Cotton Catchment Communities CRC

FINAL REPORT

(due within 3 months on completion of project)

Part 1 - Summary Details

Cotton CRC Project Number: 4.03.03

Project Title: Ginning (Modified Lint Cleaner)

Project Commencement Date: 7/2006 **Project Completion Date:** 6/2009

Cotton CRC Program: Value Chain

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Part 3 – Final Report Guide (due within 3 months on completion of project)

Background

There is evidence the nep and short fibre content of Australian cotton is too high compared with other growths of similar quality[1]. These characteristics are a result of the productive and efficient harvest and ginning practices utilized by the Australian industry but the problem is exacerbated by current lint cleaner design. In particular, the combination of lint cleaner elements, i.e. the feed rollers and feed bar, grid bars and the doffing brush around the lint cleaner saw, and the transfer ratios between these elements affect fibre quality.

The broad aim of this project was to adapt and re-engineer the widely used fixed batt saw lint cleaner to reduce short fibre and nep content. The main adaption proposed at the start of this project was an auto-levelling system for the lint cleaner feed such that the weight of fibre transferred onto the saw would always be constant. Typically the unit is powered by a single 30kW motor, which regardless of the rate of fibre flow runs at full speed.

Currently in lint cleaners there are no sensors to regulate fibre flow or draft settings. Excessive speed and large draft or combing ratios, i.e. a high saw surface speed to feed roller speed, increase damage to the lint. Implementing an auto-levelling system requires sensors and variable speed devices to maintain a consistent flow of material. It has been shown in previous work[2] that low combing ratios reduced short fibre content and improved fibre length and length uniformity. Introducing constancy to the batt weight requires a greater degree of control of this combing ratio effect. Thus, the initial focus in this project was to test the possibility of sensor control of mechanical elements, in particular the feed mechanism, in the standard fixed batt saw lint cleaner and CSIRO's Modified Lint Cleaner (MLC). As well as testing fibre and batt weight variation through the lint cleaner machine, work also concentrated on the application of additional mechanical elements, e.g. a combed grid bar heel, designed to even the transfer of fibre onto the saw.

Once achieved, the objective was then to link this mechanical control to moisture control systems being developed as part of New Ginning Technology for Australian Cotton: Part II (Moisture & Contamination) project.

However, observations from flow and mass sensors applied to a commercial gin in the first year of the project, showed the delivery of fibre from the gin by the current system was too fast and too uneven to be controlled. Work on the project subsequently defaulted to proving and extending the veracity of the MLC to industry, with a view to commercialising the MLC technology.

Alternate fibre conveyor designs to give a more even feed and allow time for the batt to be levelled and humidified were drawn up towards the end of this project. These designs require greater intervention to the ginning system than was originally foreseen in this project. A new project around these designs was proposed to the CRDC in a FRP in January 2009.

[1] Gordon, S. G., Van der Sluijs, M. H. J. and Prins, M. W., 'Quality Issues for Australian Cotton from the Mill Perspective', Report to Australian Cotton Industry, Australian Cotton CRC (pub), 55 pp, Jul 2004

[2] Gordon, S. G. and Bagshaw, K. M., Improved quality of ginned Australian cotton, Final Report to the CRDC for project no. CTFT9, 50 pp, Sep. 2006.

Project Objectives

The stated objectives of the project and whether they were achieved are listed in Table I below.

Table I – Project objectives, milestones, performance indicators and achievement

Objective	No.	Milestone	Performance Indicator	Achieved
Fit inverter control to current modified cleaner in order to facilitate a constant low combing ratio	1	Test displacement/ proximity sensors to facilitate auto-sensing capabilities of lint cleaner feedworks	Demonstration that sensors accurately predict fibre weight through lint cleaner feed system	**No – Fibre throughput is measured but inverter control not fitted because measured batt weight is too variable**
		Design and retro-fit auto-levelling system to industrial lint cleaner that modulates feed rate according to weight of fibre in feedworks before combing	Successful trials of auto-levelling system in commercial gin. Success is ascribed when speed of feedworks automatically varies according to weight of fibre in the feedworks	**No – see above.** **New fibre conveyor designs proposed.**
Inverter control system is designed in modular form to allow addition of other gin production tools such as the proposed moisture replenishing system being investigated as part of project no. 4.03.04.	2	Moisture replenishing module is integrated with the modified lint cleaner control module	Sucessful implementation of moisture measurement and replenishing controls from same PC interface as the modified lint cleaner controls	**New fibre conveyor designs produced.** **Addition of moisture gives improved fibre properties.**
Prove and extend the veracity of claims about moisture management and the MLC	*2a*	*Controlled laboratory and industrial trials show MLC gives improved fibre properties*	*Results published in peer review journal and EOI document sent to US gin companies*	**Yes**
Reduce SFC and nep levels in Australian cotton through modification of ginning processes	3		SFC and nep levels are lowered on average by 25% and 15% respectively.	**Yes – Length and SFC are significantly improved by the MLC.** **Nep levels are improved by the MLC and the addition of moisture.**

Methods
Work on this project was conducted largely during the Narrabri gin seasons of 2007, 2008 and 2009. Gin seasons in these years were shorter than usual due to drought and typically ran from late April through to late June.

Proposed auto-levelling of a fixed batt saw lint cleaner
At the start of this project it was proposed that control of fibre input onto the lint cleaner saw would require monitoring of the input feed using a light switch on or around the lint cleaner condenser as per Figure 1, followed by a calibrated proximity sensor to measure the mass (density) of lint passing through the lint cleaner feed rollers as per Figure 2.

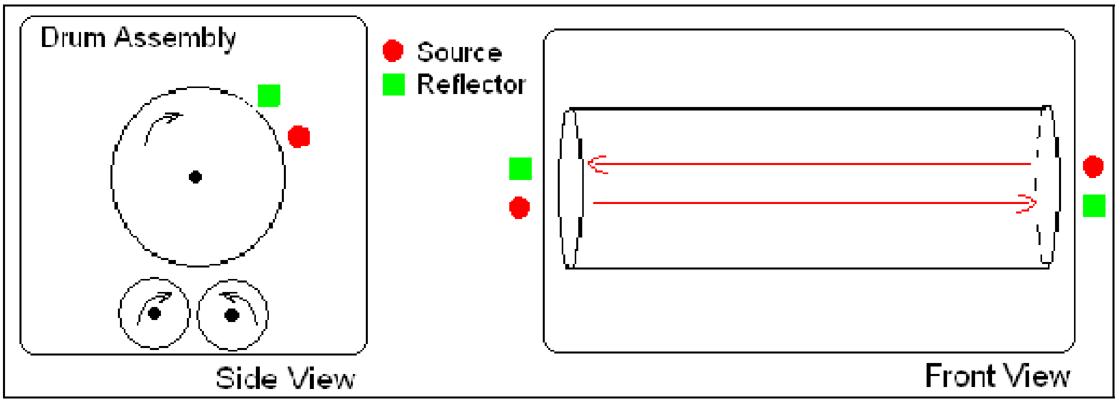

Figure 1 – Input feed monitoring with for example a photo-electric reflex switch fixed to the lint cleaner condenser.

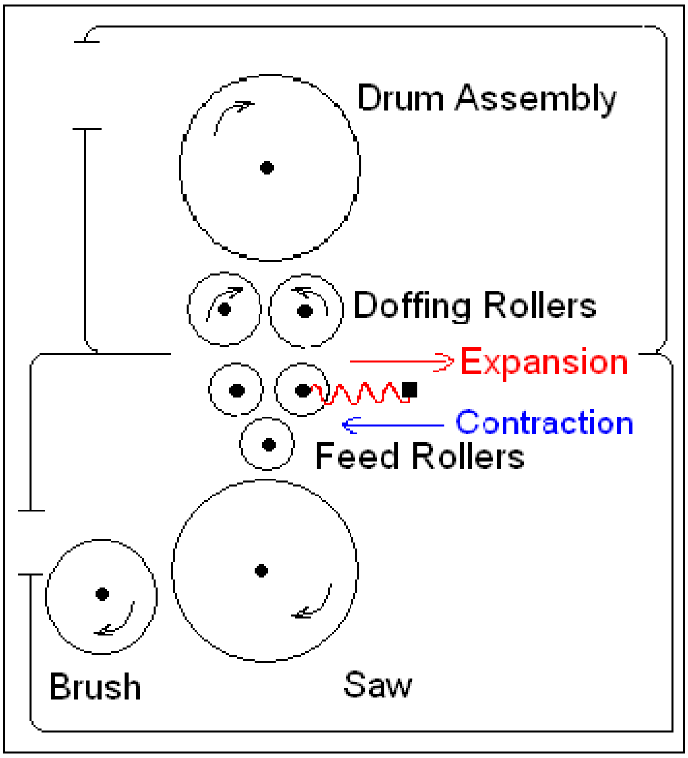

Figure 2 – lint flow (volume) measurement using for example a calibrated spring and proximity sensor fixed to the lint cleaner feed rollers.

According to this system when cotton is detected the variable speed system (the inverter) of the lint cleaner would operate. When lint is not detected for an extended period, perhaps seconds, the doffing and feed rollers would decelerate to an idle speed. Then, as the feed resumes the roller speed would accelerate back to processing speeds. To ensure constancy in the batt mass or density and thereby combing ratio, a proximity sensor would be used to measure the displacement of a doffing or feed roller spring. A calibrated spring integrated with the sensor would allow the calculation of lint volumes passing between the rollers to be determined at any given moment (see Figure 3).

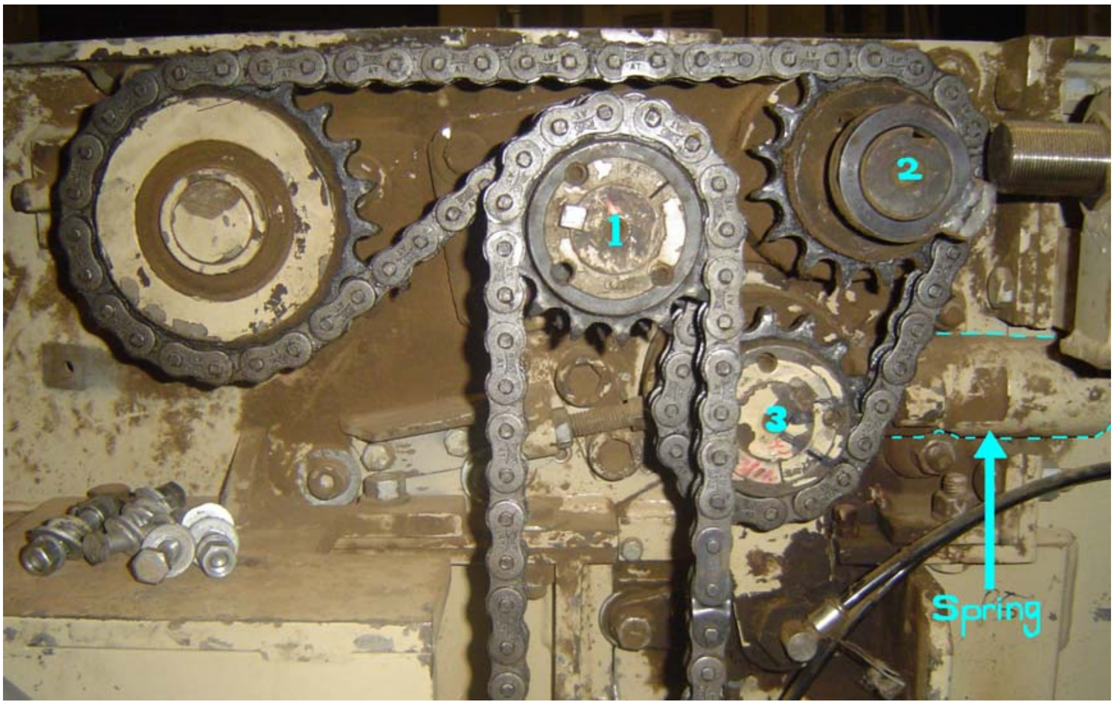

Figure 3 – Photo showing proposed location of calibrated spring to the feed roller (3).

Mass and air-flow measurements
Measurements of air flow and mass movement were made in 2007 in order to determine the mass variations in the lint cleaner batt weight or density to be corrected by the sensor-controlled inverter as per Figures 1 and 2. Measurements were made using a purpose made capacitor and an off-the-shelf hot wire anemometer fitted into the ducting of Auscott Narrabri's Gin Number 8 between the gin stand and lint cleaner. The capacitor forms the basis of the moisture meter built as part of New Ginning Technology for Australian Cotton: Part II (Moisture & Contamination) project. Mass and air-flow rates were monitored for week long periods during normal gin production.

Calibration of the capacitor mass value was conducted by setting different masses of equilibrated, static cotton between the capacitor plates and recording the capacitance values (in pico-Farads (pF)). Important in this calibration was the sensitivity of the sensor rather than its absolute accuracy.

Addition of new mechanical elements to the MLC
In addition to monitoring fibre mass and airflow new combing grid bars heels were designed, built and fitted to the first lint cleaner behind gin stand number 4 in Gin Number 8 at the Auscott Narrabri. The concept and initial laboratory trials of these grid bars are described in PART A in the Final Report to the CRDC for Project No. CTFT9.

The Auscott gin was visited in September 2006 to measure the lint cleaner dimensions and discuss with ginners the best method of fixing the new grid bars to the saw. Figures 4 and 5 show technical drawings of the combing grid bar heel and the method with which it is fixed relative to the saw. The grid bars were constructed in CMSE's workshop at Belmont and fitted by Auscott engineers to the second and third grid bar positions on the first lint cleaners in Gin Number 8. Pin height to the saw was set at 1/16 inches in accordance with the stated grid bar heel setting (Continental Eagle 24D Manual).

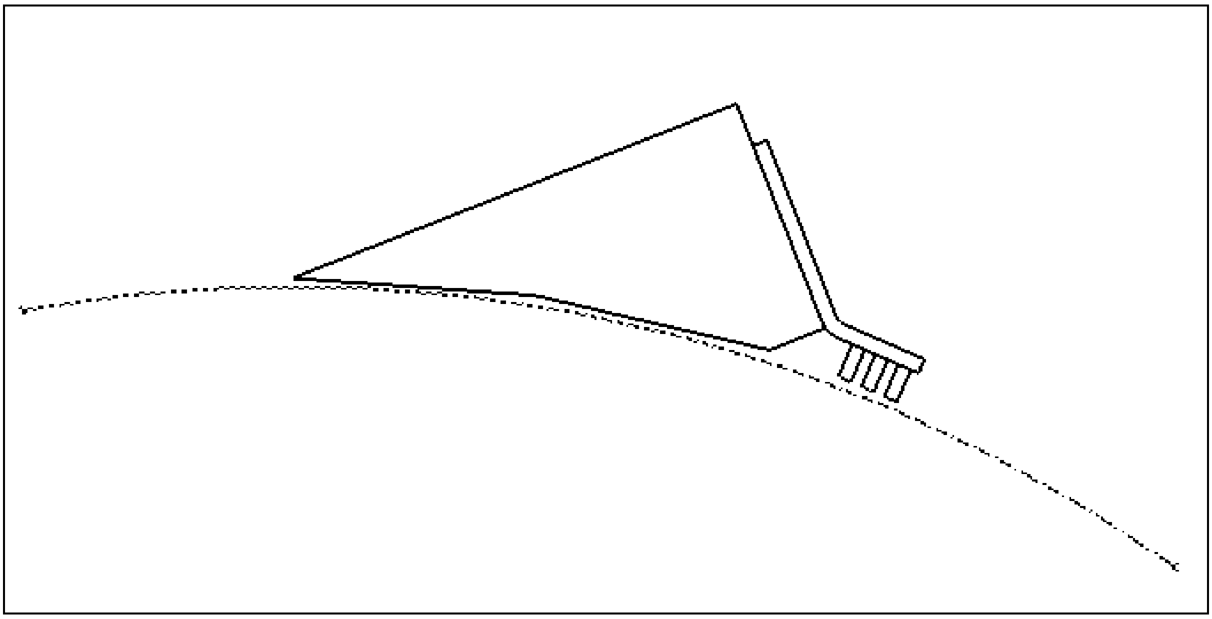

Figure 4 – Scale diagram showing side profile of CSIRO's combed heel grid bar and position to the saw. Combed heel grid bars were fitted to the second and third grid bar positions.

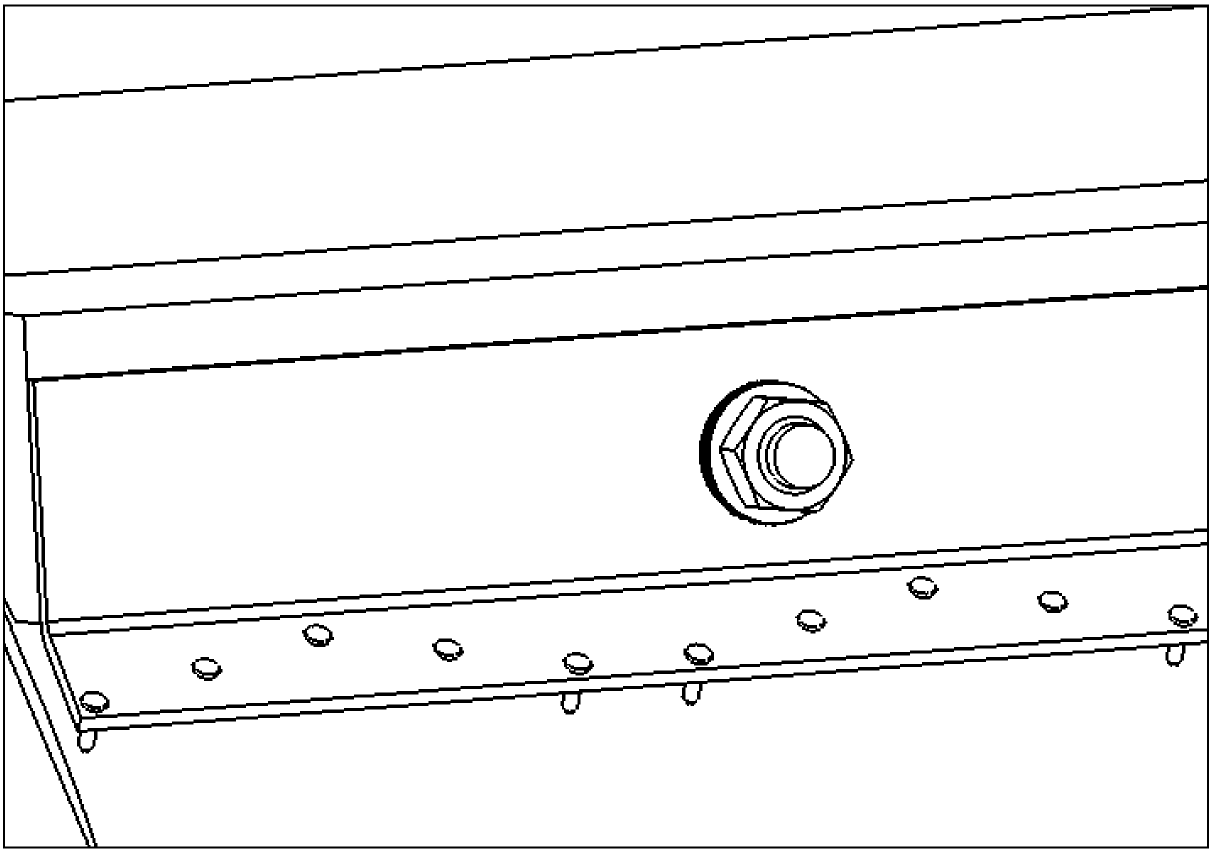

Figure 5 – Scale diagram showing combing heel pin profile and method of fastening grid bar to saw chassis.

