COTTON AUSTRALIA

A SUSTAINABLE COTTON INDUSTRY

The story of a modern, sustainable agricultural industry that's helping to clothe the world. Cotton Australia's Cotton Education Kit provides current, authoritative information for all teachers and students, and includes:

- Targeted Australian Curriculum outcomes for Years 7-12, and outcomes for Years 11-12 from NSW, QLD, SA, WA, NT & ACT syllabi in each of its 10 chapters.
- Case studies and multimedia that are embedded in the Kit. Additional school resources, lessons and worksheets are found online in the Cotton Classroom.

Cotton Classroom

THIS CHAPTER WILL LOOK AT FOUR IMPORTANT AREAS OF **SUSTAINABILITY IN THE AUSTRALIAN COTTON INDUSTRY:** THE *my*BMP PROGRAM, WATER, BIOTECHNOLOGY AND CLIMATE CHANGE.

Soil, water, plants, air and animals are all part of what makes a dynamic and healthy cotton farming system. As custodians of the land, Australia's cotton farmers strive to find the delicate balance between producing fibre to clothe the world and the responsible conservation of natural resources.

For the past three decades, the Australian cotton industry has invested millions of dollars in improving its use of natural resources. These investments have been in research, development and delivery, on the farm and through the supply chain. This enormous effort has paid off, with the Australian cotton industry now recognised internationally as a leader in sustainable cotton production and a model for change in other Australian agriculture industries. A 2012 study "Australian Cotton Industry: Third Environmental Assessment" tracked improvements since 2003, and found the industry's major achievements included:

- Substantial reduction in the use of chemicals, particularly insecticides and the mitigation of serious off-farm impacts in rivers and wetlands.
- Major gains in water use efficiency calculated at 3-4% per year.
- Significant uptake of Integrated Pest Management (IPM).
- Major advances in cotton growers' attitudes and actions concerning natural resource management on-farm, particularly deep drainage, riparian vegetation management, groundwater conservation and delivery of ecosystem services.
- Development of an integrated research, development and extension system delivered to growers via an online Best Management Practices program *my*BMP.

THE FOURTH ENVIRONMENTAL AUDIT OF THE AUSTRALIAN COTTON INDUSTRY IS UNDERWAY AND IS DUE TO BE RELEASED LATE IN 2021.

AUSTRALIAN COTTON INDUSTRY **SUSTAINABILITY REPORTING**

Australian cotton growers have been quietly improving their sustainability for decades. Following the industry's first five-year Sustainability Report in 2014, the 2019 Australian Cotton Sustainability Report meets the industry's commitment to providing a balanced summary of its sustainability performance for the five years to June 2019. The report focused on the sustainability topics most important to the industry and its stakeholders. Through a process of consultation and review, a range of environmental, economic and social topics were chosen for reporting on every five years. These include water, carbon, biodiversity, pesticides, efficiency, profitability, safety, diversity and training, wellbeing and social capital.

2014 TO 2019 SUSTAINABILITY RESULTS

↓ 9.4%

Water: A long-term decrease in the volume of water used to grow a bale of cotton has continued.

CO_2 ↑ 12.6%

Carbon: Carbon emissions have increased, mainly from increased nitrogen fertiliser use. The amount of carbon stored on farms is not currently measured.

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Biodiversity: The area of land managed for conservation has declined slightly or remained steady.

↓ 18.2%

Pesticides: The amount of toxic pressure on human health and the environment from pesticides has continued to decrease. Work to reduce the hazard and volume of pesticides is ongoing.

↑ 9.9%

Efficiency: The amount of cotton grown per hectare continued its long-term increase.

↑ 75.8%

Profitability: Increased yields and historically high cotton prices increased profitability.

↑ ↓

Quality of work life - safety: Injuries have decreased, but fatalities have increased.

↑ ↓

Quality of work life - diversity and training: Most diversity indicators increased; the proportion of young people decreased.

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Wellbeing and social capital: The wellbeing and social capital of growers and their communities was measured for the first time.

Butcher bird in Cotton Field.

The Australian cotton industry's second five-year Sustainability Report, released in 2020, revealed producing a bale of cotton now requires 48% less water, 34% less land, and 97% less insecticides than in 1992. The report also highlighted areas the industry can do better in, such as the need to make greater efforts to reduce carbon emissions, improve nitrogen use efficiency, increase on-farm carbon sequestration in soil and native vegetation, and improve farm safety.

To be a global leader in sustainable cotton production, the Australian cotton industry sets bold targets, ensures the research and adoption programs can help growers achieve those targets, and frequently and transparently shares progress on the targets with internal and external stakeholders.

COTTON **BLOG**

Follow the cycle of cotton farming from a cotton grower in Emerald, Queensland.

Renée Anderson is passionate about strong rural communities, the people in them, agricultural advocacy, biosecurity and the continual improvement of farming practices through research and policies that empower farmers to constantly work towards sustainability goals in the face of challenging times.

On the blog, you will discover the huge diversity of the weekly themes as the seasons change.

