If you are participating in the presentations this year, please provide a written report and a copy of your final report presentation by 31 October. If not, please provide a written report by 30 September.

Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: **CMSE 1213**

Project Title: Comparison of Fibre Quality from Round and Conventional Modules

Project Commencement Date: 01/01/2012 **Project Completion Date:** 30/06/2012

CRDC Program: Value Chain

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Part 3 – Final Report Guide

(The points below are to be used as a guideline when completing your final report.)

Background

1. Outline the background to the project.

The John Deere (JD) 7760 harvester, which has been described as a hybrid of a cotton harvester and an oversized round hay baler, has on board module building capacity which produces round modules. These modules are covered with an engineered polyethylene film that both protects the seed cotton and provides compressive force to maintain the module density. These modules can have a diameter of 2.44 metres and a width of 2.39 metres and depending on moisture content can weigh 2,000-2,600 kg's which produce an average of 4 bales. In contrast a harvester with a basket system, typically build conventional (traditional) modules that are 2.4 x 3.0 x 12 metres and can weigh 12-16,000 kg's which produce an average of 24 bales.

The introduction of the JD 7760 harvester to the Australian cotton industry in 2008, has led to the harvester being taken up very quickly. The main reasons for the Australian cotton industry embracing this new technology is that these machines can harvest cotton virtually non-stop, which makes it very productive, and it requires less labour and capital to harvest as it dispenses with the requirement of module building.

There were around 80 of the JD 7760 harvesters operational during the 2010/11 cotton season and these harvested around 44% of the 4.2 million bale crop. It has been suggested that there were over 200 of these harvesters operational during the 2011/12 cotton season harvesting around 75% of the estimated 5.4 million bale crop. This is the largest percentage of any crop harvested by the JD 7760 harvester worldwide, with indications that there will be even more of these harvesters operational in Australia during the forthcoming cotton season.

There have been some suggestions that the quality of the cotton lint harvested by the JD 7760 harvester during the 2011/12 season was more variable and trashier than fibre harvested by the traditional basket machines which produce the conventional modules. Figure 1 highlights the variability in colour as experienced by a classing facility during the 2011/12 season.

Figure 1. Variability of Classing Grade for bales from module made up from six round modules.

Aside from the variability in colour, the cotton was also trashier, with leaf/trash grades of 4 and lower, when compared to cotton lint from conventional modules. A leaf grade of 4 leads to a discount of $US20-25 per bale over base grade (3 leaf) cotton for the grower.

The suggested reasons for the difference are;

- There is limited in-field blending with round modules; the seed cotton in one round module can represent only the section of the field that may have more leaf than other sections, e.g. the head ditch compared with the tail drain.
- The JD 7760 harvester is able to start earlier in the morning and harvest longer into the night where moisture (dew) is present. Moisture at harvesting may have a significant effect on leaf/trash content.
- Lack of air flow during formation of round module as compared to the basket harvester may contribute to more leaf / trash content.
- Moisture content of round modules may increase the occurrence of staining particularly if modules are not ginned for some time.
- Ginning systems are not designed to provide blending.

In order to compare the quality from these two harvesting systems it is necessary to harvest a single field utilising both harvesting methods.

Objectives

2. List the project objectives and the extent to which these have been achieved.

The broad objectives of the project are to:

- Compare the quality of cotton harvested by the John Deere 7760 harvester to that harvested by basket harvesters that produce traditional Conventional modules.
- Provide feedback to various industry segments, i.e. ginners, classers and merchants on the results achieved.

Methods

3. Detail the methodology and justify the methodology used. Include any discoveries in methods that may benefit other related research.

To ensure that environmental variables are accounted for, trials were conducted in the Gwydir Valley (central) and the Lachlan Valley (south) growing areas. In order that direct comparisons can be made, rows of the test fields were harvested alternatively by the JD 7760 and basket system harvesters, which are both spindle pickers. In other words it is proposed that the JD 7760 will harvest seed cotton from the first six rows then skip four rows and then harvest the next six rows until the field has been completed. The basket harvester, which is a four row harvester, will then harvest the rows that were not picked by the JD 7760.

The test fields were harvested at the same time of day, with moisture continually recorded to ensure that it stays below 12%. The modules produced, both the Conventional and Round Modules were staged in the sequence that they were produced to allow for direct comparison and to highlight issues such as infield variation or leaf defoliation etc. Round and Conventional modules were ginned at the same gin within a similar timeframe to ensure that there is no weathering effect applied to part of the sample modules.

