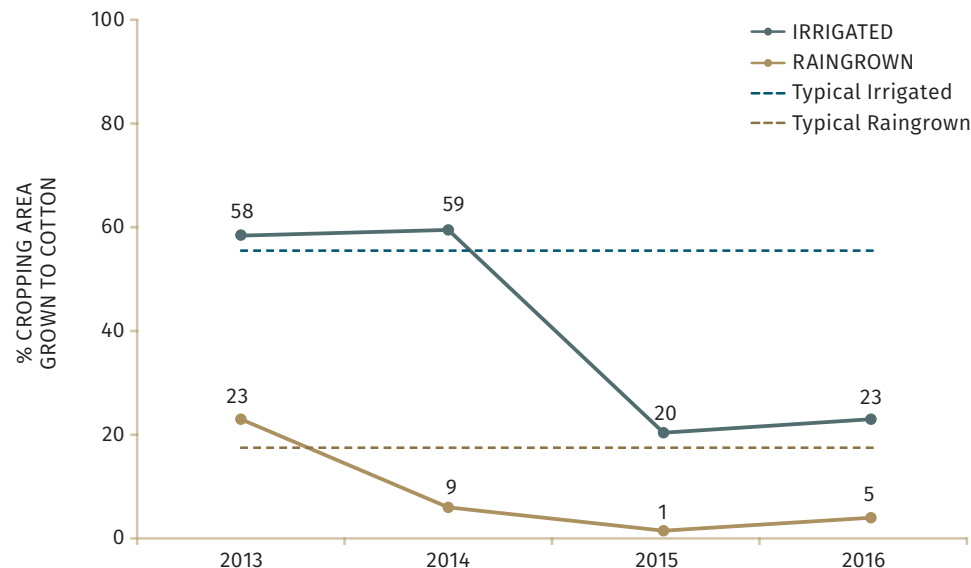


Figure 3

Proportion of land in each region developed for irrigation planted to cotton over 4 seasons

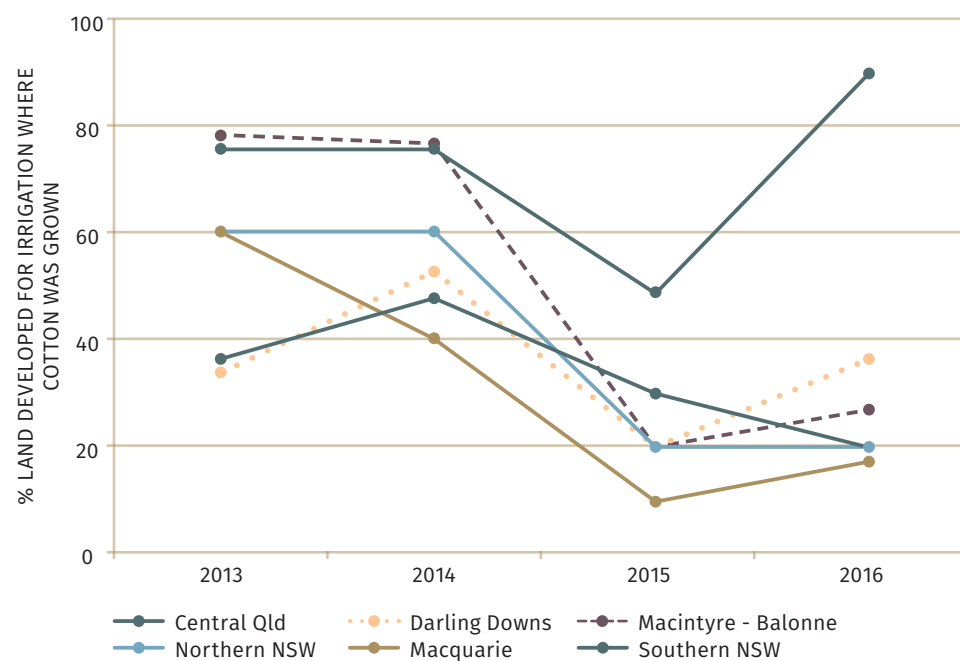
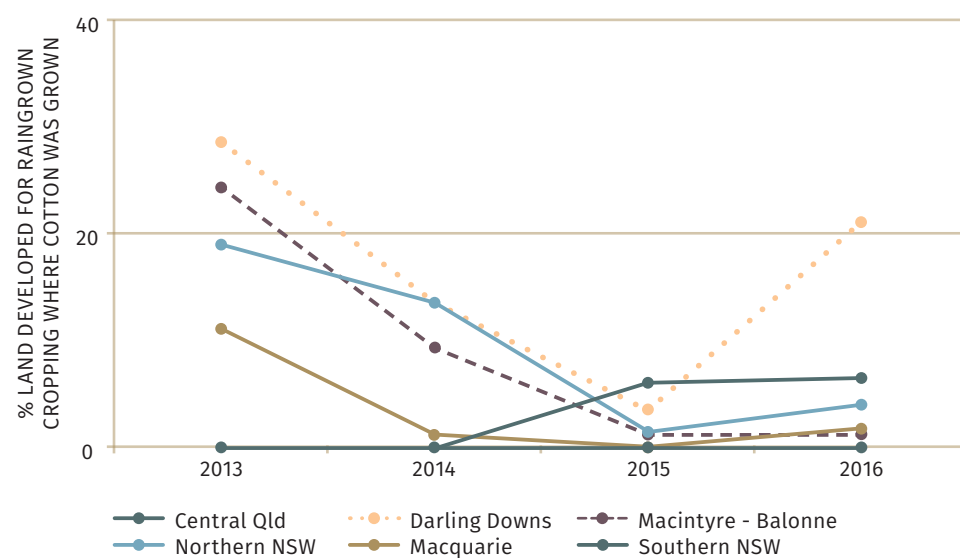


Figure 4

Proportion of land in each region developed for raingrown cropping planted to cotton over 4 seasons



Planting raingrown (dryland) cotton

Raingrown cotton had been grown on 61% of respondent farms (Figure 5). Of the farms that do produce raingrown cotton:

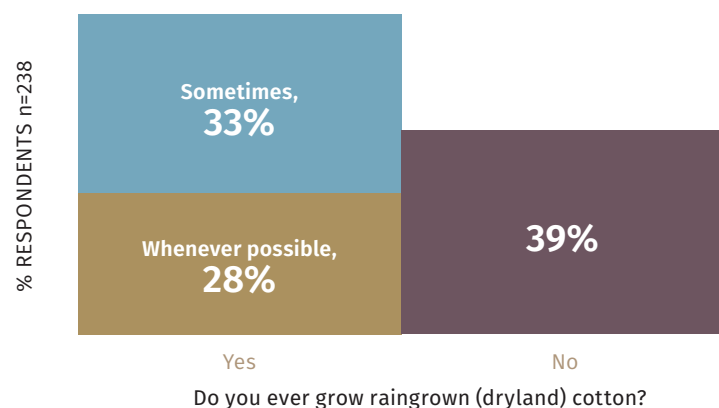
- » 74% grow both raingrown and irrigated cotton (45% of all respondents);
- » 26% grow cotton solely raingrown, having no irrigation development (16% of all).

Just under half of the farms producing raingrown cotton do so 'whenever possible'.

Q. Do you ever grow raingrown (dryland) cotton?

Figure 5

Proportion of respondents growing dryland cotton

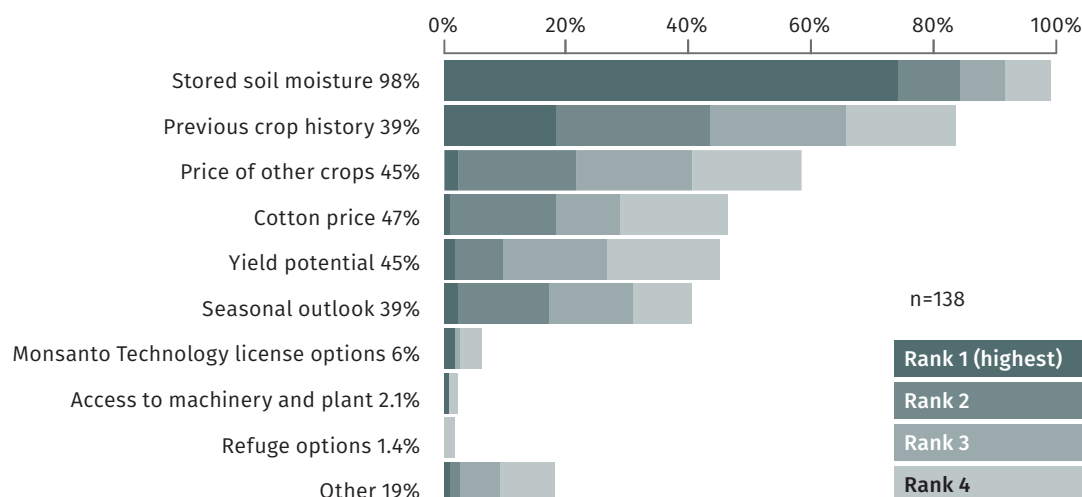


Q. For raingrown (dryland) cotton, what are the key drivers in your decisions about planting cotton or not and the area planted? Please rank the top 4 factors below in order of significance (1 most significant)

The factors most commonly driving the decision of whether to grow raingrown cotton and the area grown are: stored soil moisture (ranked in the top 4 issues by 98% of respondents and ranked highest by 73%) and previous crop history, followed by price of other crops and price of cotton (Figure 6). This figure displays in the axes labels the total % of respondents giving any ranking 1-4.

Figure 6

Factors most influencing decisions about planting raingrown cotton



Management to optimise yield for seasonal conditions

The 2014-15 season saw record yields from a smaller total cotton crop area. Limited irrigation water for the 2014-15 season resulted in a smaller overall cotton area planted. Ideal in-season weather conditions contributed to some extremely high yields and the extremely high industry average of 12 bales/ha for irrigated cotton (Cotton Yearbook). However, there were also many areas with limited yields. CRDC were particularly interested to understand the role of good management in achieving high yields and the strategies used to adapt to seasonal conditions.

Going in to the 2015-16 season rainfall was below average and irrigation water supplies were greatly limited in many regions. Considering this, how did growers adapt their management to suit the seasonal conditions? What strategies did they use to manage the limited water available?

Three open ended questions were asked:

- » What factors or management do you think most contributed to any high yields you achieved last season (2014-15)?
- » Please describe any specific management strategies that you used to suit the seasonal conditions and high yield potential of last season (2014-15).
- » What have you done / will you do differently in managing cotton this season (2015/16) compared to last season? Why?

The comments (listed in full in Table 2) attribute high yields in 2014-15 to a mix of weather and management, including:

- » Weather conditions – water, sun, dry finish, no prolonged heat events;
- » Timing – irrigations, rainfall events, earliness;
- » Water management;
- » Fertiliser;
- » Ground preparation;
- » Attention to detail;
- » Fields without verticillium wilt.

A number of different management options were described by growers for their 2015-16 crop compared with what they had done the previous season (Table 3). Key findings were:

- » Changes in 2015-16 cotton management were most commonly related to:
 - Planting configuration to adapt to limited water
 - Time of planting
 - Nutrition.
- » 20 respondents indicated there was nothing different in how they were managing their 2015-16 crop compared with the previous season. A further 60 respondents skipped this question.

Table 2

Management strategies for the high yield potential in 2014-15

Region	Factors & management believed to have contributed to high yield	Management strategies for 2014-15 seasonal conditions
Central Queensland	Weather.	The right amount of fertiliser up front. Side-dressing. Timing of irrigations.
	Dry season.	Timing.
	Irrigation schedule. Good weather.	
	Cyclone Marcia coming at the right time delaying defoliation and crop setting a massive top crop which delayed harvest but greatly increasing yield by up to 3-4 bales / ha.	Multiple applications of fertilizer incrop - small amount precrop 75 units nitrogen, then 150 units cultivating in at first 10 nodes, then one or two applications of 50 units. All with a spreader none deep drilled.
	Seasonal Conditions.	None.
	Early crop that was not so weather affected.	Early.
	Weather was favourable	Central Queensland.
	Dry pick	
Darling Downs	Water, sun, nutrient.	Kept the crop going.
	Management of crop.	Timing.
	Warm March.	
	Row configuration. Water management. Ground prep.	As to left.
	Variety grown. Irrigating at optimum times. Application of K mix 320 (potassium).	
	Hot Dry Season.	
	Dryland cotton - at emergence we had a very gappy plant stand with a quite low average plants per metre. This reduced the draw on soil water early in the crop's growth cycle & then we received, by luck, some very timely rainfalls Irrigated cotton - after a low water use when pre watering the ground we determined that we had plenty of water so slightly reduced our irrigation deficit.	As to left.
	Plenty of water and long warm summer.	Nothing different, just great growing season.
	Best season - no waterlogging.	No chemical fertiliser.
	Early plant.	2 m rows, double skip.
	1. Higher than average heat units/day degrees for our area without excessive heat. 2. Had enough water budgeted to give the cotton what it needed.	Our water and nutrition management is designed to be flexible. Two main factors: 1. The use of composted chicken manure in addition to conventional fertilisers to ensure crop has a release of nutrient during the growing period and into the following rotation crop. This gives us available nutrition for a yield window of 11 to 14 Bales per Ha. 2. Making the call early to buy in more water to not only finish cotton but to ensure other crops were covered as well.
	Increased water frequency/decreased deficit (mm). CTF in raingrown, full soil moisture profile at planting.	Additional N applications from pre flowering to cut out using NDVI and petiole testing management zones early Increased foliar K and N applications to all crop types due to ability to manufacture in house saving \$. Utilisation of VR tech in dryland cotton following NDVI and petiole testing.
	Conventional and hadn't cut out when the rain came.	More conventional.
	Timely late rainfall.	Dry start so some skip row which yielded almost as much as the solid plant.
	Increased use of fertilizer.	In part higher yields were from seasonal and better varieties.
	Heat units.	Shorter water intervals.
Macintyre - Balonne	Good growing conditions; Fallow fields; Lower area so more attention to detail.	Kept the water scheduling very accurate Kept fertiliser requirements up to yield potential.
	Less days over 35 degrees. More frequent irrigation. Fully irrigated.	As above.
	1. Good season - mild. 2. Planted later. 3. Put on more nitrogen.	Bought temp transfer water, which ensured we had adequate water and did not have to stretch irrigation intervals.
	Moderate temperature season.	
	Strict Rotations and small detail.	Nothing different.
	Management, low number of days above 36 degrees.	Timing, only had 320 Ha.
	Cooler season. Irrigation scheduling on time. Nutrition spot on.	As above.
	Water, water and plant establishment.	
	Season and attention to detail.	Nutrition monitoring.

Region	Factors & management believed to have contributed to high yield	Management strategies for 2014-15 seasonal conditions
Macintyre - Balonne (cont'd)	Decision to grow the entire operation to an 80 ' row configuration together with intensive management over a small area.	Row configuration.
	Moderate temperatures.	
	Rain, fallow, variable fert rates.	As above.
	On time irrigation, no water logging Not extreme heat at peak flowering	We had plenty of time as we only had 25% of our normal cotton crop in due to low water.
	Perfect growing season.	Nothing really just liaised constantly with our agronomist and irrigation contractor.
	Quality premium +3.25.	Good weather 80% = Good water management 10% = Picked before 4' rain 10% = luck
Northern NSW	Good growing season. Adequate fertiliser. Timely irrigation.	
	Very good season, no heat waves or periods of excessive heat, very few cloudy overcast days. Good water and nutrient management.	
	More stored water.	
	Having enough water.	Water early and often.
	ATTENTION TO DETAIL	ATTENTION TO DETAIL
	Good management by agronomist.	made sure adequate irrigation water available.
	Irrigation timing.	Making sure we had adequate water and the timing was good.
	Weather.	Downsized to smaller diameter pipes.
	Mild summer.	Reduce deficit on water trigger.
	There were no prolonged stress events with extreme heat or prolonged cool overcast weather.	Keep the water up on a 7-8 day cycle.
	Water timing worked well, nutrition was good, and a favourable season. Have water.	
	Variable rainfall in crop.	Yield potential was limited due to very late plant (15th December). Crop then had to be conventional and fortunately insect pressure dropped off when crop started to fruit. The only different strategy was to lower the insect threshold to try to keep retention high because we only effectively had half the growing season.
	Mild season for Walgett, planting into a pulse fallow, and good defoliation conditions and pick.	Pulse fallow, good moisture profile at beginning, maximise early potential through retention.
	Timing of water and nutrition plus it was ideal weather.	good nutrition and timing of water.
	If I had applied 7ML ha would have achieved 12bales/ha but I focus on Bales/ML.	I find that 3 irrigations can give best bales per ML but also run a lateral as well to maintain good Bales Per ML.
	Nice temperatures.	
	Nutrition.	Allowed for a lot of water. Getting everything right & being a very good growing season.
	Water & N balance/ growth control.	No stress.
	Timing was right with irrigations, fertilizer right, cooler after rain in January.	Closely monitor water, nitrogen in water.
	Water. Non vert field.	Watering in short cycles.
	Mild January.	Extra N.
	Ran out of water (1.5 irrigations short) so happy with extended intervals on irrigations.	Spaced out early irrigations.
	Good weather.	Water timing.
	Mild summer, good growing conditions allowed us to make the most of our normal growing practices.	Partially irrigated some fields where water could not be accessed, spaced irrigations out to allow final irrigation.
	Rotations.	Water scheduling.
	Good growing conditions.	
	Good soil preparation, excellent seasonal conditions.	Attention to soil condition & seed bed preparation.
	Where the storm rain fell ie moisture.	1.5 m rows.
	Very good varieties. Crop rotation. Soil testing. Retaining all crop residues over long period.	None.
	Short irrigation intervals, legume rotation.	Strict 60/70mm water deficit.
	Nutrition and water timing. No vert in those fields.	Didn't really know it was going to be high, just targeted normal yield, but watered slightly more frequently.
	Water to the end, season was incredibly kind.	
		Planted later.
	Enough water - just.	
	Warm weather, good irrigation timing, good nutrition.	Split application of nutrition, later planting date (25th October).