Australian Cotton Sustainability Reports

Australian Cotton Industry: Third Environmental Assessment

*my*BMP: MANAGING THE **ENVIRONMENT** ON THE FARM

*my*BMP is the Australian cotton industry's environmental management program, which ensures Australian cotton is produced according to best practice. The voluntary program has seen widespread adoption across the industry, and *my*BMP allows growers and industry to access the latest technical data, research, find solutions to challenges, and provides practical tools to help growers operate at maximum efficiency.

Some of the *my*BMP program's benefits include developing safer workplaces and healthier natural environments, reducing input costs, ensuring farm businesses are better run, and improving community health.

THE **BEGINNINGS**

In the early 1990s, the Australian cotton industry attracted criticism for its environmental performance, particularly in relation to pesticide use. A subsequent coordinated response by the Australian cotton industry acknowledged those public criticisms and worked to address community concerns, and in so doing transformed an entire agricultural industry. While some of the negative public perceptions about cotton linking back to those early days unfortunately remain in some people's minds, the industry continues its work sharing its story and providing information about the significant improvements that have been made in the way the cotton industry operates and the way the crop is grown. The first step in tackling pesticide use was to initiate the first ever environmental audit of a whole agricultural industry in the southern hemisphere. A major finding was that the Australian cotton industry needed to improve its storage and application of chemicals and improve grower education on these issues – thus, the Best Management Practices program was formed in 1997.

INITIAL PROGRAM DESIGN

A three-year, $6 million research project provided the scientific basis for the initial Cotton Best Management Practices (BMP) program. BMP covered integrated pest management, on-farm chemical application management, the storage and handling of pesticides and petrochemicals, as well as farm design and land and water management. Best practices, risk assessments and action plans for improvements were included in a paper-based manual that growers worked through to identify areas of risk and improvement and implement action plans.

A NEW ERA FOR BMP

While the initial BMP system managed to completely transform the farming practices of the cotton industry, the sector decided to put the program online to make it easier to update and use. The online *my*BMP system was launched in 2009/10. It allows growers and industry to access the latest technical data, information and research, find solutions to challenges and provide a wide variety of tools to help growers operate at maximum efficiency. Cotton farmers record and monitor 10 key modules covering farm operations. They must also successfully complete an audit of core modules and a random module.

BIOSECURITY: for prevention, management and control of pests and diseases.

ENERGY AND INPUT EFFICIENCY: for more efficient energy inputs such as electricity, fuel and fertilisers.

FIBRE QUALITY: for growing the best quality cotton possible.

SOIL HEALTH: for maintaining and/or improving soil quality and fertility.

INTEGRATED PEST MANAGEMENT (IPM): for management of pests, weeds and diseases.

SUSTAINABLE NATURAL LANDSCAPE: for managing the vegetative and riparian assets on your farm.

PESTICIDE MANAGEMENT: for all aspects of pesticide management, storage and use on farm.

PETROCHEMICAL STORAGE AND HANDLING: for managing fuels and lubricants on farm.

WATER MANAGEMENT: covering water quality, efficiency of storage and distribution for both dryland and irrigated farming practices.

HUMAN RESOURCES AND WORK HEALTH AND SAFETY: helps growers manage employees and contractors whilst providing a safe and compliant workplace.

The Brownlie family from Theodore.

There are many benefits to the cotton industry's commitment to sustainability through *my*BMP – these include safer farm workplaces, healthier natural environments, reduced input costs, better run farm businesses and improved community health.

The *my*BMP website is an online tool for growers to assess and improve their farms.

- www.myBMP.com: a web-based resource for best practice in Australian cotton production for growers, researchers and industry
- Case Study: Cotton grower Andrew Watson from Boggabri NSW
- Fact Sheet: Cotton's myBMP Environmental Program

WATER RESEARCH AND **INNOVATION**

Australian cotton has the reputation of being the most water efficient cotton industry in the world, thanks to biotechnology and advances in precision irrigation, better water monitoring, irrigation scheduling and evaporation control. Water-use productivity by Australian cotton growers improved by 48% since 1992.

The Australian cotton industry has achieved a steady increase in yield with improved management of water over time, meaning more cotton fibre can be produced per hectare than ever before. NSW DPI, in partnership with the Cotton Research and Development Corporation, has been monitoring water productivity in irrigated cotton over the past three decades. Their research shows that:

- There has been a 97% increase since 1992 in the number of 227kg bales of cotton lint produced per megalitre of water, meaning growers are using about half the water they used to, to produce each bale.
- The industry's Whole Farm Irrigation Efficiency has significantly improved and is now 81% compared to 57% in the late 1990s, indicating more water than ever before is being used by the crop instead of being lost on-farm.

CSIRO also breeds cotton varieties appropriate for Australian and regional conditions. This means each grower can select the best and most efficient variety for their region and farm.