The subsequent bales were classed (both visual and objective) by Australian Classing Services in Wee Waa, which is a BMP certified classing facility, with samples forwarded to CSIRO MSE for further testing with the results analysed by the researcher.

Outcomes

4. Describe how the project's outputs will contribute to the planned outcomes identified in the project application. Describe the planned outcomes achieved to date.

4.1 Details of planting, variety, defoliation and ginning

The trial in the Gwydir Valley was conducted in Boomi on Cambooya farm, with the trial being conducted on two fields;

- Field 8 which is 50.5 hectares was planted on 17/10/2011, with Sicot 74 BRF. This field was first defoliated on 12/4/2012 with a mixture of leaf defoliant (0.1L/ha Dropp liquid) and a boll opener (0.5 L/ha Prep) with l L/ha of D.C.Tron. It was defoliated again on 20/4/2012 with 0.1 L/ha Dropp, 2 L/ha of Prep, and 1 L/ha of D.C.Tron.
- Field 9 which is 62.99 hectares was planted on 18/10/2011, with Sicot 71 BRF. This field was first defoliated on 29/3/2012 with a mixture of leaf defoliant (0.1L/ha Dropp liquid) and a boll opener (0.5 L/ha Prep) with l L/ha of D.C.Tron. It was defoliated again on 09/4/2012 with 0.1 L/ha Dropp, 2 L/ha of Prep, and 1 L/ha of D.C.Tron.

The harvesters used during this trial were grower owned and operated. The JD 7760 harvested seed cotton from the first six rows skipped four rows and harvested the next six rows until the field was completed. The JD 9967 basket harvester, which is a four row harvester, harvested seed cotton from the rows that were not harvested by the JD 7760. Seed cotton harvested by the JD 7760 was dumped directly into the module builder when the basket was full. The Round, completed modules were dropped in the field and picked up by a mast-type tractor mounted implement that holds the module with the axis parallel to the tractor rear axle and staged together in the sequence that they were produced. The modules were placed to allow easy access for the equipment and trucks, on a smooth, even and firm compact surface that allows water to drain away. Round modules were staged in a "Sausage" (end to end) method with a gap between modules to ensure water can run off down the ends.

Field 8 was harvested on 17/4/2012 and 18/4/2012, with Field 9 harvested on 19/4/2012 and 20/4/2012, using a JD 7760 and a JD 9976 basket harvester. Figure 2 depicts the harvesting and staging of the round and conventional modules.

Figure 2. Harvesting and Staging of modules at Cambooya Farm in Boomi

The modules were ginned under standard commercial conditions at Brighann ginning in Moree. This gin is a modern Lummus gin equipped with 4 x 170 gin stands, with each gin stand followed by Super Jet cleaners and two Sentinel Lint cleaners. Moisture of the incoming modules where monitored with the Vomax Model 851M cotton module moisture meter and at the bale with the Vomax 851 B cotton bale moisture meter. The modules were ginned sequentially with the modules from Field 8 ginned on 8/5/2012 and the modules from Field 9 ginned on 8/5/2012 and 9/5/2012.

Table 1 gives a breakdown of the number of modules and the resultant number of bales.

Table 1- Breakdown of modules and bales from Boomi Trial

Field	Modules Type	Number of Modules	Module Weight in kg	Number of bales	Gin Turnout in %
8	Round	66	161,640	291	43.9
8	Conventional	8	106,860	197	43.2
9	Round	85	208,280	349	40.4
9	Conventional	11	141,420	237	40.0

The trial in the Lachlan Valley was conducted in Hillston on Merrowie Station with the trial being conducted on two fields;

- Field K3 which is 42 hectares was planted on 08/10/2011, with Sicot 74 BRF. This field was first defoliated on 15/4/2012 with a mixture of leaf defoliant (0.18 L/ha Dropp Ultramax) and a boll opener (0. 8 L/ha Prep) and 0.5 L/ha canopy oil. It was defoliated again on 11/5/2012 with 0.12 L/ha Dropp Ultramax and 2.8 L/ha Prep.
- Field K4 which is 22 hectares and planted on 08/10/2011with Sicot 74 BRF. This field was first defoliated on 25/4/2012 with a mixture of leaf defoliant (0.18 L/ha of Dropp Ultramax) and a boll opener (0.8 L/ha of Prep) and 0.5 L/ha of canopy oil. The field was defoliated again on 11/5/2012 with 0.12 L/ha of Dropp Ultramax and 2.8 L/ha of Prep.

