Queensland technical methods - Cropping (cotton)

Australian Biomass for Bioenergy Assessment

May 2018

This document is part of a series describing the technical methods used to publish the Queensland based data for the Australian Biomass for Bioenergy Assessment (ABBA) <arena.gov.au/projects/the-australian-biomass-for-bioenergy-assessment-project>. All documents in the series are available to view and download at <publications.qld.gov.au>.

What is the Australian Biomass for Bioenergy Assessment?

ABBA provides detailed information about biomass resources across Australia. This information will assist project developers make decisions for new bioenergy projects, and provide linkages between potential biomass feedstocks—through the supply chain—to end users. To achieve this, ABBA collects datasets, on a state- by-state basis, about the location, volumes and availability of biomass, and publishes them on the Australian Renewable Energy Mapping Infrastructure (AREMI) platform <nationalmap.gov.au/renewables>. ABBA is managed by AgriFutures Australia with funding support from the Australian Renewable Energy Agency (ARENA).

Why cotton industries?

The use of agricultural crop residues has been flagged as a potential resource for the production of bioenergy (Stuckley et al 2012). In cotton farming regions, there is significant potential for the by-products or cotton crop residues to be used to produce bio-energy. This includes cottonseed for biodiesel, cotton stalk and cotton gin trash (CGT) for ethanol and biogas or direct combustion (Chen et al 2013). An assessment of CGT in the 2009-10 harvest year across Australia identified a potential renewable energy resource equated to 78 million litres of ethanol (New South Wales Government 2012).

The residues from the cotton ginning process (cotton seed and CGT) are produced and concentrated at specific locations. Some cotton gins across Australia can generate up to 100,000t of CGT in a season with associated costs of approximately $60,000 in handling and storage (Hamawand et al 2016, Pittaway and Roberts 2000). CGT can be used in products that clean up oil spills, ethanol manufacturing (Cotton Australia 2017a) as well as composted in order to create a product suitable for broad acre farming (Roberts and Pittaway 2000). The direct reapplication of cotton trash to farms is strongly discouraged due to the risk of contamination of soil borne pathogens and pesticides.

Other cotton residues such as the straw or stalk left after harvest has also attracted attention in regards to its potential bioenergy use. Cotton straw is quite woody in nature and the energy content of the stalk has been compared to the energy content of other wood products (Coates 2000). However benefits of retaining cotton straw or stalk in the field includes managing for pest resistance and soil health (through carbon sequestration) (Hulugalle and Scott 2008).

What data about cotton industries is published by ABBA?

ABBA has published data about:

- Infrastructure – the location of cotton gins in Queensland
- Residues - the amount of seed and CGT produced from the cotton ginning process and the amount of cotton straw (or stalk) produced in the field.

Data about residues is published in an aggregated form at a local government area (LGA) level. This data is produced at a broad scale and is therefore not suitable for use at a local scale.

Infrastructure

The data published by ABBA indicates the location of cotton gins in Queensland which was originally published in 2013. This data is sourced from the Department of Agriculture and Fisheries Agricultural Land Audit data (ALA) <daf.qld.gov.au/environment/ag-land-audit>.

Residues

The cotton residues which are included in this assessment are:

- Cotton seed – the seed recovered after the cotton ginning process.
- Cotton gin trash (CGT) – sticks, leaves, burs, soil particles etc and other trash which are separated from the lint during the cotton ginning process.
- Cotton straw – residue or stalk left over in field after harvest.

Methods

The method to quantify cotton residues (seed, CGT and straw) was done through the following steps and is broadly outlined in Figure 1.