PRACTICAL APPROACHES TO WATER USE EFFICIENCY ON THE FARM INCLUDE:

- Zero and minimum till farming to help retain soil moisture.
- Irrigation scheduling to ensure irrigation is only done as and when it is needed.
- In-field capacitance probes to monitor and transmit soil moisture data from the field to a central computer to help schedule irrigations.
- Thermal imaging and electromagnetic surveys to identify "leaky" dams, pipes and channels, so they can be repaired.
- Using new efficient methods of irrigating such as overhead lateral-move sprinklers, bank-less channels, syphon-less channels and drip irrigation.
- Growing cotton varieties that are suited to regional conditions and use less water. Mobile electromagnetic meters for easy and rapid assessment of soils for their suitability for irrigation construction.
- Holding water on-farm for shorter time periods to reduce evaporation.
- Laser-levelling to ensure uniform, well drained fields using GPS guidance equipment.
- Tail water recycling systems, so that water is reused.
- Reducing evaporation by shortening row lengths.
- Positioning dams closer to cotton fields to reduce evaporation losses.
- Deeper water storages and head ditches with smaller surface areas to reduce evaporation.
- Avoiding water storage on-farm by only ordering water as it is needed.
- Smaller water storage cells to reduce evaporation.
- Not putting water directly into dry storages which soak up water.
- Infield monitoring using probes to detect soil moisture levels.
- Creating a 'water budget' to monitor water use.
- Lining storages and channels with clay or non-porous materials to avoid seepage.
- Mulching and stubble retention to help retain soil moisture, reducing the need for irrigations.
- Permanent wheel beds to reduce soil compaction and increase water infiltration.
- Avoiding water logging and over-watering.
- Doubling the size of syphons to increase flow rates, and minimise deep infiltration.
- Installing monolayers for evaporation mitigation on farm dams.

Case study on siphon-less irrigation, or bankless irrigation. Tom Cush from Avymore in NSW discusses the decision to set up bankless irrigation, how they approached it, and some of the benefits he sees from this type of irrigation system.

Lesson: Murray-Darling Basin System Year 7 Geography Resources

Fact Sheet: Cottons Water Use

Solar pumping stations to reduce on-farm diesel costs and supplement with solar electricity, elevate time consuming maintenance costs derived from the bore, provide user friendly remote monitoring and fit to a budget.

GAME CHANGERS

Below are 10 of the Australian cotton industry's innovations in water-use. Efficiency that have significantly changed cotton production practices

Laser and GPS-guided field leveling for even water application.

Improved cotton seed varieties that drive overall efficiency.

Stubble retention to hold soil moisture.

Tail water recycling systems, so that water is reused.

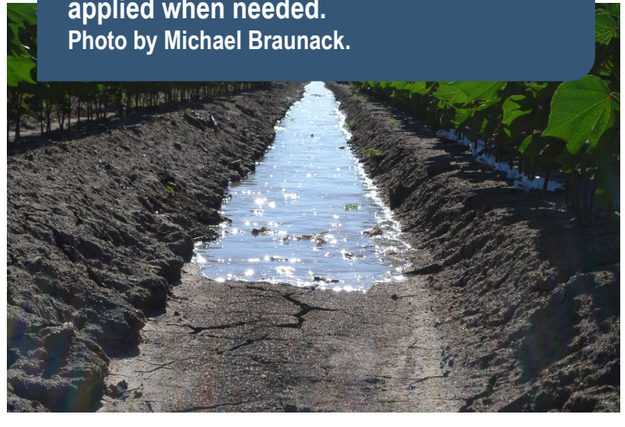
Doubling the size of siphons.
Photo by Alexandria Galea.

Closed delivery systems reduce transmission losses and improved whole-farm water efficiency.

Water monitoring to check water quality.

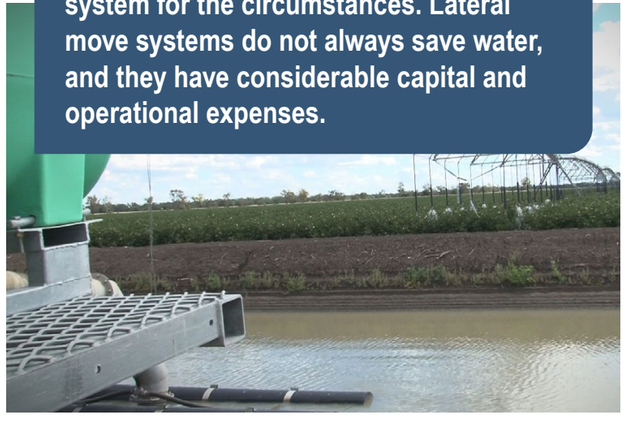
Neutron probes to measure soil moisture.

Irrigation scheduling, so water is only applied when needed.
Photo by Michael Braunack.



Monitoring water flow rates helps improve water management.

Invest in the most efficient irrigation system for the circumstances. Lateral move systems do not always save water, and they have considerable capital and operational expenses.



BIOTECHNOLOGY

Biotechnology refers to the use of cotton varieties with transgenic or genetically modified (GM) traits. GM cotton has been commercially grown in Australia since 1996 and more than 80% of the cotton grown in Australia contains GM traits. GM cotton plants are either herbicide-tolerant, or insecticidal, providing resistant to the major caterpillar pest Helicoverpa spp., or both. In 2019, 13.5 percent of all the cotton grown worldwide was genetically modified.

GM cotton that provides resistance to Helicoverpa spp. is known as Bt cotton. Bt cotton was developed using the common soil bacterium Bacillus thuringiensis (Bt). Bt cotton produces proteins that are toxic to the specific Helicoverpa spp. pest when it eats the plant.

