The *Journal of Cotton Science 21:40–50 (2017)*
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ENGINEERING AND GINNING

Survey Results of the Research Needs and Requirements of the Ginning Industries in Australia and the United States

M. H. J. van der Sluijs* and Greg Holt

ABSTRACT

A survey of four questions was sent to members of cotton ginning associations in Australia and the U.S. to determine what issues and problems need to be addressed and where their respective research institutions should focus their time, money, and energy. Responses to each question were similar between the two countries as both have highly mechanized approaches to production, harvesting, and ginning. Thus, issues associated with automation, labor, moisture, fiber quality, utilization of cotton byproducts/ waste, and plastic contamination were raised. Responses that differed between the two countries were related to issues associated with the adoption or lack of adoption of certain technologies. The prime example is the adoption of the new John Deere onboard round-module building harvester, which the Australian industry has, in a relatively short period, implemented into its production and ginning systems. In contrast, the U.S. industry is starting to scale up adoption of this technology and as such is experiencing the challenges that come with the implementation of a new technology. Consequently, U.S. gins rated the handling of the plastic wrap used by the onboard module harvester of greater importance than the Australian industry, which has more experience with this issue. Overall, the survey should assist in focusing and coordinating the research efforts of both countries in addressing research and development priorities for their respective industries.

The process of ginning cotton involves separating the fiber from the seed, which was done historically by human- and animal-powered devices. As this was laborious and slow, the process has since been replaced by higher capacity machines powered by fuel and electricity, with the modern ginning process a combination of thermal, pneumatic, and mechanical processes (Anthony and Bragg, 1987). The layout, size, type, and technology of the gin can take on a number of forms depending on the type of cotton grown, the production and harvesting conditions, economic factors, as well as consumer requirements (Estur and Gergely, 2010).

Cotton ginning facilities are an essential part of the cotton production pipeline and are a focal point of regional cotton communities and their location, resources, and contributions to local economies are critical to the cotton industry. In light of the importance of the ginning sector in the cotton value chain, a survey was conducted in 2013 in the U.S. and 2014 in Australia with the objective of identifying issues that both the Australian and U.S. ginning industry see as impediments in the cost and quality of their production and thereby assist in prioritizing research and development in this respect.

Overview of the Australian Ginning Industry. In Australia, cotton gins are located in both New South Wales (NSW) and Queensland (Qld) in close proximity to cotton growing areas (Fig. 1). Because Australia produces predominately Upland cotton (*Gossypium hirsutum* L.), saw ginning is the most prevalent gin technology; with 41 super-high-capacity saw gins. In the past, small volumes of extra long staple (ELS) *(Gossypium barbadense* L.) cotton has been produced, which has been ginned in one of the three roller gins that operate in the western part of NSW. More than 90% of all cotton is grown under irrigation, with the rest grown as rain-fed (dryland). All cotton is mechanically harvested mainly by spindle pickers, whereas some rain-fed cotton is harvested by strippers. The cost of cotton production in Australia is one of the highest in the world, at almost three times the world average (ICAC, 2013). Nevertheless, high yields (average of 2,259 kg/ha) and high-quality cotton fiber ensure that the industry has remained competitive (ICAC, 2016). The cost of

M.H.J. van der Sluijs*[1,2], [1]CSIRO Manufacturing, [2]Deakin University, 75 Pigdons Road, Waurn Ponds, Geelong, Victoria, 3216, Australia and G. Holt, USDA-ARS Cotton Production and Processing Research Unit, 1604 E. FM 1294, Lubbock, TX 79403
*Corresponding author: rene.vandersluijs@csiro.au

production is a critical issue for the cotton grower, with harvesting on average contributing 9% and ginning on average contributing 16% to the total cost of production, it is hardly surprising that there is a focus in Australia on making efficiency gains in harvesting and gin investment (ICAC, 2013). As the construction of gins is expensive, there has been a trend in Australia, as in the U.S., to replace smaller gins with larger, more productive gins (Ashley and Valco, 2014) that are capable of producing more than a 1,000 bales per day and more than 100,000 bales per season.

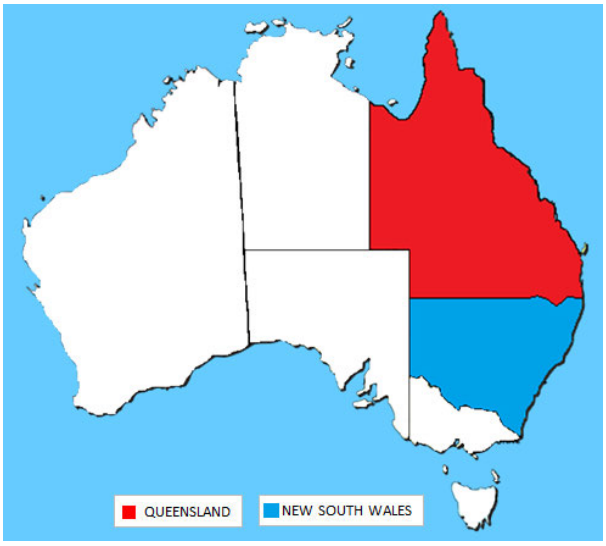

Figure 1. Map of Australia showing the cotton growing areas in the country, Queensland (Qld) and New South Wales (NSW)

Seventy-one percent of the saw gins are located in NSW where the majority of the cotton growing areas in Australia are located (> 60%), with the remaining 29% located in Qld. The three roller gins are all located in NSW.

Overview of the U.S. Ginning Industry. In the U.S., cotton gins are located in every state across the southern continental U.S. (Fig. 2). Upland cotton is the primary species of cotton grown in the U.S. Of the 601 active cotton gins in the U.S. (USDA, NASS, 2016), 575 are saw gins for processing Upland cotton and 26 are roller gins for processing ELS cotton. The roller gins are all located in the Southwest and western U.S.

