CRDC 89 C.

The Performance of INGARD® Cotton in Australia during the 1999/2000 Season.

A final report on research conducted by Cotton Consultants Australia Inc. and managed by Pieter Kwint Consulting Pty Ltd on behalf of the Cotton Research and Development Corporation.

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Contents (No page numbers as report to be edited by Bruce Pyke)

Executive Summary

A total of 48 agronomist – cotton consultants have reported on the performance of both conventional and genetically modified cotton (INGARD®). From a total collection of 340 fields, 149 paired comparisons were made. The total area surveyed comprised 191,000Ha's of which 28% was Ingard. Fields were analysed for number of sprays by valley (growing district), pest and product. Yield, average cost and return per hectare was also analysed. The survey also included several qualitative questions to evaluate service and value of Ingard.

The average number of sprays (all pests) were reduced by 40% from 10.3 in conventional cotton to 6.2 in Ingard. For heliothis the reduction in sprays was 47%, from 9.7 sprays to 5.1 in Ingard. The greatest reduction in sprays was from squaring to open boll, with an average reduction in sprays of 40%. A small difference in maturity was recorded, with substantial variation between samples. Ingard produced an average advantage of 1.3 days earlier pick compared to conventional. Heliothis pressure in 1999/2000 season was lower than the previous season.

The general attitude of consultants to the value of Ingard remains moderate. Survey results suggest an important opportunity remains for the technology provider (Monsanto) to improve service to users of Ingard (about 40% classify service by Monsanto to be poor). More frequent and timely direct contact between Monsanto and those responsible for managing cotton pests could prove beneficial. Service provided by Ingard Technology Service Providers is considered better with 70% of respondents classifying service to be "satisfactory to excellent".

Environmental reasons continue to be the principal driving factor for Ingard use (55% mentioned). Performance related reasons are being mentioned 11% of times. The best performing variety (days of heliothis control) was Nu Pearl (44% of recorded users indicating between 101-120 days control). The worst performing variety was Sicot 189i with 43% of recorded users indicating between 41 – 60 days control.

This season a marginal difference between conventional and Ingard in average cost of applied sprays was recorded: $0.19/Ha higher for Ingard. To protect their crop from insects, Ingard growers spend $72/Ha less than conventional growers. Yields vary considerably between fields. An Independent Two-Sample T Test was conducted over the means. No significant differences were obtained through this method. Due to yield variation economic

benefit or cost seem equally divided between both extremes of the benefit – cost scale. Although calculated differences are large (between $<-1000.00/Ha and $>1000.00/Ha), no significance can be attributed to the findings. The data shows similar distribution between both extremes.

From the results from this survey it can be concluded that genetically modified cotton is an economically attractive tool in managing pests in cotton. The cost per hectare to manage insects pests in Ingard crops is, on average, $72/Ha less than conventional cotton. With environmental advantages such as reduced chemical loading and environmental disruption, Ingard remains an attractive and sound proposition.

Section 1. The Impact of INGARD Cotton on Pesticide Use for the 1999/2000 Season

Introduction

For the fourth season, the CRDC have commissioned a survey to examine the impact of INGARD Cotton, (by Monsanto) on pesticide use in the Australian cotton industry. This section of the survey examines the differences in use patterns by examining details of paired comparisons of INGARD and Conventional cotton. This years survey is similar in many aspects to surveys done in previous seasons, with additional information on qualitative aspects and inclusion of statistical analysis of yields.

Heliothis pressure this season was lower compared to previous season. Incidence of some sucking pests, in particular aphids was higher in some valleys. Tipworm pressure was very low and no records were made this season.

Methods

The survey was conducted during July and August, 2000 and asked active field agronomists to supply data relating to the performance of INGARD compared to a conventional area which had the same or similar characteristics. These characteristics included: variety, soil type, field history, planting date and management of other factors apart from insects. The data were screened to ensure that the comparisons were valid and then analysed.

A copy of the questionnaire appears in the appendix. The questionnaire asked for: qualitative information, field history, spray data including dates, products, rates, application method and the pests that the sprays were targeting; yield; differences in quality, if any; relative pest pressure; differences in checking; differences in diseases; pupae control levels; reasons for growing INGARD and comments.

The average spray results for both product and pest categories are the aggregate of the data.

There are references in this report to the previous season. This refers to information in the CRDC Occasional Paper titled "The Performance of INGARD® Cotton in Australia during the 1999/2000 Season".

A total of 48 consultants responded with a total of 340 Conventional and INGARD field records. From the 340 fields 149 paired comparisons were analysed.

Table 1.

Table 1. Source of Paired Comparisons - Number per Valley

	Valley												Group Total
	Emerald	Central Qld	St George	Darling Downs	MacIntyre	Gwydir	Namoi	Macquarie	Bourke	Tandou	Lachlan	Other	
	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count
Conventional	6	3	13	23	34	23	33	17	3	1		8	162
Ingard	6	5	14	24	40	24	34	17	3	2	3	6	178

Table 2.below details area for which the respondent-agronomists were responsible.

Table 2.

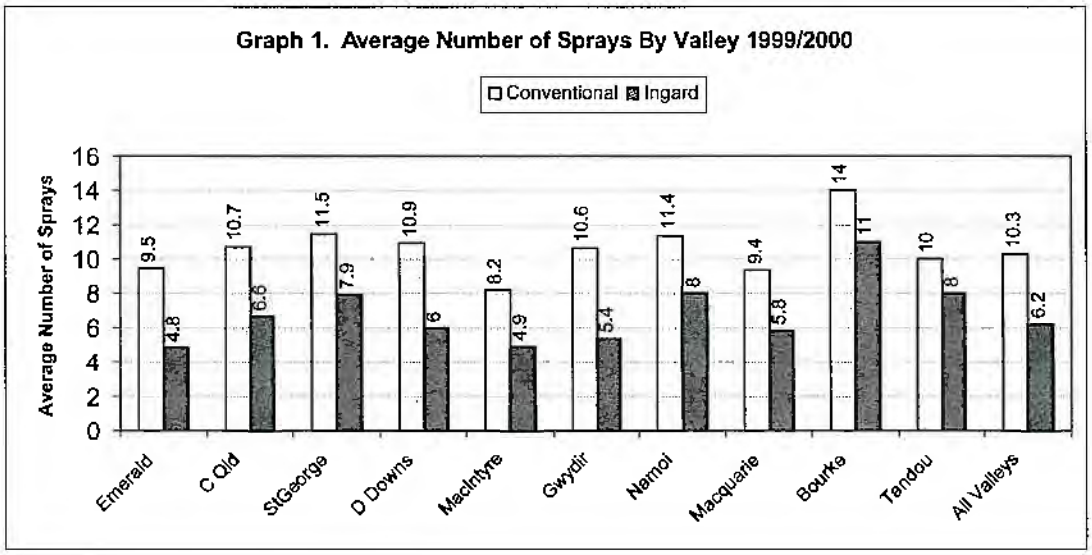
Survey Area & Industry Estimate Area 1999/2000 Season (HA)

		Emerald	Central Qld	St George	Darling Downs		MacIntyre		Gwydir		Namoi	Macquarie	Bourke	Tandou	Lachlan	Other	Total
		Irrigated	Irrigated	Irrigated	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Irrigated	Irrigated	Irrigated	Irrigated	Irrigated	
Ingard HA's	Sum	783	1800	4877	5148	304	6827	891	7953	2017	11768	3972	3855	750	915	1721	53501
Conventional HA's	Sum	1425	3400	11824	9505	1740	12538	4700	25873	4707	35452	12979	5163	5000	2608	1797	138709
TOTAL HA's	Sum	2208	5200	16701	14653	2044	19365	5591	32826	6724	47240	16951	9018	5750	3521	3518	191310

There is no analysis of individual dryland valleys as the sample size is small. From these samples, various analyses were conducted.