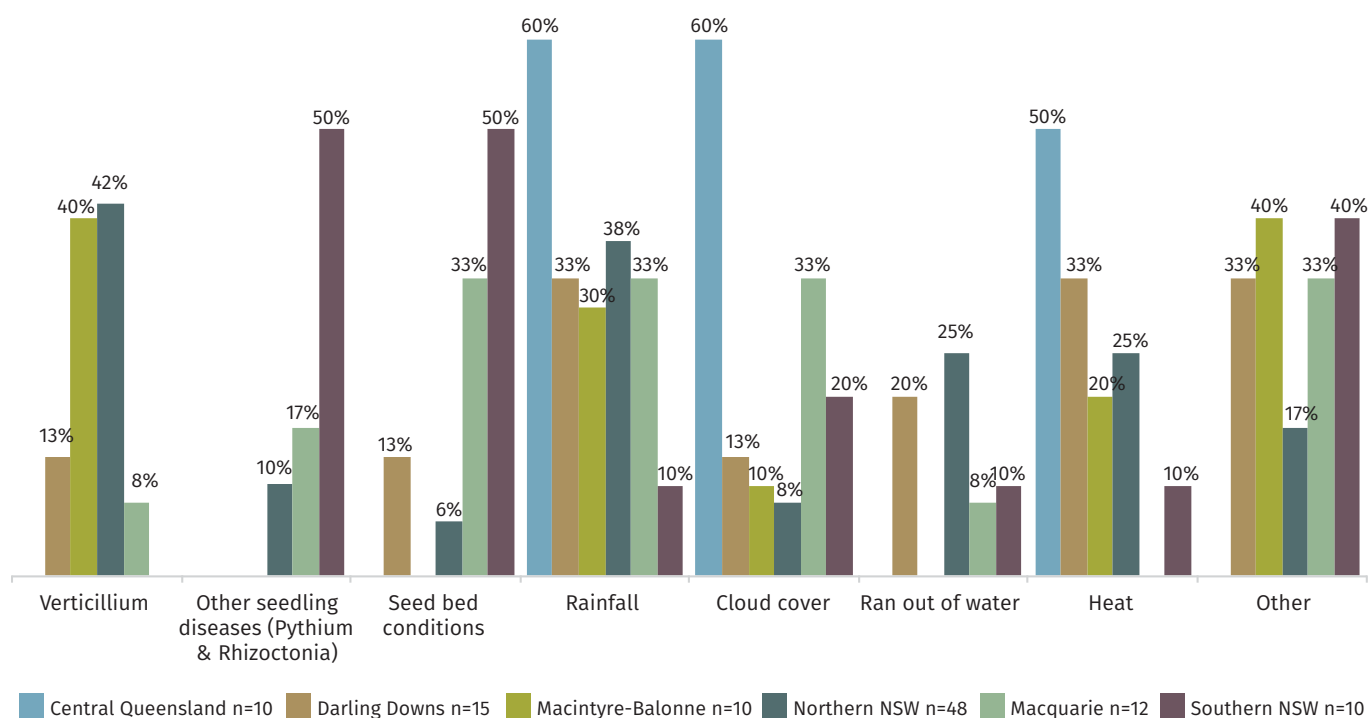
Region	Factors & management believed to have contributed to high yield	Management strategies for 2014-15 seasonal conditions
Northern NSW (cont'd)	Field selection. Easy to irrigate fields. Plant stands. Poor plant stands were punished. Replanting.	Shorter irrigation intervals. More frequent irrigations. Tried to have irrigation prior to predicted hot spells.
	The season.	Water frequently and feed nutrition.
	Favourable weather during December January and February. Improved plant stand irrigation scheduling, improved nutrition and rotation.	Plenty of seed, nitrogen and water.
	I believe the mildly average summer helped to achieve our great results, low number of cloudy days and low number of extreme heat days. Low rainfall also meant low weeds and dry scrub blocks which kept the insect pressure low.	
	Seasonal conditions. Water management. Varieties.	
	Season, management.	
	Well timed rain in season.	We planted later.
	Water management.	Ability to water when needed.
	Water on time. Plenty of N.	Shortened water interval.
	Rainfall / Irrigation timing.	Irrigation timing (early flower). Split nitrogen application (allows for tailoring of N depending on season).
	Nutrition/Variety.	Plant early. Run long.
	Double skip and only grew what we had enough water for.	Shorter irrigation intervals and nitrogen, water management.
	Newer Soil, less Verticillium wilt.	
	Timeliness of irrigation. Rotation.	Rotation.
Macquarie	Crop grown under linear move irrigator with full ground cover from sprayed out wheat cover crop, cotton strip-tilled into field.	See above. Cover crop and strip-till were major contributors to yield.
	Water.	
	Weather.	Early plant date.
	Low number of 40degree days, sunshine.	More frequent watering.
	Long, long fallow on some double skip semi-irrigated cotton. Very beneficial rain on all cotton in December 14 / January 15.	Different bed / row configuration in double skip semi-irrigated.
	Irrigation. Nutrition.	
	Full cover crop coverage. Use of strip tiller. Linear move irrigator. Long season. No sucking pest or wind damage due to cover crop.	Applied more N later than usual to suit crop potential. Kept water up to 10th March.
	Soil Uniformity.	
	Mild conditions. Good timing of pix application to control plant height.	Continuous feeding of fert with water. Pix application. Water timing.
	No temperature extremes. Warm finish. Good plant stand. Water on time.	Water timing crucial. Small water deficits.
Southern NSW	Field Layout - short run lengths to minimise water logging, and minimal humps and hollows. Soil Characteristics - good overall soil health. Fallow - previously fallow. Early Establishment - planted early in the ideal window. Canopy Management - Early growth regulator applied.	Early Establishment - plant early in the window if the soil temperatures and weather outlook are favourable. Soil Health/Characteristics - soil tests, in crop tissue tests, fertiliser management. Rotation - keep rotating fields so we have at least a 50/50 back to back to fallow ratio. Canopy Management - applied early growth regulators if required.
	Good germination and seasonal conditions.	Applied fertiliser and water as required.
	Rotation.	Rotation.
	Crop was not too thick, good layout, no water logging, free draining soil. Lucky.	
	The weather, day degrees was very good, great harvest conditions.	
	Climate - we had no heat stress during flowering.	More nitrogen as crop and season progressed well above average, short water intervals.
	Weather.	Foliar fertilisers and increased N rates to help with huge fruit load. Delayed defoliation to help late fruit make the pick.
	Just a good season.	
	Great soft season.	Increased N from 250kg to 290kg applied per ha.
	Weather. Timing. Management.	
	Early planting.	Irrigation timing for water-up based on temperature forecast.
	Fertiliser use, water timing.	Extra nitrogen.
	Excellent October/November day degrees. Cool January.	Increased some fertiliser rates to specific fields with more potential in season.
	Early crop vigour as established on rain and timely irrigations.	Tight irrigation intervals and additional in crop nitrogen.

Q. What factors do you believe LIMITED yield last season (2014-15)?

Rainfall timing and sunshine contributed to high yields for some farms. On other farms, rainfall, cloud cover and/or heat was believed to have limited yields, particularly in Central Queensland (Figure 7). Seedling diseases were also a concern.

Figure 7

Factors limiting yield in 2014-15, by region



“Other” factors limiting yield were described as:

- Poor plant stand in some paddocks
- Cool finish
- Poorly executed irrigation plan and poor plant stands in dryland and irrigated cotton
- Poor planting seed quality leading to poor emergence
- Water logging
- Excessive rain at picking time
- 40 inch instead of 30 inch row spacing?
- Water embargo - lack of irrigation water
- 40ha was sprayed by plane with 2,4D - it yielded 7.4 b/ha
- Late plant
- Hail
- Hail
- 2 hail storms
- Fertiliser application
- Late planting rain
- Plant stand
- Lack of water
- Irrigator breakdown
- Low plant stands
- Irrigator breakdown
- Pig damage!!!!
- Planting window, seed establishment
- Black root rot
- Sclerotinia
- Water 1500 EC at the end.

Table 3

Changes to cotton management in 2015-16 compared with 2014-15

Note: each row of this table presents one respondents' strategies

Region	Nutrition	Water	System, Planting, Pests, Other
Central Queensland		We will be watering up a lot more of our cotton.	Planter set up will be vital and more checking behind while planting is going on.
		Plant into stubble	
	Adjust fertiliser rates and add a foliar zinc application.		Planted a lot more winter wheat and double cropped cotton back into wheat stubble using zero till strategies
	Rely more on Urea application for N2 and less on Gas WHY? More uniform, across rig, application.		
	Fertiliser rates increased to try and improve yield		
		Flush everything, however this reduces our options in regards to utilising soil moisture	
			Plant more crop early, early trial work has shown a good result
	N	Plant shallower.	Plant earlier
	Used Urea pre-planting as opposed to BigN. Due to ease of application.		shallow planting depth poor vigor Bollgard 3
	Increased our target yields, so therefore increased the Nitrogen application through winter.		Everything has been treated the same only difference is that we have applied pix this season due to the amount of rain we have received
Macintyre - Balonne	All management has been the same except for slightly higher rates of fertiliser on back to back areas.		Due to greater winter crop areas in rotation we have 25% of our crop this year back into last years cotton ground. Every year the management is different due to the available, and variable, day degrees in our area.
		3 irrigation's is fully irrigated on the Central Darling Downs!	
		Aim to Plant earlier next year	
		Use of some pre-emergent herbicides rather than relying totally on Roundup Ready herbicide	
		Why? Feathertop and peach vine escapes	
	Increased the nitrogen levels and based the requirements more on petiole results rather than past history		
		Same as. If it ain't broken don't fix it !	
		Staffing adjustments; increased investment in well-performing staff, terminated employment of non-performing	
	Run N in water at mid bloom/flowering. Applied extra 50 kgs N.		Took more risk than last year so planted more area.
			Pix earlier, smaller plant size for picking, more residual herbicides in fallow to control weeds
			BG3 cotton on limited area.
		Planted 1 week earlier for full water cotton; Planted 70 ha in mid November as more water was available	

Region	Nutrition	Water	System, Planting, Pests, Other
Northern NSW		Later planting date on fully irrigated and earlier planting date on the semi irrigated double skip cotton. Slightly higher planting rates	
	Used Dynamic Lifter		Get onto country more quickly. Late winter crop harvest meant that tractor was being used to drive a chaser bin
			More IPM towards whitefly
			Last season very tough in dryland with a less than ideal moisture profile at plant SO changed from solid 36' config to 30' single skip. This I hope will help in more marginal years in dryland without jeopardizing yield should the season go well AND also suit my irrigation
		Not grown any cotton under overhead irrigation systems. Because in a hot season and the soils we have it on the demand outweighs the ability to supply water.	
			NDVI imagery and variable rate pix
		Minimise water use, due to low rainfall and no unregulated water access	
		Heavy use of skip row cotton, due to water availability	
			Will go back to harvesting with strippers' Last year pickerbalers did a poor job. Way too much tagging
			I don't normally grow dryland cotton
		Different crop monitoring tools such as stem diameter measuring tools.	
		Changed irrigation deficit, irrigating more frequently.	
		Switched mid season from furrow to lateral irrigation because of water shortage from farm dam.	
			I need to maintain better stubble cover prior to planting rain grown.
		Decreased the irrigation deficit. Irrigating slightly more frequently.	
			Control growth better
	Mild January so added more N	Growing rain grown/partially irrigated cotton. Solid plant in a lower plant population Why? Based on experience/knowledge gained from lack of water last season and partially irrigating some fields	
		Planted solid instead of single skip. Fitted size of field ready compared to available water.	
		Reduced area planted to ensure sufficient water available	
		Have done experiments with nano calcium to act as a suntan cream & lower transpiration during heat waves. Reason is to try & lower heat stress & water use	
			Take a punt on dryland cotton - the CSD offer of replacement seed if crop fails along with Monsanto EPR reduce financial risk.
			More early pix
	Increased fertiliser applied to not run out again. Trialled application strategies to improve efficiency.	Planted earlier due to more available water	
		Grown a smaller area due to a smaller amount of water being available.	
		Make sure Dam is full at end of January!	
		Water availability was looking poor as at November 14 post winter crop harvest, the decision was made that the best/cheapest option to manage fallow irrigated fields was leave as standing stubble & only prepare irrigated ha's as water became available. At planting of 15/16 crop 137ha's were planted solid leaving 150ha of irrigated country in stubble with a good profile of moisture & planted double skip post November 15 rain event. January rain event created 200ML surplus in water budget allowing a mid February watering of now 'semi irrigated' crop. Some will get a 2nd irrigation in coming days. This planning process allowed an 'all options open' approach with flexibility to adapt to seasonal conditions, save \$\$\$ on unnecessary ground prep operations & capture the most soil moisture from rain events.	

Region	Nutrition	Water	System, Planting, Pests, Other
Northern NSW			Used more furrow treatments at planting to control seedling pests and diseases. Traditional seed treatments were ineffective and expensive. No replanting required this season.
			We planted into chickpea stubble for the first time – won't do it again!
	Increased in crop applied N proportion to ensure sufficient N to finish the crop.	Planted a smaller area so irrigation timing could be improved. Irrigation timing has massive impact on yield. Watered up 100% of the crop to increase water use efficiency and improve establishment.	Increased the amount of growth regulant applied to lower plant height and increase average boll weight
		Tighter irrigation scheduling to reduce water stress.	
	Applied more fertiliser to target the higher yields achieved last year		
Macquarie	More fertiliser, NPK		
		Won't plant on marginal moisture	
			Plant shallower, lack of vigour.
		Included semi irrigated - attractiveness in lean water years	
		Decreased water deficit for irrigations due to herbicide damage.	Increasing seeding rate: 15 to 17 seeds/m. Because of low vigour 74BRF Try to manage Bollgard III RF cotton for earliness to avoid pupae busting.
Southern NSW	More nitrogen; Poor yields last year		
	Carefully considered nitrogen budget	Pre water some fields that are prone to root disease.	Planting into wheat stubble in irrigated cotton system
			Canopy management - apply growth regulators when required early to maximise fruit development and retention Rotation - with newly developed area which has previously grown rice, grow a winter cereal or maize crop as break crop prior planting cotton
	Applied gypsum and pre watered before planting to achieve better plant stand		Depends on yield from this year. Good prep is key to good establishment.
		Re-lasered some blocks for better water efficiency	Spraying for heliothis to improve first position fruit. Harvest more quickly - bought another picker
			We have done more variable rate pix We will be doing more trialing of fungicides for late season disease management (sclerotinia and alternaria)
			Prepared early. So important to achieve a good start!
	Increased foliage fertiliser program to help stop shedding events		
		Irrigate more when hot	
		Increase flow rate from syphons to reduce irrigation time changes	More early season Pix applications to stop leggy plant growth

Managing limited water

Q. Please describe any other strategies you use for managing for seasonal conditions and limited water in irrigated or raingrown cotton.

Q. For irrigated / partially irrigated cotton this season (2015-16), what strategies have you used for managing limited water?

Both Figure 8 and Table 4 show the very varied strategies towards the use of limited water. Several farms used a mix of strategies to spread risk.

59% of farms planted only the area of irrigated cotton that they had enough allocation to irrigate. Some of these farms had also planted dryland cotton into irrigation land on the potential of later irrigations if water came available. A number of growers planted some cotton to be fully irrigated and a further area to be partially irrigated (some of this in skip row configurations).

Other farms preferred to plant a larger area of cotton, possibly using a skip row configuration to optimise the potential if incrop rainfall occurred. For example one respondent described it:

“Grow a partially irrigated crop and manage it according to the water available. There is more upside if we receive incrop rain and it is possible to grow a higher number of bales than a small area of fully irrigated cotton.”

6% of respondents planted fields that, at the time of planting, had only enough water available for watering up. Some farms planted later, some earlier and some did a bit of both.

It is interesting to note that many irrigated growers also grew raingrown and/or partially irrigated cotton in 2015-16 and 2014-15.

In the 2015-16 season 9.5% of farms recorded a green ha less than the field hectares (ie indicating at least some of the farm was not a solid plant configuration). 6% of respondents indicated they used a single skip under irrigation and 7% used double skip under irrigation (Figure 8). The following describes one grower's strategy:

“Irrigated, especially under sprinklers, if looking at high heat we will go skip row to ensure water capacity. I also prefer skip row under sprinkler for EL Nino forecast years to stretch the tight water budgets, and/or reduce our 100% configuration areas due to increase of water budget.”

