Cotton Growing Practices 2013

Findings of CRDC's survey of cotton growers

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Summary

The Cotton Growing Practices 2013 survey conducted for the Cotton Research and Development Corporation (CRDC) focused on Nutrition & Soils; Energy; Harvesting and Human Resources for the 2012-13 cotton crop. The season was typified by hot, dry conditions and record yields to produce the second largest Australian cotton crop on record (4.4 million bales from 405,000 irrigated hectares and 36,880ha of dryland) with the highest yet average yield of 10.2 bales/ha.

The Cotton Growing Practices survey gathers valuable information about cotton farming practices so that trends over time can be monitored when compared with similar surveys conducted in 2011, 2007, 2006 and earlier. This survey aimed to consolidate all CRDC funded surveys for 2013 into a single survey tool, to reduce the number of surveys growers are asked to complete for industry research. The information gathered feeds directly into research projects and is also used to evaluate research outcomes, plan new projects, identify priority issues and tell the cotton industry's 'story'.

Survey responses covered 92,687 ha of irrigated cotton (23% of the total irrigated crop) and 9,853 ha of dryland cotton production (27% of the total dryland crop in 2012-13). 20% (165) of the farms registered with CRDC who grew cotton in 2012-13 returned surveys. The survey was mailed to all 1000 cotton growers registered with the CRDC in July 2013. While 362 replied, many had not grown cotton in 2012-13, reducing the population to 837. 38 (23%) of the responses included at least some dryland cotton production. At a regional level the rate of response ranged from 12% to 30%. 62% of respondents have been involved with the cotton industry for 20 years or more.

Findings are presented in this report and the full data set is available from CRDC. Some interesting findings are summarized below.

2012-13 season

- Irrigated cotton on average accounted for 16% of the land area of farms where it was grown while dryland cotton accounted for 2%.
- Irrigated cotton in 2012-13 yielded close to growers' targets in NSW but fell short in Queensland.
- Dryland cotton exceeded target yields in most regions.
- The highest reported yield from an individual field was 16.2 bales/ha in the Upper Namoi.
- 43% of irrigator respondents and 24% of dryland respondents received quality discounts, ranging from $0.11/bale to $75/bale with micronaire and colour being the most costly.

Nutrition

- Rates of applied Nitrogen (N), Phosphorus (P), Potassium (K), Zinc (Zn), Sulphur (S) and trace elements have been gathered for irrigated and dryland cotton crops and are compared with application rates recorded since 1997.
- Fertiliser rates and costs are highly varied, with a wide range at the same yield levels. Nutritional inputs cost between $300 and $600/ha for 75% of irrigator respondents and between $100 and $200/ha for 60% of dryland respondents.
- Average rates of nutrient application per hectare of irrigated cotton were 243kg N, 31kg P, 24kg K, 3kg Zn and 14kg S.
- Average rates of nutrient application per hectare of dryland cotton were 84kg N, 13kg P, 10kg K, 1.8kg Zn and 5.5kg S.
- Phosphorus was applied on 76% of irrigated and 62% of dryland respondents' farms.
- Potassium was applied on 43% of irrigated and 23% of dryland respondents' farms.
- 70% of respondents varied fertiliser application rates across fields / management units in the 2012-13 season and 16% varied fertiliser rates within a field.
- 13% of irrigated farms and 20% of dryland farms had a nitrogen use efficiency (yield per unit nitrogen) within the optimum range recommended by research.

- On average 67% of nitrogen was applied pre-season for irrigated cotton, which is similar to that reported for the 2010-11 season. There was a large variation between farms.
- Application methods and timing are varied. 55% of farms apply nitrogen in bands, 40% water run N, 24% use gas, 24% apply a granular side dressing direct drilled into the hill, 18% apply a granular top dressing followed by flood irrigation, 16% apply foliar nitrogen and 8% of farms indicated they apply N through fertigation.
- 39% of respondents used manures or composts in their nutrition program.
- Barriers to improving fertiliser efficiency include weather, application risks and practicalities, product limitations, cost, agronomy factors, soils and knowledge.

Soil and petiole testing

- Soil testing tends to be carried out by many farms at the same frequency for all depths and analysis types.
- 52% of irrigator respondents have a soil surface test for Nitrate-N, pH, EC and Chloride done every season, 18% having it done on every field every season. One third of respondents soil test some fields every season on irrigated cotton.
- 13% of respondents had a petiole nitrogen test conducted on every field every season on irrigated cotton.

Soils, crop rotations and other agronomy

- Almost all respondents (99%) thought that soil health was generally increasing or steady.
- Irrigated farms grew cotton on 15-100% of their irrigation country in 2012-13 (avg 58%).
- Dryland cotton was grown on 7-54% of the farms' dryland cropping area in 2012-13 (avg 23%).
- 75% of respondents produced on average two or less cotton crops before breaking with an alternate crop or fallow. 49% usually had at least one back-to-back cotton crop. 13% grow 5 or more consecutive cotton crops.
- Wheat was the most common rotation with cotton (used in the past 3 years by 78% of respondents). Other rotation crops used in the past 3 years, in declining order of use are chickpea sorghum, barley, maize, mungbean, faba beans, canola, soybean, vetch, sunflower, French white millet, canary seed and lab lab.
- Row configuration for irrigated cotton was at 1m spacing for 84% of respondents. In dryland cotton 12% used 1 m rows, 27% 1 m single skip, 30% 1m double skip and 15% 1.5m.
- The number of machinery passes varied a lot (1-10 passes). There were on average 5.3 workings for back to back cotton and 4.1 for cotton following a rotation or fallow.
- Substantial soil compaction is observed after wet seasons and harvesting (both picker types).
- 55% of respondents vary management based on high variation detected in yield maps.
- 54% of respondents usually manage for an early finish to the season.

Crop protection stewardship

- 76% of respondents thought the long term value of complying with the Bollgard®II resistance management plan (RMP) is worth the effort and cost, 11% do not agree.
- 79% consider it important to have a choice of refuge options.
- 63% of Bollgard®II crops are checked twice a week.
- 69% consider field failure to Bollgard®II will occur within 10 years (19% within 5 years) if the current RMP continues and no other *Bt* technologies become available.
- Herbicide resistant weeds were reported by 37 farms in irrigation and 31 farms in dryland.
- 13% of respondents indicated herbicide spray drift had affected their 2012-13 cotton crop.
- 49% of respondents believe CottonMap has helped to reduce herbicide spray drift.

Energy

- Diesel accounted for 86% of energy usage, electricity for 11%.
- 11% of respondents had measured or benchmarked their total energy usage in the past 5 years, 16% had done this for individual operations and 24% of irrigator respondents had a pump efficiency investigation done.
- Solar energy, the most used alternative energy source, was mainly house or workshop use.
- Price, availability and ease of use were the most important factors in decisions about alternative energy. Environmental benefits and risks were important to a high proportion.

Harvesting

- Round module pickers (JD7760) were used on 69% of respondent's farms and 82% of their cotton area in 2013.
- Where round module pickers were used, 53% of respondents used contract harvesters, 40% purchased or leased their own and 7 % used a combination of both.
- 36% of the 37 respondents who owned a round module picker had more than one.
- The major motivations for the initial decision to use a JD7760 were the ability to pick crops more quickly, a decrease in labour and decrease in workforce health and safety risks.

Human Resources

- 73% of respondents indicated that they have a capable workforce.
- As a broad average, respondents employed 6.6 people per farm (1.6 employees/100 cotton ha). Of these, on average 2.4 employees first joined the farm in 2012 and 1.8 employees were new to cotton.
- The average vacancy rate at January 2013 was 0.4 positions per farm.
- 30% of staff are 'Entry' level, 34% 'Experienced', 17% 'Senior experienced' and 19% at 'Manager' level.
- Permanent staff are primarily full time (63%), 3% of these are 457 visa holders.
- 28% are casuals and 8% part time permanent.
- 65% of casual staff employed at January 2013 were 417 visa holders.
- 74% of all casual staff are at entry level, 82% of the 417 visa holders are at entry level.

Safety

- 62% of respondents completed inductions for some or all new workers (51% for all).
- 24% completed inductions before each season with contractors.
- 28% had a formal system for workers/contractors to report hazards.
- 26% had a documented health and safety plan.

Use of contractors

- 98% of farms in the survey used contractors for at least some operations.
- 15% used contractors for ground preparation, 7% for planting and 15% for fertiliser application.
- 48% used contract harvesters and 34% had all of their harvesting done by contractors.
- 43% used ground rig contractors for spray application (16% for all of this work).
- 85% had modules transported by contractors.

Information and research

- 73% of respondents consider that cotton industry research and development is effectively communicated to them.
- 84% use a smart phone or tablet for accessing information about their farming system.
- 50% of respondents use the cotton industry's myBMP site at least slightly.
- Social media use is low (2% high-moderate use, 14% slight use).
- 61% considered that cotton specific mobile apps could be helpful, a number of suggestions are reported.
- The Australian Cottongrower, Cotton Pest Management Guide, CRDC's Spotlight and technical fact sheets rated most highly as preferred mechanisms to receive cotton R&D information.
- 77% believe the cotton industry has effective collaborative structures for prioritizing R&D.
- 91% consider that R&D drives continuous improvement of the Australian cotton industry.

Cotton productivity and profitability

- 86% of respondents believe that cotton is profitable and consistently their crop of choice.
- 31% believe they can continue to farm productively for 50 years with current practices.
- 32% indicated they will not be able to farm profitably into the future if recent trends in input costs and cotton prices continue.
- 78% agreed that in most seasons their farm generates a viable profit.
- Water and weather were the most frequently identified limitations to productivity and profitability, followed by farm characteristics, labour, costs, finance and varieties.
- The most mentioned drivers of productivity and profitability were yield and price followed by water, costs and nutrition.
- Above average yields were most commonly attributed to weather, agronomic inputs (water, irrigation timing and efficiency, nutrition, varieties) and management (timing, attention to detail, management and profit).

Aspirations

- Many respondents intend to improve their farm business (70%) and infrastructure (66%).
- Close to half intend to grow their farm assets and/or cotton enterprise.
- One third intend to transition the farm ownership to family members.
- 11% will move out of farming to retire or for other reasons.

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Background

Information about farming practices used in cotton production, yields obtained and fibre quality are of enormous value in planning research and extension efforts, in industry activities and in telling the industry's 'story'. Without regular surveys there is relatively limited information about current practices used on-farm or changes over time. Survey findings are used to evaluate research and development uptake and identify areas for further research to help improve cotton production.

The Cotton Growing Practices 2013 survey was conducted in late winter 2013, focusing on the 2012-13 cotton crop. The hot, dry 2012-13 season produced the second biggest Australian cotton crop on record with the highest yet average yield of 10.2 bales/ha[1]. 4.384 million bales were produced from 405,000 ha of irrigated cotton. Dry conditions restricted the dryland plantings to 36,880 ha producing 132,300 bales.

Survey design

The survey was designed to be a single, coordinated survey of cotton growers conducted by CRDC and its research partners in 2013. Where possible it has been aligned with historical surveys so that trends can be monitored. By consolidating CRDC funded surveys CRDC aimed to reduce the number of surveys growers are asked to complete. A call was made to all CRDC funded researchers and other industry research leaders asking them to identify any questions they would like asked to aid their research or extension effort. This identified that surveys were planned by the NCEA (Harvesting by John McLean-Bennett and Energy by Gary Sandell). It gathered questions from The University of Melbourne (Workforce by Jennifer Moffatt) and several other researchers.

As a result, the survey was developed to focus on the major themes of:

- Nutrition & soils
- Energy
- Harvesting
- Human resources.

The survey was printed and mailed out to 1000 cotton growers listed on the CRDC's industry contacts list. Together with the survey growers received:

- an introductory letter from CRDC;
- a snapshot booklet of findings from previous surveys;
- a quick response form for people who would not be returning the survey (eg people who did not grow cotton in 2012-13, were not growers or did not want to respond) and for updating contact details; and
- a stamped, addressed return envelope.

Additional copies of the survey were provided to Regional Delivery Officers (RDOs) and an online response option was promoted via Cotton Australia's "Cotton Matters" newsletter and some RDO's regional newsletters. The survey was also promoted through a series of articles in CRDC's Spotlight magazine.

After an initial response window, a team of regional people experienced with their local cotton industry were engaged to call growers to encourage additional responses.

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[1] Australian Cotton Yearbok 2013

Survey response

Survey responses cover approximately 23% of the 2012-13 irrigated cotton production area and 27% of the dryland cotton area (based on the survey responses that recorded crop area and the total crop area reported in the 2013 Cotton Yearbook).

At least 20% of farms registered with CRDC that grew cotton in 2012-13 completed surveys. Replies were received from 362 people (36% of the 1000 surveys mailed out). Of these, 165 returned the survey and 153 completed the majority of it. 34 declined to complete the survey. The population size can be reduced to 837 by excluding 163 people (46% of the replies) from the sample as: 55 replied that they did not grow cotton in 2012-13, 3 had their crop destroyed, 70 were not cotton growers, 17 were returned to sender and 18 of the initial list were duplicates for the same farm. Of the remaining population it is impossible to know what proportion were active cotton growers in 2012-13. If the 46% rate of non-active growers in the replies is extrapolated to the whole population then the sample would be reduced to 537 growers and thus the response rate would be 31%. However, the response rate from non-growers was likely higher (a simple, single page form). It can be estimated that the 165 surveys received represents between 20% and 31% of those on the CRDC's mailing list who grew cotton in 2012-13. 160 people amended their contact details and 45 asked to be removed from the list.

38 of the replies were from dryland growers, with 15 of these having grown both irrigated and dryland cotton in 2012-13. A much larger number of dryland growers returned the response form to say they did not grow cotton in the 2012-13 season. The distribution of the survey responses at a regional level is depicted in Table 1 while Table 2 shows the area of cotton surveyed. When compared with the total Australian cotton production estimate (Cotton Yearbook 2013), the surveyed area represents 23% of the total irrigated crop and 27% of the total dryland crop. Regions have been aggregated where appropriate into climatic zones for regional reporting. Particular caution should be taken in considering results from Central Queensland as it is a small sample and mainly from the Dawson Callide, with only 3 replies from Emerald. A detailed survey of Emerald growers was done in 2012.

Table 1 Regional distribution of surveyed growers and response

Response Total	Number of growers on mailing list	Active population (Excludes those who indicated they didn't grow cotton 2012-13)	Number of responses	% response
Burdekin	8	8	-	
Central Queensland	105	90	11	12 %
Darling Downs	231	195	33	17 %
Border Rivers	75	53	14	26 %
St George / Dirranbandi	44	39	10	26 %
Gwydir	119	101	18	18 %
Lower Namoi	145	120	22	18 %
Upper Namoi	89	70	15	21 %
Macquarie	119	90	27	30 %
Bourke	6	6	1	17 %
Southern NSW	61	54	14	26 %

Table 2 Area of cotton planted 2012-13 represented in the survey

	IRRIGATED				DRYLAND			
	No. of farms	Field ha	Green ha	Ha not picked	No. of farms	Field ha	Green ha	Ha not picked
Central Qld	11	2,453	2,431	65	0	0	0	0
Darling Downs	21	5,418	4,820	8	18	5,177	3,251	116
Southern Qld	21	24,356	24,346	617	4	640	458	0
Northern NSW	48	34,445	34,265	860	14	3,636	2,312	1,976
Macquarie	27	14,346	14,164	340	2	400	346	80
Southern NSW	14	11,669	11,596	15	0	0	0	0
All regions	**142**	**92,687**	**91 ,622**	**1,905**	**38**	**9,853**	**6,368**	**2,172**

Demographics of respondents

Cotton in the farm landscape

On average across respondents from all regions cotton production in 2012-13 accounted for 18% of the farm land area (16% irrigated, 2% dryland) (Figure 1). There is some variation across regions as depicted, in Southern NSW, farms have a larger proportion of the farm developed for irrigation.

On those farms that reported they have irrigation, irrigated cotton accounted for on average 23% of the land area with a range from 1% to 100%. On farms producing dryland cotton, the area of dryland cotton accounted for an average of 18% of the land area (Range 5%-53%).

Figure 1 Land use mix, average across all cotton growing farms surveyed 2012-13

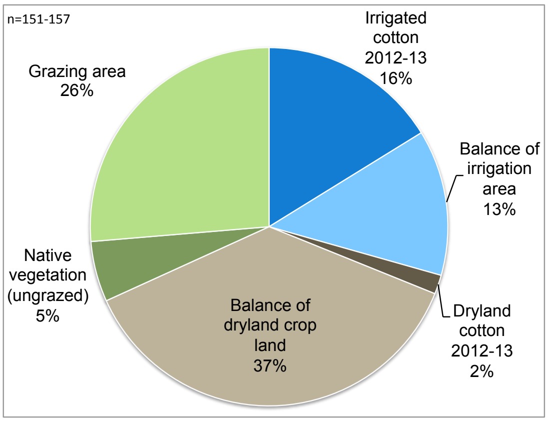
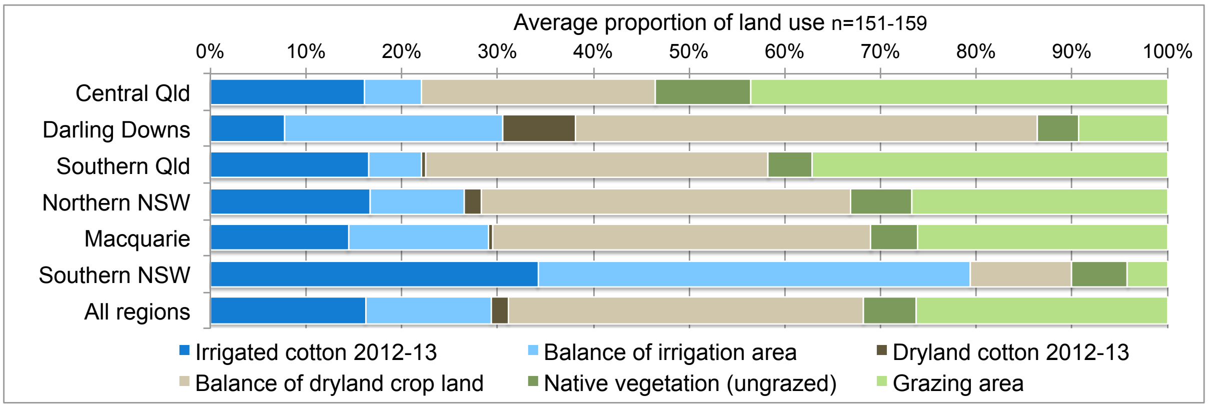


Figure 2 Average proportion of land use types on cotton growing farms surveyed, by region 2012-13



Note: Responses from Central Qld are predominately in the Dawson-Callide region. Farms in the Emerald Irrigation Area typically have the majority of the farm used for cotton production and would differ from what is presented here.

People

62% of respondents have been involved with the cotton industry for more than 20 years (Figure 3). The majority of respondents were aged between 35 and 64 (Figure 4). Note, that the one respondent over 80 years of age completed only the first page of the survey.

Figure 3 Years involved with the cotton industry

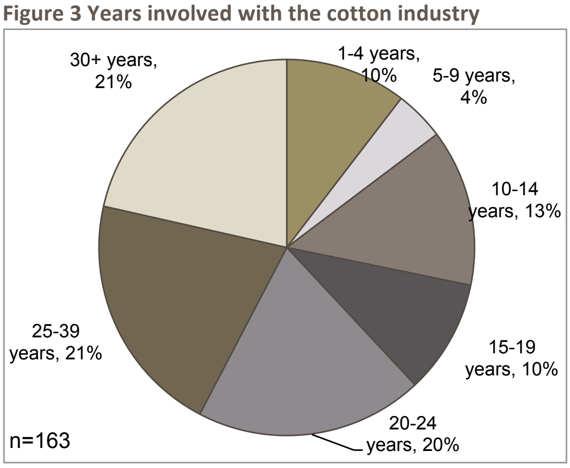
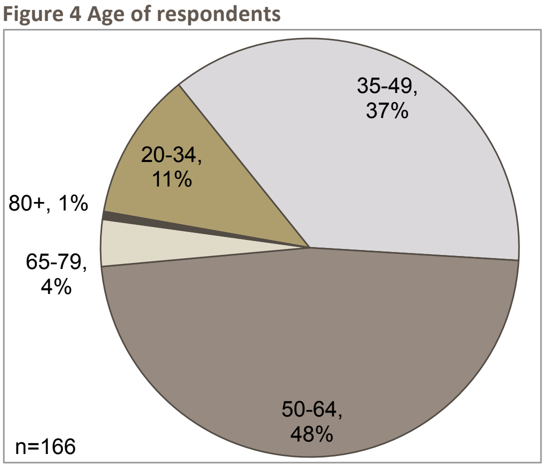


Figure 4 Age of respondents

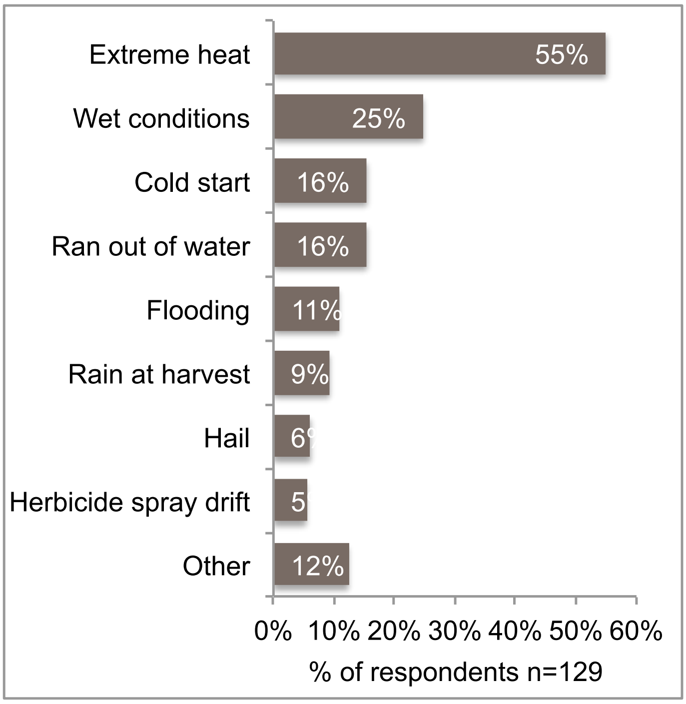


Findings

2012-13 Season

The 2012-13 season was typified by a dry, hot summer with some very high temperatures recorded in most regions. There was significant rainfall in January and March in many regions with some experiencing January flood events. A number of respondents indicated that these seasonal conditions impacted substantially on the yields achieved (Figure 5).

Figure 5 Issues substantially impacting on yield



Were there any issues that substantially impacted on the yield or quality of your 2012-13 cotton crop?

"Other" issues were: Crop didn't defoliate well, Ginning, Replant, No Irrigation planted because of zero water, Hard start, Dry Start, Poor Establishment, Planting rain wasn't until early December first flower not till February, Bastard of a year! Seed Quality, Breakdown of bores, Wire worm, Nitrogen, Early fruit set, Hardforming soil structure damage, Management.

Irrigated cotton yields

Yield results are depicted in Figure 6. Irrigated cotton farm average yields achieved close to target yields in NSW in 2012-13 but fell short in Queensland regions. In all regions there were some high performing individual fields. The highest reported yield was 16.2 bales/ha from a field in the Upper Namoi.

Dryland cotton yields

Figure 7 illustrates that in most regions dryland cotton exceeded target yields. These averages are boosted by some particularly high yielding fields in each region. The highest yielding dryland cotton crop was 10.4 bales/ha from a field on the Darling Downs. Nine farms (24% of dryland respondents) reported an area of dryland cotton that was planted but not harvested.

Solid bars in these figures show the average yield across the region, the average of the target yields that respondent growers are aiming to achieve, the average of each farms' highest yielding field and the highest yield from an individual field from across the region.

The dotted line/transparent red bar shows the average quality discounts and the single line above this depicts the highest quality discount received.

Figure 6 Yields and quality discounts of irrigated cotton 2012-13

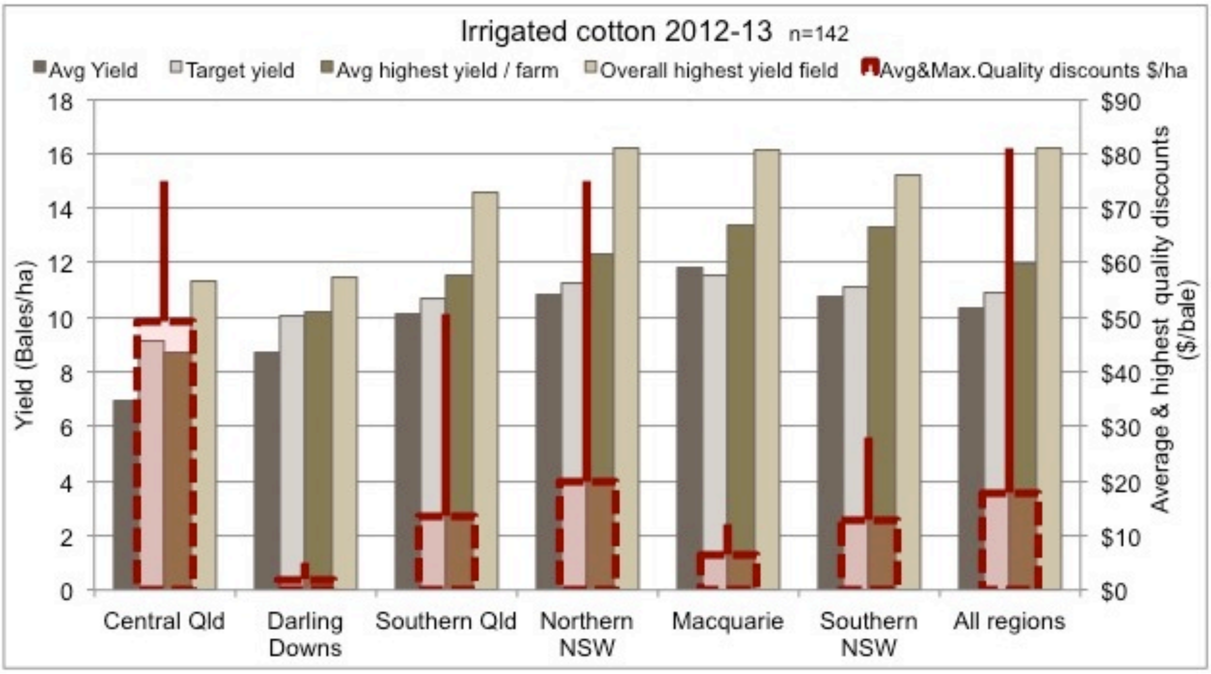
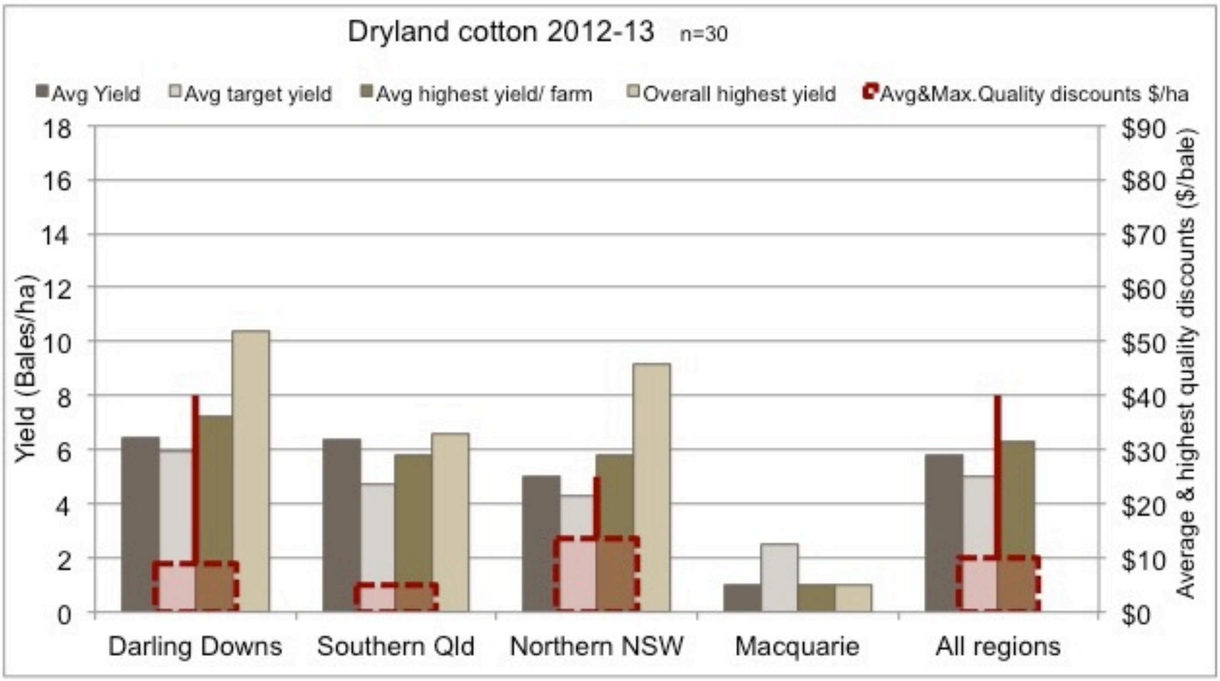


Figure 7 Yields and quality discounts of dryland cotton 2012-13



Quality

57 irrigated growers (40% of respondents) indicated they received quality discounts ranging from 11c/bale to $75/bale. Nine dryland growers (24%) received quality discounts ranging from 50c/bale to $40/bale.

35% of respondents received no quality discounts.