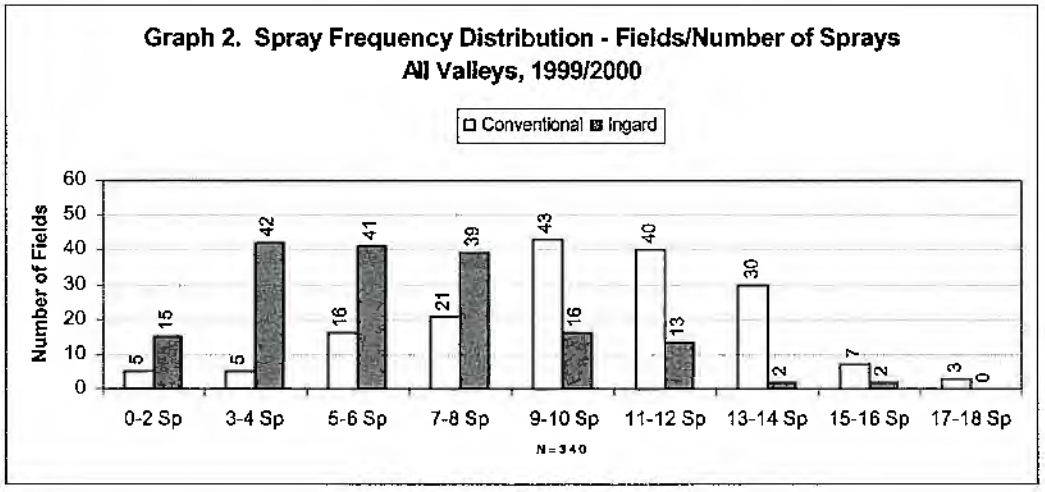
Reduction in Number of Sprays

The graph below details the reduction in number of sprays.



The average number of sprays was 6.2 for INGARD, compared to 10.3 for conventional cotton. This represents an average reduction of 40%, which is similar to the reduction achieved in 1998/1999 season (38%).

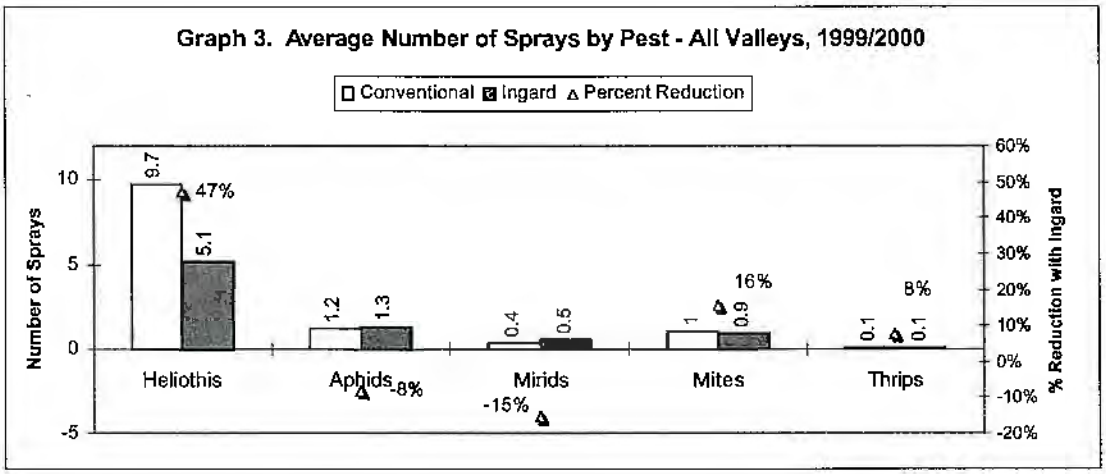
The graph below is the frequency distribution for the number of sprays. This graph compares the distribution of the number of sprays that were applied to INGARD and conventional cotton. The number of responses is given for each spray group, as indicated on the x axis. The distribution shows there is a general reduction in the level of sprays in INGARD cotton.



Pests

The graph below indicates the reduction of sprays by key pests.

Graph 3. Average Number of Sprays by Pest - All Valleys, 1999/2000

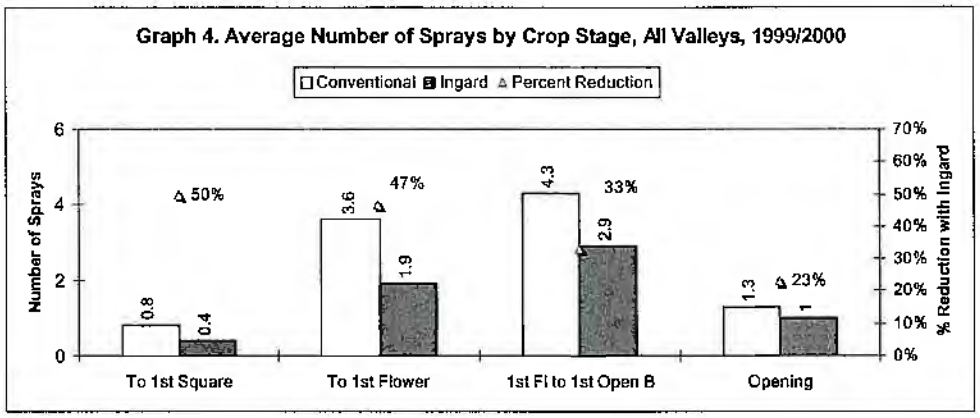


For Heliothis the reduction in 1999/2000 was 47%, slightly higher than in 1998/1999 season (43%). Little or no tipworm was recorded and hence no entries made. There was a slight increase in the number of sprays for aphid and mirids (8% and 15%), which is in line with increases recorded in 1998/1999 season. Mite sprays were slightly decreased in INGARD (16%), again remarkably similar to 1998/1999 season mite reduction (17%). Thrips sprays were rather sporadic over the valleys.