Figure 8

Strategies used for managing limited water in irrigated cotton in 2015-16

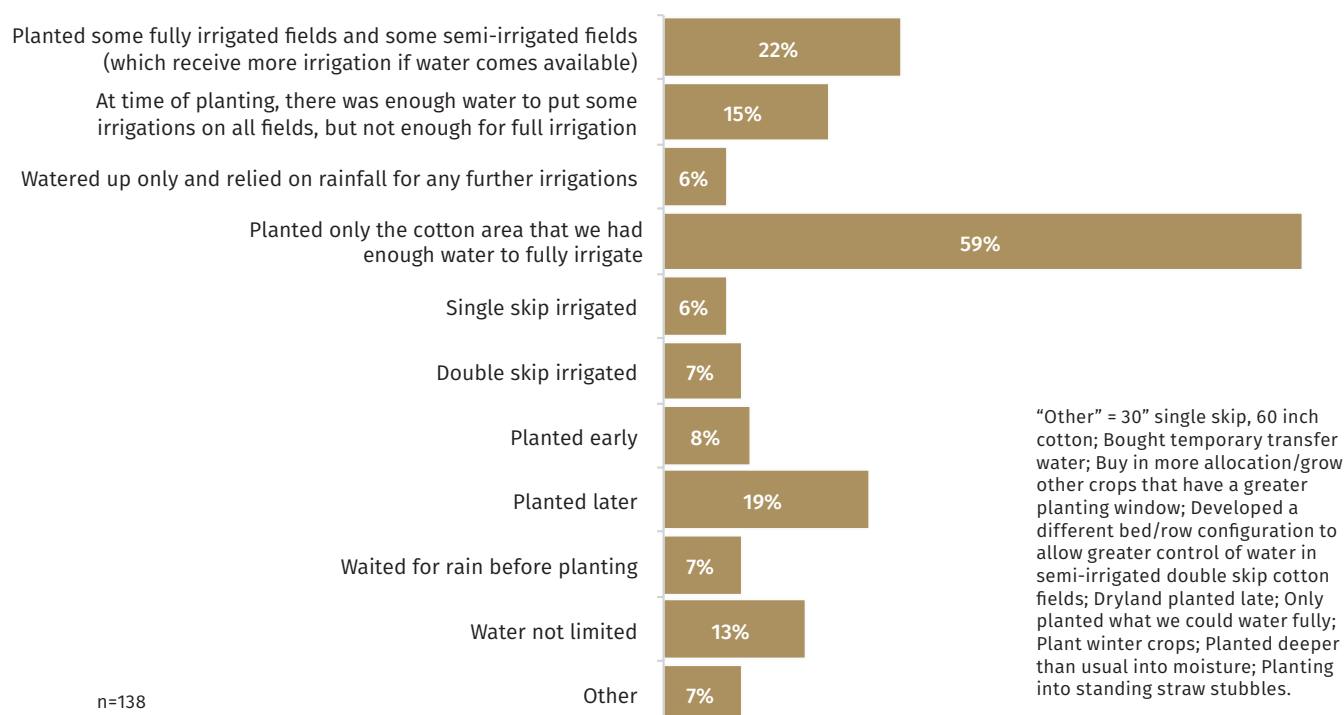


Table 4 displays the wide range of strategies described by respondents for managing seasonal conditions and limited water. Broadly, these strategies included:

- Reduced area, concentrating on better fields or those closer to pumps.
- Planning based on water available in storages and soil, not on seasonal outlook.
- Planting configuration, including skip row in irrigation, double skip raingrown.
- Manage for earliness to reduce water demand.
- Irrigation timing, monitoring and scheduling.
- Stubble cover.
- Grow more winter crop, other crops.
- Nutrition strategies.
- Flexible staffing arrangements.

At the time of the survey, 5% of farms had abandoned some of the cotton area planted due to lack of water, accounting for a total of 1.1% of the total green hectares of cotton (Table 8).

Table 4

Strategies for managing seasonal conditions and limited water in irrigated or raingrown cotton

Note: Each row provides an individual respondents' strategies

Central QLD	Timing of first irrigation
	If available water is reduced to a level below 7 ML/Ha for my total irrigation area:
	1. Reduce area planted to 7 ML/Ha.
	2. Plant fields that are most water efficient.
	3. Don't side dress N2, rely on water run soluble N2.
	4. Use shielded sprayer for inter row weed control.
	Water budgeting
Darling Downs	Reduce area of planted cotton
	For the past few years my approach has been managing for earliness. Get in, get out and limit exposure to weather and peak water demand
	Plant into fallow wheat from previous season rather than back to back cotton
	Sub soil moisture
	Long term fallow management including crop rotations to ensure surface cover during the water accumulation phase of the fallow.
	Irrigated: only plant what can be fully irrigated.
	Dryland: grow double skip rather than single skip
Darling Downs	Time of planting
	Seasonal outlook is VERY secondary to the amount of stored soil moisture and ringtank water we have at the beginning of the season. These factors will almost override the seasonal outlook in the final result. (APSRU & experience). Only thing is in a bad el Nino forecast year, planting later is a definite advantage since the late spring and early summer can be notoriously hard and hot.
	The amount of stored water, whether in profile for dry-land or in storages for irrigated is THE MOST IMPORTANT driver of the above decisions, not forecast seasonal conditions.
	Row spacing
	Electronic moisture probes (Enviroscan)
	Retaining cereal stubble cover for dryland cotton.
	For irrigated cotton, irrigating at the optimum time(s) and getting the water across the paddock as quickly as possible (flood irrigation) by way of storing up bore water in ring tank prior to irrigating.
	Matching stored moisture to row configuration
	Irrigated cotton -we have grown skip row configuration, and also reduced planting rates. Also we have sometimes increased our water deficit, to prolong our timeframe between waterings We always do a water budget after pre-watering in order to only plant area that we can successfully carry through
	Dryland cotton - we always grow double skip, and only plant if we believe stored soil moisture is adequate for a full crop. We may sometimes reduce planting rates.
	In predicted drier seasons we attempt to buy in seasonal water allocation.
	Area planted depends on water in storage for irrigation and water in profile for dryland -and price
	Irrigated - especially under sprinklers - if looking at high heat we will go skip row to ensure water capacity. I also prefer skip row under sprinkler for EL Nino forecast years to stretch the tight water budgets, and/or reduce our 100% configuration areas due to increase of water budget.
	Row configuration
	Try to start season with enough stored moisture to grow 3.5 bales / ha dryland
Darling Downs	We usually only grow the cotton hectares we have water for.
	Plant population
	Primarily based on commodity pricing

Macintyre - Balonne	Consolidate all water in the least amount of dams to reduce evaporation losses
	I have done a lot (7 Years) of on farm research trials into planting additional cotton hectares, leaving it not irrigated or giving it one irrigation, then when the rain or river arrives I restart the cotton. I have achieved some remarkable yield, fertilizer and water use efficiencies.
	A couple of years ago in collaboration with UQ Gatton Neal Menzies we submitted a research proposal to CRDC to better understand the plant physiology, plant hormone and possible epigenetic interplay, however CRDC were not interested. I have documented up to 40% yield increase and yields up to 14.7 bales per hectare under severe water stress conditions.
	Plant area equal to full water complement, but if unseasonally hot/no rain, then buy temporary transfer water or drop fields out.
	Staffing - use backpackers if unexpectedly busy
	Weather outlook play no role in my farming programme at all. We have and have had for a long time no confidence in long range forecasting.
	We have changed our management over recent years to plant cotton only what we have full water for
	Plant to water availability
	Stretch watering intervals. Don't promote excessive vegetative growth & try to hold early fruit set
	Rainman/Stream flow modelling
	Rainfall patterns over a period of wet and dry years in a 50 year range. eg el-nino / la-nina events
	Never grow a greater area than available water in storage. Seasonal outlook may dictate the type of row configurations we plant also.
	Use Rainman / Streamflow modelling pre-season
	Only grow long fallow areas
	Reducing our area so that we definitely had enough water to get through.
	We have not grown cotton during the last 2 years and have used the smaller allocation on cereal and pulse crops
	Grow a partially irrigated crop and manage it according to the water available. There is more upside if we receive incrop rain and it is possible to grow a higher number of bales than a small area of fully irrigated cotton.
Northern NSW	The seasonal outlook doesn't have a very big influence on these decisions. The row configuration, area grown is largely influenced by water availability and soil moisture at the time.
	Wider rows 60'
	Long fallow going in to cotton
	Full soil moisture profile
	Realistic yield target for Fertilizers calculations
	Fields selected
	In dryland ensure full profile or else reduce plant target population. With irrigation ensure water allocation not wasted on previous winter crop....usually wheat
	Moisture probes
	Rainfall outlook strongly effects the pre-crop ground management decisions, how early ground is prepared and then weed management pre-crop to store and maximise moisture.
	Also influences the type of chemicals used during the winter to control weeds to ensure sufficient breakdown of chemical persistence in the soil before the cotton crop
	Use best management practises to manage fallow prior to planting so as not to limit planting opportunities or crop establishment. This starts with the crop beforehand.
	If no water don't grow planting late if the window allows and rain falls
	Assessment of soil moisture profile and stored water in conjunction with current seasonal conditions and forecast conditions
	We keep stubble on our long fallow for as long as possible before planting dryland cotton.
	We won't use residual herbicides on long fallow that could lock us out of cotton.
	After March we won't use phenoxy type herbicides on any country ear marked for cotton.
	Only plant the area of cotton that you have full water available for.
	Backup water security plan. Should stored on farm water become low the farm is now capable of switching mid season from furrow irrigation to bore only lateral move irrigation to get the crop finished reducing grade penalties and increasing yield potential.
	Generally aim to be on the safe side by planting after rain and with increasing temperatures
	Timing of rainfall is critical so options need to kept open if it doesn't rain or it rains late
	Plant only the area that will have full irrigation available to it.
	Reduce the area
	Only grow area that has full water
	We make sure we get irrigation time right, we have monitors and work closely with our agronomist.
	Retaining sub moisture
	Change irrigation timing and strategy if limited water
	Plant fields as close to watering pumps as possible-less ditches being filled with water
	Maintaining our irrigation schedule of 12-14 days to ensure water budgets are realised and encourage the crop to develop a root system capable of utilising more of the available moisture profile
	Utilise 60' (1.5m) row configuration as a system fit in our complete irrigated & dryland farming system, with 3 metre controlled traffic & 3 metre wide beds. We utilise some fallow fields as temporary surge areas to capture heavy storm rains. Two cell on farm storage to minimise evaporation. We haven't grown dryland cotton before but will in the future. Our aim is to maximise production & minimise application of irrigation water. In the future we hope to be in a position to irrigate crops when we have available water or otherwise grow out as dryland, both winter & summer crops
	Stress crop when not fruited
	Water allocation / ground water

Northern NSW	Aim to maintain full ground cover & capture as much fallow moisture as possible
	Grow more winter crop
	100% bore water, only grow what I have water for
	Stubble cover very important
	Pix
	Flexibility with planting dates to make use of rain events. Delaying planting date if limited water is available
	All available water / 8ml/ha = ha's solid irrigated up to 250ha (half of our farms irrigated ha)
	Remainder of what should have been irrigated cotton in the rotation planted to dryland & opportunity irrigated if water becomes available in the water budget.
	Grow other crops
	Low water availability - single skip irrigation used
	Dryland - always single skip - like an insurance policy for QUALITY
	Keep plant population down a bit
	Praying and going to church
	Double skip for limited water & dryland
	Double skip for raingrown and limited water
	Less area , delaying first irrigation, skip rows
	Skip row,
	Plant population may be altered if positive outlook. (dryland only)
	Don't plant raingrown unless I have a full profile.
	Single double and super single rows
Macquarie	If necessary - prolonging the next watering
	Dictated mainly by the allocation amount and farm storage
	Semi irrigated
	Try and long fallow coming into cotton crop and try and build profile up before planting, sometimes removing need to water up for establishment
	Making the most of any irrigation scheduling technology advancements, making sure bed prep is done early and on time, being able to capture and use any run off water
	We grow some semi-irrigated double skip cotton to maximise in-crop rainfall infiltration
	Row Spacing, planting rates
	Restrict area to 8 ML/ha to ensure break even or better result
	Use linear move irrigators instead of surface irrigation
	Use long fallowed fields with good soil structure
	Various irrigation methods and strategies - 60', SDI , management zones for irrigation efficiency
	Area based on allocation; % left fallow ; more allocation spray out winter cereals
	Allocation of water
	100% irrigated area. Limited water like to get cotton up on rain moisture is best.
	Planting cotton before rain change coming
	Getting hills up early to maximise moisture in hill
	More inclined to moisture plant.
Southern NSW	Being located in the southern growing region, and considering the past poorer results (yield and quality) from later planted crops - we have aimed to tighten our planting/water up window to ensure we get good early establishment - to ensure we achieve an increased flowering period. To achieve this, we have moved to a 12 row planting configuration and moved to 1 metre rows from the previous 36' bed configuration. This strategy not only has dramatically increased our field operations efficiency, but it has also decreased our harvesting time by 10% due to the 90cm to 100cm row spacing configuration change. This will decrease our harvest by 2-3 days. The tighter harvesting period also hedges us from any potential weather damage (fibre quality) and yield loss.
	Reduced hectares
	Buy water if it is not too expensive.
	Good irrigation scheduling and water management
	we only plant what we have full water for, no punting on rain
	Early preparation and sowing as soon as the window opens.
	In limited water years to maximise cotton grown under lateral and backless channel systems as they use significantly less water for good yield returns. During the season we will add foliage fertilisers if needed but all other urea and map requirements are mostly the same every year.
	Irrigated Crop only
	A. Early prep
	B. Split N Fert - 100N + 150N
	C. Early Pre-water and sow + quick flush (saves water).
	Irrigation timing in relation to forecast temperatures
	Use more bore water
	We either have water in storage for crops or we don't, not much we can do otherwise. if no water then no crop.

Seasonal outlook and decision making

Q. Achieving optimal cotton yields is a combination of genetics, environment and management. We are interested in knowing more about the management decisions you made to manage cotton with the conditions of different seasons such as this season (2015-16) and last season (2014-15) or in earlier years.

Comments in Table 4 show that stored soil moisture and/or water in storages are more influential than the seasonal outlook for many respondents, particularly in planting decisions. For example, these two comments from growers from the Darling Downs:

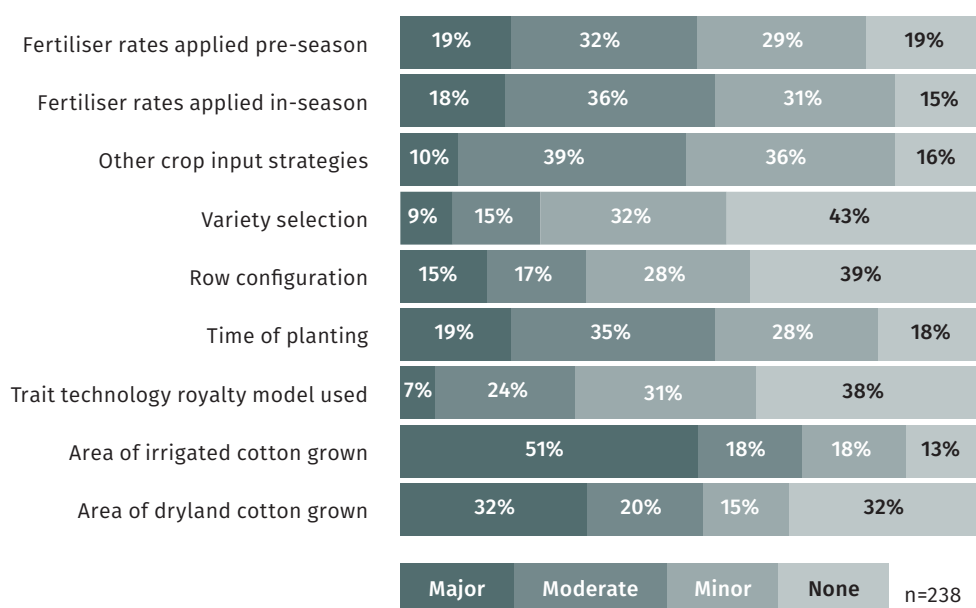
“The amount of stored water, whether in profile for dry-land or in storages for irrigated is THE MOST IMPORTANT driver of the above decisions, not forecast seasonal conditions.”

“Seasonal outlook is VERY secondary to the amount of stored soil moisture and ringtank water we have at the beginning of the season. These factors will almost override the seasonal outlook in the final result. (APSRU & experience). Only thing is in a bad el Nino forecast year, planting later is a definite advantage since the late spring and early summer can be notoriously hard and hot.”

Approximately half of the respondents indicated that seasonal outlook had a major or moderate impact on fertiliser rate and time of planting decisions (Figure 9). Note that these figures have been adjusted to remove those who indicated ‘not applicable’.

Figure 9

Impact of seasonal outlook on cotton farming decisions



Management of high yielding cotton

Seven respondents recorded a highest yielding field of 16.5 bales/ha or above on irrigated cotton in the 2014-15 season. Most of these farms have used the strategy in 2015-16 to only plant the cotton area they had enough water to fully irrigate whilst the other has used this strategy on some fields and then also planted some fields that will require additional water.