Similar to Australia, the cost of cotton production in the U.S. is high with regards to the market price of cotton and cottonseed. Ginning accounts for approximately 25% of the cost of production (NCCA, 2016a). With ginning being almost a quarter of the cost of production, the focus of any organization working in cotton, harvesting and ginning research should be to maximize producer returns and minimize costs, which vary according to regional factors such as production methods, water, weather, and labor costs.

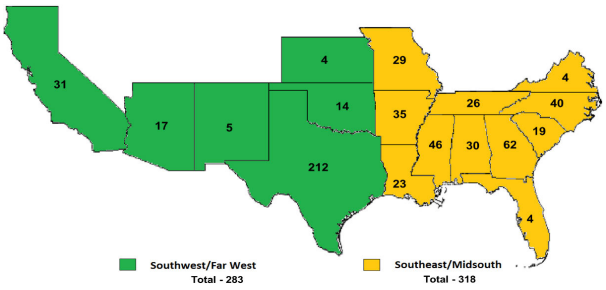

Figure 2. Map of the cotton belt of the U.S. showing cotton growing states and the number of cotton gins in each (based on USDA, NASS data, 2016).

Methods of production and harvesting have a large impact on gin costs. Rain-fed cotton farming accounts for 57% of the U.S. crop, with the remaining 43% irrigated. The two types of mechanical cotton harvesters used are spindle pickers (herein referred to as pickers) and strippers. Pickers are more discriminating and do not harvest as much cotton plant material as a stripper resulting in 36 to 57 kg of plant material harvested for every 227-kg bale of lint, whereas cotton strippers produce 159 to 367 kg of plant material for every bale of lint (Baker et al., 1994; Wanjura et al., 2015). Across the U.S., approximately 40 to 60% of the crop is harvested with pickers (calculated from NASS, 2002-2012). Each of these growing and harvesting variables results in diverse research and development challenges.

In the U.S. there are three cotton ginning laboratories, operated by the USDA, Agricultural Research Service. They are located in Stoneville, MS; Las Cruces, NM; and Lubbock, TX and address the harvesting and ginning research needs for the country.

MATERIALS AND METHODS

In light of the importance of the ginning sector in the local cotton value chain, a survey was conducted in 2013 in the U.S. and in Australia during 2014, with the objective of identifying issues that the ginning industries saw as impediments in the cost and quality of their production and to assist in prioritizing research and development in this respect. The survey, which consisted of four questions, were:

1. In your estimation, what are the top three research needs of the ginning industry?
2. What are the top three research needs of your gin?
3. In your opinion, what is the biggest improvement needed in modern day ginning?
4. What is the biggest improvement needed in harvesting cotton?

In Australia, the survey questions were emailed directly to the members of the Australian Cotton Ginners Association. Responses were received by CSIRO Manufacturing from 71% (29 of 41 gins) of the gins and as such the information gathered by the survey can be considered to be representative of the Australian cotton ginning industry. In the U.S., questions were emailed to members of the various regional cotton ginning associations (Southeastern, Southern, Texas, Arizona, and California). Responses were then forwarded to the USDA-ARS, Cotton Production and Processing Research Unit in Lubbock, TX for organizing and analysis. There was a 39% response rate from the regional ginning associations corresponding to 234 gins.

A qualitative method of analysis of the survey results was employed, with the overall results and results by region reported for each country. Survey responses were broken down into the 17 research need categories shown in Table 1. The category titles are shortened in the graphs to make reading and interpretation easier.

Table 1. Response categories created when collating all the data from the survey. The original category created and the name used (Use Name) for all the figures to help readability

	Original Category	Use Name
1	Adding value/by products/waste	Add Value
2	Automation/labor	A/L
3	Bale packaging	Bale Pack
4	Contamination/Plastic	C/P
5	Air Emissions/Control	Emissions
6	Energy	Energy
7	Marketing	Market
8	Miscellaneous	Misc.
9	Moisture/Drying	Mo/Dry
10	Module Handling/Unwrapping	Module
11	Production/Processing Costs	P/P Costs
12	Quality/Classing	Quality
13	When repairs are needed	Repairs
14	Safety	Safety
15	Trash/Bark	T/B
16	Transportation	Transport
17	Variety Issues-smaller seed	Variety

For the first question, all three responses were combined regardless of whether the response was listed first, second, or third; this change was made for ease of compiling and reporting the data. Therefore, in the figures showing results for the first question, the percentage represents the number of times that response was received in regards to the total number of responses.

Even though a few of the surveys returned were not completed, for surveys that were not complete, the responses supplied were tallied and the questions not answered were considered as "non-responsive" or "no answer". Responses were placed in the miscellaneous category, when they did not fit into any of the other categories. Some examples of responses that were classified as miscellaneous include: 1) cotton flow and warehousing efficiency, 2) online used parts directory for gins, 3) how to provide better customer service, 4) proper timing of defoliation and harvesting, and 5) coordination between gin and field. Figures 3 through 11 show the responses to the four questions asked in the survey.

RESULTS

Question 1. In your estimation, what are the top three research needs of the ginning industry? As can be seen in Fig. 3, the top four research needs of the ginning industry in Australia were 1) adding value (15%), 2) quality (15%), 3) contamination (13%), and 4) automation/labor (13%). In the U.S., the research needs were 1) automation/labor (15%), 2) round-module handling (12%), 3) production and processing costs (11%), and 4) moisture (10%). Hiring sufficient labor is a common problem for both countries and illustrates the importance of minimizing both the cost and unknowns associated with labor. Most of the automation responses referenced the challenges of obtaining and maintaining a labor force that was willing to work and that could be depended upon to stay the season. Also, the cost of labor continues to increase in both Australia and the U.S. The issues associated with labor, such as: consistency, dependability, liability, wages, insurance, and safety cause management to look to automation to help control operating cost, improve safety, and maintain consistency in day-to-day operations.