Growth Stage

The graph below gives results for the reduction in the number of sprays for the following growth stages:

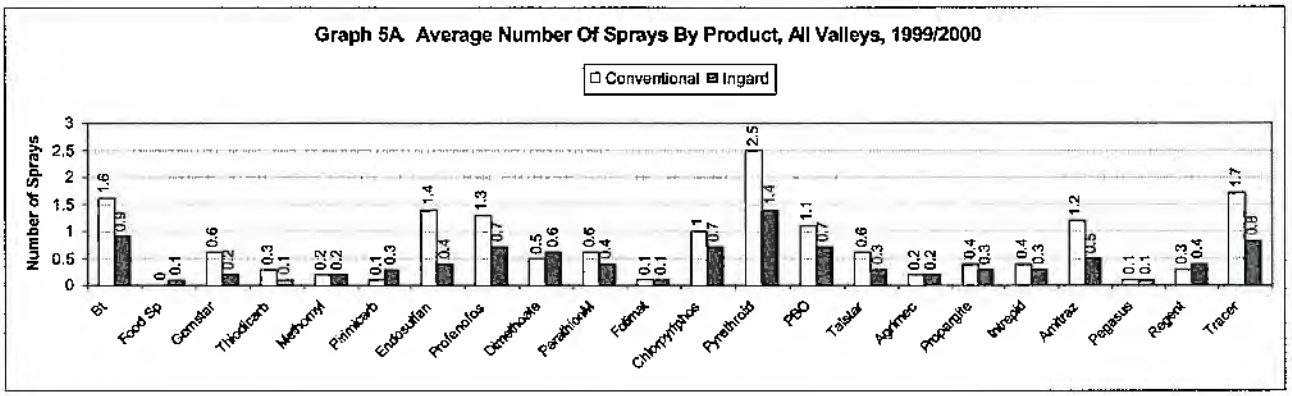
- Planting to 1st square
- Square to 1st flower
- 1st Flower to 1st open boll
- Opening

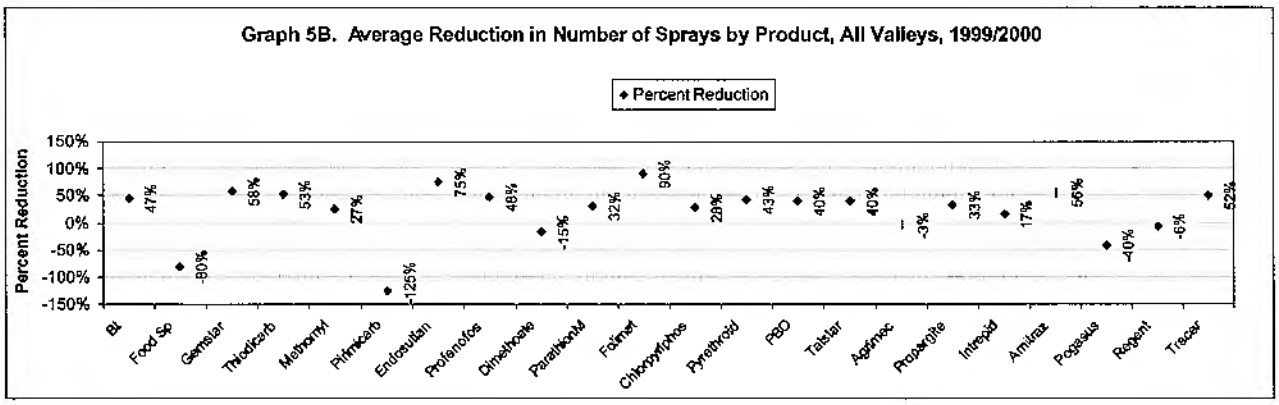


The greatest reduction in sprays was during squaring – 1st open boll. Spray reduction for Opening was 23%, which is similar to last season (25%).

Products

There was a large variation in the reduction of sprays for individual products as detailed in the graphs below. Trade names have been used in some cases for simplicity. Although data was collected by brand name, records have been aggregated for simplicity.





One can conclude from the above graphs that in general sprays are reduced with Tracer and Bt's in particular increasing its share in the market. Endosulfan is down from last season (from 4.4 sprays in conventional to 1.4 sprays in conventional). The reduction in endosulfan in INGARD (75%) is similar to last season (71%). The reduction in pyrethroids is 43%, which is up from last year's 33% reduction.

Interestingly use of products with a fit in IPM systems such as Gemstar, Tracer and Bt's have similar reductions in Ingard, in line with overall reductions in sprays. Use of monocrotophos was negligible and not recorded.

Products targeting mites were increased, however Comite is slightly down and Intrepid records no reduction.

Dimethoate use (to control sucking insects) is equal in both conventional and INGARD. Folimat is reduced in INGARD. This is contrary to last season were the use of products to control sucking insects were increased in INGARD fields. Regent use was equal in both Conventional and INGARD.

Overall use of all products is down except Pirimicarb, Dimethoate, Intrepid, Pegasus and Regent.

Differences in Maturity

Differences in maturity of INGARD compared to conventional cotton were measured by comparing the difference in planting date to first defoliation date and to the picking date. There was substantial variation in the samples however when averaged there was 0.3 days difference between INGARD and conventional (INGARD being 0.3 days quicker which the same as 1998/1999 season). When comparing days to picking, INGARD is on average 1.3 days quicker than conventional (last season 0.4 days).

There was no statistical significance between means in the data set.

Table 3: Difference in the Number of Days Between planting and First Defoliation or Picking for INGARD and Conventional Cotton Paired Samples

Event	1st Defoliation	Picking
Average number of days difference between INGARD and Conventional – INGARD being quicker	0.3	1.34
Number of samples where INGARD was longer	72 (47%)	45 (46%)
Number of samples where INGARD was shorter	81 (53%)	52 (54%)

Relative Pest Pressure

Table 4. Relative pest pressure. 0 = Nil; 1 = Very low; 2 = Low; 3 = Medium; 4 = High; 5 = Very high

Pests	INGARD			CONVENTIONAL		
	Squaring	Boll fill	Opening	Squaring	Boll Fill	Opening
Aphid	1.7	2.2	2.2	1.4	1.7	1.7
Helicoverpa	2.0	2.7	2.6	2.3	2.9	2.7
Tipworm	0.4	0.1	0.1	0.5	0.1	0.2
Mirids	1.6	1.0	0.6	1.4	0.9	0.5
Mites	0.9	2.3	2.6	0.8	2.2	2.4
Gr.Veg. Bug	0.7	1.3	1.1	0.5	0.8	0.7

Table 4 summarises differences respondents gave for relative pest pressure. These were qualitative assessments.

Aphid pressure was perceived to be slightly higher in INGARD, whereas there was little difference recorded for heliothis. Heliothis pressure was considered lower than last season. Tipworm pressure was negligible and not considered a problem this season. Mirid and mite pressure was similar for both INGARD and conventional. In relation to green vegetable bug, pressure was considered higher in INGARD, particularly during boll fill and opening.

Relative Control of Pests

Table 5. Control of Helicoverpa & Tipworm. 0 = not relevant; 1 = very poor; 2 = poor; 3 = average; 4 = good; 5 = very good.