Table 5

Strategies of growers with fields yielding 16.5 bales/ha or above

	Darling Downs	Macintyre	Balonne	Lower Namoi	Lower Namoi	Southern NSW	Southern NSW
Yield (Bales/ha) - Best field	16.6	17	17	18	17	16.5	16.5
- Farm Average (irrigated)	16.6	12.3	15	17.8	14	16	12.1
Target Yield	16	12.3	13	12	15	15	12
Cotton area - Field ha	90	4000	155	99	324	350	1300
- Green ha	90	4300	155	66	324	350	1300
Irrigation ML/ha		7	7.9	6.35	8	16	10
Contributors to high yield	Water, sun, nutrient		Season and attention to detail	Good soil preparation Excellent seasonal conditions	Nutrition Variety	Weather	Fertiliser use, water timing
Management for high yield potential	Kept the crop going	Area planted depends on water in storage for irrigation and water in profile for dryland -and price	Nutrition monitoring	Attention to soil condition & seed bed preparation	Plant early. Run long.	Foliar fertilisers and increased N rates to help with huge fruit load. Delayed defoliation to help late fruit make the pick	Extra nitrogen
Changes to 2015-16 planting strategy				Reduced area planted to ensure sufficient water available	Won't plant on marginal moisture	Increased foliage fertiliser program to help stop shedding events	

2014-15 Season Results

The yields and quality discounts of cotton grown in 2014 are shown in Table 6 and on the next page. The graphs show the average whole farm yield by region, the average of the highest yielding fields on each farm and the average quality discounts. The error bars depict the highest and lowest values in each region.

Yields

Some exceptionally high yields were achieved (18 bales/ha). However, yields were highly variable as can be seen in the range of yields displayed in Table 6.

Table 6

Cotton yields, quality and irrigation use in each region, 2014-15

	WHOLE FARM YIELD			HIGHEST YIELDING FIELD	QUALITY DISCOUNTS RECEIVED \$/BALE			IRRIGATION VOLUME	IRRIGATION EFFICIENCY
	AVERAGE	BALES/HA	RANGE		AVERAGE	MAX	% FARMS	ML/HA	BALES/ML
IRRIGATED									
All regions	12.4	2.0	17.8	18.0	13	80	59%	8.1	1.7
Central Qld	10.5	9.3	11.7	14.5	8	60	44%	7.8	1.4
Darling Downs	11.3	4.0	16.6	16.6	15	50	62%	5.1	2.5
Macintyre - Balonne	12.4	5.0	15.1	17.0	13	60	61%	8.5	1.6
Northern NSW	12.6	2.0	17.8	18.0	17	80	68%	7.9	1.7
Macquarie	14.0	11.7	15.9	16.1	6	20	43%	8.4	1.7
Southern NSW	12.5	10.5	16.0	16.6	6	50	50%	10.1	1.2
PARTIALLY IRRIGATED									
All regions	8.0	3.0	14.8	14.8	26	162	58%	3.4	3.0
Central Qld	10.5	10.5	10.5	12.1	0	0	0%		
Darling Downs	9.7	4.0	13.2	14.0	31	162	71%	2.7	4.0
Northern NSW	7.2	3.0	14.8	14.8	12	70	44%	4.0	2.3
Macquarie	4.6	4.2	5.0	5.0	65	80	100%	1.6	2.6
RAINGROWN									
All regions	3.1	1.0	6.0	7.0	19	60	64%		
Central Qld	2.5	2.5	2.5	3.0	5	5	100%		
Darling Downs	4.3	2.0	6.0	7.0	26	60	67%		
Macintyre - Balonne	5.1	5.1	5.1	5.6	3	3	100%		
Northern NSW	2.7	1.0	4.0	5.5	20	55	62%		
Macquarie	1.0	1.0	1.0	1.0	0	0	0%		

Figure 10 Yields and quality of irrigated cotton 2014-15

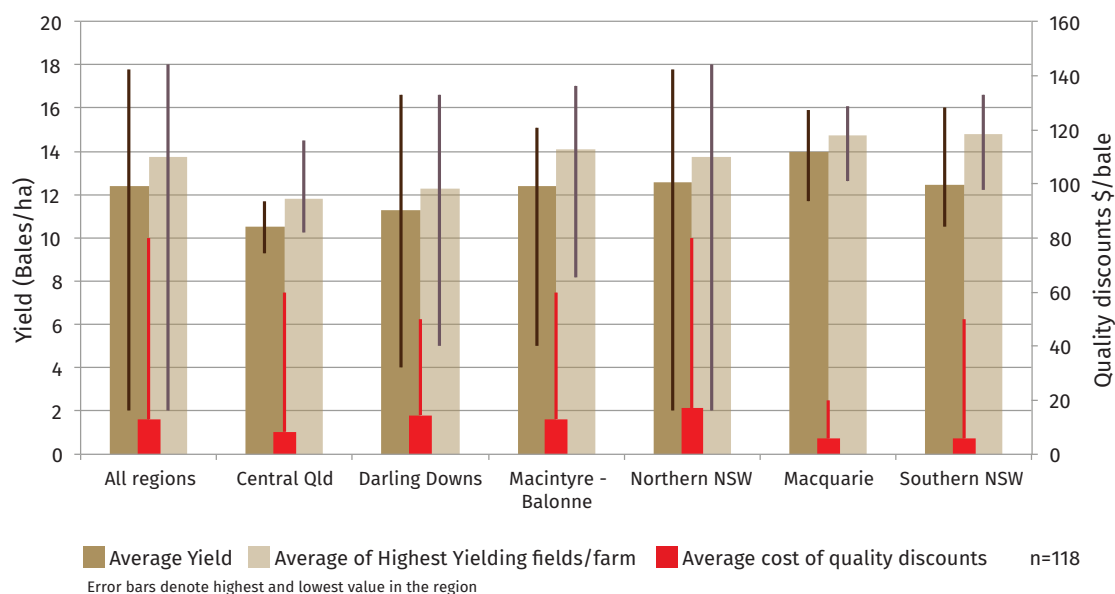


Figure 11 Yields and quality of partially irrigated cotton (up to 3 irrigations) 2014-15

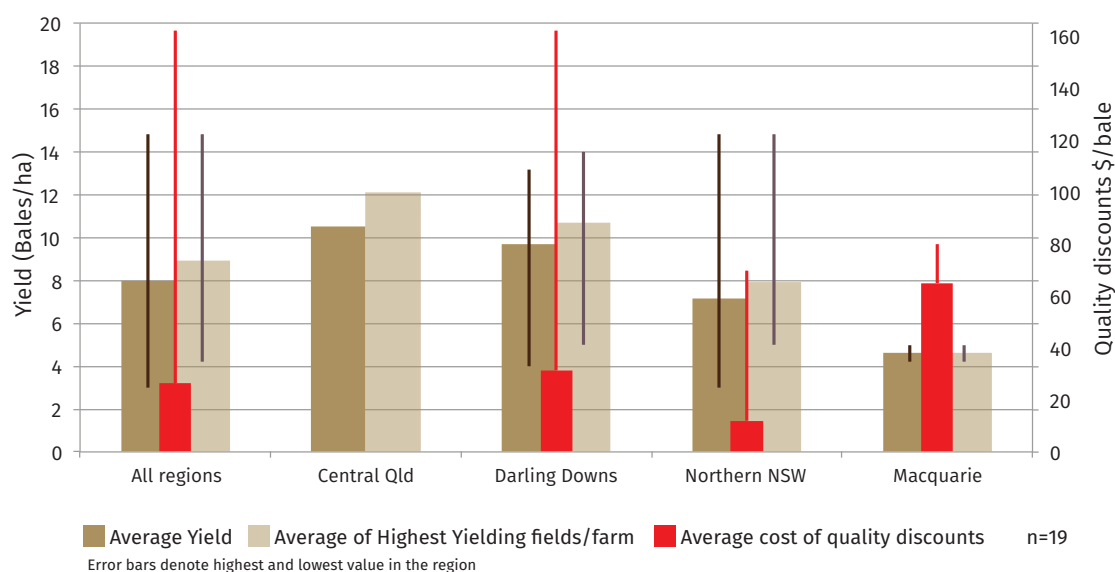
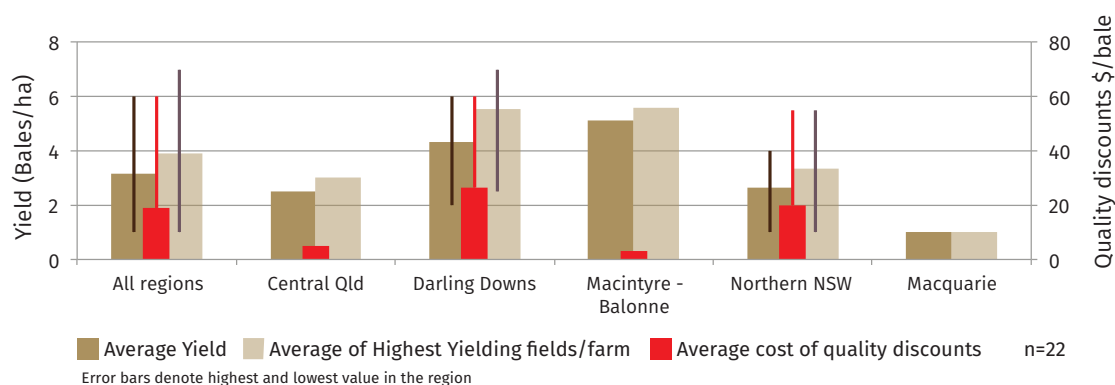


Figure 12 Yields and quality of raingrown cotton 2014-15



Quality

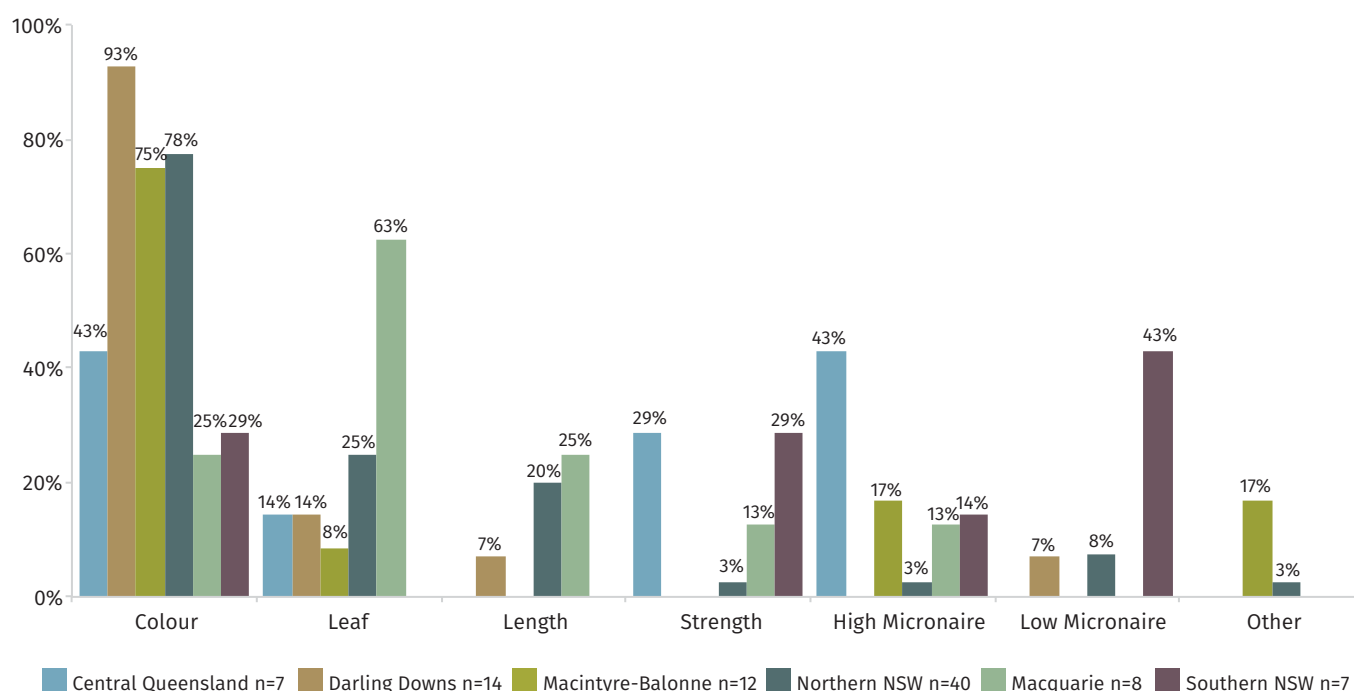
Q. Which quality discounts (if any) were the most costly for you last season?

Discounts for quality on 2014-15 cotton were recorded for 59% of irrigated cotton crops, 58% of partially irrigated crops and 64% of raingrown crops (Table 6). On average these discounts were \$13/bale on irrigated, \$26/bale on partially irrigated and \$19/bale on raingrown cotton.

Discounts for colour were seen across all regions in 2014-15, particularly widespread in northern NSW and southern Queensland (Figure 13). No respondents reported costly discounts for sticky cotton.

Figure 13

Quality discounts on 2014-15 cotton by region



Irrigation efficiency

Irrigation efficiencies were generally high, though varied. Fully irrigated cotton reported an average 8.4 ML/ha (Table 6). This ranged from 2.7 ML/ha to 16 ML/ha recorded from individual farms. On partially irrigated cotton an average of 3.4 ML/ha and a range of 1.2 to 10 ML/ha was recorded.

Average irrigation efficiency, approximated from the Bales/ha and ML/ha figures provided, was on average 1.7 Bales/ML on irrigated and 3.0 Bales/ML on partially irrigated cotton.

Costs of production

Average costs of production, excluding interest, reported by respondents are provided in Table 7. Costs are highly variable, ranging from \$200 /ha to \$1,900/ha in raingrown cotton, \$900 to \$2,700/ha in partially irrigated and \$500 to \$5,700 / ha in irrigated cotton. The farm reporting \$200/ha costs had noted that they had grown conventional cotton to suit the seasonal conditions (therefore no technology trait licence fees).

The variation in costs does not appear to be aligned with target yield (Figure 14). Much of this variability is likely due to differences in which costs respondents have attributed to the cotton crop, the allocation of costs such as machinery and labour and the estimates made.

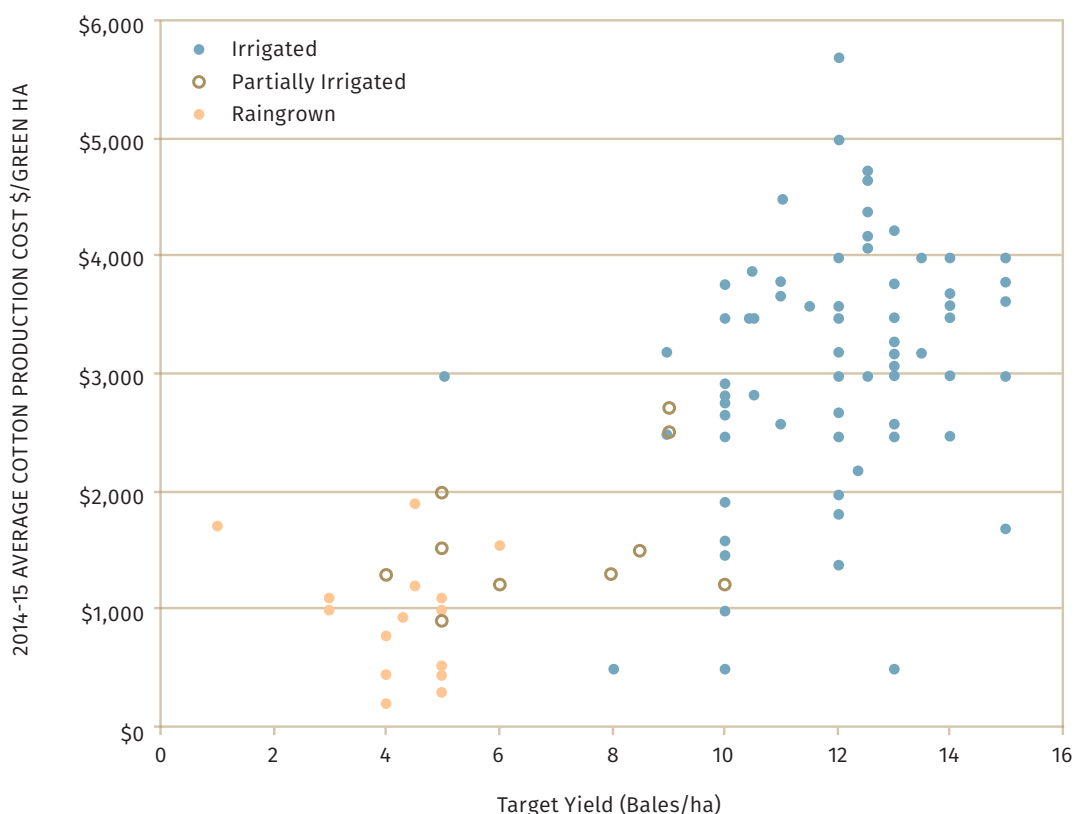
Table 7

Average costs of production by region

	Cotton production cost per green hectare (\$/ha)		
	Irrigated	Partially Irrigated	Raingrown
All Regions	\$ 3,123.53	\$ 1,656.36	\$ 948.18
Central Queensland	\$ 2,065.00	-	-
Darling Downs	\$ 2,586.00	\$ 1,968.00	\$ 850.00
Macintyre-Balonne	\$ 3,110.00	-	\$ 915.00
Northern NSW	\$ 3,103.28	\$ 1,275.00	\$ 918.55
Macquarie	\$ 3,432.14	\$ 1,640.00	\$ 1,700.00
Southern NSW	\$ 3,583.33	-	-

Figure 14

Average cotton production cost vs target yield 2014-15



Replant and Abandoned Cotton 2015-16

The 2015-16 season saw 11% of the total green hectares of cotton reported as either replanted or abandoned at the time of survey responses (February-April 2016). 34% of respondent farms were affected with individual farms reporting from 4 ha up to 1,500 ha of replant. Table 8 shows that poor plant stand was the main issue, with 18% of farms replanting cotton due to poor plant stand, most prevalent in Central Queensland and the Darling Downs. Hail storms, lack of water and herbicide drift also impacted cotton. These issues are described in Table 9. Comments also note some areas affected but grown through.