The harvesters used during this trial were contractor owned and operated. As cotton was planted with a 12 metre planter, the JD 7760 harvested seed cotton from the first twelve rows then skipped twelve rows and harvested the next twelve rows until the field was completed. The Case 2555 and Case 2155 basket harvesters, which are four row harvesters, harvested seed cotton from the rows that were not harvested by the JD 7760. Seed cotton harvested by the Case 2555 and 2155 was dumped into tractor drawn boll buggies which unloaded the seed cotton into the module builders. As was the case with the trials in Boomi, the Round, completed modules were dropped in the field and picked up by a mast-type tractor mounted implement and staged together in the sequence that they were produced. The modules were placed to allow easy access for the equipment and trucks, on a smooth, even and firm compact surface that allows water to drain away. Round modules were staged in a "Sausage" (end to end) method with a gap between modules to ensure water can run off down the ends.

Field K3 was harvested on 22/5/2012 and 23/5/2012, with Field K4 harvested on 23/5/2012 and 24/5/2012. Figure 3 depicts the harvesting and staging of the Round and Conventional modules.

Figure 3. Harvesting and Staging of modules at Merrowie Station in Hillston

The modules were ginned under standard commercial conditions at the Australian Cotton Ginning Company in Hillston, which is a joint venture between Namoi Cotton Co operative and the Twynam Agricultural Group. This gin is a modern Continental gin equipped with 3 x 181 gin stands, with each gin stand followed by Super Jet cleaners and two 24D Lint cleaners. Moisture of the incoming modules were tested using hand held moisture measuring equipment and at the bale with the Vomax 851 B cotton bale moisture meter. The modules were ginned sequentially with the modules from Field K3 ginned on 16/8/2012 and the modules from Field K4 ginned on 17/8/2012.

Table 2 gives a breakdown of the number of modules and the resultant number of bales.

Table 2- Breakdown of modules and bales from Hillston Trial

Field	Module Type	Number of Modules	Module Weight in kg	Number of bales	Gin Turnout in %
K3	Round	58	130,540	241	41.7
K3	Conventional	10	129,480	240	41.9
K4	Round	30	68,220	130	43.5
K4	Conventional	5	65,720	126	43.6

4.2 Turnout

There were varieties used in these 2 trials, Sicot 74BRF and Sicot 71BRF, which are currently the most popular Upland varieties used in Australia. When one looks at the turnout achieved (Table 1) in the trial conducted at Boomi one will note that, irrespective of the harvesting method, Sicot 74BRF on average has 3.4% higher turnout than Sicot 71 BRF. The variety in the trial conducted in Hillston was Sicot 74

BRF and the results (Table 2) show some variability in the turnout which is field related and not related to the harvesting method.

4.3 Quality

All the HVI results, including Micronaire, staple length, length uniformity and staple strength for all the 1811 bales were received by CMSE. Samples from the Boomi trial were tested on a HVI 1000 and the samples from Hillston, which were smaller in size, were tested on a HVI 900. Unfortunately ACS misplaced the samples from Hillston and thus only the samples from Boomi were forwarded to CMSE. The number of neps and seed-coat neps (SCN), short fibre content (SFC) as well as trash and dust were determined by an Uster Technologies Advanced Fibre Information System (AFIS PRO). Fibre fineness was determined using the Cottonscan instrument, which determines fibre fineness (linear density) by measuring the length of fibre in an accurately weighed specimen of fibre snippets. Combined with an independently measured Micronaire value from the HVI, the average fibre maturity was also calculated using Lord's empirical relationship between Micronaire, maturity ratio and fineness.

A summary of the results for the trial in Boomi is represented in Table 3 (a, b) & 4 (a, b) with the results for Hillston represented in Table 5 (a, b) & 6 (a, b).