The average cost where quality discounts were received (ie excluding zero or non-response) was $17.80/bale for irrigated cotton and $10/bale for dryland cotton. Of the two discounts of $70 or more/bale, one was linked to colour (this Central Queensland crop had rain at harvest after extreme heat in the growing season) and the other to micronaire in a Northern NSW crop that ran short on water with extreme heat conditions.

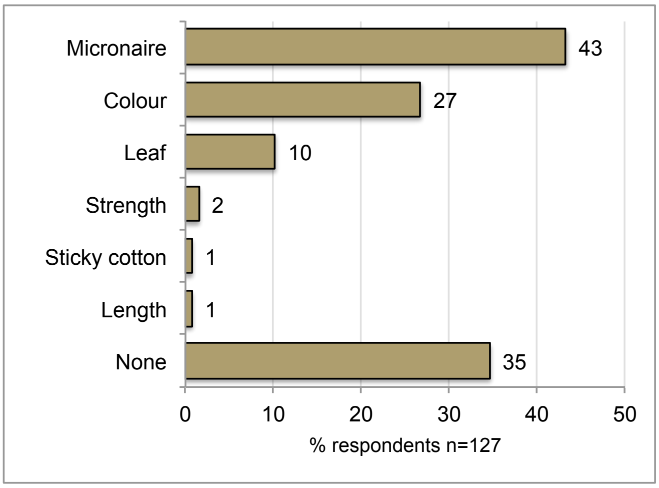
As in 2011-12, quality discounts were significant in Central Queensland (Figure 6). The most common quality discounts experienced in each region were:

- Central Queensland: Colour & leaf
- Darling Downs: Colour & micronaire
- Southern Queensland: Colour & micronaire
- Northern NSW: Micronaire, colour
- Macquarie: Micronaire, leaf, colour
- Southern NSW: Micronaire, colour.

43% of respondents reported that micronaire problems caused costly quality discounts for them in the 2012-13 season (Figure 8). These micronaire discounts occurred in all regions other than Central Queensland. Whilst we cannot distinguish if this was high or low micronaire, it is known that high micronaire is most often a problem when there is very hot weather in the growing season (as in 2012-13).

Colour was a costly discount for 27% of farms. Colour problems occurred across all regions but was most prevalent in Central Queensland where 64% farms indicated that colour was a problem.

Figure 8 Most costly quality discounts received by growers



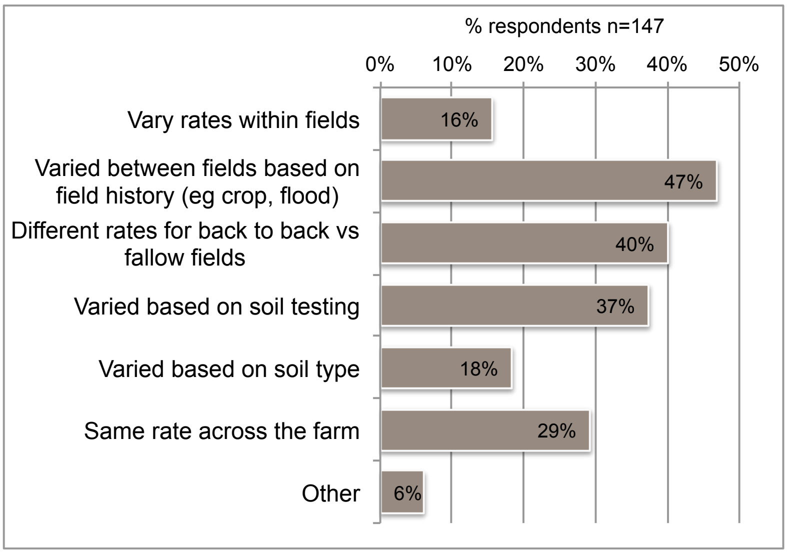
Which quality discounts (if any) were the most costly for you this year?
(or are likely to be if you don't have results yet)
Please tick all that were a substantial cost

Nutrition

Fertiliser rates

Fertiliser nutrient rates were recorded as the 'typical rates' applied across each farm (Table 3). Fertiliser application rates were varied across fields / management units in the 2012-13 season on 70% of respondents' farms, with field history being the most common basis for variation (Figure 9). 16% vary fertiliser rates within a field and 29% use the same rate across the farm.

Figure 9 Variation in fertiliser rates between fields or management units



Was there any variation in your fertiliser application rates between different fields/management units last season? Please tick any that apply

"Other" reasons for variation were described as: based on removal of target / larger yield (4 responses); based on petiole tests; irrigation systems (lateral, flood), varied based on row configuration, different row configurations = better N.V.E. due to less irrigation.

Rates were supplied by grower respondents as either nutrient rates or as fertiliser product rates. Where fertiliser rates were provided these were converted to nutrient rates for that farm. There was often confusion between the two and a number of follow up calls were made to clarify nutrient rates vs fertiliser rates.

Table 3 reports the nutrient rates used in 2012-13, as averages across those farms using each type of nutrient (ie zero values are excluded from the averaging calculation) and the proportion of farms applying each type of nutrient. Table 4 compares nutrient rates in 2012-13 with previous years, showing that most nutrients have, as expected, increased over 16 years but have remained relatively stable over the past two seasons.

Figure 10s 10 to 12 show the rates of N, P and K applied to irrigated cotton on individual farms vs the farm average yield on those farms, with each region presented differently. Figure 13 shows rates of N, P and K for dryland cotton vs yield. These figures show the variation between farms and regions is considerable.

There is a high variation in potassium (K) application: while over half of the farms apply no K, others apply high rates. Several factors may influence this including: soil type, field history or K may be applied on some years only on some farms.

Nutrient rates were gathered based on previously used categories of application (Table 4). Several people also used liquid fertilisers as well – while used in relatively low rates per hectare (especially at planting) they are clearly important in some growers' nutrition strategies.

Table 3 Nutrient rates applied to cotton crops in 2012-13

Applied Fertiliser (nutrient rates) n=136	Irrigated Avg.	Irrigated Min	Irrigated Max	Irrigated % farms	Dryland Avg.	Dryland Min	Dryland Max	Dryland % farms
Preseason nitrogen – solid fertiliser (kg N/ha)	135	9	250	75	89	60	140	54
Preseason nitrogen – gas fertiliser (kg N/ha)	169	70	230	34	70	10	120	27
In season nitrogen – solid fertiliser (kg N/ha)	100	6	310	53	33	3	75	12
In season nitrogen – gas fertiliser (kg N/ha)	88	2	150	8	-	-	-	0
In season nitrogen – water applied (kg N/ha)	61	4	150	41	-	-	-	-
Total applied Nitrogen	243	93	370	100	84	2	140	85
Preseason phosphorus – fertiliser (kg P/ha)	31	0.1	180	70	14	4	30	50
In season phosphorus – fertiliser (kg P/ha)	15	1.6	40	11	8	4	20	15
Total applied Phosphorus	31	1.7	180	76	13	1	30	62
Preseason potassium – fertiliser (kg K/ha)	26	0.2	80	34	10	0.7	30	23
In season potassium – fertiliser (kg K/ha)	12	1	50	11	-	-	-	0
Total applied Potassium	24	1	80	43	10	0.7	30	23
Zinc fertiliser (kg Zn/ha)	3.0	0.25	30	59	1.8	0.1	5	54
Sulphur (kg S/ha) *	14	1.5	180	40	5.5	.7	13	42
Trace elements (kg.ha)	9.1	4.4	15	3	-	-	-	-

NB zero values are excluded from calculations – each average is the average for those farms using this type of application
In-season 'solid' N includes liquid & foliar fertilisers. A few high rates of sulphur are from large applications of gypsum.

Table 4 Trends in fertiliser rates on cotton over 16 years

FERTILISER	1997	2001*	2006*	2007*	2011^ Irrigated	2013 Irrigated	2011^ Dryland	2013 Dryland
Pre season nitrogen - solid fertiliser (kg N/ha)		80	87	101	142	135	89	89
Pre season nitrogen - gas fertiliser (kg N/ha)		78	71	60	155	169	84	70
In season nitrogen – solid fertiliser (kg N/ha)		17	29	60	99	100	45	33
In season nitrogen – gas fertiliser (kg N/ha)		8	14	18	83	88	40	-
In season N water applied (kgN/ha)					57	61	5	-
TOTAL applied N kg/ha	125	176			217	243	96	84
Pre season phosphorus fertiliser (kg P/ha)		23	30	35	42	31	14	14
In season phosphorus fertiliser (kg P/ha)		2	3	2	20	15	13	8
TOTAL applied P kg/ha					40	31	16	13
Pre season potassium fertiliser (kg K/ha)		8	16	24	33	26	7	10
In season potassium fertiliser (kg K/ha)		0	2	4	15	12	2	-
TOTAL applied K kg/ha					28	24	7	10
Zinc fertiliser (kg Zn/ha)		5	5	5	4.4	3	3.7	1.8
Sulphur (kg S/ha)					6.3	14	2.4	5.5
Trace elements					21	9	4	-

* Roth G (2009) Economic, environmental and social sustainability indicators of the Australian Cotton industry. Cotton CRC.
^ GHD Hassall (2011) Cotton Grower Practices Survey. Cotton CRC and CRDC.

Figure 10 Nitrogen rates used on irrigated cotton farms vs yield

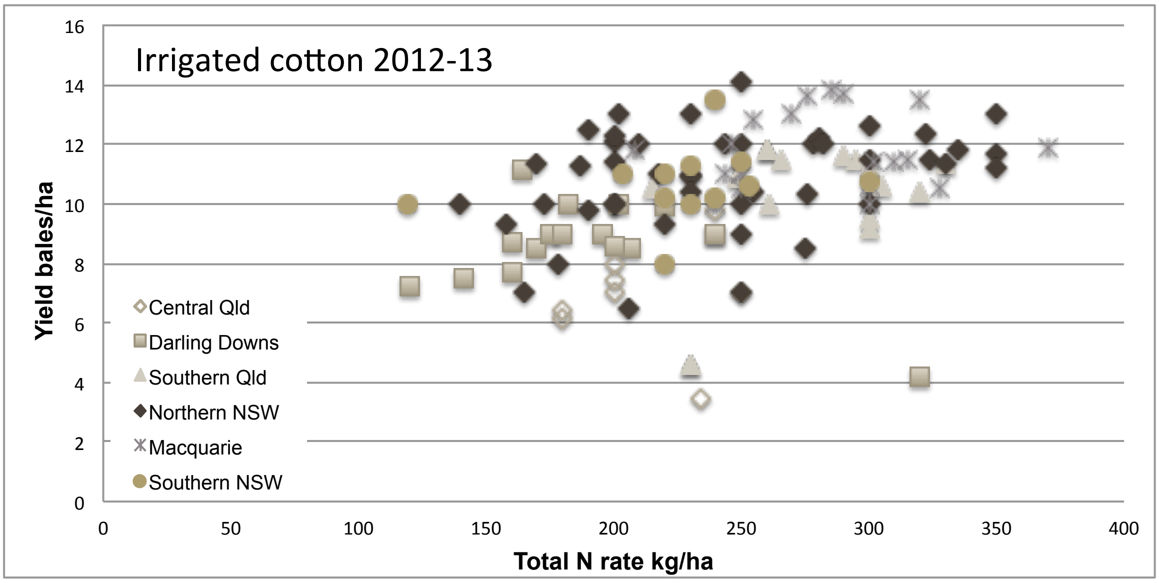


Figure 11 Phosphorus rates used on irrigated cotton vs yield

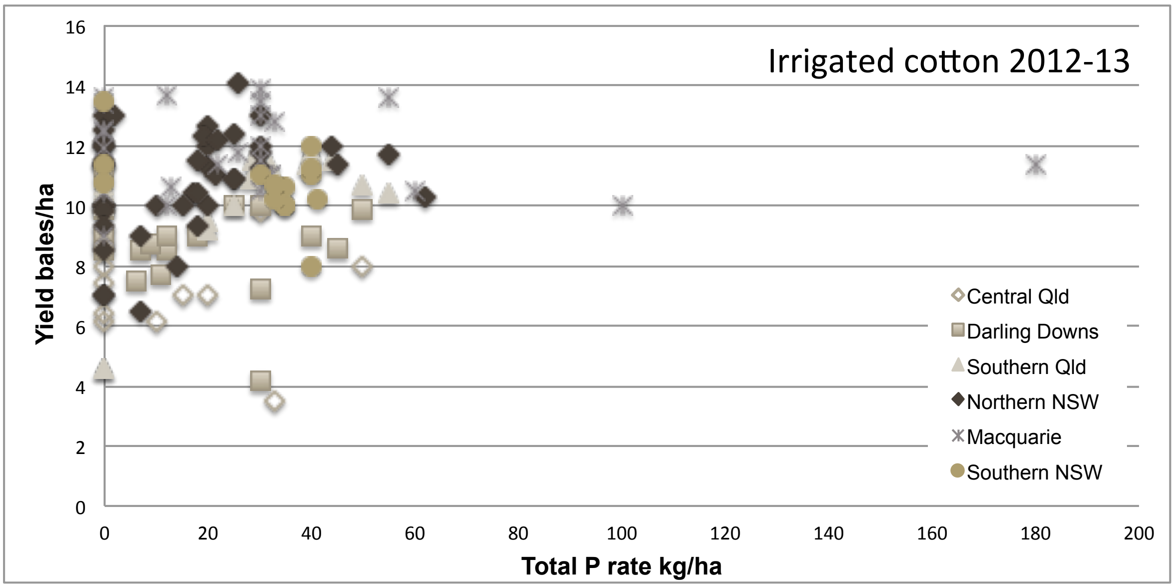


Figure 12 Potassium rates used on irrigated cotton vs yield

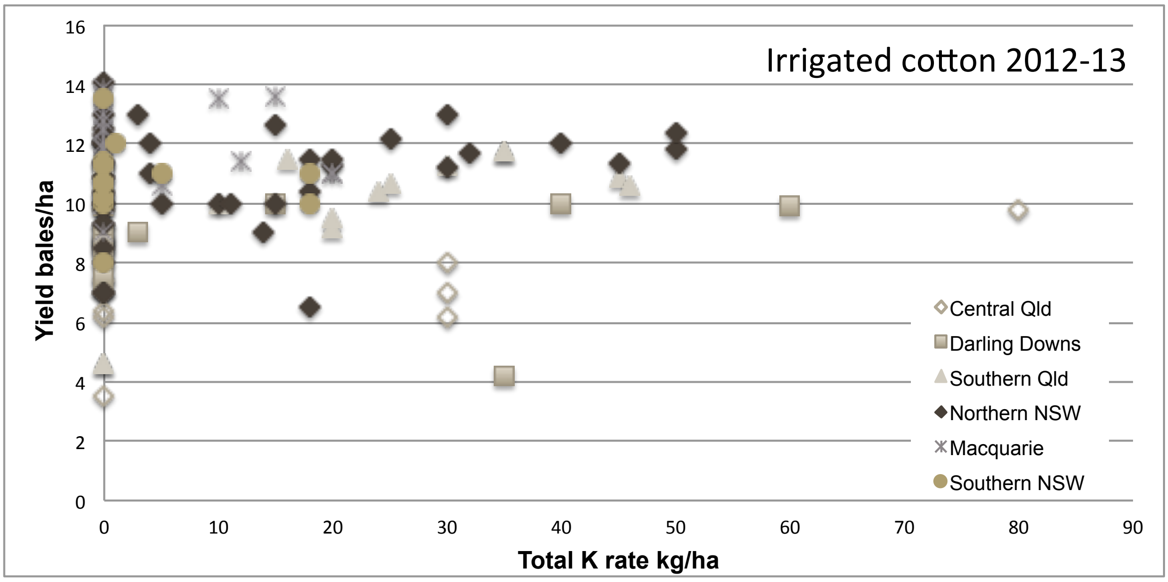
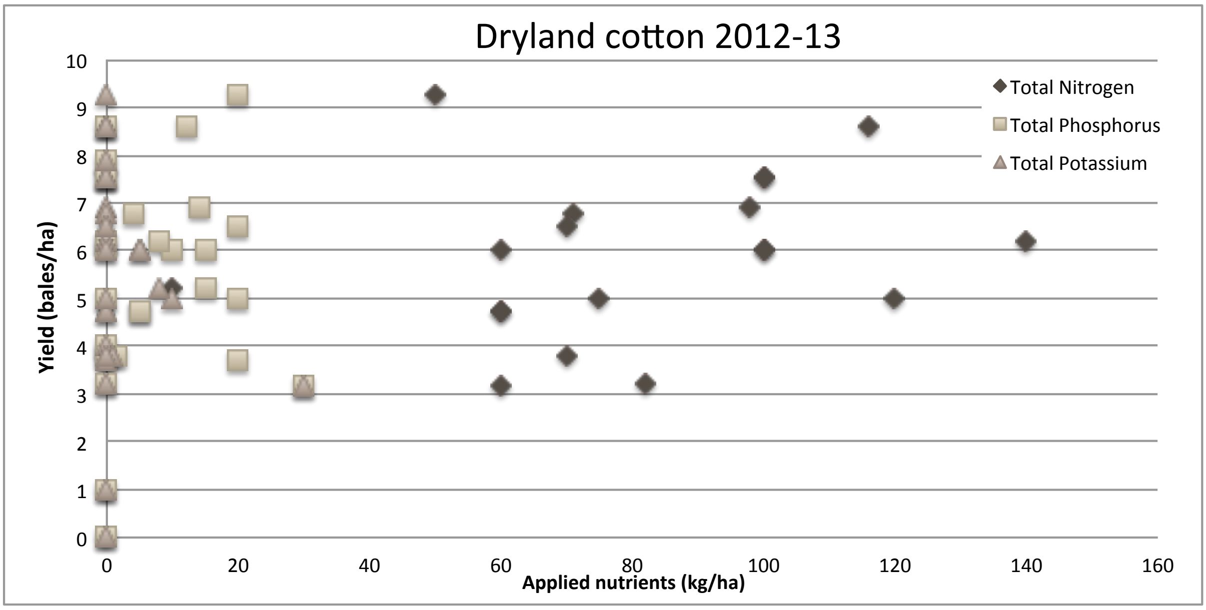


Figure 13 NPK fertiliser rates used on dryland cotton vs yield



Nitrogen fertiliser use efficiency

Calculation of the nitrogen fertiliser use efficiency (NFUE: kg lint/ha divided by the kgN/ha) reveals that only 13% of respondent farms are achieving NFUE on irrigated cotton within the optimal range of 12.5 to 16 kg lint/kg N recommended by Dr Ian Rochester's (CSIRO) research (Table 5).

There is quite a degree of regional variation (eg 27% of irrigated farms in Northern NSW have NFUE in this optimal range), which appears to be linked to yield variations. In the majority of irrigated cotton farms, the NFUE is lower than optimal (ie they are applying more N than necessary for the amount removed in harvest).

Note that this measure does not take into account the background level of nitrogen or any N applied in manures and composts, it is only based on the reported fertiliser application rates to the cotton crop and harvested yields. This may contribute to the high NFUE in dryland crops – eg if N has been over applied to the previous crop with a subsequent low rate on cotton.

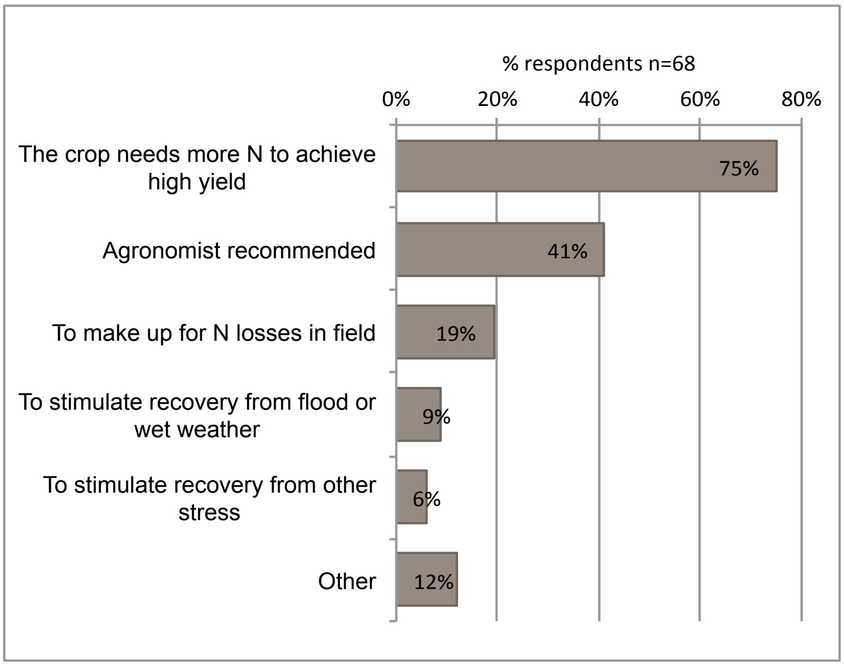
Table 5 Calculated nitrogen fertiliser use efficiency

Region	Irrigated		Dryland	
	Average kg lint/kg N	% of farms in optimum range # (12.5 to 16 kg lint/kg N)	Average kg lint/kg N	% of farms in optimum range (12.5 to 16 kg lint/kg N)
Central Qld	7.5	0 %	-	-
Darling Downs	10.7	12 %	17.4	17 %
Southern Qld	8.3	0 %	17.8	33 %
Northern NSW	10.6	27 %	35.7	20 %
Macquarie	9.7	5 %	-	-
Southern NSW	11.1	0 %	-	-
All regions	**10.0**	**13 %**	**22.0**	**20 %**

optimum range based on work by Dr Ian Rochester

Close to half (46%) of irrigator respondents recorded total Nitrogen rates of 250 kg/ha or higher on irrigated cotton. The main reasons given for this were the crop's needs for high yield and agronomist (Figure 14). This pattern is similar in all regions with the exception of the Gwydir where agronomist recommendation was rarely identified as a reason for the higher rate. Other reasons given were: Back to back cotton, leaf analysis and *"To ensure crop is green at the finish. I will pick up leftover N in subsequent crops."*

Figure 14 Reasons for N rates higher than 250 kg/ha



If your total applied Nitrogen rate is higher than 250 kg N/ha, what are your primary reasons for this?

Gypsum

Findings about gypsum applications in 2012-13 can be summarised as:

- 16 farms (12%) applied gypsum to irrigated cotton.
- Between 36 and 934ha were treated on these farms.
- The area treated on each farm equated to between 4 and 83% of the area of the farm developed for irrigation.
- Rates applied ranged from 1 to 5 tonnes/hectare, on average 2.2 tonnes/ha.
- No dryland cotton received applications of gypsum.

What area of your irrigated and/or dryland cotton did you apply gypsum to in 2012-13 and at what rate?

Fertiliser costs

75% of irrigated cotton respondents spent between $300 and $600 per hectare on nutritional inputs for their 2012-13 cotton crop (Figure 15). On dryland crops, 95% of respondent farms spent less than $300 per hectare (Figure 16).

Across all respondents there was a wide range of fertiliser costs for the same levels of yield (Figure 17). Higher rates are broadly linked to higher yields but it is interesting to note the wide range of fertiliser spend for the same yield. For example, fertiliser inputs for crops yielding over 12 bales/ha ranged from $200-250/ha through to more than $750/ha.

Most of the irrigated crops with costs below $250 received nitrogen fertiliser at rates between 140 and 240 kgN/ha and no other fertilisers. There was no clear pattern of timing of application for the low fertiliser cost farms, with most having split N applications. The irrigated farm with fertiliser cost below $50/ha was using a complete sewerage program. Farms with fertiliser costs over $600/ha had N rates between 200 and 370kg/ha and most were also applying other nutrients.

It is possible that some respondents may have included application in their cost estimates.

Figure 15 Fertiliser costs on irrigated cotton: proportion of farms in each cost bracket

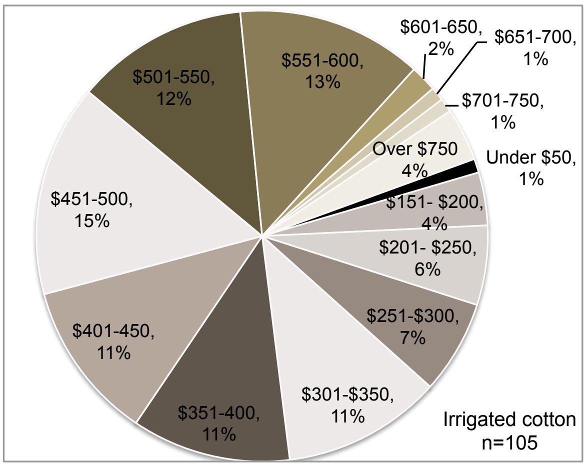
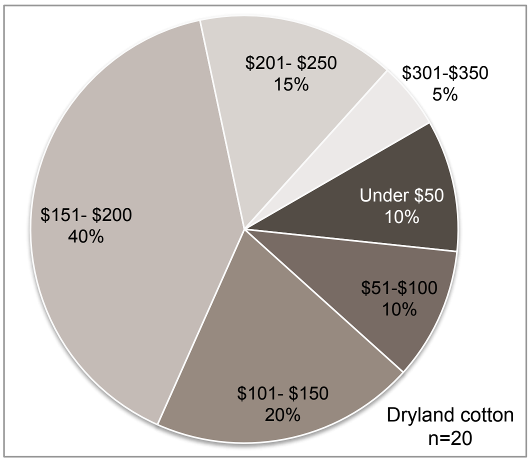
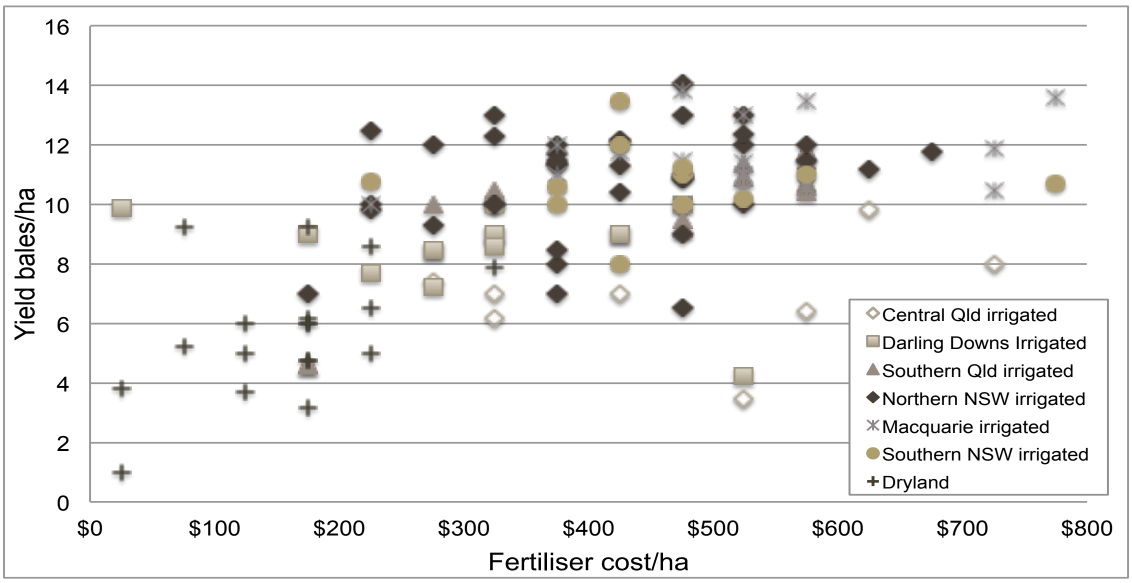


Figure 16 Fertiliser costs on dryland cotton: proportion of farms in each cost bracket



What was the approximate cost per hectare of nutritional inputs for your 2012-13 irrigated and/ or dryland cotton crops?

Figure 17 Fertiliser cost vs yield on individual farms



Fertiliser application methods and timing

Analysis of the rates of nitrogen applied pre-season vs in-crop reveals:

- The proportion of N applied pre-season is highly variable (Figure 18).
- On average 67% of nitrogen was applied pre-season for irrigated cotton.
- 15% of irrigated farms applied all nitrogen pre-season and 26% applied more than 80% of nitrogen pre-season.
- Two irrigated farms applied all nitrogen in-crop.
- 17% of irrigated cotton farms applied less than half the nitrogen pre-season.
- Almost all nitrogen on dryland crops was applied pre-season.

There had been some speculation that a higher proportion of fertiliser would have been applied pre-season in the dry winter of 2012 as compared to the wet winter of 2010 which had restricted pre-season application. However, the average of 68% nitrogen being applied pre-season in 2012-13 is only slightly higher than the average of 60% in 2010-11.

