

Cotton Research



The Cotton Consultant Australia 2006 Bollgard Comparison
Report
Information from the 2005-2006 Season

A Report Prepared for

The Cotton Catchment Communities CRC

And

The Cotton Research and Development Corporation

On Behalf of

Cotton Consultants Australia Inc

Brendan Doyle & Michael Coleman

February, 2007

**IRF Cotton Research, UNE
Armidale NSW 2351**



ACKNOWLEDGEMENTS

The authors would like to thank the members of Cotton Consultants Australia Inc. for their assistance in providing information for this report. A special thank you to Jon-Maree Baker in the CCA executive office along with the CCA survey committee. This report would not be possible without the generous assistance of CCA members throughout the valleys, the survey team would like to thank them for their time.

It is stated here and must be understood by any reader that 'users of the information contained in this report do so at their own discretion'. While every care has been taken to verify the accuracy of figures and associated claims, the data is supplied by respondents across all cotton growing regions, and their individual assessments and interpretations are 'best estimates' from sampled survey data and must be used in that light.

Finally while all care has been taken in the preparation of this report, users of the compiled information do so at their own risk and discretion.

COPYRIGHT NOTICE

Copyright in this publication is owned by the Cotton Research and Development Corporation, the Cotton Catchments Community CRC and Cotton Consultants Australia Inc. unless otherwise indicated.

You may download, store, display, print and reproduce this material in unaltered form only for your personal, non-commercial use or use within your organisation so long as you give appropriate acknowledgement to the copyright owner.

Apart from any use as permitted under the Copyright Act 1968, all other rights are reserved.

Requests for further authorisation should be directed to the Communications Manager of the Cotton Catchment Communities Cooperative Research Centre.

© Copyright 2007 Commonwealth of Australia

Executive Summary

Bollgard technology continues to dominate the cotton production landscape in Australia. The 2005-2006 production season saw approximately 85 per cent of cotton planted with Bollgard varieties while production forecasts from growers suggest that Bollgard varieties will increase to 90 per cent in the 2006-2007 season.

This report overviews data collected from three sources. Grower data from Cotton Consultants Australia Inc. (CCA) *Grower Feedback Survey* is presented in combination with information from the *CCA Consultant Survey*. Data were also contributed for this report from consultants who use Paddock Action Manager (PAM) software, resulting in field level data for 346 Bollgard fields and 98 Conventional fields.

Growers and consultants were asked to comment on their experience with the technology. Thoughts on yield and associated fibre quality for Bollgard and Conventional varieties were well represented with a majority of respondents indicating very similar yields tending to a slight increase for Bollgard crops. Quantitative information contributed for the report correspond with these qualitative assessments with average Bollgard yields for the 30 field comparisons at 8.39 bales per hectare, with Conventional cotton yielding 8.32 bales per hectare. Questions remain in relation to associated fibre quality attributes in some Bollgard crops with a number of survey respondents indicating that Conventional varieties are less variable in quality overall.

The CCA membership found that Bollgard technology “mostly” performed to expectations just less than 85 per cent of the time, with only 8 per cent of respondents indicating that it did not meet expectations. Suggested reasons for adopting Bollgard technology were again well contributed. In summary these were; managing risk associated with the growing operation, particularly OH&S and spray timing issues; reducing the variability of cost and uncertainty associated with controlling insects and environmental considerations such as boundary areas, populated areas and other sensitive sections of the farm such as waterways and grazing paddocks. “Lifestyle factors” were also suggested as being very important including reducing general hassles associated with the crop and reduction in operator time commitments associated with insect management in particular.

The long-term success of Bollgard technology relies on effective resistance management. The principle industry response revolves around the Insecticide Resistance Management Strategy (IRMS) which combines judicious use of insecticides combined with refuge crops. Refuges are reported as being a point of contention for most growers but tolerated as a necessary cost associated with Bollgard technology. Many questions are posed in relation to the “science” behind the guidelines, with a number of consultants reporting that growers find refuges costly and a large inconvenience, however commitment to “protect the technology” is strong. Pigeon Peas are most frequently mentioned as the refuge of choice. Recorded spray reductions for the sample average at 7.7 fewer sprays on Bollgard fields with the largest portion of sprays on Conventional varieties being reserved for Helicoverpa. Mirids are the pest most sprayed on Bollgard fields.

The economic result for the comparison fields submitted for this report highlight the economic reason behind the continuing high level of adoption of Bollgard technology. The average benefit from growing Bollgard as opposed to Conventional varieties is approximately \$250 per hectare for the sample supplied.

When considering the impact of biotechnology in agriculture, it is generally accepted that production systems will change over time in response to the management innovation. The Australian cotton industry has seen the effective overhaul of insect management strategies that are fast moving production to a situation where Conventional varieties are maintained as seed-stock for infusion with biotechnology rather than being grown in large-scale commercial quantities. This report highlights a wide range of benefits attributable to Bollgard cotton. For these benefits to continue, it will be imperative that stewardship of the technology is foremost in the thoughts and actions of all industry participants.

Table of Contents

Acknowledgements.....	3
Executive Summary.....	5
1 Introduction.....	9
1.1 Methods.....	9
1.1.1 Grower Type.....	9
1.1.2 Grower Regions.....	11
1.2 Structure of the Report.....	13
2 Grower Survey Data.....	14
2.1 Gene-Stack Mix.....	14
2.2 Refuges.....	21
2.3 Conclusion.....	21
3 Consultant Data.....	22
3.1 Bollgard Performance.....	22
3.2 Refuges.....	25
3.3 Reduction in Spray Applications.....	27
3.4 Pest Pressure and Spray Comparisons.....	30
3.4.1 Bollgard Pressure, Control and Sprays.....	30
3.4.2 Conventional Pressure, Control and Sprays.....	31
3.5 Sprays by Production Stage.....	33
3.6 Conclusion.....	35
4 Economic Analysis.....	36
4.1 Yield Comparison.....	36
4.2 Spray Costs.....	37
4.3 Conclusion.....	40
5 Paddock Action Manager Data.....	41
Appendix 1	
Appendix 2	

1 Introduction

This report outlines the experiences of growers and consultants with respect to the performance of Bollgard Cotton varieties during the 2005-2006 cotton growing season. Data are drawn from growers and consultant members of Cotton Consultant Australia.

The data collected allows for an independent analysis of the performance of Bollgard cotton in the Australian Industry as compared to conventional cotton fields that have similar production parameters in terms of soil type, water availability and other constraints to the production season. Quantitative data and qualitative information from growers and consultants is used to inform the reader of the underlying thoughts and attitudes surrounding issues of importance to the industry.

1.1 Methods

The report presents data from two sources. Information from questions relating to Bollgard production from the CCA's Annual Cotton Grower Feedback Survey is presented along with responses from consultants in the CCA Membership Survey.

The 2006 Cotton Grower Feedback Survey achieved a response rate of 14.6 per cent, or 122 survey responses out of an initial mailing list of 834 cotton growers and on-farm agronomists. Telephone reminders to growers revealed that approximately 15 per cent of growers on the database had ceased cotton production; hence the effective survey response rate is estimated to be slightly more than 17 per cent. Survey respondents were responsible for 56087 Hectares of cotton in the 2005/06 season, representing 18.8 per cent of the total cotton area for the season (2005/06 season industry estimate of 297,817 Hectares).

1.1.1 Grower Type

Information from growers is presented in two formats. Grower type is where data is presented using groups defined by a clustering of farms with similar farming contexts. This divisive clustering process sets out to find a collection of farms within the sample such that the members of each group are as similar as possible to one another and each of the groups developed were as dissimilar to one another as possible. The result is discrete groups of farmers who have differing production contexts.

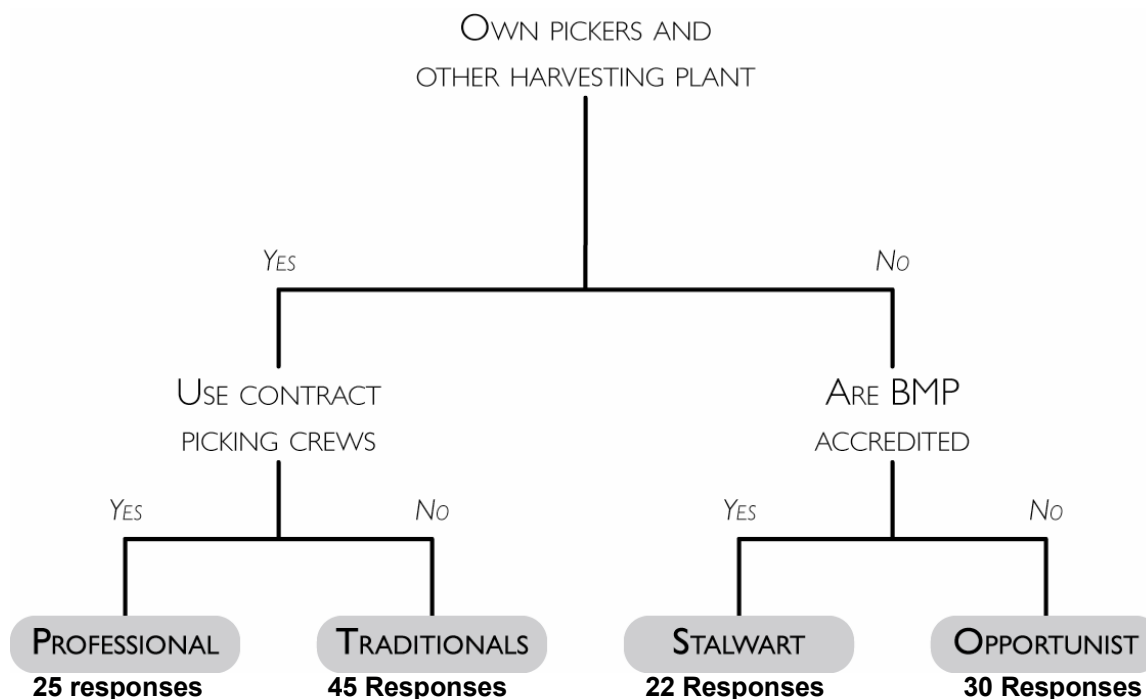
The following contextual variables are used to determine group membership.

Table 1

On farm water storage
Follow BMP guidelines
Are BMP Accredited
Eight-row equipment
Twelve-row equipment
Measure water use efficiency
Monitor ground water levels
Measure soil salinity on your farm
Measure soil sodicity on your farm
Measure soil organic content quality
Have soil erosion risks assessed
Some overhead irrigation systems
Some drip irrigation systems
Your own pickers and other harvesting plant
Use contract picking crews

The clustering procedure considered binary responses as to whether growers surveyed were undertaking the practices presented in the farm context table above. The clustering process first split the sample into two groups based on whether they had their own pickers and harvesting plant. For the group that did have their own pickers and harvesting plant, a further split was made into two groups, on the basis of whether they used contract picking crews or not. The group that did not have their own pickers and other harvesting plant were split into two groups on the basis of whether they were BMP accredited or not. Therefore the analysis delivers four distinct groups of growers:

Figure 1



- 1. The Professionals:** On average the oldest of the four groups, they have the largest amount of green hectares on their property, and planted the largest area of cotton in the 2005/06 season. Professionals have on average the second highest yield, and employed the most full time staff.
- 2. The Traditionals:** While the second oldest group on average, they have also been involved in the cotton industry for longer than the other groups. They have the smallest total property area, the smallest cotton area planted, but planted the highest percentage of Conventional cotton varieties. Traditionals also employ the least full time staff.
- 3. The Stalwarts:** On average the youngest group, the Stalwarts have by a significant margin the largest total property area, as well as the highest cotton yield for the 2005/06 season. They planted the highest percentage of Bollgard RR varieties, and employed the most casual staff.
- 4. The Opportunists:** Have been involved in the cotton industry for the least time, and were projected to plant on average the most cotton area for the 2006/07 season. They planted the highest percentage of Bollgard varieties in 2005/06, and employed the lowest number of casual staff on average.

Table 2

Demographic Characteristics by Grower Type					
Mean of Scores	Professional	Traditionals	Stalwart	Opportunist	Total
Year of birth	1957.58	1958.18	1961.38	1960.03	1959.08
Year first involved in cotton	1986.42	1983.33	1985.33	1990.96	1986.16
Total hectares	6369.96	1948.66	14765.73	5285.70	6038.56
Green hectares	1859.14	608.30	1791.32	1216.67	1233.07
Dryland cropping/grazing	1035.80	729.80	9214.29	2757.67	2840.49
Cotton Hectares 05/06	639.88	301.14	636.64	351.32	446.14
Cotton Hectares 06/07	425.64	255.50	442.09	449.75	371.45
Cotton Yield 05/06	7.83	7.39	8.35	7.65	7.73
Conventional % 05/06	9.41	14.41	7.09	5.44	10.03
Conventional RR % 05/06	5.91	6.74	5.91	3.96	5.82
Bollgard % 05/06	21.51	27.00	12.00	32.48	24.02
Bollgard RR % 05/06	63.18	53.05	75.00	58.13	60.60
Full Time Staff	6.04	3.02	5.77	3.25	4.21
Part Time Staff	0.52	0.40	2.95	0.82	0.99
Casual Staff	3.04	2.84	6.80	0.50	3.06

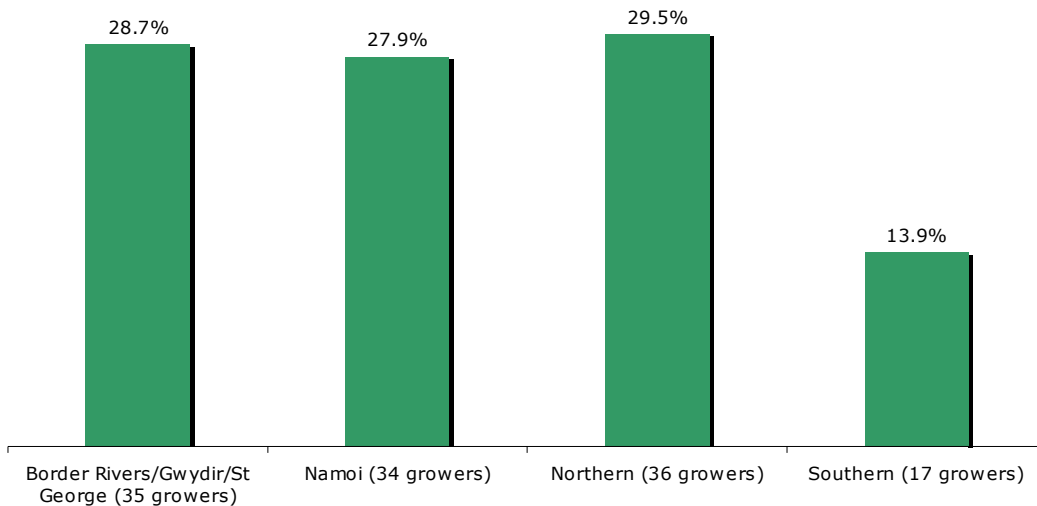
1.1.2 Grower Regions

For the purposes of analysing the data in this report, survey responses have been aggregated into four cotton growing regions:

- 1. Northern (36 respondents):** Includes the Darling Downs and regions further north, including Emerald and the Dawson Valley.
- 2. Border Rivers/Gwydir/St George (35 respondents):** Includes St George/Dirranbandi, Mungundi, Moree, and the Macintyre valley.
- 3. Namoi (34 respondents):** Includes Gunnedah, Narrabri and Wee Waa and surrounding districts.
- 4. Southern (17 respondents):** Includes the Darling River and Macquarie valleys; Bourke, Warren, Hillston and Hay and surrounds.

Figure 2

Percentage of grower responses by region: survey total (122 Responses)



The breakdown of grower types for each of the four regions is presented in the following four figures.