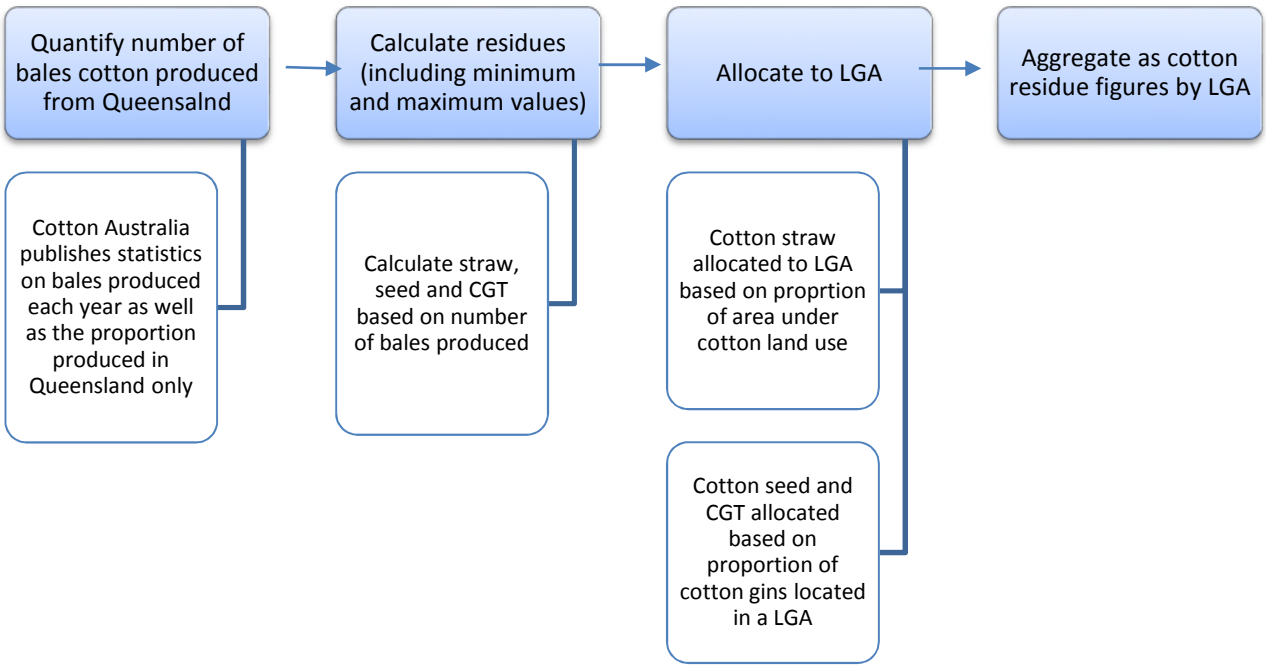

Figure 1. Process for estimating residues from cotton industries in Queensland

Step 1: Calculate cotton seed and cotton gin trash (CGT) residues.

Cotton Australia produces statistics on the number of bales produced in Australia each year (Table 1). The number of bales produced in Queensland for the past 5 years was provided by Cotton Australia (Cotton Australia 2017a)

Table 1. Number of cotton bales produced in Queensland between 2013 and 2017

Year	Total bales of cotton produced in Australia	% of cotton produced in Queensland	Number of bales produced in Queensland
2016/2017	3874675	38	1453564
2015/2016	2482535	39	969258
2014/2015	2234683	34	757714
2013/2014	3918865	37	1464135
2012/2013	4465910	35	1577009

Seed cotton is the cotton which is harvested and baled in the field and sent to a cotton gin for processing in order to separate the lint from the cotton seed and trash. The proportion of cotton lint, seed and CGT (the three products from a cotton ginning process) for one unit of seed cotton is separated as follows:

Generally, for one unit of seed cotton:

- 42% is lint
- 48% is cotton seed
- 10% is CGT

For example: If there is a 1000 kg seed cotton bale coming in from the field. 420 kg will end up as lint, 480 kg will be cotton seed and 100 kg will be CGT.

Therefore a standard cotton bale (the final cotton bale) weighing 227 kg, produces 259 kg of cotton seed and 54 kg of CGT (Chen et al 2013, Cotton Australian 2017b, Hamawand et al 2016).

Step 2: Calculate cotton straw residues

The amount of stalk or straw was also determined from the number of cotton bales produced. Chen et al (2013) assessed that for every 2 million bales of cotton, 0.4 million tonnes of cotton stalk was produced. This was determined through interviews with cotton farmers and cotton ginners (Chen 2017 pers comm, NCEA, USQ).

A standard bale of cotton is 227 kg so for 2 million bales of cotton there is 400,000 tonnes of straw produced using the following workings:

Lint		Straw
2 million bales	=	0.4 million tonnes
Convert to kilograms		
454,000,000 kg	=	400,000,000 kg
1 kg lint	=	0.88 kg straw

Step 3: Allocated cotton residues to LGA

Cotton seed and CGT residues are produced as part of the cotton ginning process and are concentrated at the gin. These residues were allocated to a LGA by the proportion of cotton gins (compared to the total across Queensland) located within a LGA.

Cotton straw residues were allocated as a proportion of land under cotton land use in each LGA. The area of land under cotton land use was calculated from the data in the Queensland Land Use Mapping Program (QLUMP). The land outlined in this assessment indicates both irrigated and non-irrigated cotton production. For more information about the Queensland Land Use Program visit <qld.gov.au/environment/land/vegetation/mapping/qlump>

Step 4: Calculate minimum and maximum residues

The minimum and maximum residue totals (for each of seed, CGT and straw) were also calculated in order to gain a picture of the potential fluctuation of these residues between years. The calculations of seed, CGT and straw were based off the minimum and maximum number of bales produced in the last 5 years (Table 2)

Table 2. Minimum and maximum bales produced between 2013 and 2017.