Figure 18 Proportion of nitrogen applied pre-season vs yield for irrigated cotton

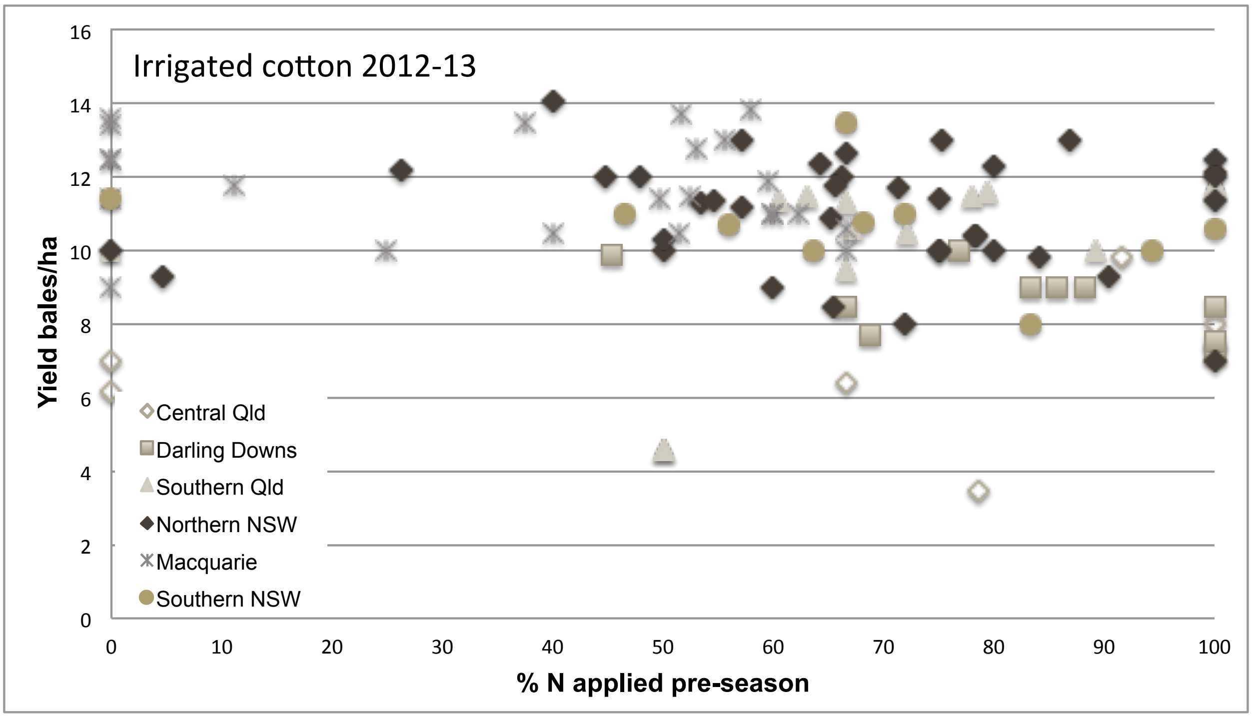
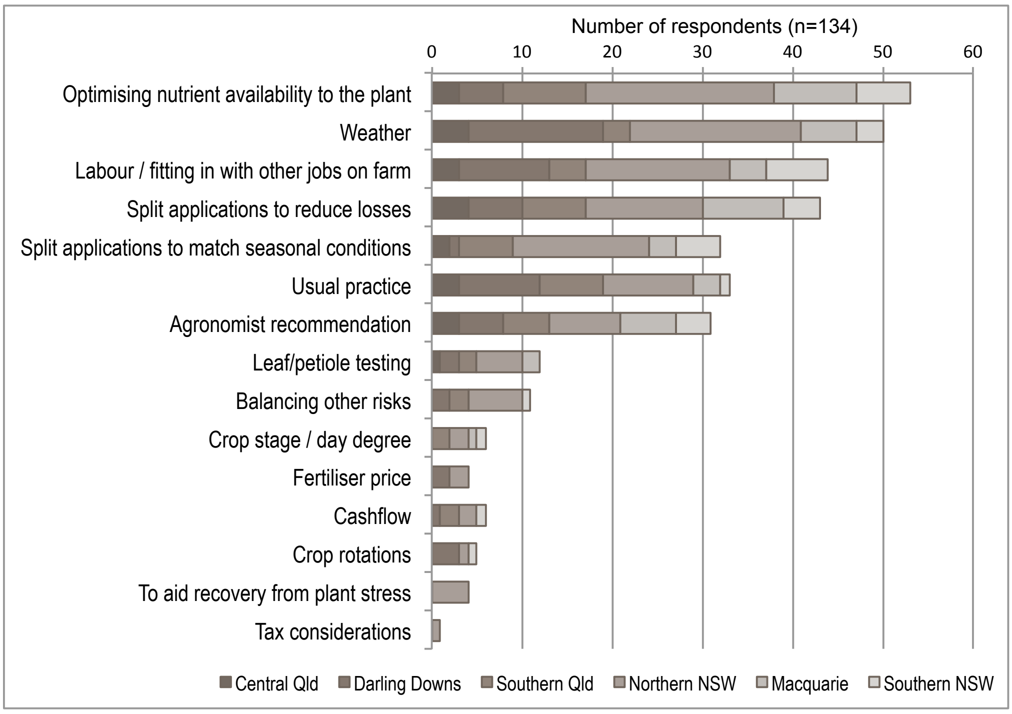


Figure 19 shows that the main factors influencing timing of fertiliser applications were optimising nutrient availability to the plant (40% of respondents), weather (36%), labour (33%) and split applications to reduce losses (32%)

Figure 19 Factors influencing timing of fertiliser application



What factors most influenced the timing of fertiliser applications last season?

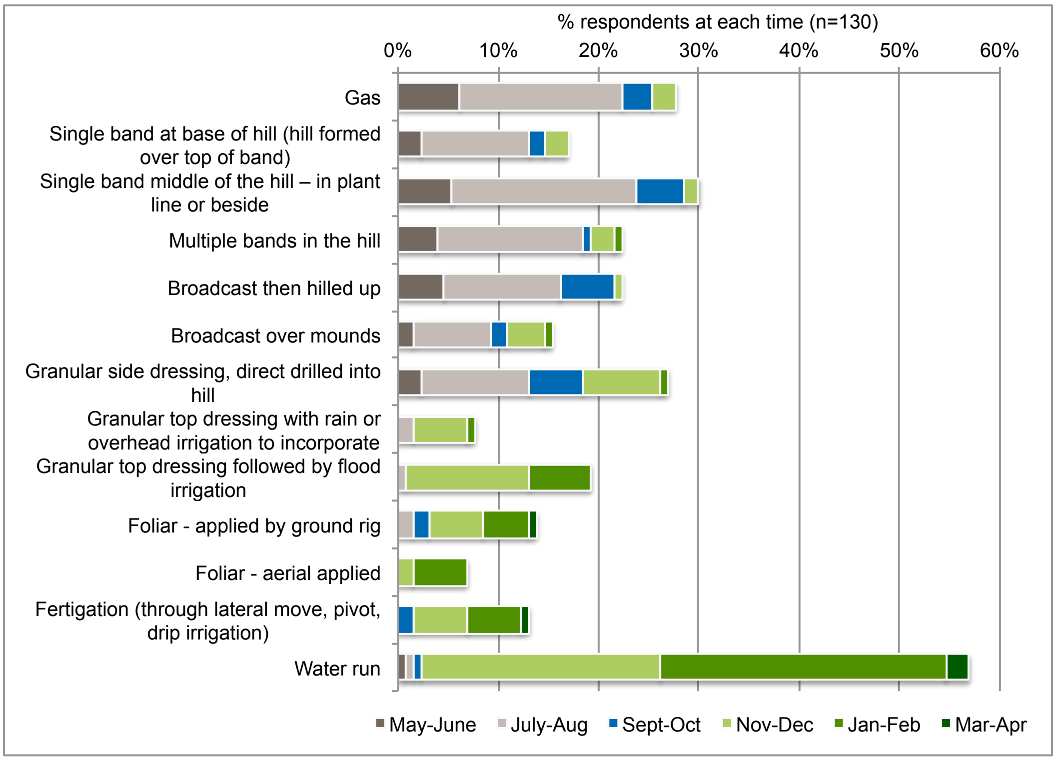
Figure 20 illustrates the timing and methods of nitrogen fertiliser application while Figure 21 shows the methods of applying P, K and other fertilisers. Note that several respondents indicated two timings of N application via a given method (eg Gas in May-June and in July-August) – we are unable to determine whether these are two separate applications or whether it is a single application applied at some time during that wider window). There are no clear regional trends in the application methods used.

These graphs show considerable variety in the methods of application, particularly for nitrogen. Several farms use two or more methods of applications, particularly for Nitrogen (eg gas, banded and/or waterrun). Conversely, other farms have used only gas in July-August.

Nitrogen application methods included:

- 55% of farms applied nitrogen in bands of some form.
- 41% of farms water run nitrogen at least once.
- 31% broadcast nitrogen.
- 24% of farms applied nitrogen as a gas. Of these all except one farm also applied Nitrogen in another form.
- 24% apply N as a granular side dressing direct drilled into hill.
- 5% apply N as a granular top dressing with rain or overhead irrigation to incorporate.
- 18% use a granular top dressing of Nitrogen followed by flood irrigation. It would be interesting to understand how this is done as their can be high risk of down furrow movement in some conditions.
- 16% of farms applied foliar nitrogen either by air or groundrig.
- 8% of farms used fertigation (through lateral move, pivot or drip irrigation) to apply nitrogen. This appears to be quite high. We did not ask about the irrigation type being used and so are unable to calculate the proportion of farms with overhead or drip irrigation who fertigate.

Figure 20 Timing and method of application of nitrogen fertilisers



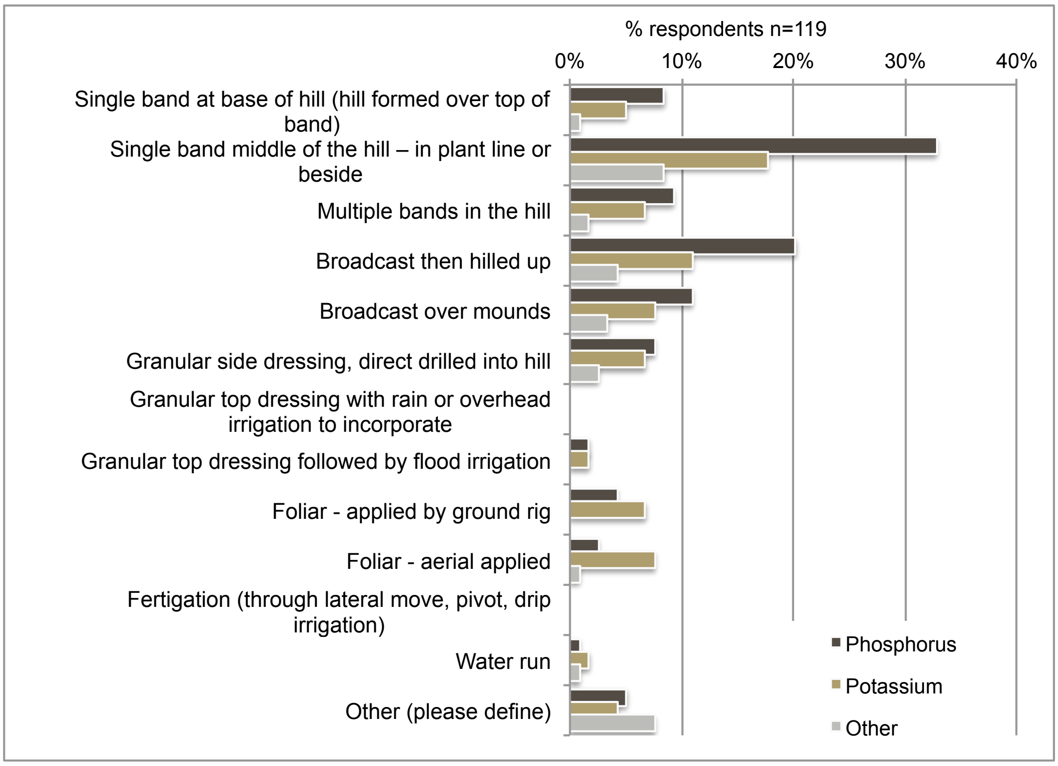
How and when did you apply nitrogen fertiliser for cotton crops in 2012-13?

NB each farm is counted for each time period where the fertiliser methods has been used. Thus the cumulative bars are the accumulation of all periods where a method has been used. eg in total 41% of farms water applied N, many of these did this more than once.

Phosphorus is most commonly applied in bands (45% of respondents with 32% applying P in a single band at the middle of the hill, in the plant line or beside). Broadcasting P is also popular with 28% broadcasting P either over mounds (10%) or followed by hilling up (21%).

Potassium is banded by 27% of respondents, most commonly as a single band in the middle of the hill (17% of respondents). 17% broadcast K over the mound (7%) or followed by hilling up (11%).

Figure 21 Method and timing of phosphorus, potassium & other fertilisers

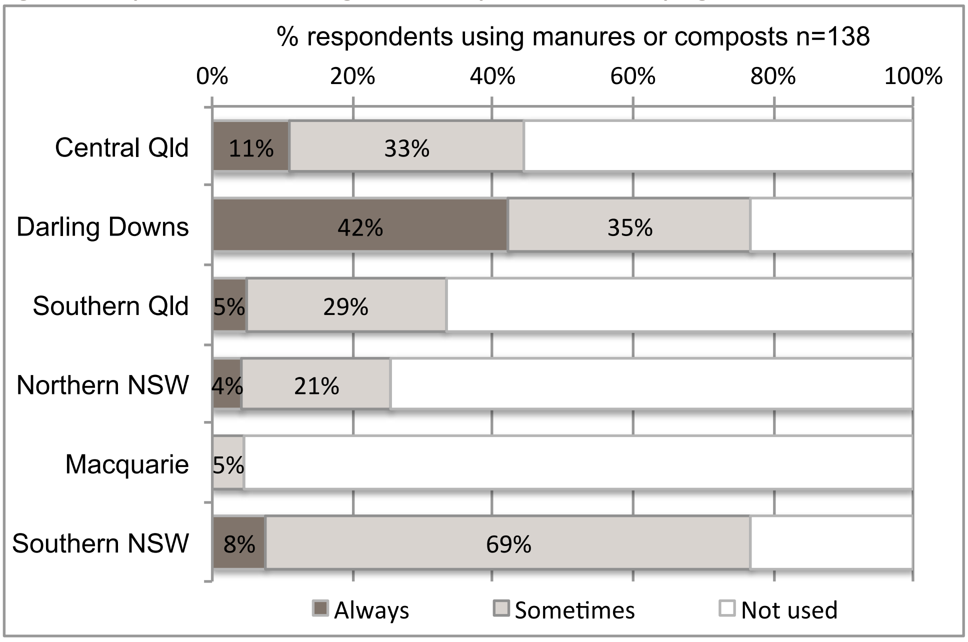


How did you apply phosphorus, potassium and other nutrients for cotton crops in 2012-13?

Manures & composts

39% of surveyed farms used manures or composts at least sometimes as part of their nutrition program. The use is much higher on the Darling Downs and in Southern NSW (Figure 22), likely due to closer proximity to feedlots and poultry farms.

Figure 22 Proportion of farms using manures as part of a nutrition program



Do you use manures or composts as part of your nutrition program?

The most commonly used are chicken and cattle manure. A few use cotton compost (gin trash) and one farm reported using pig manure.

What type of manures or composts and what role does this play in your nutrition program?

Comments made about manures mainly described them as being used for their nutritional inputs of phosphorus, potassium, zinc and trace elements and by a few to improve waterholding capacity or to 'activate the biology'.

Some farms noted that they use manures as a part of their longer term nutritional program (eg "Feedlot manure used every 3-5 years at 9t/ha" or "5t Cattle & chook manure every second year, keep a mixed fertiliser plan") whilst others are more opportunistic ("Aged cow manure - we use as much as we can source at a fair price") or on a needs basis ("Cow manure on cut area after land forming").

Cotton compost was used by some for phosphorus and potassium.

Soil, leaf and petiole testing

How often do you usually soil, leaf and /or petiole test for each of these nutrients/ conditions?

These questions sought to understand the nature of soil, leaf and petiole testing carried out by cotton growers. This involved the combination of the depth of testing, the frequency of testing and the types of tests.

The proportion of growers conducting each type of test at the various frequencies is shown for irrigated cotton in Figure 23 and for dryland cotton in Figure 34.

Note, the groupings of elements used (eg Nitrate, pH, EC Chloride) were advised by Dr Mike Bell (QDAFF) as they are those that are commonly offered as a set by laboratories. The differences in soil testing depth in the irrigated and dryland questions is based on the differing recommendations for each of these systems.

Some observations on the patterns of use of soil and plant testing:

- Most growers use the same frequency of soil testing for all depths and analyses. That is, when they do soil test, they carry out all tests rather than using a differing strategy for each depth or element for soil test.
- One third of respondents soil test some fields every season on irrigated cotton.
- 52% of irrigator respondents have a soil surface test for Nitrate-N, pH, EC, Chloride test done every season, 18% having it done on every field every season.
- 13% have a petiole nitrogen test conducted on every field every season on irrigated cotton.
- Some growers use only leaf and/or petiole testing, conducted every season.

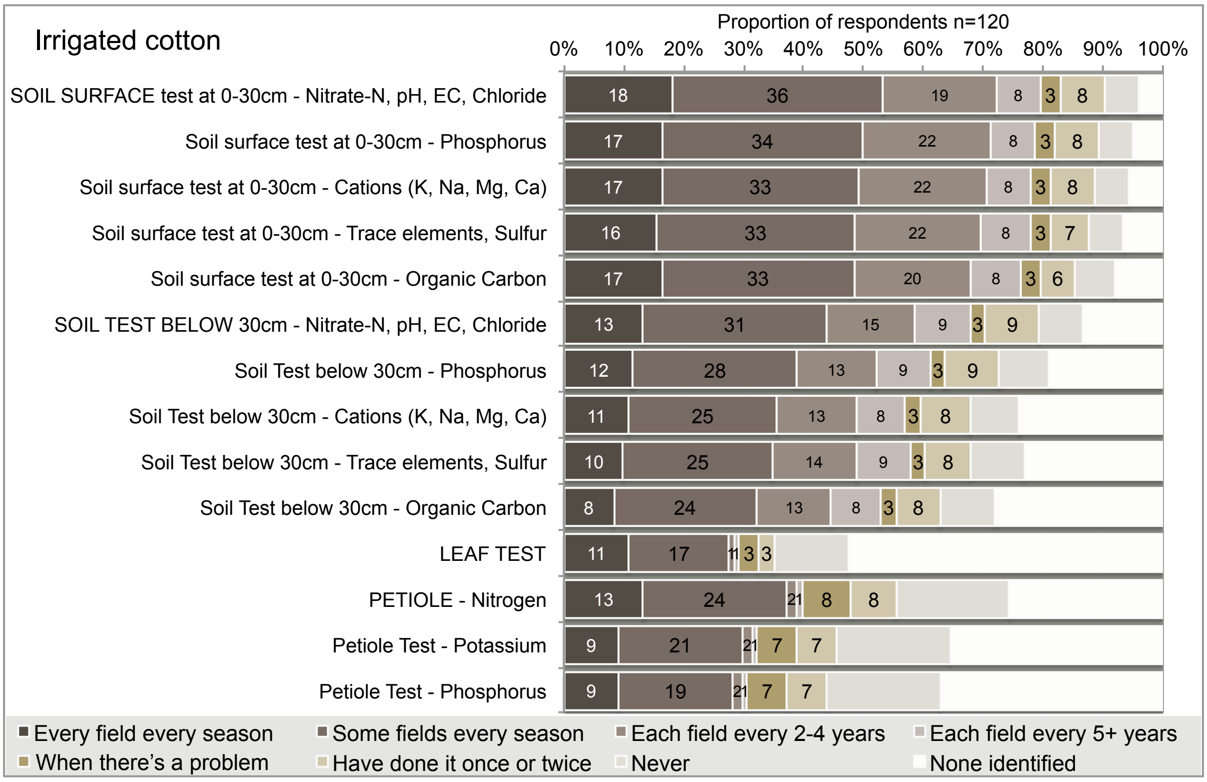
Barriers to improving fertiliser use efficiency

Growers were asked to identify the main barriers to improving their fertiliser use efficiency. The responses to this open ended question are presented in Table 6.

The identified barriers can be grouped as relating to:

- weather,
- application and practicalities,
- fertiliser and inhibitor products and availability,
- efficiency of application,
- costs,
- agronomy,
- soils, and
- knowledge.

Figure 23 Frequency of soil, leaf and petiole testing used by growers for irrigated fields



"None identified" categorises those growers who responded to the question but did not select a response to that testing process – we can likely assume this means that they do not do that form of analysis.

Figure 24 Frequency of soil, leaf and petiole testing used by growers for dryland fields

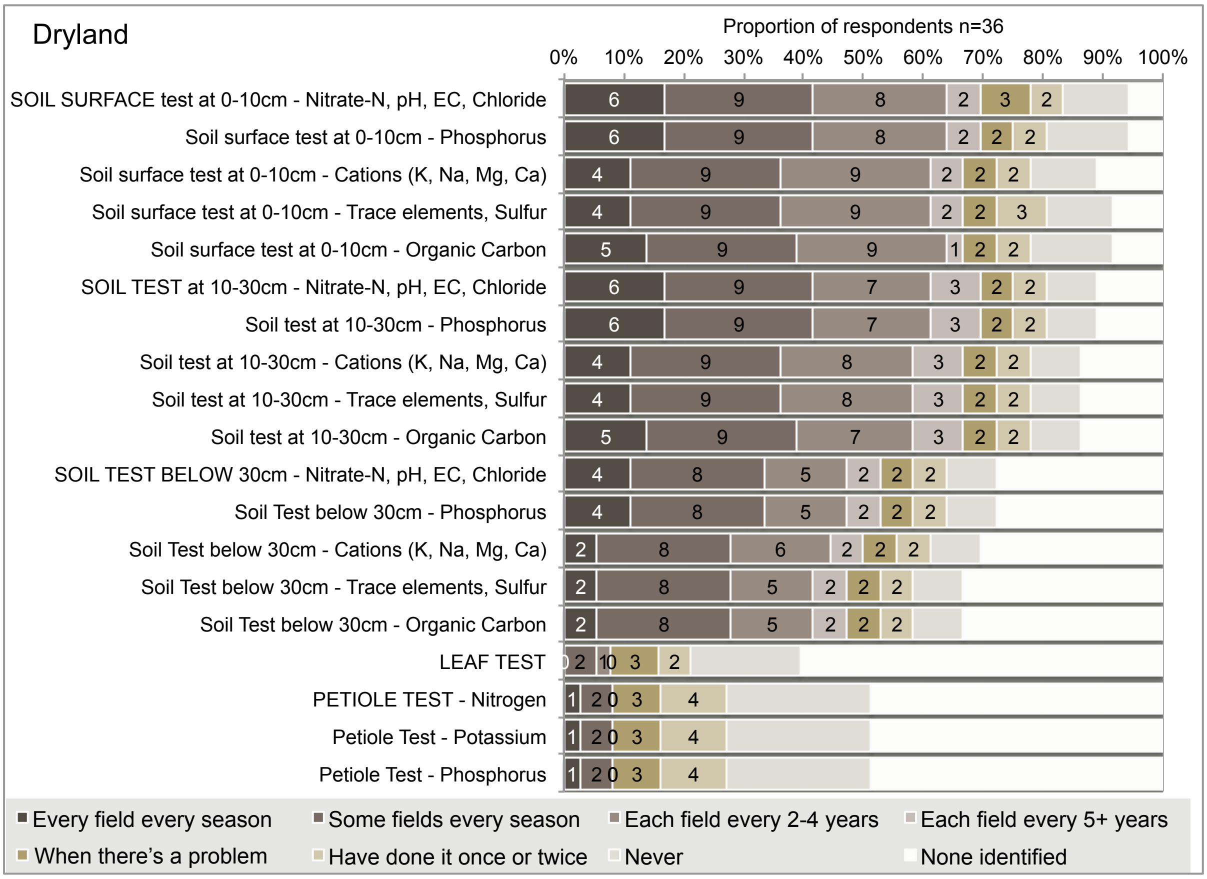


Table 6 Barriers to improving fertiliser efficiency

n= 87

Weather	Application & practicalities	Knowledge
• Weather and predictability • Time, Weather (x3) • Soil, Weather • Lack of rain • Often rain events • Moisture (X2) • Weather - High rainfall • Climate • Weather, Machinery • Flooding • Uncertainty of water supply • Season Length	• Managing application & supply risks (X3) • Seasonal conditions and practical issues (x3) • Equipment is a limitation (X2) • Being able to apply small amounts more often • Good application • Application methods and timeliness • Ease of use & timing issues • Timely applications • Deep placement • Balancing the risk between wanting to apply it in crop when it needs it and actually being able to do this • Type of application matching plant yield to n requirement • Stop buying / developing farms	• Industry hasn't come up with a better fertiliser plan • Not knowing how to be more efficient • Knowing yearly fertiliser requirements • Knowledge (x2) • Always trying to improve • Lack of knowledge • Not able to measure it. • Accurate knowledge of crop demands • lack of trial data and knowledge • How to measure it • Information (X2) • Trials are very time consuming • Better understanding • Knowledge - lack of
Products	**Efficiency of application**	**Cost**
• Lack of availability of Big N - use of Urea is insufficient • Lack of Nitram • Availability of products • Type of product - no nitram available • Lack of cost effective nitrogen loss inhibitors	• Getting N into soil with minimal losses. • Leaching • Denitrification during wet periods. Gross margin from legume crops are poor on irrigated country eg: Soybeans, Mungbeans, Fababeans, Chickpeas • Don't know how to or if there is any evidence for split applications having a benefit	• Cost (x2) • Cashflow and labour reliability • Cost of application • Freight logistics cost • Cost and water availability • Weather x labour =cost • Timing and cost of application
Agronomy	**Soils**	
• Variability of response and having N available if crop requires it • Trying to increase yields • Growing conditions • Yield Vs rates • Lack of fallow in high water availability years • Irrigation, slope of fields	• Volatilization, Deep Drainage, Sodic Soils, Rainfall, Root Biomass • Soil Biology • Soil Health - Organic matter • Soils proneness to waterlogging events (esp; flood events) had much better efficiency during the drought • Reducing wheel track compaction and water logging. • Soil conditions • Varying results from soil/leaf tests	

Understanding nitrogen pathways

Question 9 in the survey asked growers to rate their level of agreement to disagreement with a number of statements. Figure 25 illustrates responses to the statements relating to nitrogen. This perhaps indicates a potential to supply more information to improve many growers understanding of nitrogen use efficiency and emissions losses as:

- 45% of respondents believe that they have enough information to calculate nitrogen use efficiency.
- 62% have a good understanding of how to maximize nitrogen use efficiency (compared with 13% whose calculated nitrogen use efficiency fell inside the recommended optimum range).
- Less than a third of respondents (28%) indicated that they understand how to reduce nitrous oxide emissions from their system.

Figure 25 Perceptions on understanding and information for nitrogen management

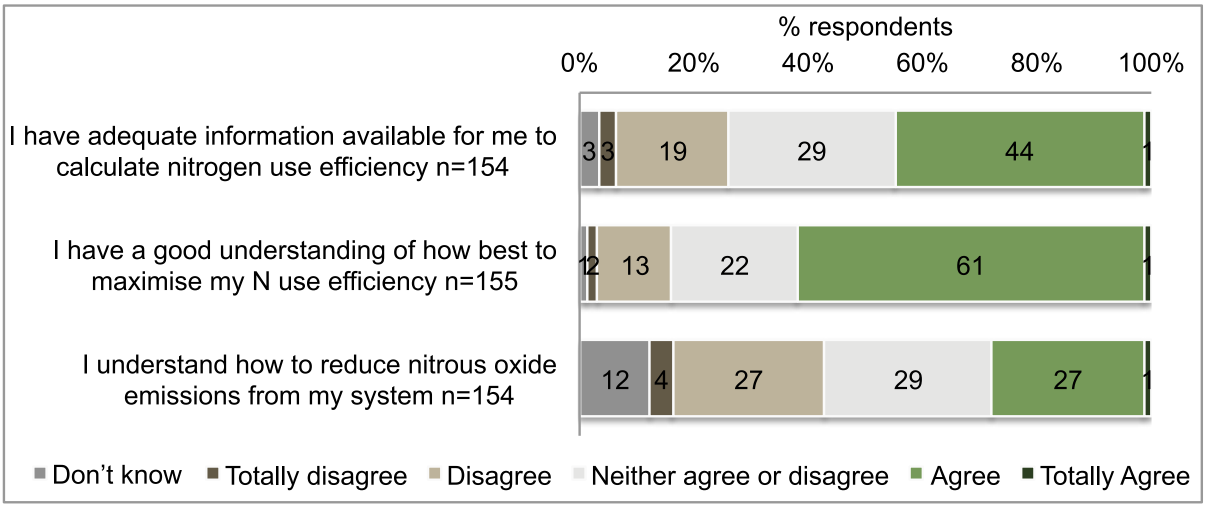


Table 7 illustrates that there are highly varied views about the proportion of nitrogen that is used by the crop, tied up in soil or lost. Respondents' estimates of the proportion of applied nitrogen that is used by the crop ranged from 35% to 100%. The majority of growers felt that between 60 and 90% of nitrogen fertiliser was used by the crop (average 69%). 89 growers responded to this question, some of the non-respondents indicating that they didn't know, and some who did respond noting that it was 'only a guess really'.

Table 7 Estimated proportions of nitrogen fertiliser thought to be used, stored or lost

n=89	% into the crop	% tied up in the soil at the end of the season	% lost to leaching or run-off	% lost into the air
Average	68%	12%	12%	8%
Range	35 – 100%	0 – 45%	0 – 30%	0 – 30%

Approximately what proportion of Nitrogen fertiliser you apply do you think goes to each use/loss.

Soil, land preparation & crop rotations

In response to the question "In general across your farm, do you consider the health of your soil is increasing, steady or declining?":

- 71 respondents thought the health of the soil was increasing
- 69 thought it was steady and
- 1 respondent thought it was declining.