Figure 3

**Percentage of each grower type in Border Rivers/Gwydir/St George
(35 Responses)**

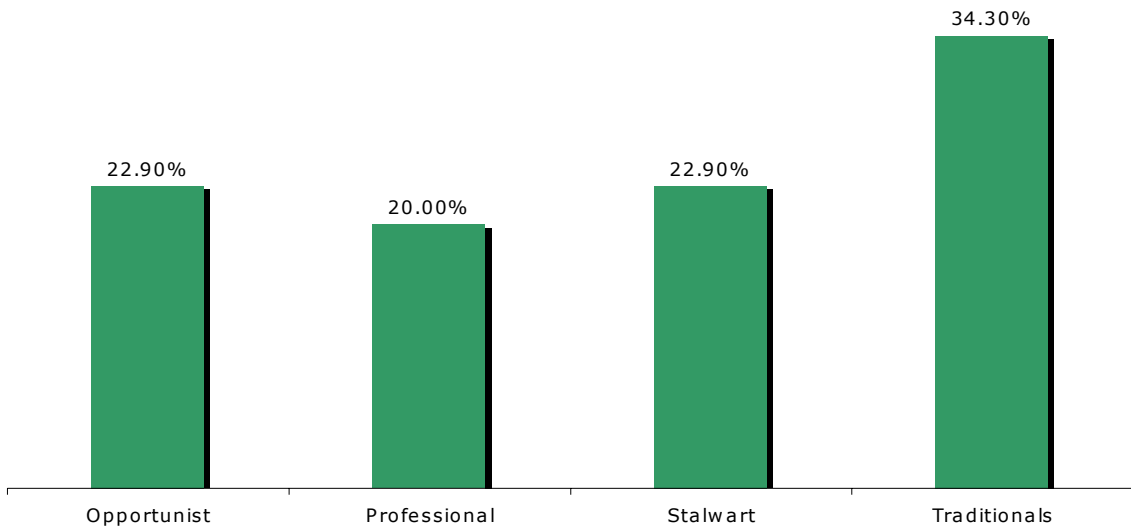


Figure 4

Percentage of each grower type in Namoi (34 Responses)

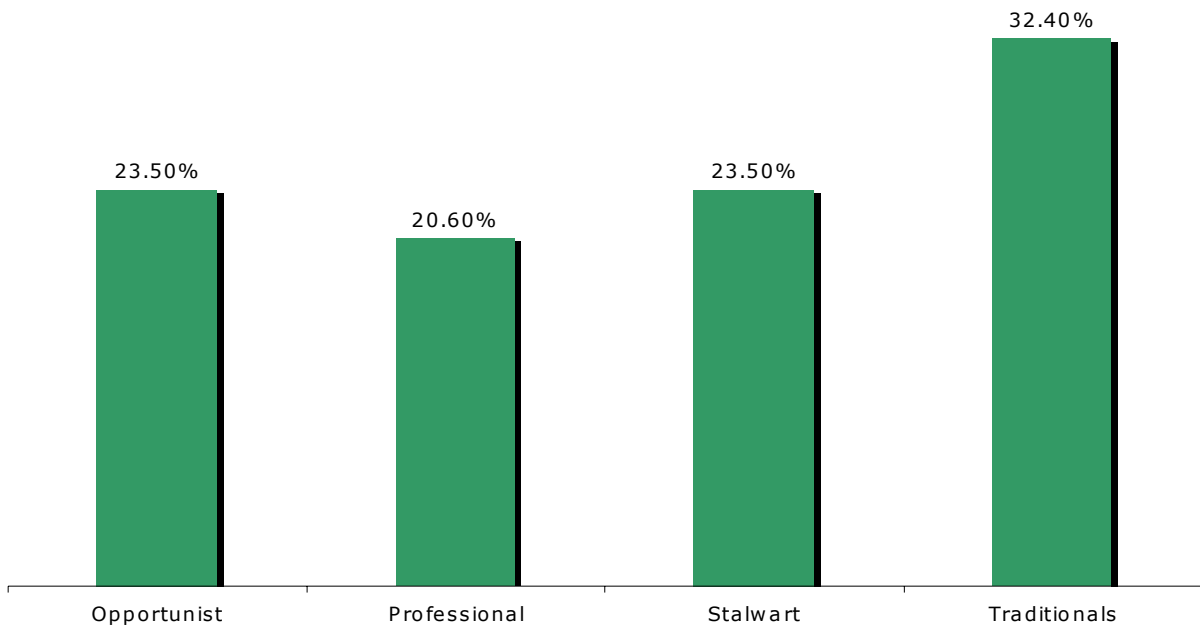


Figure 5

Percentage of each grower type in Northern (36 Responses)

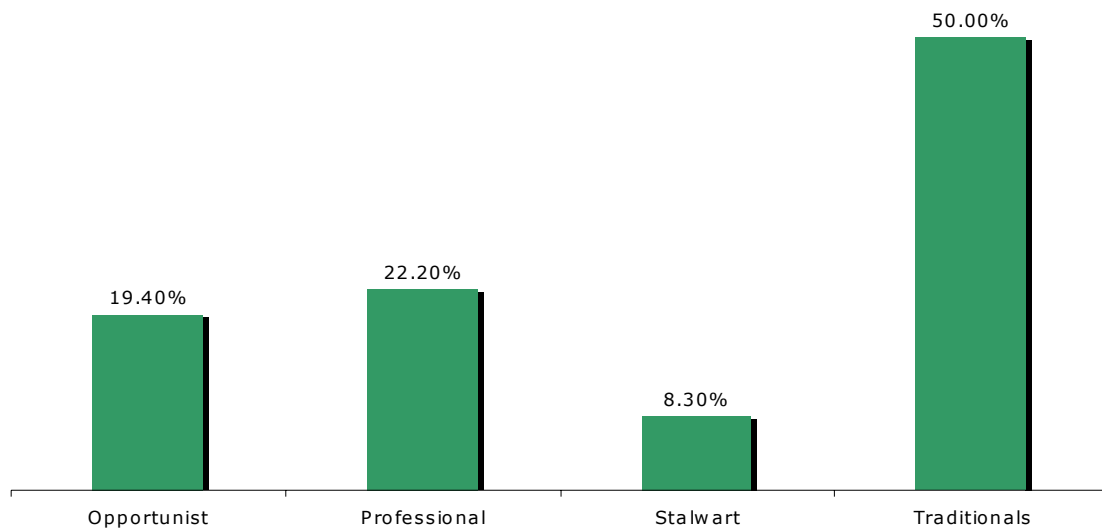
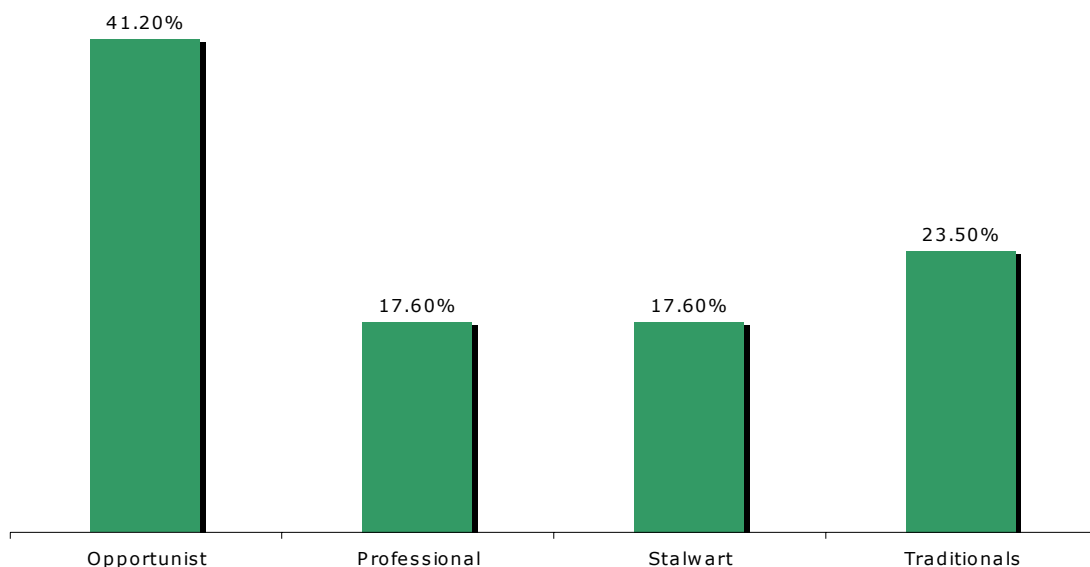


Figure 6

Percentage of each grower type in Southern (17 Responses)



1.2 Structure of the Report.

This report comprises this introduction and 4 subsequent sections. Data from growers are presented in section 2 with an overview of information from agronomic advisers in section 3.

Economic outcomes are arrived at and discussed in section 4. A brief analysis of field level data from Paddock Action Manager (PAM) is displayed in section 5. Individual application data is outlined in complete detail in the 2 appendices.

2 Grower Survey Data

This section presents data from the grower survey highlighting the percentage of crop planted to Bollgard, yield and quality differences and thoughts on refuges.

2.1 Gene-Stack Mix

The grower survey collected data with respect to the balance of gene-stack planted for each individual grower. Figures 7 – 10 outline the data for the 2005-2006 season and the planting intentions for these growers as they look to the 2006-2007 season. The data shows an average of approximately 85 per cent Bollgard planting with the area set to increase to approximately 90 per cent for the 2006-2007 season for the sample.

Figure 7

Mean break-down of gene stacks for 2005/06 season: percentages by Region

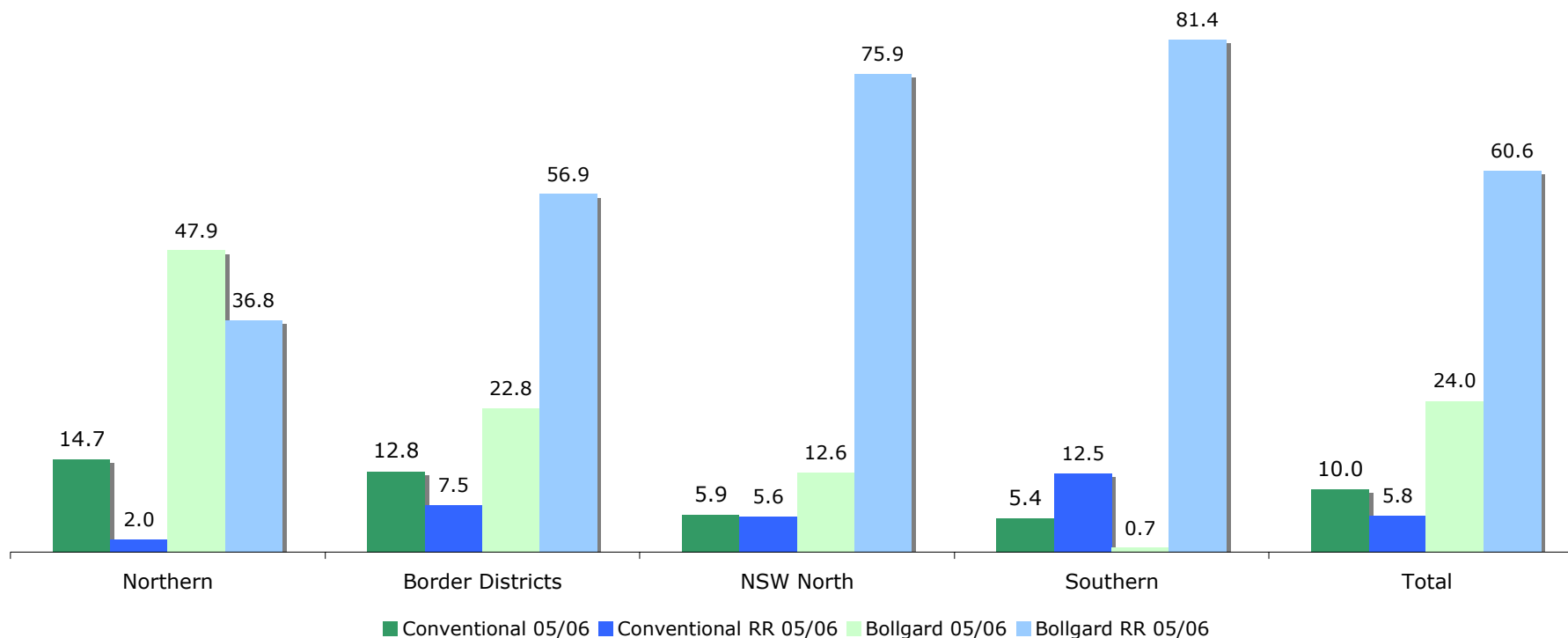


Figure 8

Mean break-down of gene stacks for 2005/06 season: percentages by Grower Type

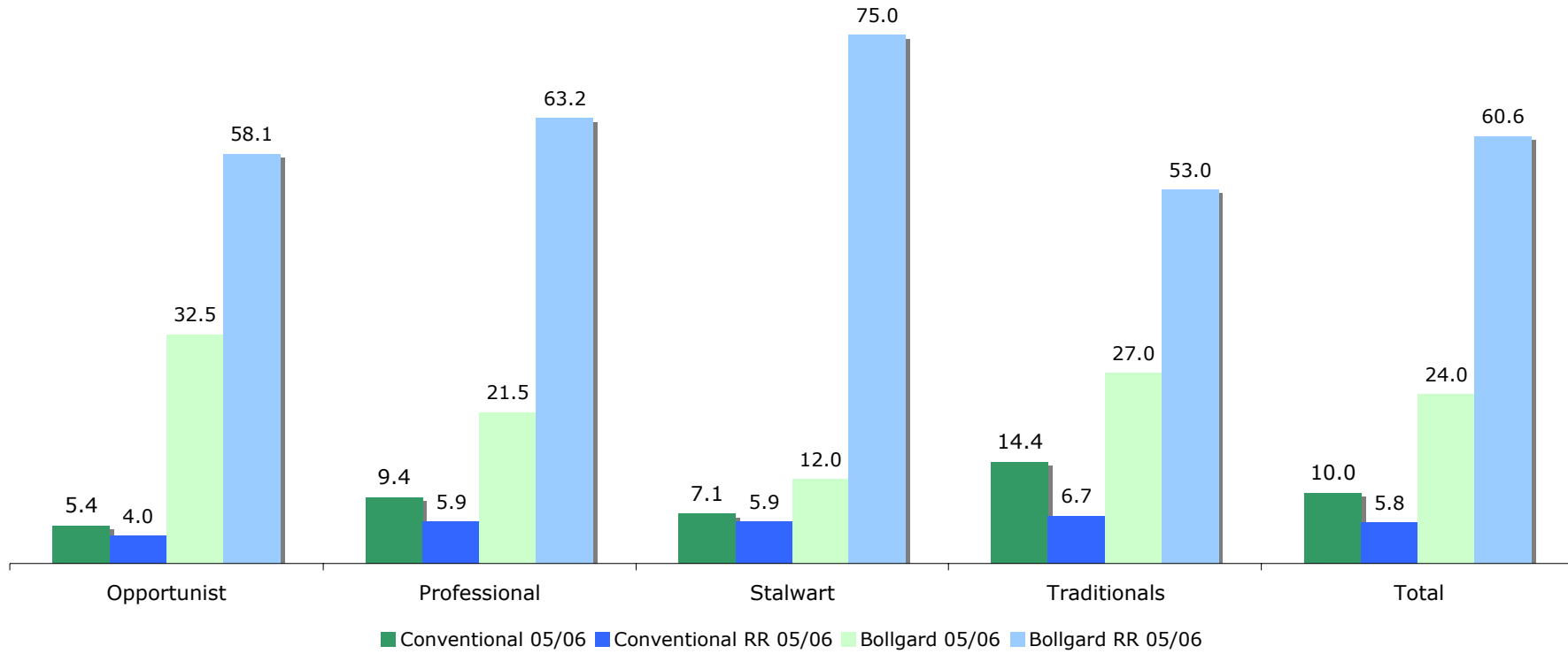


Figure 9

Mean forecast break-down of gene stacks for 2006/07 season: percentages by Region

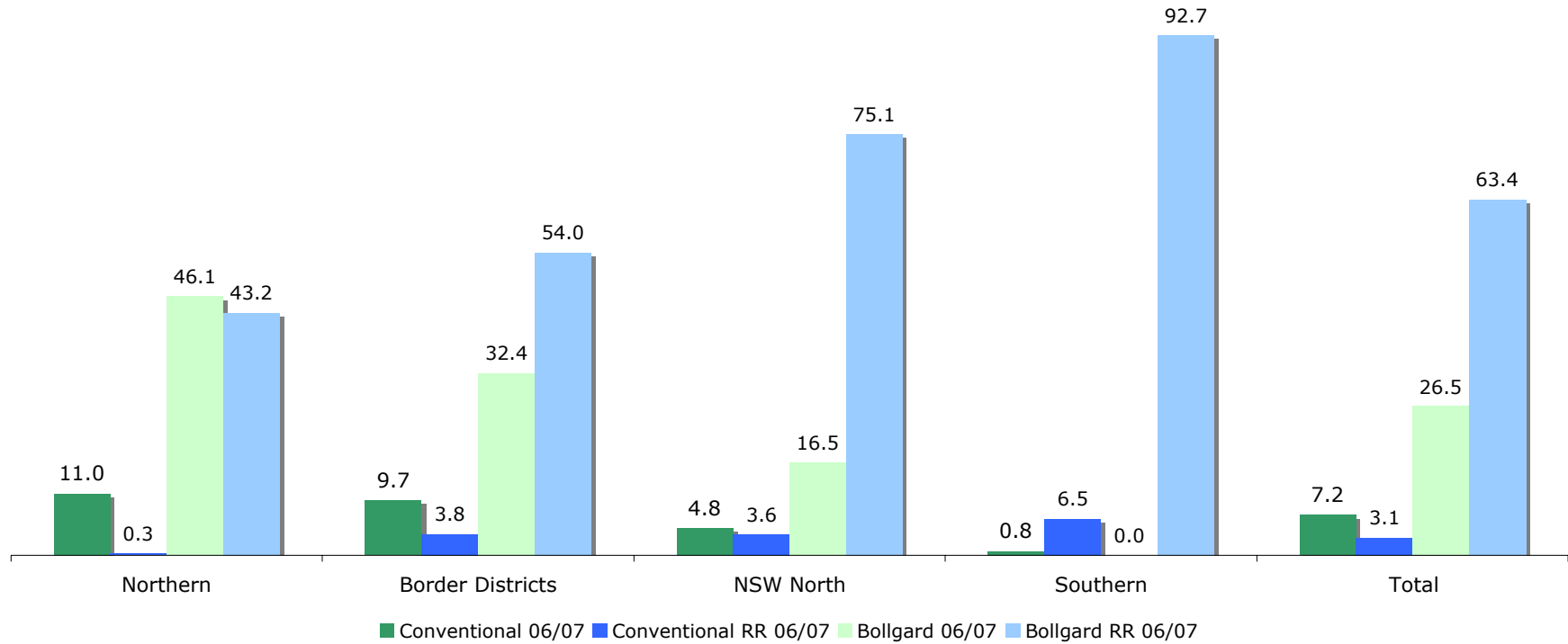


Figure 10

Mean forecast break-down of gene stacks for 2006/07 season: percentages by Grower Type