Year	Total bales of cotton produced in Australia	% of cotton produced in Queensland	Number of bales produced in Queensland
2016/2017	3874675	38	1453564
2015/2016	2482535	39	969258
2014/2015	2234683	34	757714 (MIN)
2013/2014	3918865	37	1464135
2012/2013	4465910	35	1577009 (MAX)

The final data is rounded to the nearest 10 by the following rules:

- Data at the midpoint is rounded up (e.g. 35 has been rounded to 40)
- Data less than five is given a value of zero

- Data five or larger (but less than 10) is given a value of 10.

Outputs

- Location of cotton gins in Queensland
- A table of estimated average annual cotton seed (dry tonnes) by LGA
- A table of estimated average annual Cotton Gin Trash (dry tonnes) by LGA
- A table of estimated average annual cotton straw (dry tonnes) by LGA

Assumptions

The assumptions made when calculating the residues for cotton residues include:

- Calculations do not take into account the different technologies employed by individual farms and the variable harvesting operations (harvesters, machinery etc), noting that Management techniques and harvesting may change significantly from year to year and between districts.
- The area harvested is represented by the Queensland Land Use Mapping Program data which is relatively stable in the medium term. However the area harvested can vary significantly between years.
- All residues are calculated as a dry weight based on the assumption that the dry weight of the lint bale translates to the dry weight of the seed, CGT and straw.
- The calculations for straw report total biomass produced only and does not assess whether it physically or economically viable to gather remaining straw. There have been no life cycle assessments conducted.
- A sustainability factor has not been applied to the cotton straw estimates. There are soil health and yield benefits to retaining cotton straw in the field after harvest which includes maintenance of soil carbon and nutrient levels, maintaining soil biota, decreasing risks of soil erosion and runoff and decrease need for fertilisers through retention of nutrients from trash. By removing this straw there is also the potential to decrease yields due to loss of water and nutrients from the system (Hamawand et al 2016). This leads to a higher degree of complexity of utilising in field residues for a bioenergy purpose which has not been considered in this assessment.
- The calculations do not take into account any existing beneficial use that seed, CGT or straw may already be utilised for.
- The calculations do not include an assessment of the economics and feasibility of harvesting cereal straw residues – ie is more energy potentially expended to gather cereal straw than would be generated as bioenergy.

References

Chen, G., Sandell, G., Yusaf T., Baillie, C. (2013) Evaluation of alternative energy sources for cotton production in Australia. In: SEAg 2013: Innovative Agricultural Technologies for a Sustainable Future, 22-25 Sept 2013, Barton, Western Australia

Coates W.E. (2000) Using cotton plant residue to produce briquettes. Biomass-Bioenergy 18, 201-208.

Cotton Australia. (2017a). Processing, exporting and marketing. [ONLINE] Available at: <cottonaustralia.com.au/cotton-library/fact-sheets/processing-exporting-and-marketing>. [Accessed 29 June 2017].

Cotton Australia. (2017b). Statistics. [ONLINE] Available at: <cottonaustralia.com.au/cotton-library/statistics>. [Accessed 28 June 2017].

Hamawand. I, Sandell. G, Pittaway P, Chakrabarty S, Yusaf T, Chen G, Seneweera S, Al-Lwayzy S, Bennett J and Hopf J (2016) Bioenergy from Cotton Industry Wastes: A review and potential, Renewable and sustainable energy reviews 434-448.

Hulugalle, N.R. and Scott, F. (2008) A review of the changes in soil quality and profitability accomplished by sowing rotation crops after cotton in Australian Vertosols from 1970 to 2006, Australian Journal of Soil Research, 46, 173-190.

NSW Government. (2012). Bioethanol prospects from cotton gin trash. [ONLINE] Available at: <dpi.nsw.gov.au/content/archive/agriculture-today-stories/ag-today-archive/december-2012/bioethanol-prospects-from-cotton-gin-trash>. [Accessed 28 June 2017].

Pittaway. P and Roberts. G (2000) Low –tech gin trash composting to remove pathogens and residues in Proceedings from the 2000 Australia Cotton Conference, <insidecotton.com/xmlui/handle/1/844>

Stuckley, C., Schuck, S., Sims, R., Bland, J., Marino, B., Borowitzka, M., Abadi, A., Bartle, J., Giles, R. and Thomas Q. (2012) Bioenergy in Australia: Status and Opportunities, Bioenergy Australia, NSW.

Queensland contacts

Project manager: Phil Norman

p 07 3170 5756

e Phil.Norman@des.qld.gov.au

Project officer: Kelly Bryant

p 07 3170 5636

e Kelly.Bryant@des.qld.gov.au