Pests	INGARD			CONVENTIONAL		
	Squaring	Boll fill	Opening	Squaring	Boll Fill	Opening
Tipworm	1.3	0.6	0.5	1.0	0.7	0.6
Helicoverpa	3.5	3.3	2.6	3.5	3.3	3.1

Table 5 summarises control of tipworm and heliothis. Control of heliothis in both INGARD and Conventional was equal during squaring and boll fill. Control during opening was considered below average in INGARD during opening. Tipworm control was considered not relevant in many cases during 1999/2000 season.

INGARD Performance

Table 6 below details responses for performance of INGARD.

Table 6.

Ingard Performance

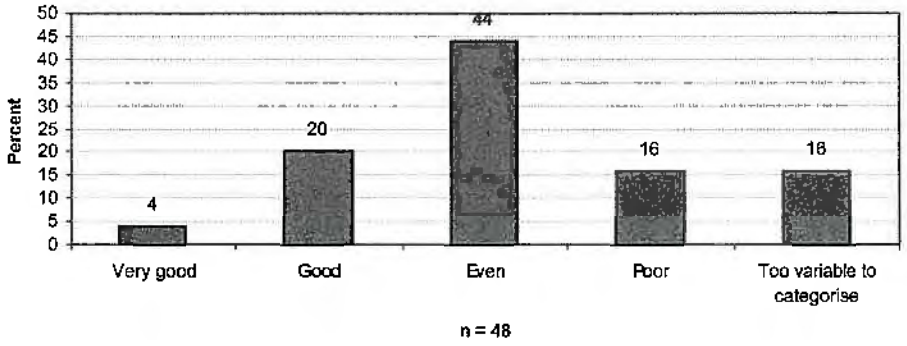
	Always	Mostly	Rarely	No
	%	%	%	%
Ingard performed to my expectations	7%	73%	16%	4%
I followed industry thresholds	24%	69%	7%	
I allowed 2 consecutive checks before spraying	29%	60%	7%	2%

n = 48

Response levels were similar to last seasons responses. Most felt that INGARD performed to their expectations. Most respondents followed industry thresholds most of the time. Again these findings are similar to last season.

The graph below gives respondents perceptions of the value that INGARD gave them. About a quarter felt that INGARD is "good value for money" which is slightly up from last year (one fifth of respondents.

Graph 6. Value for Money for Ingard



16% believe that INGARD is "too variable to categorise" and 16% believe that INGARD is "poor" value for money.

The table below describes how respondents rated **services provided by Monsanto.**

Table 7.

Rating of Services Provided by Monsanto

	Good	Satisfactory	Poor	None received	Not applicable
	%	%	%	%	%
Information regarding Ingard (i.e. performance data)	15%	23%	40%	19%	2%
Feedback on any inquiries regarding Ingard (if any)	4%	28%	38%	9%	21%
In field support/service calls	2%	21%	26%	45%	6%

n = 48 - % Consultants

About 40% of respondents believe service to be "satisfactory to good" and a similar percentage believe service to be "poor". Verbatim comments below describe to an extent improvements can be made in relation to field presence and support.

Valley	Verbatim Comments – Service Provided by Monsanto
Tandou	1 visit by Monsanto rep with Ag & Vet
Gwydir	They just don't want to know. Worse last season than the one before.
StGeorge	The problem is administrative. Each district must be given 30% INGARD, keeping in mind the maximum for the total industry of 500,000Ha. Last year some people had >30% on "non-sensitive" areas, others had less; St. George had less than it's share.
DDowns	Monsanto only contacted me when I complained about their product and then they spend the time covering themselves. They are never helpful.
Namoi	What service??? Feedback only was required on hectares allowed and requirements on the audit. Most of the time could not contact the reps as they are too busy. Very poor in field service for the product
CentQld	Monsanto still have no idea what's going on in our area.
Namoi	Useless from day one. If INGARD had been conventional chemistry the industry would have removed it out and not used it. If Monsanto had gone to stuff this product up they could not have done a better job at it. Monsanto release of INGARD will be studied as how not to release a product
Gwydir	When problems arouse with CS189i expression, little was done in the way of field data collection to try and establish the cause of the problem
Bourke	INGARD information only received from seed companies. Monsanto needs to get off their butts and do some work for the price we pay
Macquarie	Unfortunately they have the monopoly on the technology. God help them when they have competition
Gwydir	Local rep Roger was good but tech support from head office very poor – failed to return calls etc etc.
Emerald	Our Monsanto rep is based in Cairns so we don't see him a great deal.
Gwydir	I could not be sure that we have been told all we should have about INGARD, in particular the 189i variety over the past 3 years
MacIntyre	Overall support of INGARD by Monsanto at a user level appears to be almost non existent
Namoi	Who are Monsanto????

The table below describes how respondents rate **service provided by INGARD Technology Service Providers**.

Table 8.

Rating of Services Provided by Ingard Technology Service Providers

	Excellent	Good	Satisfactory	Poor	None received
	%	%	%	%	%
Level of support provided	9%	24%	36%	13%	18%
Quality of audit management provided	7%	20%	49%	11%	13%

n = 48 - % Consultants

This table indicates that 30% have a positive rating ("good" to "excellent"), whereas a comparatively small proportion believe services to be "poor". A substantial proportion claim to have received "none".

Valley	Verbatim Comments – Services Provided by INGARD Technology Service Providers
Namoi	Should pay CCA to give INGARD service. Resellers have a conflict of interest and it's obvious. This is not a chemical
Namoi	We are a TSP. Good!
DDowns	There are a few service providers who do not ensure pupae busting is (done), their audit in the end is poor or not existent. They phone the grower and ask him if he has done it instead of checking themselves and then we have to push the issue with the grower to get results.
Namoi	Very good people and were most helpful; better organized than Monsanto for service.
CentQld	No problems with back providers for my clients. I wouldn't say the same for other growers serviced by one provider.
Macquarie	Seed company involvement has been good.
Namoi	Don't see anyone very much at all
Namoi	Monsanto have stuffed this one up as well. Also R/D has been stuffed up by Monsanto
MacIntyre	Consultants do all the work with regard to INGARD audits, refuge management and monitoring etc and don't get paid for it

Reasons for Growing INGARD

An open question was asked relating to the reason for growing INGARD. Most respondents answered this question, with a few giving multiple reasons. They were asked to rank their responses ("Most important" – "second most important"). The table below details reasons for growing INGARD.

Table 9.

Reasons for Growing Ingard Cotton

	Environmental		IPM		Reduce Sprays		Better Heli Control		Look & See		Value		Yield		Total	
		%		%		%		%		%		%		%		%
Most Important Reason	28	74%	1	3%	4	11%	1	3%			4	11%			38	100%
2nd Most Important	4	14%	5	17%	13	45%	2	7%	3	10%	1	3%	1	3%	29	100%
3rd Most Important	2	9%	2	9%	3	14%	3	14%			9	41%	3	14%	22	100%

Count

Environmental reasons, spray reduction are the principal reasons which is similar to last years reasons. "Value" was also mentioned this year as a reason. Interestingly, "Value" was not mentioned last year.

Performance related reasons (Yield and Better Heli Control) is mentioned only 10 times of the total 89 records.