Table 8

Replanted and abandoned cotton 2015-16, by region

		Herbicide Drift		Poor plant stand		Lack of water		Hail		Other	
		REPLANTED	ABANDONED	REPLANTED	ABANDONED	REPLANTED	ABANDONED	REPLANTED	ABANDONED	REPLANTED	ABANDONED
Central Queensland	Total ha reported	0	0	1857	0	0	0	0	0	0	15
	% of green ha planted	0%	0%	16.6%	0%	0%	0%	0%	0%	0%	0.1%
	% farms affected	0%	0%	64%	0%	0%	0%	0%	0%	0%	9%
Darling Downs	Total ha reported	23	53	701.5	168	0	0	51	742	0	0
	% of green ha planted	0.2%	0.5%	7.1%	1.7%	0%	0%	0.5%	7.5%	0%	0%
	% farms affected	3%	7%	30%	10%	0%	0%	3%	17%	0%	0%
Macintyre-Balonne	Total ha reported	0	0	515	0	0	131	1000	189	0	0
	% of green ha planted	0%	0%	3.5%	0%	0%	0.9%	6.8%	1.3%	0%	0%
	% farms affected	0%	0%	9%	0%	0%	5%	14%	9%	0%	0%
Northern NSW	Total ha reported	0	115	1638	310	0	440	0	0	10	5
	% of green ha planted	0%	0.5%	6.7%	1.3%	0%	1.8%	0%	0%	0.04%	0.02%
	% farms affected	0%	3%	10%	9%	0%	6%	0%	0%	1%	1%
Macquarie	Total ha reported	0	0	0	0	0	245	0	0	200	0
	% of green ha planted	0%	0%	0%	0%	0%	3.8%	0%	0%	3.1%	0%
	% farms affected	0%	0%	0%	0%	0%	18%	0%	0%	6%	0%
Southern NSW	Total ha reported	0	0	36	0	0	0	0	0	0	0
	% of green ha planted	0%	0%	0.4%	0%	0%	0%	0%	0%	0%	0%
	% farms affected	0%	0%	27%	0%	0%	0%	0%	0%	0%	0%
ALL REGIONS	Total ha reported	23	168	4747.5	478	0	816	1051	931	210	20
	% of green ha planted	0%	0.2%	6.3%	0.6%	0%	1.1%	1.4%	1.2%	0.3%	0%
	% farms affected	1%	2%	18%	6%	0%	5%	2%	4%	1%	1%

Table 9 Reasons for replanting or abandoning 2015-16 cotton

Central Queensland	Plant stand	Planting into moisture. Your timing when planting and planter set up is vital
	Plant stand	Hot weather moisture problems
	Plant stand	Variety Vigour, Bed preparation, Planting into inadequate moisture
	Plant stand	Rainfall after planting
	Plant stand	Was planted into good pre watered moisture, at the CSD recommendations for depth etc. and the germplasm lacked the energy/vigour to produce a viable emergence.
	Plant stand	Poor vigour
	Plant stand	Poor seedling vigour
	Other	Water running off soil. Soil getting hard on top
Darling Downs	Plant stand	Poor plant stand
	Plant stand	Dry and planted too deep!
	Plant stand	Low vigour Bollgard 3 seed
	Plant stand	Heavy rain after planting
	Plant stand	poor vigour Bollgard 3
	Plant stand	Cold
	Hail Plant stand	hail 23 Dec, Replanted with Maize
	Hail	Totally destroyed
	Hail	A severe hail storm on the 23rd Dec damaged the crop and it was too late to replant with cotton
	Hail	Too late to replant
	Herbicide damage	Sprayed 'Diuron' post plant pre-emergent After emergence a thunderstorm dropped 15mm and washed the diuron into the seed trench The roots picked up the diuron and wiped out most of the plant stand
	Other	Poor strike following heavy unexpected rain post planting
Macintyre-Balonne	Plant stand	Seed vigour is poor
	Lack of water	I have plenty of allocation but Beardmore dam doesn't hold enough water. So abandon 131 Ha (missed 2 irrigations), but rain and river run so restart abandoned cotton target still 12.5 bales/Ha
	Hail	Hail storm 25 December assessed as total right-off.
	Hail	Hail
	Hail	Massive hailstorm wipeout at 2-4 leaf, replanted afterwards
Northern NSW	Plant stand	Not enough moisture
	Plant stand	Lack of moisture
	Plant stand	Difficult soil variation across paddock
	Plant stand	Poor establishment due to smaller seed varieties
	Plant stand	Rain at planting caused crusting and poor establishment
	Plant stand	Poor water up
	Plant stand	Moisture loss
	Plant stand	Poor germination, lack of vigour.
	Plant stand	Dry soil at planting
	Lack of water; Herbicide; Plant stand	Very low rainfall amounts in the season. e.g. 10mm instead of 25mm Summer storms means lots of fallows need to be sprayed.
	Herbicide damage, Plant stand	Sand blasting and herbicide drift
	Lack of water	A marginal rainfall event led to uneven germination and high seedling mortality
	Lack of water	Ran out of water during watering up
	Lack of water	Poor rain event resulted in uneven plant stand so decision to conserve the moisture for a winter crop was made
	Herbicide	Had 100% drift affected cotton but did not replant or abandon crop
	Herbicide	I have had moderately severe 24D damage in my cotton and there still may be a chance it gets removed
	Other	Water logging
	Other	Sand blasting
Macquarie	Lack of water	Didn't rain enough
	Herbicide	None abandoned or replanted but herbicide damage across every field
	Lack of water	No water got up on rain
	Other	Root disease at emergence
	Plant stand	Poor plant stand
Southern NSW	Plant stand	Poor plantstand
	Plant stand	Poor recycling system
	Plant stand	Rain after an irrigation, before emergence.
	Plant stand	waterlogged

Mining exploration wells

There have been some concerns raised about possible leakage from old mining exploration wells, particularly those that are 30+ years old and may not have been adequately sealed. CRDC has invested in research by Dr Bryce Kelly, UNSW to investigate this. To help focus locations for this research Cotton Australia requested that the survey gather some information from growers about the presence of mining exploration wells on their farms.

Q. Research led by Dr Bryce Kelly, UNSW for the cotton industry is seeking to understand potential connectivity between groundwater systems and mining exploration drilling wells (coal, coal seam gas, petroleum, etc). It would help this research if you can advise of any current or abandoned mining exploration wells in your area, including any that are several decades old.

As far as you are aware, has there been any drilling for mining exploration on or near your property at any time? If yes:

- *How many exploration drilling wells do you know to exist: On your property? On public land adjacent to your property?*
- *Are you willing to have your contact details provided to cotton groundwater researcher Dr Bryce Kelly, UNSW?*
- *Any other comments or information about exploration drilling wells in your area?*

Drilling for mining exploration had occurred on or near 27% of respondents' properties. 66% reported there had been no drilling and 7% were unsure.

Table 10 describes the number of properties in each region and also the number of wells identified, where respondents were able to give a count of the number of wells. Of the 48 respondents who had had exploration drilling on their properties, two thirds were willing to have their contacts passed on to groundwater researcher Dr Bryce Kelly to further investigate.

Table 10

Number of farms with mining exploration drilling and number of wells

	Number of farms & % of farms in region		Number of wells identified ^	
			ON FARM	PUBLIC LAND
All Regions	48	(27%)	134*	103
Central Queensland	5	(46%)	8	6
Darling Downs	17	(50%)	96*	72
Border Rivers	2	(13%)	0	3
St George / Dirranbandi	0		0	0
Gwydir	2	(11%)	0	2
Lower Namoi	3	(8%)	1	0
Upper Namoi	12	(70%)	3	17
Macquarie	4	(17%)	18	3
Southern NSW	3	(20%)	8	0

^ NB total is likely larger as some respondents indicated 'many'

* Includes 81 CSG wells on one farm (not exploration)

Table 11

Region	Comments
Central Queensland	No groundwater - so no impact to it from drilling The drill holes referred to at Q27 were core sampled while drilling, electronically read, then sealed with cement. I don't know of any open drilling wells.
Darling Downs	Drilling nearby but not adjacent to our farm. Coal mine 15 km west of our property exploration drilling took place 25 to 40 years ago not sure how many are causing a problem. Plugging exploration holes properly is a concern - preventing inter aquifer transfers Adjacent to CSG Developments It is on the horizon but so far we (the local farming community) have managed to keep them at bay. Arrow Energy have recently carried out Seismic testing of the Tipton fault line in our immediate area. CSG wells-not exploration Total number includes grazing support land adjacent to cropping country Have already worked with Bryce We think we can work along with these companies
Gwydir	Well for gas drilled 15km east
Lower Namoi	CSG exploration well on neighbours' farm, think it may have been capped & rehabilitated though.
Upper Namoi	As they are only EXPLORATION wells and of short duration then fully plugged on completion any issues are negligible. The drilling technology (if undertaken correctly) used is of the highest standard. Any connectivity created is sealed by the concrete plug. This may not be the case for production wells however. In addition if we do not use exploration wells how do we know if there are any issues or not. Also, EVERYTHING in life has a degree of risk including life itself...the risk in this case is a very minor one. Our neighbour is Shenhua Watermark, they have drilled many holes however we do not know how many in total 2 drilling wells on private property, one roughly 10kms to east & one roughly 10kms to west. Seismic testing along the stock route adjoining us. Exploration leads to mining, cotton industry response to threats from extractive industries has been lacklustre to say the least. We are in the BHP Billiton EL @ Caroona. Most Farmers fought hard to stop them gaining access for Exploration. Many wells on public land adjacent to property
Macquarie	Drilling for gold on neighbouring property in past 5 years Very little around our area Gold exploration
Southern NSW	The test hole is now used for watering stock

Cotton Research

The survey gathered information about growers' perceptions and understanding of the Cotton Research and Development Corporation and priorities for research.

Q. Are you aware of the Cotton Research and Development Corporation (CRDC)?

Q. How well would you say you understand what the Cotton Research and Development Corporation (CRDC) does?

The survey found:

- » 99.6% of respondents are aware of CRDC;
- » 70% understand fairly well or very well what CRDC does (Figure 15).
- » Understanding of CRDC is strongest in Central Queensland and the Macquarie and lowest on the Darling Downs and in Southern NSW (Figure 16).

Figure 15

Level of understanding of what CRDC does

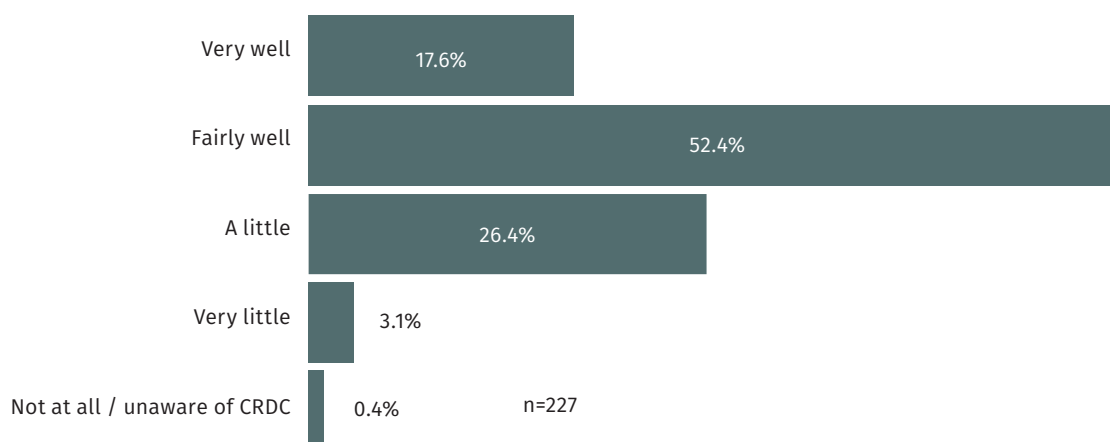
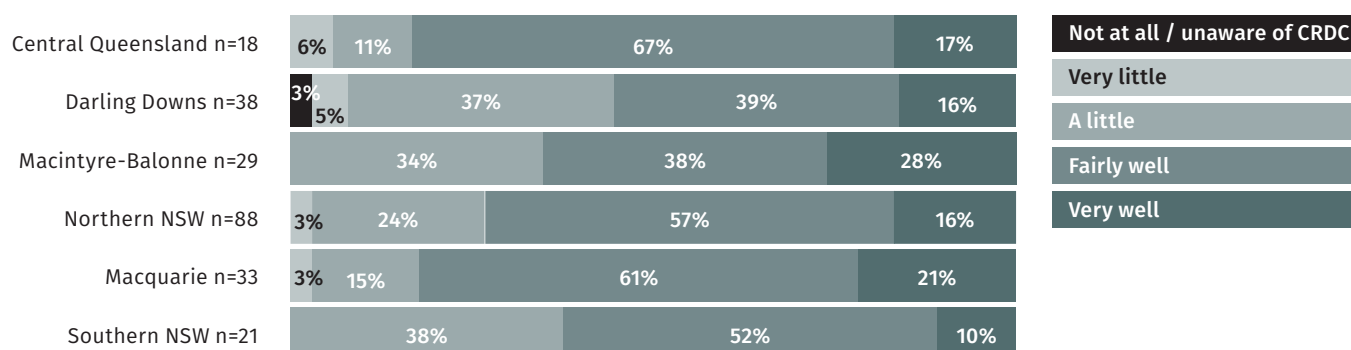


Figure 16

Understanding of what CRDC does, by region

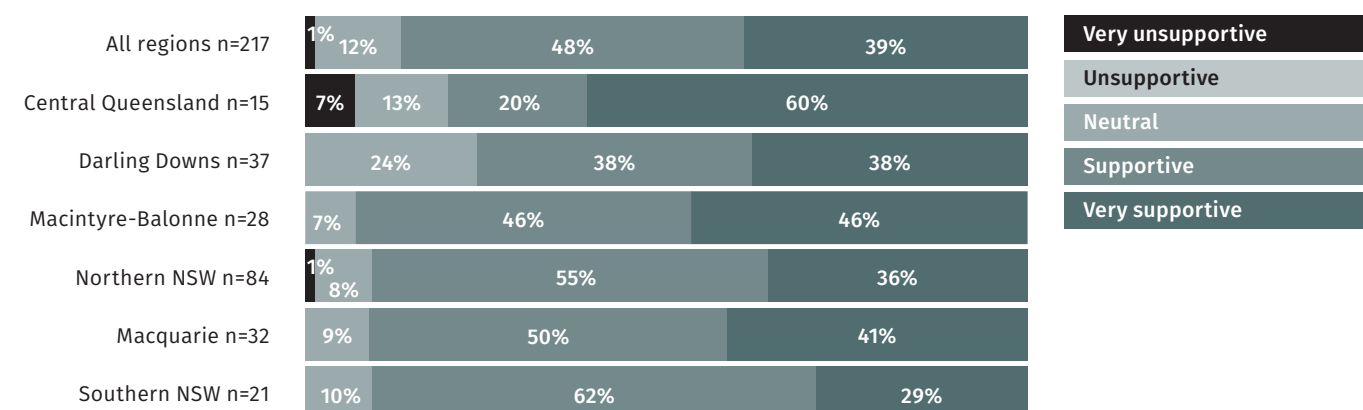


Q. Overall, how supportive are you of CRDC's research investments and activities?

88% of respondents indicated that overall they are supportive of CRDC's research and investments (Figure 17). 1% (1 respondent in Central Queensland and another in Northern NSW) indicated they were very unsupportive. 12% gave a neutral response.

Figure 17

Level of overall support for CRDC research investment and activities



Q. How would you rate the Cotton Research and Development Corporation (CRDC)'s performance in...

The majority of cotton growers responding to the survey were reasonably satisfied with CRDC's performance. Table 12 provides the net positive rating for each area as the total proportion of respondents who gave a 'Good' or 'Excellent' rating.

Table 12

Net positive rating of CRDC performance

	Good + Excellent ratings
Investing in cotton R&D	83%
Providing useful, credible information	77%
Listening to growers about R&D needs and priorities	59%
Communicating with growers about R&D investments	52%
Working collaboratively within the cotton industry	77%
Working collaboratively with other agricultural industries	43%
Driving continuous improvement in the industry	75%

Respondents generally felt that CRDC was doing a good job in investing in cotton R&D and in providing useful, credible information and in driving continuous performance in the industry (Figure 18). 19-23% felt they were doing an excellent job in these areas. Respondents were generally less positive in their ratings of CRDC's performance in communicating with growers about R&D investments and in listening to growers about R&D needs and priorities (Figure 19) with 10% or less giving an 'excellent' rating and a poor or very poor rating given by 15% (for communicating) and 9% (for listening).