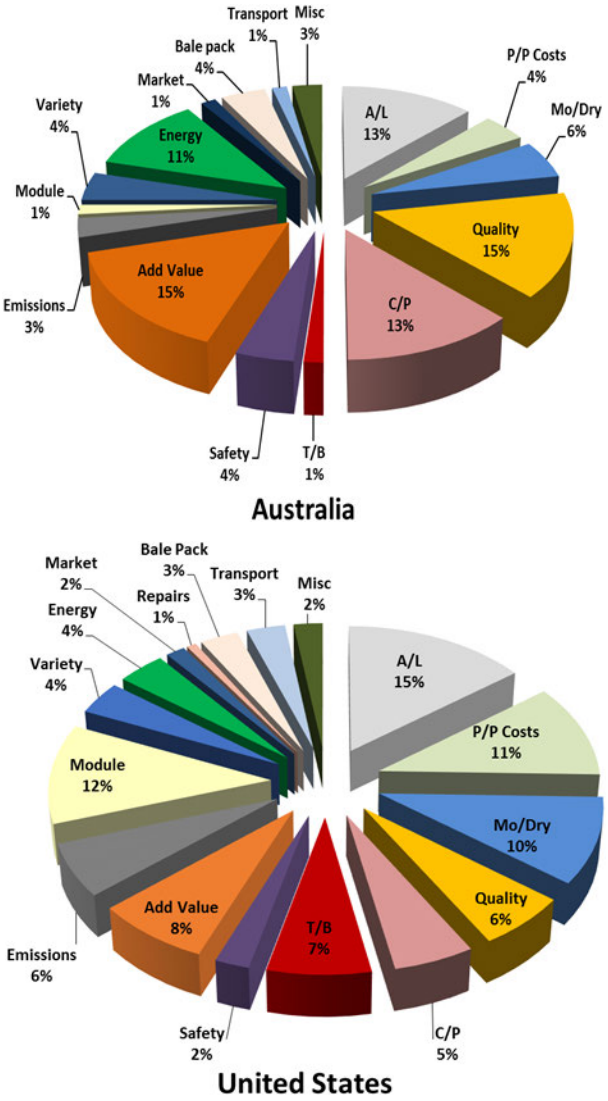

Figure 3. Overall response to research needs of the cotton ginning industry in Australia and U.S.

The responses concerning the add-value category reflect ginning company issues encountered with the quantity and quality of cotton gin byproducts that is generated during the ginning season. The byproducts are often defined as any organic material other than the cotton lint and seed. As it is common practice for gins to combine all the waste generated from the various gin processes, evaluation of the potential value of cotton gin byproducts is difficult. In Australia, the majority of gins compost and/or mulch the cotton gin byproducts, before returning it to the land, with a small number of gins stockpiling the cotton gin byproducts on site. Although composting disposes of the byproducts, it is time consuming and uses water, with the gins earning little, if anything, from their efforts; hence, they are seeking alternatives for the use of cotton gin byproducts, which can add value. In the U.S. the search for additional value is important but successful utilization is regional, with the Southwest area using the material as a source of roughage in confined livestock feeding operations. Other areas of the U.S. utilize the material similar to Australia, composting and/or returning to the land.

The module handling/unwrapping responses for the U.S. are the result of the release in 2008 of the John Deere (JD) (Moline, IL) onboard module building harvesters that wrap compacted seed cotton into round modules in plastic (polyethylene) film for protection during storage and handling. The Australian industry has adopted this technology and is not experiencing the issues associated with changing from conventional modules to round modules wrapped in plastic as the U.S. industry is. It is believed that as more growers and cotton gins in the U.S. become more familiar with round modules, this response will more closely mirror the importance seen in Australia. Likewise, the emphasis on contamination will replace the issues with module handling and unwrapping because the plastic wrap is the primary concern with the Australian response associated with contamination.

Whereas Australian cotton generally is viewed worldwide as a quality fiber purchased for a premium with the intention of producing high-quality, fine-count ring-spun yarn; quality, the second research need listed for Australia, can be further improved by direct action during harvesting and at the gin. Ginning quality particularly at the lint cleaner, is important in the maintenance of fiber length and in the reduction of neps and short fiber content. These are priorities in the current premium quality fiber market. To this end, 32% of the gins installed in Australia have installed the Uster® Intelligin system that enables them to automatically measure trash and color grade so that the number of lint cleaner passages and the settings can be optimized to meet the needs of both the grower and the spinner.

Production and processing costs, the third ranking priority for the U.S., is of interest to growers and gin managers in both countries due to low market prices of cotton in comparison to the input costs. Even though some of the

responses associated with this category can be addressed in conjunction with other categories such as automation/labor, energy, and others, it was listed separately in the responses indicating that even though the other categories might have elements associated with this response, the respondents saw it as a separate item. In the U.S., the value of production less operating costs has dropped from $US43.16 per ha ($106.84/ac) in 2012 to $19.69/ha ($48.76/ac) in 2014 (NCCA, 2016a). This reduction in value compared to other row crops is why cotton acreage in the U.S. has steadily declined over the last couple of years (NCCA, 2016b).

The number four priority of the U.S., moisture, was footnoted in many responses with the issue of growers harvesting cotton too early. Either the cotton was too green (i.e., not allowed to desiccate fully) or harvested when there was too much surface moisture on the seed cotton (i.e., too early in the morning or too late in the evening). High moisture issues in seed cotton require more energy to dry the cotton prior to ginning and also can negatively impact quality by poor trash removal and a change in color.