Comments were also made to **general requirements/effectiveness of the resistance management plan for INGARD**. The verbatim below describes the responses.

Valley	Verbatim Comments - Requirements/effectiveness of the resistance management plan for INGARD
DDowns	The % of INGARD allowed to be grown should be higher in more monoculture coastal areas
Gwydir	Should be based on grub growth more -- not just number/metre
Namoi	I believe there should be a separate IRMS for INGARD. Reduce amount of highly resistance products applied to INGARD, ie. Pyrethoids
Namoi	Need BT. Foliar sprays on INGARD. Need new different chemistry in Stage II and StageIII, when BT has run out. Aphids are going to be a problem.
Namoi	Satisfactory. More than 30% of total crop to INGARD would be nice if feasible.
StGeorge	It would be better if foliar Bt were not allowed on refuges
DDowns	We need more soft options so that we can remove Dipel from refuges
Namoi	Resistance strategy worked well. BT foliar should be pulled out from refugee's in stage I
CentQld	Prefer conventionally treated cotton to non sprayed refugia for moth production. Non sprayed areas produce too many moths. I can live with the requirements.

Macquarie	Fair and reasonable – needs to be enforced to ensure it is effective;majority do comply.
Gwydir	Plan approved to satisfy requirements of managing. Dilution of resistant individuals
Macquarie	Should we exclude foliar Bt's from refugia?
Bourke	Adequate and workable to this point in time
Macquarie	More emphasis needed on pupae destruction. The refuge should not become a nursery for helio early season.
Gwydir	Seems to be effective at the present time
Gwydir	Seems to be a strategy that will/is working. Important to keep focus upon IRMS for life of products
Emerald	With the newer softer chemicals we shouldn't need to use Bt sprays on INGARD refuges. Hopefully the IRMS will be changed to stop this.
Gwydir	Foliar Bt on unsprayed refuges is still a requirement considering the environmental sensitivity of some farms. To this end, maintenance of a soft program INGARD or conventional will be pivotal on the inclusion of Tracer in Stage II
Gwydir	The requirements are ok – I can't comment on the effectiveness of the resistance management plan for INGARD because I don't know if it is effective or not.
Gwydir	The system works well
MacIntyre	The proposed elimination of use of Bt products on sprayed refuges will be a challenge.
StGeorge	Think requirements and effectiveness of RMS for INGARD very satisfactory at present although should not be allowed to apply topical Bt sprays on INGARD refuges
Gwydir	Needs to be more flexible and need the ability to spray on eggs if large egg lay occurs
Emerald	As effective as can be with the 1 gene technology – spraying Bt's on INGARD cotton it should be removed from strategy.
Walgett	Requirements of the resistance management plan are relatively easy to follow. May be some more emphasis should be put on damage levels as I have found that threshold levels on larvae numbers >3mm could be extended if the damage levels were not excessive.
DDowns	On the Downs we would like more options re refuge for dryland, like irrigated, a good compromise at present

Pupae Control

Respondents were asked to rate the percent of INGARD and conventional cotton that received good pupae control.

The table below describes the findings.

Table 10.

Percent Respondents Indicating Percent of Crop Receiving Good Pupae Control

	50%	75%	100%
	%	%	%
Ingard		13%	87%
Conventional	2%	27%	71%

n = 48

Pupae in INGARD is similar to last year, whereas in conventional a considerable higher proportion received good pupae control (71% this year against 46% last year).

Number of Days of Effective Heliothis Control with INGARD varieties.

Respondents were asked to indicate for each INGARD variety the average number of days effective heliothis control (i.e. the time from planting up to when the crop required use of foliar insecticide for heliothis). The frequency table below details the responses.

Table 10.

Number of Days Effective Heliothis Control With Ingard Varieties
Days After Planting

	0-20	21-40	41-60	61-80	81-100	101-120	121-140	>140
	Count	Count	Count	Count	Count	Count	Count	Count
Sicala V2				1				
Sicot 189		1						
Siokra V16				1	1			
Sicala V2i		3	3	8	5		1	
Siokra L23i					1			
Siokra V15i		2	4	11	5		2	3
Sicot 189i	1	4	10	5	1	1		1
NuCOTN 37			1	1	11	8	3	3
DP5690rr/1				1				
Delta Pearl							1	1
DP 5690								1
Sicala V3i				1			1	
Siokra V16i			1		3			1
Sicot 289i				1		2	1	
Siokra V3RRi					1			
DP50B				1		1		
DP20B				1		1		
Nu Pearl				5	2	12	5	3
NuCotn 38						1		

Count

Of the varieties with the highest use frequency (Sicala V2i, Siokra V15i, Sicot 189i, NuCotn 37 and Nu Pearl) the best performing was Nu Pearl with 44% of records in the 101-120 day period. The worst performing was Sicot 189i with 43% of records in the 41-60 day period.

Valley	Verbatim Comments – Average Number of Days Effective Heliothis Control with INGARD Varieties
DDowns	All INGARD varieties performed very good to excellent except for 189i which was extremely poor
Bourke	V2i had poor efficiency for 7-10 days in mid December then returned
Namoi	189i was worse than v15i and v2i. V15i ran out so much earlier than preciously.

	Nu pearl clear out better
Namoi	Did not spray once for Heliothis.
DDowns	The Nu Pearl variety showed good efficiency till late February. Sicot 189 was generally extremely variable in efficiency. Some fields expressed poorly in early January and never recovered. Some fields expressed poorly in early January and faded in and out with regard to efficiency.
StGeorge	This is for planting on October 20th, first sprayed 189i on 2/12 and NC37 on 19/1. The NC37 was sprayed when it had 4.5 grubs/m but had consistently controlled up to 5.5 grubs/m until then. Under less pressure it would have lasted longer and in fact continued to work later.
DDowns	Sicot 189i never worked. Siokra V15iwas ok, much better than last year and this was probably due to low pressure. Nu pearl was the best performer and maintained lower numbers on or below threshold for nearly 4 months
CentQld	Had early pressure (which is normal) being experienced 189i would have been sprayed much earlier. I doubt that the Nu Pearl or NC37 would have been treated earlier
Bourke	189i the worst. Nupearl, V3i and V16i the best. V3i excellent
Namoi	INGARD worked well this year. Better than seen before. Pressure was up to medium and not heavy till INGARD out.
Namoi	V15i very variable, "shocking", not the same variety on the same farm, same fields Some don't yield between 1.5b/a to 3.2 on same farm. 1b/a difference in the same field. Eg V21 –3.1 b/a and V15 2.0b/a.
Macquarie	V2i total 11 fields = 734 ha. Average of 61.82 days from emergence to 1st spray. NuCotn 37 = 1 field = 66ha = average of 84 days
Bourke	189i did not have good efficacy this season and sustained considerable damage. V15i didn't appear to have good efficacy but defoliation showed early and yield ok. V2i and V16i both good through out season. V3i in particular and 289i showed excellent control and for a longer period into the season.
Macquarie	The new construct is way in front
Gwydir	One field did not get sprayed at all for heliothis. The V3Rri was pure seed so it had programmed sprays
Gwydir	Nu Pearl remained unsprayed until mid January, whereas 189i was sprayed in the first week of December
Emerald	All varieties handled the very low pressure in stage I and most of stage II without requiring heliothis spray
Lachlan	5690RRi was in a UNR field and thresholds were lower. The first heliothis spray was a foliar Bt (MVP2) chasing eggs. Generally better efficacy of INGARD in 5690RRi than V15i.
Gwydir	NuCotn 38 performed well followed by Siokra V15i. Sicot 189i performed worst.
Macquarie	V2i not effective at all
Gwydir	Nupearl was very impressive in comparison to the 189i
MacIntyre	Nucotn 37 and Nu Pearl seemed to give the largest control
StGeorge	Sicot 189i extremely disappointing
Walgett	The field of Nucotn 37 which only had 83 days of effective control suffered with cold shock after planting, black root rot and had 2 light hails storms through it
Namoi	Days of control varied from field ti field and from farm to farm but Deltapine varieties were far superior to CSD. Days given are minimum