Table 3a. Overall quality of bales produced from Field 8, harvested with Conventional modules

	Length inches	UI %	Strength cN/tex	Mic µg/inch	Colour Rd	Colour +b	Nep/ gram	SFC(w) %	Fineness mtex	Maturity Ratio	SCN/ gram	Dust/[1] gram	Trash/[2] gram
Avg	1.22	84	33.2	4.7	83.2	7.7	233	7.5	209	0.87	22	162	31
Min	1.19	82	31.7	4.4	80.9	7.2	209	6.1	196	0.81	12	110	19
Max	1.25	85	35.4	4.9	84.1	8.0	273	8.9	220	0.94	29	251	58
Std	0.01	0.45	0.52	0.52	0.46	0.14	14.89	0.66	6.87	0.03	4.31	33.9	9.03

[1]. Refers to dust particles per gram of <500µm
[2]. Refers to trash particles per gram of >500µm

Table 3b. Overall quality of bales produced from Field 8, harvested with Round modules

	Length inches	UI %	Strength cN/tex	Mic µg/inch	Colour Rd	Colour +b	Nep/ gram	SFC(w) %	Fineness mtex	Maturity Ratio	SCN/ gram	Dust/[1] gram	Trash/[2] gram
Avg	1.22	84	31.1	4.7	83.9	7.6	236	6.5	201	0.91	21	176	38
Min	1.18	82	28.9	4.6	80.6	7.1	217	5.6	194	0.87	14	107	22
Max	1.25	85	34.7	4.9	85.1	8.2	254	7.3	211	0.95	35	218	56
Std	0.45	0.39	0.98	0.06	0.45	0.15	11.29	0.42	4.66	0.03	5.51	37.45	9.48

[1]. Refers to dust particles per gram of <500µm
[2]. Refers to trash particles per gram of >500µm

Table 4a. Overall quality of bales produced from Field 9, harvested with Conventional modules

	Length inches	UI %	Strength cN/tex	Mic µg/inch	Colour Rd	Colour +b	Nep/ gram	SFC(w) %	Fineness mtex	Maturity Ratio	SCN/ gram	Dust/[1] gram	Trash/[2] gram
Avg	1.20	83	30.1	4.5	82.6	7.6	276	7.0	201	0.86	21	244	45
Min	1.17	81	28.0	4.2	80.1	6.9	243	6.1	193	0.79	16	154	26
Max	1.23	84	33.5	4.7	84.3	8.2	304	8.1	213	0.90	33	504	86
Std	0.01	0.46	1.24	0.09	0.74	0.23	16.95	0.48	4.75	0.03	3.70	68.43	14.03

[1]. Refers to dust particles per gram of <500µm
[2]. Refers to trash particles per gram of >500µm

Table 4b. Overall quality of bales produced from Field 9, harvested with Round modules

	Length inches	UI %	Strength cN/tex	Mic µg/inch	Colour Rd	Colour +b	Nep/ gram	SFC(w) %	Fineness mtex	Maturity Ratio	SCN/ gram	Dust/[1] gram	Trash/[2] gram
Avg	1.20	83	29.8	4.3	83.4	7.7	274	6.9	201	0.80	21	204	60
Min	1.15	81	28.2	3.9	75.8	6.9	224	5.5	192	0.73	10	143	21
Max	1.23	85	32.3	4.7	85.2	8.8	316	9.1	212	0.88	31	336	67
Std	0.02	0.58	0.62	0.12	0.94	0.26	20.02	0.69	5.35	0.03	4.28	44.55	10.9

[1]. Refers to dust particles per gram of <500µm
[2]. Refers to trash particles per gram of >500µm

The samples were also visually classed by a cotton classer to assess the colour (colour grade), visible trash (leaf grade) and preparation (degree of smoothness or roughness of the cotton sample) according to the current grades established by the United States Department of Agriculture (USDA). The assigned grades for the samples varied between 21-2 and 21-3, irrespective of harvesting method. Thus all the cotton is considered Strict Middling cotton which is above (i.e. better than) the current Australian base grade of 31-3 (Middling).