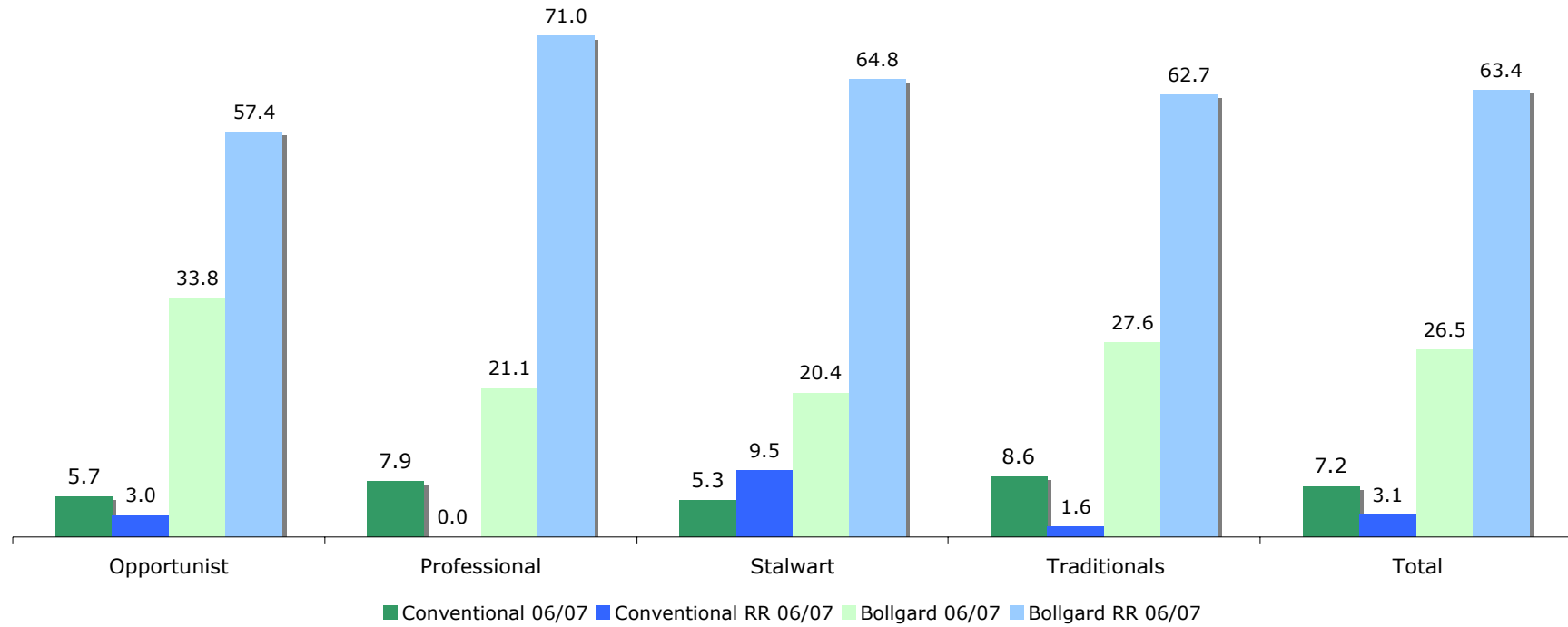


Table 3 outlines comments from growers with respect to observed differences in yield and quality of Bollgard varieties. The responses indicate a wide range of opinions and experiences with the technology with an emphasis on higher Bollgard yields and slightly lower quality at times.

Table 3 – Comments on yield and quality differences between Conventional and Bollgard cotton

Grouped Region	Grower Type	
Border Districts	Opportunist	Similar
Border Districts	Opportunist	Conventional slightly better.
Border Districts	Opportunist	100 to Bollgard- no comparison.
Border Districts	Opportunist	Bollgard cotton is out-yielding Conventional. Conventional quality is better than Bollgard.
Border Districts	Professional	Same
Border Districts	Professional	No clear pattern
Border Districts	Professional	Bollgard as an average would be higher. However, it depends on planting date, watering schedule etc.
Border Districts	Professional	The yield of Bollgard in the last two seasons has been below that of conventional.
Border Districts	Stalwart	Consider yield in Bollgard is better however quality needs to be watched in our area - high mic
Border Districts	Stalwart	N/A
Border Districts	Stalwart	Higher yields in conventional
Border Districts	Stalwart	Bollgard yields are higher and easier to grow.
Border Districts	Stalwart	Both the same.
Border Districts	Traditional	Our conventional varieties have always had superior yield and quality, often exceeding \$300/ha
Border Districts	Traditional	No definitive conclusions
Border Districts	Traditional	Bollgard is a higher yield foe me because of sensitive areas for spraying.
Border Districts	Traditional	71 BR High micronaire 70% Yield very similar.
Border Districts	Traditional	Bollgard cannot let it get hot. Conventional is more forgiving.
Border Districts	Traditional	Bollgard is a softer crop. Yield and quality down on well managed conventional.
Northern	Opportunist	Have generally seen yield advantages with Bollgard
Northern	Opportunist	Have found yield and quality better with Bollgard.
Northern	Opportunist	Weather has impacted more than anything in recent years.
Northern	Professional	Bollgard out-yielded conventional significantly this season, more than in previous years. No quality difference.
Northern	Professional	Bollgard has a higher yield and lower quality but quality is still ok.
Northern	Professional	There does not appear to be very much.
Northern	Professional	Bollgard yield higher quality same.
Northern	Professional	Bollgard higher yield and tends to be higher rate
Northern	Professional	Bollgard is up on both.
Northern	Professional	Conventional cotton still has better quality.
Northern	Stalwart	None
Northern	Stalwart	Similar but less risk with Bollgard.
Northern	Traditional	At least 2-5 to the hectare better
Northern	Traditional	Bollgard seems to suffer quality when under stress
Northern	Traditional	Conventional sometimes has the edge.
Northern	Traditional	I believe Bollgard will almost always yield more and the quality seems the same.
Northern	Traditional	Quality same. Yield marginally higher for Bollgard over conventional in dry/high pressure years.
Northern	Traditional	Bollgard has higher yield. No quality difference.
Northern	Traditional	Very little difference
Northern	Traditional	Bollgard slightly higher
Northern	Traditional	Bollgard yields better.
Northern	Traditional	Yield has been slightly better with Bollgard. Quality no difference.
Northern	Traditional	None Compared here.
Northern	Traditional	Varies from season to season bottom line more important than

		yield.
Northern	Traditional	Bollgard is slightly better
NSW North	Opportunist	All Bollgard
NSW North	Opportunist	Not much difference in yield. Quality is variety dependant
NSW North	Opportunist	Very similar
NSW North	Opportunist	No conventional grown
NSW North	Opportunist	Both yield and quality has improved.
NSW North	Opportunist	Used all Bollgard RR
NSW North	Professional	This year our Bollgard quality was good but our yields were disappointing
NSW North	Professional	No difference
NSW North	Professional	Our yields and quality have been consistently better with Bollgard.
NSW North	Professional	Both yield and quality have been very similar this year Conventional picks and gins easier.
NSW North	Professional	Yield is comparable, quality varies between season and variety.
NSW North	Professional	Quality a little bit tricky, yield a little bit better.
NSW North	Stalwart	Last year we saw 0.4 bale/ac difference between conventional yield higher than Bollgard.
NSW North	Stalwart	Conventional cotton always yields higher. No quality difference.
NSW North	Stalwart	05-06 conventional yield 0.3 bales/acre better than Bollgard. Bollgard quality problems as well. 04-05 some Bollgard better yield, other the same as conventional.
NSW North	Stalwart	Very small if at all
NSW North	Stalwart	Early season fruit load retained.
NSW North	Stalwart	Have not grown both
NSW North	Traditional	On last years results, Conventional marginally higher.
NSW North	Traditional	Similar
NSW North	Traditional	Only grow Bollgard. Quite happy with yield and Quality.
NSW North	Traditional	Yield similar and quality slightly worse on Bollgard.
NSW North	Traditional	In our farm: more often conventional out yields Bollgard. There has been no significant quality difference.
NSW North	Traditional	Nil at the moment
NSW North	Traditional	Minimal quality difference. Have not grown conventional cotton for two seasons.
NSW North	Traditional	(Dryland) conventional double yield same grade over Bollgard.
NSW North	Traditional	Bollgard out-yielded conventional. No quality difference.
Southern	Opportunist	Haven't compared the two in one season.
Southern	Opportunist	Yields increased, quality overall has increased.
Southern	Opportunist	Some BG HA shorter length.
Southern	Opportunist	100% Bollgard
Southern	Opportunist	All Bollgard
Southern	Professional	Farm yields pre Bollgard: 3.7 bales/ acre - Bollgard yield for 2005/2006: 4.8 bales/acre
Southern	Professional	Bollgard yields higher generally - Conventional- quality better, generally
Southern	Professional	Difficult to achieve good yields from Bollgard cotton.
Southern	Stalwart	Not much difference this season - around half bale/Ha.
Southern	Stalwart	Unsure
Southern	Traditional	Yield is certainly higher quality is good also if nutrition and moisture are right
Southern	Traditional	In low insect years conventional seems to out yield Bollgard
Southern	Traditional	Both yield and quality improved with Bollgard RR

Data from the attitudinal questions from the grower survey are presented in figures 11 and 12 below. These data confirm the comments from the qualitative question in Table 3 and show a spread of opinions on the question of whether Bollgard yields were higher than comparable Conventional cotton fields. In total, 49 per cent of growers totally or somewhat agreed that yields were higher in Bollgard fields as opposed to the 24 per cent who either somewhat or totally disagreed. Slightly more than 1 in four growers neither agreed or disagreed with the statement which could suggest that they considered there was no difference or that they were uncertain.

Figure 11

Bollgard yields were generally a bit higher than comparable Conventional fields

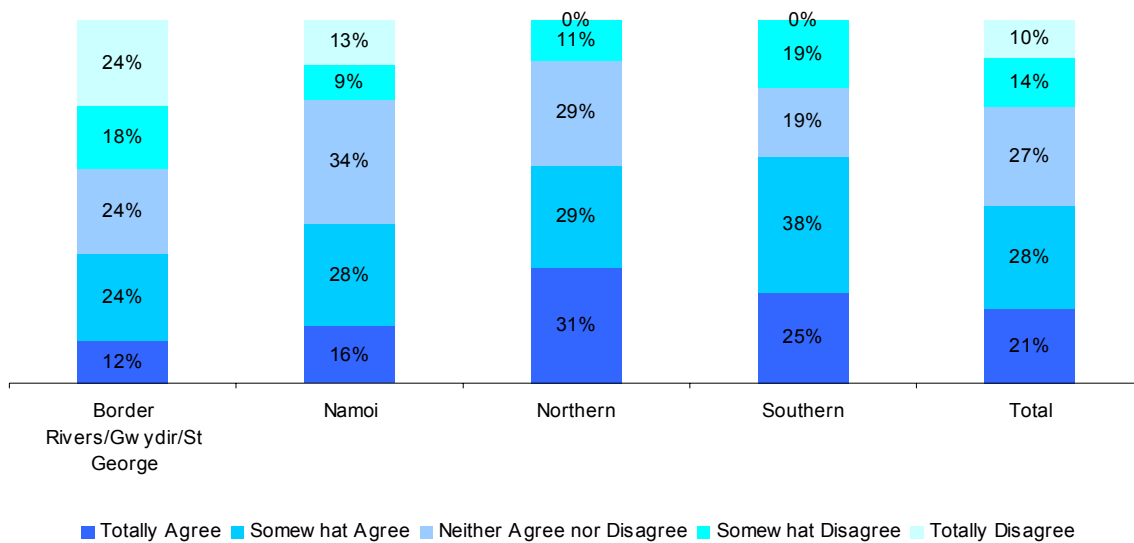
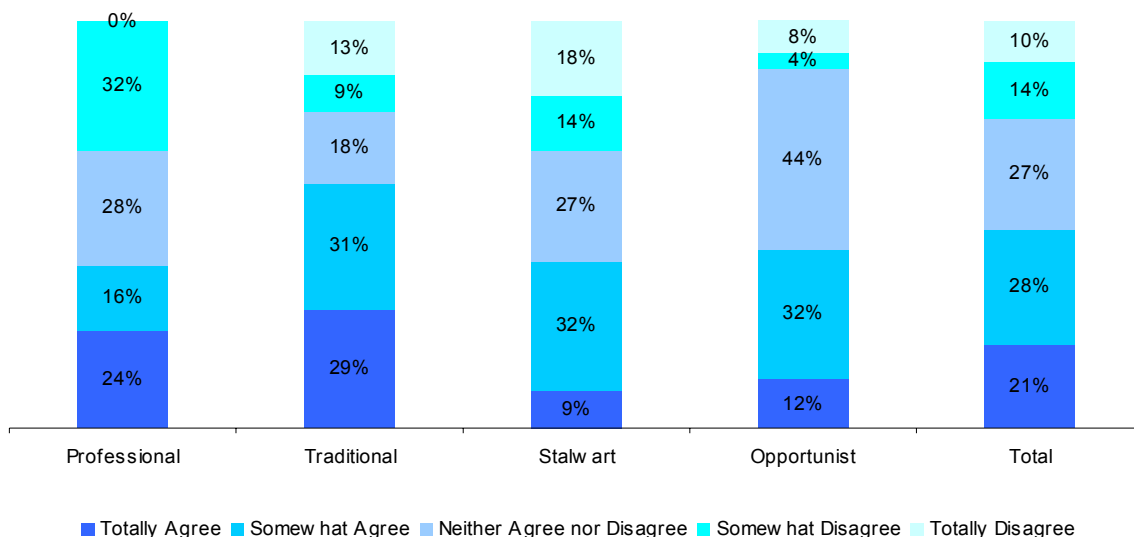


Figure 12

Bollgard yields were generally a bit higher than comparable Conventional fields

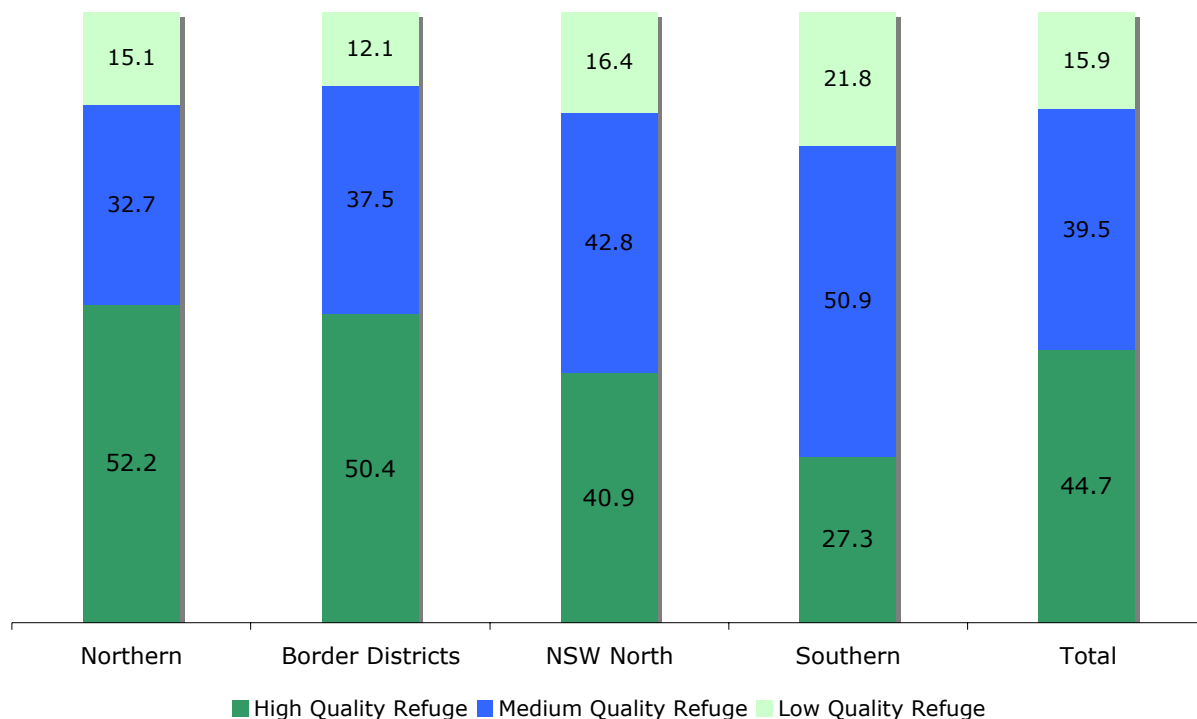


2.2 Refuges

Figure 13 presents data associated with grower opinions on Refuge attractiveness and effectiveness. Overall, refuge quality during the 2005-2006 season was judged as high or medium quality in the majority of cases.