Lint Cleaner and MLC Laboratory Trials

Laboratory trials are described in the paper entitled 'The effect of working elements in the fixed batt saw lint cleaner on ginned fibre properties' published in the Beltwide Cotton Conference proceedings of 2007. In this work the effects of lint cleaner elements, i.e. the feed roller, grid bars and brush, on three different Australian cottons; 'long & fine', 'standard' and 'short & coarse' were tested. A full copy of the paper appears in Appendix 1.

In further trials the MLC concept and the interaction of moisture with LC variables was tested on the same laboratory system used in these trials. Table II lists the variables tested in these trials.

Table II – Laboratory trials comparing fibre quality after treatments such as batt density, moisture equilibrium, saw speed, and combing ratio are applied

Variable		**Settings**
Cotton	3	Short & coarse, standard Australian and long & fine
Saw speeds	2	685 m/min (726 rpm) & 500 m/min (530 rpm)
Combing ratios	2 (5)	23 (95 rpm feed – 29.8 m/min) & 50 (44 rpm feed – 13.7 m/min)
Batt densities	2	100 gsm & 200 gsm – manually prepared
Conditions	2	wet (30^{o} & > 70%RH) & dry (30^{o}C & <30% RH)
Replicates	8	8 test replicates
Test replicates	5	5 AFIS replicates x 8 test replicates = 40 replicates/sample
Total tests (exc. test reps.)	**>400**	

Fibre samples were tested on an AFIS instrument using standard procedures. Simple statistics were calculated using MS Excel and analyses of variance to test the effect of each LC variable were performed using Minitab 15. Note comprehensive analyses of these test data will appear in a peer review paper currently in preparation. A brief overview of the results is given in the Results and Outcomes section of this report.

MLC Industrial Trials

Controlled industrial experiments testing the performance of the MLC at different combing ratios (CR) and the standard lint cleaner (SLC) with combing grid bar heels (GBH) were conducted during the ginning seasons of 2007 and 2008. During these trials gin feed and saw speed and lint cleaner saw speed were kept constant. Performance was measured in terms of fibre damage and efficiency in terms of running ability, i.e. ease of continuous operation with the MLC settings and elements in place.

The trials were conducted when large runs of the same cotton (same grower and paddock) were available. Trials in 2007 were limited to one grower and one variety. No pre LC samples were collected for these trials. Trials in 2008 were conducted over several days on a wide variety of cultivars. Tables III and IV list the time, date, the number of samples and the cotton used in trials during 2007 and 2008 respectively.

Table III – Treatments and samples tested during 2007 gin season

Date	**Time**	**Cotton**	**Lint Cleaner treatments**	**Combing ratio**	**No. samples**
Mid-June	12 hours	Sicot 71BR	MLC	19, 23, 27 & 30	10/CR = 40
			SLC	27	40
			SLC w/ GBH	27	40
					120 - total

Table IV – Treatments and samples tested during 2008 gin season

Date	Time	Cotton	Lint Cleaner treatments	Combing ratio	No. samples
Mid-May	12 hours	Sicot 71BR	MLC	19, 23, 27 & 30	
	6 days	Var. CSD	SLC	19 & 27	
			SLC w/ GBH	27	
June	12 hours	Var	MLC	19, 23, 27 & 30	
	2 days		SLC	19 & 27	
			SLC w/ GBH	27	
					400 - total

Fibre samples were tested on HVI and AFIS instruments using standard procedures. Simple statistics were calculated and plotted using MS Excel. Confidence intervals (95%) were calculated and applied to each mean to enable the significance of each treatment to be seen in each Figure.

Expression of Interest to commercialise the MLC

A targeted expression of interest (EOI) document has been drafted to provide parties interested in commercialising the MLC with information about the invention and the CSIRO commercialising process – see Appendix 2.

Results and Outcomes

Fit inverter control to current modified cleaner in order to facilitate a constant low combing ratio

Figure 6 below is given as evidence for not pursuing the application of an auto-levelling system to the standard fixed batt saw lint-cleaner. Short-term auto-levelling systems currently used within the textile processing industry, e.g. in the drawing process, contend with drafts in the range of 4 to 9, and thus short and long term mass variances largely within 20% of the input mass. Moreover, in these systems the inertial mass of the system and the mass of the input are relatively small compared to the inverter size.

Figure 6 shows the input fibre mass into the LC condenser and feed system can vary in excess of 50% within seconds, making application of a sensor controlled inverter without first condensing and mechanically balancing the feed problematic.

New conveyor

Plans for a buffer hopper and feed trunk capable of delivering a more even and thicker batt to the lint cleaner saw have been proposed to the CRDC. Aside from auto-levelling capabilities another advantage of collecting and evenly re-feeding fibre through a buffer hopper mechanically, rather than with air, is that it avoids large volumes of air being drawn through the fibre prior to cleaning which in turn provides the opportunity to condition the fibre, i.e. make it more resilient, before it is cleaned (and damaged) by the lint cleaner saw.

Further details of this proposal can be found in Appendices 3 and 4.

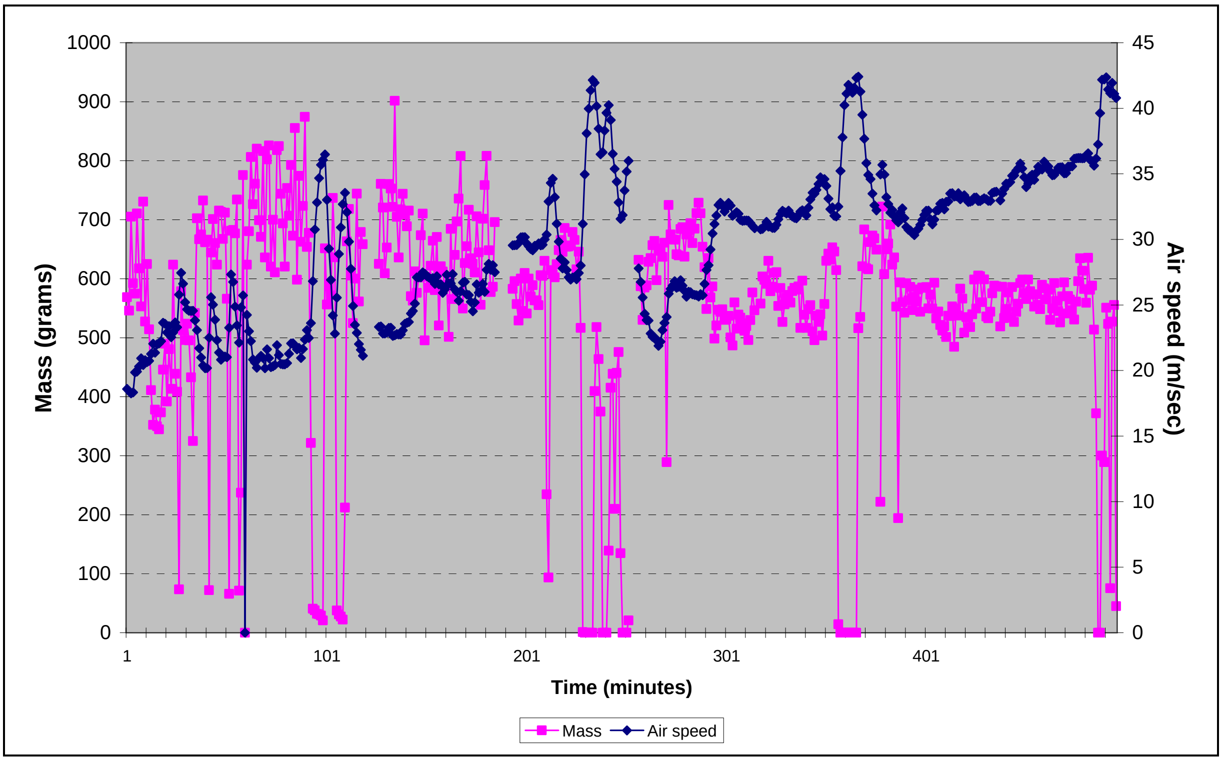

Figure 6 – Graph showing the uneven feed (in grams) and variable air speed through the duct connecting the gin stand to the first lint cleaner

Additional mechanical elements for the MLC

The effect of adding combing grid bar heels to grid bar positions two and three on fibre quality are described in the discussion on the MLC industrial trials.

MLC Laboratory Trials

The laboratory trial set-up used in these trials is largely described in the Beltwide Cotton Conference in Appendix 1. In these trials the effects from LC variables, e.g. batt density, combing ratio etc were partitioned from the large experimental error associated with the complex mechanical interactions at play in the LC. It is noted the three cottons used in these trials had all previously been subject to one or two standard lint cleaners before baling. The nep levels recorded in these trials are therefore higher than would normally be expected.

Figures 7 to 9 show the effects of cotton type, moisture, saw speed and combing ratio on nep levels. Figure 7 shows long, fine fibre will nep more than short, coarse fibre and that moisture provides some protection against nep formation in the lint cleaner. The protection given to fibre equilibrated at higher moisture contents is greater in long, fine fibre (~13% less neps in long, fine cotton conditioned to 6.5% w/w cf. with cotton conditioned to 5% w/w) than for shorter, coarser fibre (~3%). The largest interaction between these variables is associated with moisture content.

Figure 8 shows similar relative effects for saw speed, i.e. high saw speed creates more neps than a slow saw speed. Slow LC saw speeds produced around 10% less neps in long, fine cotton than high speeds. The effect was reduced for shorter, coarser fibre.

Figure 9 shows lower combing ratios create fewer neps. Long, fine cotton subject to low combing ratios (23) had around 6% fewer neps than cotton combed at a very high ratio (50).

The cumulative affect of these variables is much less than their individual contribution; the total reduction in nep count in long, fine cotton, as a result of subjecting moist cotton to low combing ratios and saw speeds, is around 20%. It is noted the batt density of the samples tested here was 50% lighter than the batt density typically passed through a SLC. The responses to the variables and interactions measured here are therefore diminished.

Analyses of variance for these variables on nep creation (see Table V) confirm the significance of the visual results. Cotton-type, saw speed, combing ratio and moisture content all had significant effects on nep content. Significant interactions occurred between cotton-type and saw speed and cotton-type and moisture content. A significant three-way interaction also occurred between these variables. The interactions illustrate the potential of long, fine cotton to nep when it is subject to fast saw speeds and dry conditions. These interactions diminish for shorter, coarser cottons. The effect of combing ratio was muted by the lighter weight batt used in these experiments.

Similar effects were also seen for average fibre length and SFC. Trash results were affected by cotton-type, saw speed and combing ratio but not moisture content.

Table V - Analysis of variance for nep including select interactions. Sources of variation include cotton (3), saw speed (2), combing ratio (2), moisture equilibrium (condition) (2) and 40 (8 x 5) test replicates.

Source	**DF**	**Seq. SS**	**Adj. SS**	**Adj. MS**	**F-value**	**Prob.**
Cotton	2	19076741	19076741	9538370	6565.66	***0.000***
Saw speed	1	108588	108588	108588	74.75	***0.000***
Combing ratio	1	88897	88897	88897	61.19	***0.000***
Condition	1	200508	200508	200508	138.02	***0.000***
Physical replicates	7	9515	9515	1359	0.94	*0.478*
Test replicates	4	2514	2514	629	0.43	*0.785*
Cotton*Saw speed	2	65208	65208	32604	22.44	***0.000***
Cotton*Combing ratio	2	6605	6605	3303	2.27	*0.104*
Cotton*Condition	2	113051	113051	56526	38.91	***0.000***
Saw speed*Combing ratio	1	5463	5463	5463	3.76	*0.053*
Saw speed*Condition	1	17052	17052	17052	11.74	***0.001***
Combing ratio*Condition	1	3293	3293	3293	2.27	*0.133*
Cotton*SSpeed*CRatio	2	3246	3246	1623	1.12	*0.328*
Cotton*SSpeed*Condition	2	11860	11860	5930	4.08	***0.017***
Cotton*CRatio*Condition	2	8041	8041	4021	2.77	*0.063*
Error	928	1348167	1348167	1453		
Total	959	21068749				

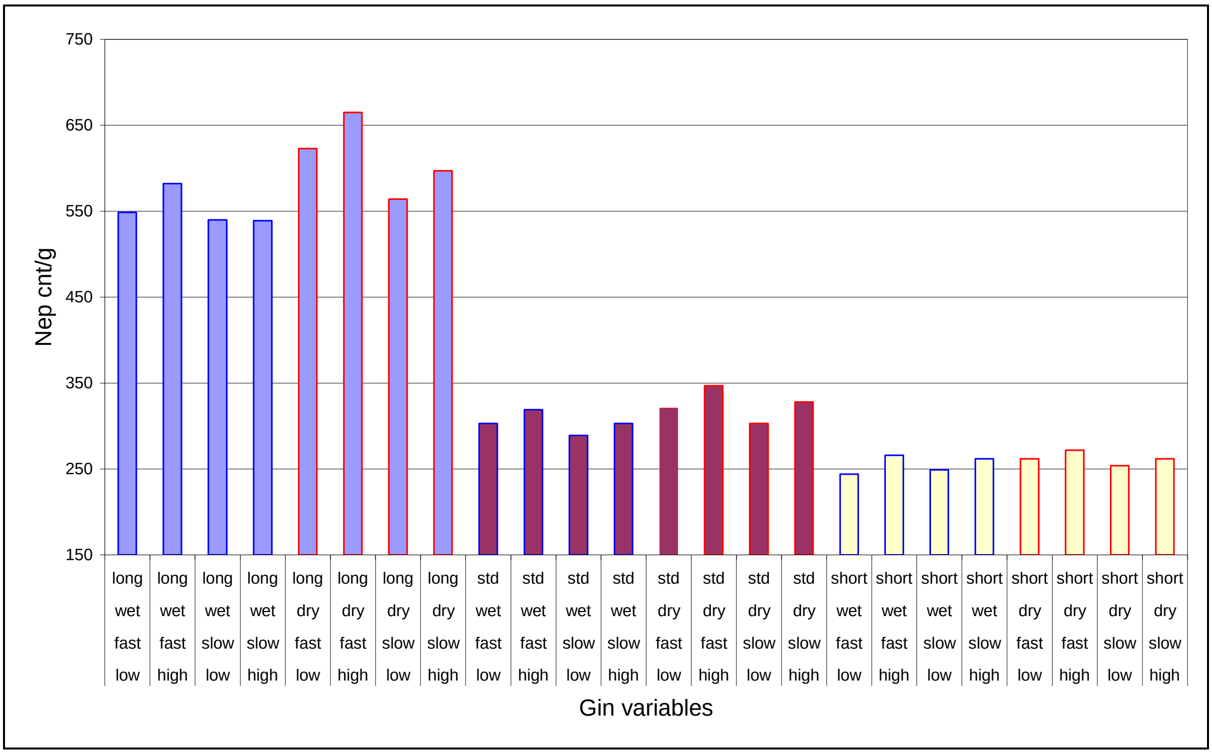

Figure 7 – Nep counts indicated on the basis of cotton type and wet or dry treatment; blue = 'long & fine' cotton, maroon = 'standard' cotton and beige = 'short & coarse' cotton. Blue outline indicates wet treatment, red outline indicates dry treatment. Other variables also listed on x-axis but not highlighted.