Australia was one of the first cotton-producing nations to grow transgenic varieties (the other was the USA), starting in 1996 with Ingard®. This first new strain of cotton was developed and trialled over many years before its limited release in 1996. In the 1996-97 cotton season, Ingard® constituted 10% of the national crop and pesticide applications reduced by more than 50%. Ingard® contained one insecticidal protein, Cry1Ac, derived from Bt.

In 2004, Ingard® was replaced by a new GM variety, Bollgard II®, which contained two insecticidal proteins, Cry1Ac and Cry2Ab. A variety that contains more than one GM trait is known as a 'stack'.

Bollgard 3® is the current Bt cotton grown in Australia, which replaced Bollgard II® in 2016. It contains three different insecticidal proteins (Cry1Ac, Cry2Ab and Vip3A). This protein 'stack' contributes to resistance management as it is more difficult for the pest to develop resistance to all three toxins in unison.

Herbicide-tolerant cotton, Roundup Ready®, was commercially released in Australia in 2001. Roundup Ready Flex was released in 2005 which gave rowers more flexibility in the herbicide application window. The Roundup Ready® cotton is resistant to the herbicide glyphosate. Glyphosate-tolerant crops are not harmed by the application of glyphosate to the weeds around them, providing growers with greater flexibility in weed control options. Technology providers are currently looking at introducing new varieties that provide tolerance to herbicides with different modes of action than glyphosate. This is important for managing resistance to herbicides.

In Australia, each genetic trait is individually assessed on a case-by-case basis by the Office of Gene Technology Regulator (OGTR), Food Standards Australia New Zealand (FSANZ), and the Australian Pesticides and Veterinary Medicines Authority (APVMA).

The commercialisation and ongoing monitoring of Bt cotton in Australia is a unique process involving the technology provider, growers, scientists and government regulatory bodies. These stakeholders are also involved in the development and ongoing review of ecologically-based stewardship strategies that aim to delay the evolution of resistance to Bt cotton.

Biotechnology - transgenic cotton varieties repel cotton's biggest pest - the Heliothis caterpillar

BENEFITS OF BIOTECHNOLOGY

The use of biotechnology in cotton has made a significant contribution to the dramatic reduction in insecticides applied to Australian cotton crops. Before the availability of Bt technology, most Australian cotton crops were typically sprayed 10 – 14 times per season with insecticides for Helicoverpa spp. management (Wilson et al. 2013), in order to deliver effective control. Since 1993, there has been a 97% decrease in insecticide use. Crops are now typically subject to no more than 0 - 3 insecticide treatments per crop.

The introduction of Bt cotton has enabled the implementation of improved Integrated Pest Management (IPM) on cotton farms. IPM strategies use a combination of natural controls and pest-specific chemistry to further reduce pesticide use.

The use of herbicide-tolerant technology has seen a reduction in the use of residual herbicides and soil tillage. This has environmental benefits through reduced herbicide run-off and reduced soil erosion.

Other environmental, social and economic benefits of biotechnology in cotton include:

- increased populations of beneficial insects and wildlife in cotton fields;
- reduced pesticide run-off;
- improved farm worker and neighbour safety;
- more time for farmers to spend with their families;
- a decrease in labour and fuel usage;
- improved soil quality;
- reduced production costs;
- increased yield;
- reduced production risks;
- further opportunities to grow cotton in areas of high pest infestation.

There are financial benefits for cotton farmers using biotechnology. Graham Brookes, Director of PG Economics UK told the National Press Club in an address in 2012, “Since 2010, the total farm income gain derived by Australian cotton farmers from using this technology has been $395 million, an average of about $180 per hectare.”

Performance of transgenic and conventional cotton. Bollgard 2 Cotton and Conventional Cotton exposed to the same insect attack.

Fact Sheet: Cotton and Biotechnology

PREVENTION OF RESISTANCE TO **BT**

Resistance is an outcome of exposing pest populations to a strong selection pressure, such as an insecticide. Genes for resistance naturally occur at very low frequencies in insect populations. The genes remain rare until they are selected for by a toxin, either from an applied pesticide or from within Bt cotton. Once a selection pressure is applied, resistance genes can increase in frequency as the insects carrying them are more likely to survive and produce offspring. If selection continues, the proportion of resistant insects relative to susceptible insects may continue to increase until reduced effectiveness of the toxin is observed in the field.

A very small number of Helicoverpa in Australia are naturally resistant to the Bt toxins and this could pose a problem. If these insects survived, they could breed with other resistant insects, creating a population of Bt-resistant Helicoverpa.

To combat this potential problem, the cotton industry in collaboration with government regulators and the technology provider, have developed a Resistance Management Plan (RMP) designed to mitigate the risk of resistance developing to the toxins contained in Bt cotton. All cotton farmers who grow Bt cotton are required to follow the RMP guidelines.

The key elements of the RMP impose limitations and requirements for management on farms that grow Bollgard 3® cotton, including:

- Mandatory growing of non-Bt refuges. Refuges act as a nursery for Helicoverpa that have not been exposed to the Bt toxins to breed and potentially mate with any resistant moths emerging from the Bt cotton.
- Reducing the exposure of the Helicoverpa population to the Bt toxins. Limiting the length of time Helicoverpa are exposed to the Bt toxins reduces the risk of resistance developing. This is done by implementing mandatory planting windows (set calendar times cotton can be sown), controlling all volunteer and ratoon cotton plants and mandatory crop destruction at the end of the season.