Figure 13

Refuge Quality Percentages (Attractiveness and Effectiveness): By Region



2.3 Conclusion

This section outlined the mix of varieties grown on Australian cotton farms during the 2005-2006 season and revealed an increase in Bollgard plantings for the 2006-2007 season. Opinions on yield differences between Bollgard and Conventional varieties were presented and showed that on balance, Bollgard varieties were seen to yield slightly higher, but not without some issues surrounding lint quality. Refuges were consistently judged as being of a high to medium quality in terms of attractiveness and effectiveness.

The next section considers data from Consultants.

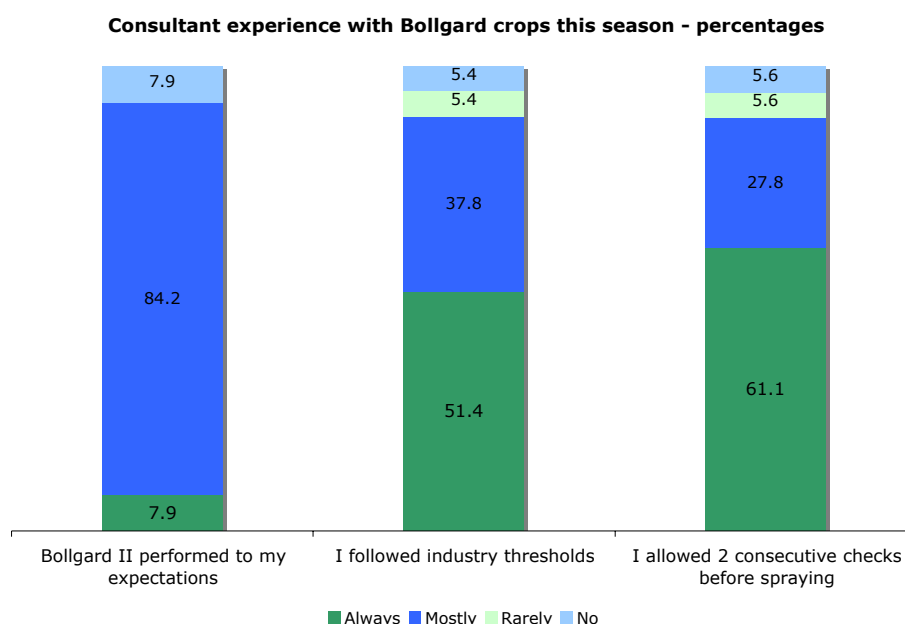
3 Consultant Data

Responses were received from 40 consultants who collectively managed 55 per cent of the cotton area for the 2005-2006 season. Quantitative data from survey responses to the Consultant Survey have been included in the appendix to this report. These data have been extracted from Paddock Action Manager (PAM) reports and consequently allow for field level, date of application data to be presented. The data from section 3.3 through to the end of section 4 are drawn from 30 paired comparison fields. This number of comparisons is less than historically achieved, however this reflects the reduced planting of conventional varieties and the apparent lack of field situations that are suitable for direct comparison.

3.1 Bollgard Performance

The performance of Bollgard on Helicoverpa is summarised in Figure 14. Generally, Bollgard was judged to have performed to the expectations of consultants, always or mostly. Similarly, consultants advise that they followed industry thresholds and allowed 2 consecutive checks prior to spraying always or mostly. Where industry thresholds were not strictly adhered to, the alternative thresholds are listed in table 4.

Figure 14



Macquarie	Did not need to spray for Heliothis, but this was a result of low pressure rather than outstanding Bollgard performance
Macquarie	When spraying for other pests, we lowered the threshold for medium grubs from 1/metre to 0.5/metre in single check.
Gwydir	Changed with crop retention/maturity and insect pressure.
Gwydir	I did not spray B.T cotton for Heliothis. Mirids - 2+metre, GVB - 1+ metre
Gwydir	Sprayed on e.g. Numbers during high pressure periods.
Namoi	Numbers of Heliothis infested in flowers
Namoi	My thresholds were a combination of damage and stage of the crop
Upper Namoi	2s/M second check and consider damage.
Macintyre	When using Dipel in stage 3 and 4 we used a damage threshold and 1 worm/m if there was a lot of eggs following
Macintyre	Once we saw 1 to 2 grubs per m (small size) at peak fruit set, combined with heavy egg pressure, we sprayed. This happened in general once during the season. Early and late in the season we were more comfortable with industry thresholds.
Darling Downs	Many crops had more 15 than 0.5 medium per metre and I ignored this
Emerald	Mirids, depending on the crop stage and fruit retention thresholds varied up and down.

Table 5 outlines the reasons that consultants suggested Bollgard was grown by their growers. In summary these reasons include; managing risk associated with the growing operation, particularly OH&S and spray timing issues; reducing the variability of cost and uncertainty associated with controlling insects; environmental considerations such as boundary areas, populated areas and other sensitive sections of the farm such as waterways and grazing paddocks; finally lifestyle factors including reducing general hassles associated with the crop and operator time commitments.

Table 5 - Reason(s) for growing Bollgard II cotton (in order of importance).

	Reason 1	Reason 2	Reason 3	Reason 4
Southern NSW	Ease of logistics	Ability to grow cotton	OH&S	
Southern NSW	Grower convenience.	Performance / insecticides.		
Southern NSW	Cost effective compared to conventional given chemical + application + time organising sprays + monitoring sprays	Safety of people, community and environment.	Management tool for earliness in cool seasons.	Payment terms
Macquarie	Ease of management			
Macquarie	Minimise downside yield risk	Ease of management	Minimise insecticide cost blow out	
Macquarie	Reliability of Heliothis control	Environmental - reduced sprays	Ease of Management	
Macquarie	Full season control of Helicoverpa	Environmental	Neighbours and cattle	To have some kind of life in the summer
Bourke	Reduced insecticide use	Cost effective	Focus more on irrigation scheduling and nutrition	Sensitive areas
Gwydir	Sensitive areas	No decent conventional RR varieties available		
Gwydir	Ease of management.	Potential profit differential in high Helicoverpa season.	Reduction in environmental disruptions.	Ability to use a 'softer' chemical program.
Gwydir	Growers like having more accurate spray forecasts.	Better for lifestyle.		
Gwydir	Environmental reasons	Technology		
Gwydir	Environment	Heliothis	Cost of conventional medicine	Availability of (lack of) chemical control
Gwydir	Life style	Reduce pesticide load	Reduce pesticide Resistance.	
Gwydir	Environmental concerns in some areas. Especially in more closely settled areas.	No other reason really. I am confident enough in Magnet that I am just as happy to grow non BGII cotton if the varieties are better suited to the situation.		
Namoi	Convenience	Neighbours	BMP	
Namoi	Lifestyle	Spray and drift management / OH & S	Fixed Heliothis costs	Yield
Namoi	Management of Heliothis (Armigera).	Increased gross margin.	Environmental issues.	Need to use less pesticides - OH & S issues.

Namoi	Reduced reliance on insecticides	OH & S less chemicals for workers to be exposed to	Reduced tractor / aerial operations	
Upper Namoi	Less risk of cost explosion.	Less labour - less spraying.	Confidence in yield ability.	Less hassles from neighbours - more environmentally friendly.
Upper Namoi	Lifestyle - Christmas.	No planes and pressure to get spray on.	Seem to be getting higher yields.	Environment and neighbours - e.g. green crop, cattle.
Upper Namoi	Heliothis Armigera.	Environment.	Mixed farming.	
Macintyre	Environmental safety (reduced sprays)	Floor price in costs	Less operations	Life style
Macintyre	Eases management of conventional cotton			
Macintyre	Economic benefits through reduction in yield variability	Environmental benefit through less spraying	Risk management	Easier to grow, better lifestyle for farmers and consultants.
St George / Dirranbandi	Reduction in Pesticide	Ease in Management	Cost	
St George / Dirranbandi	Cost effective.	Insurance against significant blow-out in insecticide budget.	Better for the environment - less pesticide load.	Better lifestyle - easier for the grower to manage from a spray point of view, less stress, healthier living.
Darling Downs	Better Heliothis control than conventional	Higher yield potential	Neighbour relationships	Reduced workload
Darling Downs	Yield and generally lower costs	Environmental	Easier to grow	The future technology
Darling Downs	Risk/Return factors. i.e. know roughly what insect control costs will be.	Ease of management	Reduction in insecticide usage	
Darling Downs	Ease of management.	Less spraying of harmful products.	Relatively cost effective.	Better for lifestyle.
Darling Downs	Ease of management - less spraying	Higher yield expectation	Knowing approximate growing costs up front.	Potential environmental benefits e.g. less drift.
Darling Downs	Savings in the cost of pest (Heliothis) control	Less insecticide load in the environment	Certainly a lifestyle advantage to both farmer and consultant	Less insecticide use reduces but doesn't negate the risk of secondary pests.
Darling Downs	Helicoverpa management	Environmental	Yield potential	
Emerald	Reduce risk	Reduced environmental problems	Ability to concentrate on other management issues	Cost controls
Emerald	Risk management	Environmental impact	Lifestyle	Industry image

3.2 Refuges

As outlined in section 2, growers considered that the majority of refuge crops were of high to medium quality in terms of attractiveness. Consultants were canvassed to ascertain their impressions of grower's thoughts and opinions; these are outlined in table 6. Basically, refuges are, for the most part, tolerated as a necessary cost associated with Bollgard technology. Many questions are posed in relation to the "science" behind the guidelines, with a number of consultants reporting that growers find refuges costly and a large inconvenience.

Table 6 - Could you summarise the thoughts or opinions of your growers with respect to refuges grown for Bollgard II fields?

Southern NSW	Not flexible enough in terms of cropping options - more research needs to be done. Pigeon peas require better varietal traits, in particular seedling vigour.
Southern NSW	Can be quite annoying and a waste of area and water in a drought year.
Southern NSW	Pigeon peas have been used. There are concerns over how effective they are at attracting moths in our region. Would like to see a comparison of Pigeon peas and conventional cotton because I'd prefer to use 5% unsprayed cotton as it establishes better in our environment, has more weed control options, simplifies farming practices and I believe it will be as effective, if not better than Pigeon peas.
Macquarie	Indifferent - accepted as something that has to be done for the good of the technology
Macquarie	Opportunity-cost generally accepted due to the reduction in risk that BGII offers, and deemed necessary for protection of BGII from resistance. In a tight water year it is treated as a poor cousin. Weed control of refuges has improved markedly over last few years as growers realise the long-term implications of letting weeds escape. Generally they use the lowest yielding country or an area not suited to growing cotton to minimise the lost area.
Macquarie	A cost we have to bear to preserve the Bollgard technology. I would like to see more science involved in determining the area to be grown
Gwydir	They are probably a necessary evil. They take both land and water away from the production of cotton. They are there for the protection of the Bollgard genes against resistance. With so much other summer crop being grown, such as sorghum, sunflowers and maize, in many of the cotton growing areas, maybe a specified refuge is not required. This could be looked at on a location by location basis.
Gwydir	Least area possible, and aim for a possible production outcome for minimal outlay and expense.
Gwydir	* Weed management a problem. * RR OTT and drift can kill refuge. * Water usage. * Costs for unproductive hectares.
Gwydir	Expensive to grow. A waste of time. The percentage should be smaller, The idea of not allowing refuge to be grown next to Conventional is ridiculous
Gwydir	Most now swinging away from 5% Pigeon pea to 10% Roundup Ready conventional cotton, because it is possible to at least get a break-even yield from the conventional cotton.
Gwydir	Concerned about cost of producing refuge crops, questioning the value of refuge to the resistance strategies.
Gwydir	Don't like to grow crops like Pigeon peas. Much prefer to grow say non-BG cotton refuge sprayed normally. At least he gets production from that.
Namoi	What is the true cost?
Namoi	Afterthought, necessary for compliance
Namoi	Most see them as a necessary evil - not keen to maintain them as continuously attractive refuges for Heliothis generation.
Namoi	Pigeon peas can be a host crop for Mirids and Green Vegetable Bugs so some chemical control is needed, increasing the cost of growing the refuge. Pigeon peas can also increase black root rot and fusarium wilt.
Upper Namoi	Loss of productive land, do not realise the importance and long-term value. Management consideration lacking.
Upper Namoi	1. Expense - not growing cotton on that area. 2. Water usage. 3. Too limited on mixed area; e.g., some farms are growing sunflower, corn, sorghum and soybean as well.
Upper Namoi	Seem to comply well. Find it worthwhile to do the right thing.
Macintyre	The unsprayed cotton refuge was popular but will swing to Pigeon peas this year because most cotton refuges had no yield this season. PP also require less water than cotton to keep attractive

Macintyre	Refuge is 50 % conventional cotton. Any more than this increases the cost of Bollgard too much.
Macintyre	Our growers either used sprayed conventional cotton or Pigeon peas as their refuge in order to minimise their unproductive area. Growers realise the need to manage resistance to BG but are concerned about the cost and are keen to minimise this cost as much as possible without jeopardising the technology.
St George / Dirranbandi	Generally growers would like to reduce refuge areas and don't really understand or care about the importance of them.
St George / Dirranbandi	Most growers view refuges as a necessary evil, but some see them as a major inconvenience and cost. They would like to see the refuge area required reduced.
Darling Downs	Difficult to justify considering: the landscape and percentage of other crops grown on the Downs, the levels of late season parasitism, the water requirements, difficulty of pupae busting hard ground in winter, perceived lack of Heliothis production from Pigeon pea
Darling Downs	Irrigated: 5% Pigeon peas bearable. - Dryland: 10% unsprayed cotton unbearable, should be 5% especially in mixed cropping areas
Darling Downs	Would like the use of sorghum as a refuge for dryland cotton. Sorghum performs extremely well on the Darling Downs and given the large number of acres sown to it each season and the wide planting window, it should alleviate flowering window concerns.
Darling Downs	Refuges have a real cost. That cost can be quite high, particularly with dryland production. The refuge issue needs to be researched further.
Darling Downs	Hard to fit recommended areas of refuge into the farming system. Lack of dryland refuge options. Thoughts of refuge area being a non-producer for the farm.
Darling Downs	On the Downs, it certainly isn't popular in a region where H. armigera is endemic in a mixed cropping area. The refuge options for dryland growers are seen as particularly onerous and discriminatory. Pigeon peas are probably the first choice for irrigators because less land is tied up (and valuable irrigation water).
Darling Downs	Quiet costly. How well do they do their job - don't we have enough other refuges anyway?
Emerald	Believe refuges although a necessity are a cost burden, and create management problems such as weed control in these areas
Emerald	Some growers see refuge requirements as a hassle, and were it not mandatory probably would not comply, however this is the minority of growers and most strive to achieve an attractive refuge.

Table 7 outlines the refuge mix nominated by consultants. Pigeon Peas dominate plantings as they are considered less expensive to grow, often requiring less irrigation water as an input and perhaps more importantly require less area to be committed as a refuge than other options.

Table 7 - In light of these assessments, what is the mix of refuges on the farms you consult on? Does any one particular refuge dominate, and if so why?

Southern NSW	Mostly Pigeon pea followed by Maize/Pigeon pea combo or Maize/conventional cotton.
Southern NSW	Pigeon pea - smallest area required.
Southern NSW	Pigeon peas.
Macquarie	Pigeon pea dominates - smallest required area, easiest to manage.
Macquarie	5% Pigeon peas dominate - lowest cost option. Generally on small hectares growers have opted to maximise BGII for ease of management. Some bigger growers had 10-50% conventional cotton which was used as refuge. No unsprayed cotton.
Macquarie	Pigeon peas. This refuge option uses the least amount of land and resources for growers who grow all Bollgard. A minority still use sprayed cotton as refuge and keep Bollgard area below 50%
Macquarie	Pigeon pea and unsprayed cotton. Unsprayed cotton was planted as a trial to see if we could recover some costs of the refuge in the form of yield. This was not the case so therefore we will revert to Pigeon pea as we only have to plant 5%
Bourke	Refuges mainly consist of sprayed conventional cotton or Pigeon pea.
Gwydir	Sprayed Cotton - do not grow more than 40% Bollgard
Gwydir	Pigeon peas.
Gwydir	Pigeon pea dominates, with less hectares to be planted and less water used.
Gwydir	Unsprayed cotton, Sorghum, Pigeon pea
Gwydir	50/50 conventional/Bollgard or 5% Pigeon pea

Gwydir	Yes, Pigeon pea plantings dominate because of the reduced area required.
Gwydir	Sprayed non-BG cotton. One farm has Pigeon peas due to the proximity to town and the need to grow all BGII.
Namoi	Pigeon pea due to smaller area
Namoi	Pigeon peas 95%, conventional cotton 2.5%, sorghum, 2.5%, Pigeon peas dominate due to ease of growing
Namoi	Pigeon peas: smallest hectares required; less expensive.
Namoi	Pigeon pea only
Upper Namoi	Unsprayed cotton.
Upper Namoi	1. Pigeon peas - small areas in HA. 2. Sorghum and corn - already growing both.
Upper Namoi	Pigeon peas, Sorghum.
Macintyre	Last year 80% unsprayed cotton & 20% Pigeon peas. Next year 80% peas and 20% cotton.
Macintyre	Refuge is 50% conventional cotton
St George / Dirranbandi	99% Pigeon pea - Less area required. 1% conventional cotton.
St George / Dirranbandi	On the minority of farms still growing some Conventional cotton the refuge mix is Conventional cotton and Pigeon peas. On Bollgard only farms all the refuge area is Pigeon peas. The reason is that unsprayed cotton rarely produces any cotton in our environment, and Pigeon peas require half the area as compared to unsprayed Conventional.
Darling Downs	Pigeon pea as it requires less water and is considered the best at overall farm gross margin
Darling Downs	Irrigated: 5% Pigeon peas. Dryland: half -10% unsprayed and half - 50% conventional cotton
Darling Downs	Pigeon pea dominates in irrigated systems due to being the lowest area used. Sorghum and corn used on mixed farming enterprises with enough country to do it.
Darling Downs	40% - 50/50 BG/Conventional. 40% - 10% unsprayed cotton. 20% - Pigeon peas.
Darling Downs	Conventional cotton - viable return from the refuge.
Darling Downs	Unsprayed cotton in dryland situations and Pigeon peas for irrigators are the main refuges. As above, Pigeon peas are chosen because less land and water is tied up on irrigation farms. Successive plantings of corn, sorghum etc as refuges are difficult to manage. Sorghum midge is encouraged by successive flowerings in sorghum refuges. Unsprayed cotton refuges normally do not produce a yield to cover the planting and growing costs in dryland situations.
Darling Downs	20% sprayed cotton; 40% Pigeon pea; 30% unsprayed cotton; 10 % corn sorghum. Pigeon pea because less area required
Emerald	Pigeon pea is the dominant refuge because it allows the greatest area of Bollgard to be planted
Emerald	Pigeon pea is the dominant refuge. Smaller farms require less area to commit to the refuge and there is a requirement to grow a Pigeon pea trap crop as well. There are some summer cereal options taken in the Comet region, and this is used as a field rotation, but it has management issues with 3 stage planting.