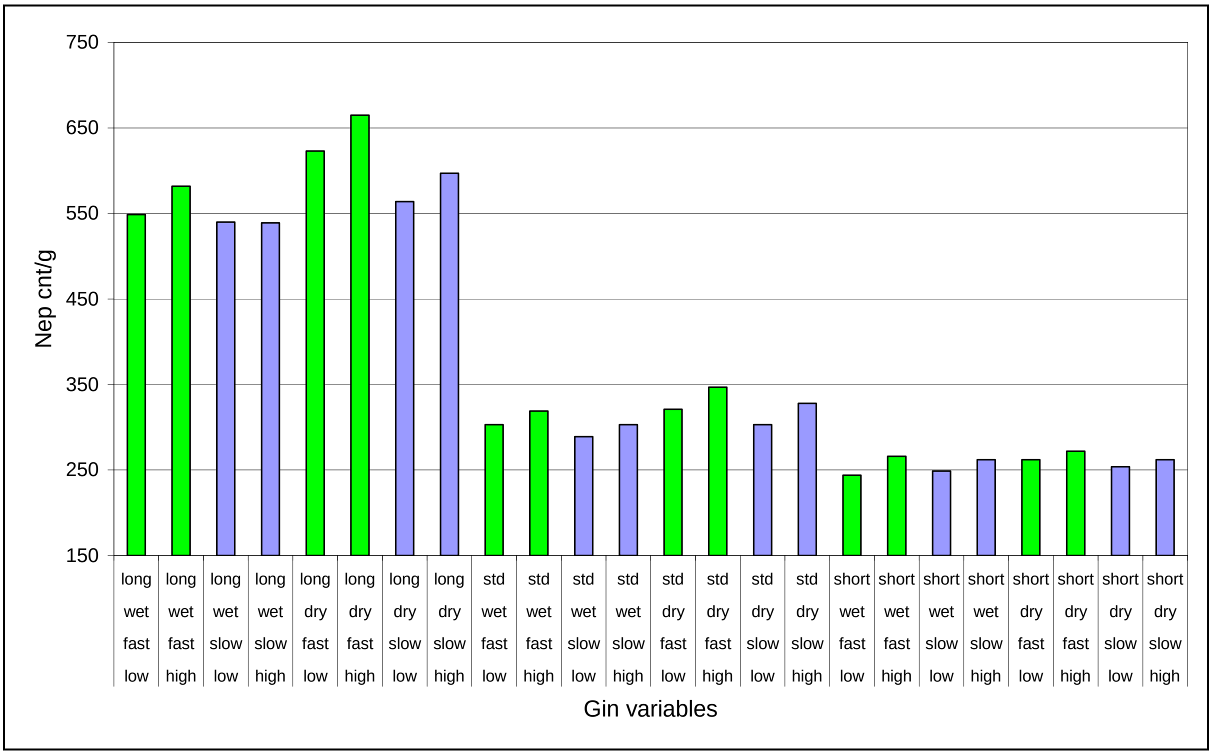

Figure 8 - Nep counts indicated on the basis of LC saw speed; green = fast, blue = slow. Other variables also listed on x-axis but not highlighted.

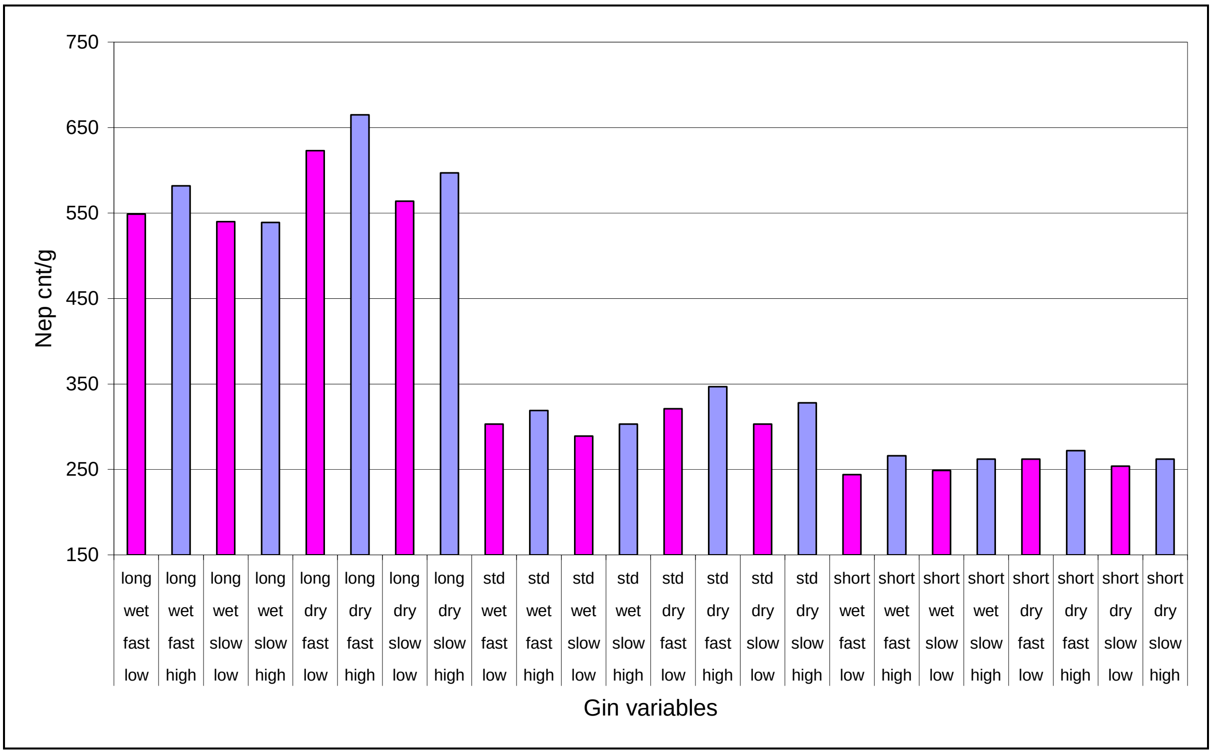

Figure 9 - Nep counts indicated on the basis of combing ratio; pink = low (23), blue = high (50). Other variables also listed on x-axis but not highlighted.

MLC Industrial Trials – Results

Trials of the MLC in industry were conducted over two years. The objective of the trials was to essentially apply the conclusions drawn from the laboratory trials above to industry, i.e. put a lower density batt onto the lint cleaner saw at a lower combing ratio. Moisture content, saw speed and cotton-type were not tested, and we note these did not vary widely during the trials. Trials were performed on the same machines in the same gin each season. No significant changes, other than batt density and combing ratio were made to the lint cleaners and gin stands used.

The trials allowed direct comparison of fibre property effects of standard lint cleaner (SLC) processing with the effects from a SLC fitted with combing grid bar heel (GBH) and the MLC. The effect of combing ratio (19, 23, 27 & 30) on fibre quality through the MLC was tested in 2007 and 2008, and the effect of combing ratio (19 & 27) on quality through the SLC with GBH was tested in 2008. The combing ratio of the SLC was kept constant at 27 for both years.

Except for batt density the effect of the SLC with GBH at a combing ratio of 19 is nominally the same as the MLC at a combing ratio of 19. We note that batt density whilst lighter in the MLC was not necessarily as well controlled as the SLC. Despite an adapted feed roller the extra distance between the MLC's additional drafting rollers was too wide (@ 300 mm) to properly control the batt. At lighter combing ratios the batt would pull apart before being gripped by the final feed rollers. The consequence of this was some unevenness in the MLC feed onto the saw. The likely effect of this was a reduction in the cleaning ability of the MLC, which was reflected in these comparisons, and a lessening of the ameliorating affects of the MLC on nep content. A shorter distance between these draft rollers and smaller roller diameter (from 150 mm to 100 mm) is required to further optimize the MLC performance.

Figures 10 to 15 illustrate comparisons made in 2007 and Figures 16 to 23 illustrate comparisons made in 2008. The 2008 data also compares the effect of each LC system on a before LC and after LC basis.

The trial results show that fibre through the MLC with a combing ratio of 19 was consistently and significantly better in UHML, uniformity and SFC than the SLC with a combing ratio of 27. Moreover the MLC with a combing ratio of 27 gave consistently although not significantly better fibre length properties than the SLC. Analysis of fibre properties before and after LC showed that the reduction in fibre length through the MLC was not statistically significant, whereas the reduction in fibre length through the SLC was consistently significant.

On average, cotton through the MLC with a combing ratio of 19 had 0.02 inches or 0.53 mm more length in terms of UHML (a 2% increase), a 1.34 increase in length uniformity (a 2% increase) and a 1.16% decrease in SFC (a 12% decrease) than the SLC. As per the laboratory trials it was noted the effects were better for longer cotton, with the industrial MLC typically saving 0.03 inches ($1/32^{nd}$) in cotton with UHML values greater than 1.15 inches.

The results also showed that while there was no significant difference in nep content through each system, neps were consistently lower for the MLC at lower combing ratios and the SLC with GBH at a combing ratio of 19.

Although trash levels as measured by HVI and AFIS were consistently higher for LC systems with lower combing ratios including the MLC, the differences were not significant and not reflected in lower classing grades. It is proposed that further adapting the MLC to improve control of the batt and batt evenness the number of neps and trash could be reduced further.

