CHAPTER 2
A Sustainable Cotton Industry
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 responsible conservation of their resources.

For the last 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 recent 2012 study “Australian Cotton Industry: Third Environmental Assessment” tracked improvements since 2003, and found the industry’s major achievements to include:

- Substantial reduction in the use of chemicals, particularly insecticides and herbicides and the disappearance 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 grower’s attitudes and action 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 (myBMP)

This chapter will look at four important areas of sustainability in the Australian cotton industry: the myBMP program, water, biotechnology and climate change.

Blog: Cotton Pickin – the Boggabri blog
Report: Australian Cotton Industry: Third Environmental Assessment
Lesson: Studies in Sustainability: The Cotton Industry in Northern NSW and Southern Queensland
**MYBMP: MANAGING THE ENVIRONMENT ON THE FARM**

MyBMP is the Australian cotton industry’s environmental management program, a voluntary system for achieving best practice in the growing, ginning and classing of cotton.

MyBMP is a web-based system that acts as a one-stop-shop for best practice and scientific information. It links supporting knowledge, data and resources to best practice principles and guidelines, allowing growers, ginners and classers immediate access to cutting-edge research as well as support from industry and extension staff when there is an issue to solve or investigate.

**THE BEGINNINGS**

In the early 1990s, the Australian cotton industry came under fire for its environmental performance, particularly in relation to pesticide use. A coordinated response by the Australian cotton industry did more than address the immediate concerns - it transformed an entire agricultural industry. Unfortunately, some of the negative perceptions associated with this period of the cotton industry haven’t been updated in some people’s minds, particularly the older generations. Cotton Australia and others continue to work hard to change these outdated notions.

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 to improve grower education on these issues - thus, the Best Management Practices program was formed.

**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 BMP system managed to completely transform the farming practices of the cotton industry, the industry decided it needed to put the program on-line to make it easier to update and use. The new, on-line myBMP 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, monitor and are audited in 11 key areas of farm operations:

- **BIOSECURITY:** the avoidance, management and control of pests and diseases
- **BIOTECHNOLOGY:** for GM cotton varieties
- **ENERGY AND GREENHOUSE GASES:** efficient use of energy inputs like fuel and fertilisers
- **FIBRE QUALITY:** for growing the best quality cotton possible
- **HUMAN RESOURCES:** managing staff and contractors
- **INTEGRATED PEST MANAGEMENT:** for weeds, pests and diseases
- **NATURAL ASSETS:** managing vegetative and riparian assets
- **PESTICIDE MANAGEMENT:** pesticide storage and use
- **PETROCHEMICAL STORAGE AND HANDLING:** petrochemical storage and use
- **SOIL HEALTH:** ensuring healthy soils for the long term
- **WATER MANAGEMENT:** water quality, efficiency of storage and distribution, dryland and irrigated farming practices

There are many benefits to the cotton industry’s commitment to sustainability through myBMP - these include safer farm workplaces, healthier natural environments, reduced input costs, better run farm businesses and improved community health.
The Australian cotton industry has achieved a 40% increase in water productivity over the last decade through a combination of better water monitoring and irrigation scheduling, evaporation control, and improved irrigation techniques. Australia's cotton industry is now considered the most water-efficient in the world, producing “more crop per drop” than any other nation at more than double the world’s average yields.

Appropriate varieties, a massive research effort, use of the latest technologies and cutting edge on-farm practices all combine to produce Australian cotton fibre that is farmed with less water per hectare than ever before. The Australian cotton industry now produces on average 1.9 bales of cotton per megalitre, compared to 1.1 bales per megalitre 10 years ago, representing a substantial improvement in productivity and water use efficiency.

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-leveling 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 purchasing 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
- Covering water storages to reduce evaporation
- 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
- Slowing the rates of water application to ensure water soaks into the root zone where it’s needed most, rather than running off
- Installing monolayers for evaporation mitigation on farm dams

Case Study: A report on the use of an ultra-thin film (polymere) on water storages to mitigate evaporation

Lesson: A HSC on-line activity analysing irrigation systems in the Murray-Darling Basin and assessing options for improved efficiency

Fact Sheet: Practical Approaches to Water Use Efficiency in the Australian Cotton Industry
GAME CHANGERS

Below are 10 of the Australian cotton industry’s innovations in water-use efficiency that have significantly changed cotton production practices:

- **Accurate water metering** delivers only what is needed to the fields.
- **Deeper head ditches** to reduce evaporation.
- **Neutron probes** to measure soil moisture.
- **Doubling the size of syphons**.
- **Irrigation scheduling** to ensure water is only applied when the crop needs it.
- **On-farm storages** with evaporation prevention polymers (in the wind) – half the water is mirror flat and half has waves.
- **Closed delivery systems** reduce transmission losses and improve whole-farm water use efficiency.
- **Monitoring syphon flow rates** helps growers improve water management.
- **Lateral move irrigation systems** save water.
- **Stubble retention** to hold soil moisture.
Biotechnology refers to the use of cotton varieties with transgenic or genetically modified (GM) traits. The use of biotechnology in cotton has made a significant contribution to the dramatic reduction in insecticides applied to Australian cotton crops – 85% in the last decade. In fact, this environmental reason is the main one for cotton growers to take up this technology on their farms.

Almost 100% of Australia’s cotton crop is now grown with biotech varieties that require far less insecticides than conventional cotton plants. Across the world, transgenic varieties now account for 21% of world cotton area.