3.3 Reduction in Spray Applications

This section outlines the pest pressure and reduction in insecticide use associated with Bollgard crops compared to Conventional. Figure 15 shows the average reduction in sprays for all comparisons and for each valley respectively. The largest average reduction can be observed in the St George/Dirranbandi region where a reduction of 13.3 sprays resulted from the comparisons. The smallest reduction occurred in the Darling Downs where just less than 5 fewer sprays were recorded. Figure 16 shows the distribution of sprays across the sample for both Bollgard and Conventional fields displaying the percentage of fields with their final spray numbers.

Figure 15

Average Number of Sprays 2005-2006

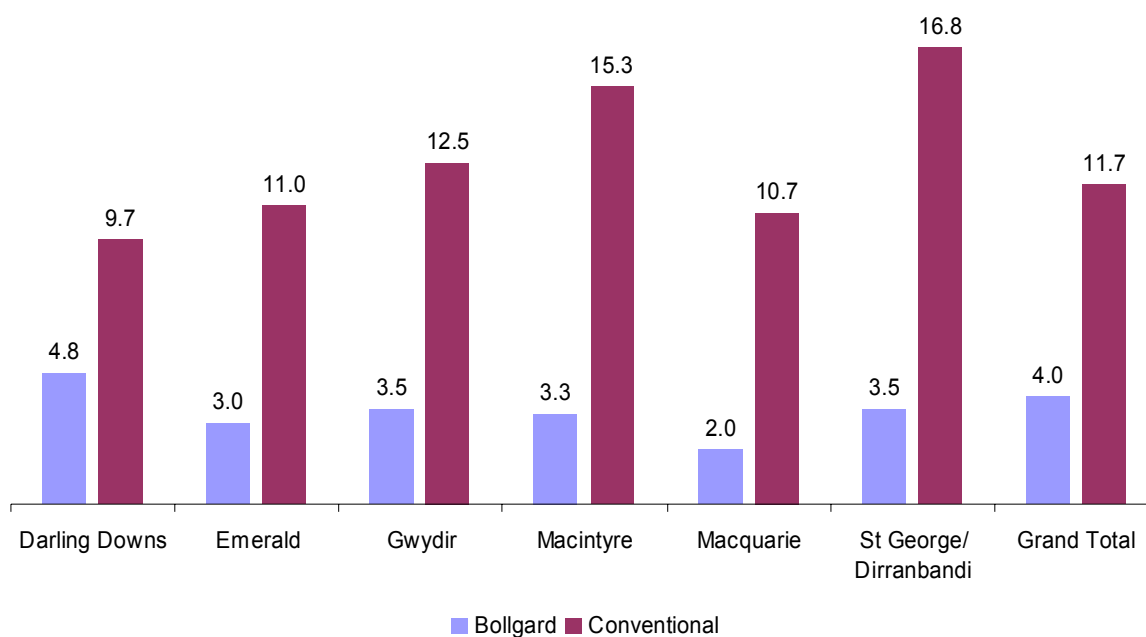


Figure 16

Number of Sprays - All Valleys 2005-2006

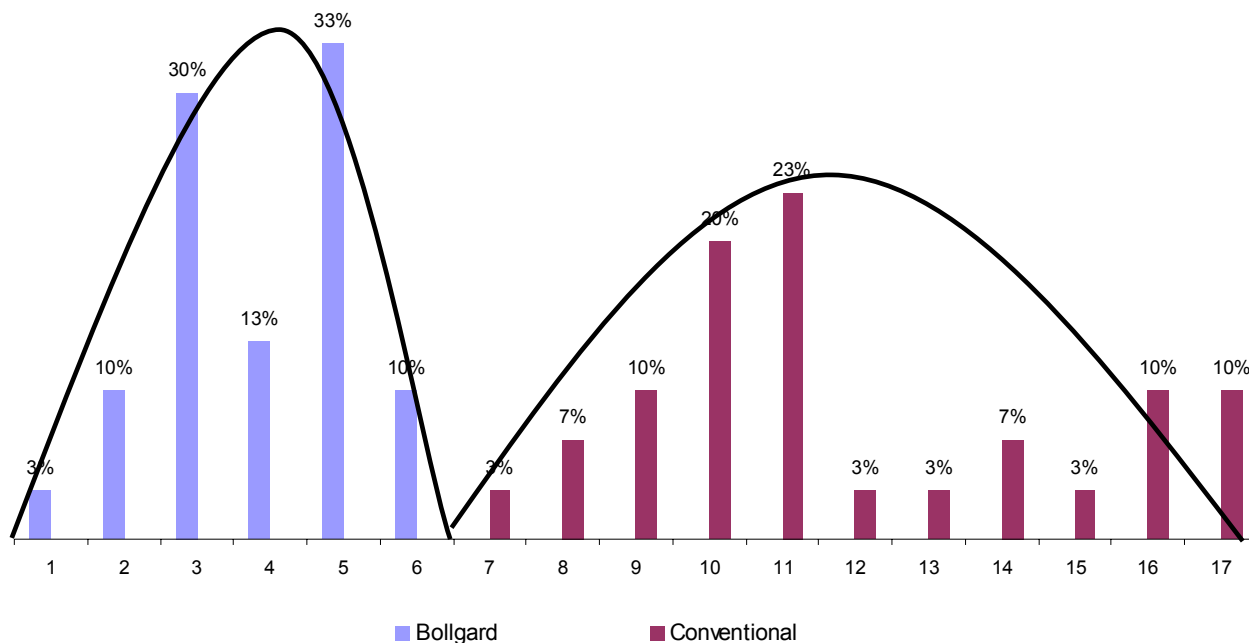
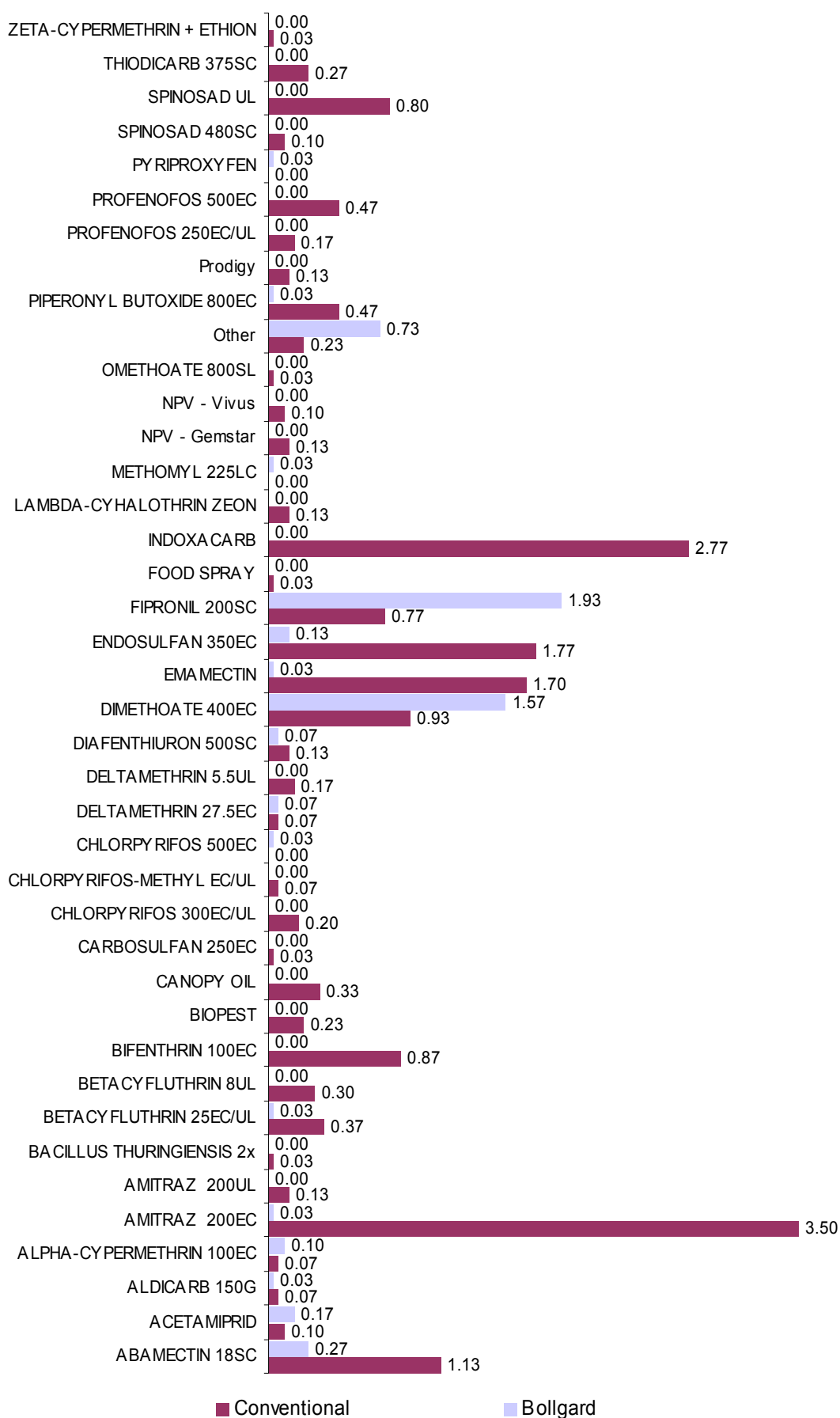


Figure 17 overviews the average number of sprays per hectare for all insecticides used on the comparison fields. These figures are arrived at by calculating the total number of sprays for each insecticide and dividing this figure by the total number of fields for each of Bollgard and Conventional cotton respectively.

Figure 17
Average Number of Sprays by Product



3.4 Pest Pressure and Spray Comparisons

3.4.1 Bollgard Pressure, Control and Sprays

Pest pressure for the 2005-2006 season is presented in Table 8 for Bollgard fields along with the ease of control for the season. Control was deemed as being harder than the 2004-2005 season for Helicoverpa. This difficulty of control corresponded with higher pressure. Table 9 shows that for the regions combined, the pests that required the highest number of sprays in Bollgard crops on average were Mirids followed by Aphids. Interestingly, Helicoverpa were suggested as being harder to control by more than 50 per cent of respondents, the Gwydir is the region that reported the highest number of Helicoverpa specific sprays where 0.5 sprays per hectare were applied to treat for Helicoverpa.

Table 8

The general incidence of a pests, and the relative ease or difficulty of control in BOLLGARD cotton compared to the 2004-2005 season.

	Lower Pressure	Similar Pressure	Higher Pressure		Control Easier	Control Similar	Control Harder
Aphids	34.3%	51.4%	14.3%	Aphids	17.6%	79.4%	2.9%
Helicoverpa	5.9%	26.5%	67.6%	Helicoverpa	3.0%	45.5%	51.5%
Tipworm	32.1%	53.6%	14.3%	Tipworm	16.7%	79.2%	4.2%
Mirids	8.8%	44.1%	47.1%	Mirids	5.9%	76.5%	17.6%
Mites	24.1%	58.6%	17.2%	Mites	14.3%	67.9%	17.9%
Green Vegetable E	9.4%	43.8%	46.9%	Green Vegetable Bug	6.5%	61.3%	32.3%
Whitefly	3.3%	43.3%	53.3%	Whitefly	4.3%	78.3%	17.4%
Jassids	10.0%	70.0%	20.0%	Jassids	4.0%	96.0%	0.0%
Thrips	18.8%	62.5%	18.8%	Thrips	13.3%	80.0%	6.7%
Rutherglen Bug	11.1%	37.0%	51.9%	Rutherglen Bug	4.2%	79.2%	16.7%
GreenShield Beetle	7.7%	73.1%	19.2%	GreenShield Beetle	4.2%	83.3%	12.5%

Table 9

Average Number of Sprays by Pest - Bollgard Fields 2005-2006

	Darling Downs	Emerald	Gwydir	Macintyre	Macquarie	St George/ Dirranbandi	Grand Total
Aphid	0.1	0.0	0.5	1.0	0.3	0.3	0.3
Aphid & Whitefly	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Green Veg Bug	0.1	0.0	0.5	0.0	0.0	0.0	0.1
Green Veg Bug & Mirid	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Green Veg Bug & Thrips	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Helicoverpa	0.0	0.0	0.5	0.3	0.0	0.0	0.1
Mirid & Helicoverpa	0.0	0.0	0.5	0.0	0.0	0.0	0.1
Jassids	0.3	0.0	0.0	0.0	0.0	0.0	0.2
Mirid	3.0	1.0	0.8	1.3	1.0	2.3	2.2
Mirid & Jassids	0.5	1.0	0.0	0.0	0.0	0.0	0.3
Mirid & Mites	0.0	0.0	0.0	0.7	0.7	0.8	0.2
Thrips	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Mirid and Thrips	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Whitefly	0.1	1.0	0.0	0.0	0.0	0.0	0.1
Whitefly & Cutworm	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Wireworm & Thrips	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Grand Total	4.5	3.0	3.5	3.3	2.0	3.5	3.8

3.4.2 Conventional Pressure, Control and Sprays

In conventional crops, higher pressure was noted for Helicoverpa, Whitefly and Rutherglen bug by over half the respondents indicating pressure for a particular pest as outlined in table 10. Of these, Helicoverpa was the pest that stood out, being nominated as being harder to control during 2005-2006 by 66.7 per cent of consultants. The data in table 11 confirms this belief showing that on average across all regions; slightly more than 10 of the 11.5 sprays were for Helicoverpa or a mix of Helicoverpa and other secondary pests.

Table 10

The general incidence of a pests, and the relative ease or difficulty of control in CONVENTIONAL cotton compared to the 2004-2005 season.