When it came to how CRDC works collaboratively with others (Figure 20), the majority felt CRDC were doing a good job in working within the cotton industry. However, 5% felt CRDC performed poorly or very poorly in this regard. When considering how CRDC works collaboratively with other industries, the response overall was less positive, with 22% indicating that they didn't know.

Figure 18

Perceptions of CRDC's performance in investing RD&E

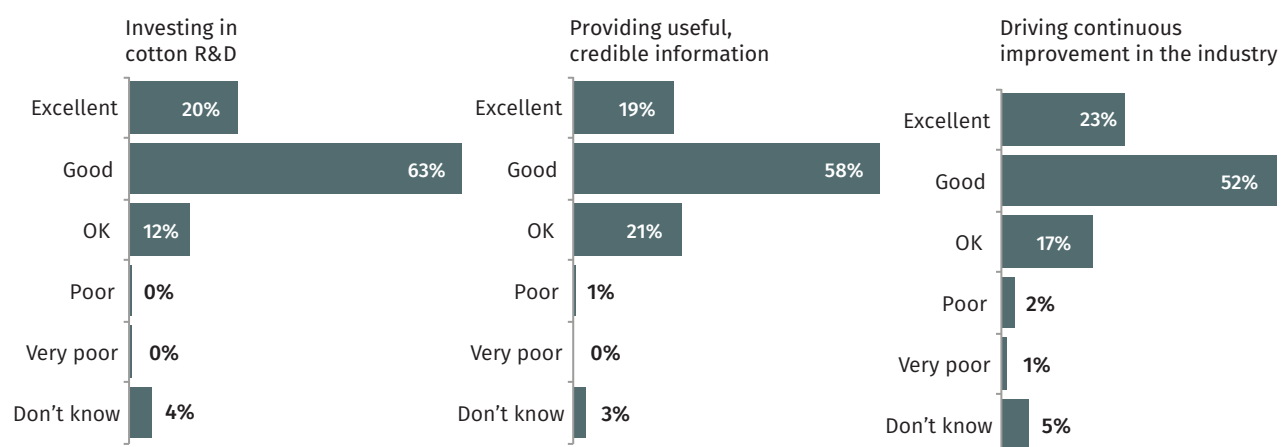


Figure 19

Perceptions of CRDC's performance in communicating with growers and listening about R&D

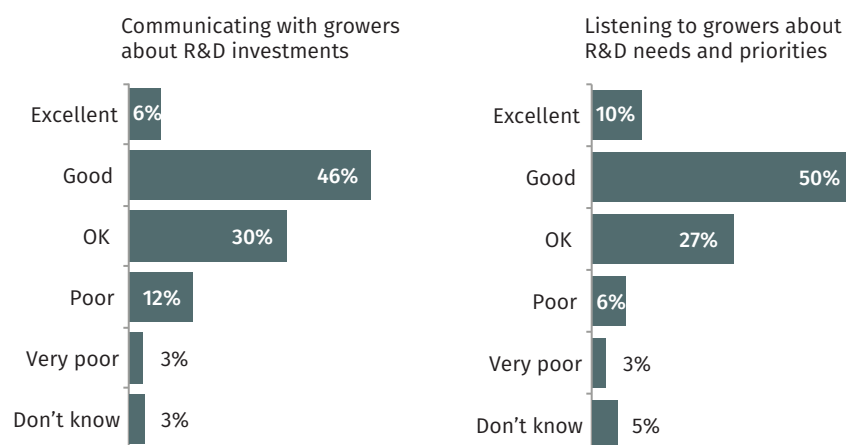
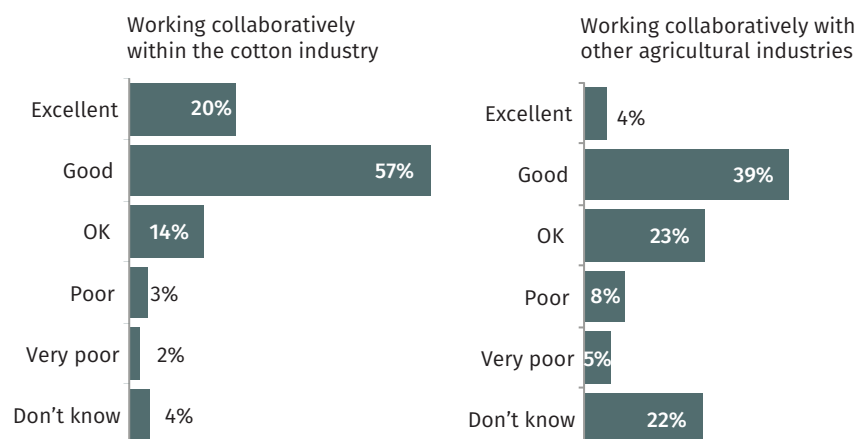


Figure 20

Perceptions of CRDC's performance in working collaboratively



Research priorities and grower input to CRDC

Q. In addition to this survey, how do you have input into the Cotton Research and Development Corporation (CRDC) about cotton research, if at all?

74% of respondents have input to CRDC about cotton research and 95% know how they can have this input.

Cotton Growers Associations (CGAs) were the most common avenue used to have input into CRDC about research (Figure 21). Every respondent in Central Queensland and 92% in Northern NSW indicated they had input through CGAs (Figure 23).

Of the 26% (57 respondents) who indicated they do not have input to CRDC, the most common reasons were a lack of time or being happy with what is being done. 19% of these (5% of all respondents) indicated they didn't know how to have input.

Figure 21

Ways of having input to CRDC about research

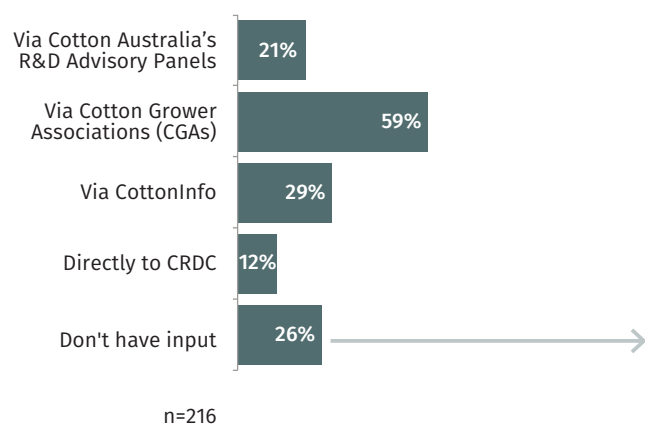


Figure 22

Reasons for not having input to CRDC about research

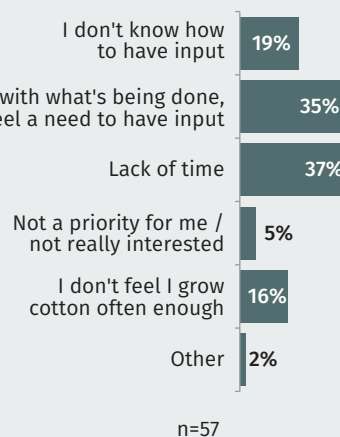
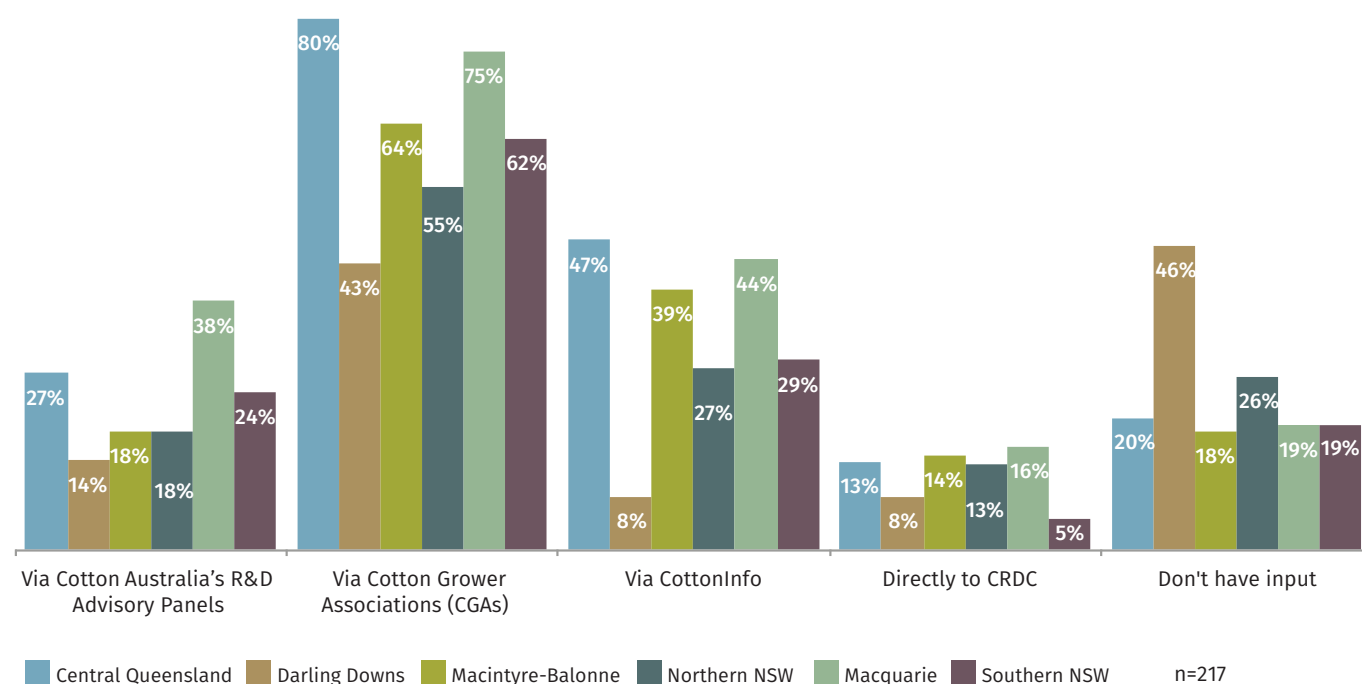


Figure 23

Avenues used for giving input to CRDC about research, by region



Q. Imagine you were to invest \$50 million in cotton research and development. Please indicate how you might distribute these funds to different areas of work. Allocate a total of 50, using whole numbers where 1 = \$1 million i.e. the total adds up to 50 (= \$50million)

Growers were asked to allocate 50 points (representing \$50 million) as they wished to different areas of cotton research and development. The minimum allocation was 1. 50 was chosen as it was double the number of topics listed, thus giving more chance to see variation, and also as \$50 million is approximately 3 years investment for CRDC.

The average ratings are shown in the first column of Table 13. The highest ranking areas were varieties / plant breeding (an area not currently resourced by CRDC) and the crop agronomy topics (nutrition, pest control and irrigation). When averaged across all responses there is a fair spread across all topics. Further investigation shows considerable variation in the preferred areas of investment. For example, Table 13 and Figure 24 indicate that 19% of respondents would make no investment in varieties/plant breeding whilst 4% would invest over \$20 million in this same topic. Comments and suggestions are provided Table 14.

Figure 24

Proportion of respondents suggesting each level of investment in areas of Cotton RD&E

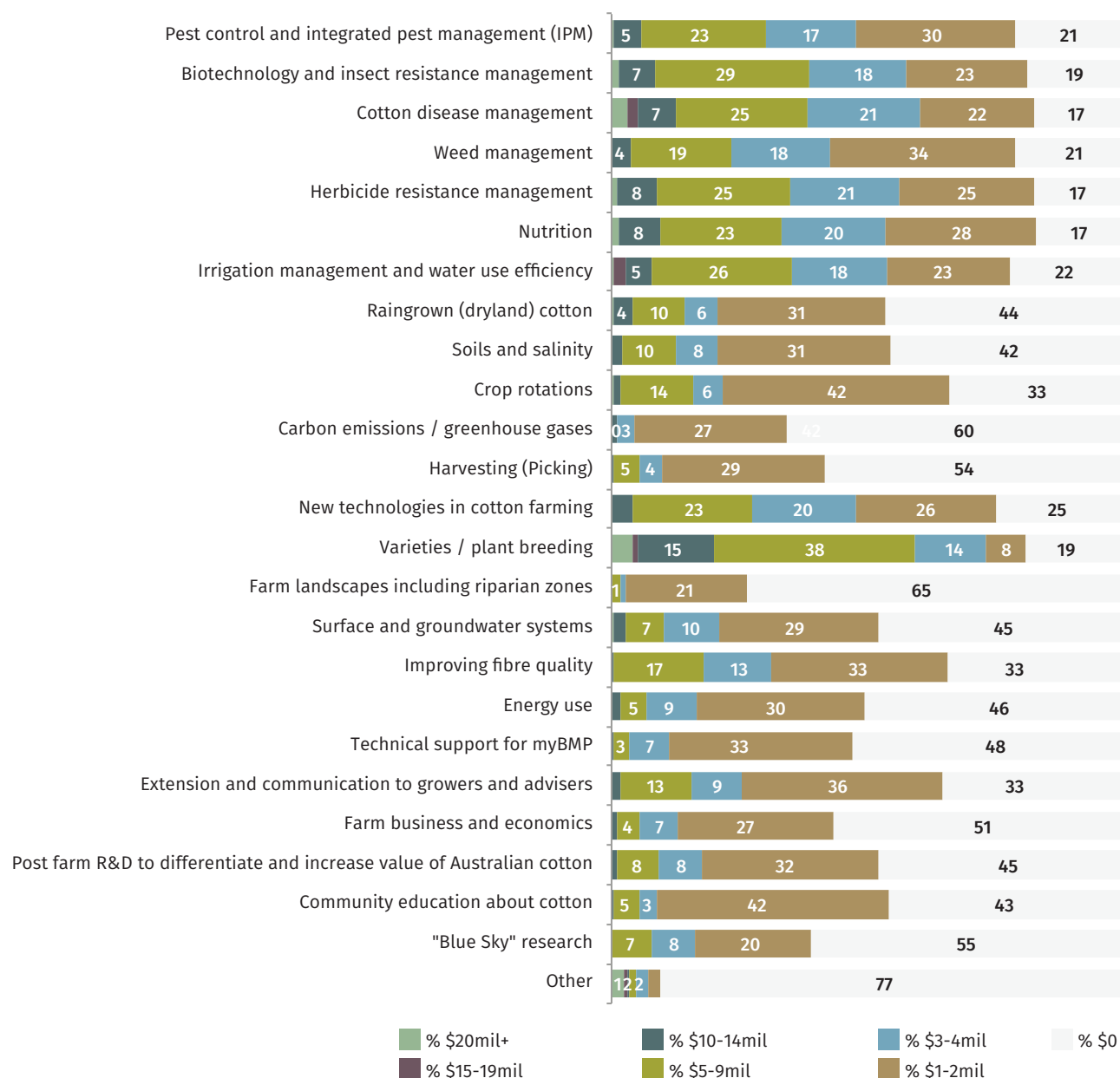


Table 13**Priority areas of investment**

	Avg	Max.	% respondents allocating an amount in the range of (\$millions of total \$50million):					
			\$0	\$1-4	\$5-9	\$10-14	\$15-19	\$20+
Varieties / plant breeding	5.4	35	19	21	39	15	1	4
Cotton disease management	4.4	50	17	43	25	8	2	3
Biotechnology and insect resistance management	3.7	30	19	41	29	7	0	2
Cotton nutrition	3.6	25	17	48	23	8	0	2
Herbicide resistance management	3.5	20	18	46	25	8	0	1
Irrigation management and water use efficiency	3.5	20	22	41	26	5	2	1
Pest control and IPM	3.0	20	21	47	24	5	0	1
New technologies in cotton farming	2.7	10	25	46	23	4	0	0
Weed management	2.6	12	21	52	19	4	0	0
Improving fibre quality	1.9	10	33	46	17	1	0	0
Crop rotations	1.8	25	33	47	14	1	0	0
Raingrown (dryland) cotton	1.8	25	45	37	10	4	0	1
Extension and communication to growers and advisers	1.8	10	33	46	13	2	0	0
Soils and salinity	1.5	10	42	39	10	2	0	0
Surface and groundwater systems	1.5	20	45	39	7	2	0	1
Post farm R&D to differentiate and increase value of Australian cotton	1.4	10	45	41	8	1	0	0
Energy use	1.2	10	46	39	5	2	0	0
Community education about cotton	1.0	10	43	45	5	1	0	0
Farm business and economics	1.0	10	52	34	4	1	0	0
“Blue Sky” research	1.0	8	55	28	7	0	0	0
Technical support for myBMP	0.9	10	48	40	3	1	0	0
Harvesting (Picking)	0.9	10	54	33	5	1	0	0
Carbon emissions / greenhouse gases	0.6	10	60	30	0	1	0	0
Farm landscapes incl. riparian zones	0.4	5	65	22	2	0	0	0
Other	1.5	50	78	4	1	1	1	2