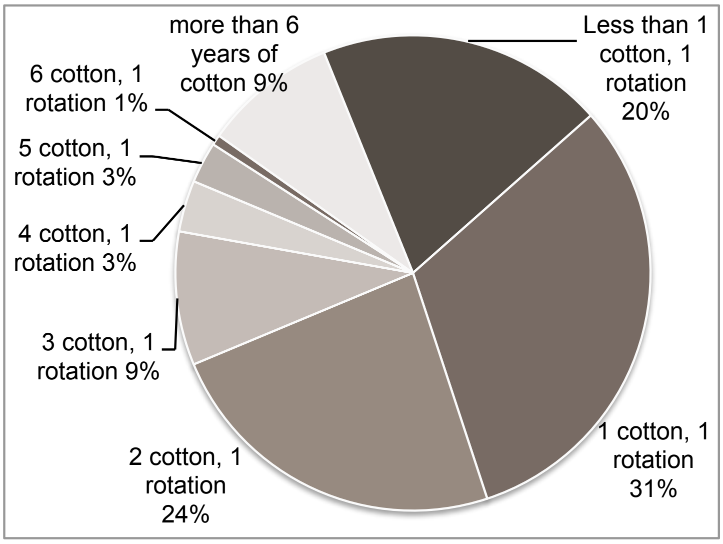
Rotations

Growers were asked to identify the average frequency of cotton production in any field on their farms. The proportion of growers using each frequency is presented in Figure 26. Comparison with historical responses to this same question since 1996 (Table 8) shows this fluctuates over time, likely influenced by commodity prices and seasonal conditions.

Findings about rotations and land use include:

- 75% of respondent growers will on average have 2 or less cotton crops before having an alternate crop or fallow break.
- Almost half (49%) of respondents usually grow at least one "back-to-back" cotton crop and 25% will have at least 2 cotton crops in a row.
- 13% will grow 5 or more cotton crops before a break.
- Irrigation farms used between 15% and 100% of their irrigation country for cotton production in 2012-13 with an average of 58%.
- Dryland cotton accounted for between 7% and 54% of the area developed for dryland cropping on each farm, with an average of 23% in 2012-13.

Figure 26 Average frequency of cotton production in a field on each farm



On average, what is your frequency of cotton production in a field?

Where rotation = a crop other than cotton or a fallow of 18 months or more

Less than 1 cotton, 1 rotation is where cotton is followed by two or more alternate crops or fallow breaks.

Table 8 Percentage of farms growing cotton at each frequency in a rotation, from 1997 to 2013

Cotton production frequency	1997	2000	2006	2007	2013
Less than 1 cotton, 1 rotation	4%	9%	19%	3%	20%
1 cotton: 1 rotation	42%	22%	36%	28%	31%
2 cotton: 1 rotation	24%	17%	20%	10%	24%
3 cotton: 1 rotation	9%	15%	6%	6%	9%
4 cotton: 1 rotation	6%	6%	6%	7%	3%
5 cotton: 1 rotation	2%	6%	2%	8%	3%
6 cotton: 1 rotation	n/a	3%	2%	4%	1%
More than 6 cotton/rotation	12%	18%	8%	22%	9%

The crops grown in rotation with cotton in the past three years are listed in declining order of popularity in Table 9. It shows that most respondents (78%) had a wheat crop grown in rotation with cotton in the past 3 years and that 46% of growers thought that wheat was the crop having the most positive affect on the subsequent cotton crops.

The 11% of farms that did not grow any other crops in rotation with cotton were all irrigated cotton farms, located across several regions.

Table 9 Rotation crops grown and those seen to have most positive affect on subsequent cotton crops

	Proportion of farms growing it past 3 years	% that thought this had the most positive affect on subsequent cotton
Wheat	78%	46%
Chickpea	31%	12%
Sorghum	26%	4%
Barley	20%	5%
Maize; corn	19%	16%
Mungbean	12%	2%
Faba Beans	10%	11%
Canola	10%	0%
Soybean	3%	4%
Vetch	3%	4%
Sunflower	1%	0%
Other: French white millet; Canary seed; Lab lab.	8%	9%
None	11%	4%

In the past 3 years, which of the following crops did you grow in rotation with cotton?

Of these crops or fallow breaks, which did you think had the most positive affect on the subsequent cotton crop? Why?

Reasons cited for the positive affect of wheat crops on cotton included:

- Moisture: more moisture, wheat moisture retention.
- Soil structure: cereal crop cracks soil open, adds organic matter; Soil drying, cracking (stubble) fallow; wheat does a good job of breaking up the clods making the soil more friable, wheat was good for breaking out compaction and leaching out salts
- Stubble: Crop residue, Stubble cover, Different type of crop stubble, Ground cover, *"We were left with more stubble so soil softer and held more moisture and I believe we had more organisms in the soil as a result"*
- Other: VAM host, Disease break, weed control; Research suggests it is better; easiest to go back to cotton.

Chick peas, faba beans and maize were the next most commonly mentioned crops in having positive impacts on subsequent cotton crops with reasons being:

- Maize / corn / feed corn: improved soil structure; Plant vigour and health seems better, soil cover, microbial activity, different weed spectrum, shallow roots, high organic matter *"I need management herbicide rotation", "Its a rotation from cotton and I feel cotton responds better to a short fallow".*
- Chickpeas and Faba beans: Organic Nitrogen that's stable in the soil, legumes for soil improvement, soil tilth and some N, softer soil, improved soil structure and fertility. *"Faba beans are very good for soil health on older type fields"*

Positive affects were also reported from less common break crops including:

- Vetch: Vetch then wheat, soil tilth, N response, organic carbon
- Mungbean – *"positive affect, no idea why!"*
- Soybeans due to buildup soil nutrients and tilth; less moisture extracted.
- French white millet – *"best cover for moisture used"*
- Canary seed - Disease and soil health
- Sunflowers *"definitely improve deep soil friability (breaks deep compaction)"*
- No break crop – mulch, "*I haven't seen much difference*".

There was concern about a possible negative impact from canola:

- "We think Canola may have reduced Cotton Yield – VAM?"

Row spacing

Irrigated cotton was primarily (84% of responding farms) solid planted at 1m rows (Table 10).

69% of dryland cotton was planted at 1 m rows but there was more variation in the planting configuration. The most common were 1m double skip (30% of responding farms) and 1m single skip (27%). 1.5m and 2m plantings and even wider were also used. There does not appear to be a regional pattern in the row configurations used for dryland cotton.

What row spacing did you use for cotton in 2012-13?

Table 10 Proportion of farms using each type of planting configurations for cotton in 2012-13

	Less than 75cm	75 cm or 30"	90cm or 36"	1 m	1 m single skip	1m double skip	1.5 m	2 m	More than 2 m
Irrigated cotton	0	1%	6%	84%	3%	0	4%	2%	0
Dryland cotton	0	0	0	12%	27%	30%	15%	9%	6%

Machinery operations and its impacts

Machinery operations undertaken for cotton crops are listed in Table 11. Note that some who responded to this question only gave figures for either the cotton after rotation/fallow or cotton follows cotton situation. It may be that they do not have the other as part of their system.

On average, how many of each of the following types of tillage passes did you do for your last cotton crop (from July 2012 to June 2013)?

There is considerable variation in the number of machinery passes carried out on each farm, ranging from 1 to 10 passes. Overall there is more cultivation for back-to-back cotton (5.3 passes on average) than for cotton following a rotation (4.1 passes on average).

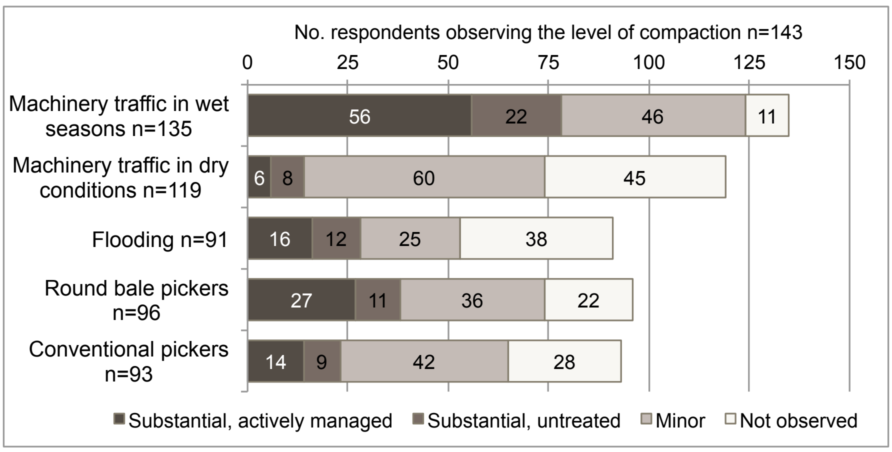
Table 11 Number of tillage passes used in cotton production

Number of passes		Light operations **eg harrowing, root cut, plant, interrow cultivation**	Medium operations **eg pupae busting, discing**	Heavy operations **eg deep ripping, listering**	Total
Where cotton followed cotton n=99	Average number of passes	2.7	1.6	1	5.3
	Maximum	7	5	4	10
	% of farms doing some of these operations	90%	90%	72%	100%
Where cotton followed rotation or fallow n=89	Average number of passes	2.1	1.3	0.7	4.1
	Maximum	5	7	6	10
	% of farms doing some of these operations	60%	53%	36%	100%

Soil compaction continues to be an issue requiring management in cotton production (Figure 27). Note in this graph there are a number of people who responded to the question but not to some of the sub-questions. This may be because the issue was not experienced on their farm (eg flooding, round bale pickers).

Machinery traffic in wet seasons has resulted in some degree of observed soil compaction on 92% of respondent farms with 41% actively managing this compaction. Machinery use in dry conditions was observed by 62% of respondents to result in some soil compaction, mostly at a minor level (50%). Compaction has been observed following both round module pickers (70%) and conventional pickers (69%). The severity of the compaction is considered substantial by more respondents following round module pickers (39%) than it is for conventional pickers (25%).

Figure 27 Soil compaction observed as a result of activities

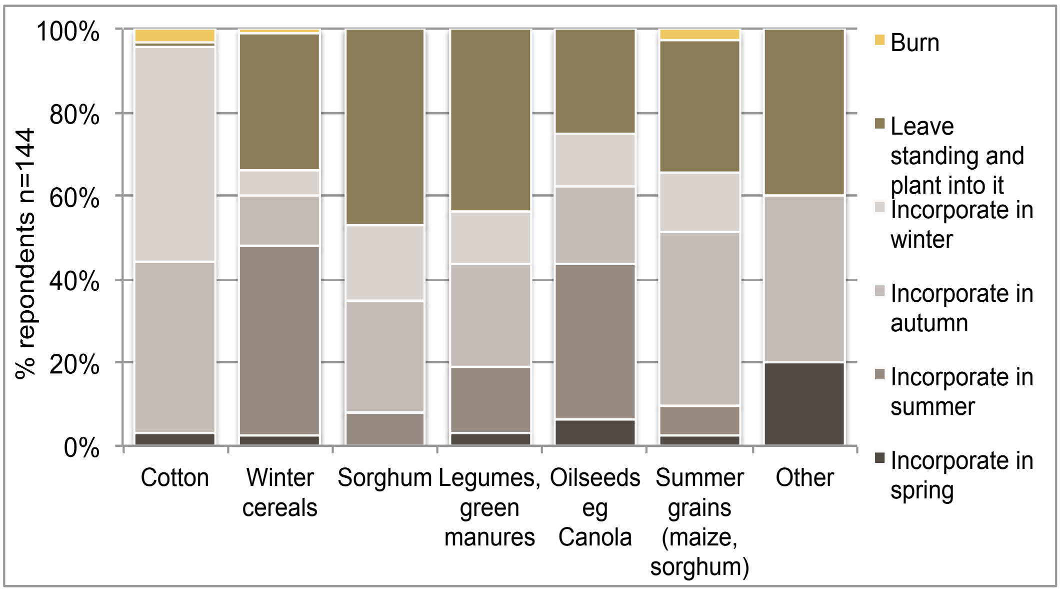


Have you observed soil compaction as a result of any of the following activities on your farm over the past two years?

Crop residues

The majority of respondents incorporate residues from the prior crop before planting cotton (Figure 28). Planting directly into standing crop residues is used by some in winter cereals (26% of respondents), sorghum (16%) and legumes (10%). Burning of crop residues is used by less than 5% of respondents. Cotton stubble is incorporated in autumn or summer by the large majority of respondents.

Figure 28 Usual management of crop residues before planting cotton



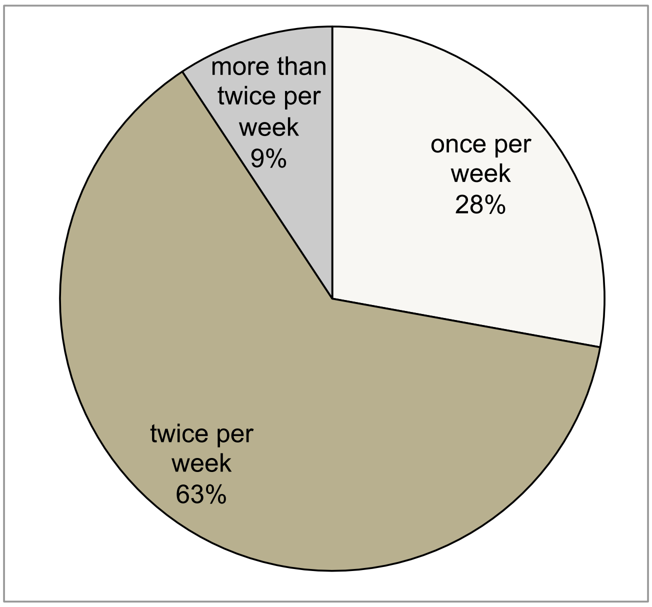
How do you usually manage residues / stubble from the previous crop before planting a cotton crop?

Crop protection stewardship

Biotechnology

Bollgard®II crops are mostly checked by an agronomist twice a week (63% of respondents) to inform insect management decisions (Figure 29). Just over a quarter of responding farms are checked once a week while 9% have their crops checked more than twice a week. No respondents indicated their Bollgard®II crops were checked less than once a week.

Figure 29 Frequency of checking of Bollgard®II crops by an agronomist for insect pest management decisions



How frequently does your consultant/ agronomist (or yourself) check your Bollgard®II cotton for making decisions about insect pests?

n=140

There is majority, but not complete, support for the insecticide and Bt resistance management efforts:

- 76% of respondents think that the long term value of complying with the Bollgard®II resistance management plan is worth the effort and cost (Figure 30). 11% do not agree with this.
- 7% of respondents indicated that they disagreed with the statement "All of my insecticide use decisions are consistent with the Insecticide Resistance Management Strategy" and 2% indicated they don't know.
- Few respondents (13%) considered that Bollgard®II could be profitable if it required up to 4 insecticide sprays due to resistant grubs. There were some qualifying comments with this question including "depends which sprays they were".
- 79% consider it important to have a choice of refuge options (Figure 30).

There were varied views about which element of the Bollgard®II resistance management plan was the most effective in delaying resistance (Figure 31). The industry has promoted the view that a combination of mechanisms is important.

- Refuges (37% of respondents) and pupae busting (36%) were mostly frequently considered to be the most effective. Only a few people considered the planting window or limited use of foliar Bt to be the most effective strategy (each 4%).
- 69% of respondents forecast that field failure to Bollgard®II will occur within 10 years if the cotton industry continues to use Bollgard®II as per the current Resistance Management Plan and no other Bt cottons become available. 19% think this would occur within 5 years.

Figure 30 Perceptions about insect resistance management

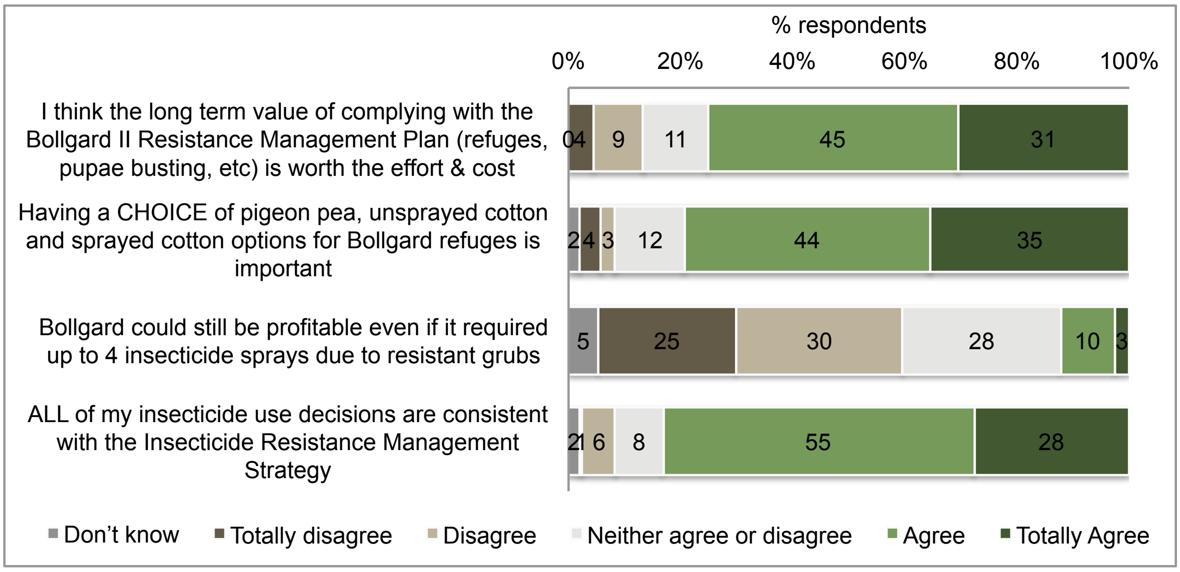
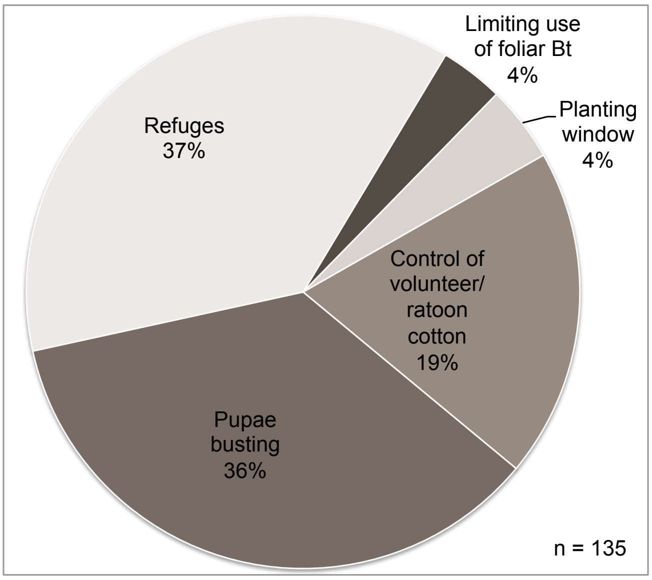
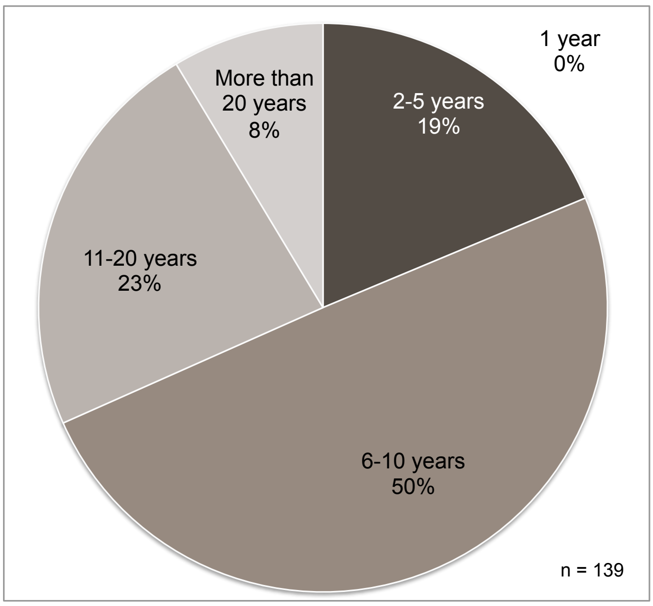


Figure 31 Proportion of respondents who considered each element of the Bollgard® II Resistance Management Plan to be the most effective for delaying resistance



Of the 5 elements of the Bollgard® II Resistance Management Plan which one element do you think is most effective for delaying resistance?

Figure 32 Perceived time to field failure of Bollgard® II managed under RMP with no new Bts

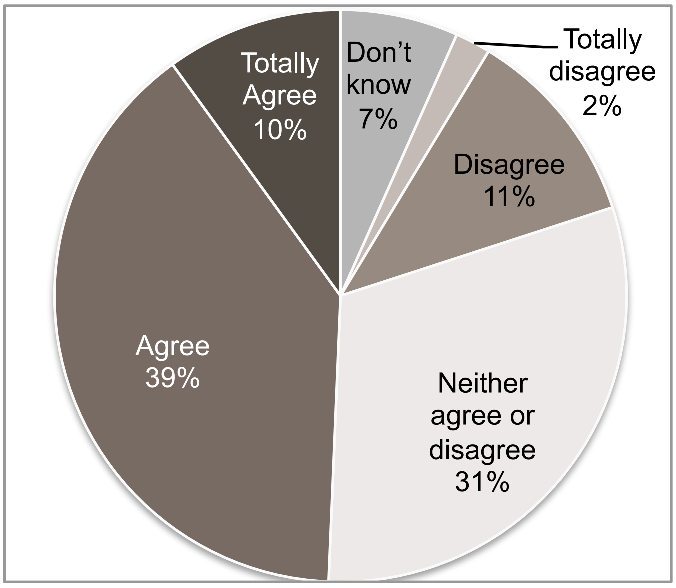


We are interested in understanding your perception of the robustness of the Bt technology. If the cotton industry continues to use Bollgard II as per the current Resistance Management Plan and no other Bt cottons become available (eg no Bollgard3) how many years DO YOU THINK will it be before 'field failure' of the technology occurs because of resistance?

Herbicide resistance

49% of responding farms believe they are proactive enough with their weed management to prevent herbicide resistance from developing on their farm (Figure 33). Some who disagreed or were neutral on this noted that they while they are proactive in their herbicide management practices they do already have herbicide resistant weeds present.

Figure 33 Perceptions on effectiveness of herbicide resistance management practices used



Please indicate how closely the following statement reflects your cotton farming practices by indicating your agreement or disagreement:

I am proactive enough with my weed management to prevent herbicide resistance on my farm

37 farms reported an area of herbicide resistant weeds on irrigation land, totaling 12,052 ha across these farms (Table 12). 31 farms reported herbicide resistant weeds detected in their dryland areas, totaling 7,608 ha. It is not possible to assess the proportion of farms affected as only 83 respondents completed this question and we are unable to determine whether the blanks are zero values, unknown areas or simply not reported.

Table 12 Number of farms that identified herbicide resistant weeds and the areas affected

n=83	Herbicide resistant weeds on IRRIGATED land				Herbicide resistant weeds on DRYLAND			
	No. Farms	Area reported (ha)			No. farms	Area reported (ha)		
		Avg.	Min	Max		Avg.	Min	Max
Resistant summer grasses	21	51	1	200	18	140	1	1000
Resistant winter grasses	15	173	2	934	15	135	2	600
Resistant broadleaf weeds	14	599	2	5000	8	281	80	1000
All resistant weed types	37	326	1	5100	31	245	1	1200

NB zero values are excluded from calculations – each average is the average for those farms reporting herbicide-resistant weeds; Dryland areas are not necessarily areas where dryland cotton is grown.

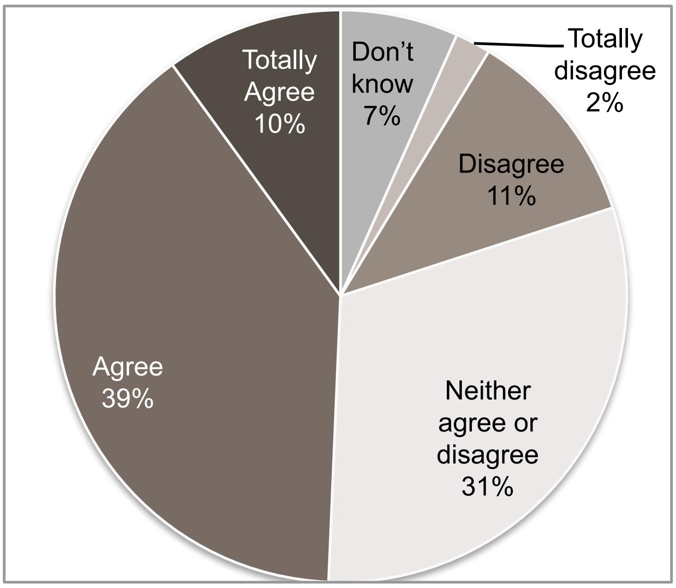
Herbicide spray drift

21 growers (13% of respondents) indicated that herbicide spray drift affected their 2012-13 cotton crop. Collectively, these growers reported a total area of 2,106 ha affected, ranging from 5 ha to 400 ha on individual farms and averaging 100.3 ha per farm.

One third of the affected farms indicated no loss of yield resulting from spray drift. 14 farms indicated an estimated yield loss due to spray drift of between 0.3 and 3 bales/ha (average 1.1 bales/ha).

Almost half of respondents considered that the CottonMap initiative has helped to reduce herbicide spray drift (Figure 34).

Figure 34 Perceptions on the effectiveness of CottonMap in reducing herbicide drift



Please indicate how closely the following statement reflects your cotton farming practices by indicating your agreement or disagreement: CottonMap has helped to reduce herbicide spray drift

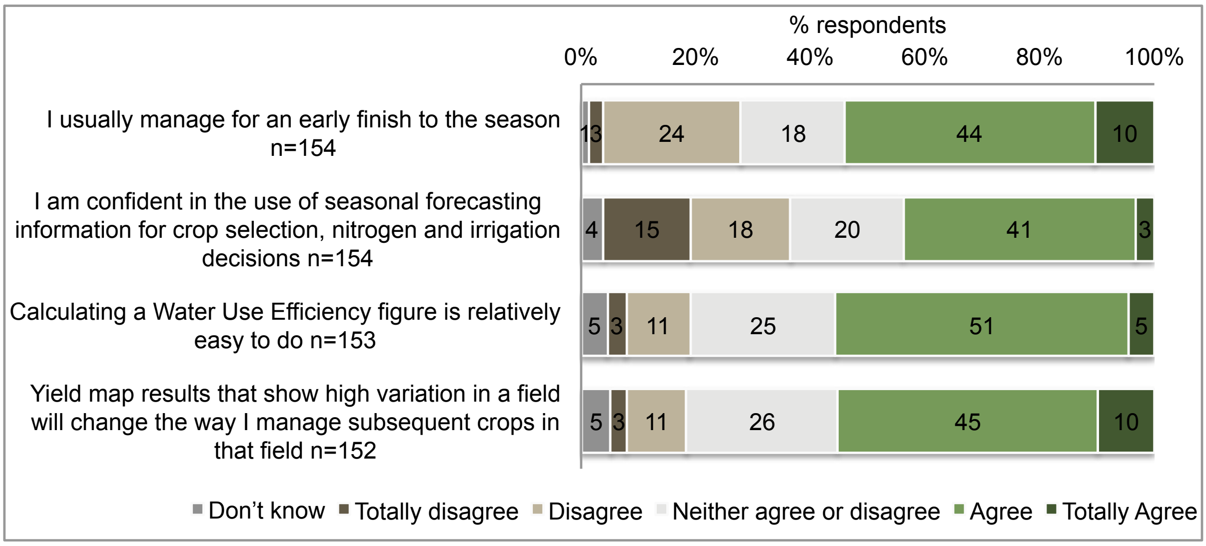
Other agronomy management

Whilst the survey focused on the themes nutrition, soils, energy, harvesting and workforce, there are many other agronomy issues of importance. The intent is for these issues to be explored in more detail in future years.

Responses to broad questions about a earliness, seasonal forecasting, water use efficiency and yield mapping are presented in (Figure 35). Some broad findings are:

- 54% of respondents usually manage for an early finish to the season. Earliness was a key issue prior to Bollgard®II crops due to the high insecticide costs of growing a crop for longer. Now that this is less of an issue it is interesting to note that earliness is still important to many growers.
- There may be some scope to increase growers' confidence in seasonal forecasting information for crop selection, nitrogen and irrigation decisions (41% agree that they are confident in use of this information, 3% totally agree).
- Just over half of respondents (56%) considered it easy to calculate a water use efficiency figure. Only 5% totally agreed that this calculation is easy to do. The high proportion of neutral and don't know responses may indicate many have not tried to calculate it and/or dryland growers may not see it is relevant to them.
- A similar pattern exists with the use of yield map results to influence subsequent management. 55% indicated that yield map results that show high variation in a field will change the way subsequent crop are managed in that field. 31% gave a neutral or 'don't know' response to this question.

Figure 35 Perceptions on management strategies



Energy

Energy has been widely discussed in industry forums as a major, increasing cost in cotton production. The survey sought to gather some quantification of energy costs and also gather information for a CRDC funded NCEA project on alternative energy options by Gary Sandell.

Energy usage

77 respondents provided information or estimates on the energy used for their 2012-13 cotton crop. This indicates that half of the respondents were unable or unwilling to share their energy costs for the crop. Perhaps related to this is the finding that relatively few respondents (11%) have measured or benchmarked their total energy use in the past 5 years (Figure 38). Table 13 displays the gathered and calculated information about energy use and cost. There are some considerable limitations in this data as they are estimates, costs per unit are highly varied and we are not certain that all respondents have estimated energy usage for the cotton crop only (vs whole farm use). It should therefore be regarded as broadly indicative only.

Where respondents have provided both usage and cost there is considerable variation in the costs / unit. For example, diesel costs vary from $0.92-$1.67/L. This may relate to differences in consideration of the diesel fuel rebate.

Please estimate the energy usage for your 2012-13 cotton crop (either usage or cost or both, approximate estimates are all that is needed)

Where a cost only has been provided, a usage quantity has been estimated using standard. We note this may be too low n some cases. For example, while electricity costs indicated by the few respondents who gave usage and cost figures were mainly in the range of $0.21 to $0.25/kWhr, one indicated a cost of $0.40/kWhr. Responses with diesel costs less than $500 were excluded as these appear to be costs/ha. Another entry with excessively high costs/L was also excluded as an error. One petrol cost of below $10 was excluded.