	Lower Pressure	Similar Pressure	Higher Pressure		Control Easier	Control Similar	Control Harder
Aphids	51.9%	48.1%	0.0%	Aphids	28.0%	68.0%	4.0%
Helicoverpa	7.4%	25.9%	66.7%	Helicoverpa	7.4%	25.9%	66.7%
Tipworm	36.4%	31.8%	31.8%	Tipworm	15.8%	63.2%	21.1%
Mirids	11.1%	66.7%	22.2%	Mirids	7.4%	77.8%	14.8%
Mites	26.9%	65.4%	7.7%	Mites	15.4%	80.8%	3.8%
Green Vegetable I	4.0%	60.0%	36.0%	Green Vegetable Bug	0.0%	76.0%	24.0%
Whitefly	0.0%	37.5%	62.5%	Whitefly	0.0%	75.0%	25.0%
Jassids	16.7%	70.8%	12.5%	Jassids	9.1%	90.9%	0.0%
Thrips	29.2%	62.5%	8.3%	Thrips	21.7%	78.3%	0.0%
Rutherglen Bug	20.8%	25.0%	54.2%	Rutherglen Bug	5.0%	85.0%	10.0%
GreenShield Beet	15.0%	70.0%	15.0%	GreenShield Beetle	0.0%	100.0%	0.0%

Table 11

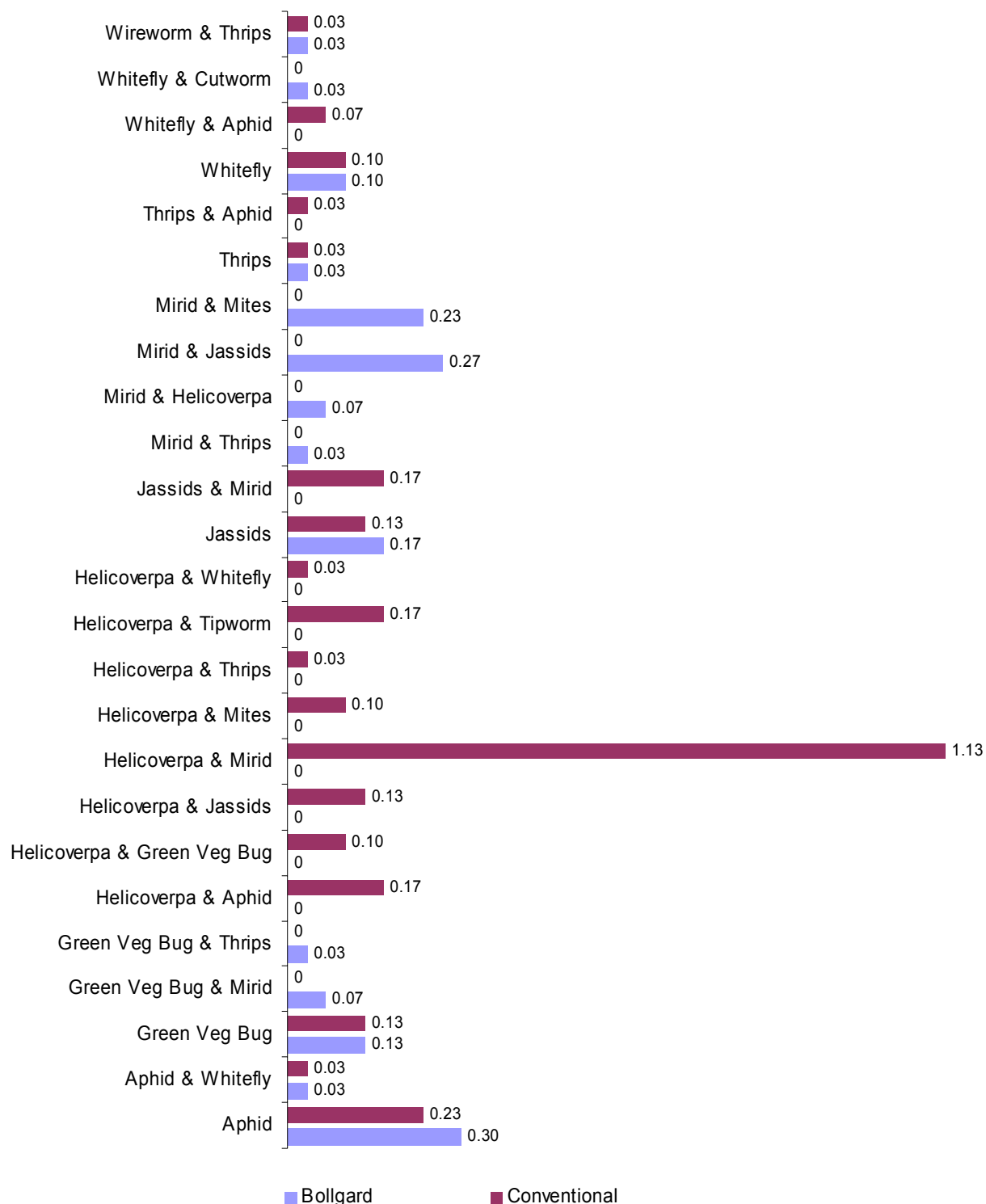
Average Number of Sprays by Pest - Conventional Fields 2005-2006

	Darling Downs	Emerald	Gwydir	Macintyre	Macquarie	St George/Dirranbandi	Grand Total
Aphid	0.2	0.0	0.3	0.0	0.3	0.5	0.2
Aphid & Whitefly	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Green Veg Bug	0.3	0.0	0.0	0.0	0.0	0.0	0.1
Helicoverpa	5.1	8.0	10.0	14.3	7.3	15.8	8.4
Helicoverpa & Aphid	0.1	0.0	0.0	0.7	0.7	0.0	0.2
Helicoverpa & Green Veg Bug	0.0	0.0	0.8	0.0	0.0	0.0	0.1
Helicoverpa & Jassids	0.3	0.0	0.0	0.0	0.0	0.0	0.1
Helicoverpa & Mirid	1.9	0.0	1.0	0.0	0.0	0.5	1.1
Helicoverpa & Mites	0.0	0.0	0.0	0.0	1.0	0.0	0.1
Helicoverpa & Thrips	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Helicoverpa & Tipworm	0.1	0.0	0.0	0.0	1.3	0.0	0.2
Helicoverpa & Whitefly	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Jassids	0.3	0.0	0.0	0.0	0.0	0.0	0.1
Jassids & Mirid	0.3	0.0	0.0	0.0	0.0	0.0	0.2
Mirid	0.4	0.0	0.0	0.0	0.0	0.0	0.2
Thrips	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Thrips & Aphid	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Whitefly	0.1	2.0	0.0	0.0	0.0	0.0	0.1
Whitefly & Aphid	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Wireworm & Thrips	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Grand Total	9.2	11.0	12.5	15.3	10.7	16.8	11.5

Figure 18 displays the information graphically, contrasting the difference in sprays for all comparisons combined. In this figure, exclusive sprays for Helicoverpa and Mirids have been removed to allow the smaller numbers of treatments for secondary pest groupings to be displayed.

Figure 18

**Average Number of Pest Sprays
(Excluding Exclusive Heliothis¹ and Mirid² Sprays)**



1. Helicoverpa - 8.43 sprays on Conventional, 0.1 sprays on Bollgard.
 2. Mirid - 0.2 sprays on Conventional, 2.7 sprays on Bollgard.

3.5 Sprays by Production Stage

The stage of production when sprays were applied is recorded by consultants returning comparison field data. Figures 19 through 22 show the number of sprays per stage by region and these data expressed as the percentage of sprays being applied throughout each stage.

Figure 19

Average Number of Sprays by Production Stage (Bollgard)

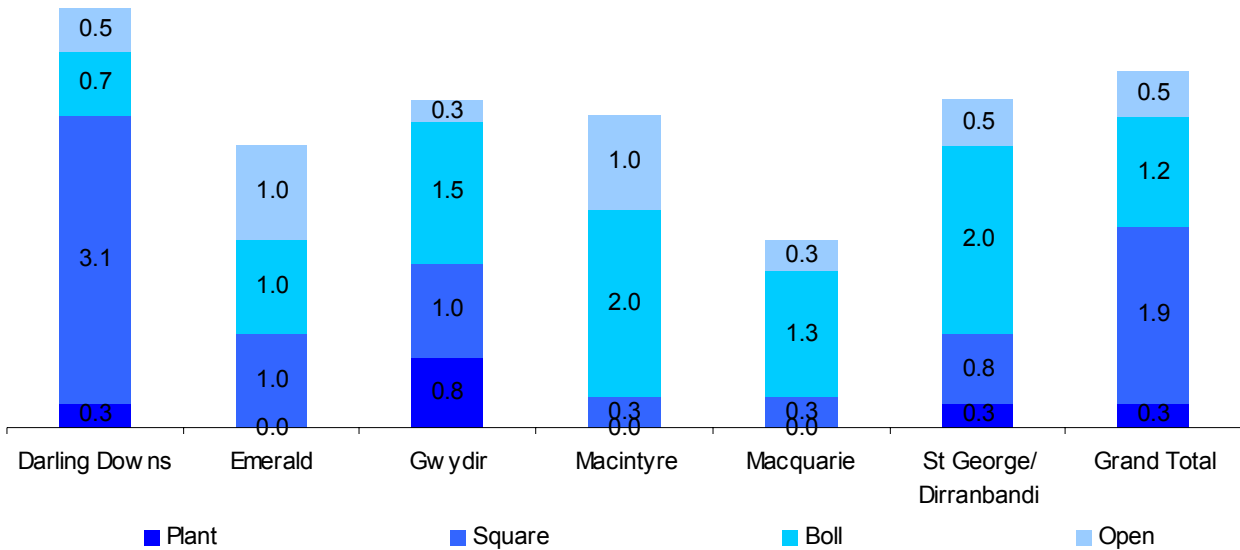


Figure 20

Average Number of Sprays by Production Stage (Conventional)

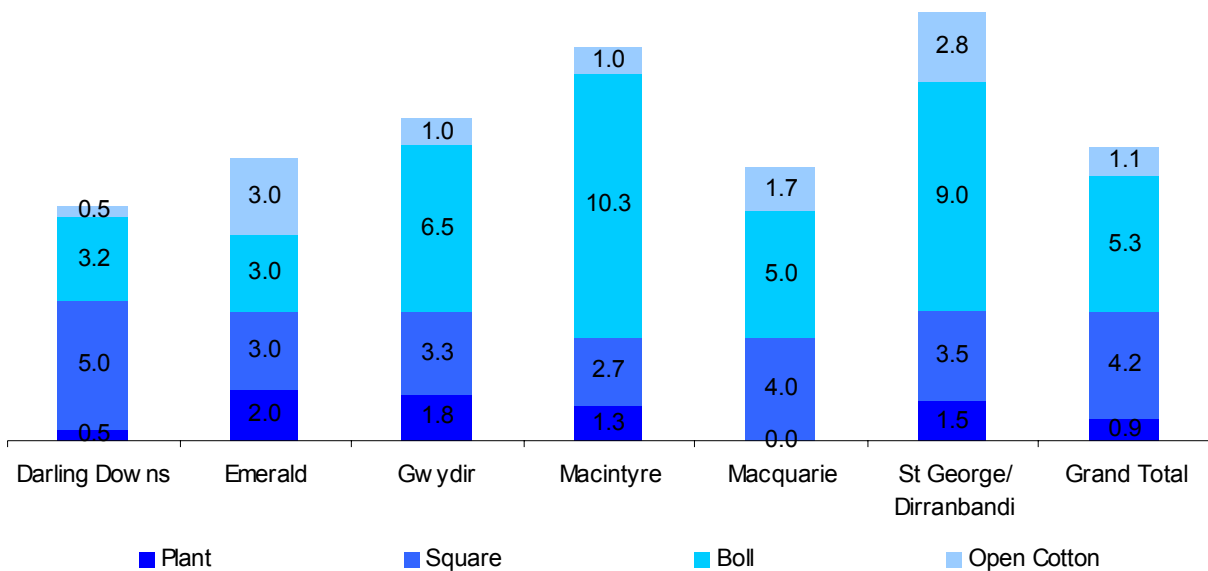


Figure 21
Average Percentage of Sprays by Production Stage (Bollgard)

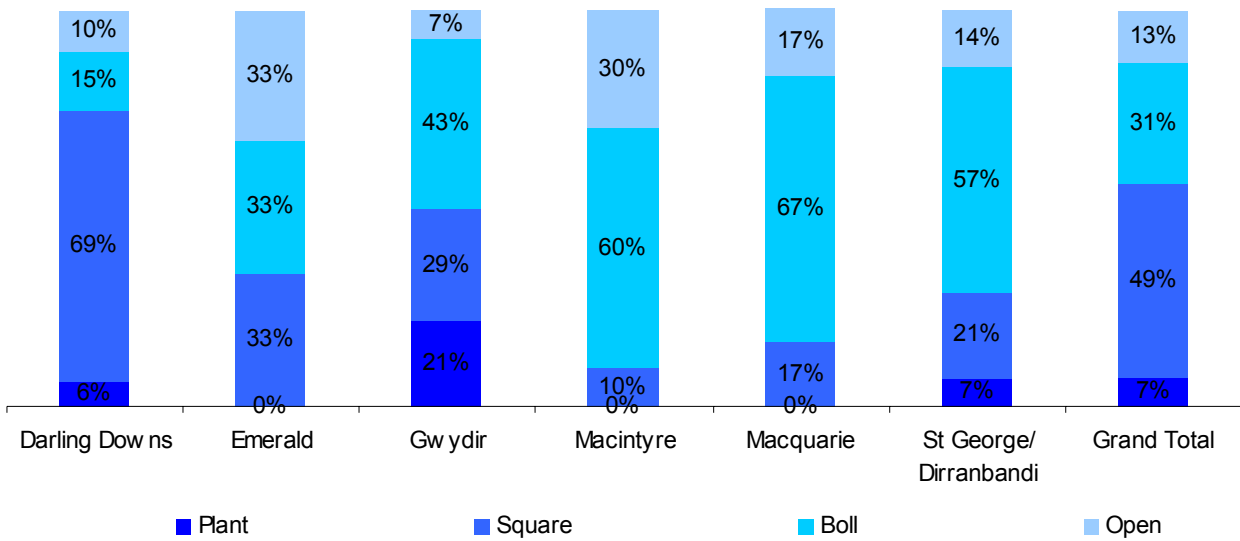
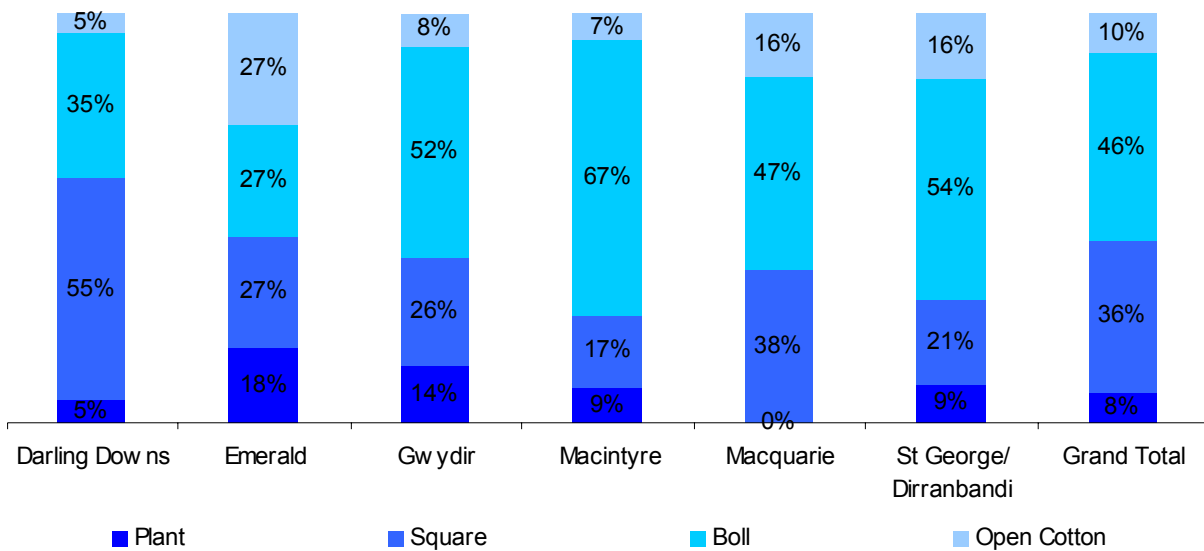


Figure 22
Average Percentage of Sprays by Production Stage (Conventional)



Finally, Table 12 outlines comments from consultants with respect to the secondary pest pressure experienced on Bollgard fields as compared to Conventional. Mirids and green vegetable bugs are frequently mentioned as being more prevalent in Bollgard crops. A number of respondents point to the reduction in numbers of secondary pests in conventional fields as a consequence of sprays for the control of *Helicoverpa*.

Table 12 - Comments on secondary pest pressure in Bollgard II fields compared to Conventional fields.

Southern NSW	Green Mirids were higher in BG as we used some SP's on punctigera in conventional, and did not require specific GM sprays.
Southern NSW	Mites are lower as OP sprays keep them in check.
Macquarie	Was fairly similar
Macquarie	Mirids/Mites/GVB higher in BGII due to lack of spraying chemicals for Heli control that provide incidental control of these pests. Aphids were similar, though occurred later in the BGII fields than the conventional paddocks. Thrips/Wireworm - were not a major problem as most fields had Temik or Gaucho.
Macquarie	More Mirid pressure
Gwydir	Generally higher in Bollgard II than in conventional, possibly because the Heliiothis sprays on the conventional also have some activity on some secondary pests.
Gwydir	For Conventional, they are still secondary pests. For Bollgard, they are now primary pests, notably the increase in Mirids and GVB's.
Gwydir	Secondary pressure is higher in BG fields
Gwydir	Usually higher for GVB
Gwydir	Greater number and range of species of secondary pests in Bollgard.
Gwydir	Very little difference except on one farm with all BGII. That farm had quite high and difficult to control GVB pressure.
Namoi	More GVB
Namoi	Much higher
Namoi	Suckers are more of an issue in Bollgard - Mirids, GVB. Mites more widespread, although often not reaching threshold levels. Aphids are also more widespread late-season - most fields required one treatment.
Upper Namoi	No.
Upper Namoi	Always less.
Macintyre	Little difference but tended to be more GVBs in the conventional.
Macintyre	Mirids needed special sprays. All other pests kept in check by beneficials
Macintyre	This season Mirid, Jassid, Thrip and GVB pressure were higher in BG than conventional. Bear in mind that the conventional was sprayed a lot this season for Heliiothis and a number of the products used had activity on secondary pests.
St George / Dirranbandi	Mite, Mirid, Thrips and WF numbers were all higher in Bollgard crops.
St George / Dirranbandi	Secondary pests such as Mites, Whitefly, Jassids and GVBs appear to be far more prevalent in the Bollgard fields, due to control or suppression in Conventional from Heliiothis sprays.
Darling Downs	There were less Aphid numbers in the Bollgard and they were only seen very late season
Darling Downs	Similar, but with no Heliiothis sprays secondary pests appear higher in Bollgard
Darling Downs	Relatively similar.
Darling Downs	Mirid numbers appeared very high this season.
Darling Downs	This season, Mirids infested conventional and Bollgard fields to the same extent. I feel that green bugs were more prevalent in Bollgard crops than conventional because more sprays were applied to conventional for Heliiothis control.
Darling Downs	Similar for most pests as most conventional fields have a soft approach
Emerald	Mirids were controlled well by early Heliiothis sprays in conventional. All other pests were similar

3.6 Conclusion

Section 3 has outlined the data supplied by the industry's consulting agronomists. This resource provides a unique insight into pest management from the perspective of crop managers who have access to a wide range of situations and production contexts. The data has shown for the most part that Bollgard continues to perform admirably in the majority of situations. Bollgard is suggested as providing a suite of management benefits including gains in OH&S, improvements in logistics, increases in time available for improved management and personal pursuits and reductions in applied sprays. Refuges are reported as being a point of contention for most growers with Pigeon Peas most frequently mentioned as the refuge of choice. Recorded spray reductions for the sample average at 7.7 fewer sprays on Bollgard fields with the largest portion of sprays on Conventional varieties being reserved for Helicoverpa. Mirids are the pest most sprayed on Bollgard fields.