Table 14

Description of 'other' and comments on research investment allocation

Central Queensland	Other workforce training.
	Cotton throwing fruit in cloudy conditions.
	Soil biology and it interaction with crop yield nutrition management and water use efficiency ie soil bacteria and fungi and the nutrient cycle, and the factors that increase soil carbon and humus in the soil. There are studies indicating soil carbon levels and directly related to farm profitability.
Darling Downs	Been in this sort of place with grains.
	I won't try to answer this type of question without a LOT more information!
	Basically doing pretty good ATM, maybe dryland needs a bit more attention.
	Soil health.
	Don't choose to answer this question. I Have been very involved in this space in grains, and anyone needs much more information about effectiveness of current RD&E programs and priorities of future work to get a balanced decision. Decisions should never be knee-jerk.
	Always felt more work needs to be done about refuges in areas like the Downs where so many other crops are grown for resistance management.
	Also CQ - large areas of dry-land have been locked out because of rigid planting windows in the past and (normally) rain comes too late - maybe OK with BG III.
	Varieties with better seedling vigour.
	Planter technology to improve plant stand i.e. There is new equipment available to retrofit to Maxemerge planters to improve planting.
	Get a small demo planter for trials & infield demos. Precision Seeding Solutions has this gear. This could be done in conjunction with CSD.
	Need loads more info to undertake such a task.
	Water is the number 1 resource on the downs, so water use efficiency and nutrition to match the water available is the largest factor on yields and hectares grown.
Macintyre-Balonne	Improving yield and quality by novel methods eg plant hormones
	Evaporation control Novel gene transfer Nematodes.
	Potential threats disease insects from overseas Improving photosynthesis efficiency.
	Leadership/workforce development esp next generation.
	Cotton disease is a big issue with me. Verticillium Wilt in particular.
	Verticillium wilt is our main problem and is stopping us growing cotton, we need answers!
	# system to be established and managed to realise the IP of those that work in the cotton industry # Assist growers into emerging markets
	# Research into 21 century high quality spinning in Australia # epigenetics, triggers for both active and dormant genetic expression from cellulose production to the phy-b gene expression # 3d printing using cellulose from cotton fibre # the interaction of hormones in the cotton plant. I believe the cotton industry boasts about how advanced we are in R & D however very little is being done to put us 20 years out there, a huge missed opportunity.
	Development of cottonseed products and value adding.
	30 inch rows on 1.5 m beds vs 40 inch rows.
Northern NSW	Asking how to distribute \$50,000,000 is not very relevant.
	I believe verticillium wilt is a huge problem and is seen in 80% of fields in the Lower Namoi. This is a problem that will only get worse and needs to be addressed.
	Harvesting compaction Issues.
	Attracting more young people to the cotton industry coal face.
	This question is stupid. I am not qualified to judge where the \$ should be spent. All the areas suggested are important.
	Expect Monsanto and CSD to contribute towards weed and pest management.
	CSD and Monsanto are already contributing to plant breeding.
	Verticillium is now a major disease CRDC funds should be injected into this part of plant breeding.
	Phenoxy drift.
	Stopping herbicide 2,4D drift.
	Making cotton more tolerant of 2,4D.
	Crop nutrition I would only focus on Nitrogen especially, in terms of rates / types / depths / timing / and other factors.
	Subsidies for growers/seed subsidy.
	Other: terminator gene for GM cotton, it's a major pest in following fallow/crops and a hindrance to growing dryland.
	Varieties: newer varieties seem less able to tolerate rain on open cotton so my response to varieties/ plant breeding is based on maintaining fibre quality after rain.
Macquarie	Biotechnology/ resistance management, IPM - should this be done by Biotechnology and chemistry provider considering they stand to make the \$\$ out of products etc?
Southern NSW	I believe it is difficult to figure the 'ideal' funding distribution and I think that for the Australian cotton industry to be competitive in the global markets, we need to maintain our paramount fibre quality and our quality assurance systems. I also believe that it is very important to continue to invest in new varieties/plant breeding as well as irrigation management and water use efficiency. This is our number one focus in our business as, put very simply - if we are more efficient with our water, it increases our bottom line.
	Any above that I haven't put values against or zero should have money spent on them. Some things are being done outside the industry. The industries key limitation is water. A major focus should go into using it more efficiently. Without water we are stuffed.
	Biological farming to prove enhanced Carbon retention using composted cotton trash systems holds even more potential for better crop nutrition in 1st & 2nd & 2nd year back-to-back (or back-back-back cotton).

CRDC Strategic Plan Statements

The 2013 Cotton Practices Survey asked growers of their views on a number of statements about cotton growing and research communication. These statements are drawn from the CRDC 5 Year Strategic R&D Plan 2013-2018. This question aims to track progress towards these goals set by CRDC and the industry in that plan. The questions were repeated in this survey and the findings are presented in the following graphs as the percentage of respondents giving each rating, compared with the 2013 responses. There was little change in these views over the 2 ½ years.

Figure 25

Views about cotton profitability, % respondents compared over time

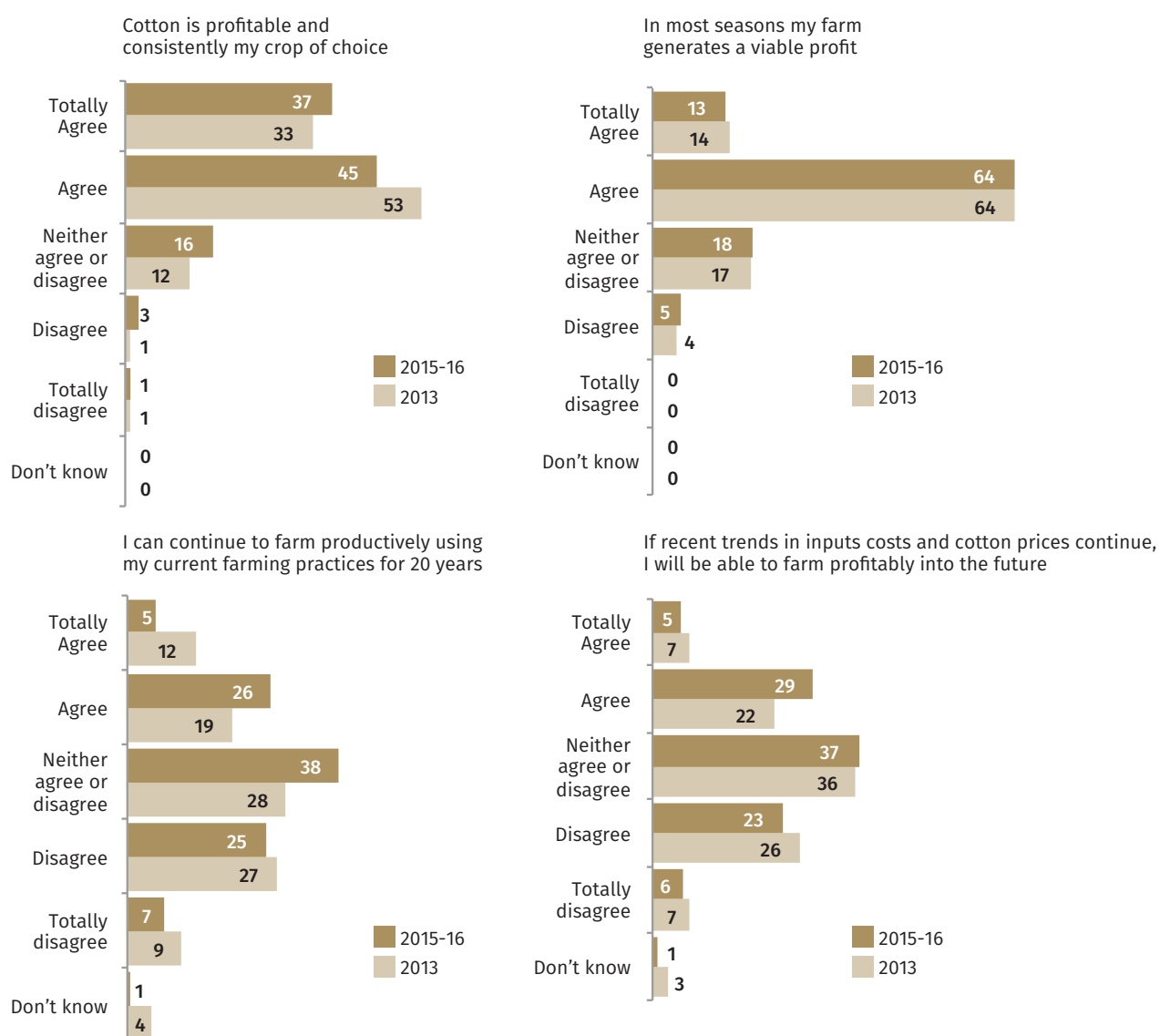


Figure 26

Views on aspects of the Australian cotton industry, % respondents over time

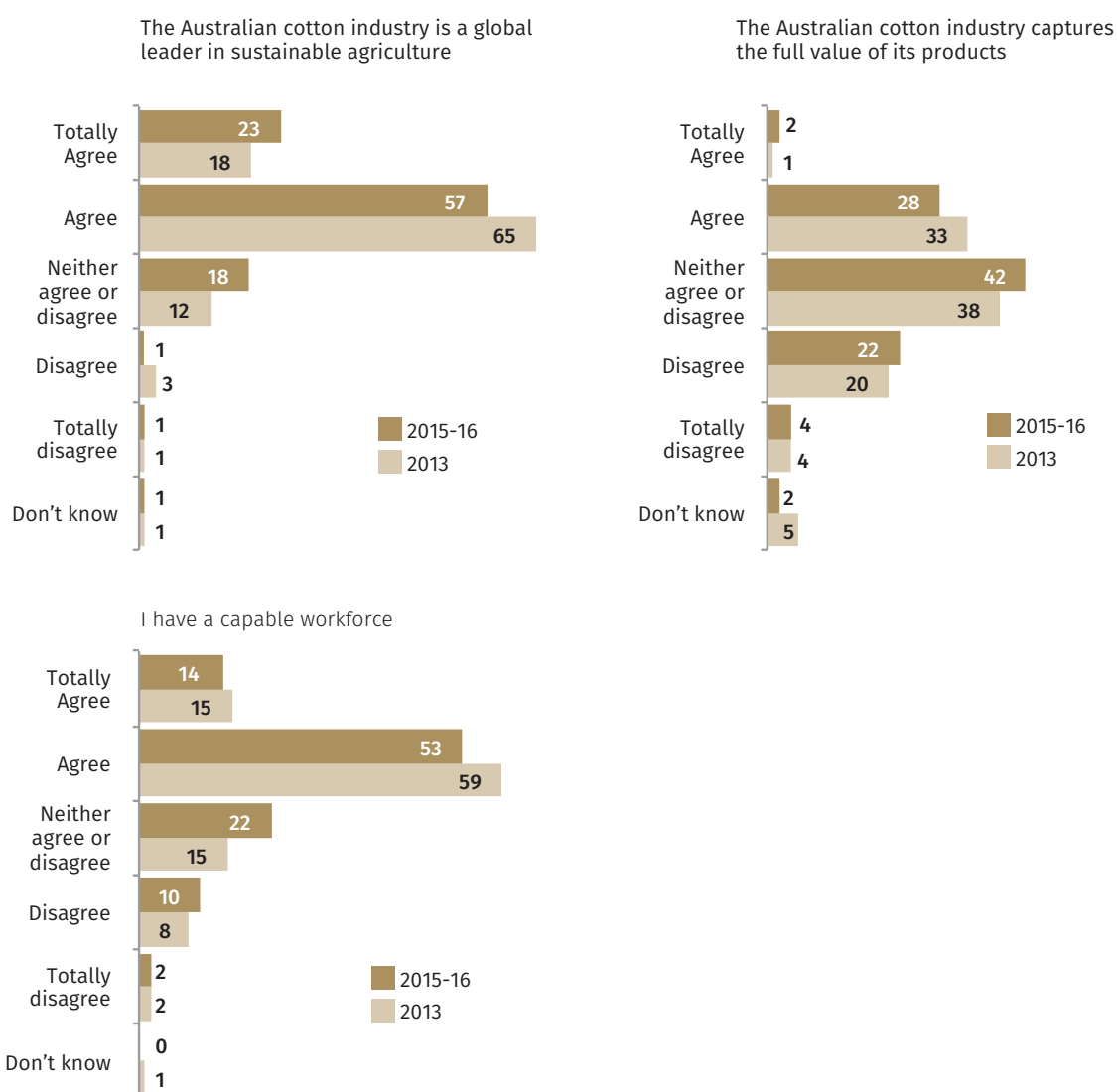


Figure 27

Views on cotton industry RD&E, % respondents compared over time

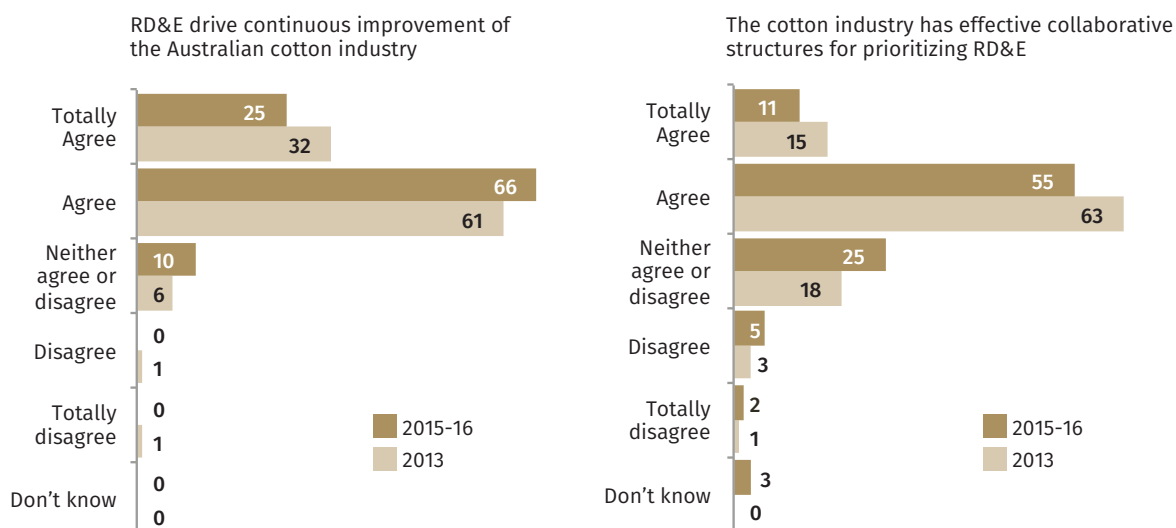
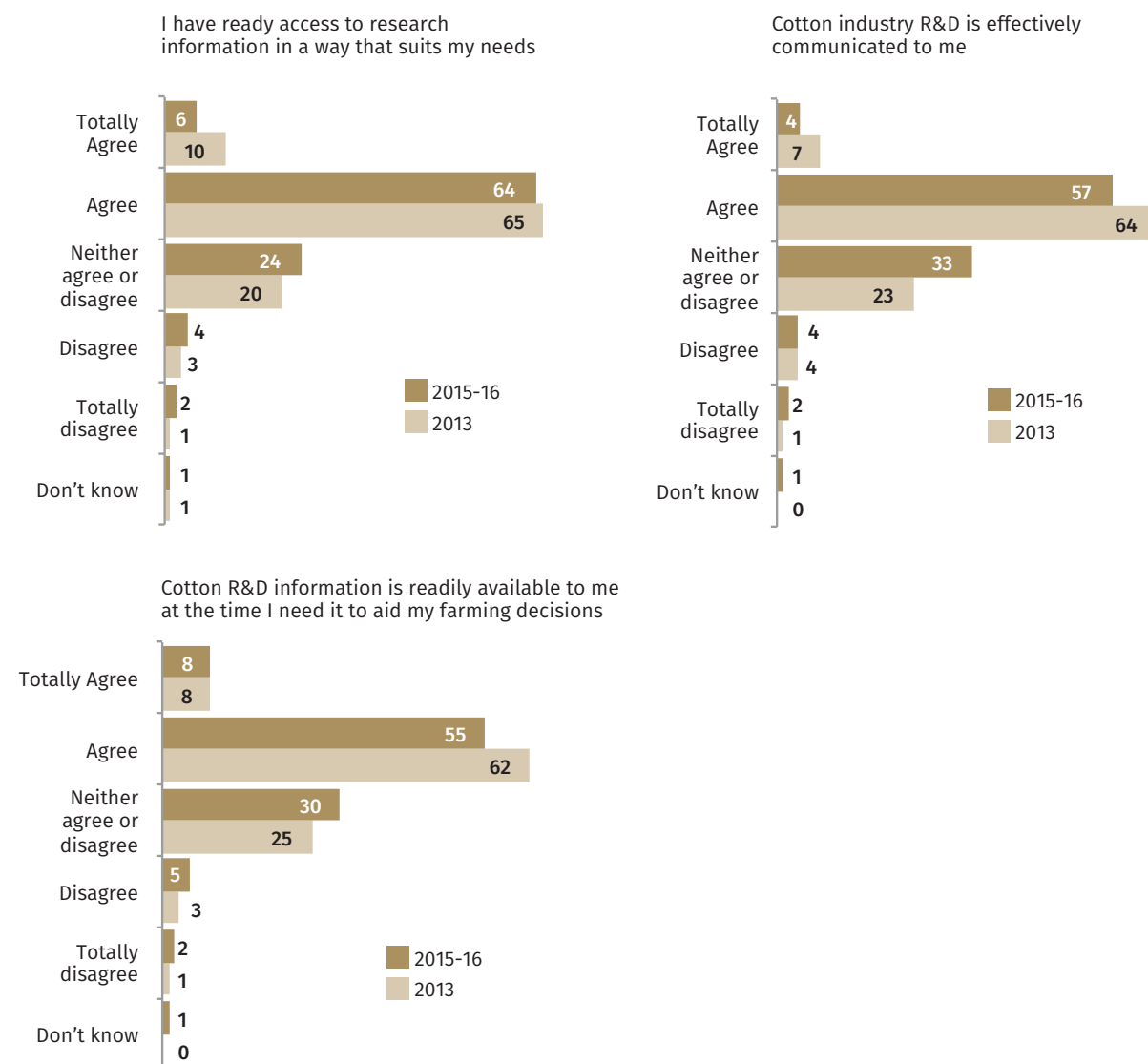


Figure 28

Views on cotton research communication, % respondents over time



Other comments

At the end of the survey growers were asked to share any other comments (Table 15). Most of these related to research issues, several reinforced issues raised earlier. Verticillium wilt was repeated a number of times, highlighting the importance of the issue.