Table 13 Reported and calculated energy use by farm and cotton area

n=77	No. respondents reporting use	Average use per farm ^	Average GJ use per farm	Average cost per farm ^	Average use per cotton ha *	Average cost per cotton ha *
Diesel	71 (92%)	195,545 L	7,548 GJ	$272,202	228 L/ha	$318 /ha
Petrol	18 (23%)	4,481 L	153 GJ	$6,082	7 L/ha	$10 /ha
Gas	2 (2.6%)	1,528 L	39 GJ	$1,100	1.1 L/ha	$1 /ha
Electricity	37 (48%)	273,388 kWhr	984 GJ	$65,516	525 kWh/ha	$125 /ha

^ based on actual values provided or where only usage was provided or only cost provided a figure has been calculated using rates from the NGER Technical guide: $1.41/L diesel; $1.33/L petrol; $0.72/LPG and $0.24 / kWhr electricity

* per cotton ha figures are calculated based on the area of cotton grown on each farm in 2012-13 (irrigated + dryland). They are very approximate as it is uncertain whether energy values have been provided specifically for cotton ha only.

The relative use of each type of energy can be compared both by expenditure (Figure 36) and total energy use (Figure 37). Diesel, used by 92% of respondents, is the highest both in total use and expenditure, followed by electricity. Note that solar energy is not included due to the limited cost/usage information provided. While 17% of respondents indicated they have solar in use somewhere on their farm (Figure 39), only two reported usage figures. This difference may be due to difficulty in calculating the usage metrics and cost for solar energy or it may be that the solar is not used for cotton production (eg household use only).

Figure 36 Relative expenditure on each energy type

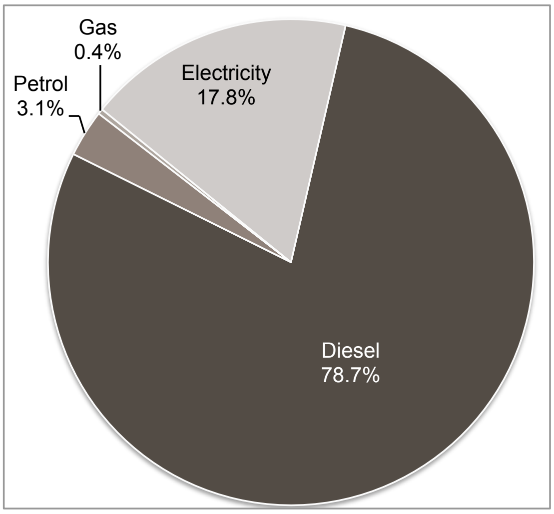
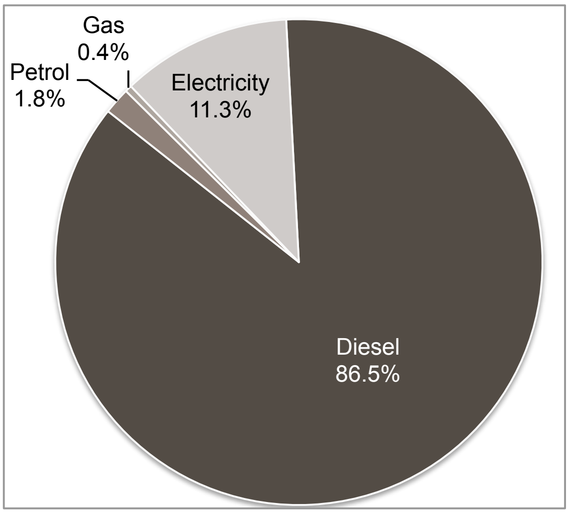
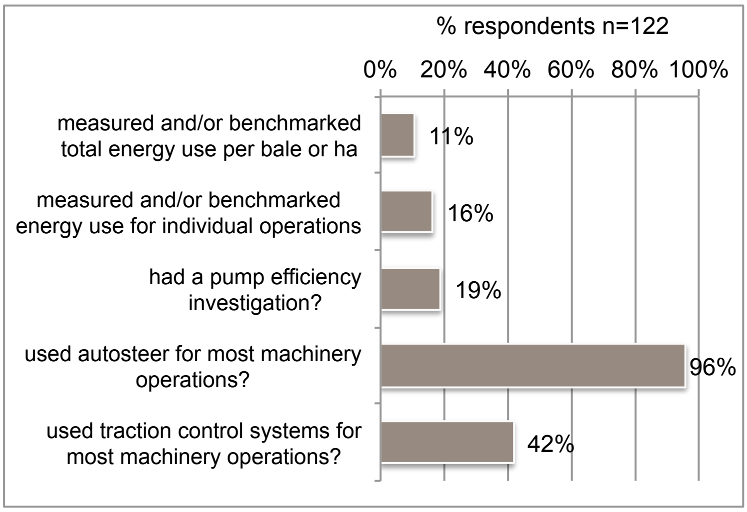


Figure 37 Relative use of each energy type (GJ)



Whilst there has been considerable discussion around energy costs in the industry, Figure 38 shows that only a small proportion of respondents had measured their energy use per bale or ha (11% of respondents) or of individual operations (16%). While irrigation is one of the major energy uses on irrigation properties[2], only approximately 24% of irrigator respondents have had a pump efficiency investigation done. By comparison, the machinery related energy saving practices had high rates of uptake (96% used autosteer and 42% used traction control). There are a number of reasons other than energy savings that may have motivated the uptake of these practices.

Figure 38 Energy investigations and selected energy saving practices used by respondents in the past 5 years



In the last 5 years have you …

* Graph shows all respondents (including dryland). Approximately 24% of irrigator respondents have had a pump investigation done

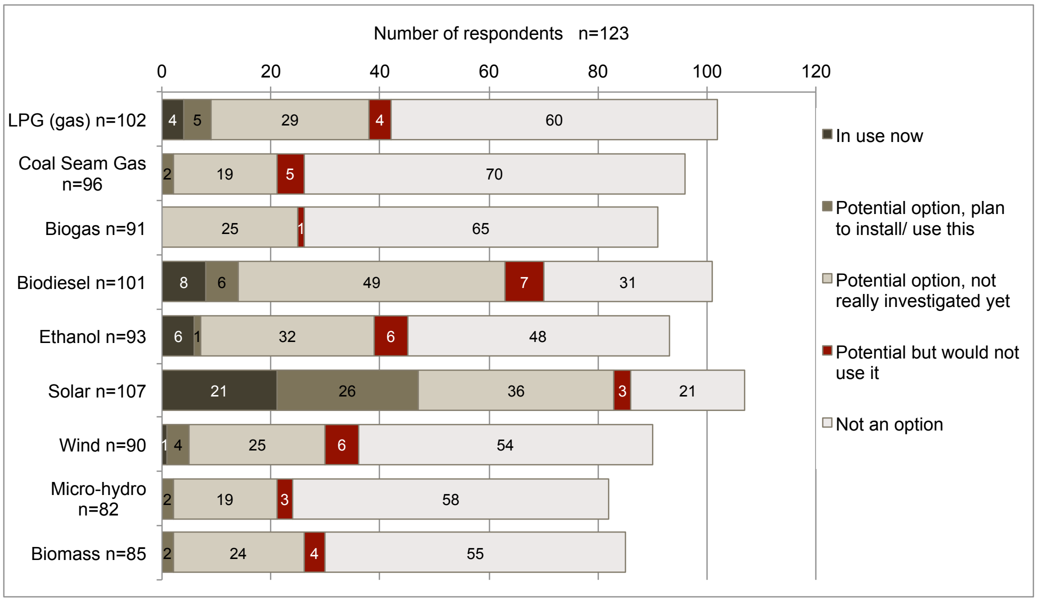
[2] Chen, Guangnan and Baillie, Craig (2007) Development of EnergyCalc – a tool to assess cotton on-farm energy uses. Report for the Cotton Research and Development Corporation (CRDC). NCEA Publication 1002565/1

Alternative energy

As part of an NCEA research project, the survey investigated current and potential use of energy sources alternate to diesel, petrol and electricity. While 123 people responded to this question, none gave an answer for every energy type, perhaps indicating their level of interest in or consideration of each energy type. The following analysis is based on the number responding to each part of the question.

26% of responding farms are using at least one of the alternative forms of energy listed in Figure 39. 8% are using two or more of these energy types. The most widely used alternative energy is solar (20% of respondents) with a further 24% planning to install it in the future. In addition to the current use, up to 58% of respondents believe they have the potential to use one of these alternative energy sources. The intended uses are shown in Table 14.

Figure 39 Use or perceived relevance of alternative energy sources



Please indicate how relevant each of these energy types are for your farm.

For those with relevance, please indicate how you would use them

A small number of respondents identified some potential energy sources that they would not use. Comments made (Table 14 and Table 15) indicate that reasons include: Biodiesel – problems with blocking injectors on machinery, not recommended by machinery manufacturers and may void warranty; Coal Seam Gas – environmental concerns; and Solar - expense.

Table 14 Applications used or intended for each type of alternate energy and other comments

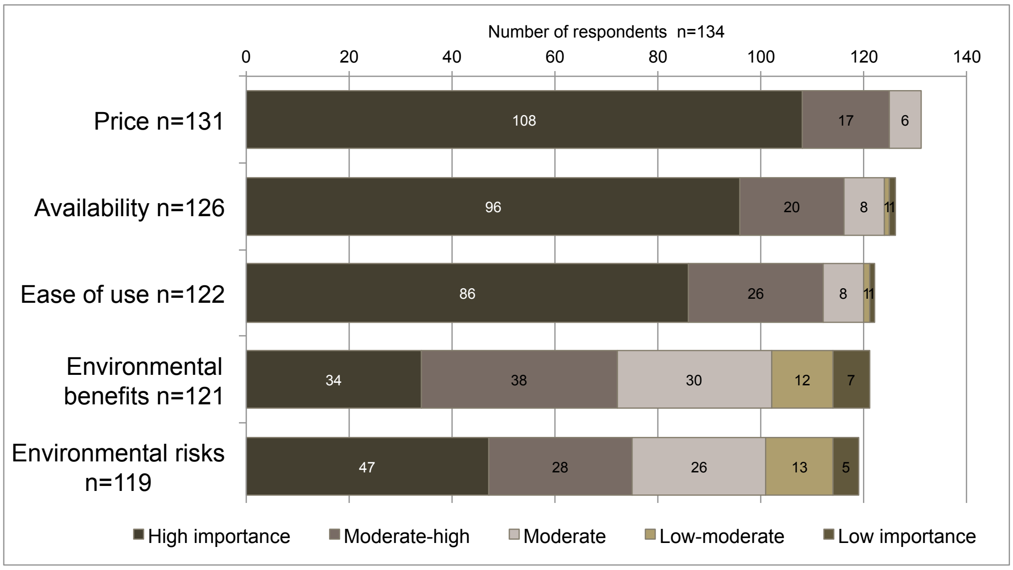
Each * indicates an individual response to this open ended question	LPG	Coal Seam Gas	Biogas	Bio-diesel	Ethanol	Solar	Wind	Biomass
House	*					******* *	*	*
Workshop	*					******	**	*
Irrigation / pumping	******* ******	*******	***	********** *	**	**		
Bore engines	**							
Machinery fuel	**	***	******	********** **	*****			*
Grain drying	*							
Have used in past				****				
Other comments		Never ever. Wells on farm but don't produce		Not recommend-ed by John Deere Whole farm		Feed into grid		Soil

Table 15 Growers' experiences with and views on adoption of alternative energy sources

General comments	Lower energy costs	Darling Downs
	Practicality, reliability	Northern NSW
Pumps	Using electricity on 6 of 12 high volume bore pumps is not worth the problems of a change over from diesel pumping	Northern NSW
	Slightly reducing flow from electric bores to save on power bills during peak power periods	Northern NSW
	Diesel /Gas pump Motor and cost of gas to high for any pump in costs	Macquarie
Biodiesel	Biodiesel- No problem	Northern NSW
	Use of biodiesel blocked filters	Northern NSW
	Investigated Bio-diesel and found the red-tape and costs to comply with Govt standards are prohibitive and are designed to deter you from using Bio-diesel "legally".	Northern NSW
	Biodiesel clogged filters and injector pump on truck	Northern NSW
	No experience. need biodiesel option from Cottonseed, Sunflower, Canola(On farm or Gin Biodiesel plant)	Northern NSW
	Biodiesel not suitable for newer common rail diesel engines in some of our machines- voids warranty	Macquarie
	Tried biodiesel - Bad experience with injectors on machinery. Would use again if available	Southern NSW
Solar	Spent a lot of money putting solar panels on 6 houses - very disappointed with process and the gain is uneconomic	Darling Downs
	Solar industry is a rip off	Darling Downs
	We have very positive experience with 10kw solar panel sites	Northern NSW
	2x 1.5kw Solar panels - haven't guarantied savings	Northern NSW
	Solar-maintenance, installation contractors	Northern NSW
	Solar grid connected - cost effective in reducing general workshop/ house electricity bill	Northern NSW
	Solar powered bores	Northern NSW
	Solar perhaps, not achieved levels of energy promoted	Southern NSW

Price, availability and ease of use are clearly the major factors influencing decisions about energy type (Figure 40). Environmental benefits and risks are also important considerations to the large majority of respondents.

Figure 40 Relative importance of factors in decisions about alternative energy



How important are each of these factors in your decision about using alternative energy sources on your farm?

Other issues identified were: current alternatives not yet economically feasible, long term prices, expenses and performance.

The significance of price and availability were further reinforced in responses to an open ended question *"what is the greatest limitation in improving energy use efficiency"* to which:

- 47% referred to cost as the major limitation
- 19% identified capital costs
- 19% indicated availability and
- 19% identified a knowledge or information limitation.
- Ease of use and time were also issues.

Other limitations included:

- We have to work ground (cultivate) / pupae busting
- Impractical as our business uses electricity- watering and ginning both have experienced huge cost blow out due to unfair electricity pricing.
- Total amounts used is in high usage bracket
- Other parts of our farming system that need improvement more would give a bigger bang for your buck
- Uneconomic to do so ie: costs more to change than what you will save
- standardized expertise to operate
- Distance from suitable energy source; eg: 3 Place power high, horsepower needs.

Harvesting

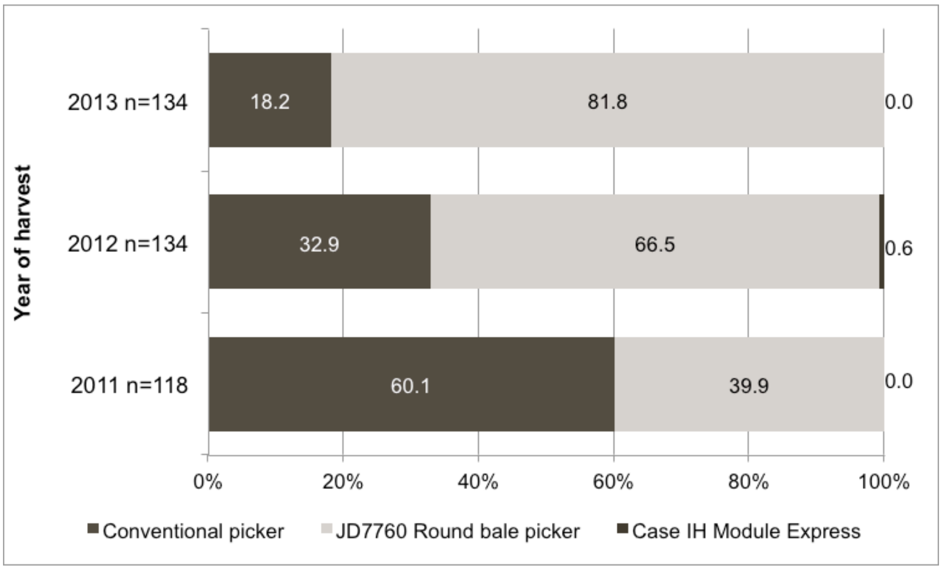
By John McLean Bennett, NCEA

This section is primarily concerned with the incorporation of the John Deere 7760 round module picker (JD7760) into the farming system, specifically understanding the driving motivation to use and/ or purchase a JD7760, the perceived impacts of the technology and the attitudes associated with its use. This informs a CRDC funded research project by the NCEA.

All picking technologies

Growers were asked to indicate if they used conventional, JD7760 or Case IH 625 Module Express (CaseIH625) picking technology during harvest in the 2010-2011 through 2012-2013 seasons, and if so what area was picked with each technology. The reported areas picked are presented in Figure 41 and the proportion of growers using each technology reported in Figure 42. Since the 2010-2011 seasons, there has been a steady increase in the use of the JD7760 as compared to the conventional system. The JD7760 was introduced to the Australian cotton industry in 2008 and the results presented here support a rapid adoption of the technology, with the numbers reporting the area picked by the conventional system almost halving with each subsequent season.

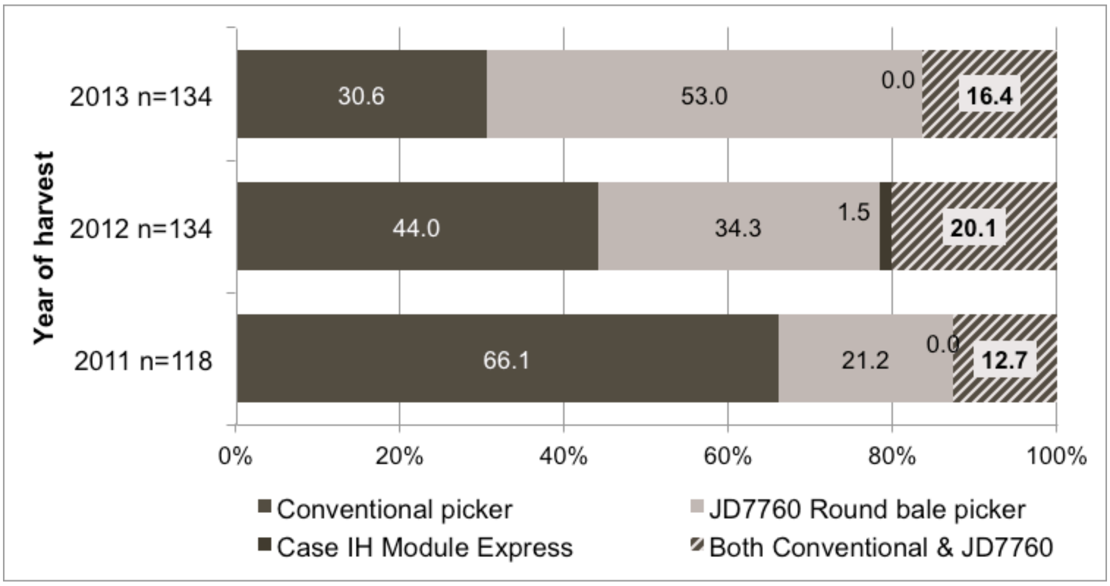
Figure 41 Cotton area picked using the various technologies for 2010-2011 through 2012-2013 seasons



What area of your cotton crop was harvested by each of type of picker in each of the past 3 years?

Results are presented as a percentage of the harvested area allocated to each technology for each season by respondents.

Figure 42 Percentage of growers using the various picking technologies for 2010-2011 through 2012-2013 seasons



When looking at the number of respondents reporting the use of the various picking technologies, it can be seen that fewer JD7760 machines, as a percentage of respondents, are required to pick the same area as the conventional system. This supports two interrelated notions:

- The conventional system is generally being retained by smaller operators
- The JD7760 is capable of a faster pick (further supported by Figure 43 and Figure 45)

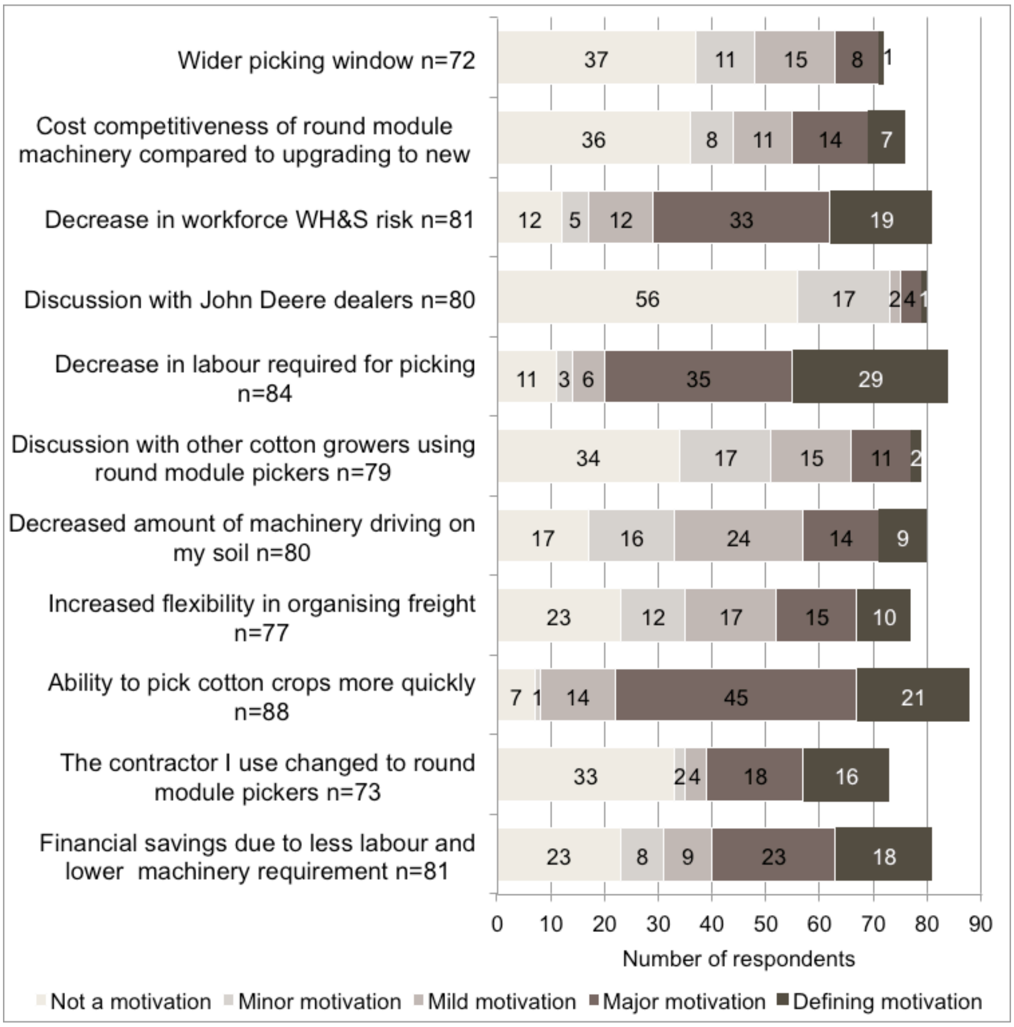
For example, in the 2012-2013 season, 81.8% of the reported area was picked using a JD7760 and 69.4% of growers reported using a JD7760, while 47% of growers reported using the conventional system to pick 18.2% of the reported area. On this basis, from the 201-2011 through 2012-2013 seasons, it is apparent that the JD7760 picking has become more efficient improving from 1.17 (ratio of JD7760 picked area and JD7760 reported use) to 1.27 area/use.

During the 2011-2012 season two growers reported using the CaseIH625 on board module picker. Anecdotal discussions with growers and dealers suggest that there are no CaseIH625 machines commercially operating in Australia. It might be that this use represented as demonstration of the technology as the total area reportedly picked by the CaseIH625 was 591 ha.

The John Deere 7760 picking technology

The following results refer only to growers who indicated the use of the JD7760 picking technology. Growers were asked to indicate from a list of statements their initial motivations to use the JD7760 picking technology (Figure 43) in order to understand the driving motivation for the technology adoption.

Figure 43 Initial motivation to use the JD7760 picker whether using a purchased machine or contract harvest



Please indicate the extent to which each of the listed issues motivated your initial decision to USE the round module picking system (either purchased or contracted).

In total 92 growers responded to parts of this question

"Decrease in labour required for picking" was the initial motivation most selected by responding growers as the defining motivation. When considering "defining motivation" and "Major motivation" categories together, "Decrease in workforce WH&S risk", and "Ability to pick cotton crops more quickly" should also be considered as major driving motivations of technology adoption.

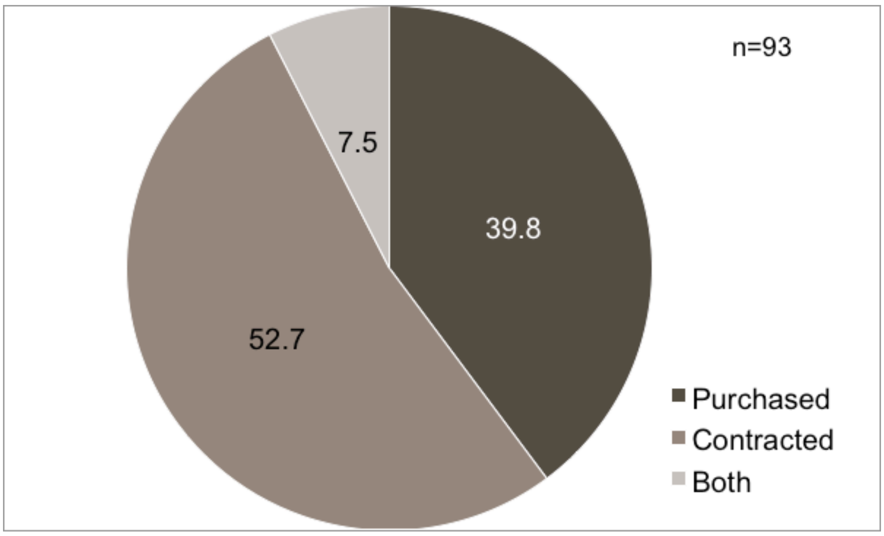
Interestingly, "Financial savings due to less labour and machinery requirement" is relatively evenly split between low and high motivation, with a slight majority leaning towards it being a driving motivation (combination of Major and Defining motivation categories). One grower commented that *"Round bale cost a lot more $ overall!!"*, while another suggested that *"It is not true that there are financial savings in labour and machinery from changing to round module pickers."* The cost of the conventional and JD7760 systems has been considered on par by the industry[3] and comparative costs of the two systems will be calculated in CRDC project NEC1301. However, it is apparent that irrespective of any actual financial savings that the prospect of a financial saving did act as a driver for adoption for a large proportion of responding growers.

The decision to adopt the JD7760 appears to been at an individual grower level, with the majority of respondents considering "Discussion with John Deere dealers" and "Discussion with other cotton growers using round module pickers" as low motivations to adopt.

During the 2012-2013 season, contract harvesting accounted for all or part of the harvesting on the majority (60.3%) of the responding farms that used a JD7760 (Figure 44). Where machines were purchased (47.3% of the respondents using a JD7760), the vast majority of picking was performed by one picker (Figure 45). In this season the average cotton picked by an owned/ leased JD7760 machine was 650.36 ha (*n*=37). In three cases during this season, growers reported that a single machine was picking almost twice the average area for the season, which indicates that other machines may be being underutilised.

The area of cotton picked exclusively by machines that were owned or leased rather than contract picked (39.8%, Figure 44) represented 54% of the total cotton area picked by JD7760 machines. So, while there were more people using a contracted JD7760 machine for harvest (52.7% using a contractor, Figure 43), as compared to 39.8% using an owned/ leased machine, the area of cotton picked by contractors was less (46% of the cotton harvested by JD7760 machines). This might indicate a potential saturation of JD7760 machines in the Australian market.

Figure 44 Percentage of growers indicating the use of a JD7760 in 2013 who purchased / leased a machine, used contract harvesters, or both

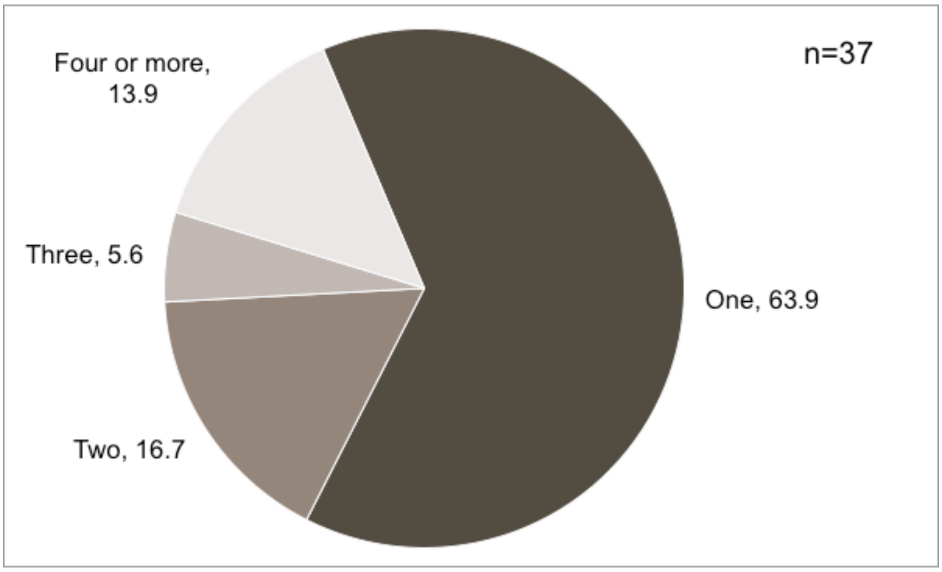


Did you purchase your own round module picker/s or use a contractor with a round module picker for your 2013 crop?

[3] Woodhouse, N.P., Bennett, J.McL., Jensen, T.A. (2013) *Change in the cotton harvesting system: A review and implications for the John Deere 7760 cotton picker*. National Centre for Engineering in Agriculture Publication 1004960/13/1, USQ, Toowoomba.