Table 5a. Overall quality of bales produced from Field K3, harvested with Conventional modules

	Length inches	UI %	Strength cN/tex	Mic µg/inch	Colour Rd	Colour +b
Avg	1.19	81	28.3	3.7	82.0	6.8
Min	1.14	79	27.2	3.6	78.8	5.6
Max	1.23	83	30.3	4.0	83.8	7.4
Std	0.01	0.62	0.46	0.08	0.64	0.31

Table 5b. Overall quality of bales produced from Field K3, harvested with Round modules

	Length inches	UI %	Strength cN/tex	Mic µg/inch	Colour Rd	Colour +b
Avg	1.20	80	29.6	3.7	82.2	6.6
Min	1.16	78	27.5	3.5	78.1	5.5
Max	1.25	83	31.9	4.0	84.4	7.6
Std	0.02	0.91	1.00	0.10	1.02	0.40

Table 6a. Overall quality of bales produced from Field K4, harvested with Conventional modules

	Length inches	UI %	Strength cN/tex	Mic µg/inch	Colour Rd	Colour +b
Avg	1.20	81	30.2	3.9	82.6	6.6
Min	1.17	79	28.0	3.7	80.3	6.3
Max	1.23	82	32.7	4.1	84.6	7.2
Std	0.02	1.15	1.05	0.10	1.25	0.10

Table 6b. Overall quality of bales produced from Field K4, harvested with Round modules

	Length inches	UI %	Strength cN/tex	Mic µg/inch	Colour Rd	Colour +b
Avg	1.19	81	29.5	3.8	83.4	6.5
Min	1.14	78	27.1	3.6	79.8	5.8
Max	1.25	82	32.1	4.1	84.8	7.1
Std	0.01	0.55	0.30	0.15	0.90	0.05

The samples were also visually classed by a cotton classer to assess the colour, visible trash and preparation. The assigned grade for all the samples was 21-2, irrespective of harvesting method. Thus all the cotton is considered Strict Middling cotton which is above (i.e. better than) the current Australian base grade of 31-3 (Middling).

The results from the two trials conducted on four fields in Boomi and Hillston show that there were no differences in the grade of the cotton fibre that was harvested by the JD 7760 spindle harvester and spindle harvesters with basket systems. In actual in both cases the grade was above the Australian base grade which would result in the two growers obtaining a premium for their cotton.

As the return for the grower is also related to the length, Micronaire and strength the results were further analysed to determine if there were any significant differences in these fibre properties due to the cotton being harvested by the JD 7760 and basket systems.

As can be seen from Figure 4, there were no significant differences in fibre length of the four fields that were harvested. It is however apparent that the fibre length of the Sicot 74BRF that was grown in Boomi was longer and more uniform than the same variety grown in Hillston.

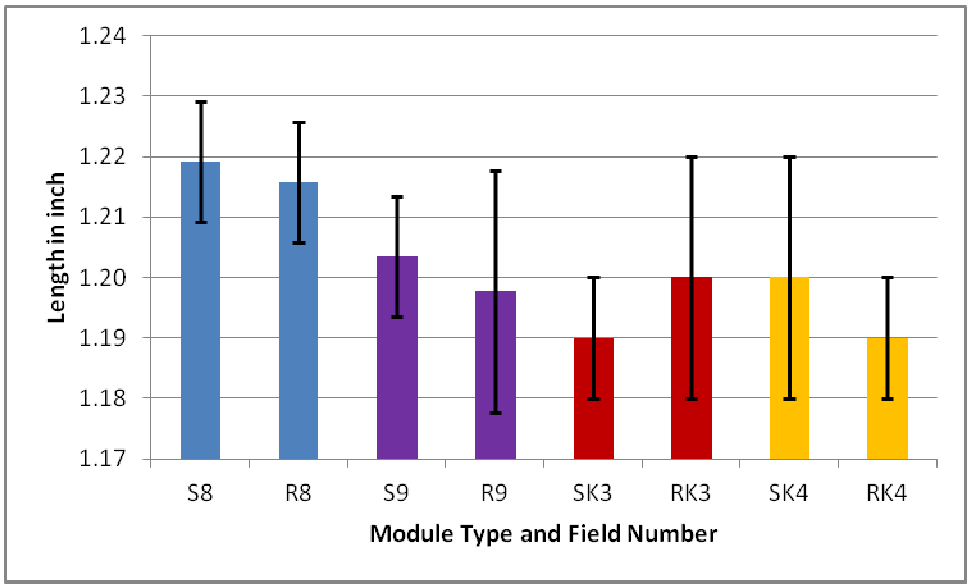

Figure 4. Length and standard deviation by module type and field number (R = Round module and S= Conventional module)

As can be seen from Figure 5, there were no significant differences in Micronaire of the four fields that were harvested. It is however apparent that the Micronaire values of the cotton grown in Boomi was coarser than the cotton grown in Hillston.