Figure 4 compares and contrasts the responses to question 1 from the different regions of Australia and the U.S. For NSW the top-rated response was add value, at 19%, followed by quality and contamination, both at 13%, and energy and automation/labor at 11%. At 38%, the top research need for Qld was quality, followed by automation/labor at 15% and contamination and energy, both at 10%. For the U.S., automation/labor at 15% was the top research priority for both the Southeast/Midsouth (S/M) and Southwest/Far West (S/FW). For S/M, automation/labor was followed by moisture at 12%, add value and round module handling both at 9%. For S/FW, round module handling was tied with automation/labor at 15% as the top priority followed by production and processing costs at 11% and then dust, trash, quality, and moisture, all at 8%. As illustrated in the graphs, different regions of a country can have different priorities/concerns based on a wide variety of factors associated with the customer base of the cotton gins in the region such as water availability, weather, size of production area, distance to cotton gin, and type of harvesters, just to name a few. For example, NSW had six responses not listed by Qld: transportation, round module handling, production and processing costs, moisture, and safety. Qld respondents listed trash and bark, not cited by those in NSW, which is a specific quality issue. Likewise in the U.S., the gin managers in the S/M listed research priorities of repairs, market, and variety; none of which were rated by the S/FW.

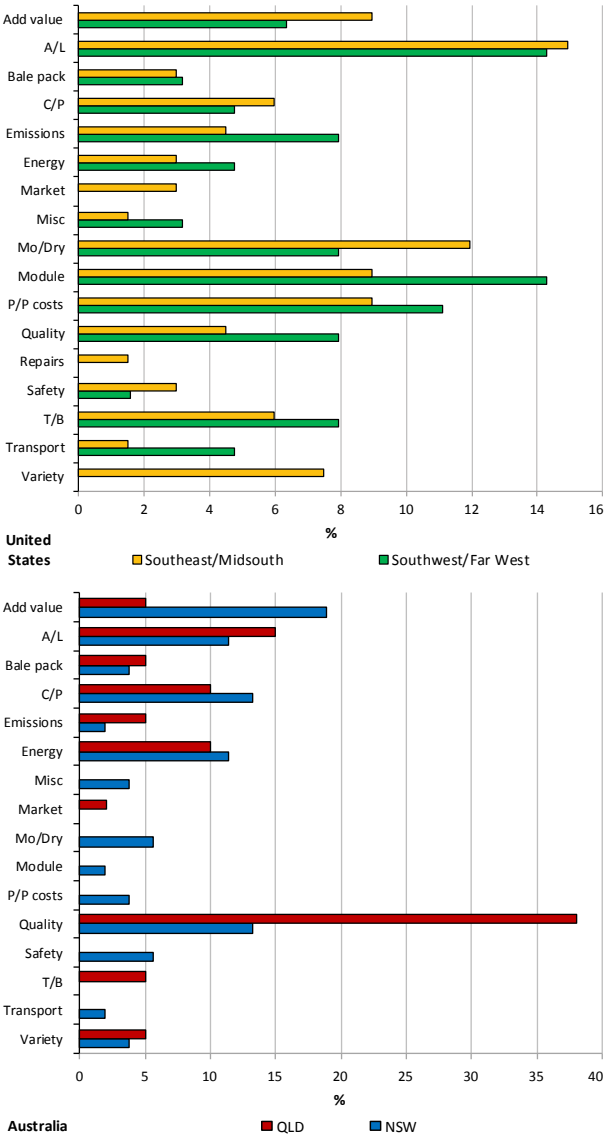

Figure 4. Response by region to the top three research needs of the cotton ginning industry in Australia and U.S.

Question 2. What are the top three research needs of your gin? As can be seen in Fig. 5, at 18%, automation/labor was rated as the top research priority needed in Australia, by the individual gins followed by add value and energy, both at 13%, and then production and processing costs at 11%. At 20%, automation/labor also was rated as the top research need by the individual gins in the U.S., followed by moisture at 15%, production/processing costs at 11%, and trash at 10%.

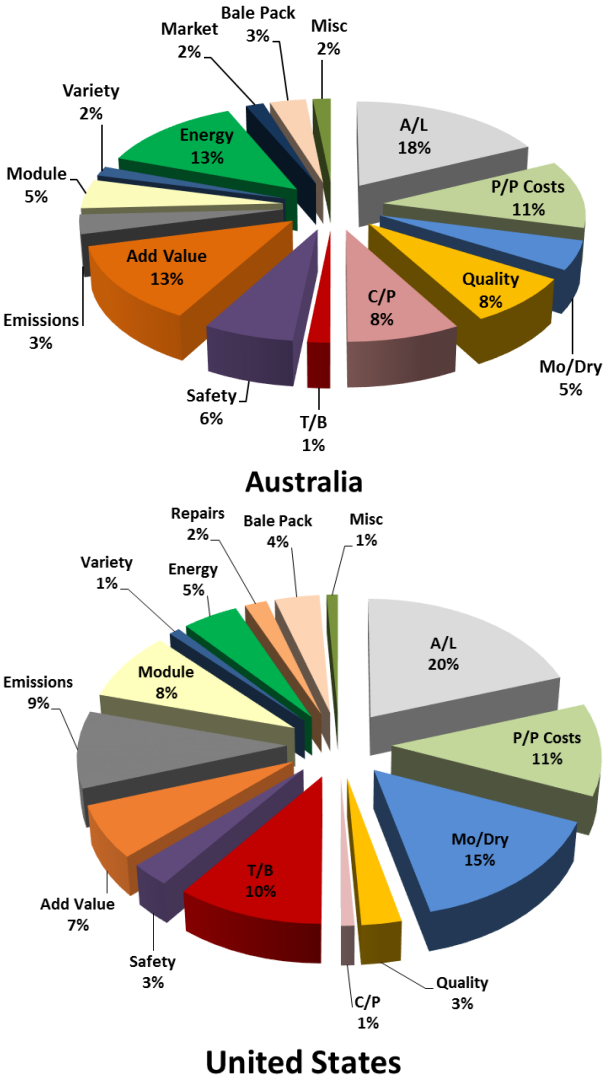

Figure 5. Overall response to research needs of your cotton gin in Australia and U.S.