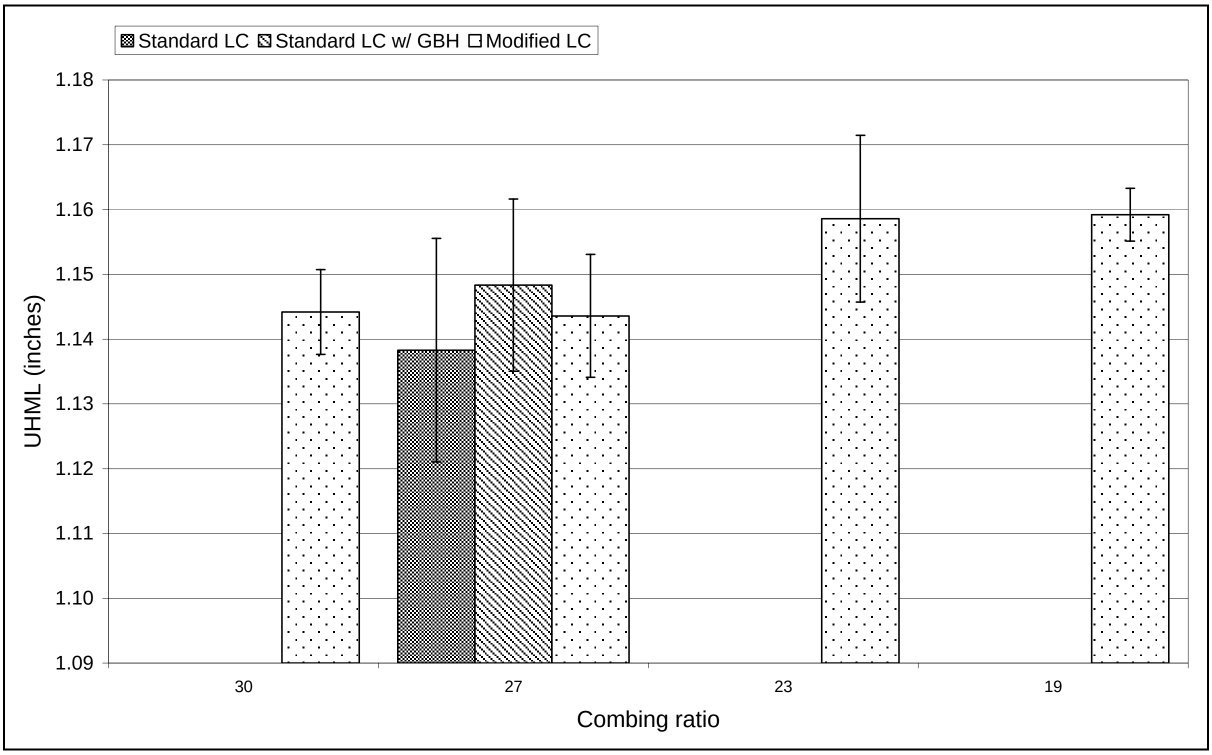

Figure 10 – UHML for combing ratio and LC treatments in 2007

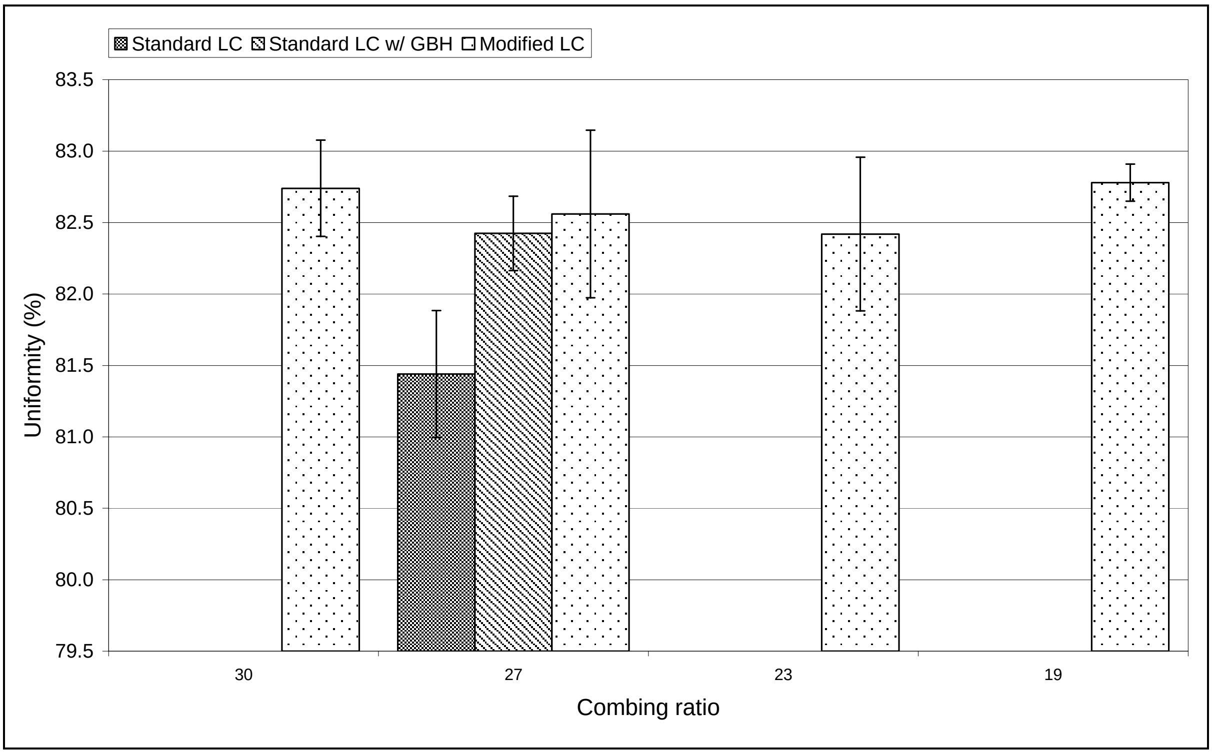

Figure 11 – Uniformity for combing ratio and LC treatments in 2007

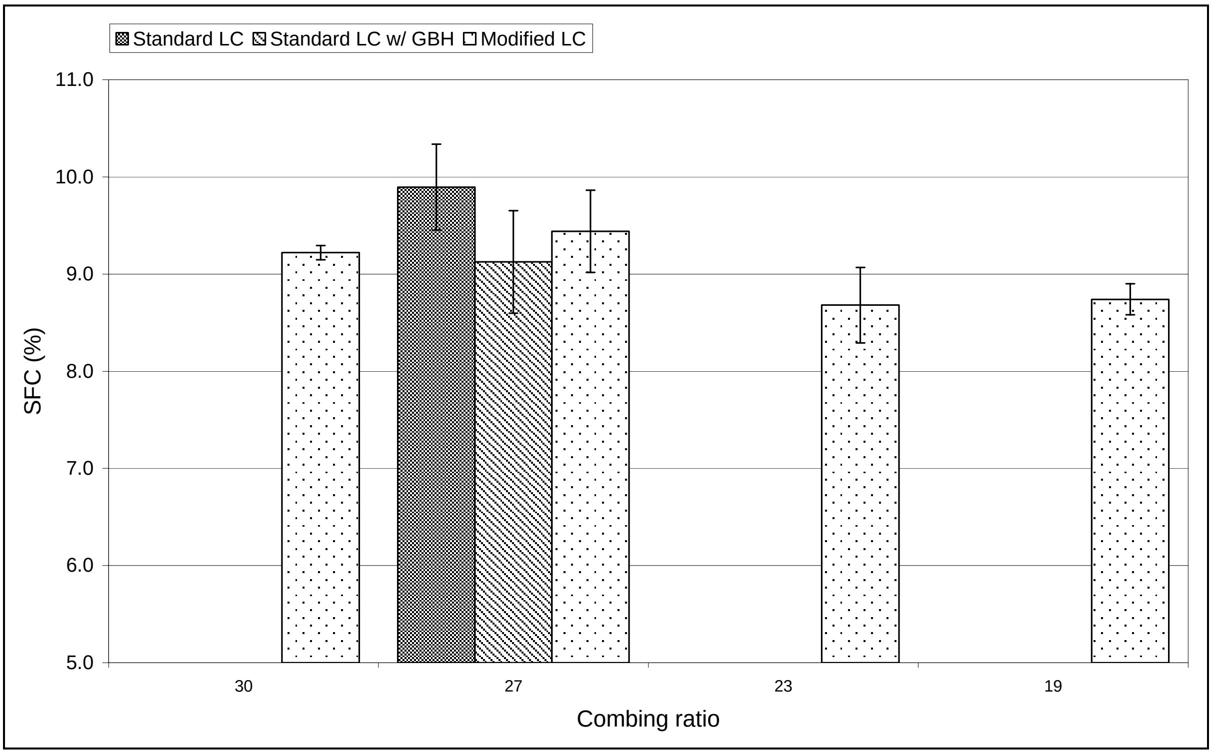

Figure 12 – SFC for combing ratio and LC treatments in 2007

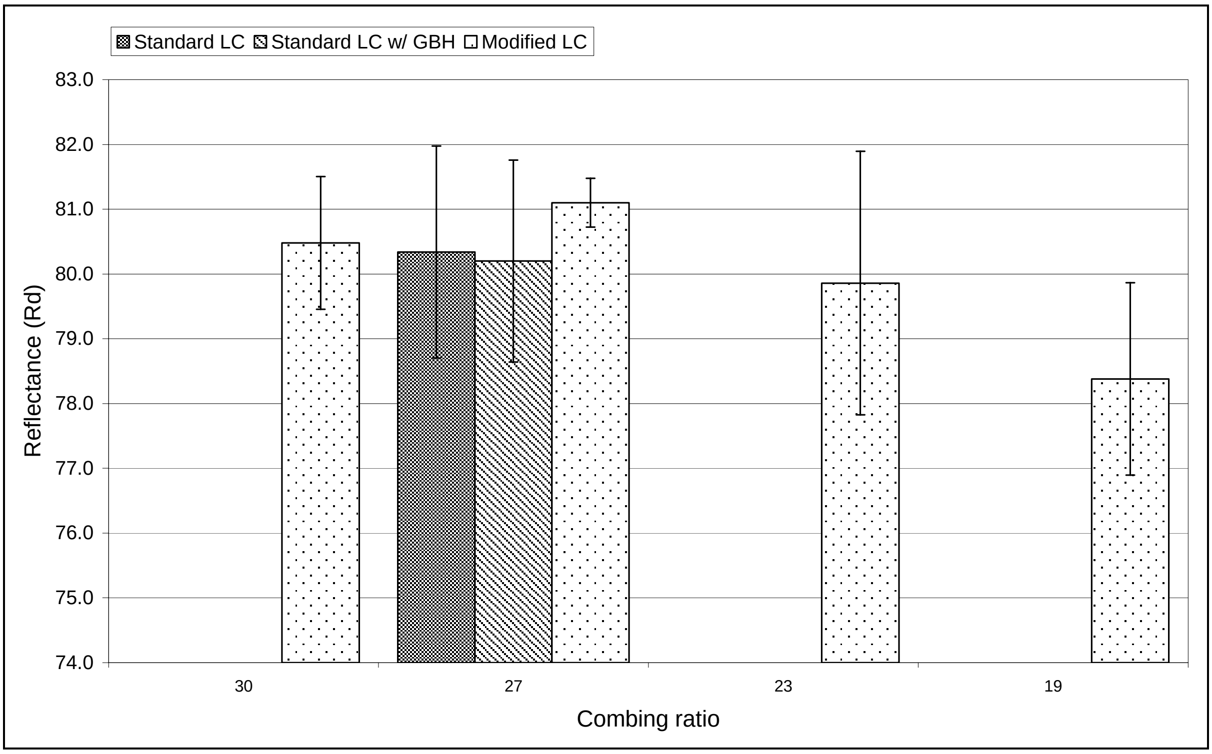

Figure 13 – Reflectance (Rd) for combing ratio and LC treatments in 2007

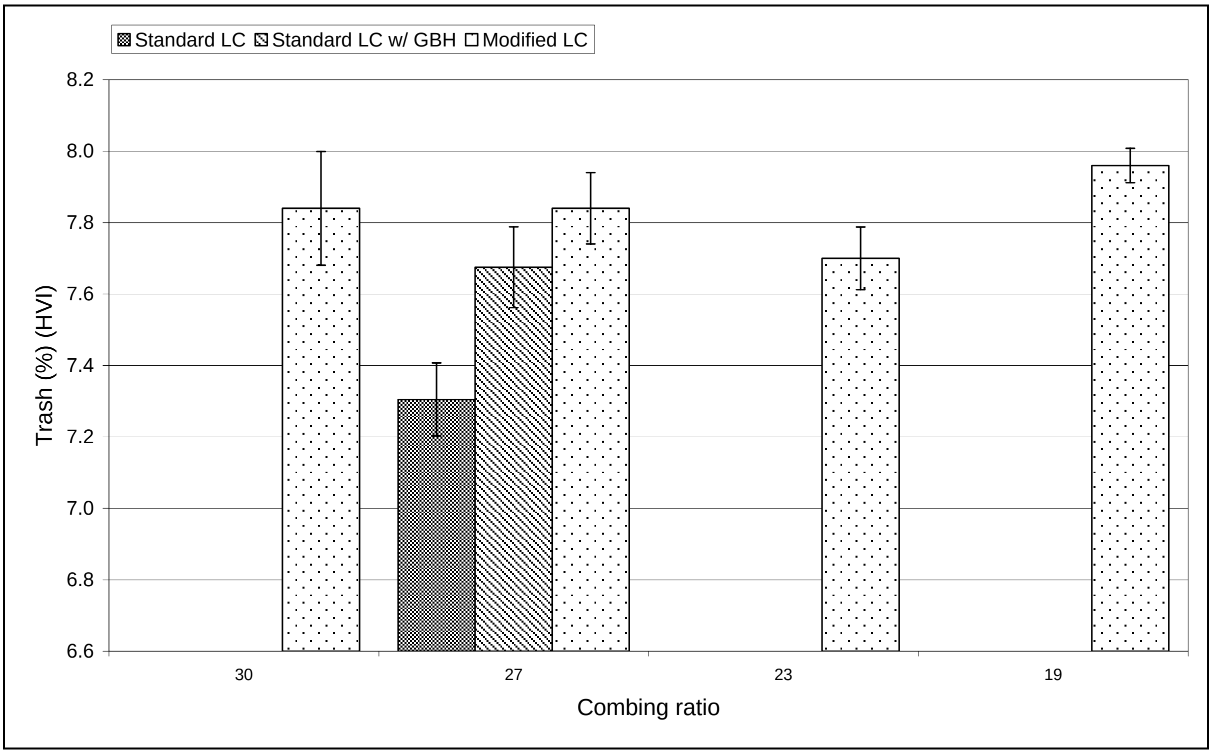

Figure 14 – HVI Trash (%) for combing ratio and LC treatments in 2007

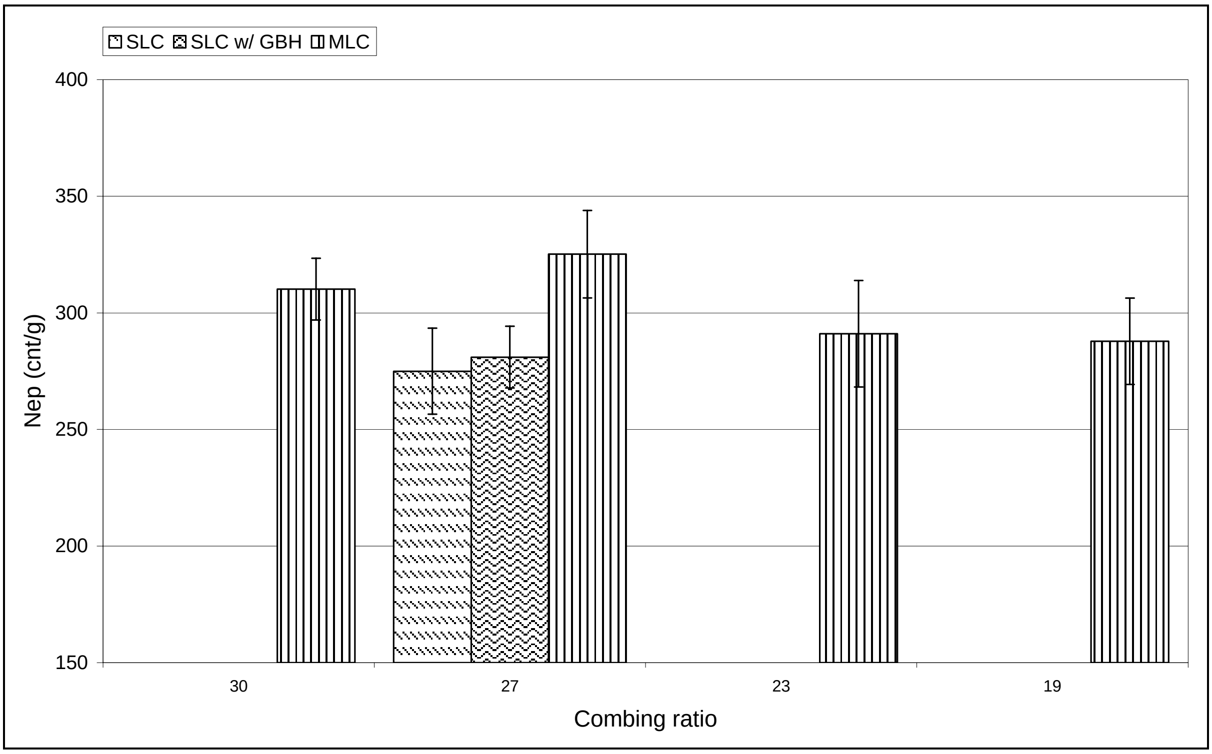

Figure 15 – AFIS Neps (count/g) for combing ratio and LC treatments in 2007

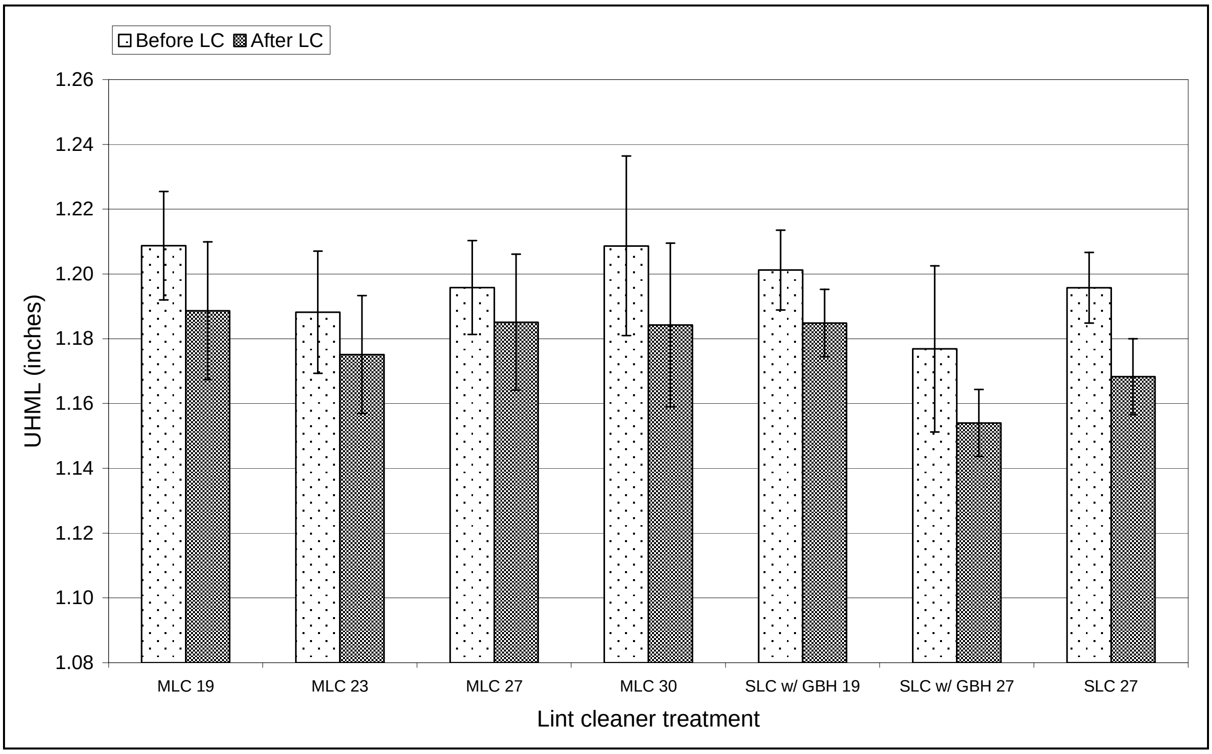

Figure 16 – Difference in UHML (inches) before and after combing ratio and LC treatments in 2008.

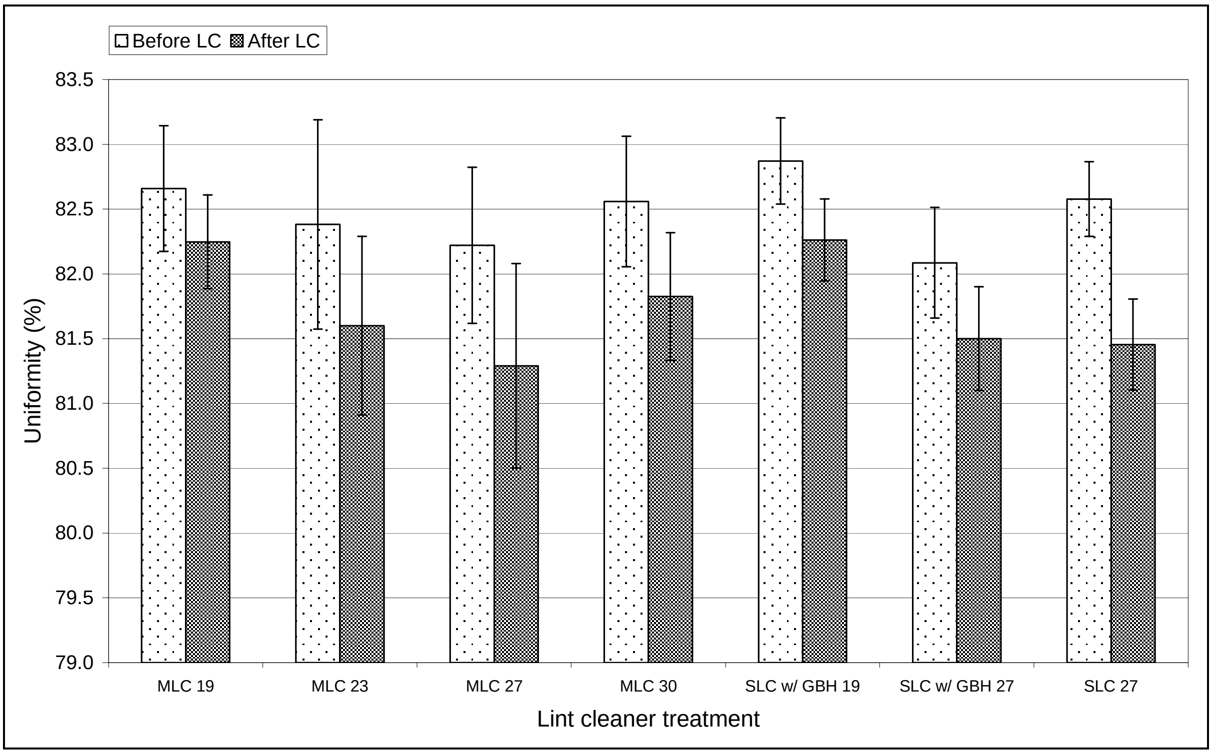

Figure 17 – Difference in Uniformity (%) before and after combing ratio and LC treatments in 2008.

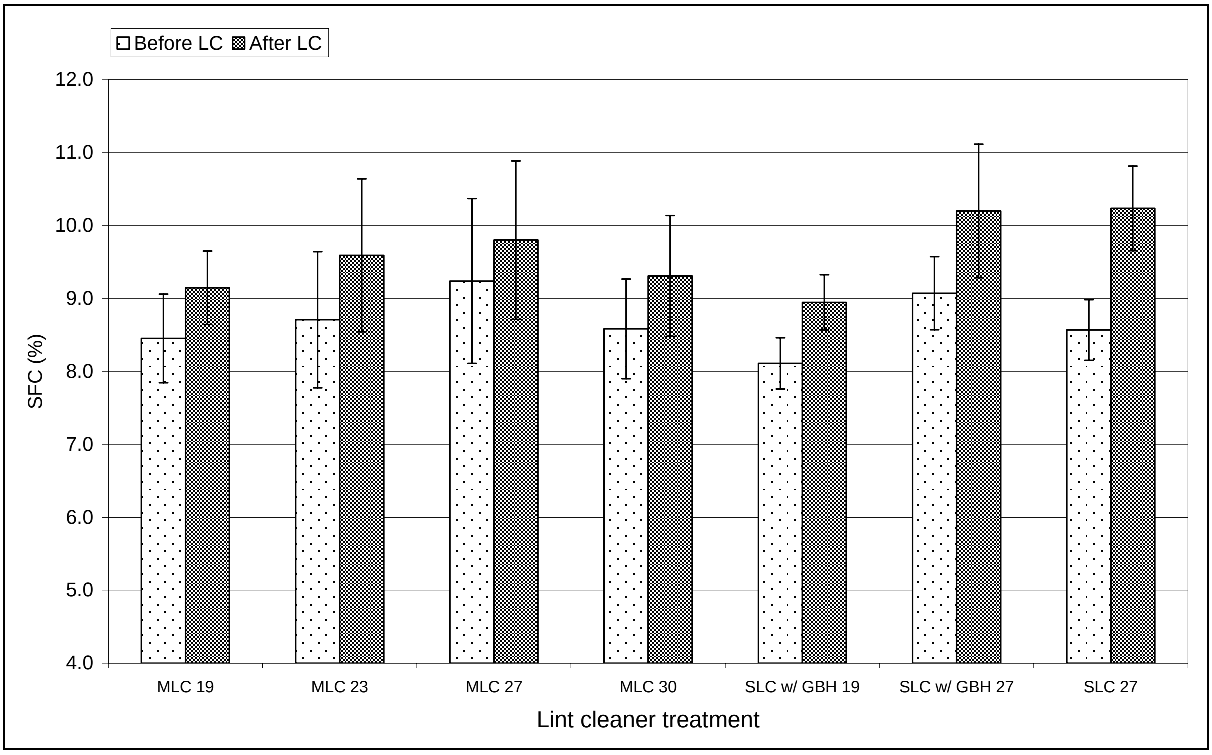

Figure 18 – Difference in SFC (%) before and after combing ratio and LC treatments in 2008.