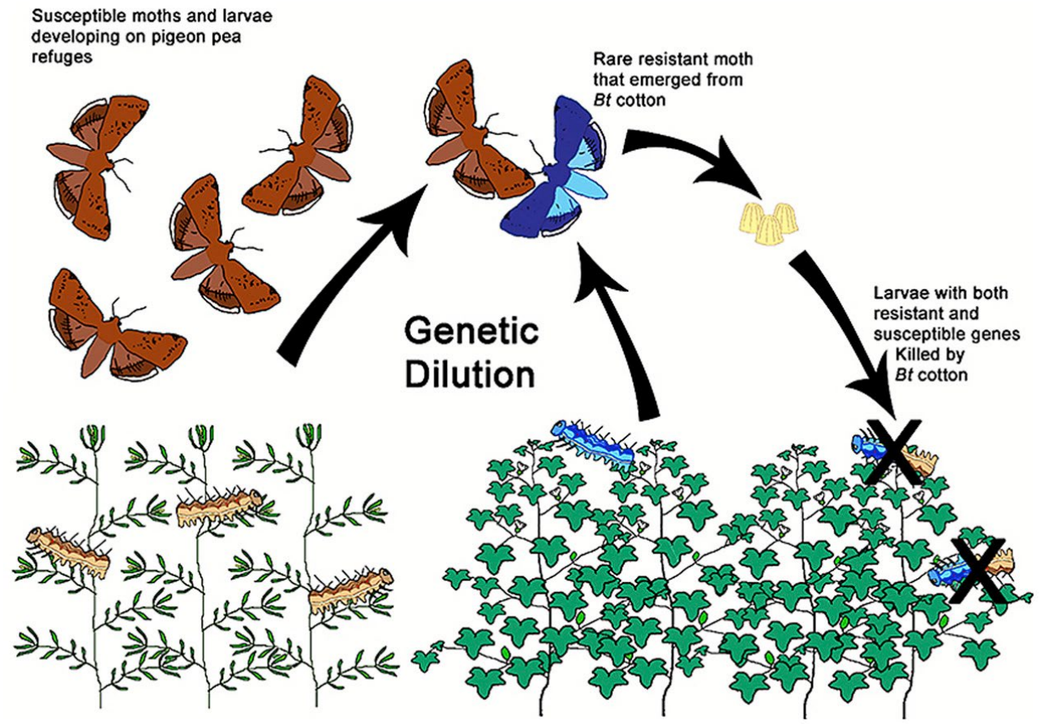
So far, the RMP in Australia has been successful in delaying the evolution of resistance. As part of the RMP, annual resistance monitoring of the Helicoverpa population is undertaken.

Cotton Pest Management Guide 2020-21

The 2020 Australian Cotton Production Manual is a critical reference tool for cotton growers. The manual is a one-stop-shop for growers, outlining all the various decisions that need to be made on-farm in preparation for, and during, cotton production. The manual provides an understanding of cotton physiology, and discusses important considerations for both productivity and profitability.

The Australian Cotton Production Manual is published by CRDC and CottonInfo and is updated each year to incorporate the latest research and consistent improvements in industry best practice.

Helicoverpa resistance testing. Insecticide resistance is a major consideration when planning pest management programs. Dr Sharon Downes from CSIRO explains how researchers test for Helicoverpa resistance in a field population.