Growers were asked to indicate to what degree the considerations listed in Figure 45 featured in the purchasing/ leasing decision making process. This question differs to the data presented in Figure 43 in that is relates to purchasing considerations, rather than motivations, or impetus, to use the machine. That is to say, one might be motivated to use a machine by a defining impetus, but the decision to buy a machine is governed by a decision making process with various characteristics. This question seeks to understand those characteristics. This question also excludes those who only use contract JD7760 harvesting.

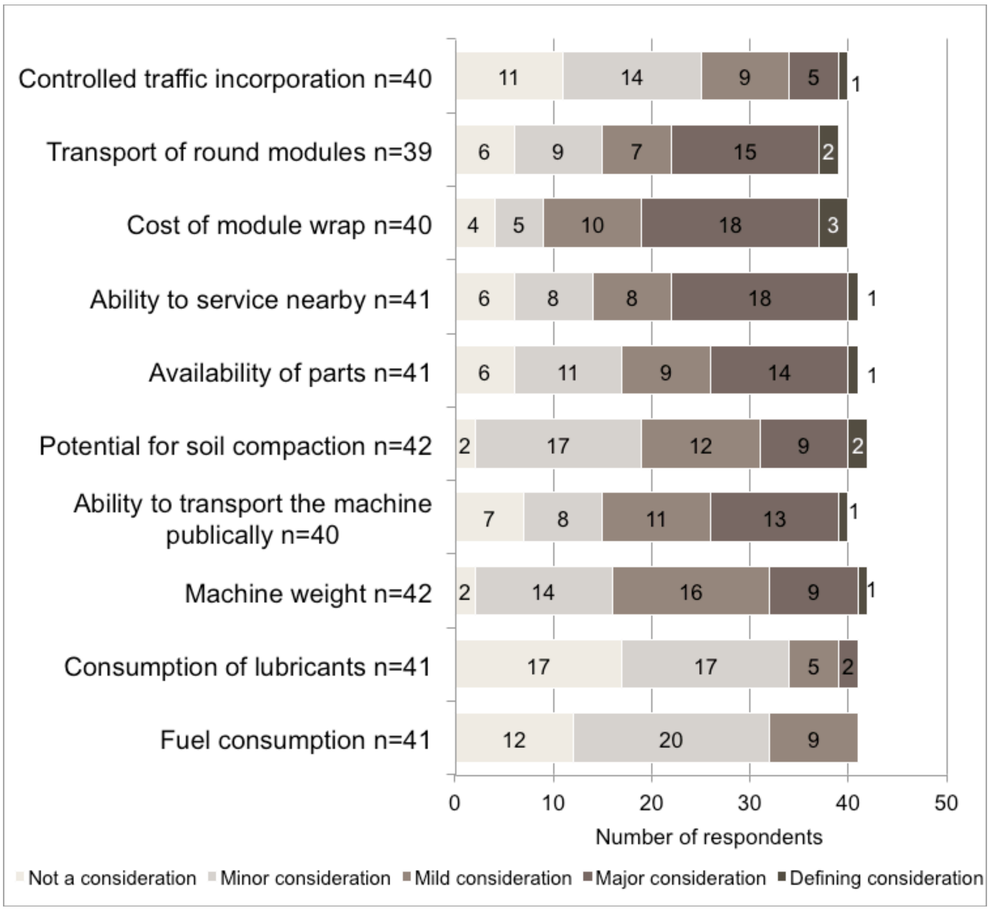
Figure 45 Number of JD7760s per farm as a percentage of respondents who had a machine



How many round module pickers do you currently have (owned or leased)

If you bought it in partnership with others please list your share of ownership (eg ½)

Figure 46 Considerations made by growers during the purchase / lease process of the JD7760



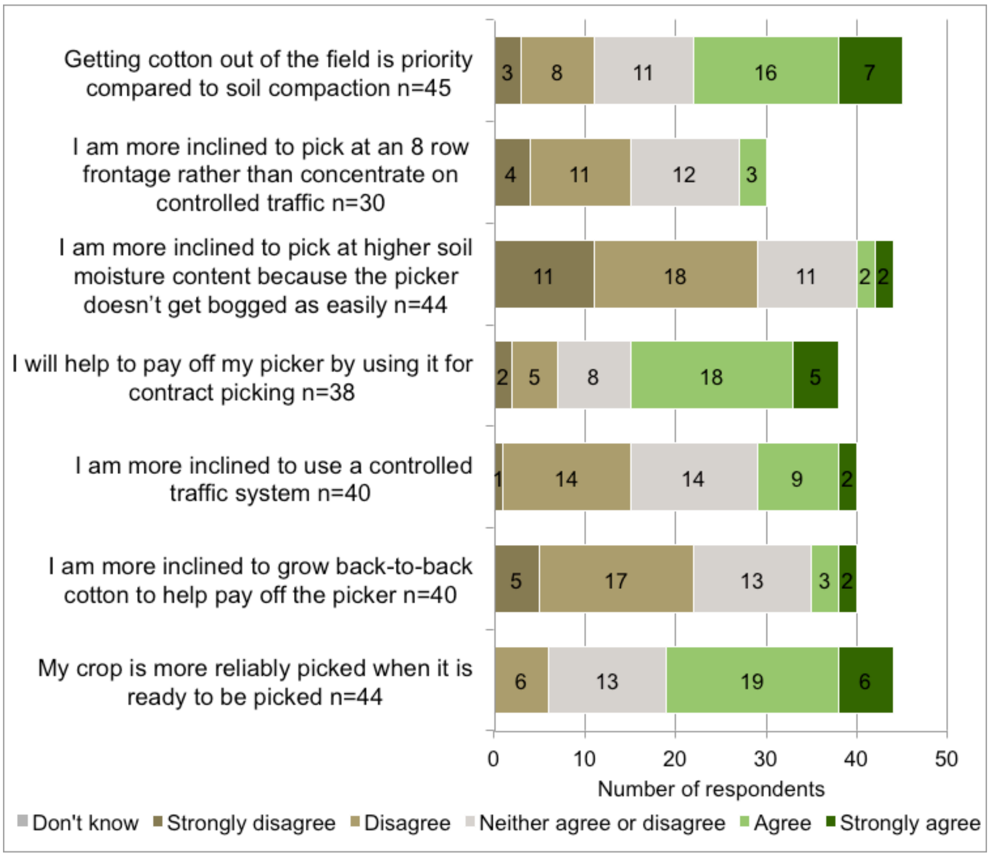
Please indicate the extent to which each of these issues were considered in your initial decision to PURCHASE or LEASE the round module picking system

Interestingly, there was no single overriding defining consideration identified by responding growers. The major considerations in purchasing related to the ability to have the machine serviced, the cost of module wrap, the availability of parts, the transport of round modules and the transport of the machine itself. Consumption of fuel and lubricants were generally not important considerations.

The machine weight and potential for soil compaction were cursory considerations with the majority of response in the Minor and Mild categories. The machines ability to be incorporated into a controlled traffic system was even less of a consideration.

Respondents who had purchased/ leased their JD7760 were asked to what extent they agreed/ disagreed with the attitudinal statements in Figure 47 in terms of utilising their picker within the farming system. These questions were split into those relating to soil compaction, attitudes towards paying the machine off and machine performance. Responding growers clearly thought that harvesting cotton was more important than causing soil compaction, but conversely were not inclined to pick at higher soil moisture content just because the machine could. This suggests that if climatic conditions and external circumstances require cotton be picked at detrimental soil moisture, then it will be. However, the more important point here is that where possible growers will attempt to avoid traffic at detrimental soil moisture.

Figure 47 Grower attitudes towards the use of an owned / leased JD7760 picker in their farming system



Please indicate the extent to which you agree or disagree with the following farm operations statements regarding your use of your JD7760 round module picker. When using my round module picker…

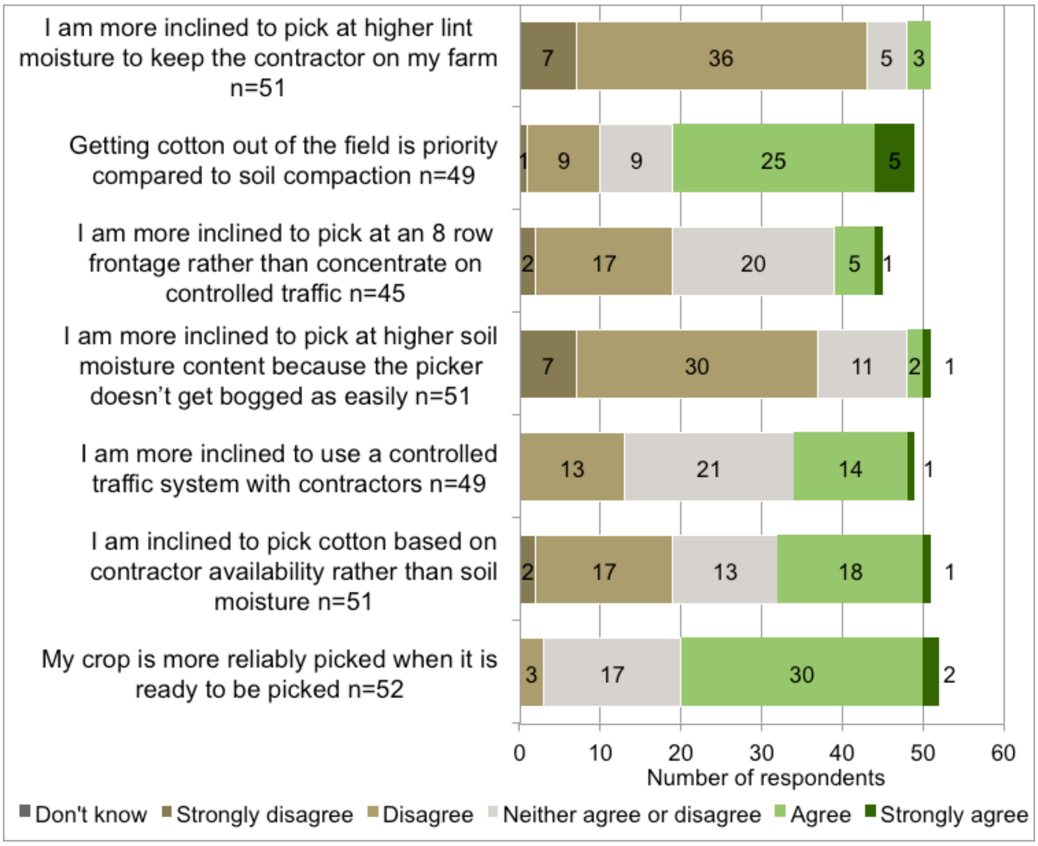
On the other hand, while many did consider the machine weight in their purchasing process (substantial weight between 32 and 36 tonnes), they were not overly inclined to consider a controlled traffic regime as being any more important than with their previous system. The ability to modify a JD7760 to pick on an 8 row frontage allows those using skip-row cotton systems to harvest more quickly by ensuring that all 6 heads are picking rather than running in skip rows. While the number of growers considering this was not assessed, it appears that the ability to do this does not cause growers to be any more inclined to do so.

In regards to paying off the JD7760 picker, 60.5% of respondents indicated they would use the picker for contract harvesting whilst only 12.5% are more inclined to grow back to back cotton.

Given the data presented earlier that might suggest that the Australian market for JD7760 pickers is becoming saturated and pickers are not necessarily picking at capacity. The fact growers are considering contract harvesting as a method to pay off their machine could be a pressure on the contract harvesting market and therefore the future ready availability of contract pickers. Although, those using contract pickers agreed that their crop was more reliably picked when it was ready to be picked (Figure 48); this statement, in terms of contractors, pertains to picker availability.

Respondents tended to agree that the JD7760 was more reliable at picking than previous systems, which is further demonstrated as an increased effective capacity of the machine (area of a field harvested per hour including unproductive time such as turning, unloading and maintenance).[4]

Figure 48 Grower attitudes towards the use of a contractor with a JD7760 picker in their farming system



If and when you use a CONTRACT round module picker, please indicate the extent to which you agree or disagree with the following statements.

When using a contractor with a round module picker ….

While removing cotton from the field was still a clear priority as compared to avoiding soil compaction for respondents using contractors, encouragingly, they indicated that they did not feel more inclined to pick at high soil moisture just because the machine could. However, may feel slightly pressured to do so (split between disagree and agree) depending on contractor availability. Similarly, growers using contractors were no more inclined to use controlled traffic than those purchasing/ leasing their machines. This also means that they were generally no less inclined to use controlled traffic systems as a result of contract picking with a JD7760.

Respondents also indicated that they did not feel pressured to pick at higher lint moisture to keep the contractor on the farm.

[4] Woodhouse, N.P., Bennett, J.McL., Jensen, T.A. (2013) *Change in the cotton harvesting system: A review and implications for the John Deere 7760 cotton picker*. National Centre for Engineering in Agriculture Publication 1004960/13/1, USQ, Toowoomba.

Human Resources

Survey respondents were asked a number of questions about their workforce as at January 2013 (ie mid-season). They were asked to include themselves and their family, but exclude gin staff in their responses. Table 16 provides basic figures on the average number and range of people employed on cotton farms as at January 2013, vacancies and recruitment.

Table 16 Cotton farm employment as at January 2013, numbers per farm

Numbers per farm	No. respondents	Average	Min. per respondent	Max. per respondent
Number of people employed	n=138	6.6	0	55
Vacancies	n=110	0.4	0	8
Number new to the farm in 2012	n=110	2.4	0	25
Number new to the industry in 2012	n=110	1.8	0	20

A crude calculation of the reported employment figures at January 2013 in relation to the area of cotton production in 2013 can be made (n=129). As the employment figures are for the whole farm (not only those who work in cotton), these calculations are least accurate for larger farms where cotton is only a small portion of the enterprise. This indicates that:

- Respondent farms have on average 1.6 employees per 100 cotton ha
- The hectares of cotton per employee is highly varied (9.8 to 449 cotton ha/employee), largely influenced by the area of cotton grown in 2012-13 relative to the overall farm size. Average area of cotton per employee is: Central Qld 92 ha; Darling Downs 87 ha; Southern Qld 149 ha; Northern NSW 118 ha; Macquarie 93 ha; Southern NSW 81 ha.
- The average is raised by a small proportion of farms who have large employee numbers and a number who had little cotton in 2012-13.
- 13% have less than 0.5 employees per 100 cotton ha
- 33% engage 0.5-1 employee per 100 cotton ha
- 25% have 1-2 employees per 100 cotton ha
- 23% have more than 2 employees per 100 cotton ha.

On-farm workforce: current staff, vacancies, those new to the farm and new to cotton, and planned recruitment

By Dr Jennifer Moffatt, The University of Melbourne

This section of the survey complements research work being carried out by The University of Melbourne for the CRDC.

Survey findings for on-farm workforce (excluding contractors) can be summarised as:

- Experienced staff are the largest group of staff reported in this survey, followed closely by those at Entry level. Most vacancies were also at these levels, however the largest number planned to be recruited were Entry level staff. The results suggest that this may refer to casuals on 417 visas.
- While full time permanent staff constituted approximately two-thirds of staff in January 2013, most of the remainder were casuals. In the permanent workforce the largest group are Experienced staff, however in the casual workforce the largest group is Entry level.
- The vacancy gap recorded in January 2013 is smaller (4.8%) than has been identified in other regional research evidence (vacancy gaps ranging from 11% to 20%).
- The number of people new to the farm in 2012 is comparatively similar to that for planned recruitment for 2013, the majority of which is Entry level.
- For about one-third, the decrease in labour requirements was a defining influence in deciding to use a round module picker; and for approximately one-quarter the reduction in Workplace, Health and Safety risk was a defining influence.
- More than three-quarters of those who used a round module picker indicated that it had reduced their labour requirements.

While 110 to 138 people responded to each of the questions on workforce, the questions comprised a number of sub-questions and many respondents left some cells blank. The number of respondents per sub-question in this section of the report varied from nil to 89; no conclusions can be drawn about those who did not respond to these sub-questions. As non-probability sampling was used, the results cannot be generalized beyond this sample. Due to the low response rate these results must be interpreted with great caution.

Table 17 shows that for those who responded to the survey questions on workforce, in total there were 913 staff in January 2013. The level of experience are shown in numbers of staff or vacancies in Table 17 and as relative percentages in Figure 49.

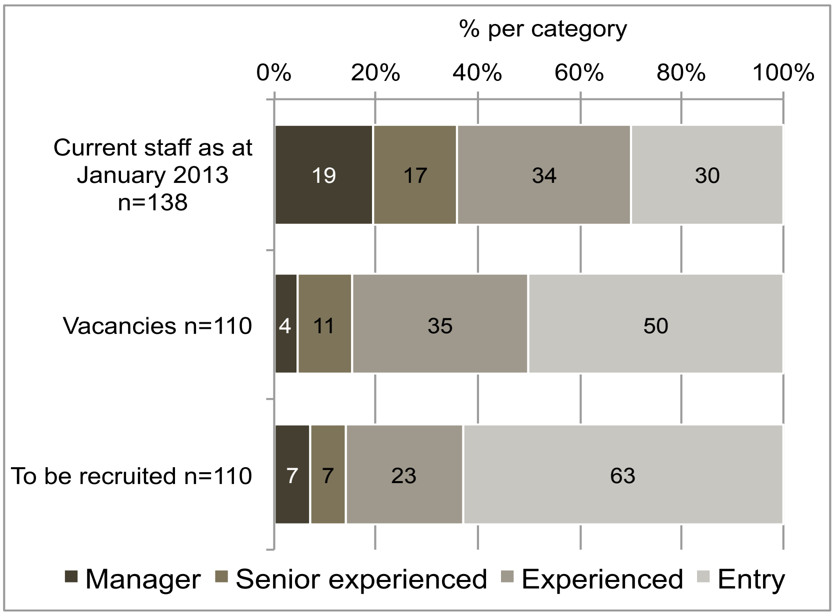
The largest number of staff per level, were Experienced (312, 34.2%), followed by Entry level (272, 29.8%). A person at the Experienced level would be an experienced farm hand or machinery operator, whereas Entry level would be an assistant farm hand or driver who requires supervision or is inexperienced.

Table 17 Staff and vacancies at January 2013, and planned recruitment for the next 12 months, by staff level

Level	Number of staff	Number of vacancies as of January 2013	Full staff (no. staff + vacancies	No. staff to be recruited in 2013
Manager	177	2	179	20
Senior experienced	152	5	157	19
Experienced	312	16	328	64
Entry	272	23	295	176
TOTAL	913	46	959	279

The proportion of vacancies was highest for Entry level (half of the vacancies) and almost two-thirds of those to be recruited were Entry level staff. However approximately one-third of the vacancies were for Experienced staff and almost one-quarter of those to be recruited were Experienced staff. When the staffing gap is estimated, overall it is 4.8%, being higher for Entry level (7.8%) and Experienced level (4.9%) and lower for Manager and Senior Experienced.

Figure 49 Staff and vacancies at January 2013 and planned recruitment for the next 12 months, by staff level



In JANUARY 2013, how many people were employed in each of the following positions on your farm? Include yourself and family but exclude gin staff

When considering your farm workforce in January 2013, in each type of position how many vacancies did you have in January?

How many staff do you plan to recruit in the next 12 months, in the following positions (including any current vacancies you will try to recruit for)?

The most prominent feature of Figure 49 is the gradient for Entry level staff. They constitute almost one-third of staff (29.8%), and half of the vacancies are at this level (50%), yet almost two-thirds (63.1%) of those to be recruited are at this level. The Manager level shows a similar feature with vacancies and planned recruitment. While 4.4% of the vacancies are at Manager level, almost double this, 7.2% of those to be recruited, are at this level. By contrast for Senior experienced and Experienced staff, the pattern is reversed.

While 10.9% of the vacancies are for Senior experienced staff, less than 7% (6.8%) of those to be recruited are at this level; similarly, while approximately one-third (34.8%) of the vacancies are for Experienced staff, less than one-quarter (22.9%) of those to be recruited are at this level. Disaggregating the levels into staffing categories provides some insight into these results, to which we now turn.

The largest category of staff, almost two-thirds, were full time permanent staff (63.5%), and most of the remainder were casuals (28.1%)(Table 18). Of the casual staff, almost two-thirds (64.6%) were backpackers (those on 417 visas). Of the full time permanent staff, only 17 were 457 visa holders.

Table 18 Number and proportion of fulltime permanent, part time permanent and casual staff, January 2013
(raw scores and percentages)

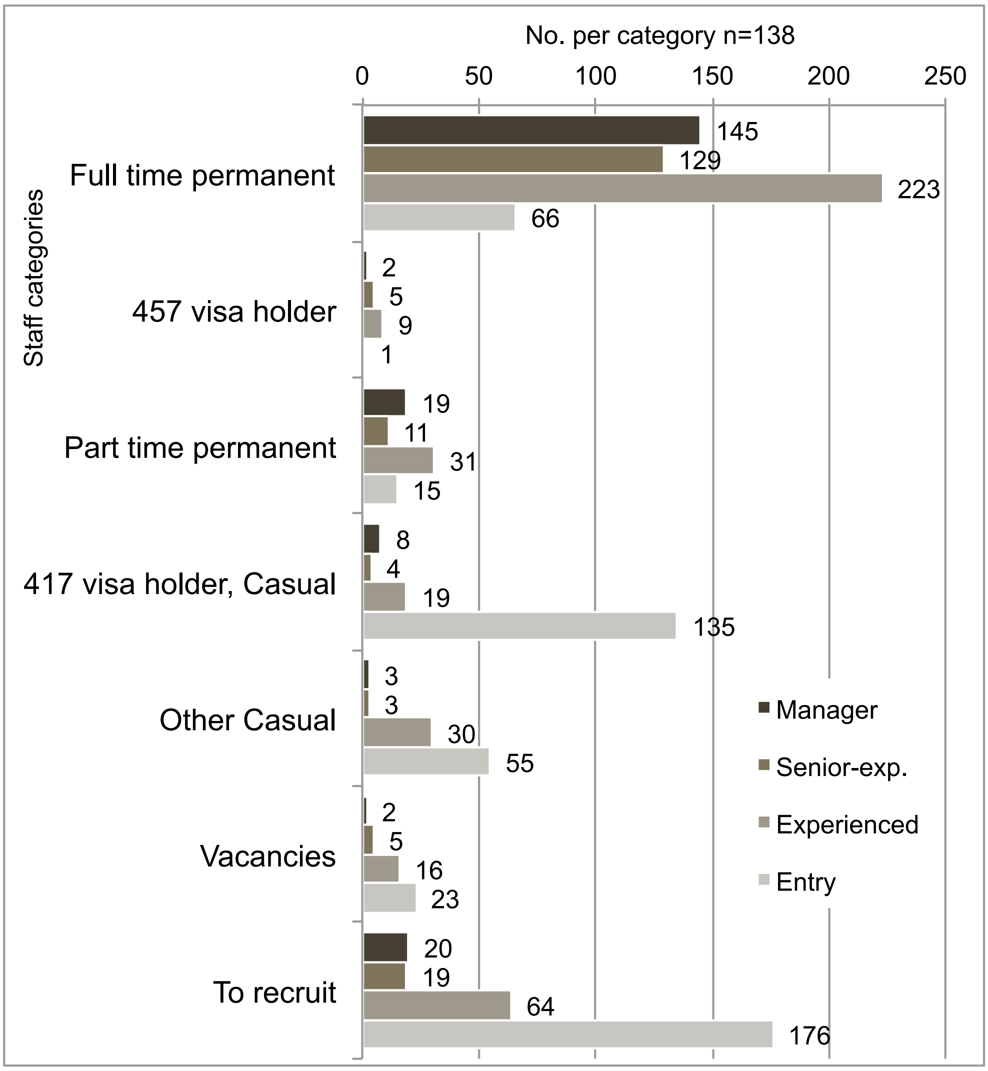
Staff category	Number	%	Staff sub-category	Number	%
Full time permanent	580	(63.5)	- 457 visa holders	17	(3)
			- Other full time	563	(97)
Part time permanent	76	(8.3)			
Casuals	257	(28.2)	- 417 visa holders	166	(64.6)
			- Other casuals	91	(35.4)
Total	913	(100)			

Figure 50 shows the staff (permanent and casual) and vacancies in January 2013, and those to be recruited over the next 12 months. It clearly depicts:

- the dominance of the full time permanent workforce
- the large number of Casuals at Entry level and in particular those on 417 visas
- the very small numbers of vacancies
- the plans to recruit a large number of Casuals at Entry level (To recruit)

The result for vacancies, a gap of 4.8% differs from CRDC workforce research conducted by The University of Melbourne in three production valleys, during 2012-2013. The results from those grower surveys were Emerald - 20% gap (November – December 2012); Gwydir - 16% gap (November – December 2012); and Lachlan Murrumbidgee – 11% (September 2013). Due to the differences in methodology between the case study and this survey, direct comparison is not possible. It may reflect differences between responding farms and regions. It may potentially indicate that the vacancies present in early season have been filled by mid-season.

Figure 50 Staff (permanent and casual) and vacancies at January 2013 and recruitment in the next 12 months (Raw scores)



In JANUARY 2013, how many people were employed in each of the following positions on your farm? Include yourself and family but exclude gin staff

When considering your farm workforce in January 2013, in each type of position how many vacancies did you have in January?

How many staff do you plan to recruit in the next 12 months, in the following positions (including any current vacancies you will try to recruit for)?

Permanent staff

For the purpose of this discussion, the terms "full time staff" and "part time staff" exclude those who are 457 visa holders as they are referred to specifically.

Experienced staff formed the largest category of the permanent workforce recorded by respondents to this survey question (Table 19, Figure 50).

The Experienced staff level was the largest group of permanent full time staff (39.6%), permanent part time staff (40.8%) then 457 visa holders (9 of 17). The rankings of proportions varied for the other staff categories. For employees who are not 457 visa holders, those at Manager level were the second largest group, with approximately one-quarter of permanent full time staff (25.7%) and permanent part time staff (25%). Senior experienced staff were the second largest group among 457 visa holders (5 of 17), third largest group of permanent full time staff (22.9%), and fourth largest group of permanent part time staff (14.5%). For permanent staff, Entry level were the smallest proportion in all categories except permanent part time staff, where they were the third largest proportion. (Full time permanent 11.7%; 457 visa holders 1 of 17; permanent part time staff 19.7%).

While there were plans to recruit permanent staff across all types of staff, the demand for Experienced staff was apparent with this being the category for which most recruits were sought, with almost one-third (30.2%) of the proposed full time permanent recruits, almost half of the permanent part time staff to be recruited (48.1%) and two-thirds of the 457 visa holders to be recruited (6 of 9). Entry level staff were the next largest group of proposed recruits, also across all staff categories – 27% of intended full time permanent, 26% of part time permanent and proposed 457 visa holder recruits (2 of 9). The numbers of proposed recruits for 457 visa holders and part time permanent staff are too low to elicit any discernable trend.

Table 19 Permanent staff in January 2013 and planned recruitment during the next 12 months
(Raw scores and percentages)

		Number	%	Number to recruit	%
Full time (excluding 457 visa holders)	Manager level	145	(25.8%)	12	(19.0)
	Senior experienced	129	(22.9%)	15	(23.8)
	Experienced	223	(39.6%)	19	(30.2)
	Entry	66	(11.7%)	17	(26.0)
	Totals	***563***	***(100)***	***63***	***(100)***
457 visa holders	Manager level	2		nil	
	Senior experienced	5		1	
	Experienced	9		6	
	Entry	1		2	
	Totals	***17***		***9***	
Part time permanent (excluding 457 visa holders)	Manager level	19	(25.0)	4	(14.8)
	Senior experienced	11	(14.5)	3	(11.1)
	Experienced	31	(40.8)	13	(48.2)
	Entry	15	(19.7)	7	(25.9)
	Totals	***76***	***(100)***	***27***	***(100)***

Casual staff

While casual staff constituted between one-quarter and one-third (28%) of staff in January 2013 (Table 18), it is a small, but important proportion for this seasonal crop. The results of this survey indicate that, for this sample, in the casual workforce, Entry level staff are the largest group and where the most future demand is, in particular for the 417 visa holders (Table 20).

The staffing profile of casuals contrasts with that of permanent staff, with most casual staff being at Entry level – for 417 visa holders (81.3%) and Other casuals (60.4%)(Table 20). In addition, most proposed casual recruits are at Entry level – 417 visa holders (93.5%), and as Other casuals (46.5%). This indicates a very strong demand for 417 visa holders, who are almost exclusively at Entry level.

While the proportion of Experienced 417 visa holders as casuals is small (11.4%) and the aim is to recruit few here, this contracts with the Other casuals result. Almost one-third of 'Other casuals' were Experienced staff (32.97%) and almost two-thirds at entry level (60.4%) with the future demand for both levels being similar (Experienced 44.2%; Entry 46.5%).

Table 20 Casual staff in January 2013 and planned recruitment during the next 12 months
(Raw scores and percentages)

	Staff category	Number	%	No. to recruit	%
417 visa holders	Manager level	8	(4.8)	2	
	Senior experienced	4	(2.4)	Nil	
	Experienced	19	(11.4)	7	
	Entry	135	(81.3)	130	(93.5)
	Totals	***166***	***(100)***	***139***	***(100)***
Other casuals	Manager level	3	(3.3)	2	(9.3)
	Senior experienced	3	(3.3)	Nil	
	Experienced	30	(32.0)	19	(44.2)
	Entry	55	(60.4)	20	(46.5)
	Totals	***91***	***(100)***	***43***	***(100)***

New to the farm in 2012, and new to cotton

Respondents were asked to indicate the number of employees in January 2013 who were new to their farm in 2012, and how many were new to cotton in 2012.