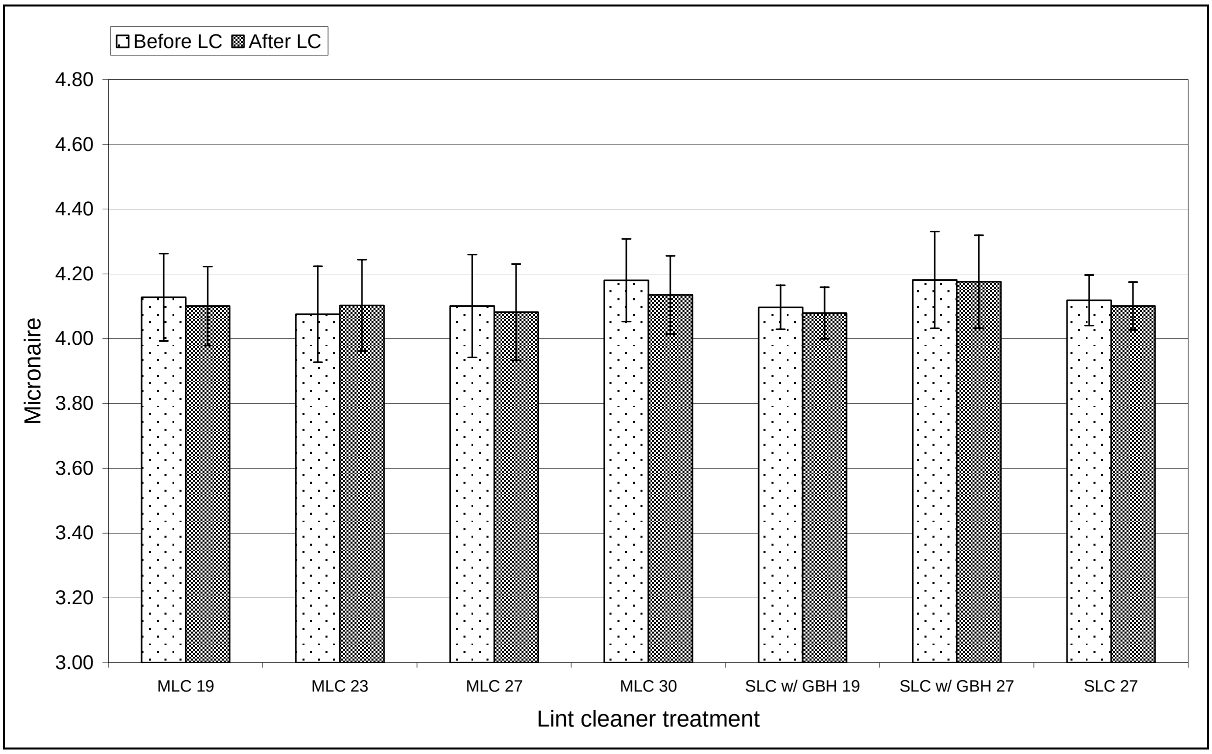

Figure 19 – Difference in Micronaire-value before and after combing ratio and LC treatments in 2008. This Figure is shown to illustrate the uniformity of Micronaire throughout the trial and the negligible effect of CR and LC treatments on its value.

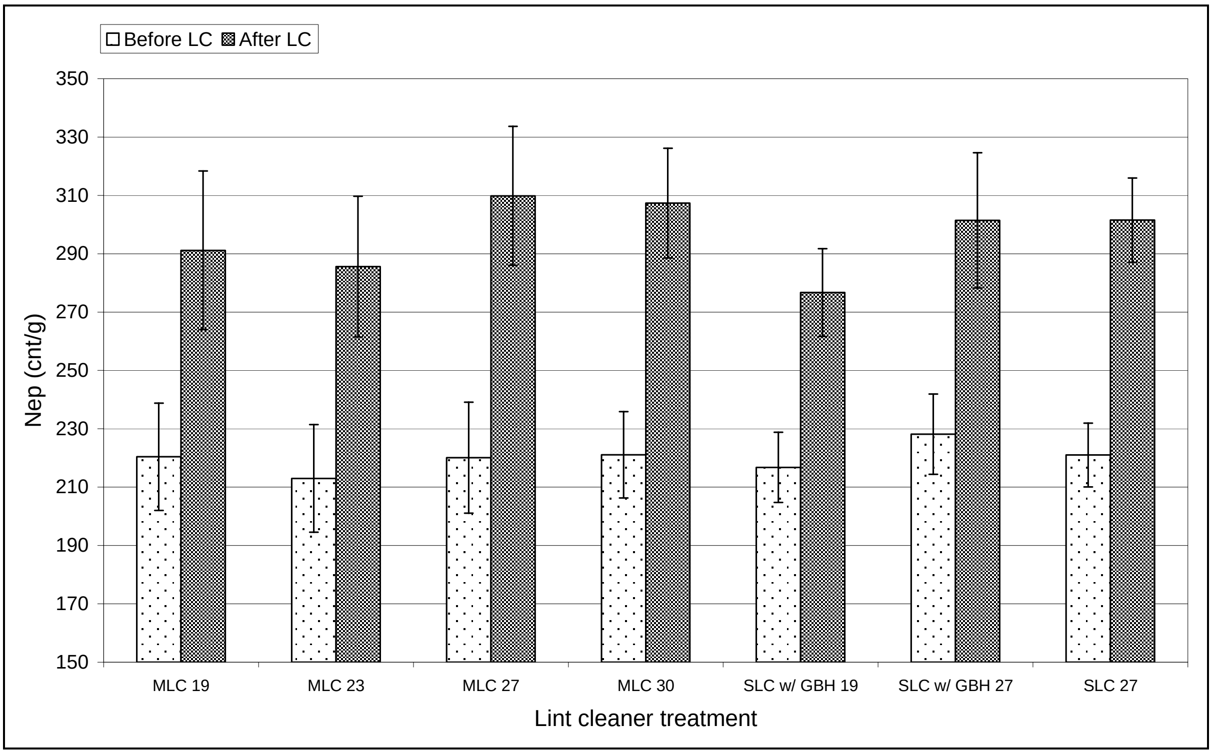

Figure 20 – Difference in Nep (count/g - AFIS) before and after combing ratio and LC treatments in 2008.

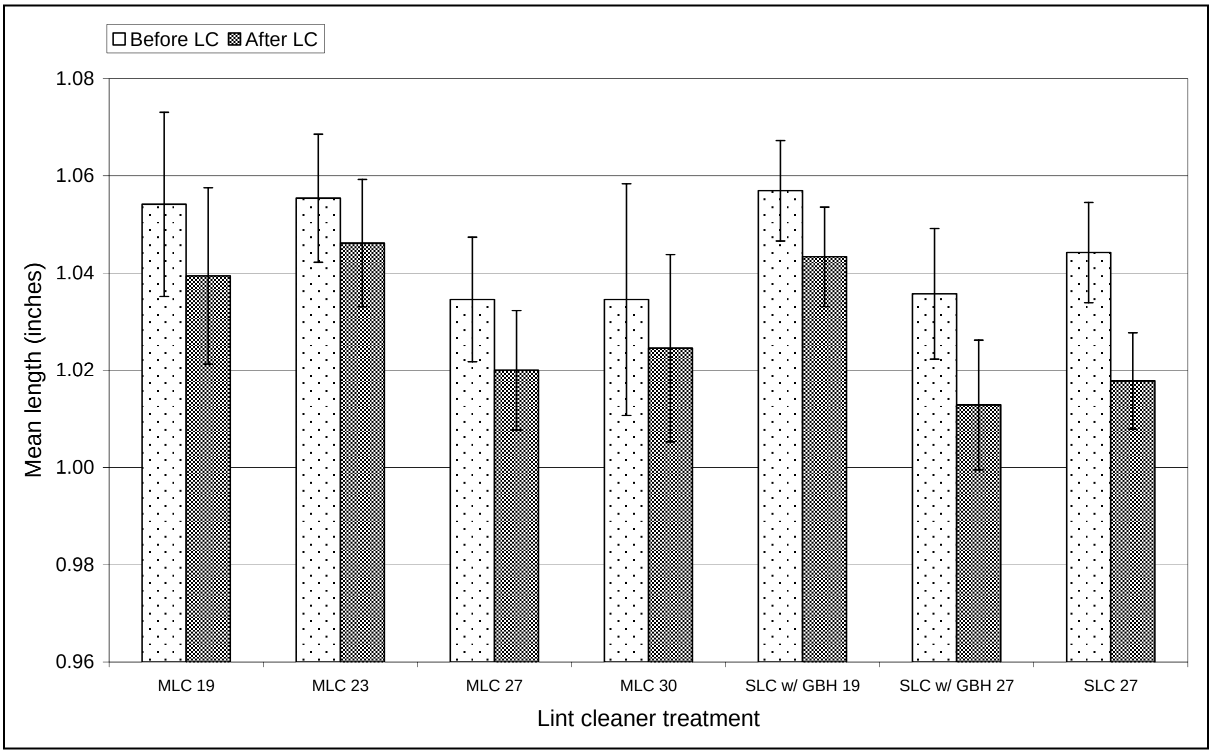

Figure 21 – Difference in average length (inches – AFIS) before and after combing ratio and LC treatments in 2008.

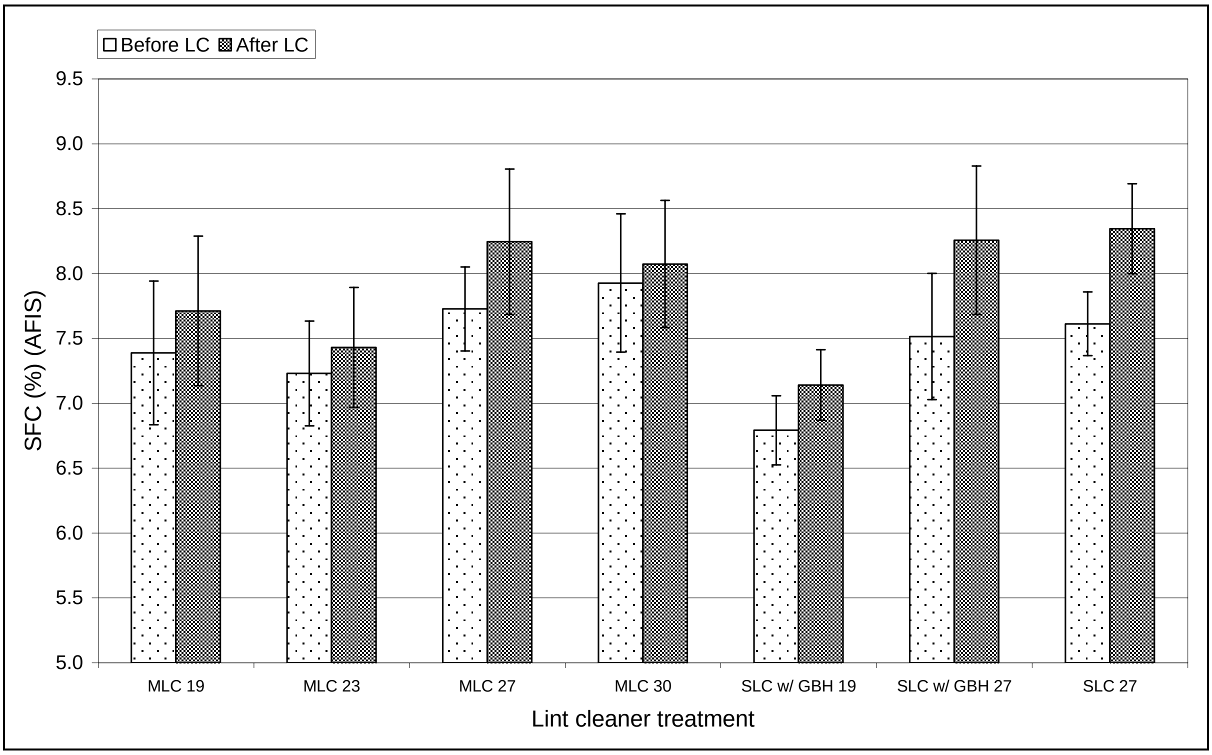

Figure 22 – Difference in SFC (% – AFIS) before and after combing ratio and LC treatments in 2008.

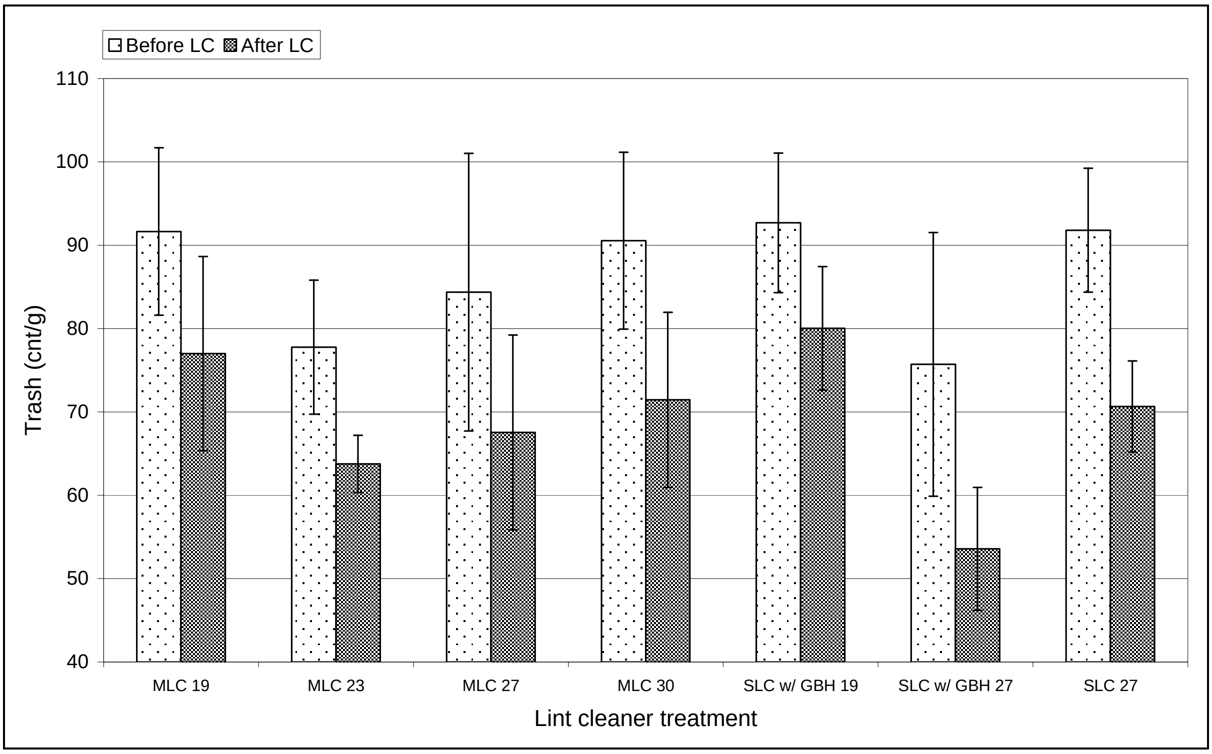

Figure 23 – Difference in Trash (count/g – AFIS) before and after combing ratio and LC treatments in 2008.

Conclusion

Observations from flow and mass sensors applied to a commercial gin in the first year of the project, showed the delivery of fibre from the gin by the current system was too fast and too uneven to be auto-levelled. Work on the project subsequently defaulted to proving and extending the veracity of the MLC to industry.

In laboratory and industrial trials the effects of LC set-up and the application of the MLC on fibre properties were examined. Laboratory trials that varied cotton type, moisture, saw speed, batt density and combing ratio showed the cumulative affect of these variables on nep reduction is much less than their individual contribution. The total reduction in nep count in long, fine cotton, as a result of subjecting moist cotton to low batt density and low combing ratios and saw speeds, was around 20%. Individually, cotton-type, saw speed, combing ratio and moisture content all had significant effects on nep content. Similar effects were seen for average fibre length and SFC. Trash results were affected by cotton-type, saw speed and combing ratio but not moisture content.

Industrial trials showed cotton through the MLC with a combing ratio of 19 had 0.02 inches or 0.53 mm more length in terms of UHML (a 2% increase), a 1.34 increase in length uniformity (a 2% increase) and a 1.16% decrease in SFC (a 12% decrease) than the SLC. It is noted the effects as per the laboratory trials were better for longer cotton, with the MLC typically saving 0.03 inches (1/32nd) in cotton with UHML values greater than 1.15 inches. The results also showed that while there was no significant difference in nep content of fibre through a SLC or MLC, neps were consistently lower for the MLC at lower combing ratios.

Although trash levels as measured by HVI and AFIS were consistently higher for LC systems with lower combing ratios including the MLC, the differences were not significant and not reflected in lower classing grades. It is proposed that further adapting the MLC to improve control of the batt and batt evenness the number of neps and trash could be reduced further.

Extension Opportunities
As per intentions of the EOI document – see Appendix 2.

Publications

1. Gordon, S. G. and Bagshaw, K. M., The effect of working elements in the fixed batt saw lint cleaner on ginned fibre properties, *proceed.* Beltwide Cotton Conference; New Orleans, LA. 2007
2. Bange, M., Long, R. L., Constable, G. and Gordon, S. G., Evaluation of in-field monitoring methods to reduce neps, *proceed.* Beltwide Cotton Conferences, National Cotton Council, San Antonio TX, Jan 2009
3. Apparatus and Process for Cleaning Cotton – Provisional patent application re-filed – March 2009 AU2007/901174
4. Gordon, S. G., Bagshaw, K. M. and Horne, F. A., The effect of lint cleaner elements, settings and humidification on cotton fibre quality: Laboratory trials – Part I, *Transactions of ASABE*, (in preparation)
5. Gordon, S. G., Bagshaw, K. M. and Horne, F. A., The effect of lint cleaner elements and settings on cotton fibre quality: Industrial trials – the modified lint cleaner – Part II, *Transactions of ASABE*, (in preparation)

There is evidence the nep and short fibre content of Australian cotton is too high compared with other growths of similar quality. These characteristics are a result of the productive and efficient harvest and ginning practices utilized by the Australian industry but the problem is exacerbated by current lint cleaner design. In particular, the combination of lint cleaner elements, i.e. the feed rollers and feed bar, grid bars and the doffing brush around the lint cleaner saw, and the transfer ratios between these elements affect fibre quality.

The broad aim of this project was to adapt and re-engineer the existing fixed batt saw lint cleaner to reduce short fibre and nep content. The main adaption proposed at the start of this project was an auto-levelling system for the lint cleaner feed such that the weight of fibre transferred onto the saw would always be constant. In addition to monitoring fibre mass and airflow, new combing grid bar heels were designed and fitted to the modified lint cleaner (MLC).

Unfortunately, the auto-levelling system could not be applied without significant changes to the lint cleaner feed. The changes required were beyond the scope of this project. Nevertheless, plans for a new feed system to deliver a more even and thicker batt to the lint cleaner were drawn up. Aside from auto-levelling capabilities another advantage of collecting and evenly feeding fibre through a buffer hopper is that it would avoid large volumes of air being drawn through the fibre prior to cleaning and provide the opportunity for the fibre to be conditioned before the fibre is cleaned by the lint cleaner saw.