Apart from a dramatic reduction in pesticides, other benefits of biotechnology in cotton are:
- increased populations of beneficial insects and wildlife in cotton fields
- reduced pesticide run off
- improved farm worker and neighbour safety
- a decrease in fuel usage
- improved soil quality
- reduced production costs
- increased yield
- further opportunities to grow cotton in areas of high pest infestation

Australia was one of the first cotton producing nations (the other was the USA) to grow transgenic varieties, starting in 1996 with Ingard®. This first new strain of cotton was developed and trialed 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 were reduced by over 50%.

Further research led to a variety of cotton with two genes that produce two different proteins in the leaves that are toxic to heliothis called Bollgard II®, introduced to Australia in 2004. Scientists isolated a protein that occurs normally in soil borne bacteria called Bacillus thuringiensis (Bt) that attacks only the heliothis insects. When the caterpillar ingests a small part of the cotton plant, the Bt protein disrupts the caterpillar’s digestive system and it dies.

**TYPES OF BIOTECH VARIETIES GROWN IN AUSTRALIA**

The cotton industry currently uses a number of types of transgenic cotton:
- Bollgard II® (with two different genes from the naturally occurring soil bacterium Bacillus thuringiensis (Bt))
- Roundup Ready Flex® (with genes from the soil bacterium called Agrobacterium tumefaciens)
- Liberty Link® (with genes from the soil microorganism Streptomycetes hygroscopicus)
- Herbicide tolerant cotton (Roundup Ready Flex® and Liberty Link®) can reduce the amount of soil cultivation and herbicide required on cotton crops to control weeds and facilitates healthier soils through less soil disruption and reductions in residual herbicides

**RESISTANCE TO BT**

A very small number of heliothis caterpillars are naturally resistant to Bt and this can pose a problem. If these insects survived, they could breed with other resistant insects, creating a population of Bt resistant heliothis.

To combat this potential problem, the cotton industry and government regulators have developed Resistance Management Plans for each cotton region, along with thorough testing of every cotton crop throughout the growing season to monitor any potential problems.

Practical examples of strategies in these Resistance Management Plans include:
- planting conventional cotton alongside Bt cotton, so that large numbers of insects will survive and swamp the resistant insects during breeding to dilute the resistant population
- compulsory pupae busting to destroy insect nests
- the planting of “trap crops” that attract natural predators of heliothis in strips close to Bt cotton

These predators are then encouraged onto the cotton by a food spray, and in turn destroy the heliothis when they arrive.

There has been some misguided concern that transgenic cotton could fertilise wild cotton plants creating hybrids. However, researchers have measured pollen movement from transgenic crops and found that there is no possibility of this occurring, nor the widespread movement of pollen to other cotton.
Over the last 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 and reducing wrinkles in fabrics.

The use of transgenic cotton is a key component of grower’s Integrated Pest Management (IPM) strategies that use a combination of natural controls and pest-specific chemistry to further reduce pesticide use.

**NEW VARIETIES IN THE PIPELINE**

**Drought Tolerance**

Research Trials, 2006-07

**Case Study: Meet a cutting-edge young scientist in the front line of managing resistance in Australia’s cotton biotech varieties**

**COTTON AND CLIMATE CHANGE**

Cotton is an annual crop grown in regions that experience climate variability driven by El Nino/La Nina cycles. Consequently cotton growers have already 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 has invested in climate change research to understand further opportunities for cotton farms to reduce or capture emissions.

Current estimates from the Australian Greenhouse Office (2006 Inventory) are that on-farm activities (excluding energy use) across agriculture are responsible for around 16% of Australia’s greenhouse gas emissions. This is more than the transport sector and second only to the electricity producing sector. Methane from livestock is the dominant agricultural greenhouse gas (70% of agricultural emissions) with nitrous oxide from farming activities representing approximately 12% of agricultural emissions.

Greenhouse Gas Emissions (GHG) from the Australian cotton industry are small, representing:

- Less than one third of one per cent of Australian agriculture’s GHG emissions (ranging from 0.16-0.29%)
- Approximately 0.15% of the nation’s total emissions in 2010/2011

The main sources of Greenhouse Gas Emissions that can be associated with cotton growing include:

- Nitrogen from fertiliser and organic nitrogen sources
- Carbon dioxide from soils (biological decomposition of crop and pasture residues which is increased by balleage and additional moisture and nutrient present in irrigated systems)
- Carbon dioxide from fuel and fertiliser (during planting, cultivation, harvesting, chemicals, pumping, fertilisers)

**IMPACT ON AUSTRALIAN AGRICULTURE**

Australia’s climate is inherently variable but specific climate change impacts are predicted to include increases in temperature and atmospheric carbon dioxide, decreases in rainfall and increased frequency of extreme weather events.

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.

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.

Dr Sharon Downes, 2011 CSD Researcher of the Year Finalist

One of the world’s most pre-eminent plant breeders

CSIRO’s perspectives on how the Australian cotton industry is putting together its sustainability building blocks

Lesson: a teaching unit that explores organic chemistry in cotton

Lesson: Cotton classrooms has a range of lessons and units on biotechnology
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 (eg plant breeding and nitrogen use efficiency)
- Measuring the level of greenhouse gas emissions (N2O / CO2) from different production systems
- The development of calculators to assist farmers to estimate 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 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
- Improvements in soil management through stubble retention, reduced tillage and reduction in spraying operations

Case Study: A Life Cycle Assessment of a 100% Australian Cotton T-Shirt, by one of Australia’s leading cotton scientists, Dr Peter Grace

Fact Sheet: Cotton and Climate Change