If the number of people new to the farm in 2012 (Table 21) was treated as a proxy measure for recruitment, this would show that 269 people were recruited in 2012 (new to the farm), however as a proxy measure it needs to be treated with caution. The percentages recruited during 2012 generally reflect the percentages for proposed recruitment in 2013, which suggests a level of consistency (Table 21). For Manager and Senior experienced staff the difference between those recruited in 2012 and those proposed to be recruited during 2013 was within two percent. However, fewer (6.1%) Experienced staff and more (5.5%) Entry level staff were to be recruited in 2013, than were recruited in 2012.

When those new to cotton were considered, Table 21 shows that overall, approximately one-quarter (26.8%) of 2012 recruits had cotton experience, but this varied depending on the level of the employee. Very few of those at Entry level had cotton experience (6.4%) but one-third of those at Manager level did. More than three-quarters (76.2%) of the Senior Experienced recruits had cotton experience and approximately half (52.6%) of the Experienced staff did. This suggests that there is some staff movement in on-farm cotton production positions. The large number of Entry level staff new to cotton potentially reflects the 417 visa holders.

Table 21 Employees new to the farm in 2012 and new to cotton in 2012
(Raw scores and percentages)

	New to farm	% new to farm in 2012	% to be recruited in 2013	New to cotton	% with cotton experience
Manager level	15	5.6%	7.2%	10	33.0%
Senior experienced	21	7.8%	6.8%	5	76.2%
Experienced	78	29.0%	22.9%	37	52.6%
Entry	155	57.6%	63.1%	145	6.4%
Totals	***269***	***100***	***100***	***197***	***26.8%***

Number of hectares and staffing levels

Of those who responded to both the employment question and the farm size question, the total farm hectares reported is 502,166, serviced by 913 staff, giving one person per 550 hectares. When full time permanent staffing was compared across the size of the hectares, some trends appeared. The total number of hectares was divided approximately into thirds for the purposes of analysis (Small size: nil to 640 ha; Mid size: 650-1830; Large size: more than 1850ha). Each staffing level (eg Entry) was categorised into one only staff member in January 2012 at this level, two at this level and three or more at this level. Analysis was conducted on the levels and hectare size. The results generally reflect greater staff numbers as the number of hectares increases.

Entry level staff

- Where just one Entry level staff member was employed they were most likely to be on a mid size (53.8%), followed by large (30.8%), then small (15.4%).
- When two Entry level staff members were employed, they were most likely to be on a large size (60%), followed by mid (40%), then small (10%).
- If there were three or more Entry level staff, they were most likely to be on a large size (66.7%) or mid (33.3%).

Experienced staff

- Where just one Experienced staff member was employed this person was almost equally likely to be on any of the three sizes (Small: 36.7%, Mid: 33%, Large: 30%)
- If there were two Experienced staff employed, this was more likely to occur as the hectare size increased (Large: 40%, Mid: 36%, Small: 24%)
- When three or more Experienced staff were employed they were almost equally likely to be on large (48.3%) or mid (44.8%) and least likely to be on small farms (6.9%).

Senior experienced staff

- If just one Senior Experienced staff member was employed this person was most likely to be on a mid size (60%), but least likely to be on a small (20%) or large size (20%)
- When two Senior experienced staff were employed they were far more likely to be on a large size (71.4%), than small (21.4%) or mid size (7.1%)
- When three or more Senior experienced staff were employed, most would be on a large size (80%) with the remainder on a mid size (20%).

Manager level

- If only one Manager was employed, this person would be almost equally likely to be on any of the three sizes (Mid: 35.2%, Small: 33.3%, Large: 31.3%)
- Where two Managers were employed they were most likely to be on a mid size (47.6%), followed by large (33.3%), then small (19%)
- If there were three or more Managers, this was more likely to occur on larger properties (Large: 69.2%, Mid: 23.1%, Small: 7.7%).

The round module picker and workforce

In deciding to use a round module picker, the highest percentage attributed to being a defining influence was a decrease in the labour required (34.52%), while reducing the Workplace Health and Safety risk was ranked third at 23.46%. When asked the impact of using a round bale picker, more than half (53.26%) strongly agreed and more than one-quarter (28.26%) agreed that it had reduced their labour requirements.

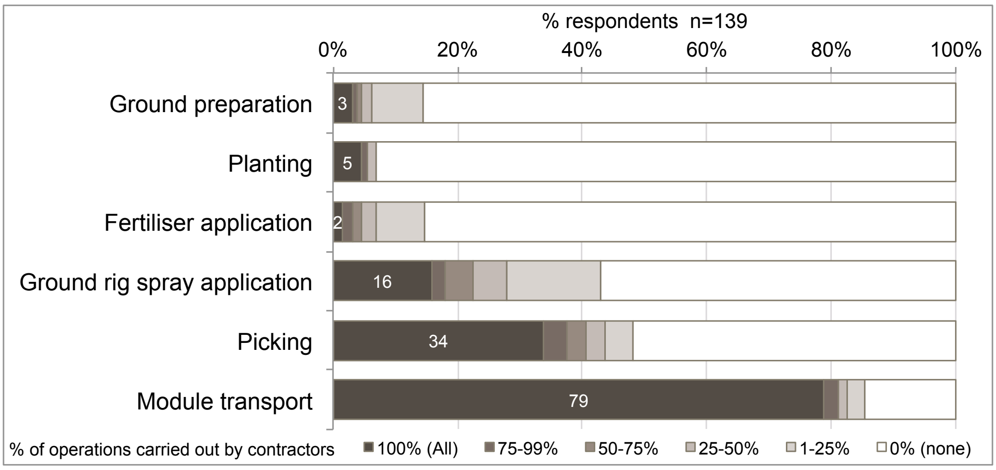
Use of contractors in farming operations

To understand the cotton industry workforce it is important to understand not only the staff employed by the farm but also the use of contractors. Contractors are engaged to undertake a range of farming operations to varying degrees on different farms (Figure 51):

- 98% of farms use contractors for at least some operations (including aerial application).
- 95% of farms use contractors for at least some of their on-farm operations (ie including aerial application and picking but excluding module transport).
- 49% of farms use contractors for on-ground, crop establishment and management operations (ie ground preparation, planting, fertiliser application and/or groundrig application.
- The 5% of farms who do not use contractors for any on-farm operations (ie anything other than module transport) are all located on the Darling Downs with farms less than 1900ha in size. Of these, 4 farms also do their own module transport.

Module transport is undertaken primarily by contractors with 85% of farms using contractors for this task at least some of the time and 79% of farms having all modules transported by contractors. 48% of farms engaged harvesting contractors for at least some of the harvest with 34% using only contract pickers. 43% of farms use ground rig contractors for some operations. Fewer farms use contractors for early crop stage operations with 15% of farms using contractors for some ground preparation, 7% for planting and 15% for fertiliser application.

Figure 51 Use of contractors to undertake various cotton farming operations



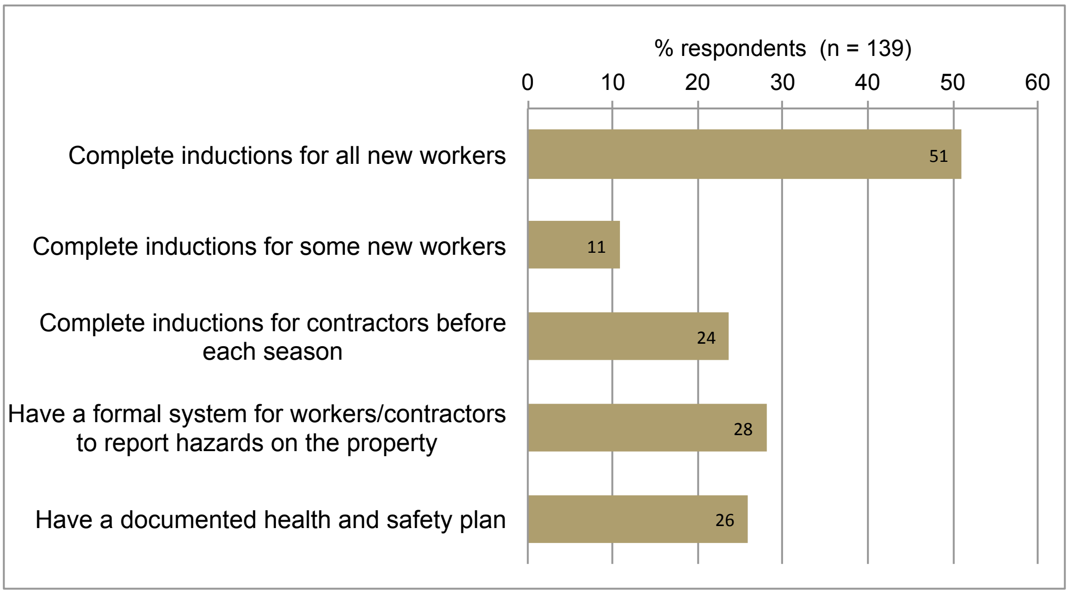
To what degree did you use contractors for any of these operations for your 2012-13 cotton crop?

Farm safety practices

Farm safety practices are an important part of the cotton industry's myBMP system. 62% of farms complete inductions for at least some workers, with 51% doing this for all new workers. As we know from Figure 51 that 98% of responding farms used contractors, it is interesting to note the lower use of inductions with contractors each season (24%). This may relate to repeated use of the same contractors each season. Relatively few farms are using formal systems for reporting farm hazards (28% of respondents) or have a documented health and safety plan (26%).

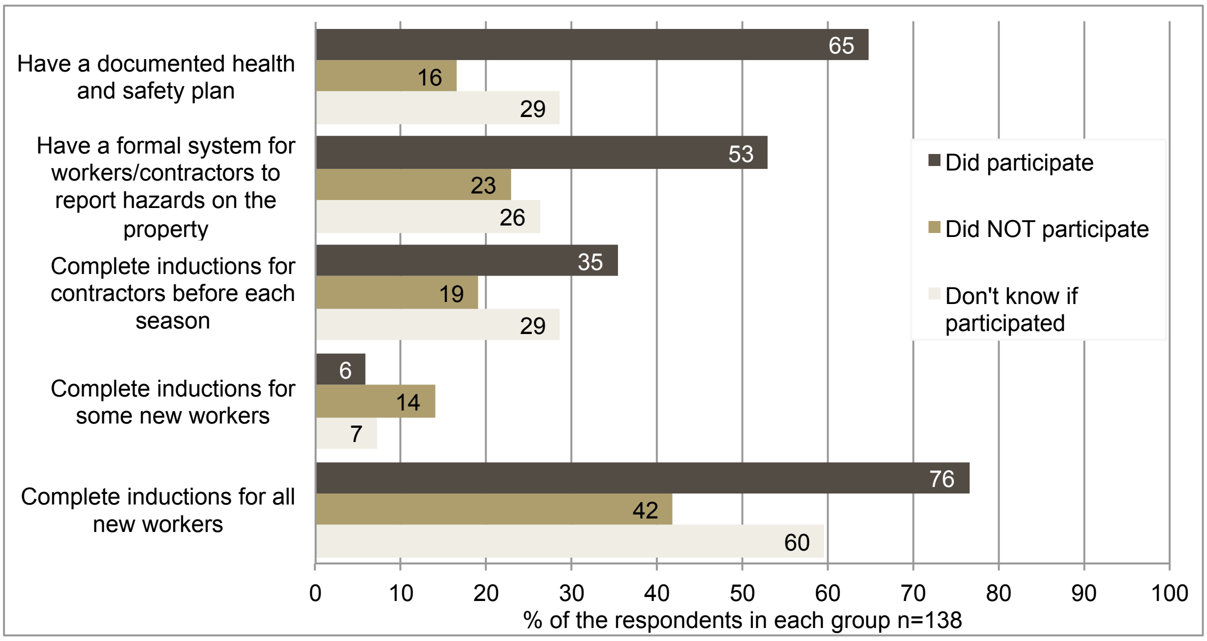
The survey sought to understand whether the *Cotton Small Business Workers Compensation Premium Discount Program that operated in 2002 – 2003* had an impact on ongoing safety practices. Only 17 respondents (12%) indicated that they had participated in this program whilst 30% did not recall whether or not they had. There appears to be a higher uptake of safety systems and plans amongst those who participated in the premium discount program (Figure 53).

Figure 52 Use of workplace induction and safety practices and systems



Do you do any of the following induction and safety practices?

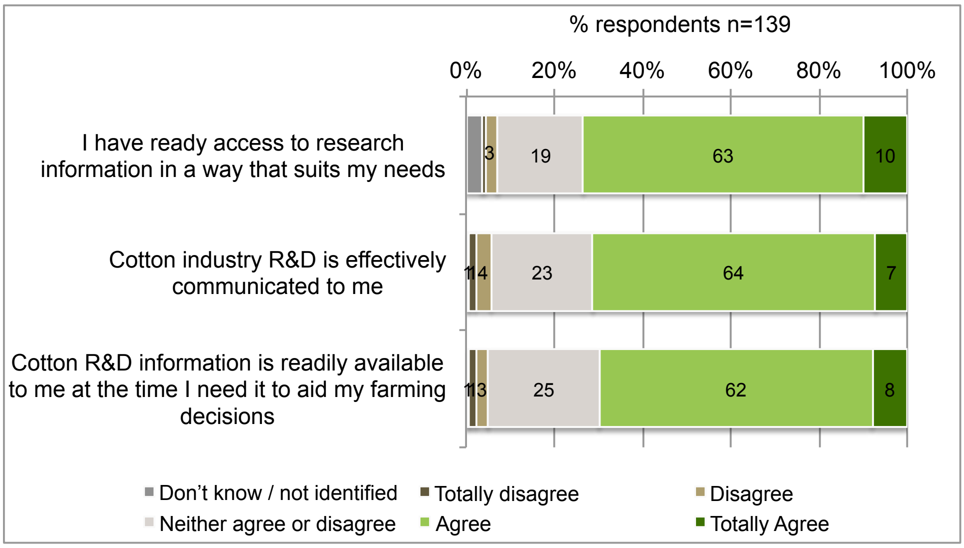
Figure 53 Use of workplace induction and safety practices according to participation in the Cotton Small Business Workers Business Compensation Plan (2002-2003)



Information for Cotton Decisions

70 – 73% of respondents indicated that cotton industry research and development is effectively communicated with information available in a timely manner to aid farming decisions (Figure 54). 19-25% neither agreed nor disagreed with these statements about communication of cotton R&D – possibly indicating that they do not seek out R&D in their decision making.

Figure 54 Perceptions on the communication of cotton research and development



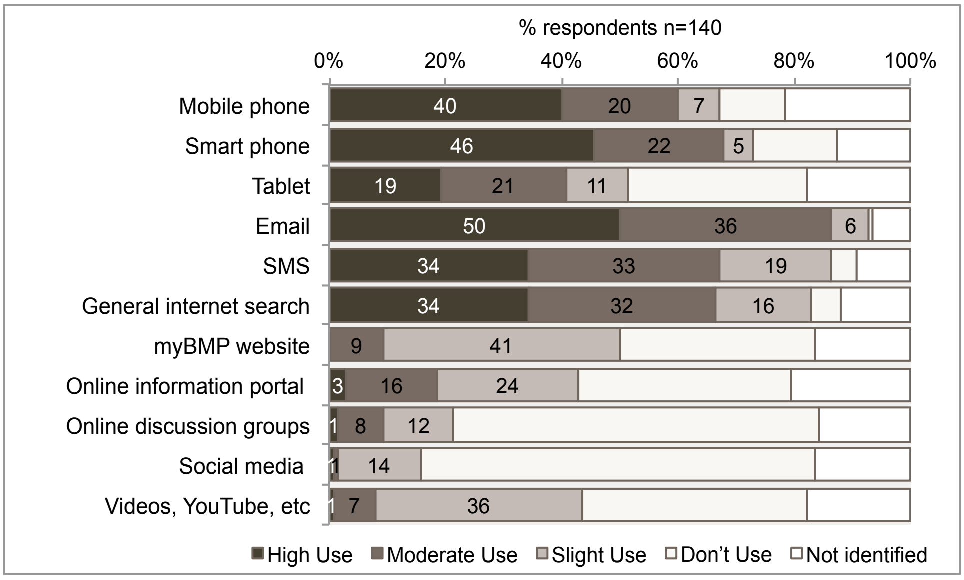
Please give your opinion on each of the following statements in relation to your cotton farming enterprise and the cotton industry

A further question asked about the use of information communication technologies to obtain information about the farming system (Figure 55). All of the 140 respondents to this question used some form of the listed technologies. The majority using several of these technologies with only one respondent indicating the only of these technologies he used was a mobile phone.

Other key points about use of information communication technologies in the farm business include:

- Mobile technology use is high with 82% of respondents indicating moderate or high use of a mobile phone, smart phone and/or tablet.
- Of the 27% of respondents who did not use a smartphone to access farming information, 47% of these did use a tablet.
- 84% used a smartphone or tablet.
- Social media use is low, reflecting similar findings in Cotton Australia's 2012 survey.
- 50% of respondents use the cotton industry's myBMP site, 41% only slightly.

Figure 55 Use of technologies for obtaining information about farming system



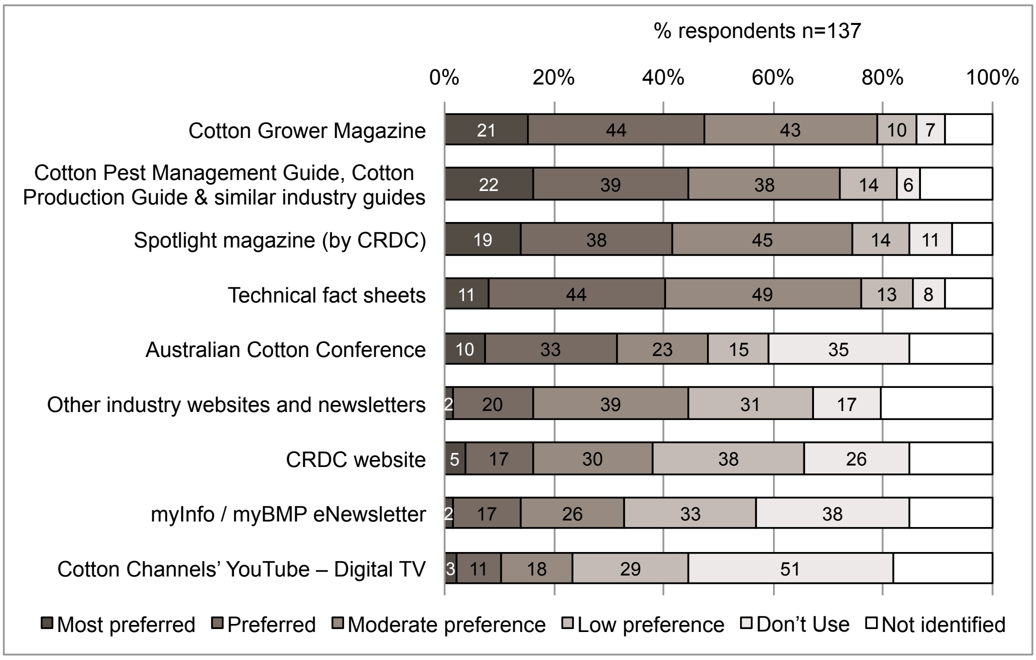
Which of the following technologies do you use for obtaining information about your farming system?

Respondents had a wide range of preferences, with the most preferred communication technology being:

- Email (35% of respondents)
- Smart phone (26%)
- General internet search (16%)
- Tablet (10%)
- Mobile phone (9%)
- SMS (2%)
- Online information portal (2%).

The most preferred mechanisms for receiving information about cotton research and development are The CottonGrower Magazine, the Cotton Pest Management Guide, the Spotlight magazine and Technical fact sheets (Figure 56). The Australian Cotton Conference and industry websites were also popular. Mentions were also made of receiving information from the agronomist and The Land or Qld Country Life.

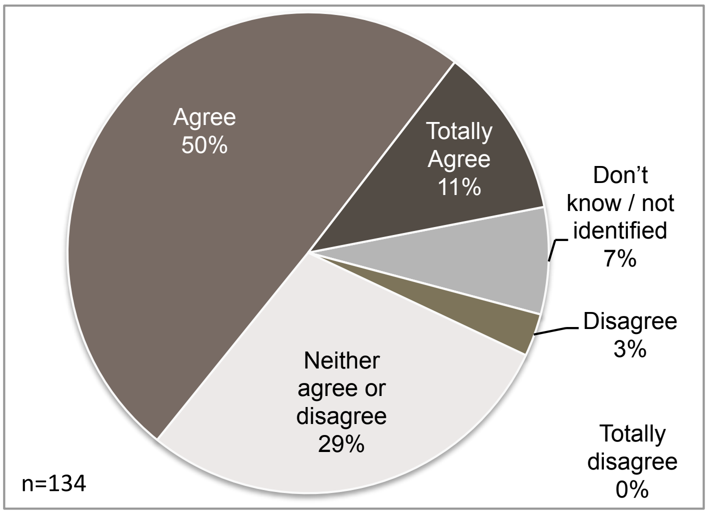
Figure 56 Preferred mechanisms for receiving information about cotton research and development



To receive information about cotton research and development please indicate your preference for each of these mechanisms

61% of respondents considered that cotton specific mobile apps could be helpful (Figure 57). 21 respondents made suggestions for the types of apps as follows.

Figure 57 Respondents' perceptions on whether cotton specific mobiles apps could help in their decisions



Please give your opinion on the following statement in relation to your cotton farming enterprise and the cotton industry: Cotton specific mobiles apps (for tablets, smartphones) could help in my cotton management decisions

The most requested topics for an app was for reliable weather information (including day degrees). Comment was made to include android apps.

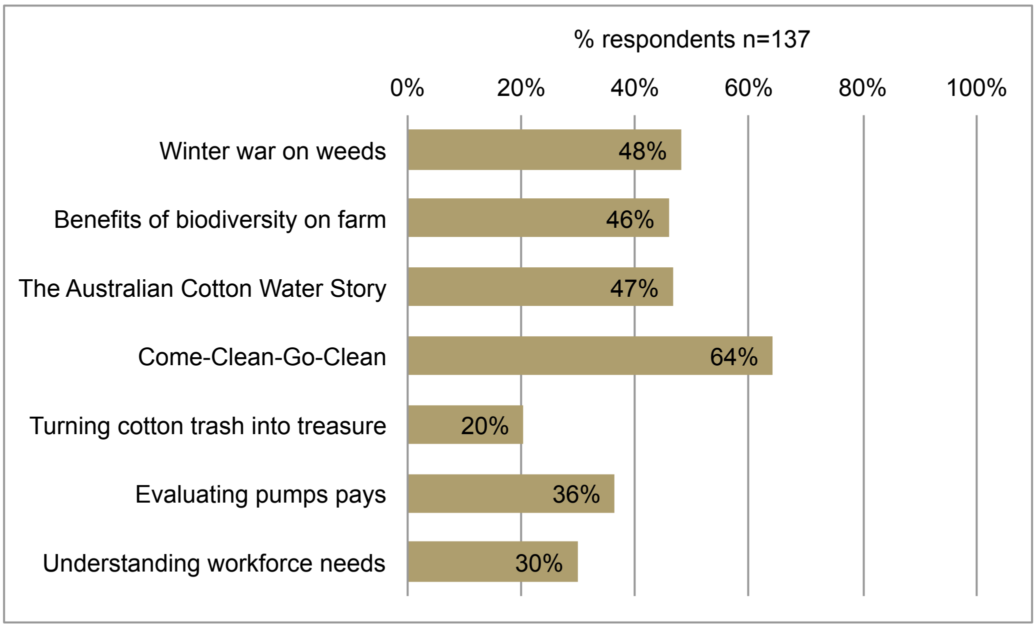
If you use smartphones or tablets, what types of apps (if any) would you like to see for cotton related information?

Other suggestions from growers were:

- Reliable Weather app
- Cotton Production Guide, Paddock record, gross margin comparisons
- Marketing
- Paddock Data entry, GPS mapping ,Round bale scanner
- Field manager, record keeper
- To be able to send round bale RFID info direct from picker to gin with an iPad or phone
- Mapping, survey
- Weather, day degrees
- Insect Identification
- Weather and Cotton market and Fert Market
- Weather, day degrees
- Insects, disease symptoms
- Water use, insect ID
- Spray Records
- Weather alerts , marketing
- Day degrees calculator
- Everything - agronomy, finance, OH&S
- Fertilizer and spray tables
- Irrigation Scheduler linked to weather- gives planning.

The surveys asked about growers' recall of some of elements of some of the research and development campaigns promoted over the past 12 months. Figure 58 illustrates recalls of specific messages by between 20% and 64% of respondents with the highest recall being of the long term campaign "Come-Clean-Go-Clean" (64% of respondents).

Figure 58 Recall of key research and development messages promoted over the past 12 months



In the past 12 months, do you recall reading or hearing about...

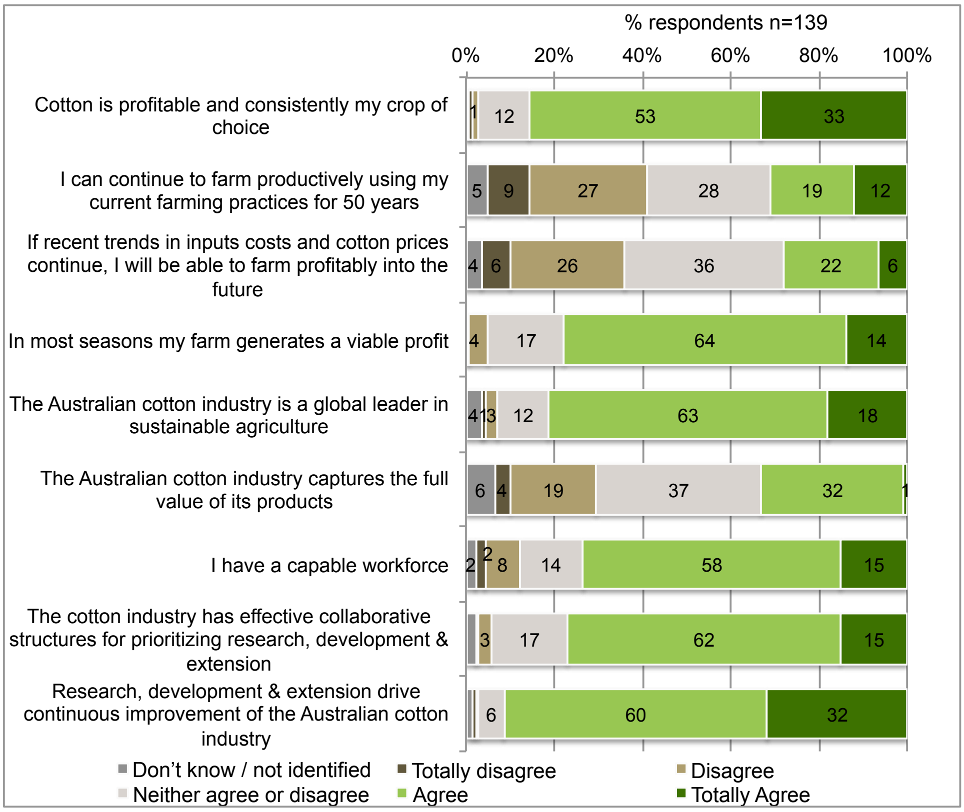
Perceptions and intentions

CRDC Strategic Plan Statements

The survey sought to establish a benchmark at the start of the CRDC Strategic R&D Plan 2013-18. As well as gathering data on a number of practices, growers were asked to indicate their level of agreement with a number of statements that reflect the stated outcomes of the CRDC Strategic R&D Plan. These responses, detailed in Figure 59, can be summarized as follows:

- CRDC Program: Farmers
  - 86% of respondents believe that cotton is profitable and consistently their crop of choice
  - 31% believe they can continue to farm productively using their current farming practices for 50 years
  - 28% indicated that if recent trends in inputs costs and cotton prices continue, they will be able to farm profitably into the future
  - 78% agreed that in most seasons their farm generates a viable profit
- CRDC Program: Industry
  - 81% of respondents regard the Australian cotton industry as a global leader in sustainable agriculture
- CRDC Program: Customers
  - 33% believe the Australian cotton industry captures the full value of its products
- CRDC Program: People
  - 73% indicated that they have a capable workforce
  - 77% believe the cotton industry has effective collaborative structures for prioritizing research, development & extension
- CRDC Program: Performance
  - 91% consider that research, development & extension drive continuous improvement of the Australian cotton industry.