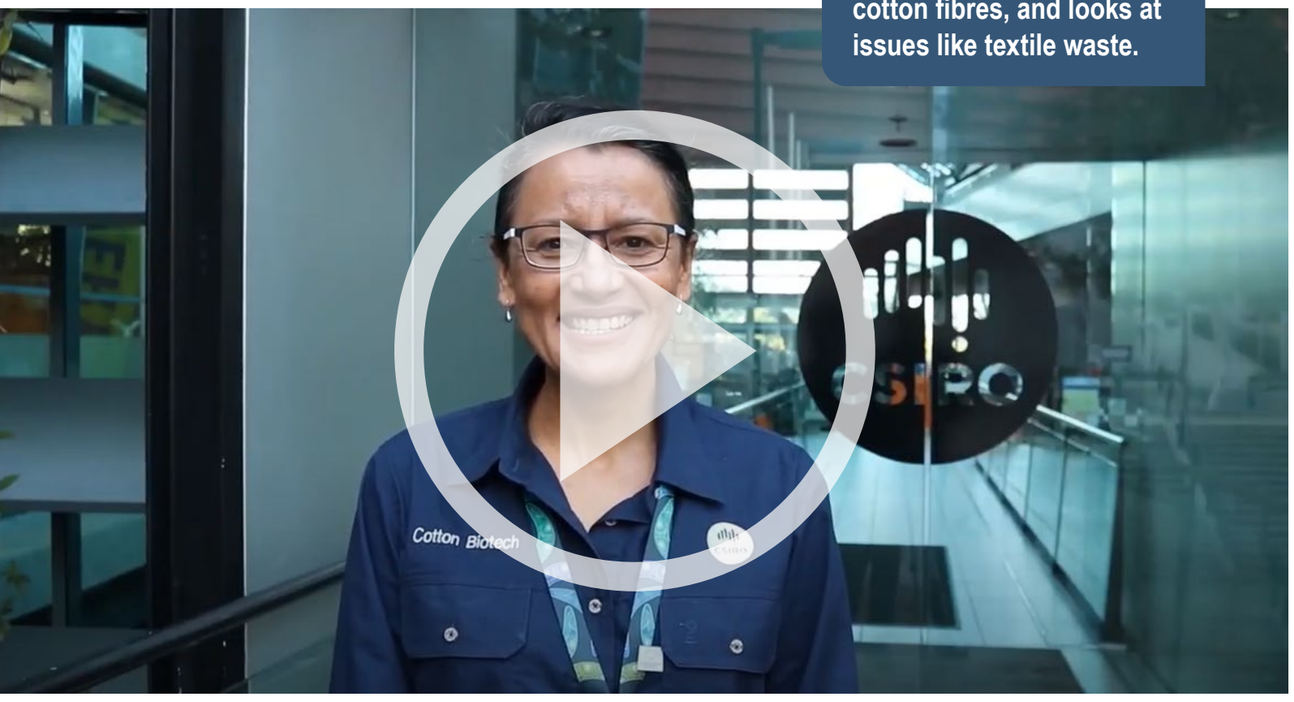


Source: Crop Protection, Volume 100, 2017: http://www.sciencedirect.com/science/article/pii/S0261219417301667

NEW VARIETIES IN THE PIPELINE

Over the past decade, cotton varieties have been developed with new features such as improved fibre quality, disease resistance, maturity and regional adaptability. Research is being undertaken to develop varieties that require less water and/or are drought-tolerant and have better fibre qualities like increasing flame resistance, coloured cotton and reducing wrinkles in fabrics. The use of biotechnology is a key component of innovation in improved cotton characteristics.

Dr Colleen McMillan takes you on an multimedia tour of the lab facilities at CSIRO in Canberra, including a presentation that takes you inside the cotton plant, explains some of the state-of-the-art equipment used to test cotton fibres, and looks at issues like textile waste.



ABC News Report: CSIRO scientists discover how to grow coloured cotton, removing need for harmful chemical dyes.

Case Study: Next Generation Cotton from CSIRO

COTTON AND CLIMATE CHANGE

Cotton is an annual crop grown in regions that experience climate variability driven by El Niño and La Niña cycles. Consequently, cotton growers have developed highly efficient and flexible farming systems that can meet the challenges of climate change. Despite being a very small contributor, the Australian cotton industry continues to invest in climate change research to understand further opportunities for cotton farms to reduce or capture emissions.

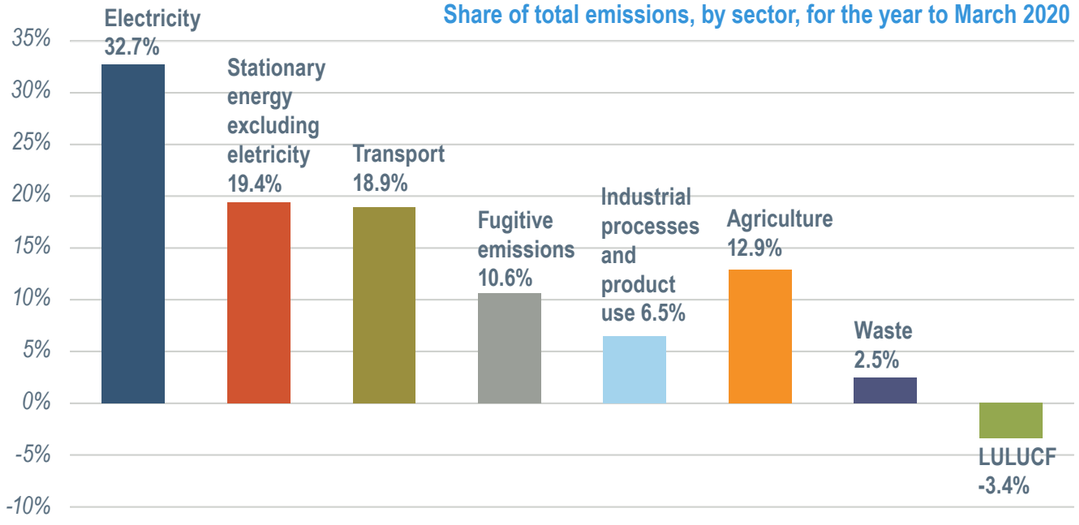
Current estimates from the Australian Greenhouse Gas Inventory (March 2020 Inventory) are that on-farm activities (excluding energy use) across agriculture are responsible for 12.9% of Australia's greenhouse gas emissions. The electricity and energy sectors are the biggest at 53.1% (OR - 32.7 and 19.4 respectively) followed by transport 18.9% then agriculture. Climate and markets for Australian agricultural produce influence yearly production and in turn resulting emissions. Methane from livestock thends to be the dominant agricultural greenhouse gas (of agricultural emissions) compared to fuel use or nitrous oxide (fertiliser use) from farming activities.

Greenhouse Gas Emissions (GHG) from the Australian cotton industry are small.