Industrial trials showed that on average cotton through the MLC operated at lower combing ratios had 0.02 inches or 0.53 mm more length in terms of UHML (a 2% increase), a 1.34 increase in length uniformity (a 2% increase) and a 1.16% decrease in SFC (a 12% decrease) than the SLC. It is noted the effects as per the laboratory trials were better for longer cotton, with the MLC typically saving 0.03 inches ($1/32^{nd}$) in cotton with UHML values greater than 1.15 inches.

The results also showed that while there was no significant difference in nep content through each system, neps were consistently lower for the MLC at lower combing ratios. Although trash levels as measured by HVI and AFIS were consistently higher for LC systems with lower combing ratios including the MLC, the differences were not significant and not reflected in lower classing grades. It is proposed that further adapting the MLC to improve control of the batt and batt evenness the number of neps and trash could be reduced further.

These results confirm the commercial potential of the MLC, which will be tested in the near future through the release of an EOI document outlining preferred commercialisation of the MLC.

Appendix 1
Gordon, S. G. and Bagshaw, K. M., The effect of working elements in the fixed batt saw lint cleaner on ginned fibre properties, *proceed.* Beltwide Cotton Conference; New Orleans, LA. 2007

Appendix 2
CSIRO Expression of Interest (EOI) call (November 2009)

Appendix 2a
Business rationale for patenting the MLC

Appendix 3
PRP – CRDC Investment for 2009/10, New fibre conveyance system for Australian cotton gins (Ginning I)

Appendix 4
Ginning conveyor – working doc

THE EFFECT OF WORKING ELEMENTS IN THE FIXED BATT SAW LINT CLEANER ON GINNED FIBRE PROPERTIES

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Abstract

It is widely known the fixed batt saw lint cleaner damages fibre during cleaning and preparing cotton for market. Many studies have been conducted that show levels of nep and short fibre increase, while staple length and residual trash decrease with the number of passages through the fixed batt saw lint cleaner. However, the influence of the working elements, i.e. the feed, grid bars and brush, on fibre damage is not widely understood. In this study the effects of these elements on fibre quality have been studied on a lint cleaner modified to enable the fibre feed and collection, with and without these elements. The effects of these elements are examined on three different cottons; a long and fine cotton, a short and coarse cotton and an average Australian export cotton.

Introduction

Modern lint cleaning, in most cases, refers to the fixed or controlled-batt saw type lint cleaner, which was introduced to gin operations after World War II and quickly became widespread. Its introduction followed the advent of mechanized harvesting, which also increased the amount of trash found in cotton harvested this way as compared to hand-harvested cotton. Figure 1 shows the main elements of a fixed batt saw lint cleaner. In these systems ginned lint is formed into a thick batt of around 250 g/m^2 on a slow moving condenser drum. The formed batt is then doffed from the condenser and fed with minimal draft through a series of close set rollers to a nip point between a final resiliently mounted feed roller and fixed feed bar. The batt is then combed onto a saw moving in excess of 1500 m/min. The draft i.e., the ratio of the surface speeds between the final feed roller and the saw, is fixed and is usually set between 23 and 35. The fibre transferred onto the saw is cleaned by grid bars, which deflect the (contiguous) fibre web back into the saw teeth at the same time as expelling heavier discrete trash particles that are subject to greater centrifugal force than the fibre. Most modern lint cleaners use between five and eight grid bars. Fibre is removed from the saw by a brush cylinder (herein called a brush) revolving at 1.35 times the speed of the saw, i.e. a speed in excess of 2000 m/min. Lint doffed by the brush can be subject to further identical lint cleaning passages or can be collected and compressed into a bale.

The elements of the system described above work well to clean trashy cotton but they also create higher levels of short fibre content (SFC) and neps. Australian cotton is a high quality growth; in 2005/06 over 95% of the crop was classed 31-3 or better with less than 5% of the crop classed with 4 leaf grade [1]. This result is due to a combination of factors including dry autumn weather, good harvest preparation and the application of one, but more usually two lint cleaning passages. The effect is clean cotton that often has higher nep and SFC. Trials in Australia and elsewhere involving cotton subject to 0, 1 and 2 lint cleaning passages show incremental increases in fibre damage, i.e. nep and SFC, with increased number of lint cleaner passages [2, 3, 4]. With a move towards production of longer, finer cotton, there are questions from the Australian industry about the applicability of the fixed batt saw lint cleaner.

Whilst it is clear that fixed batt saw lint cleaners cause damage, it is unclear where the damage in the lint cleaner occurs, particularly with regard to different fibre types. It is generally agreed that fibre is damaged during the combing of the batt from the feed works onto the fast moving saw. However, there is little data on the specific impact of this transfer point particularly with respect to particular fibre types and removed from the effects of other ‘cleaning’ points in the system, e.g. the grid bars and the brush.

In this study, the effects of the feed, grid bars and brush elements on fibre quality are separated by partitioning the fibre feed through a lint cleaner built to allow feed and collection of fibre, with and without the feed works, i.e. the feed rollers and feed bar. Three types of cotton fibre are examined in this study including long and fine, short and coarse, and one current average Australian export cotton.

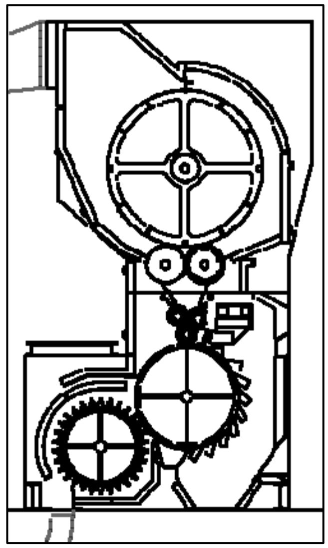

Figure 1 – Cross-section of a commercial fixed batt saw lint cleaner

Materials

Table I lists the high volume instrument (HVI) properties; upper half mean length (UHML), micronaire (MIC), tenacity (STR) and uniformity index (UNI), of the cotton varieties used in this study. Cotton was drawn from the 2006 Australian crop on the basis of the specified HVI properties and supplied to CSIRO as 227 kg commercial bales. It is noted each cotton type had already been subject to at least one industrial lint cleaner passage.

Table I – HVI fibre properties of test cottons

Cotton sample	UHML	MIC	STR	UNI
Short-coarse	1.03	5.2	28.5	80.3
Australian-std.	1.13	4.4	33.0	82.2
Long-fine	1.23	4.0	34.0	82.0

Methodology

A purpose built laboratory lint cleaner with an independent variable speed drive for the feed (Fig. 2) was used for the trials. Features of the machine include a 10 inch saw, four grid bars and a doffing brush geared to the saw drive. The model was to examine the effects of the lint cleaner on different fibre types. Without a condensing drum on this system, a fibre batt of 100 g/m^2 was manually prepared on a tray, which was then positioned to supply fibre through the feed or directly onto the saw. In this sense the feed is batched rather than continuous. We note that the batt supplied was somewhat lighter than that produced in an industrial cleaner but observe that in our experience, using a heavier batt gave rise to more variable test results. A combing ratio of 23 was used between the final feed roller and the saw. Saw speed was 870 r/min or 685 m/min with the brush geared at the same ratio as an industrial cleaner.

The cotton samples in Table I were tested in replicates of eight through configurations of the lint cleaner as listed below:

1. No lint cleaning; **control (bale cotton)**
2. Standard; **feed, grid bars and brush**
3. No grid bars; **feed and brush**
4. No feed or grid bars; **brush**

Collected samples were conditioned and five specimens tested per sample as per AFIS PRO standard procedures [5]. Hence, the averages reported here are means of (8 x 5) 40 AFIS PRO tests. Test measurements of upper quartile length by weight (UQL(w)), nep count, SFC by weight (SFC(w)) and trash count were examined in this study.

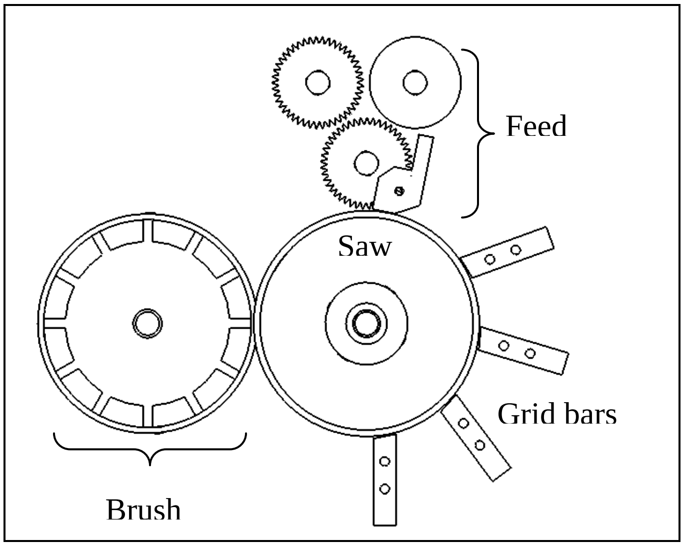

Figure 2 – Laboratory lint cleaner showing elements examined in this study

Data analysis

AFIS PRO measurements were subject to two-tailed Student t-tests (n = 8 test replicates) to test the significance of differences between fibre subject to the different lint cleaner configurations and the control (bale) cotton. Tables II and III list the length (UQL(w) and SFC(w)), and nep and trash properties of fibre subject to each configuration. Scatterplots of UQL(w) versus nep, SFC(w) and trash count data further illustrate the effects observed on cottons subject to the different configurations (Figures 3, 4 and 5).

Table II – Length properties of different cotton through different lint cleaner configurations

Cotton	Configuration	UQL(w) (inches)		SFC(w) (%)	
Short-coarse	**Control**	**1.076**	***p***	**12.44**	***p***
	Feed, grid bar & brush	1.080	*0.4291*	12.48	*0.8544*
	Feed and brush	1.075	*0.7054*	12.58	*0.4803*
	Brush only	1.074	*0.5587*	12.55	*0.5403*
Australian-std.	**Control**	**1.180**	***p***	**10.26**	***p***
	Feed, grid bar & brush	1.163	*0.0037*	10.76	*0.0446*
	Feed and brush	1.177	*0.6186*	10.65	*0.0698*
	Brush only	1.181	*0.7582*	10.13	*0.3095*
Long-fine	**Control**	**1.231**	***p***	**11.38**	***p***
	Feed, grid bar & brush	1.219	*0.0088*	12.11	*0.0015*
	Feed and brush	1.214	*0.0002*	12.13	*0.0002*
	Brush only	1.225	*0.1387*	11.68	*0.0757*

Table III – Nep and trash counts of different cotton through different lint cleaner configurations

Cotton	Configuration	neps (cnt/g)		trash (cnt/g)	
Short-coarse	**Control**	**199**	***p***	**47**	***p***
	Feed, grid bar & brush	220	*0.0059*	34	*0.0003*
	Feed and brush	220	*0.0006*	34	*0.0004*
	Brush only	209	*0.0545*	40	*0.0461*
Australian-std.	**Control**	**247**	***p***	**64**	***p***
	Feed, grid bar & brush	278	*0.0013*	44	*0.0011*
	Feed and brush	268	*0.0073*	46	*0.0015*
	Brush only	250	*0.7176*	49	*0.0013*
Long-fine	**Control**	**424**	***p***	**44**	***p***
	Feed, grid bar & brush	518	*0.0000*	38	*0.0063*
	Feed and brush	503	*0.0002*	40	*0.0921*
	Brush only	450	*0.0957*	41	*0.1474*

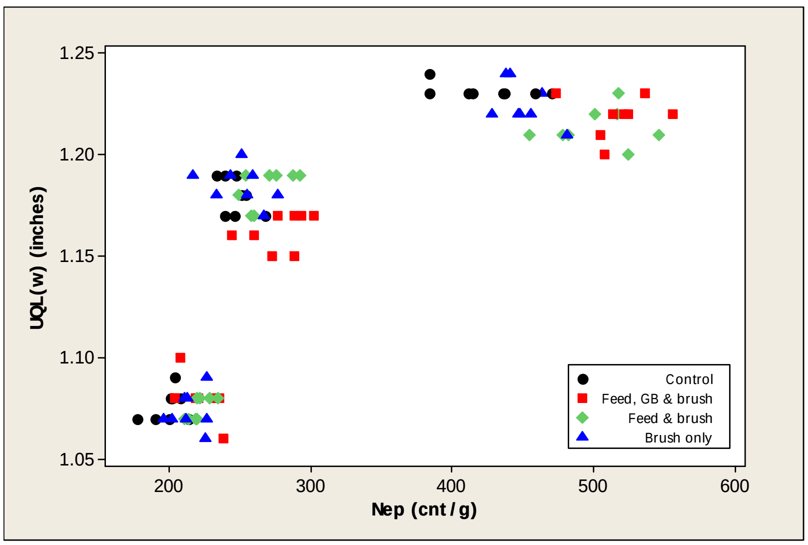

Figure 3 – Scatterplot of UQL(w) vs. nep for the 3 cottons through different lint cleaner elements

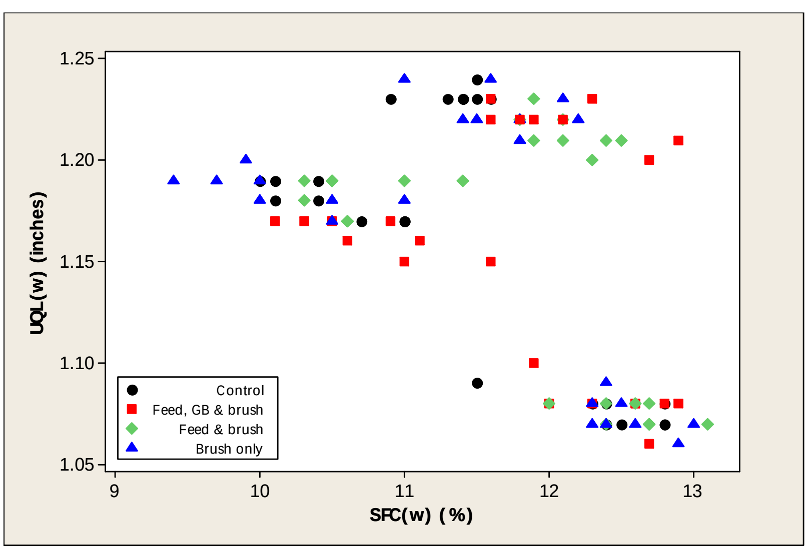

Figure 4 – Scatterplot of UQL(w) vs. SFC(w) for the 3 cottons through different lint cleaner elements

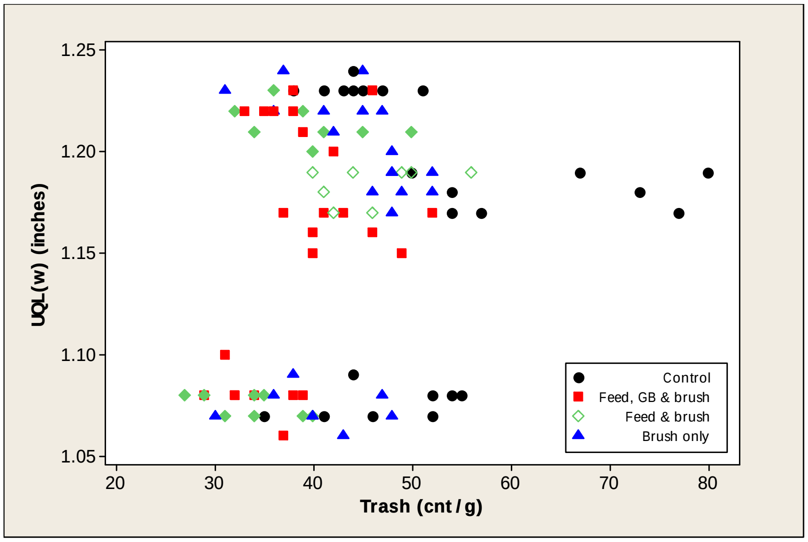

Figure 5 – Scatterplot of UQL(w) vs. trash for the 3 cottons through different lint cleaner elements

Results and Discussion

From the data in Tables II and III and Figures 3, 4 and 5, we note the relative damage on different cotton types caused by each of the lint cleaner elements examined in this study. By elimination, the contribution of the feed, grid bars and brush can be measured.

Across all cotton types, the feed of the lint cleaner created the most damage measured in terms of neps and SFC, although the effects were muted in the shorter, coarser cottons. Noticeable from the tabled data is the relative resilience of short-coarse cotton compared to long-fine cotton. This is clear from the probabilities listed in Tables II and III, which were not significant for the short-coarse cotton and very significant for treatments applied to the long-fine cotton. Whilst nep levels in the short-coarse cotton increased by around 10% through the standard configuration, the increase in the Australian standard and long, fine cottons was in the order of 12% and 20% respectively. The removal of grid bars reduced nep levels in these longer cottons by only 4% and did not change nep levels in the short-coarse cotton. Across all the cottons, the removal of the feed and grid bars together removed any significant difference in neps between the control and brush samples.

The feed can have a significant effect on fibre lengths, although this is dependent on the length of fibre being processed. The length characteristics of the short-coarse did not change significantly through any configuration, whilst the long-fine and Australian-standard cottons lost 0.3 and 0.4 mm of their UQL(w) respectively after passage through the standard configuration. Differences for both cottons through the standard configuration were significant at the 1% level. However, the grid bars and brush did not affect the UQL(w) of either cotton. Increases in SFC(w) were highest in the longer cotton samples subject to the standard configuration.

The grid bars on the model system did not improve the cleanliness of the cotton as much as expected. The main cleaning point appears to be at the transfer of the fibre onto the saw, with only a small subsequent contribution from the grid bars. The level of cleaning did not improve, or improved only marginally, for the Australian standard cotton when grid bars were added. It is interesting to note that the brush removed relatively greater amounts of trash from the short-coarse and Australian-standard cottons than the grid bars. The ability of the fixed batt saw lint cleaner to adequately clean long-fine fibre is questioned. The standard configuration reduced trash counts by only 14% in this cotton compared with 28% and 31% for the short-coarse and Australian-standard cottons respectively.

Figure 3, 4 and 5 show scatterplots of UQL(w) with nep, SFC and trash counts, which further illustrate the different responses to the configurations tested.