The responses for the individual gins (question 2) mirror, for the most part, the responses for the ginning industry as a whole (question 1). The differences shown in Fig. 6 illustrate how the perception of what the research priority needs of the industry as a whole (question 1) can vary from what the individual gin priority needs are. For example, the Australian responses to question 1 had quality tied as the number one need (15%), but it was fourth on an individual gin basis (8%). Conversely, the Australian ginners saw a greater need individually for automation/labor, production/processing costs, and round module handling than they saw it for the industry. In the U.S., round module handling was the number two response (12%) on a national basis but individually it was rated sixth, at 8%. There were two items that made the list on a national level that did not show up on an individual level: transport and market. Transport was listed on a national level, but not individual, for both Australia and U.S. Sometimes, the differences between national and individual research needs are based on perceptions formed by industry news, trade literature, regional issues facing local growers/ginners, or in discussions at industry meetings with other gin managers.

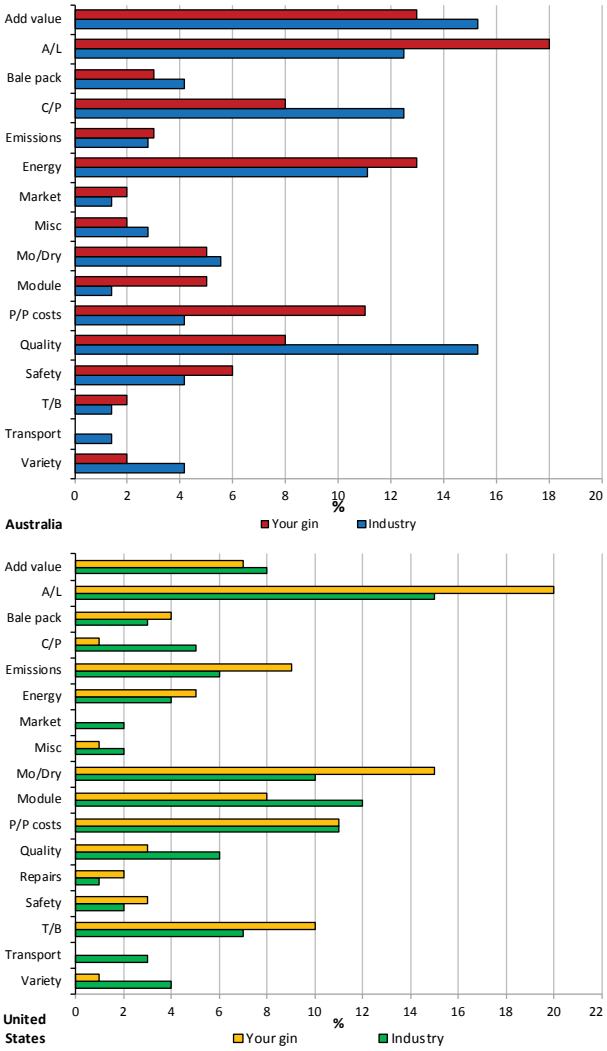

Figure 6. Differences between industry and individual gin research needs in Australia and U.S.

When looking at the different regions of the country for question 2 (Fig. 7), the top Australian responses for NSW were automation/labor, energy, and production/processing costs all at 14%, followed by add value at 12%. The top research need for the individual gins located in Qld were automation/labor, contamination, and quality all at 20% followed by energy and add value at 10%. In the U.S., the S/FW prioritized automation/labor (30%), moisture

and round module handling at 14%, followed by production/processing costs at 10%. The S/M areas prioritized trash and moisture as the top rated priority at 16% followed by production/processing costs at 13% and dust and automation/labor tied at 11%.

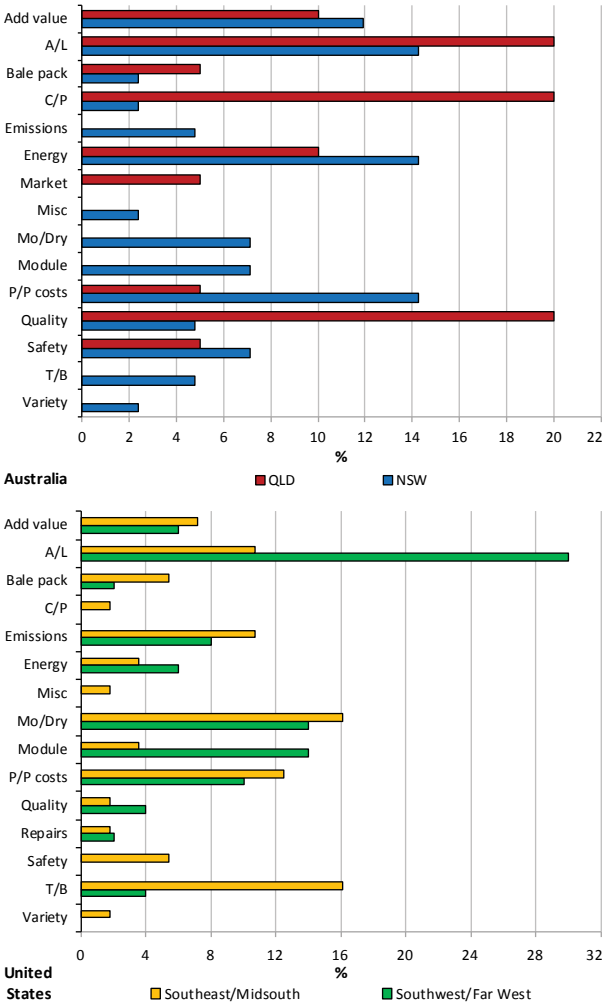

Figure 7. Response by region to the top three research needs of your cotton gin in Australia and U.S.