Cotton production emits about 0.2 per cent of Australia's greenhouse emissions. The main sources of emissions to grow then ship to port one bale of cotton in the five years to 2018-19 were:

- nitrogenous fertiliser (58 per cent)
- on-farm fuel (15 per cent)
- ginning energy (10 per cent)

It's important to remember emissions are one side of the carbon cycle; on the other side, farms sequester and store atmospheric carbon in soil and vegetation. Research is now showing some farms are carbon positive: that is, more carbon is stored by the farm than is emitted by its cotton production. Due to a lack of data on the amount of carbon stored on farms at the industry scale, the industry is currently measuring only emissions, which does not provide the full picture. Measuring cotton's carbon footprint is a target area for further research.



KEY: LULUCF = Land Use, Land Use Change and Forestry
Source: Department of Industry, Science, Energy and Resources
Source: https://www.industry.gov.au/sites/default/files/2020-08/nggi-quarterly-update-march-2020.pdf

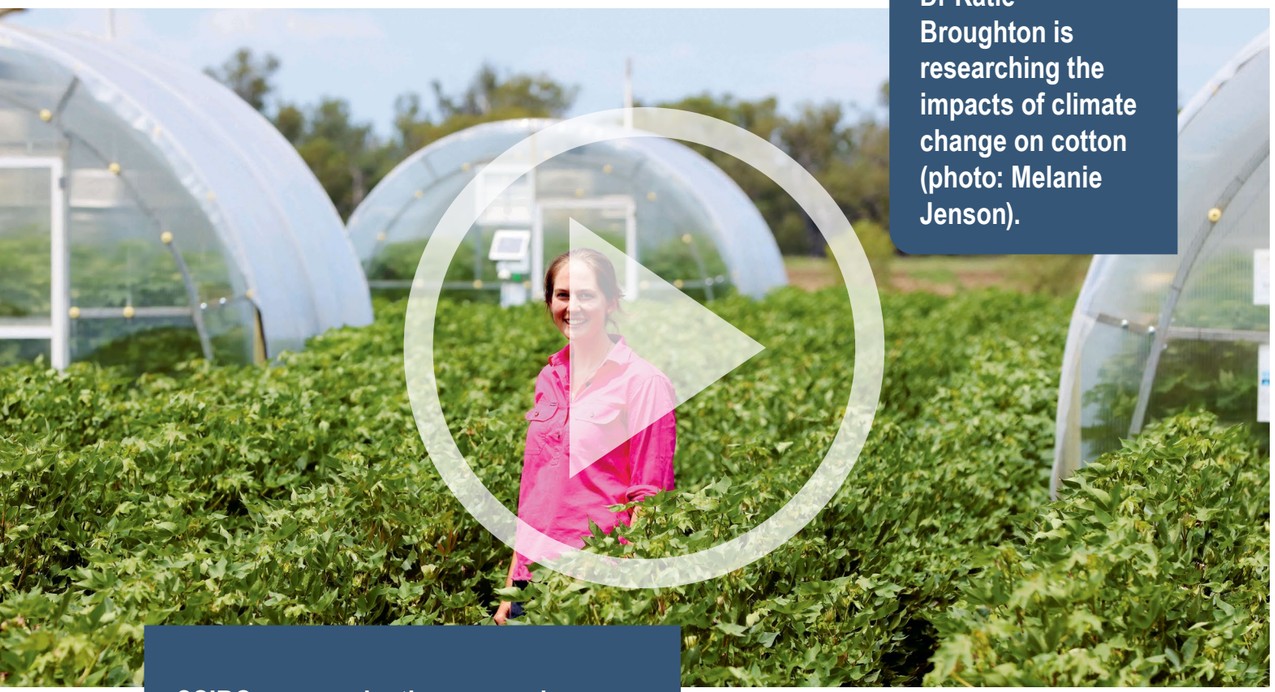
IMPACT ON **AUSTRALIAN AGRICULTURE**

Australia's climate is inherently variable but specific climate change impacts are forecast to include increases in temperature and atmospheric carbon dioxide, higher temps, increased evaporation, and less frequent but more intense rainfall.

All major sectors in Australian agriculture are vulnerable to climate change, with potential negative impacts on essential natural resources, the amount and quality of produce and reliability of production. The ability to ship and export product can vary for several reasons, including effects of the global COVID-19 pandemic and access to ports and markets.

Changes in the climate could have both positive and negative impacts on our ability to grow cotton. An increasing concentration in carbon dioxide levels could potentially increase photosynthesis and subsequent water use efficiency could in fact lead to higher crop yields. However, these benefits may be offset by declines in rainfall, increases in temperature and/or increases in atmospheric evaporation.

Climate change is affecting the normal flow of rivers.



Dr Katie Broughton is researching the impacts of climate change on cotton (photo: Melanie Jenson).

CSIRO are conducting research into the potential impacts of warmer temperatures and elevated CO2 on cotton plants to better understand varietal responses and management of cotton into the future.

All there is to know about gene technology from the CSIRO

Cotton Seed Distributors and CSIRO's unique partnership has seen our top-quality seed grown in the U.S.A., South America, South Africa and in Europe.

Cotton Australia's link to mythbuster

The use of round modules has led to energy reduction in harvest and handling through the removal of some operations and machinery.