Summary and Conclusions

The effects on the properties of different cottons of the working elements of fixed-batt saw lint cleaners, i.e. the feed, grid bars and brush, were investigated using a purpose built laboratory-scale lint cleaner. The study suggests the differences in fibre properties identified are representative of the situation found using industrial scale equipment.

In fixed-batt saw lint cleaners, the feed, and in particular the transfer point between the final feed roller and the saw, is where fibre is damaged most during the lint cleaning process. The other elements used to clean and move cotton through this system, i.e. the grid bars and brush, create very little damage by comparison. The longer and finer a cotton is, the greater the damage.

This work provides an objective method for testing future developments in lint cleaning and to identify new technologies that attenuate the amount of fibre damage created at the feed:saw transfer point, particularly as the premium for longer, finer cotton grows.

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3. Draheim, D., 'Auscott Limited Nep Trials', Trial Report, 37 pp, 2001
4. van der Sluijs, M. J. H., Gordon, S. G. and Naylor, G. R., 'Australian Fibre Quality and International Feedback', *proceed* 12th ACGRA Cotton Grower Conference, Gold Coast Australia, August 2004
5. ASTM D5866-05 'Standard Test Method for Neps in Cotton Fibers (AFIS-N Instrument)', 2005

Acknowledgements

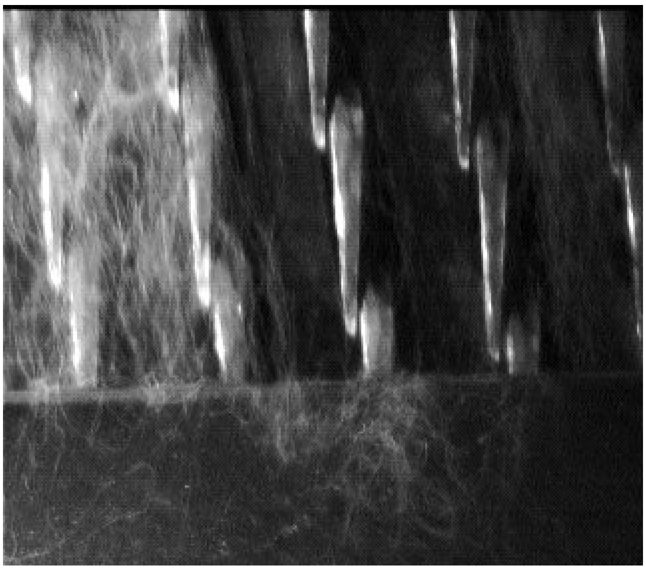
The authors wish to acknowledge the financial contribution to this project by the Australian Cotton Research and Development Corporation and CSIRO. The contribution of Auscott Limited for their supply of the cotton used in this study is gratefully acknowledged. The quick, able and responsive technical assistance by Susan Miller, Geni Kozdra and Karen Letts is also acknowledged.

Request for:

Expression of Interest

The Modified Lint Cleaner is a system whereby the fixed batt saw lint cleaner is modified in order to produce, control and transfer a lighter, more even batt onto the lint cleaner saw at a lower combing ratio.

Closing Date: 3.00 pm on 17th December 2009



CONTENTS

1. Introduction

1.1 Purpose of this EOI

CSIRO is issuing this Expression of Interest ("EOI") in order to seek proposals from suitable companies for the productisation, manufacture, deployment and support (“Commercialise’) of the Modified Lint Cleaner (MLC). The MLC is a system whereby the drive, drafting system and grid bars of a fixed batt saw lint cleaner are modified in order to produce and control a lighter, more even batt that is transferred onto the lint cleaner saw at a lower combing ratio, hereafter called the MLC or the “Technology”, in accordance with the requirements specified in this EOI.

1.2 CSIRO Profile

CSIRO - the Commonwealth Scientific and Industrial Research Organisation - is Australia’s largest scientific research organisation and one of the largest and most diverse scientific organisations in the World. Our purpose is to deliver benefits to Australia and to industry:

One of the means by which it does this is by commercialising the technologies that it develops. Commercialisation is the process of obtaining a financial return to CSIRO by transferring technologies from the organisation to external enterprises that intend to manufacture and market the technology to end users around the globe.

CSIRO is an independent statutory authority constituted and operating under the provisions of the *Science and Industry Research Act 1949* and the *Commonwealth Authorities and Companies Act 1997*. Further information about CSIRO can be found at www.csiro.au

1.3 Background

The MLC is a system whereby the drive, drafting system, feed roller and grid bars of a fixed batt saw lint cleaner are modified in order to produce, control and transfer a lighter, more even batt onto the lint cleaner saw at a lower combing ratio without loss of production.

The MLC improves fibre quality in terms of reduced trash and nep content, and improved staple length, length uniformity and (reduced) short fibre content. The modification works particularly well on long, fine Upland cottons. Reductions in nep and short fibre content by 20% and 15% respectively have been measured along with increases in staple length in excess of 1/32nd.

A MLC has been successfully tested and demonstrated in industry for the last two years.

1.4 Objectives of this EOI

CSIRO is pursuing the following objectives through the issue of this EOI:

(a) To invite interested parties to submit proposals to Commercialise the Technology, if given an opportunity to do so;

(b) To identify from those parties who submit proposals, a suitable company or companies that are able to demonstrate their ability to further develop the Technology, including:

- Their knowledge and experience in the application and deployment of a similar technology, and
- Their ability to further develop, manufacture, market and provide ongoing after sales support of the Technology.

2. EOI Structure and form of response

2.1 EOI Structure

This EOI and its attachments sets out information concerning CSIRO's requirements in relation to the commercialisation of the Technology, the conditions of the EOI, evaluation methodology, evaluation criteria and all other matters concerning this process.

The EOI document is structured as follows:

(a) The body of the EOI which provides an overview of the Technology that CSIRO wishes to commercialise and the criteria for selecting the preferred company or companies for CSIRO to transfer the technology to;

(b) The attached Annexure:

Annexure 1 – Description of the Technology and Performance Characteristics;
Annexure 2 – Summary Response Template

3. EOI process

3.1 Restricted EOI

3.1.1 The EOI is conducted on a restricted basis, whereby only companies that have already shown an interest in the Technology and/or companies known to manufacture and market similar technologies into the end user space are invited to respond.

3.1.2 Respondents should register their contact details with the CSIRO Primary Contact nominated below so that they can be advised of any alteration, correction or notice in relation to this EOI.

3.2 CSIRO's Primary Contact Details

CSIRO's primary contact for all communications and contacts related to this EOI is (the 'Primary Contact):

Name	Lionel Henderson
Role	Primary Contact
Email	lionel.henderson@csiro.au

3.3 Timetable

The following indicative timetable will apply to this EOI:

Event	Indicative Dates	
	Start Date	End Date
Release of the EOI	27th November 2009	17th December 2009
EOI Response Closing Time and Date	17th December 2009	
Evaluation of EOI responses	22nd January 2010	
Selection and notification of short-listed Respondents	5th February 2010	12th February 2010
Interview of short-listed respondents		TBD
Selection and notification of finalists Respondent		TBD
Due diligence and reference checks on finalist Respondent		TBD
Negotiation with finalist Respondent		TBD
Contract negotiations with finalist Respondent		TBD
Sign contract with selected finalist Respondent		TBD
Technology Transfer/implementation		TBD

TBD = To Be Determined

3.4 Timetable Variations

The indicative timetable set out in clause 3.3 may be varied by CSIRO at any time at its discretion.

4. Process Rules

4.1 Closing Date and Time and Lodgement of EOI Response

4.1.1 Completed EOI responses must be lodged electronically in .pdf format with the Lionel Henderson Contact at the email address Lionel.Henderson @csiro.au before 3.00 PM (Australian Eastern Standard Time) on Thursday 17th December 2009 (the 'EOI Closing Time and Date').

4.2 Extension of Deadline for Lodgement of EOI Response

4.2.1 The EOI Closing Time and Date are at the sole and absolute discretion of CSIRO and may be extended at CSIRO's discretion at any time prior to the EOI Closing Time and Date published in this EOI.

4.2.2 Any extension of the EOI Closing Time and Date will be notified to all those Respondents who have registered with the Primary Contact.

4.3 Exclusion of Late Responses

Late Responses will be excluded from the EOI process, and will not be admitted to evaluation.

4.4 Clarification

4.4.1 Clarification Questions

Respondents may seek clarification of the meaning of the content of this EOI from CSIRO's Primary Contact at any time prior to the EOI Closing Time and Date. All enquiries must be in writing submitted to CSIRO's Primary Contact's e-mail as identified at clause 3.2.

CSIRO will, in its sole discretion, determine whether or not to respond to such questions. Any election not to respond will be notified to the Respondent asking the question.

In all cases CSIRO reserves the right to forward any clarification of the meaning of the content of this EOI to all Respondents on a non-attributable basis.

4.4.2 New Information and Errors

If a line of questioning by a Respondent in a briefing reveals new information that, in the sole opinion of CSIRO may be material to the outcome of the EOI, or such questioning reveals an error in information previously distributed by CSIRO, the new or corrected information will be distributed to all Respondents.

Process Questions or Complaints:

Any questions or complaints from Respondents relating to the EOI process should be directed to the Primary Contact in the first instance.

5. Conditions of Participation

CSIRO will exclude any Respondent from further consideration and evaluation if CSIRO considers in its absolute discretion that the conditions of participation set out in this clause have not been met by the Respondent. That is, notwithstanding anything else contained in this EOI, Respondents must as a minimum satisfy the following listed requirements to be considered:

- Completed the attached Summary Response Template;
- An indicative business plan providing a basic outline of how the Respondent might look to integrate the Technology into the Respondent's business and to market the Technology to potential customers;
- Details of the Respondent's previous experience in commercialising; including product development, manufacturing, distributing and reselling similar technologies;
- Details of the Respondents financial standing - include the last 3 years Financial Statements; and
- Details of the Respondent's key personnel relevant to this technology.

6. Evaluation Process

6.1 Evaluation Objective

The purpose of the evaluation process is to identify and select the Respondent or Respondents that CSIRO considers has the appropriate business acumen, technical know-how and financial capacity to commercialise the Technology and deliver benefits to Australia, as assessed in accordance with the evaluation criteria and methodology adopted by CSIRO.

Please Note: CSIRO has the right not to select any Respondent if in its absolute discretion it considers none of the Respondents is suitable or has the ability to commercialise the Technology.

6.2 Exclusion from Evaluation

Respondents excluded under EOI clause 5 will not be included in the evaluation.

6.3 Evaluation Process Overview

The evaluation process will include the following steps:

a) Detailed evaluation of EOI responses from the Respondents;

b) Selection of short-listed Respondents;

c) Clarifications from the Respondents;

d) Reference checks, including site visits, if required;

e) Due diligence of short-listed Respondents by CSIRO;

f) Negotiations and further clarification with short-listed Respondents;

g) Update evaluation; and

h) Select preferred Respondent or Respondents (if CSIRO determines that more than one company has the ability to commercialise the Technology);

i) If CSIRO does select a preferred Respondent or Respondents, further negotiations over the terms and any rights granted by CSIRO to commercialise the Technology.

6.4 Evaluation Criteria

In ascertaining the Respondent or Respondents who will best meet CSIRO's requirements, Respondents will be evaluated in accordance with the following evaluation criteria:

- Experience in developing similar Technology;
- Fit with Respondents existing business;
- End user Application knowledge;
- Manufacturing capability;
- Sales and application support (pre and post sales);
- Installation, maintenance and repair capability;
- Ability to commercialise the Technology in as many countries as possible
- Financial capacity;
- Quality of a 3 year and business plan including product development;

The order in which the evaluation criteria are listed does not indicate their importance relative to each other. CSIRO reserves the right to allocate weightings to the criteria in its evaluation process, at its discretion. Respondents' are encouraged to demonstrate potential avenues for maximising the benefits to Australia.

6.5 Reference Checks and Further Information

Respondents are requested to submit a statement of facts as to previous experience and achievement in commercialising similar technologies in the market, or in similar markets.

a) CSIRO may conduct reference checks (including site visits, if relevant) on Respondents.

b) CSIRO may also request further information from Respondents during the evaluation process.

6.6 Due Diligence on Technology

CSIRO may provide short-listed Respondents with the opportunity to conduct due diligence on the Technology subject to entering into a confidentiality agreement.

6.7 Discussions and Negotiations with Respondents

CSIRO will, as appropriate, engage in discussion or negotiations with any Respondent for the purpose of clarifying or improving its response. CSIRO may, in its absolute discretion, conduct simultaneous discussions to clarify or improve proposals with more than one Respondent. Where information of a material nature is provided to one Respondent, it will also be provided to all other Respondents (on a non-attributable basis) who are currently participating in the evaluation process.

6.8 Use of Information in the Evaluation

c) The Respondent's written EOI response to the requirements set out in this EOI will be used by the evaluation team to evaluate Respondents against the evaluation criteria.

d) The evaluation team may also use any relevant information obtained in relation to the EOI (whether from the Respondent as part of clarification, reference checks, negotiations, presentations or by any other independent inquiry) in the evaluation of EOI responses.

6.9 Debriefing

Unsuccessful Respondents may request an EOI debriefing if a contract is awarded to a successful Respondent or Respondents. Respondents requiring a debriefing should contact the CSIRO's Primary Contact.

7. Conditions of EOI

7.1 Ownership of Response Material

7.1.1 All material submitted in response to this EOI becomes the property of CSIRO. Such intellectual property as may exist in the information contained in the response will remain vested in the Respondent.

7.1.2 By submitting an EOI, the Respondent allows CSIRO to copy to the submitted material for the purpose of evaluating the Respondent's response.

7.2 Confidentiality of Information

7.2.1 CSIRO's Confidential Information

Respondents are required to ensure that any of their employees, agents or sub-contractors involved in meeting CSIRO's requirements do not either directly or indirectly record, divulge or communicate to any person any confidential information concerning the Technology, the affairs of the CSIRO or a third party acquired or obtained in the course of preparing a EOI response, or in discussions or negotiations with CSIRO. This confidential information includes any documents, data or information provided by CSIRO and which CSIRO indicates to Respondents is confidential or which Respondents know or ought reasonably to know is confidential.

7.2.2 Respondents' Confidential Information

CSIRO will treat as confidential any information provided by a Respondent which is nominated by the Respondent as confidential information. CSIRO's obligations in relation to Respondent provided confidential information will not be taken to have been breached to the extent that the information:

a) is disclosed by CSIRO to its advisers, officers, employees, subcontractors or advisors in order to conduct the EOI process, including the preparation of any resultant contract;

b) is disclosed to CSIRO's internal management personnel or advisors, solely to enable effective management, approval or auditing of the EOI process;

c) is disclosed by CSIRO to its Department or to the responsible Minister;

d) is disclosed by CSIRO in response to a request by a House or a Committee of the Parliament of the Commonwealth of Australia;

e) is authorised or required by law to be disclosed; or

f) is in the public domain otherwise than due to a breach of the relevant obligations of confidentiality.

7.3 Conflict of Interest

During the EOI process, the Respondent must immediately advise CSIRO in writing of any circumstances or relationships constituting a Conflict of Interest or potential Conflict of Interest which might impact on CSIRO's determination as to the most appropriate party to commercialise the Technology. CSIRO may in its absolute discretion:

a) enter into discussions to seek to address such Conflict of Interest;

b) exclude the Respondent from the process and further evaluation; or

c) take any other action it considers appropriate.

7.4 Ethical Dealing

CSIRO's policy is to engage in the highest standards of ethical behaviour and fair dealing throughout the EOI process. CSIRO requires the same standards from those with whom it deals. EOI's should be compiled without improper assistance of employees or former employees of CSIRO and without the use of information improperly obtained or in breach of an obligation of confidentiality.

7.5 EOI Response Validity

All responses to the EOI will be deemed to be valid for a period 120 days from the EOI Closing Time and Date unless otherwise indicated by a Respondent in its EOI response.

7.6 Right Not to Proceed

CSIRO is not bound contractually, or in any other way, with any Respondent who responds to this EOI. CSIRO reserves the right not to proceed with this EOI or any part of it, and to suspend or vary the EOI and/or its requirements at any stage.

7.7 Costs Borne by Respondent

All costs and expenses incurred by Respondents in any way associated with the development, preparation and submission of an EOI response, including but not limited to attendance at meetings, discussions, presentations and providing any additional material required by CSIRO, will be borne exclusively by the Respondents.

7.8 No Legal Relationship

No binding legal relationship will arise out of this process until execution of a contract with the preferred Respondent.

7.9 Information

CSIRO will not be liable for any incorrect or misleading information or omission to disclose information.

7.10 Respondents to Inform Themselves

Respondents are considered to have:

a) examined this EOI, any documents referenced in this EOI and any other information made available by CSIRO to Respondents for the purpose of responding to the EOI;

b) examined all further information which is obtainable by the making of reasonable inquiries relevant to the risks, contingencies, and other circumstances having an effect on their EOI response;

7.11 Respondent Acknowledgements

EOI's are submitted on the basis that Respondents acknowledge:

a) they do not rely on any representation, letter, document or arrangement, whether oral or in writing, or other conduct as adding to or amending these conditions unless issued by the Primary Contact;

b) they do not rely upon any warranty or representation made by or on behalf of CSIRO, except as are expressly provided for in this EOI, but they have relied entirely upon their own inquiries and inspection in respect of the subject of their EOI response; and

c) CSIRO is not responsible for any loss, damage, costs or expenses incurred by Respondents or any person if, for any reasons, a EOI or any other material or communication relevant to this EOI, is not received on time, is corrupted or altered or otherwise is not received as sent, cannot be read or decrypted or has its security or integrity compromised.

7.12 Complaint Handling

For complaints in relation to any item in this EOI or the EOI process contact Primary Contact.

8. INTERPRETATION OF EOI

8.1 Definitions & Interpretation

In this EOI, unless the contrary intention appears:

a) **Conflict of Interest** means any matter, circumstance, interest, or activity affecting the Respondent (including the officers, employees, agents and subcontractors of the Respondent) which may or may appear to impair the ability of the Respondent to provide the requirements to CSIRO diligently and independently;

b) **Late EOI** means an EOI that is not lodged by the EOI Closing Time and Date,

c) **Primary Contact** means CSIRO's primary contact for all contacts in relation to this EOI, as specified in clause 3.2;

d) **EOI Closing Time and Date** means the date and time set out in clause 4.1;

8.2 Governing Law

The governing law of the New South Wales applies to this EOI. The courts of the New South Wales have exclusive jurisdiction to decide any matter arising out of this EOI.