Section 2. Economic Performance of INGARD Cotton for the 1999/2000 Season

Introduction

A total of 48 consultants responded with a total of 340 Conventional and INGARD field records. From the 340 fields 149 paired comparisons were analysed for yield.

The following economic assumptions are used:

- Average net price per bale of cotton: $460/bale. This figure was arrived at after discussions with several cotton merchants to determine the likely final returns per bale to farmers from the 1999/2000 crop.

- Application costs: aerial: $10.20/Ha average quoted price over the season for LV and ULV spraying.

- Application cost: ground: $9.00/Ha average quoted price over the season.

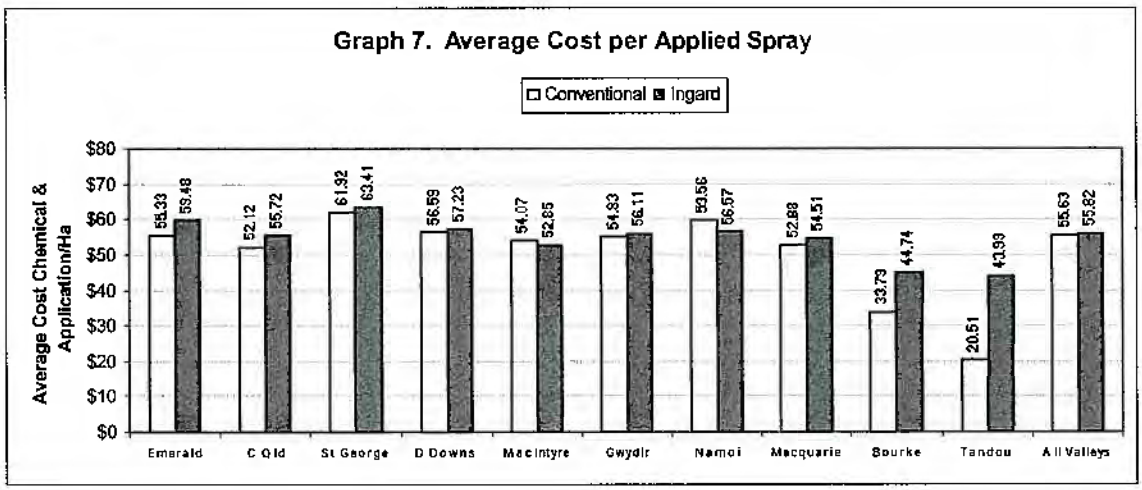
- Chemical costs: recommended retail prices valid for 1999/2000 season.

- Additional cost of INGARD seed: $7.00/Ha

- INGARD licence fee: $155.00/Ha

Average Cost per Spray

The graph below details the average cost per spray by valley.



On INGARD fields the average cost per spray/Ha was $55.82 compared to $55.63 for conventional fields. The average difference was $0.19/Ha.

This seasons difference is smaller than previous seasons:

1999/2000	$0.19/Ha
1998/1999	$3.97/Ha
1997/1998	$4.17/Ha
1996/1997	$7.34/Ha

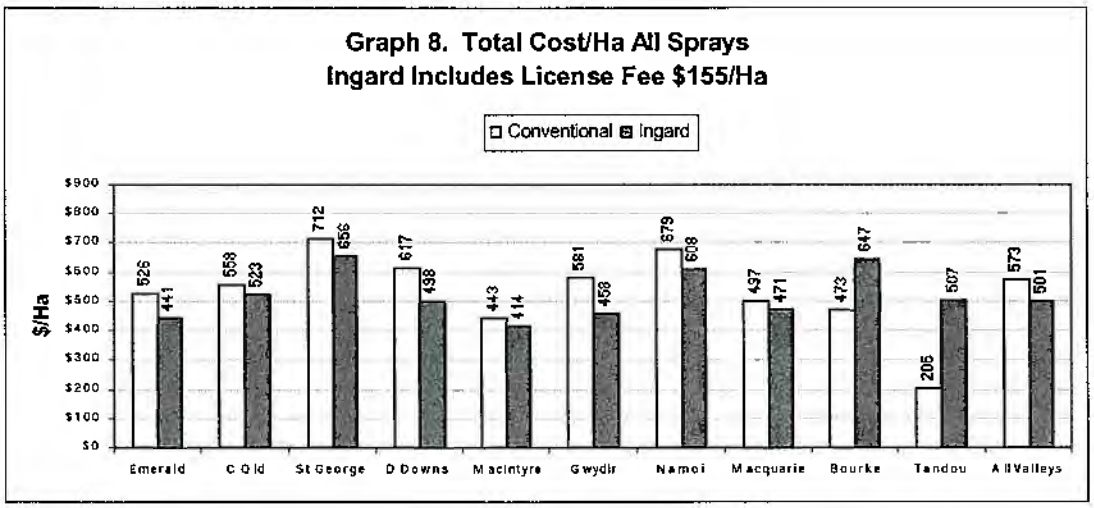
Lighter heliothis pressure resulting in fewer heliothis sprays in both INGARD and conventional is a likely reason for the smaller differential in 1999/2000 season.

In 1999/2000 season the cost for INGARD sprays is up by 0.5% over last year and in conventional is up by 7%. This increase can be attributed to use of more expensive chemical alternatives due to more restrictive endosulfan use guidelines early season.

Average Cost/Ha

Respondents provided comprehensive details of all insecticide sprays applied to the selected fields. For comparative purposes, the cost of INGARD licences of $155/Ha was added to the applied chemical costs on INGARD fields.

The graph below details the average cost/Ha of both INGARD and conventional



The costs/Ha on INGARD fields were on average $72 lower.