4 Economic Analysis

This section of the report outlines the economic performance of the technology drawing from the paired comparison data. This result is calculated by subtracting from the total revenue (Yield x Price) the spray cost (and licence fee for Bollgard) for each of the fields in a paired comparison and subtracting the net result for the Bollgard field per hectare from the result achieved by the paired conventional field, per hectare.

Assumptions for the analysis are outlined in table 13 below, pricing for chemical inputs are arrived at annually using data from a cross-section of agricultural re-sellers.

Table 13 Assumptions for the Economic Analysis

Net price per bale of cotton	\$400.00
License Fee per Hectare	\$300.00
Aerial spraying	\$12.50
Ground Rig Spraying	\$9.50

4.1 Yield Comparison

Figure 23 provides an overview of the yield comparisons from the paired fields. This figure shows an average for all comparisons of 8.39 bales per hectare on Bollgard fields and 8.32 for conventional. Regional variation can be observed. Overall, the data suggest that there are no consistent significant variations in yield that would contribute substantially to differences in the economic outcomes associated with Bollgard varieties.

Figure 23

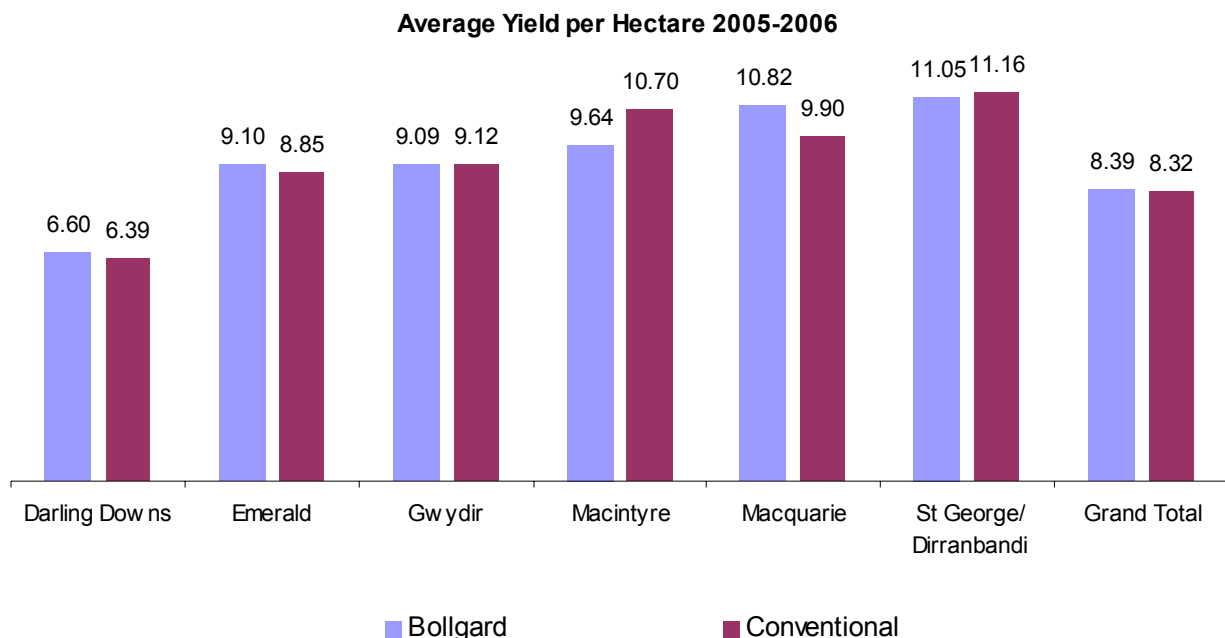
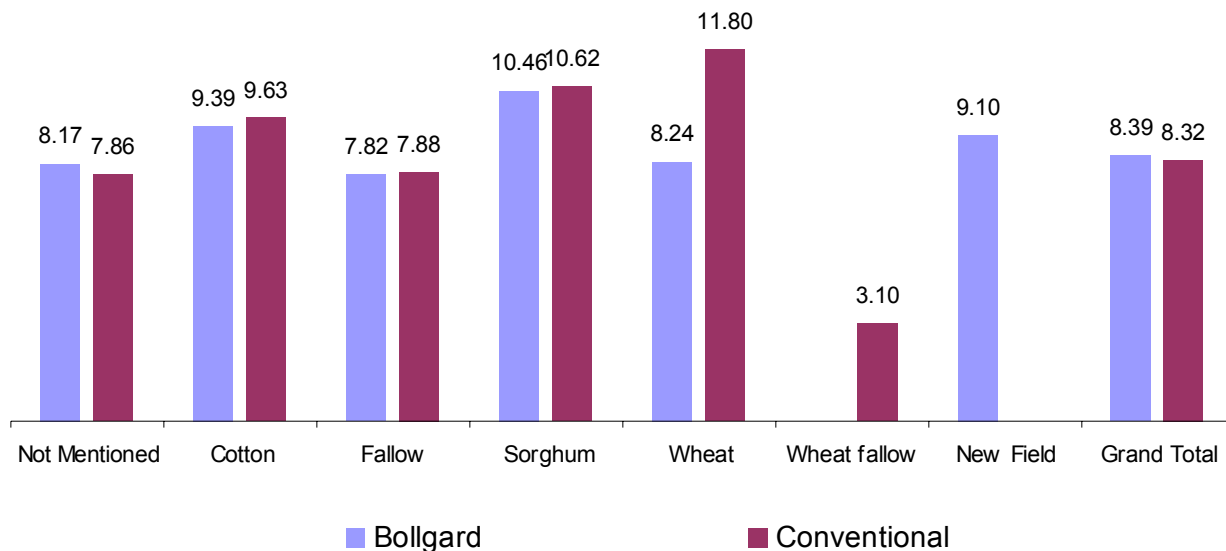


Figure 24 displays the yield for fields based on their previous cropping histories. Fields where sorghum and wheat were the previously produced crop recorded the highest yields for the sample.

Figure 24

Yield by Previous Cropping History



4.2 Spray Costs

Figure 25 displays the spray costs associated with the comparison fields for this sample. The average difference across the full sample is a \$280 reduction in total spray costs. In terms of the economic result for the technology, the reduction in spray costs is clearly the primary driver.

Figure 25

Average Total Spray Costs per Hectare including Bollgard Licence Fee

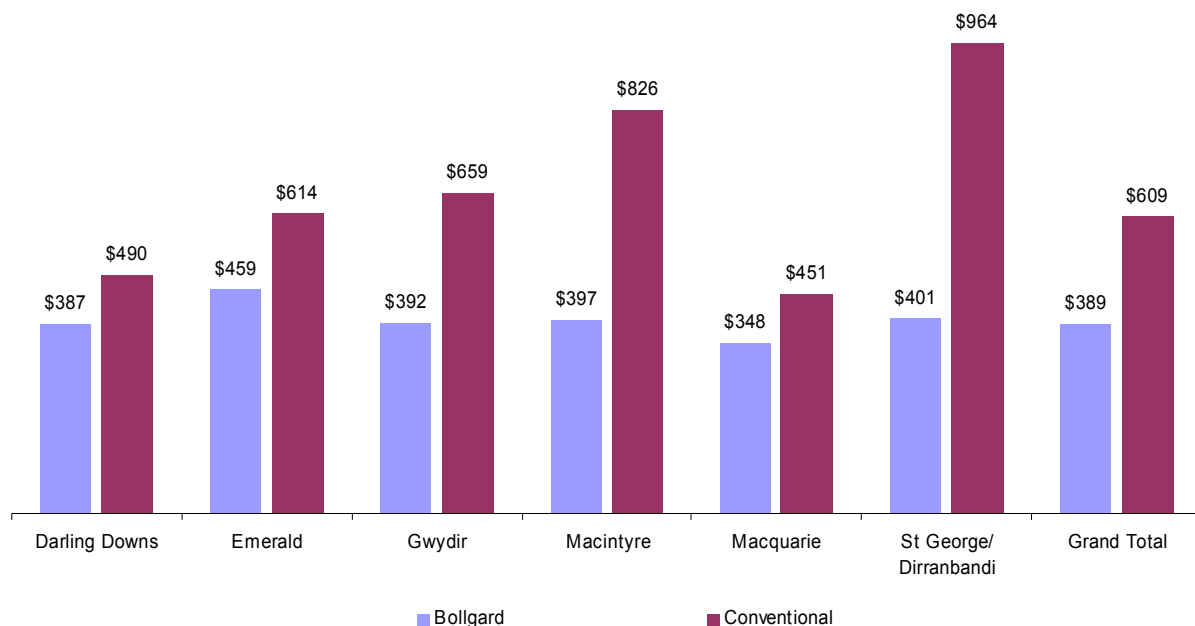


Figure 26 displays the cost of insecticide costs per bale of cotton harvested.

Figure 26

Average Total Spray Costs per Bale including Bollgard Licence Fee

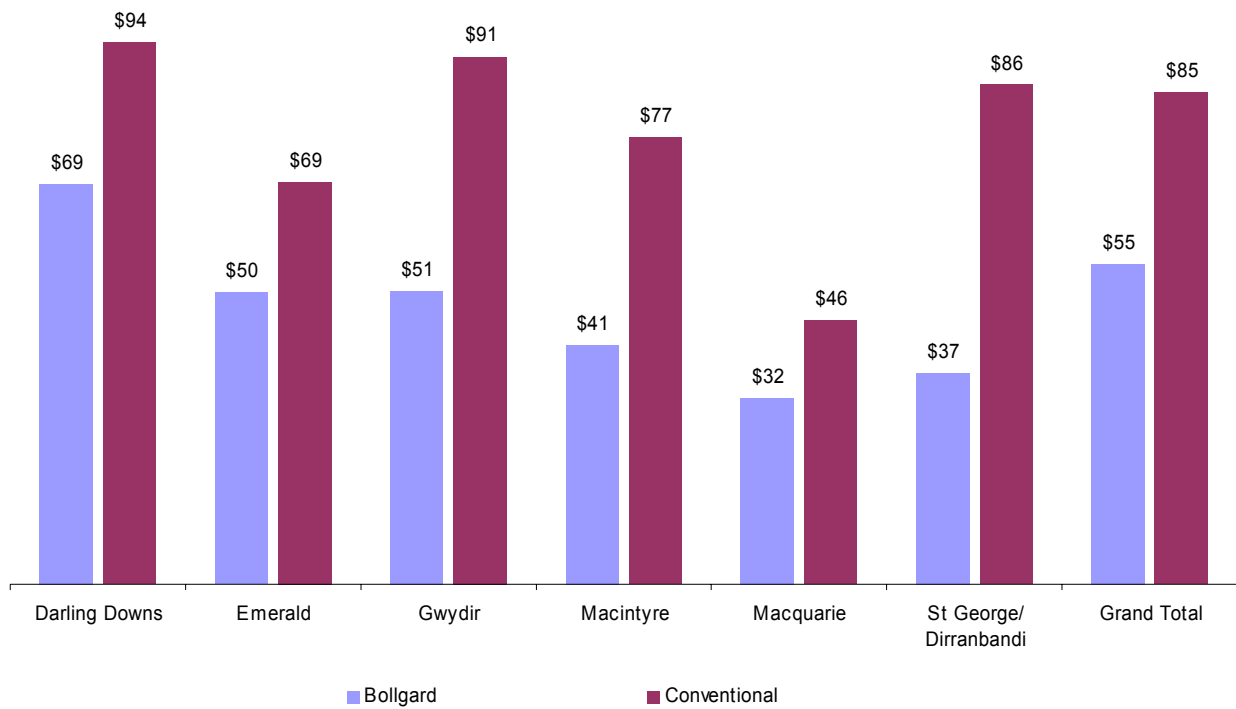
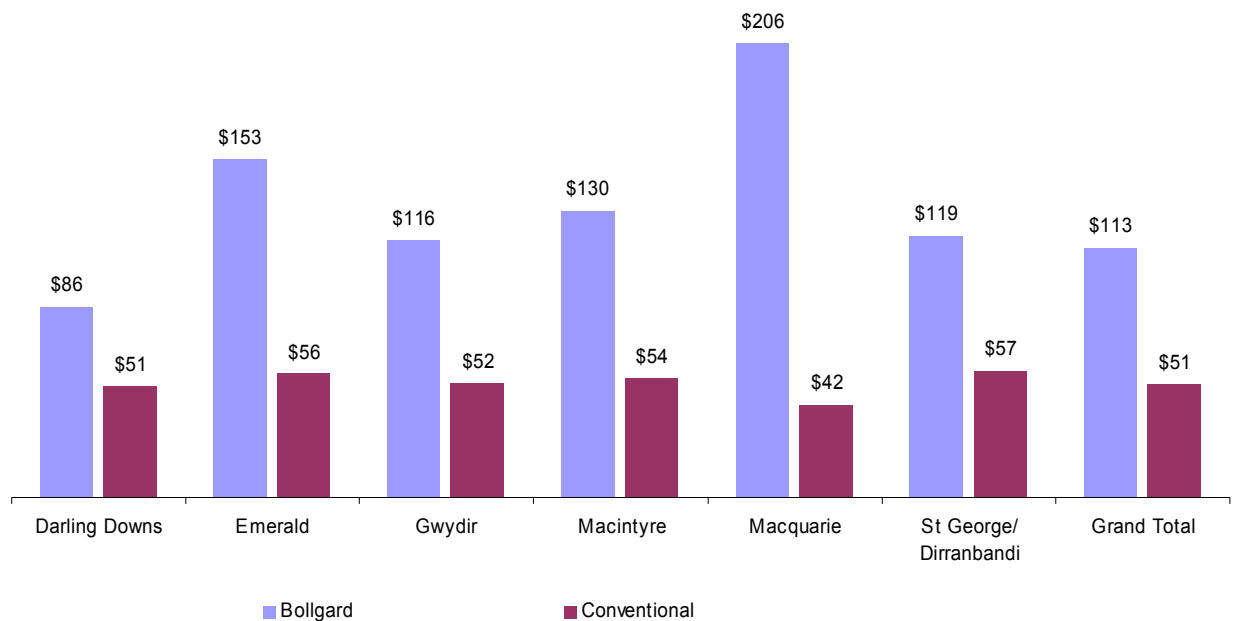


Figure 27 presents the average total cost of insecticide sprays per applied spray.

Figure 27

Average Total Spray Costs per Spray including Bollgard Licence Fee



Figures 28 and 29 show the financial result when considering the total revenue and costs associated with each comparison. Figure 28 shows that of the 30 comparisons submitted, only 4 produced an economic result that was in favour of Conventional cotton varieties. Figure 29 reveals that the financial result for Bollgard when considering variable input costs resulted in 87 per cent of comparisons ending in an economic benefit from growing Bollgard with an average for the total sample of \$250.46 benefit associated with growing Bollgard Cotton.