The cotton industry is funding, or has funded, a range of interesting climate change research projects, including:

- Investigating the inter-relationship of potential impacts of changes in rainfall, carbon dioxide concentration, reduced water availability, lower humidity and increases in temperature;
- A number of projects to manage climate change on-farm (e.g. plant breeding and nitrogen use efficiency);
- Measuring the level of greenhouse gas emissions (N20 / CO2) from different production systems;
- The development of calculators to assist farmers in estimating total greenhouse gas emissions.

Practical examples of cotton production practices to minimise emissions and manage soil carbon include:

- Improved water use efficiency, which reduces pumping and waterlogging;
- A move to use of round modules, which has led to energy reduction in harvest and handling through removal of some operations and machinery;
- Placing nitrogen at depth in cooler times in wet soils to maximise nitrogen efficiency (and thus minimise losses to the atmosphere);
- Assessing and optimising nitrogen fertiliser use and the use of alternative sources such as legume rotations;
- Using lower emissions machinery and assessing and improving existing machinery and irrigation pumping performance;
- Alternative fuel sources, including solar generation on-farm;
- Improvements in soil management through stubble retention, reduced tillage and reduction in spraying operations.

Case Study: The Life Cycle Inventory & Life Cycle Assessment of Cotton Fibre & Fabric

Fact Sheet: Environment and Climate Change

Current research, development and extension (RD&E) is important for Australian cotton growers to help them improve their productivity, profitability, practices and performance. Spotlight is published quarterly by Cotton Research and Development Corporation (CRDC): the Australian cotton industry's RD&E investment body, jointly funded by Australian cotton growers and the Australian Government.

THEMES AND AUSTRALIAN CURRICULUM OUTCOMES FOR SECONDARY SCHOOL

The Cotton Education Kit has been linked to the Australian Curriculum for Years 7-10, and targeted outcomes for Years 11 -12 from all state & territory curriculums across Australia. A list of themes is provided for teachers as a quick guide to assist linking the content to their unit of work or syllabi in their state or territory.

A full list of the individual syllabuses that have been mapped against the Cotton Education Kit can be found in the Cotton Classroom.

Cotton Classroom

CHAPTER TWO THEMES

- Australian cotton industry sustainability reporting
- *my*BMP: Managing the Environment on The Farm
- Water Research and Innovation
- Biotechnology
- Types of Biotech Varieties Grown in Australia
- Resistance to Bt
- New Varieties in the Pipeline
- Cotton and Climate Change

Australian Curriculum	Course	Chapter 2: A Sustainable Cotton Industry
Australian Curriculum	Year 7 Science	ACSSU116 (Water as a resource) ACSHE136 (Science influences on agriculture)
Australian Curriculum	Year 7 Geography	ACSHE136 (Forms of water as a resource)
Australian Curriculum	Year 8 Science	ACSHE136 (Science influences on agriculture)
Australian Curriculum	Year 10 Science	ACSSU189 (Global systems)
State / Territory	**Senior Secondary Course**	
New South Wales (HSC)	Agriculture (2013)	P1.1 P1.2 P2.1 P2.3 P3.1 P5.1 H1.1 H2.1 H3.1 H3.3 H3.4 H5.1
	Agriculture Life Skills (2018)	ALS12
	Design and Technology Life Skills (2018)	DTLS11
	Earth and Environmental Science (2017)	EES11-11
	Geography (2009)	H4 H5 H6
	Primary Industries (VET) (2020)	AHCWRK209 AHCWRK309 AHCPMG302
	Textiles and design (2013)	P3.2 H3.2 P5.1 H5.2 P6.1 H6.1
Victoria (VCE)	Agriculture and Horticulture Studies (2020)	Unit 3: AoS 1 Innovations and solutions Unit 4: AoS 1 Sustainable land management Unit 4: AoS 2 Sustainable business practices
	Agriculture, Horticulture, Conservation and Land management (VET) (2020)	AHCWRK209
	Environmental Science (2016)	Unit 3: AoS2 Is development sustainable?
Queensland (QCE)	Agricultural Practises (Applied) (2019)	C5.1
	Agricultural Science (General) (2019)	Unit 2: Topic 1 Unit 4: Topic 2
	Earth and Environmental Science (2019)	Unit 1: Topic 3
	Geography (General) (2019)	Unit 3: Topic 1
Western Australia (WACE)	Plant Production Systems (General) (2017)	Unit 2: Sustainable production Unit 3: Sustainable management practices
	Plant Production Systems (ATAR) (2017)	Unit 2: Sustainable production Unit 3: sustainable management practices
South Australia / Northern Territory (SACE)	Agricultural Production Stage 2 (2021)	Topic 3: Resource management
Tasmania (TCE)	Agricultural Systems (2019)	Unit 1: Introduction to Systems Thinking

KEY **LINKS**

- Cotton Australia.
- 360-degree digital film of a cotton farm, the latest addition to Cotton Australia's suite of educational resources informing city and country residents about the Australian cotton industry.
- Google Arts & Culture
- Australian Cotton
- Cotton Research and Development Corporation
- Cotton Seed Distributers
- CottonInfo
- Primezone: Primezone provides teachers and students with access to the latest quality primary industries education resources

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