Table 15

Other comments

Diseases and seedling vigour	Verticillium Wilt is becoming a major issue and must be addressed ASAP. I rotate crops and do everything I am supposed to but it continues to grow.
	VERTICILLIUM WILT!!!!!!!!!!!!!!!!!!!!!!
	All good thanks. Stay mind full of Vert.
	Verticillium is a major problem facing cotton production in our area, we are happy to help do research trials if your interested.
	Vert., vert., vert!!!!
	Some research on seedling vigour would be very good.
Phenoxy drift	I believe the greatest limitation to cotton yields at the moment is early and late season diseases in cotton. This is the area where research dollars need to be targeted, particularly Black Root Rot and Sclerotinia.
	Major issue is phenoxy spray drift. If it continues the industry will end. Money must be invested in this area before unruly farmers take matters into their own angry hands. If someone is not made a example of including retailers agronomists operators and farmer it shall destroy many cotton growers.
	Just on this operation it is costing 100k plus per season. I would be putting this as number one priority.
Cotton research and survey	It could destroy a seasons' work tonight or tomorrow. It is a now issue.
	Keep up the good work!
	Survey was too long! More people would respond if it was shorter.
	I believe that we are poorly serviced by our info team in both St George and Mungindi. I have not seen or heard of them until recently. I am concerned that we are not getting any value out of these people they would appear to need more oversight by their supervisors.
	Support high quality. Support innovative thinking. Support on farm R & D, help growers protect their IP and they will share with industry.
	Thanks Guy & Ingrid!
	I found the \$50 million question a bit ridiculous - it may have been easier to rank each project or quantify one against the other.
	Good work.

Preferences for survey reporting

83% of survey respondents were interested in seeing a copy of the report. 60% as an email link to the report, 14% in hard copy and 24% in CRDC's Spotlight magazine.

Appendix: Survey Questions

Cotton Practices Survey

Thanks for your input into the Cotton Practices Survey. These surveys gather really valuable industry data on farm practices and perceptions that help to inform R&D and policy work of the industry's organisations.

All survey information is treated anonymously, and is presented as aggregated data (industry and regional). Previous survey reports are available from www.crdc.com.au

This year's survey is looking at three key areas:

1. Management for seasonal conditions'
2. Cotton industry research
3. Mining exploration wells

PLEASE COMPLETE ONLINE AT
www.crdc.com.au/growersurvey

OR POST TO:

Ingrid Roth
PO Box 802
Narrabri 2390

OR EMAIL TO

ingridroth@roth.net.au

Region

1. Which region are you in?

- | | | |
|---|---|------------------------------------|
| ☐ Northern Australia (Burdekin, FNQ, Ord, NT) | ☐ Border Rivers | ☐ Upper Namoi |
| ☐ Central Queensland | ☐ St George / Dirranbandi | ☐ Macquarie |
| ☐ Darling Downs | ☐ Gwydir | ☐ Bourke |
| | ☐ Lower Namoi (including Walgett) | ☐ Southern NSW |

Seasonal management

Achieving optimal cotton yields is a combination of genetics, environment and management. We are interested in knowing more about the management decisions you made to manage cotton with the conditions of different seasons such as this season (2015-16) and last season (2014-15) or in earlier years.

2. On your farm, what level of influence does the seasonal outlook have on decisions about:

Please tick one per line	N/A	None	Minor	Moderate	Major
Fertiliser rates applied pre-season	☐	☐	☐	☐	☐
Fertiliser rates applied in-season	☐	☐	☐	☐	☐
Other crop input strategies	☐	☐	☐	☐	☐
Variety selection	☐	☐	☐	☐	☐
Row configuration	☐	☐	☐	☐	☐
Time of planting	☐	☐	☐	☐	☐
Trait technology royalty model used	☐	☐	☐	☐	☐
Area of irrigated cotton grown	☐	☐	☐	☐	☐
Area of dryland cotton grown	☐	☐	☐	☐	☐

3. Please describe any other strategies you use for managing for seasonal conditions and limited water in irrigated or raingrown cotton

4. Do you ever grow raingrown (dryland) cotton?

☐ Yes, whenever possible ☐ Yes, sometimes ☐ No (> Please go to Q 6)

5. For raingrown (dryland) cotton, what are the key drivers in your decisions about planting cotton or not and the area planted?

- | | |
|--|--|
| ☐ N/A – no raingrown cotton | ☐ Access to machinery and plant |
| ☐ Stored soil moisture | ☐ Refuge options |
| ☐ Seasonal outlook | ☐ Monsanto Technology licence options |
| ☐ Yield potential | ☐ Cotton price |
| ☐ Previous crop history | ☐ Other |
| ☐ Price of other crops | |

Cotton research

6. Are you aware of the Cotton Research and Development Corporation (CRDC)?

☐ Yes ☐ No ☐ Unsure

7. How well would you say you understand what the Cotton Research and Development Corporation (CRDC) does?

☐ Not at all / unaware of CRDC ☐ Very little ☐ A little ☐ Fairly well ☐ Very well

8. How would you rate the Cotton Research and Development Corporation (CRDC)'s performance in...

Please tick one per line	Don't know	Very Poor	Poor	Ok	Good	Excellent
Investing in cotton R&D	☐	☐	☐	☐	☐	☐
Providing useful, credible information	☐	☐	☐	☐	☐	☐
Listening to growers about R&D needs and priorities	☐	☐	☐	☐	☐	☐
Communicating with growers about R&D investments	☐	☐	☐	☐	☐	☐
Working collaboratively within the cotton industry	☐	☐	☐	☐	☐	☐
Working collaboratively with other agricultural industries	☐	☐	☐	☐	☐	☐
Driving continuous improvement in the industry	☐	☐	☐	☐	☐	☐

9. In addition to this survey, how do you have input into the Cotton Research and Development Corporation (CRDC) about cotton research, if at all? (tick all that apply)

- ☐ Via Cotton Australia's R&D Advisory Panels ☐ Directly to CRDC
- ☐ Via Cotton Grower Associations (CGAs) ☐ Other
- ☐ Via Cotton Info ☐ Don't have input (go to Question a.)

a. If you don't have input to CRDC about cotton research, please explain why

- ☐ I don't know how to have input ☐ Not a priority for me / not really interested
- ☐ Happy with what's being done, don't feel a need to have input ☐ I don't feel I grow cotton often enough
- ☐ Lack of time ☐ Other – please describe:

10. Overall, how supportive are you of CRDC's research investments and activities?

- ☐ Very unsupportive ☐ Unsupportive ☐ Neutral ☐ Supportive ☐ Very supportive

11. Imagine you were to invest \$50 million in cotton research and development. Please indicate how you might distribute these funds to different areas of work.

Allocate a total of 50, using whole numbers where 1 = \$1 million i.e. the total adds up to 50 (= \$50million)

\$million
Pest control and integrated pest management (IPM)
Biotechnology and insect resistance management
Cotton disease management
Weed management
Herbicide resistance management
Cotton nutrition
Irrigation management and water use efficiency
Raingrown (dryland) cotton
Soils and salinity
Crop rotations
Carbon emissions / greenhouse gases
Harvesting (Picking)
New technologies in cotton farming
Varieties / plant breeding
Farm landscapes including riparian zones
Surface and groundwater systems
Improving fibre quality
Energy use
Technical support for myBMP (the industry's Best Management Practices program)
Extension and communication to growers and advisers
Farm business and economics
Post farm R&D to differentiate and increase value of Australian cotton
Community education about cotton
"Blue Sky" research
Other:
Total 50

12. Comments

13. Please give your opinion on each of the following statements in relation to your cotton farming enterprise and the cotton industry

Please tick one per line	Don't know	Totally disagree	Disagree	Neither agree or disagree	Agree	Totally Agree
Cotton is profitable and consistently my crop of choice	☐	☐	☐	☐	☐	☐
I can continue to farm productively using my current farming practices for 20 years	☐	☐	☐	☐	☐	☐
If recent trends in inputs costs and cotton prices continue, I will be able to farm profitably into the future	☐	☐	☐	☐	☐	☐
In most seasons my farm generates a viable profit	☐	☐	☐	☐	☐	☐
The Australian cotton industry is a global leader in sustainable agriculture	☐	☐	☐	☐	☐	☐
The Australian cotton industry captures the full value of its products	☐	☐	☐	☐	☐	☐
I have a capable workforce	☐	☐	☐	☐	☐	☐
Research, development & extension drive continuous improvement of the Australian cotton industry	☐	☐	☐	☐	☐	☐
The cotton industry has effective collaborative structures for prioritizing research, development & extension	☐	☐	☐	☐	☐	☐
I have ready access to research information in a way that suits my needs	☐	☐	☐	☐	☐	☐
Cotton industry R&D is effectively communicated to me	☐	☐	☐	☐	☐	☐
Cotton R&D information is readily available to me at the time I need it to aid my farming decisions	☐	☐	☐	☐	☐	☐

Your Farm

14. On your farm, what is the total:

Area developed for irrigated cropping ha

Typical area of irrigated cotton in a good year ha

Area developed for raingrown / dryland cropping ha

Typical area of raingrown / dryland cotton in a good year ha

15. When did you most recently grow cotton?

- ☐ This season (2015-16)
- ☐ Last season (2014-15) > Please go to Q22
- ☐ 2013-14
- ☐ 2012-13
- ☐ 2011-12
- ☐ 5-10 years ago
- ☐ More than 10 years ago
- ☐ Have not yet grown cotton, considering it > Please go to Q27
- ☐ Not a grower > Please go to Q27

Your Cotton This Season (2015-16)

If no cotton grown last season, please skip to question 21

16. Please list the area in hectares of irrigated and / or raingrown (dryland) cotton crops planted this season (2015-16)

	Irrigated		Partially Irrigated *		Raingrown	
Field area planted		bales/ha		bales/ha		bales/ha
"Green" area planted *		bales/ha		bales/ha		bales/ha
Target Yield		bales/ha		bales/ha		bales/ha

* Partially Irrigated = up to three irrigations

* 'Green' area is the solid plant equivalent if you use skip row or similar configuration

17. Please indicate any area (green hectares) of your 2015-16 planted cotton that has been replanted or abandoned due to:

	Area Replanted	Area Abandoned
Herbicide drift		Green ha
Poor plant stand*		Green ha
Lack of water		Green ha
Hail		Green ha
Any other reason		Green ha

18. Please comment on factors leading to the need to replant or abandon the crop

19. What have you done / will you do differently in managing cotton this season (2015/16) compared to last season?

Why?

20. For irrigated / partially irrigated cotton this season (2015-16), what strategies have you used for managing limited water?

Please tick all that apply or describe your strategy in 'other'

- ☐ Not applicable – water not limited
- ☐ Not applicable – raingrown farming only
- ☐ Planted some fully irrigated fields and some semi-irrigated fields (which receive more irrigation if water comes available)
- ☐ At time of planting, there was enough water to put some irrigations on all fields, but not enough for full irrigation
- ☐ Watered up only and relied on rainfall for any further irrigations
- ☐ Planted only the area that we had enough water to fully irrigate
- ☐ Single skip irrigated
- ☐ Double skip irrigated
- ☐ Planted early
- ☐ Planted later
- ☐ Waited for rain before planting
- ☐ Other Please describe

21. Did you grow cotton last season (2014-15)?

- ☐ Yes - please go to the next question ☐ No - please go to question 27

Last season (2014-15) yields, quality and area of cotton

22. Please list details of your cotton crop from LAST SEASON (2014-15). If none please record 0 in green ha

	Irrigated	Partially Irrigated *	Raingrown
Field area planted	Bales/ha	Bales/ha	Bales/ha
"Green" area planted *	Bales/ha	Bales/ha	Bales/ha
Target Yield	Bales/ha	Bales/ha	Bales/ha
Highest yield from one field	Bales/ha	Bales/ha	Bales/ha
Average cost of quality discounts	\$/bale	\$/bale	\$/bale
Average cotton production cost* / green ha	\$/ha	\$/ha	\$/ha
Irrigation volume used for cotton per ha	ML/ha	ML/ha	

To convert acres to ha divide by 2.47 To convert bales/acre to bales/ha multiply by 2.47;

* 'Green' area is the solid plant equivalent if you use skip row or similar configuration; Costs excluding bank interest.

23. Which quality discounts (if any) were the most costly for you last season?

please tick all that were a substantial cost

- | | |
|--|---|
| ☐ Colour | ☐ High Micronaire |
| ☐ Leaf | ☐ Low Micronaire |
| ☐ Length | ☐ None |
| ☐ Strength | ☐ Other (<i>please define</i>) |
| ☐ Sticky cotton | |

24. What factor/s or management do you think most contributed to any high yields you achieved last season (2014-15)?

25. Please describe any specific management strategies that you used to suit the seasonal conditions and high yield potential of last season (2014-15)

26. What factors do you believe LIMITED yield last season (2014-15)?

Tick all that apply

- | | | |
|--|---|---|
| ☐ Verticillium | ☐ Rainfall | ☐ Heat |
| ☐ Other seedling diseases (Pythium & Rhizoctonia) | ☐ Cloud cover | ☐ Other (<i>please define</i>) |
| ☐ Seed bed conditions | ☐ Ran out of water | ☐ None |

Mining exploration drilling bores

Research led by Dr Bryce Kelly, UNSW for the cotton industry is seeking to understand potential connectivity between groundwater systems and mining exploration drilling wells (coal, coal seam gas, petroleum, etc). It would help this research if you can advise of any current or abandoned mining exploration wells in your area, including any that are several decades old.

27. As far as you are aware, has there been any drilling for mining exploration on or near your property at any time?

☐ Yes ☐ No ☐ Unsure If yes:

28. How many exploration drilling wells do you know to exist:

On your property?

On public land adjacent to your property?

29. Are you willing to have your contact details provided to cotton groundwater researcher Dr Bryce Kelly, UNSW?

Yes / No

30. Any other comments or information about exploration drilling wells in your area?

Thank-you for your input into cotton industry research.

Would you like to receive a copy of the survey report?

- ☐ Yes as an email link to the report (please record your email address below)
- ☐ Yes as a hard copy report
- ☐ Yes as articles in CRDC's Spotlight magazine
- ☐ No

Any other comments or suggestions?

Please record your contact details for the prize draw and in case we need to contact you. This will not be reported with the survey results, it will be provided to CRDC for keeping your details up-to-date so you receive research information.

First Name	Address 1
Surname	Address 2
Email	Town
Farm Name	Postcode
	Phone
	Mobile

Prize draw!

We really appreciate your input. As a token of our thanks, you will be entered in a draw to win accommodation at Broadbeach during the Australian Cotton Conference this August. Our first 50 respondents also receive an extra thank-you gift. Please tick which you prefer:

- ☐ A \$25 itunes voucher (be sure you've recorded your contact details above)
- ☐ A \$25 donation to the Royal Flying Doctor Service
- ☐ Neither



Contact

Ingrid Roth

Roth Rural

PO Box 802, Narrabri 2390

ingridroth@roth.net.au

02 6792 5340

Acknowledgments

Our sincere thanks to the cotton growers who have shared information about their farming practices through this survey.

Thanks to CRDC for funding this work.

Thanks to Ian Taylor, Ruth Redfern, Mike Bange, Bryce Kelly, Angela Bradburn and Michael Murray for input to the survey design.

Thanks to Cotton Australia for assistance with survey distribution, design and review.

Cover photo credit Ruth Redfern.

Citation

Roth Rural (2016) Cotton Growing Practices 2015-16: Findings of the CRDC's survey of cotton growers. Cotton Research and Development Corporation, Narrabri.

Disclaimer

CRDC and Roth Rural & Regional Pty Ltd accept no responsibility for the accuracy or completeness of any material contained in this publication. CRDC and Roth Rural & Regional Pty Ltd disclaims all liability to any person in respect of anything and of the consequences of anything done or omitted to be done by any such person in reliance, whether wholly or partly, on any information contained in this publication. If you intend to rely on information provided in this publication you should rely on your own appropriate professional advice. Material included in this publication is made available on the understanding CRDC and Roth Rural & Regional Pty Ltd are not providing professional advice. CRDC, the authors and their organisations accept no responsibility or liability for any loss or damage caused by reliance on the information, management approaches or recommendations in this publication.