ANNEXURE 1 – Modified Lint Cleaner

Technical Background

The invention relates to modification of the standard fixed batt saw lint cleaner, which results in a reduction of fibre damage and loss, and an improvement in cleaning ability.

Fibre damage is described in terms of nep and broken or short fibre creation. Both these parameters are unfortunate characteristics of cotton produced and ginned by mechanized means. Harvesting, ginning and particularly lint cleaning are mechanical processes that inflict significant damage to cotton before it is classed and sold to spinning mills.

Industrial trials in Australia have shown lower combing ratios in lint cleaning, i.e. low drafts between the final feed roller and cylindrical saw of the fixed batt saw lint cleaner reduces the amount of fibre broken during processing. The amount of damage done and the amount of fibre loss in the lint cleaner is also dependent upon how effectively and uniformly fibre is transferred from the lint cleaner feed works onto the cylindrical saw, and how well the fibre is held by the saw teeth.

Currently, fixed batt saw lint cleaner systems draft a tightly compressed fibre batt of about 250 g/m^2 via a resiliently mounted feed bar and closely set feed roller onto the cylindrical saw. The draft between feed roller and saw is defined by the ratio of the saw surface speed to the feed roller surface speed. This ratio can vary between 16 and 40 and is more often set at values greater than 30 to ensure fibre is thoroughly cleaned. The issue with lint cleaners in this regard is that at high drafts fibre is damaged at the point where the batt is transferred from the feed roller and feed bar grip to the saw. Lower drafts lead to reduced fibre breakage however fibre cleaning ability is also reduced. Moreover, under both conditions the fibre web is often not properly secured by the saw teeth, which leads to increased fibre loss and interaction at the grid bars.

To overcome these issues the MLC combines an extra set of drafting rollers and a uniquely profiled feed roller that grips the fibre batt with enough force so the fibre fringe that emerges from the feed roller and the feed bar grip is not damaged by the combing action. The MLC ensures a lighter batt is transferred securely to the saw. The extra drafting rollers are situated between the doffer rollers and feed work rollers. The extra rollers reduce batt density by up to 30 percent. The distance between the rollers is set so the batt does not pull apart. The lighter batt means the final draft between the feed roller and saw can be reduced by up to 30 percent. Production is not affected because delivery speed of the fibre from the condenser through to the feed roller is increased proportionally by a separate variable frequency drive.

The issue in the past with processing a lighter batt has been the inability of the feed bar and feed roller zone to properly grip the batt so that it can be combed uniformly. In this invention grip is enhanced by changing the profile of the feed roller so there are more gripping points (flutes) applied to the batt. Important aspects of the new profile are the flute angle, which allow more flutes to be cut around the cylinder circumference, and the area of the flute face, which allows more even pressure to be applied to the batt. The new profile holds fibre in the batt at the feed roller onto saw transfer point for longer thereby allowing for greater combing.

Another aspect of the MLC is the first two or three grid bars after the transfer point are fitted with toothed heels that act to deflect fibres into the saw teeth, which breaks up fibre clumps and reduces loss of fibre off the saw. Further, the combing grid bar heels improve web evenness across the lint cleaner saw and decrease the interaction of fibre with grid bars, which in turn reduces nep creation.

Trials of the MLC in industry have shown increases of 3% in staple length (1/32nd) and 2% in length uniformity and decreases of 20% in neps and 15% in SFC for long, fine Upland fibre.

A provisional patent has been filed for the MLC.

ANNEXURE 2

EOI Summary Response Template

At the end of this template you will be asked to attach your detailed business plan for commercialising MLC.

Section 1 – General Respondent Information	
a) Name of respondent.	Name
b) Structure (eg. partnership, consortium, limited liability company, trust).	Structure
c) Domicile.	Domicile
d) Turnover (per annum in AUD).	Turnover
e) Number of Employees.	Number of Employees
f) Percentage of turnover derived from international sources.	% International Revenue
g) Industry sector.	Sector
h) Briefly describe your organisation's mission and why you are interested in commercialising Siromat.	
Enter your response here	

Section 2 – Experience in commercialising similar technology
a) Have you had previous experience in developing a concept demonstrator into a market ready product? If yes, briefly provide details.
Enter your response here
b) Briefly describe your proposed application and path-to-market for MLC, including your business model.
Enter your response here
c) Briefly explain your plans to develop and manufacture the MLC device (including associated hardware, software and systems).
Enter your response here
d) Briefly explain your plans to provide end-to-end support (including technical support) for customers using MLC.
Enter your response here

Section 3 – Financial capacity
a) Briefly outline your proposed model for financing the development of MLC.
Enter your response here
b) Outline your proposed model for distributing returns to CSIRO (e.g. through royalties under a license agreement; upfront) including proposed figures or percentages where appropriate.
Enter your response here

Section 4 – Proposed customers for Siromat
a) Outline the market sector(s) you intend to target with MLC and explain your proposed access to those customers.
Enter your response here
b) Briefly describe how your proposed application of MLC would benefit and add-value to your organisation. Specifically, how will MLC complement your current products and services?
Enter your response here

Attachments

Please attach the following documents:

1. Your proposed three year business plan for commercialising the Technology.
2. Your organisation’s financial statements for the last three years.
3. Any relevant business references.
4. Any other relevant documentation or proof of the above.

CTFT Business Rationale for Patenting a Technology

Short Title: Modified Lint Cleaner
Name(s): Method and Apparatus for Cleaning Cotton

Action	**Response**
Explain central business proposition	That CTFT continues patent and development of the modified lint cleaner (MLC) in order to realise: • Potential licensing revenue from manufacturer and. • Benefits specific to Australian cotton industry.
Demonstrate strategic fit	The direct and measurable benefit for Australian industry is as per the CRDC 2003 – 2008 and continued in the 2008 – 2013 Strategic Plan; "To add value to the Australian cotton industry through evolved and new premium products in transformed supply chains"; specifically outcomes of "Processing and Improvements" in gin engineering research to secure the quality of (Australian) premium cotton. The technology delivers on the bio-economy objective(s) of CSIRO Theme 1040 by means of developing technologies needed to maintain and improve the current cotton industry and to enable its transformation into a source of higher-value cotton.

Identify major market opportunities to be exploited	In 2008 Australia and USA will produce ~15% of world's cotton with over two thirds of this exported into discerning markets. Fibre quality amongst export producing nations needs to improve to maintain viability of cotton growing industries. This has been well documented. The MLC works to reduce fibre damage during ginning – this has been documented.
	
	Australia and USA operate the world's most efficient and 'damaging' gins (AUS @ 70K bales/gin and USA @ 25K/gin). There are >5200 existing controlled-batt saw lint cleaning systems in Australia (>400) and the USA (>4800). These are all potentially modifiable according to the MLC design.
	
	Potential Licencees are:
	1. Australian (agricultural) machinery manufacturer
	  a. Existing company
	  b. New spin-off company
	2. USA Ginning Manufacturers
	  a. Lummus Corporation: http://www.lummus.com/
	  b. Continental Eagle: http://www.coneagle.com/

Identify existing or potential competitors and price points	See above USA gin manufacturers, in particular the Lummus Sentinel Lint Cleaner, which gives similar benefits as MLC, although replaces rather than modifies existing controlled-batt saw lint cleaning systems. On this basis MLC is very price competitive; $10K for modification vs $80K for replacing lint cleaner.
What is the sustainable competitive advantage?*	MLC delivers significant improvements in fibre quality
What is the specific commercialisation path?	To be developed according to the attached letter to the CRDC.
Summarise IP issues	CTFT co-owns patent(s) for MLC with CRDC. Ownership of Project IP is shared after patent protection costs. Royalty returns will be shared between CTFT and CRDC in proportion to project investment; nominally 50:50.
Estimate timeframes and capital required for: Development phase Production Marketing	MLC trials to continue in 2008/09 with publication of results in peer review. Talks initiated with interested parties prior or around completion of trials – late 2008; early 2009. Trials of MLC to date have resulted in significantly improved fibre quality (length and SFC).
Additional resources - internal/external	

Estimate potential annual revenues (1 to 5 years) Show initial cost/benefit estimates	

***Sustainable Competitive Advantage**

Since 1990 CTFT has licensed Siroclear yarn clearer to Loepfe, Colored Lock sorter to Loptex and Laserscan to AWTA. The technologies have had strong patents and it has not been possible for industry to circumvent them. They technologies have become the international standard in the industry sector and the licencees have achieved dominant sales positions. The technologies have given the companies a long *term Sustainable Competitive Advantage* in the product areas through the combination of technical superiority, commercial value and monopoly rights of the patents.

Australian Government
Cotton Research and Development Corporation

PRELIMINARY RESEARCH PROPOSAL (PRP) FOR CRDC INVESTMENT 2009/10

Can this proposal be considered as part of the Corporation's tied project investment commitment to the Cotton CRC? *(Choose one.)*	***Yes***

Project Title: **(15 words maximum)**	**New fibre conveyance system for Australian cotton gins (Ginning I)**

Start Date: (dd/mm/yyyy)	1/07/2009	**Cease Date: (dd/mm/yyyy)**	30/06/2010

Please refer to CRDC's 5 Year Strategic Plan for the following.	
CRDC Program:	**CRDC Strategy: (Select most appropriate Strategy for chosen Program & enter full wording of Strategy here.)**
1. Value Chain	1.2.1 Identifying opportunities for improvements in fibre quality and cotton seed properties

ADMINISTRATOR CONTACT DETAILS:

Title:	Ms	First Name:	Jo	Surname:	Cain	
Organisation:		CSIRO Plant Industry				
Mailing Address:		ACRI, Locked Bag 56, Narrabri NSW 2390				
Phone Number:		02 6799 1500	Fax Number:		Email:	jo.cain@csiro.au

PRINCIPLE RESEARCHER CONTACT DETAILS:

Title:	Mr	First Name:	Fred	Surname:	Horne	
Organisation:		CSIRO Materials Science and Engineering				
Mailing Address:		PO Box 21, Belmont, VIC 3216				
Phone Number:		03 5246 4000	Fax Number:	03 5246 4057	Email:	fred.horne@csiro.au

PROJECT CONCEPT & RATIONALE:
Why should CRDC invest in this project on behalf of the industry? (Max 1,999 character limit)

The ginning process has a negative impact on fibre length and nep levels chiefly by the interaction of lint cleaner saws on the dense fixed batt of fibre formed at the lint cleaner condenser. Whilst mechanical approaches can be used to to lessen fibre breakage at this point, e.g. like the mechnical elements employed in the CSIRO Modified Lint Cleaner (MLC), the moisture content of the fibre plays an equal, or depending on the particular cotton quality, a more important role in preserving fibre length. Cotton above a certain moisture content, i.e. > 6.5% but less than 7.5%, is more resilient to the forces applied during lint cleaning. Currently, large volumes of air are used to transport lint from the gin stand to the lint cleaner; this air is separated from the cotton at the lint cleaner condenser when the batt is formed. As a result of this process there is a large moisture diffusion gradient at the condenser between moisture bound to the cotton and the moisture equlibrium of the air. The effect is that cotton transported by air loses a significant amount of moisture, which impacts on its ability to withstand the forces applied by the lint cleaner saw.

The aim of this project is to examine new fibre transport mechanisms between the back of the gin stand and the lint cleaner in order to reduce the amount of moisture lost from fibre and/or introduce the ability for the fibre to be conditioned prior to cleaning. The primary objective of this research is to examine and model new concepts for conveying cotton between the gin stand and lint cleaner saw. Other potential benefits include a more even batt onto the saw (further reducing breakage and nepping), which could lend the fibre to other quality inspections, a reduction in energy required to run gins (currently 40% of the energy used in gin operation is consumed by air transport fans) and a more uniform moisture profile in cotton bales.
The outcomes of this project are aligned with the industry's current strategic direction of understanding and managing fibre quality in the post-farm gate sector, with particular emphasis on realising the potential quality of new extra long staple Upland cottons currently being developed by CSIRO.

BASIC DESCRIPTION OF PROJECT:
Include brief coverage of design, methodology, linkages to other research, collaboration and expertise of principle researcher. (Max 1,999 character limit)

The best option to replace air transport of fibre from the back of the gin stand to the lint cleaner is a covered belted or roller conveyor. Initial assessments indicate that gin productivity can be maintained; thus the focus for this research is the design and implementation of a model machine that is capable of moving the same amount of lint on a relative scale to that of an industrial machine, and that is able to feed a pre-condensed batt o fibre onto the saw of a fixed-batt saw lint cleaner. Emphasis in the design will be given to the accumulation of an even, uniform batt that can be exposed for an extended period, i.e. a multiple longer than the current one second transport time between the gin stand and lint cleaner, to humidified air enroute to the lint cleaner saw.

Design options would be comprehensively checked and then developed and built into working model to demonstrate the applicability of the system. The design of the conveyor would be constrained to fit within existing gin plant without significant disruption to the current process flow.

The project uses expertise and knowledge developed during the CRDC and CCC CRC MLC and Moisture Sensor projects and the proposed projec supports developments that have come from these projects. Like the outcomes of previous ginning projects at CSIRO collaboration with individual gins and the Australian Cotton Ginners Association is key to developing a new technology acceptable to the industry. The principle researcher is Mr Fred Horne who has spent 35 years in wool and cotton fibre processing and research roles. Mr Horne will be assisted by Dr Stuart Gordon and an under-graduate mechanical engineering student.

R&D OBJECTIVE(S) & EXPECTED SCIENCE and INDUSTRY OUTCOMES: (Max 1,999 character limit)

The objective of this research is to devise an innovative method of transporting ginned lint doffed from the gin saws to the lint cleaner without air and thus without moisture loss, and to include the potential flexibility of being able to condition fibre to a level that improves the resilience of the fibre to the forces applied in the fixed batt saw lint cleaner.

One condition of the application should be that existing gin and lint cleaning systems require changes that can be made largely retrospective to any current system, and without great cost to the ginner. Aside from the preservation of moisture, the effect of slowing the fibre batt and increasing its density beween the gin and lint cleaner will enable better application of of in-line quality sensing systems for the gin, e.g. the application of CCD cameras for appraising classing grade, trash and colour.

PROPOSED R&D ADOPTION/COMMERCIAL PATHWAYS: (Max 1,999 character limit)

The outcome from this project will be a proof-of-concept that will require further testing and development in the industrial situation.

PRELIMINARY BUDGET (exclusive of GST):

Investment Per Year	2009-10 $	2010-11 $	2011-12 $	TOTAL $
CRDC Cash	25,762			$25,762
Cotton CRC Other Cash				$0
Research Provider Cash	25,762			$25,762
Other Cash				$0
TOTAL CASH INVESTMENT	$51,524	$0	$0	$51,524

CRDC In-Kind		0	0	$0
Cotton CRC Other In-Kind				$0
Research Provider In-Kind				$0
Other In-Kind	5,000			$5,000
TOTAL IN-KIND INVESTMENT	$5,000	$0	$0	$5,000

TOTAL OF ALL INVESTMENT SOURCES (CASH & IN-KIND)	$56,524	$0	$0	$56,524

Applicant's signature: ……………………..

Date: ....

Thank you for your submission.
Feedback will be provided to you by 30 November, 2008

Transporting Lint to the Lint Cleaner from gin stand

Background

At present the Lint is transported to the condenser above the lint cleaner via air duct. The lint is push by air from the doffer brush and pull by air from fan at outside the condenser.
This has several disadvantages-

- As the lint reaches the condenser the air is separated from the lint resulting in a loss of moisture. From experience if the lint dries below 5% regain there is a possibility of damage to the lint resulting in problems further in the processing line.
- The lint may become entangled if it moves in a rolling action within the air duct. This may result neps and short fibre.
- The cost of using air as the transport medium is relatively high.
- The lint does not move as a constant mass along the length of the duct. Is the lint spread evenly across the duct?.
- The conditions within the duct can vary, depending on the environmental conditions. This is because the air is fed directly from the gin which is not a conditioned area.
- The speed of the lint in the duct is 22m/sec, and there is only 5 metres from the gin stand to the lint cleaner. This means there is little opportunity to introduce moisture at this point.

Proposed Design for New Transport System.

- Instead of using air to transport the lint, the proposed model uses a conveyor belt.
- The surface speed of the condenser drum is 48m/min. Therefore if the speed of a conveyor belt is also set at 48m/min, the lint batt weight will not change

For example: In a 2. 4metres wide gin which is produces 12 bales per hour, there would be 0.8kg/sec of lint being placed on the conveyor.

Advantages of Using a Conveyor System

- The conveyor can be totally enclosed in a controlled environment which can be maintained. This is not possible in an air duct where the air itself strips the moisture from the lint on separation of air from lint.
- The cost of using this system is markedly reduced from attempting to condition the total gin environment.
- As the fibre is held between two perforated belts (see Figure 1), there is no opportunity for the lint to become entangled.
- . The lint would remain on the conveyor for 4 secs. This is enough time for the lint to absorb moisture.

This is an attempt to create an even lint batt going into the saw with a constant regain. The aim is to improve production by limiting opportunities for lint damage. Need reports that show high regain improve lint. Report on feed rate to lint cleaner saw showing advantages of set feed rates. If the bat come is uneven feed rate will chain.

Description of Conveyor System

The lint is blown into the conveyor duct using the doffer brush. Lint hits the perforated conveyor belts with the air passing through the belts and out via a dust collection unit. The lint is sandwiched between the two belts moving into the controlled atmosphere and passing up to the top of the lint cleaner, before dropping into a holding zone above the feed rollers.

Refer Figure 1.

At point labelled 1- a superjet cleaner may be installed

At point labelled 2- a levelling device may be used to spread the lint evenly across the belt.

At point labelled 3- an auto levelling unit may be used as the same design as used in a cotton card.

Figure 1 – Proposal for a new fibre conveyor system.