Figure 59 Perceptions of farm and industry performance in relation to CRDC Strategic Plan Outcomes

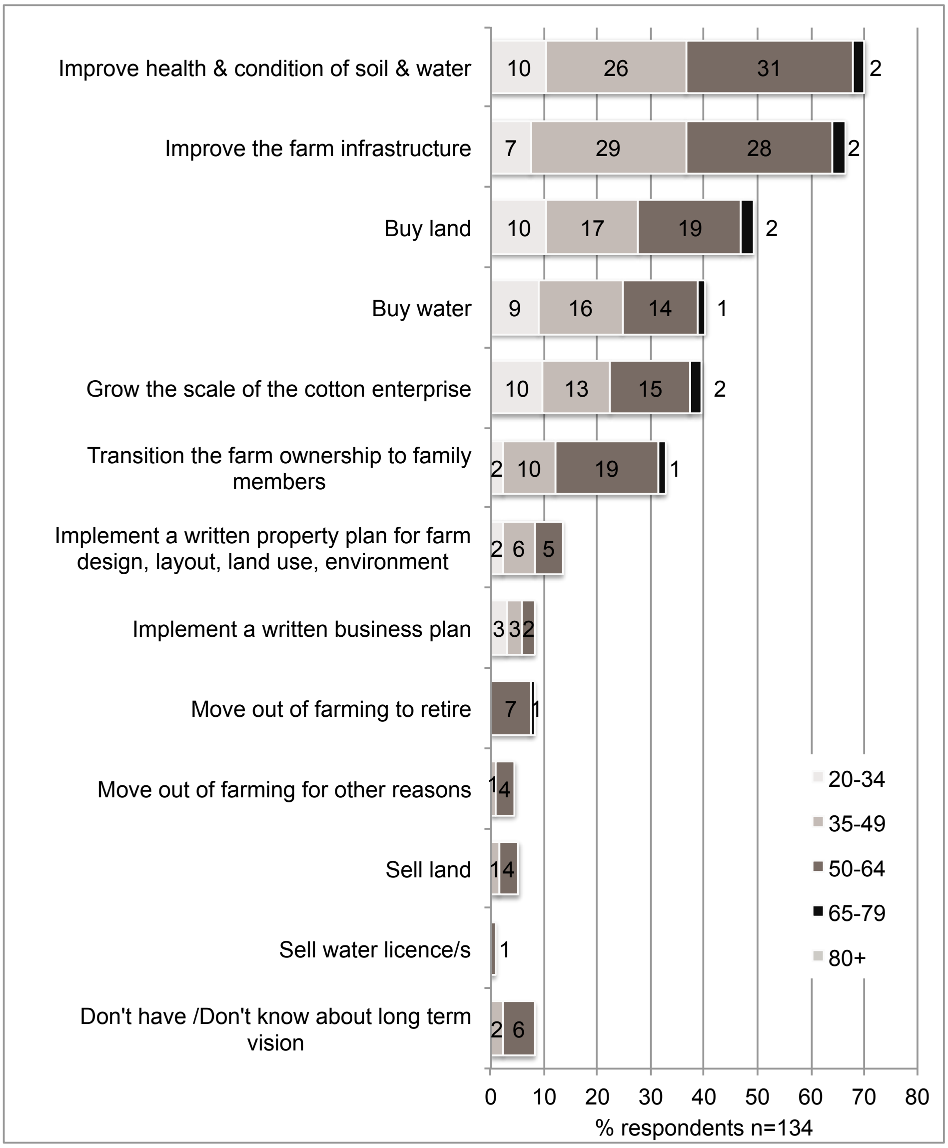


Please give your opinion on each of the following statements in relation to your cotton farming enterprise and the cotton industry

Aspirations for the future of the farming business

As part of the NCEA work on harvester decisions, they were interested to understand any differences based on future aspirations for the farm. For this purpose, the survey asked respondents to identify future plans for the farming business. Figure 60 illustrates that at least two thirds of respondents intend to improve their farm condition (70% of all respondents) and infrastructure (66%). Close to half intend to grow their farm assets and/or cotton enterprise, with 49% intending to buy land, 40% to buy water and 40% to grow the scale of the cotton enterprise. One third (33%) intend to transition the farm ownership to family members. 11% of respondents indicated they will move out of farming to retire or for other reasons, only one of these growers was under 50 years of age. There are no other strong correlations between age of respondents and their intentions. It is relevant to note that a number of the replies to the survey distribution (without a completed survey) were received from people on the cotton industry list who had retired from their cotton growing business prior to the survey.

Figure 60 Intentions for the future of the farming business by age of respondents



Which of these are a likely part of you or your employers' long term vision for this farming business?

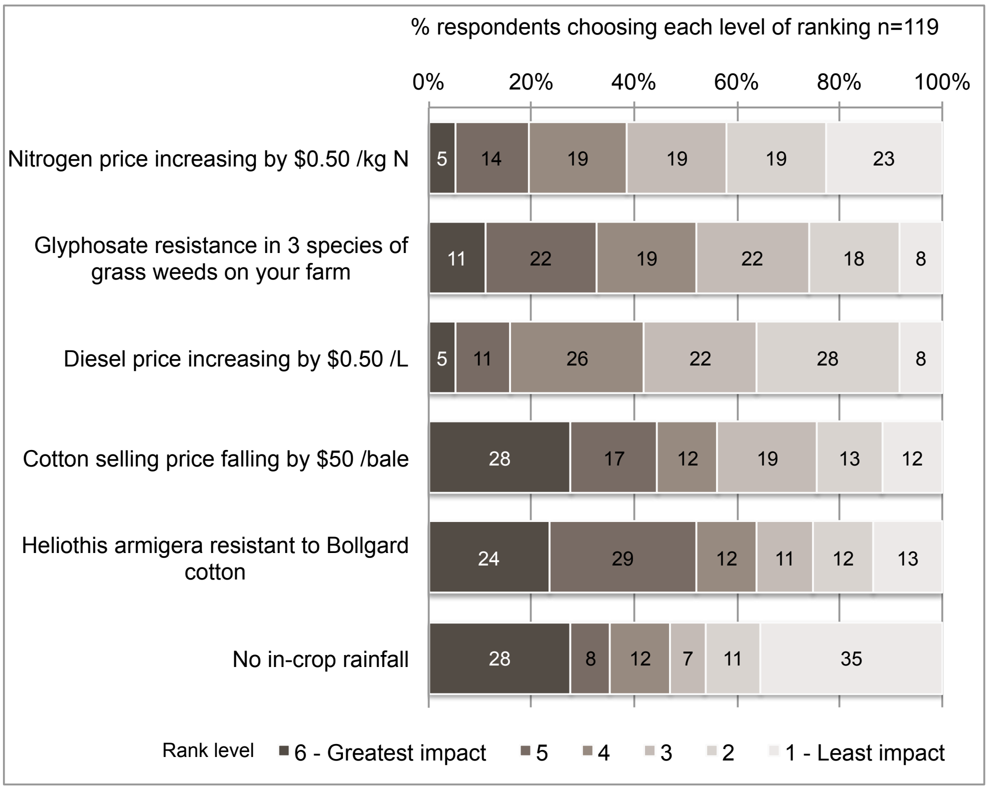
Influences on productivity and profitability

CRDC were interested to understand growers' view of the relative significance to profitability of a range of issues. Figure 61 illustrates highly varied views. It does show that the highest proportion of respondents (52%) felt that Heliothis resistance to Bollgard cotton would make the greatest or second greatest impact. The next most significant issue was glyphosate resistance, though the perceptions to this being mixed with 33% rating it as high impact (rank 5,6), 41% as moderate (rank 3,4) and 26% as least impact (rank 1,2).

The issue of no in-crop rainfall received was rated low impact (rank 1 or 2) by 46% and as high impact (rank 5,6) by 35%, possibly reflecting differences based on availability of irrigation water.

A $0.50/L increase in diesel price received mostly moderate to low levels of impact rankings (76% ranked it as 2,3 or 4) as did an increase in nitrogen price of $0.50/kg (81% ranking it 4 or lower).

Figure 61 Perceived impact on cotton gross margin of hypothetical scenarios



Of these 'hypothetical' scenarios, which would you expect to have greatest impact on your cotton gross margin?

Rank in order of impact where 1 = least impact and 6 = Greatest impact

Limitations and drivers of productivity, profitability and high yield

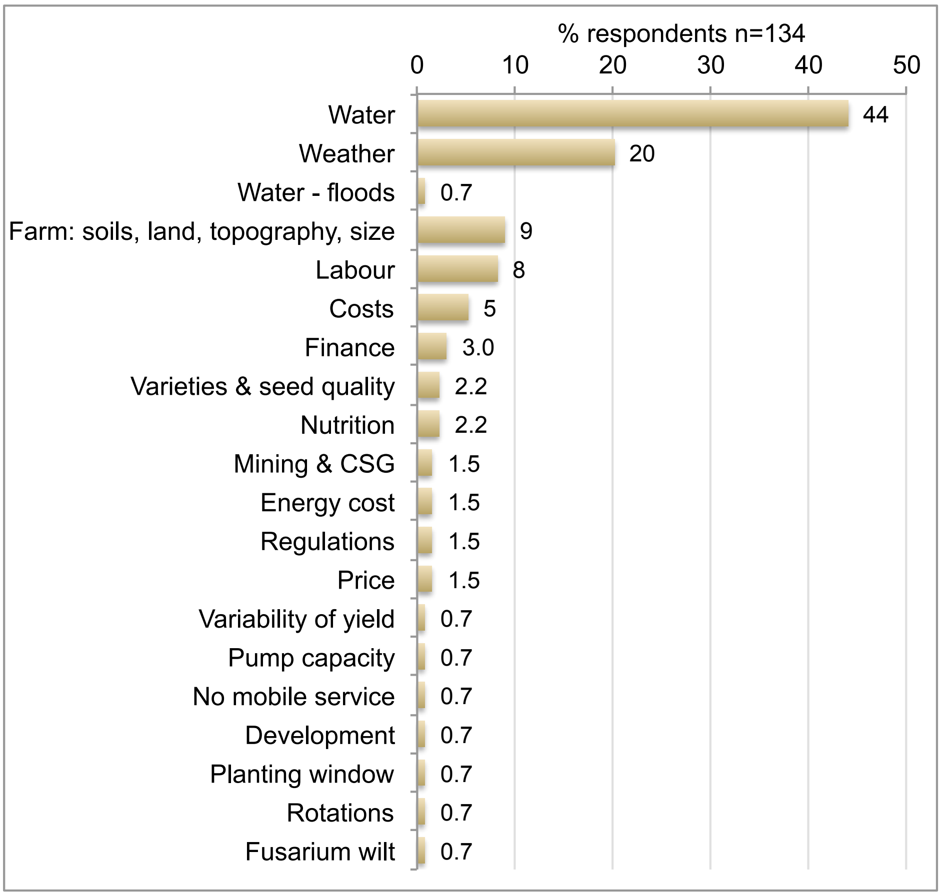
An open ended question was asked to identify respondents' views on the limitations and drivers of their cotton system. Clustered responses are depicted in the following graphs and individual responses are provided in Table 22.

Whilst several limitations to cotton production were identified, water and weather were by far the most frequently mentioned (Figure 62).

A greater variety of factors were identified by growers as the strongest drivers of profitability in their farm business (Figure 63). The three most mentioned were yield, price and water.

There was even greater variation in the factors thought to drive high cotton yields. Water and weather/seasonal conditions were again thought to be major factors. Management practices were also thought to be important, in particular the timeliness of inputs and operations (with timing of irrigations mentioned specifically), attention to detail and nutrition mentioned frequently.

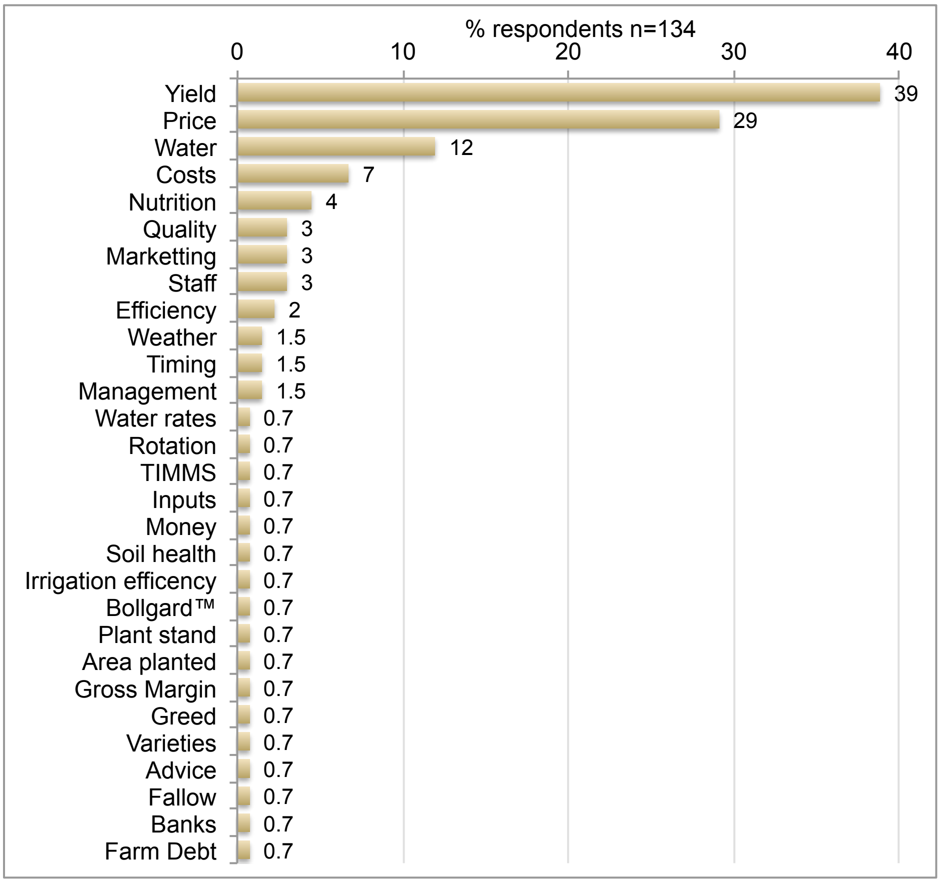
Figure 62 Biggest limitations to cotton production and profitability identified by growers



In just one or two words, please describe what you consider to be the biggest limitation to your farms' cotton production

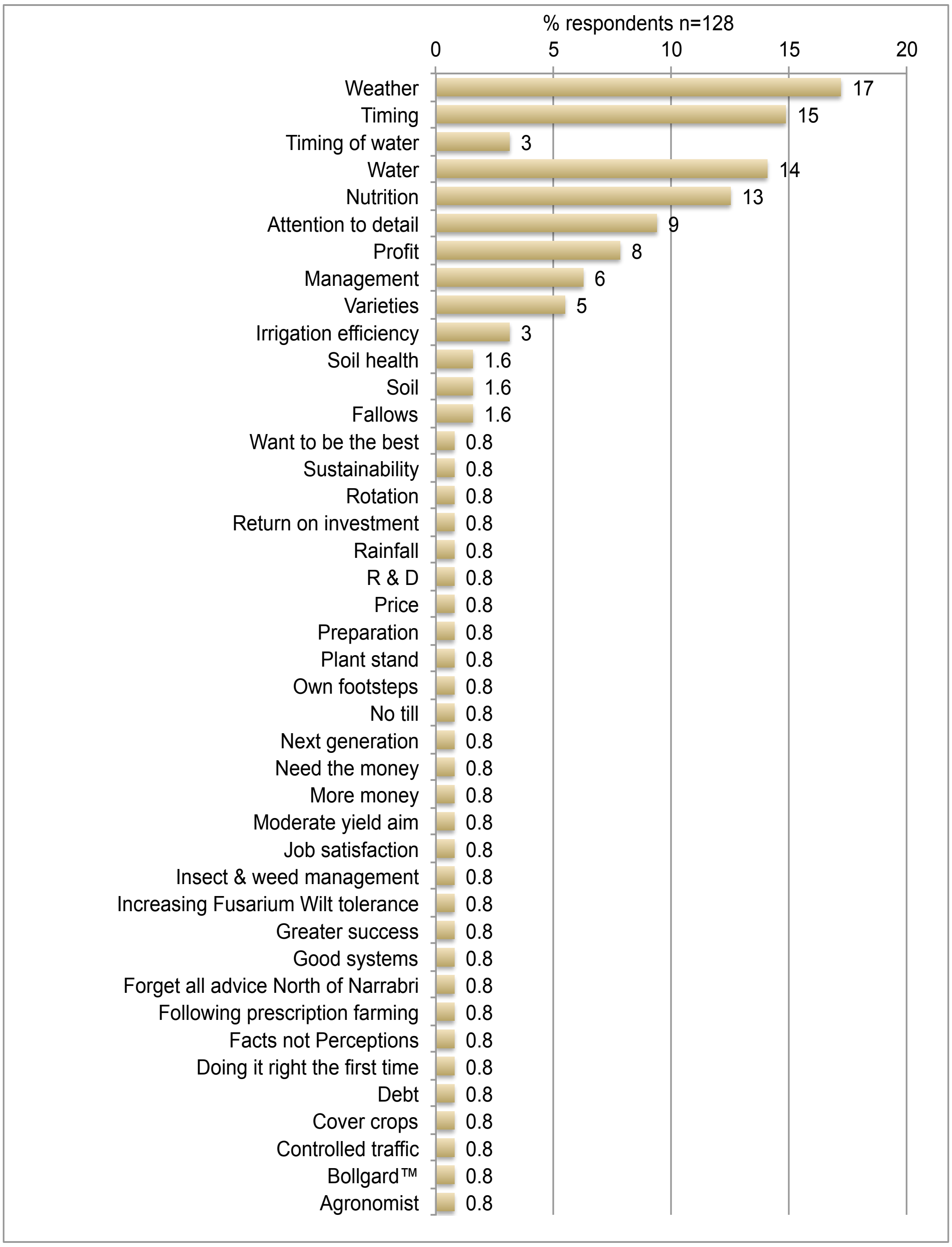
NB totals are greater than 100% as some respondents identified two issues

Figure 63 Strongest drivers of profitability from cotton in the farm business identified by respondents



In just one or two words, please describe what you consider to be the strongest driver of profitability from cotton for your farm business

Figure 64 Key reasons listed by respondents for achieving above average cotton yields



In just one or two words, please describe what you consider to be the key reasons for achieving above average cotton yields

Table 22 Individual responses identifying the limitations and drivers in cotton production and profitability

In just one or two words, please describe what you consider to be	the biggest limitation to your farms' cotton production	the strongest driver of profitability from cotton for your farm business?	key reasons for achieving above average cotton yields?
Central Queensland	Labour	Quality	Profitability
		Water rates	Water rates
	Labour	$/Bale	Want to be the best
	Soil Type		
	Weather		
	Weather /planting window	Rotation	Weather
	Weather	Keeping costs down	Management
	Weather	Marketing	Timing
	Red Tape	TIMMS	
Darling Downs	Land & Water	Yield	Profit
	Weather & Profitability	Price & yield	Attention to every detail
	Rotations/no zero fill	Price	Management, Rainfall
	End Price	End Price	Timing
	Nutrition	Nutrition	Nutrition
	Water	Cost down-price per bale	Fallows. Soil health
	Lack of Water	Increasing Yield	Management
	Water availability	Price & water	Nutrition & water
	Cotton Price	Returns	Good season and price
	World over supply of cotton. high costs in Australia	We can achieve good yields	Suitable soil and climate
	cost/ Ha	Yield	Fertiliser program
	Water, input costs	Quality, yield	Profit, sustainability
	Experienced labour	Quality not quantity	Try a moderate yield approach. Don't set standard to high
	Fusarium Wilt	Yield	Increasing Fusarium Wilt tolerance
	Rainfall/ Varieties	Yield and price	Timing
	Weather	Price for commodity	Varieties
	CSG expansion	Yield quality	
	Weather	Fertilizer/ water	
	Water	Water	Water
	Water	Inputs	Attention to detail
	Availability of water	Availability of water	Availability of water
	Nutrition	Money	More Money
	Moisture	Moisture, yield, price per bale	Cover crops, controlled traffic
	Water	Irrigation efficiency	Irrigation efficiency
	Energy costs	Soil health	Soil health and hygiene
Southern Qld	Water	Water, fertiliser	Water, timing, fertiliser
	Water	Yield	Doing it right the first time
	Soil type	Fertiliser	Timeliness
	No mobile service		
	Staff knowledge	Yield/ price	Get everything right
	Weather	Yield	Own footsteps
	Rain	Price	Good Soil
	Development	Yield	Profitability
	Water	Yield	Attention to detail
	Cost	Bollgard	No Till and Bolgard
	Rain	Plant stand /N	Plant stand/N
	Water availability	Cotton price	Fertiliser and timing of water
	Water	Input costs	Timeliness
	Weather	Yield	Water
	Weather	Yield	Water

In just one or two words, please describe what you consider to be	**the biggest limitation to your farms' cotton production**	**the strongest driver of profitability from cotton for your farm business?**	**key reasons for achieving above average cotton yields?**
	Seasonal conditions	Yield	Good systems
	Water	Yield	On time every time
	water reliability, seasonal variability	area planted, yield, price	relentless attention to detail in production system
Northern NSW	water	efficiency, price	Weather
	water	yield	attention to detail
	Water	Yield	R & D
	Government policies	40%marketing 40%production 20%costs	Management
	Rain	Rain	rain (moisture conservation at all times)
	Water	Water	Good Nutrition
	labour & timing	timing & labour	timing
	Cost of inputs, water, fertiliser, fuel etc	Gross Margin	Varieties, good season with water
	last couple of years has been the weather	Yield	Right water, nutrients and a bit of luck with weather
	Soil chemistry	Yield	Climate, Nutrition, Water
	Water	Price/ marketing	Basics right
	Topography and water	Improving Yield	Water application, fert needs
	fertiliser efficiency	cost control	water timing
	Water & weather	cost, yield, price	Next generation & debt
	Water	Yield	Attention to Detail
	Age of workers	Myself	Some good seasonal data/ weather
	good labour	greed	need the money
	Water	Yield	Fertiliser
	Water Availability	Water Availability	irrigation timing applications
	Water/ Rainfall	New Seed varieties	74BRF Seed
	Bore Yield	Cotton Price	The Weather
	Finance	Yield and Price	timing
	Water use efficiency	Yield efficiency	Attentionn to detail with operations and watering
	Water security	Price	Water management
	Water	Lastest advice	
		Yield	Timing /Luck
	Flooding	Yield	Attention to detail
	Water	Water	Water
	Trained labour OHS	Cotton prices	Seasonal conditions
	Water	Yield	Timing
	Workforce	Cotton price	Rainfall (dryland) , Insect management, weed control, fallow management
	water	Improving yields	Improved varieties
	Water	Higher yields	Good weather- high yielding varieties
	Water	Yield	Greater success
	Costs	Yield and price	Good management
	Land availability	Fallow land	Profit
	water	water	timing
	Soil moisture	Soil moisture	Liquid Nutrition
	Coal and Coal seam Gas	Yields and prices	Management and Varieties
	water, varieties	cost of production	timing
			weather
	Weather rainfall	Commodity price	Timeliness farm practices
	water	banks	water use efficiently
	soil , weather	staff	Management
	water availability	yield	timely irrigation

In just one or two words, please describe what you consider to be	**the biggest limitation to your farms' cotton production**	**the strongest driver of profitability from cotton for your farm business?**	**key reasons for achieving above average cotton yields?**
	Water	Yield	Season
	water, weather conditions	water , fert	as above
	Season variations	Weather	Mild summer moderately wet
	diesel cost	prices	new practices
	Area	?	Fertiliser, water
Macquarie	Skilled labour	Yield	Task timing and seasonal conditions
	water	yield	being on time
	Water	Yield	Preparation
	Water Availability	Yeild	Attention to detail
	Water, weather	Efficiency	Attention to detail
	Water Reliability	Yield, Price	Water and Nitrogen
	Water availablity	Yield Price	Profit Drivers
	Capital	Profit	Profit
	Water	Price	Drip Irrigation
	Seasonal variability	Yield and price vs costs	profit
	water	water	weather(sunlight)
	size, water availability	price bale	climate/ seasonal conditions and water availability
	size, water availability	price / bale	climate /seasonal conditions & water availability
	Water	Water	Water
	Water profits		
	water	people	timing
	water	team work	weather
	water	water	nitrogen
	Water	Yield	Return on investment
	water	yield/ price	income
	water	Yield is King!	Procedural timing in all operations
	labour	price	water/seasonal/ seed breeding
	Water	Cotton price	Season
Southern NSW	Water	Price	Facts not Perceptions
	Climate / water	High yields / prices	Having water available
	$, Water	Management	Following prescription farming
	Increasing costs	Price and Yield	Rotation
	Hardforming variabilty of yields		
	Layout	Farm Debt	Job satisfaction
	Water Knowledge	Yield	Good Agronomist need a Cotton Bible
	Sufficient cashflow	Timing	Timing and water management
	Farm size	Marketing	Profit
	Sodic soils	Water availability	Timely inputs
	seed quality . summer warer pump capacity	Price	Forget all advice North of Narrabri
	Weather	Cost per ML	Good conditions and hot summer

Additional comments

26 respondents made additional comments about further research and information. These are collated in Table 23. Whilst these have been clustered according to themes it should be noted that comments were made about the need to better understand the relative importance of these.

"Soils, energy efficiency and pumps , water use efficiency - where do I get the most benefit? Should I concentrate on one or try to do all together. Cost is a consideration."

"Energy efficiency; Fertiliser application - type, amount & timing, research; Staff efficiency. These are our three biggest costs."

Table 23 Suggestions for further research or information from CRDC

Theme	Comment
Crop Protection: Weeds	We badly need 'Liberty' available to manage weed resistance and should be mandatory - research needs to be done on benefits to industry of rotation of RR and liberty as is done with Canola in Canada Fleabane control
Stewardship: Resistance management	Refuge area to be reduced for RRF crops to 5% Refuges 5% unsprayed Cotton versus 5% Pigeon peas? The % of refuge in Dryland crops is too high- 5% would be acceptable We need to greatly improve the process of pupae busting and removal of crop residues for Dryland Growers- ie: less tillage operations to achieve a results
Resource efficiencies: Soils & Nutrition	I would love to be able to combine sulphur which is available readily with Starter Z. This season I have used sulphate ammonia-gran am 60-40% blend. A lot of bulk Fertiliser application - type, amount & timing, research Soils The industry needs to get off the Methadone program (excessive nitrogen use) Slow release Urea products, is the extra expense worth it? Manure - fact or fiction, application issues, type of I think there still needs to be more research into soil biology- soil microbes and how they process nutrients. A lot of how soils work is still misunderstood. Nitrogen recipe for variable seasons
Resource efficiencies: Energy	Alternative energy subsidy Energy efficiency Energy efficiency and pumps On farm Biodiesel plants or gin located, some in USA
Resource efficiencies: Tillage	Look at better methods to treat cotton stubble breakdown, eg biological spray to improve decomposition of the cotton plant into mulch.
Resource efficiencies: Water	Bankless channels Water use efficiency (x2) Saving labour in water methods eg: Bankless channels
Harvesting	We currently use controlled traffic at 12 metre centres thus 8 metres as suggested does not fit. 6m picker is used and 6m side buster (6x40' Rows) Round Module picker compaction and longterm effect on yields and sustainability
Fibre quality	Weathering of cotton lint in field ie, when best to harvest after rain.
People	Staff efficiency Employment Training for Cotton farming; OHS Training courses for Cotton business
Policy	Government interference effecting profit i.g. water controls, vegetation control etc. There is no National energy policy into the future! Very Political but someone needs to drive it before it becomes a crisis. Natural Gas may be fertilizer piggyback - N2
Research and communication	Applications for mobile/ ipad Cotton research must stay @ the fore front of every cotton grower thinking , without the research and tools to maintain cotton production we are doomed. Increasing costs vs yield/price diminishing Aussie cotton has excellent Aussie researches Cotton Bible - All Elements Required for a top Crop from the Soil to the Bale. More focus on growing Cotton South of Narrabri Where do I get the most benefit? Should I concentrate on one or try to do all together. Cost is a consideration

Table 24 Other comments about cotton production, profitability and research

Planting	Planter accuracy testing (Metermax checks)
Varieties	The Cotton Variety improvement in the last ten years is astonishing Cotton Industry needs to put more time and money into conventional RRF Varieties Sicot 74 BRF has been a large step forward for our Dryland cotton production Cotton resistant to 2,4D Need shorter season varieties - Continued Research
Water	Grow on less water/ha without reducing yield. Water charges from State Water need to be addressed
Weeds	Resistant Barnyard grass & fleabane in irrigation
Biotechnology	Cotton production profitability would dramatically increase if Bollgard licences were decreased Bt costs in low cotton price years under $450. $50 a bale when cotton is $260 is too much for Dryland and yields of 3.5-4 bales Ha Pupae Busting and ground cover conflict Unsprayed conventional cotton in strips across fields is the most effective refuge Keep promoting biotechnology as benefical for the Cotton Industry Monsanto are reducing profitability for the farmer
Energy	We can be some of the most efficient producers in the world but we need to reduce our energy costs to stay competitive.
Soil	Soil health and profitability are a key consideration in our business but Southern Cotton Farming is challenged by environmental (wet) risks and decisions on timing can over ride soil health and environment in favour of profit
Harvesting	The sleeping giant of the cotton industry at the moment is compaction from the 7760 pickers, it is starting to show up in yields after 3yrs of use Cotton wrap needs to be cheaper
Ginning	The whole Ginning process is an antiquated process . It needs to be online, transparent increase efficiency or let us send it to China to be Ginned
Seed value	Need to get better value from the cotton seed we produce. Investigate ways to either value add from the current form of the cotton seed or breed better traits into the cotton seed in order to get better returns
General	Its great to see research happening Finally, I thought I would never finish this survey! The Cotton Industry is light years ahead of the Grain and Livestock Industries The Australian Cotton Industry has remained profitable almost exclusively by its research efforts in, increased yields, fibre quality and all other agronomic pursuits ie; N, P trials etc

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Acknowledgements

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

Thanks to CRDC for funding this work and for the input of Susan Maas, Tracey Leven, Allan Williams, Ian Taylor, Rohan Boehm and Paula Jones in survey design, planning and review. Cotton Australia's Angela Bradburn and Greg Kauter gave valuable input to the survey design.

A number of cotton researchers contributed to the survey questions and review including Dr Mike Bell, Kirrily Blomfield, Sally Ceeney, Dr Greg Constable, Dr Sharon Downes, Dr Nilantha Hulugalle, Dr John McLean Bennett, Assoc. Prof. Tony Lower, Dr Jennifer Moffatt, Dr Ian Rochester, Colin Tann, Stacey Vogel, Jim Wark and Sandra Williams.

Citation

Roth Rural (2013) Cotton Growing Practices 2013: Findings of CRDC's survey of cotton growers. Cotton Research and Development Corporation, Narrabri.

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