Figure 28

The Number of Paired Comparisons Falling Within an Economic Benefit or Cost as a Result of Growing Bollgard 2005-2006

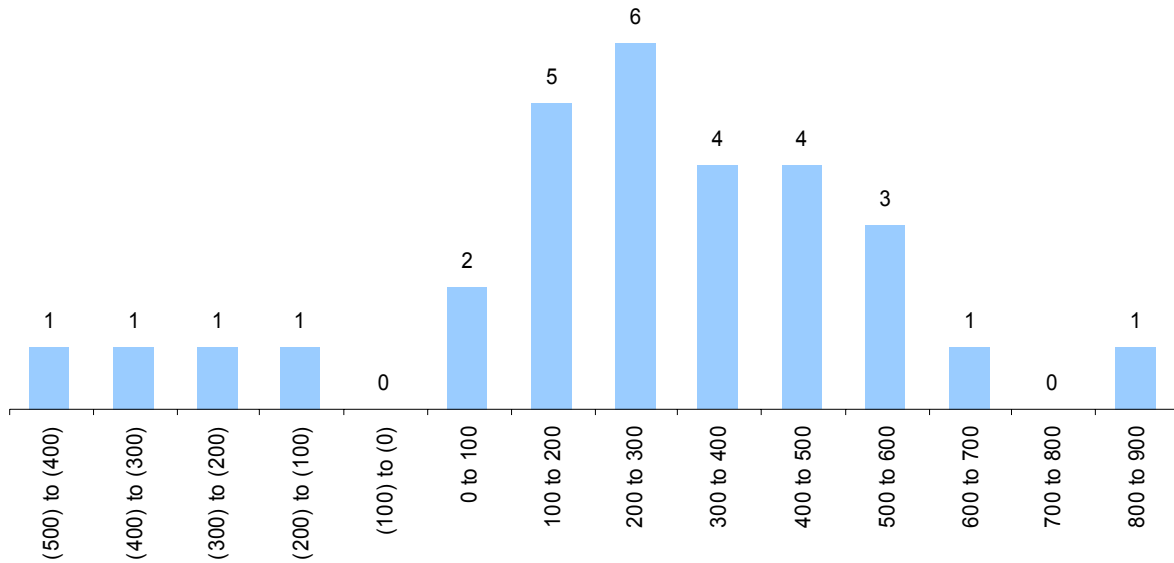


Figure 29

Economic Result for Bollgard and Conventional Field Comparisons 2005-2006

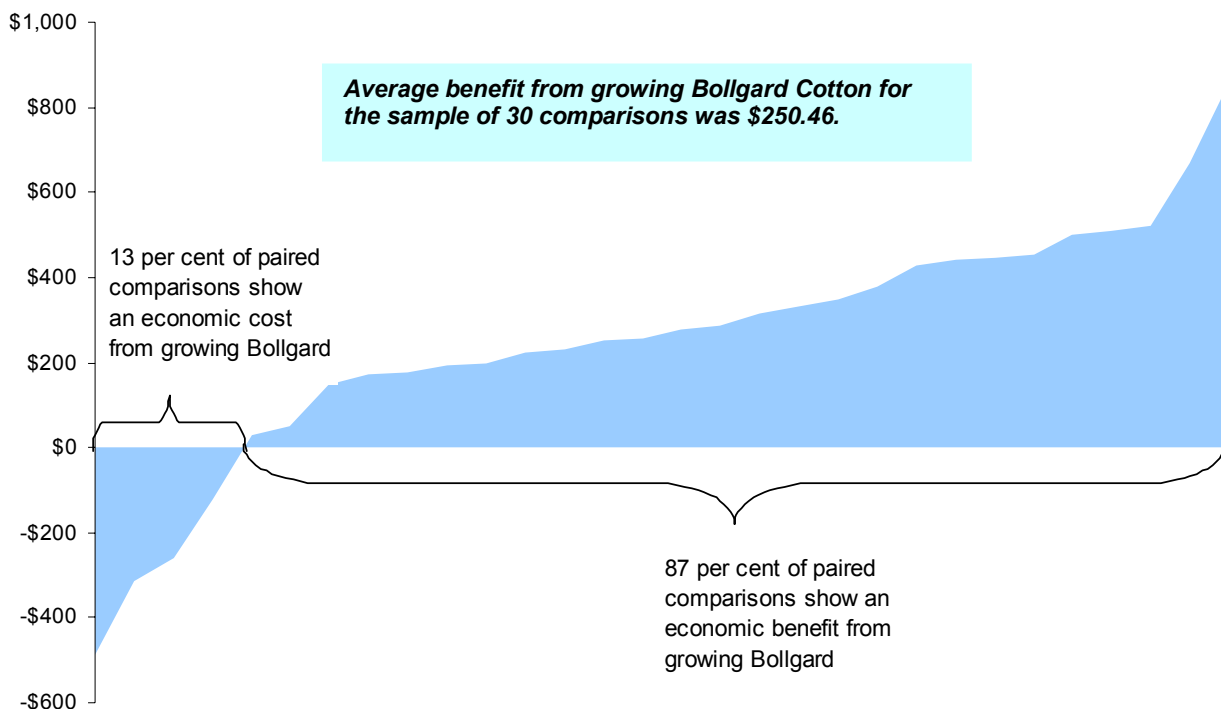
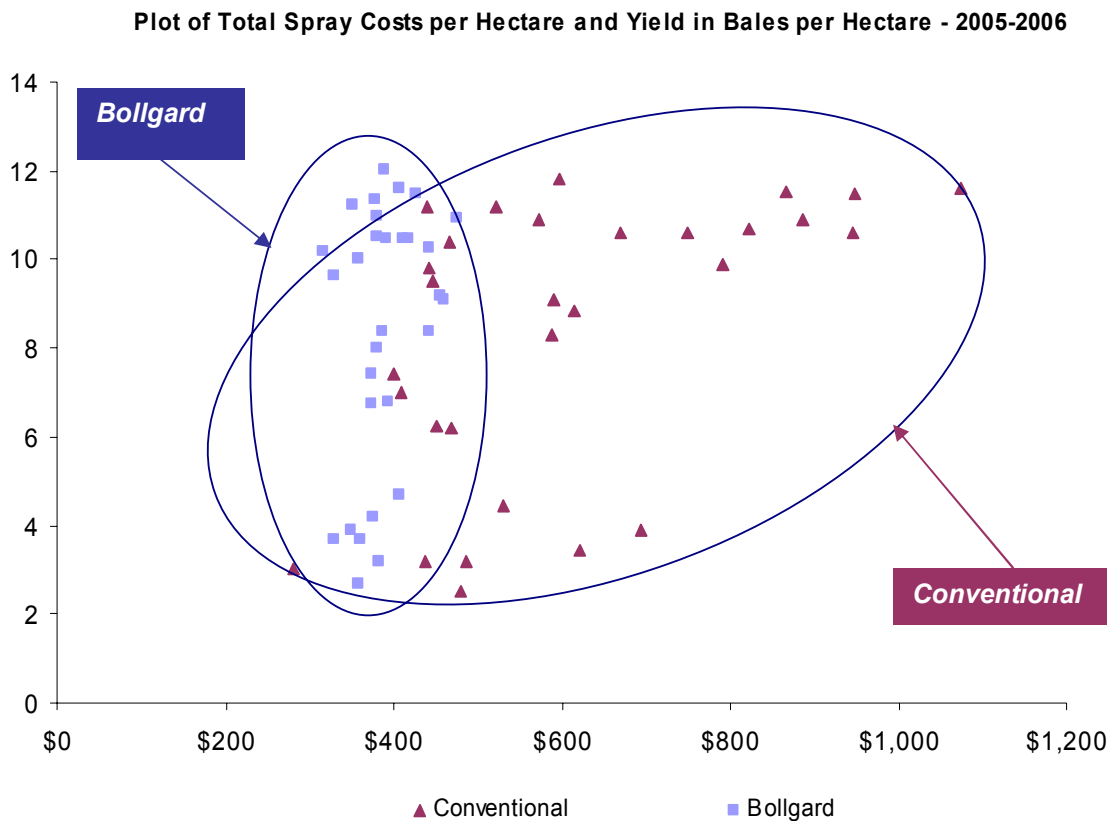


Figure 30 displays the plot of individual field yields and associated insecticide spray costs. The spread on costs associated with the conventional fields is demonstrated in the figure.

Figure 30



4.3 Conclusion

The economic result of the comparison fields submitted for this report highlight the economic reason behind the continuing high level of adoption of Bollgard technology. The average benefit from growing Bollgard as opposed to conventional is approximately \$250 per hectare for the sample supplied. It should be noted that concerns were often raised associated with reduced fibre quality in Bollgard fields, there has been no adjustment to the projections for any impact that might be associated with this quality reduction when present.

5 Paddock Action Manager Data

Data in this section is from an aggregation of field level data supplied by consultants as an export from the record management program, Paddock Action Manager (PAM). This information contains the complete spray records for 346 Bollgard fields covering 18,391 hectares across 6 production valleys and 98 Conventional fields covering 6,215 hectares across five production valleys.

Table 14 outlines the average number of sprays per hectare for insecticides used on the 346 Bollgard fields, Table 15 provides the same information for the 98 conventional fields.

Figure 31 graphs the average number of sprays for each product applied on Bollgard fields for the full sample, figure 32 does the same for Conventional fields.

Appendix 1 provides paddock level data associated with the 346 Bollgard fields reported in the PAM data format. Each field has the application date, mix of insecticides sprayed and the associated cost is calculated. Appendix 2 outlines this same information for the 98 Conventional fields.

Table 14 – Average number of sprays per hectare – 346 Bollgard Fields

	<i>Capricorn</i>	<i>D-Downs</i>	<i>Gwydir</i>	<i>Macintyre</i>	<i>Namoi</i>	<i>Southern NSW</i>	<i>Grand Total</i>
DIMETHOATE 400EC	0.18	2.68	1.37	0.11	2.59	0.36	1.25
FIPRONIL 200SC	2.65	1.25		1.40		0.06	1.03
ALDICARB 150G		0.40	0.85		0.71	0.81	0.34
BIFENTHRIN 100EC				0.83			0.31
ABAMECTIN 18SC		0.01		0.35	0.74	0.97	0.31
OMETHOATE 800SL				0.79			0.29
ALPHA-CYPERMETHRIN 100EC		0.82			0.38		0.28
PIPERONYL BUTOXIDE 800EC				0.71			0.26
THIODICARB 375SC			0.37	0.47	0.59		0.26
CHLORPYRIFOS 500EC	0.29		0.67		0.71	0.36	0.17
DELTA METHRIN 5.5UL				0.10		0.92	0.13
ALPHA-CYPERMETHRIN 16UL				0.30			0.11
DIAPENTHIURON 500SC	0.41	0.19					0.08
NPV-Gemstar				0.20			0.08
ACETAMIPRID	0.12	0.22					0.07
BACILLUS THURINGIENSIS 1x						0.56	0.06
ENDOSULFAN 350EC	0.65	0.01		0.02	0.06		0.05
BETACYFLUTHRIN 25EC/UL						0.36	0.04
PROFENOFOS 250EC/UL			0.48				0.04
PYRIPROXYFEN-Admiral	0.76						0.04
BACILLUS THURINGIENSIS 2x						0.28	0.03
METHOMYL 225LC	0.53						0.03
BIOPEST		0.08					0.02
CANOPY OIL		0.01		0.02		0.14	0.02
AMITRAZ 200EC		0.06					0.02
PROPARGITE 600						0.11	0.01
INDOXACARB		0.03					0.01
AMITRAZ 200UL				0.02			0.01
EMAMECTIN		0.01					0.00
SPINOSAD 480SC		0.01					0.00
Total	5.59	5.78	3.74	5.31	5.76	4.92	5.34

Table 15 – Average number of sprays per hectare – 346 Bollgard Fields

	<i>Capricorn</i>	<i>D-Downs</i>	<i>Gwydir</i>	<i>Macintyre</i>	<i>Namoi</i>	<i>Grand Total</i>
THIODICARB 375SC	0.6	0.8	0.4	1.4	13.3	2.4
ENDOSULFAN 350EC	2.8	0.1	2.3	1.7	3.3	1.6
INDOXACARB	2.8	1.4	2.1	1.5	0.3	1.5
AMITRAZ 200EC	3.6	1.8	2.3		1.0	1.3
PIPERONYL BUTOXIDE 800EC		1.3	1.3	1.6	0.8	1.3
EMAMECTIN	3.6	0.5	1.5	1.6	0.3	1.2
NPV-Gemstar				3.4		1.2
BIFENTHRIN 100EC		1.6	0.2	1.2		0.9
ABAMECTIN 18SC		0.4	1.5	0.6	1.8	0.8
AMITRAZ 200UL	1.4		0.3	2.1		0.8
DIMETHOATE 400EC		2.4	0.4			0.8
SPINOSAD UL	1.0	0.5	1.0	0.6	1.0	0.7
DELTAMETHRIN 5.5UL				1.2	1.8	0.6
FIPRONIL 200SC	1.0	1.0		0.5		0.5
CANOPY OIL		0.1	0.3	0.7	1.5	0.5
ALPHA-CYPERMETHRIN 100EC		0.6	1.6			0.5
PROFENOFOS 250EC/UL			2.3			0.5
PROFENOFOS 500EC			1.0		2.3	0.5
ALDICARB 150G		0.2	1.0			0.3
BIOPEST		0.5		0.2		0.2
PROPARGITE 600				0.6		0.2
CHLORPYRIFOS 500EC			0.8			0.2
SPINOSAD 480SC		0.5		0.0		0.1
DIAFENTHIURON 500SC	0.6	0.3				0.1
CHLORPYRIFOS-METHYL EC/UL		0.3				0.1
ACETAMIPRID	0.4	0.2				0.1
NPV-Vivus		0.1		0.0		0.1
METHOMYL 225LC	0.2	0.1				0.0
OMETHOATE 800SL				0.1		0.0
PRODIGY				0.1		0.0
ALPHA-CYPERMETHRIN 16UL-				0.0		0.0
BETACYFLUTHRIN 25EC/UL	0.2					0.0
CARBOSULFAN 250EC					0.1	0.0
LAMBDA-CYHALOTHRIN ZEON	0.2					0.0
PIPERONYL BUTOXIDE 800EC-PBO	0.2					0.0
PYRIPROXYFEN-Admiral	0.2					0.0
ZETA-CYPERMETHRIN + ETHION		0.0				0.0
Grand Total	18.8	14.9	19.9	19.4	27.2	19.1

Figure 31
PAM Data - Average Number of Applied Sprays - Bollgard - 346
Fields

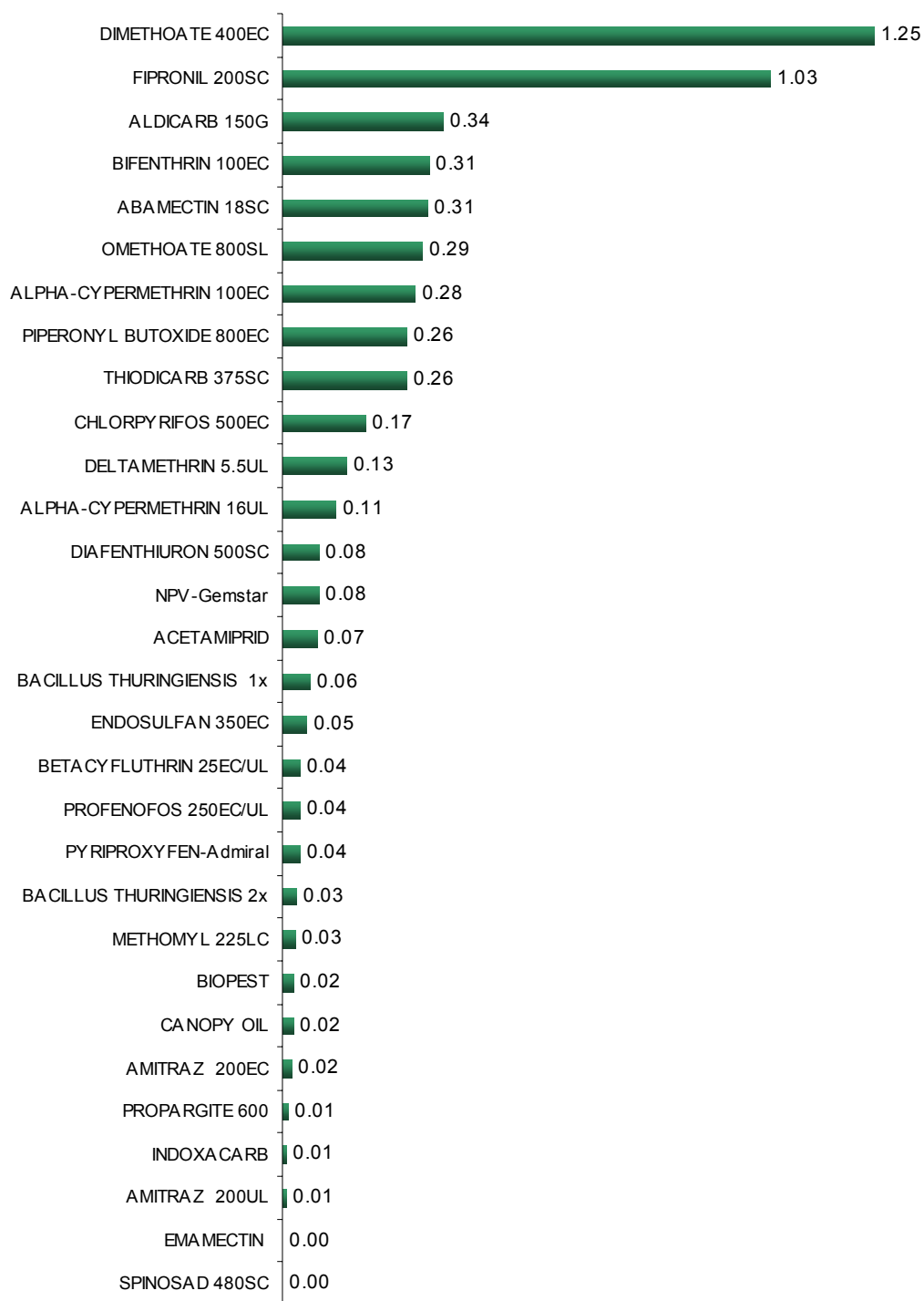


Figure 32

PAM Data - Average Number of Applied Sprays - Conventional - 98 Fields