Question 3. In your opinion, what is the biggest improvement needed in modern day ginning? As can be seen in Fig. 8, at 17% each, the major improvement needed in modern day ginning for Australia were quality, energy, and production/processing costs, followed by automation/labor at 13% followed by contamination at 10%. At 24%, the U.S. rated production/processing costs as the major improvement needed in modern day ginning, followed by automation/labor at 16% and round module handling at 15%. Even though this question might seem similar to question 1, it was intended to have the ginners focus specifically on the ginning system as a whole rather than particular issues associated with their individual gins or the industry as they perceived it. That being said, the responses were similar to those received in question 1, with variations in the ranking of specific categories. One item of interest was the differences in ranking for two of the Australian responses: add value and production/processing costs. The Australian responses for question 1 had add value as a top priority but near the bottom (3%) for this question. Conversely, production/processing costs (4%) were one of the lower responses in question 1 and tied for the top priority (17%) for this question. In the U.S., a similar situation occurred between question 1 and question 3 for bale packing. The U.S. responses also saw safety increase from 2% (question 1) to 6% (question 3). At 24 % for production/processing costs, the individual ginner saw this as a greater need than what they saw for the industry as a whole.

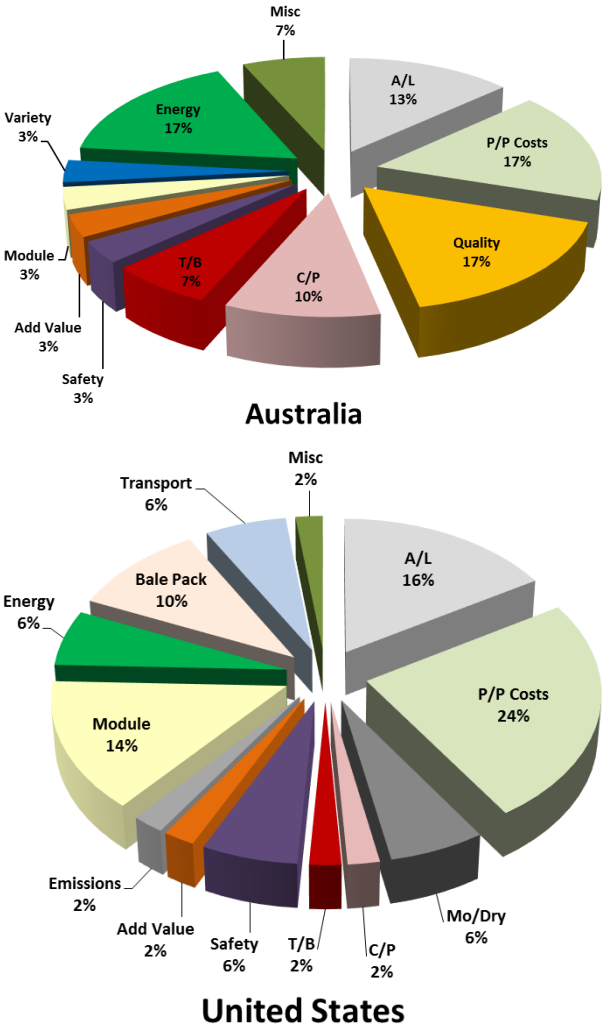

Figure 8. Overall response to improvement needed in modern day ginning in Australia and U.S.

As can be seen from Fig. 9, the responses varied greatly between NSW and Qld, with little agreement between the regions. The individual gins in NSW rated energy (22%), automation/labor, quality (17%), and contamination (13%) as the top research needs. The gins situated in Qld rated automation, safety, trash, production/processing costs, round module handling, and miscellaneous all at 17%. The differences between the two regions are in all likelihood due to the gins in NSW being generally newer, larger, and more automated, compared to those in Qld. Furthermore, the growing conditions in Qld can be more variable, resulting in higher processing costs with excessive trash and moisture content in the seed cotton. The U.S. rated production/processing costs as the most important research need for both S/M and S/FW at 28% and 22%, respectively, followed by round module handling for S/FW (20%) where more of the gins were adopting round module unwrapping systems at the time of the survey, and automation/labor (18%) for S/M. At 16%, automation/labor was rated as the third priority for S/FW, whereas for S/M it was bale packing at 13%.