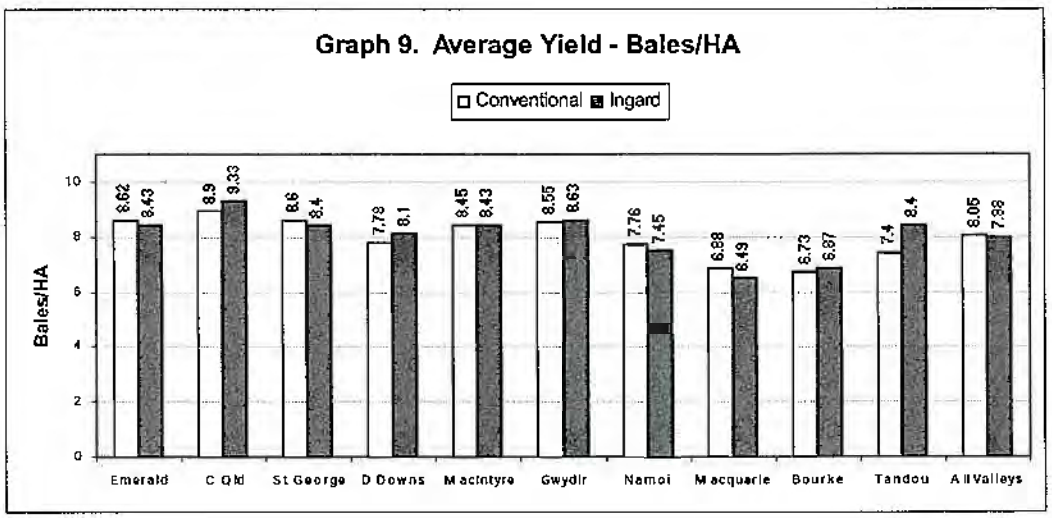
This compares to $90.74 last season,however this figure did not take into account a $7/Ha seed cost differential. When adjusted for this factor the cost difference of INGARD and conventional is 14% less/Ha in 1999/2000 when compared to 1998/1999 season.

Average Yield/Ha.

Significant yield variations were recorded in the survey.

An Independent Two-Sample T Test was conducted (means of yield by Valley and All Valleys). Results indicated that yield differences are not statistically significant. Results are detailed in the appendix.

The graph below details the results of the yield analysis.



Differences in all valleys are relatively small (<1% over all valleys), except Tandou where INGARD yielded 1 bale/ha better. Sample was however small. Compared to 1998/1999 season yield were up by 10-15% (average all valleys).

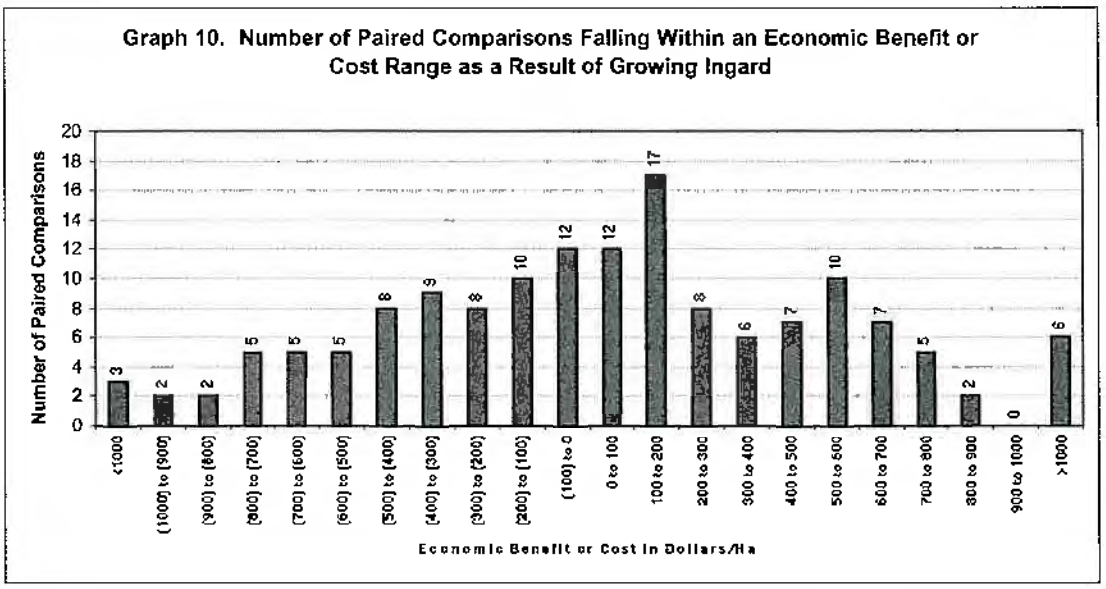
Economic Benefit/Cost of Growing INGARD.

Of the 149 Paired Comparisons included in the analysis 54% recorded some economic benefit from growing INGARD.

The results on individual comparisons are variable with extremes at either end of the scale.

The graph below details the number of Paired Comparisons falling within an economic benefit or cost range as a result of growing INGARD.

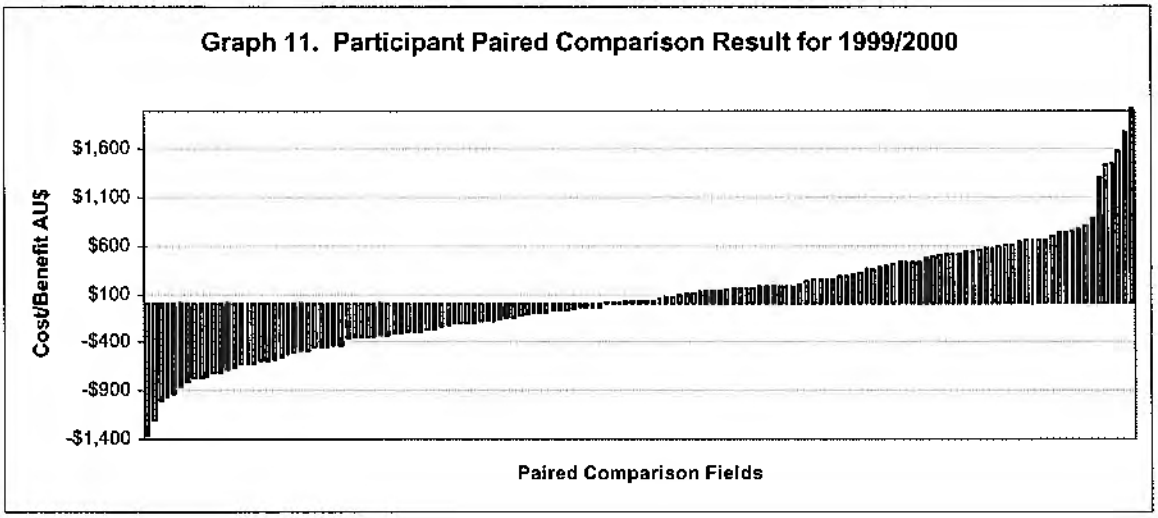
Graph 10. Number of Paired Comparisons Falling Within an Economic Benefit or Cost Range as a Result of Growing Ingard



19% of Paired comparisons recorded a net benefit of	$0 - $200/Ha
14%	$200 - $500/Ha
16%	$500 - $1000/Ha
4%	$>1000/Ha
15% of Paired Comparisons recorded a net cost of	$0 - $-200/Ha
18%	$-200 - $-500/Ha
13%	$-500 - $-1000/Ha
1%	$<-1000/Ha

The graph below details results for individual paired comparisons.