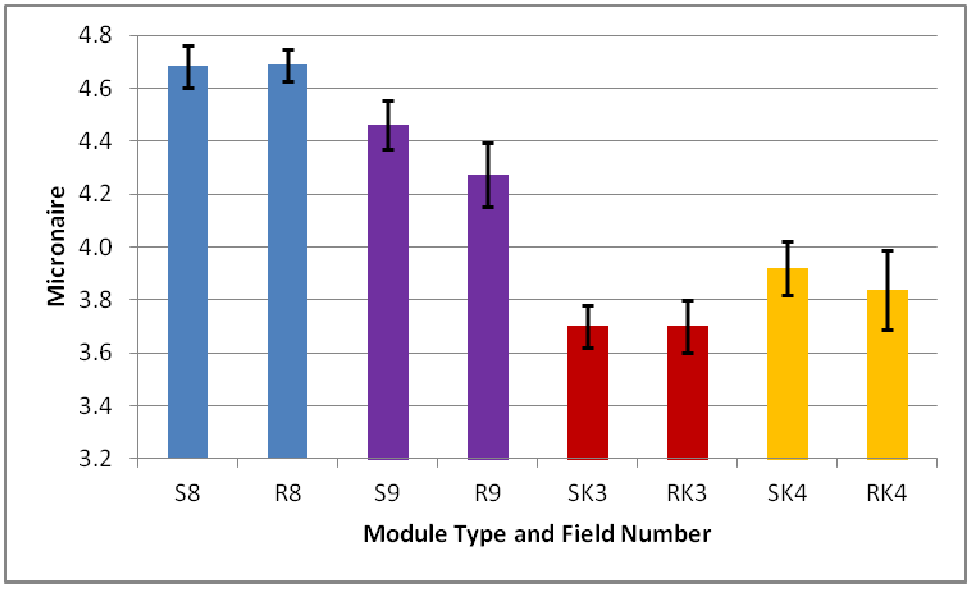

Figure 5. Micronaire and standard deviation by module type and field number. (R = Round module and S= Conventional module)

As can be seen from Figure 6, there were some significant differences in strength of the four fields that were harvested. The cotton harvested in Field 8 by the basket harvesters produced on average a stronger fibre of 2.1 cN/tex than cotton harvested by the JD 7760, although there were no significant differences of the cotton harvested from Field 9. A similar situation is found in Hillston where Field K4 that was harvested by basket harvesters on average produced a stronger fibre of 0.7 cN/tex than cotton harvested by the JD 7760. Although there were no significant differences of the cotton harvested from Field K3, it is interesting to note that the cotton harvested by the JD 7760 is in actual fact on average stronger than the cotton harvested by the basket harvesters.

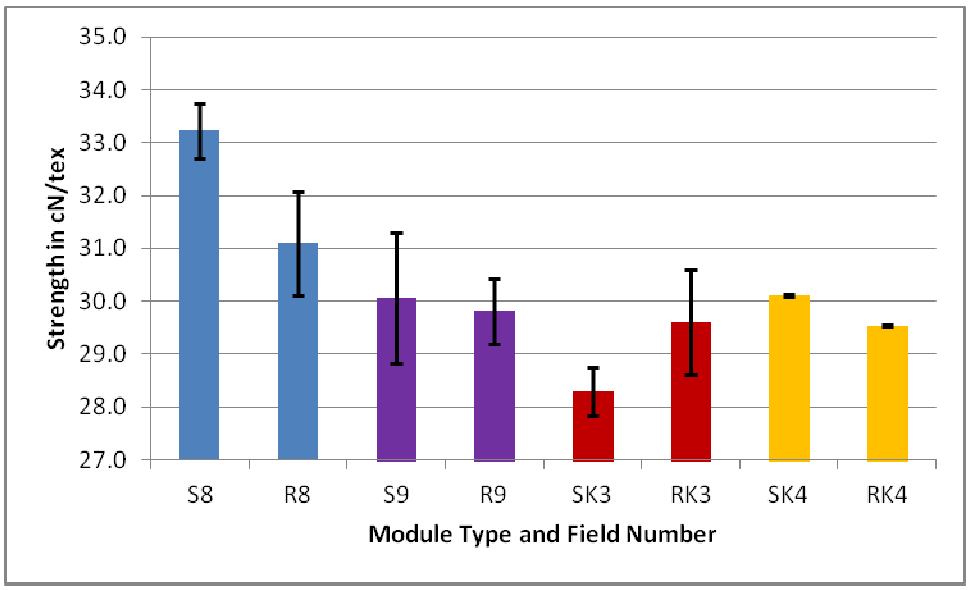

Figure 6. Strength and standard deviation by module type and field number. (R = Round module and S= Conventional module)

The differences in the strength results could be due to the natural variability of the cotton fibre and is within the accepted tolerance limit of +/- 2 cN/tex. for HVI strength.