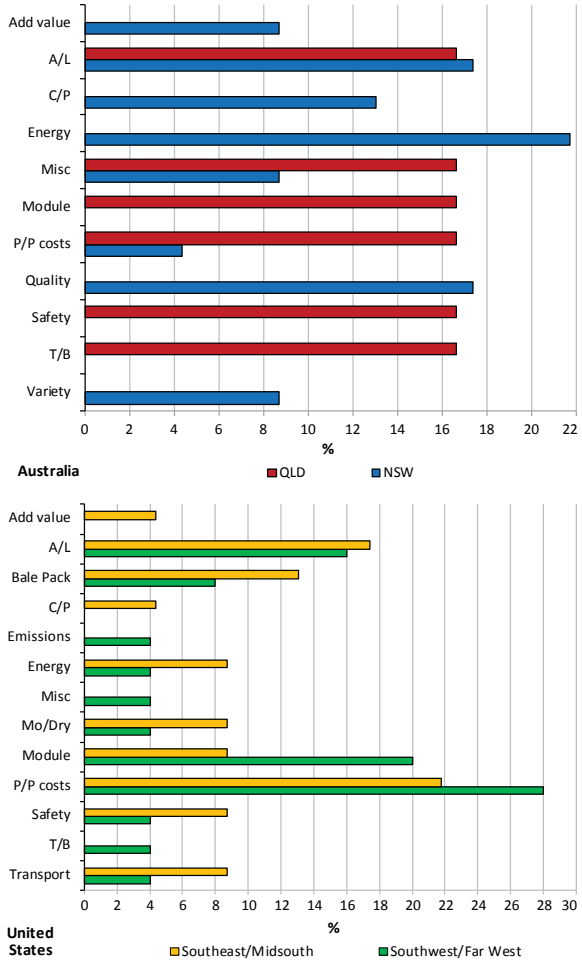

Figure 9. Response by region to the biggest improvement needed in modern day ginning in Australia and U.S.

Question 4. What is the biggest improvement needed in harvesting cotton? As can be seen from Fig. 10, at 35%, moisture (in terms of control and level) was rated as the major improvement needed in harvesting by the Australian ginning industry, followed by quality and automation/labor both at 16%, contamination at 13%, and trash at 10%. At 18%, trash was rated as the major improvement needed in harvesting by the U.S. ginning industry, followed by moisture and round module handling, both at 12%, and then quality and production/processing costs, both at 10%. The trash response in the U.S. corresponds to bark issues that have become more prevalent in certain areas in the past couple of years. Overall, the results are not surprising for either country. The JD harvesters with onboard module building capacity has been adopted rapidly in Australia, with these machines now harvesting in excess of 90% of the total Australian crop. Despite the advantages of labor and efficiency gains some concerns have been raised regarding seed cotton moisture, contamination, soil compaction, potential effect on yield of subsequent crops, and variability in quality (van der Sluijs and Krajewski, 2015; van der Sluijs et al., 2015; van der Sluijs and Long, 2016). It is thought that growers should be educated and take more interest in harvesting especially as a large proportion of harvesting in Australia is conducted by contractors.

In the U.S., moisture also is a concern for cotton ginners. This is due to issues such as difficulty in ginning, possible color change of lint in storage prior to ginning, potential damage to cottonseed, and difficulty in cleaning out leaf and other organic matter, caused by harvesting cotton when the moisture content is too high. Some of the issues are covered in other categories such as energy, trash, production/processing costs, and quality. When the moisture content is too high (≥ 12%), a cotton gin must reduce the ginning rate to process the cotton, thus increasing the cost per bale to the gin. Seed cotton at the correct moisture content (< 12%) is easier to clean, with growers less likely to experience color changes and discounts due to staining. Also similar to the comments for question 1 in regards to the U.S., is the round module handling issue becomes less of an issue as the technology becomes more prevalent and cotton gins have more experience dealing with round modules as happened with the Australian cotton gins.

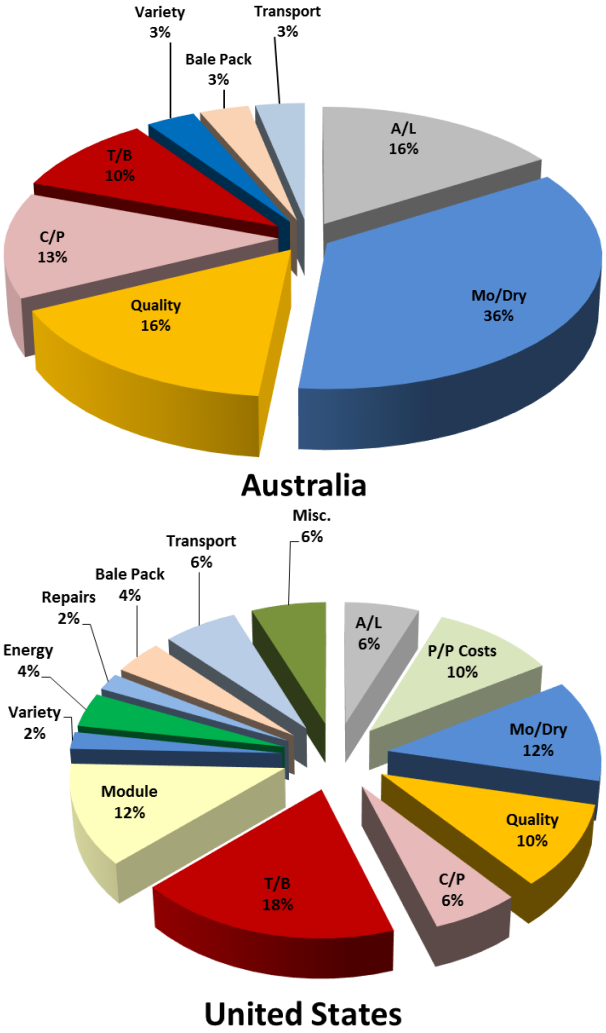

Figure 10. Overall response to improvement needed in harvesting cotton in Australia and U.S.

Figure 11 shows the responses by region to question 4. As can be seen from Fig. 11, Australian gins located in NSW rated moisture at 38% as the major improvement needed in harvesting, followed by automation/labor at 17% and quality and contamination, both at 13%. At 29%, both moisture and quality were rated as the major improvements required in harvesting by the gins located in Qld, followed by automation/labor, contamination, and trash all at 14%. NSW had several categories listed that were not included in the Qld responses, such as transport, bale packing, and variety, but at a low level.