Graph 11. Participant Paired Comparison Result for 1999/2000



The shape of this graph is similar to the graph produced in 1998/1999 season. Due to yield variation economic benefit or cost seems equally divided between both extremes of the scale. Although calculated differences are large (between $<-1000.00/Ha and $>1000.00/Ha), no significance can be attributed to the findings. The data shows similar distribution between both extremes.

Valley	Verbatim Comments on Yield
MacIntyre	No difference in yield
Namoi	Heliothis pressure was high in worms but low in eggs. Can't give any reasons, only to say it appears to be heliothis.
Namoi	INGARD retained more fruit (1st potions) therefore yielded higher.
DDowns	Sometimes the INGARD cultivar is quite different in yield or disease tolerance to it's conventional parent.
StGeorge	INGARD (NC37) is effectively running with a zero threshold. Conventional uses 2vs/m which gives excellent commercial yields but may depress yield when control problems occur, normally late.
DDowns	INGARD 189i was similar to conventional 189
Namoi	Had to spray some more than others. Soil conditions related to particular varieties. Preparation of soil prior to planting i.e. wet winter / compaction etc
CentQld	Insects (Helio) caused the 0.5 bale/ac difference with conventional crops. Even INGARD crops lost some yield.
Bourke	Due to rain after defoliation some varieties picked better no difference between INGARD or conventional
Gwydir	Little difference existed in yield between the INGARD and conventional cotton. Insect control was good in both.

Macquarie	Spray delays on INGARD fields due to wind direction
Macquarie	Varietal only – ie V2i lower yielding this season
Emerald	Less insect damage early season in INGARD resulted in greater yield
Gwydir	Soil type variations relating to watering issues and ground preparation etc.
Lachlan	In INGARD growth was excessive compared to conventional variety and this did not finish as early as needed in the cool season. Yields on INGARD in the past have averaged higher than conventional varieties.
Gwydir	Unable to provide yield data on some fields because not ginned yet. But yield differences could come from pests, watering, nutrition, varieties etc.
Macquarie	Poor efficacy – spray delays
MacIntyre	In a low pressure year more consistent helio control was achieved in INGARD
Gwydir	Mite pressure in INGARD slightly higher earlier. Lower than expected yield in INGARD due to high thrips pressure early setting crop back significantly coupled with cold weather. Conventional planted earlier thus getting a better start before cool weather set in.
MacIntyre	Sioka V16, V15 and V15i different variety. Planting date INGARD suffered more cold conditions early
Emerald	Good expression of gene in INGARD fields. Less pressure and damage from heliothis. Both yields could have been better but both fields suffered bad hail damage.
Walgett	The yields between conventional and INGARD were comparable when taken over the whole farm.
DDowns	Mainly better insect, helio and tipworm + rough bollworm control (early) in INGARD especially in a low pressure season.

Valley	Verbatim Comments - General
StGeorge	Get rid of 189i. Do not release varieties like this again.
Tandau	A little cheaper would be equitable
Gwydir	Hopefully with CSD varieties now having gene in Delta Pine position they will express well
MacIntyre	Use full tool in sensitive areas.
Namoi	Unreliable-CSD varieties.
Gwydir	Efficiency variable. Justification of 1 licence fee by Monsanto, when product so variable? Lack of feedback to growers, in particular Re. Variability of product.
Namoi	Excellent. (189i?)
DDowns	The new generation INGARDs eg. v15i and Nu Pearl seem to be quite consistent in efficiency till the end of the season compared with Sicot 189i.
StGeorge	People sometimes ask me why other consultants haven't noticed the difference between DP and CSD (some have, lots have not) I say they don't spend enough time in the field and/or they haven't had pressure
DDowns	INGARD (Except 189i) works ok under low heliothis pressure. In areas were we have no cropping to the east of our INGARD we have lower insect pressure due to very low migration onto the cotton crops and I find INGARD to be very good value in these situations. It is generally poor value in the centre of a cotton growing area as the higher heliothis pressure forces is over threshold too quickly and it suffers too much damage
Namoi	Would like to see more work done on minor pests/ major population specially in crops where more or a few insecticides are applied. There are a lot more insects in the crop when no insecticides are applied ie green vegie bugs
CentQld	Essential tool is CQ production, whether it is resistance could cripple the industry in a couple of years, that could still happen.
Macquarie	INGARD crops seem to yield better than conventional due to high resistance population from early squaring – the INGARD seemed to offer more protection

Appendix

For graphs see Excel file.

T Test Darling Downs

Group Statistics

	Gen. mod. variety	N	Mean	Std. Deviation	Std. Error Mean
Yield in Bales/Ha	Conventional	14	7.0286	1.6744	.4475
	Ingard	13	7.5692	1.5740	.4365

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Yield in Bales/Ha	Equal variances assumed	.114	.738	-.863	25	.396	-.5407	.6266	-1.8313	.7499
	Equal variances not assumed			-.865	24.994	.395	-.5407	.6252	-1.8282	.7469

T Test MacIntyre

Group Statistics

	Gen. mod. variety	N	Mean	Std. Deviation	Std. Error Mean
Yield in Bales/Ha	Conventional	16	8.8088	.5041	.1260
	Ingard	17	8.5090	1.5123	.3668

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Yield in Bales/Ha	Equal variances assumed	4.120	.051	.754	31	.457	.2997	.3976	-.5113	1.1108
	Equal variances not assumed			.773	19.709	.449	.2997	.3878	-.5100	1.1095

T Test Gwydir

Group Statistics

	Gen. mod. variety	N	Mean	Std. Deviation	Std. Error Mean
Yield in Bales/Ha	Conventional	19	8.5926	2.1470	.4926
	Ingard	20	8.6775	2.2762	.5090

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Yield in Bales/Ha	Equal variances assumed	.019	.890	-.120	37	.905	-8.487E-02	.7094	-1.5222	1.3524
	Equal variances not assumed			-.120	36.999	.905	-8.487E-02	.7083	-1.5200	1.3502

T Test Namoi

Group Statistics

	Gen. mod. variety	N	Mean	Std. Deviation	Std. Error Mean
Yield in Bales/Ha	Conventional	21	7.6700	.9953	.2172
	Ingard	18	7.2483	1.8097	.4266

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Yield in Bales/Ha	Equal variances assumed	14.625	.000	.919	37	.364	.4217	.4588	-.5080	1.3513
	Equal variances not assumed			.881	25.501	.387	.4217	.4787	-.5632	1.4065

T Test Macquarie

Group Statistics

	Gen. mod. variety	N	Mean	Std. Deviation	Std. Error Mean
Yield in Bales/Ha	Conventional	12	6.6800	1.1737	.3388
	Ingard	15	6.4927	1.2278	.3170

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Yield in Bales/Ha	Equal variances assumed	.034	.854	.830	25	.414	.3873	.4664	-.5733	1.3479
	Equal variances not assumed			.835	24.149	.412	.3873	.4640	-.5700	1.3446