In conclusion the results from the two trials conducted in Boomi and Hillston show that, taking into account the natural variability of the cotton fibre, that there were no significant differences in the turnout and quality of the cotton fibre that was harvested by the JD 7760 spindle harvester and spindle harvesters with basket systems.

5. Please describe any:-
   a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.);
   b) other information developed from research (eg discoveries in methodology, equipment design, etc.); and
   c) required changes to the Intellectual Property register.

N/A

Conclusion

6. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. What are the take home messages?

This study, which was conducted in the Gwydir Valley (central) and the Lachlan Valley (south) growing areas, has shown that there were no significant differences in the quality of cotton harvested by the JD 7760 and basket system spindle harvesters. However in order to achieve this outcome it is imperative to assure that the following steps are adhered to;

- Do not harvest cotton if moisture is above 12%
- Stage modules in the order that they were produced
- Place modules on a smooth, even and firm compact surface
- Leave a gap between modules to allow for water runoff.

Extension Opportunities

7. Detail a plan for the activities or other steps that may be taken:
   (a) to further develop or to exploit the project technology.
   (b) for the future presentation and dissemination of the project outcomes.
   (c) for future research.
8. A. List the publications arising from the research project and/or a publication plan. (NB: Where possible, please provide a copy of any publication/s)

   An overview of this work will be produced in a forthcoming edition of the Australian Cotton Grower. It is also envisaged that presentations on this work will be made to industry bodies such as the Australian Cotton Shippers Association, Australian Cotton Ginners Association, Cotton Classers Association of Australia and Cotton Australia.

The draft BMP Handbook for Harvesting has been compiled and released to the industry for feedback before formalising.

This study has shown that when everything is conducted as described in this report there are no differences in the cotton quality from the two systems. It may be important for the industry to quantify what the causes will be if cotton was harvested at various moisture percentages and not staged and ginned in sequence.

B. Have you developed any online resources and what is the website address?

N/A

Part 4 – Final Report Executive Summary

Provide a one page Summary of your research that is not commercial in confidence, and that can be published on the World Wide Web. Explain the main outcomes of the research and provide contact details for more information. It is important that the Executive Summary highlights concisely the key outputs from the project and, when they are adopted, what this will mean to the cotton industry.

The John Deere (JD) 7760 harvester has been taken up very quickly by the Australian cotton industry as these machines can harvest cotton virtually non-stop, making them very productive, requiring little labour as it dispenses with the requirement of module building. There were over 200 of these harvesters operational during the 2011/12 cotton season harvesting around 75% of the crop, which is the largest percentage of any crop harvested by the JD 7760 harvester worldwide.

There have been some suggestions that the quality of the cotton lint harvested by the JD 7760 harvester during the 2011/12 season was more variable and trashier than fibre harvested by the traditional basket machines which produce the conventional modules.

In order to compare the quality from these two harvesting systems it was necessary to harvest a single field utilising both harvesting methods. To ensure that environmental variables are accounted for, trials were conducted in the Gwydir Valley (central) and the Lachlan Valley (south) growing areas.

The test fields were harvested at the same time of day, with moisture continually recorded to ensure that it stays below 12%. The Conventional and Round modules produced were staged in the sequence that they were produced to allow for direct comparison and to highlight issues such as infield variation or leaf defoliation etc. Round and Conventional modules were ginned at the same gin within a similar timeframe to ensure that there is no weathering effect applied to part of the sample modules.

This trial which was conducted in Boomi and Hillston has shown that there were no significant differences in the quality of cotton harvested by the JD 7760 and basket system spindle harvesters. However, this can only be achieved if seed cotton is not harvested when moisture is above 12%, that the Round modules are staged and transported to the gin and processed in the sequence that they were produced, that the modules are placed on a smooth, even and firm compact surface leaving a gap between modules to allow for water runoff and ensure that the wrap is not damaged.