In terms of automation/labor, the gins in NSW felt that growers should be more aware, better educated, and take more interest in harvesting and that the technology available with the new JD harvesters such as RFID, moisture control, and GPS, are not fully utilized. Some gins would also like the size and weight of the round modules increased, which would assist with transportation and logistics. In terms of variety, the gins in the southern growing areas of NSW expressed the need for earlier finishing varieties and, in terms of quality, achieve better fiber uniformity, by eliminating immature fibers.

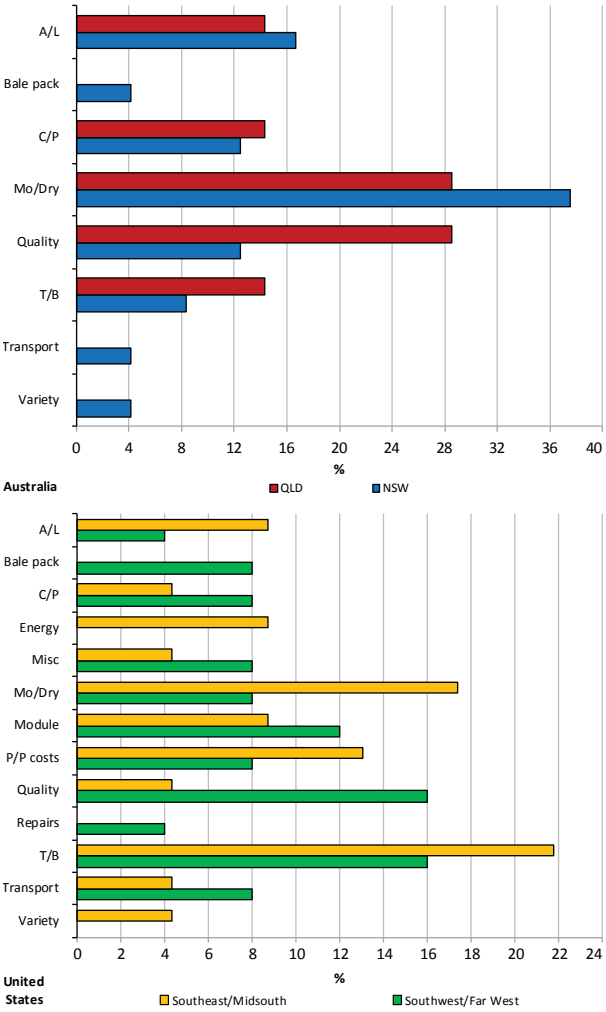

Figure 11. Response by region to the biggest improvement needed in harvesting cotton in Australia and U.S.

In regard to U.S. ginners situated in the S/M, trash at 22% was rated as the major improvement needed in harvesting, followed by moisture at 17.5% and production and processing costs at 13%. The ginners in the S/FW rated both trash and quality at 16%, as the major research need for harvesting, followed by round module handling at 12%, and then transport, bale packing, contamination, moisture, production/processing costs, and miscellaneous, all at 8%. The trash, quality, and moisture responses are related to many ginners believing that growers should allow the cotton to properly dry/desiccate in the field prior

to harvesting. Ginners believe that growers often get anxious and either start too early or finish too late and harvest seed cotton that is not as dry as it should be for module storage. They wish the growers understood that the cotton gin cannot always fix high moisture issues. Gins are often blamed for issues that occurred during harvest with the expectation that the gin "can take care of it."

SUMMARY AND CONCLUSION

Surveys were conducted in 2013 in the U.S. and 2014 in Australia with the objective of identifying issues the ginning sectors in each country saw as constraints in the cost and quality of their production, and to assist in prioritizing corresponding research and development needs. Respondents to the survey were members of the cotton ginner associations in both countries. On average the top overall responses to each of the four questions, by country, were:

1. Top research need of the ginning industry?
   Adding value to byproducts/waste (Australia)
   Automation and labor (U.S.)
2. Top research need of your gin?
   Automation and labor (Australia and U.S.)
3. Biggest improvement needed in modern day ginning?
   A tie between production and processing costs and quality/classing (Australia)
   Production and processing costs (U.S.)
4. Biggest improvement needed in harvesting cotton?
   Moisture content/drying (Australia)
   Trash/bark (U.S.)

The responses for each question, illustrate the range of challenges being faced by the ginners in each country. For the second question, the top responses for both countries were identical, due to similar challenges faced by cotton gins handling seed cotton harvested by mechanical harvesters and using state-of-the-art ginning equipment. The increasing cost of labor and insurance, as well as the challenges of finding a workforce that is reliable, knowledgeable, and willing to work long hours in sometimes dusty conditions is becoming more of a burden on gin managers, creating a need for more automation to offset such labor related issues.

Differences in responses noted between the two countries can be attributed to the types of challenges being faced by the gin's customer base and/or the region of the country where the gin was located. One particular difference noted in the responses to the first question was the high priority of round module handling and unwrapping in the U.S. Since the introduction into the market place in 2008 of the JD onboard module building harvester, Australia has adopted the technology rapidly, with more than 90% of its crop now harvested with this technology. The U.S. has not adopted the technology as rapidly and is just now starting to deal with handling and unwrapping these modules. It should be noted that the areas of the U.S. that are currently heavily adopting the technology, Southeast and Southwest, were the areas with the largest percentage requesting research into round modules. As the U.S. ginners become more experienced with handling the round modules, the priority given to this issue will more than likely diminish.

Overall, the responses to the survey will help direct the research institutions in both countries in setting research priorities to address the current and long-term needs of their respective cotton ginning industries.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance of Amanda Sullivan, Teresa McKelvey, and Brice McKelvey in collating the data and producing the graphs. The authors also express appreciation to the generous cooperation of the various ginning institutions/companies.

DISCLAIMER

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