The cotton growing industry near Bourke NSW

A future with climate change

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Cover photo from CSIRO

The cotton industry is an important primary industry for Australia. Australian cotton is a high quality product and supplies about 3 % of the world market. Australia is the world 3rd largest exporter behind the USA and it's major market is China and a number of regionally close Asian countries.

The industry employs 10,000 people in a non-drought year. (Australian Grown Cotton Sustainability Report, 2014 cited in Australian Cotton Industry Overview, 2016)

The industry in 2011/12 produced earnings of $3 billion for the year from 583,000 hectares.

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Introduction

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The industry employs 10,000 people in a non-drought year. (Australian Grown Cotton Sustainability Report, 2014 cited in Australian Cotton Industry Overview, 2016)

The industry in 2011/12 produced earnings of $3 billion for the year from 583,000 hectares.

In the regions where the crop is grown it represents 30 - 60 % of the gross value of product produced in these regions, which means that if the industry were to reduce in size, it would have a large effect on more than 152 regional communities in Queensland and NSW. (Australian Cotton Industry Overview, 2016)

Growers often rotate the cotton crops with wheat and maize to keep moisture in the soil and control weeds.

The products from the crops include cotton lint, cotton seed, which is turned into cotton oil and animal feed, and linter.

Linter is an interesting by product of the cotton harvest and is produced at the ginnery. It is the shorter fibres of the cotton attached to the seed after the ginning process. Linter is used in making high quality paper and is sort after by paper makers to make fine papers capable of carrying water marks.

Photo 1: (CSIRO, Cotton research from seed to shirt)

It is grown in a geographic band from Queensland's Darling Downs to the Riverina in NSW. There is also I region in the far north east of Western Australian around the East Kimberly that grow the product.

Figure 1. Australian cotton production regions (Stiller Warwick N. and Wilson Iain W)

Across Australia, most of the growers of cotton are family businesses. There is only about 1200 growers in Australia. In recent years the reputation of cotton farmer farming in an environmentally sensitive way has

increased. On average farms use only 60% of the farm for cropping leaving the rest for the natural environment.

In 2012-13 crop there was a bumper harvest across Australia and the top 20% of producers produced 12 bales per hectare.

Conditions for seeding must be right. Moisture must be retained in the soil before planting. Planting of the seed must not be more than 1.5 inches but no shallower than 0.5 inches. It is best to plant under 1 inch deep.

Planting should not be done until the soil temperature is 17 degrees and should not drop below 14 degrees at any time day or night. The cotton crop is a summer crop and enjoys hot weather.

Some farms are irrigated but many farmers use the dry land method with a total reliance on rain before planting and during the growing phase of the crop. A tip from some farmers is that if the first growth is damaged then the second growth from the side of the seedling becomes more resilient in dry conditions.

Growing and harvesting is done on an industrial scale. Many hectares of crop are planted on vast flat plains.

Photo 2: Industrial harvesting in the cotton industry in Australia. (Photo from: Department of Agriculture and Water Resources)

Photo 3: An eight row harvester delivering a roll of cotton to be pick up by trucks and taken to the Gin. (Photo from: World Knowing Web site)

The cotton industry and growers in Bourke Shire

This report is going to look at one of the farthest west regions of growing cotton in NSW, which is around the Bourke area.

Cotton is grown in a rainfall belt between 400 - 800 mm in NSW and Queensland and Bourke is on the edge of the 400mm range.

Interestingly the Bureau of Meteorology decadal data show that Bourke in the two decades' average from 1911 to 1930 was outside this range in the 200 to 300mm rainfall band.

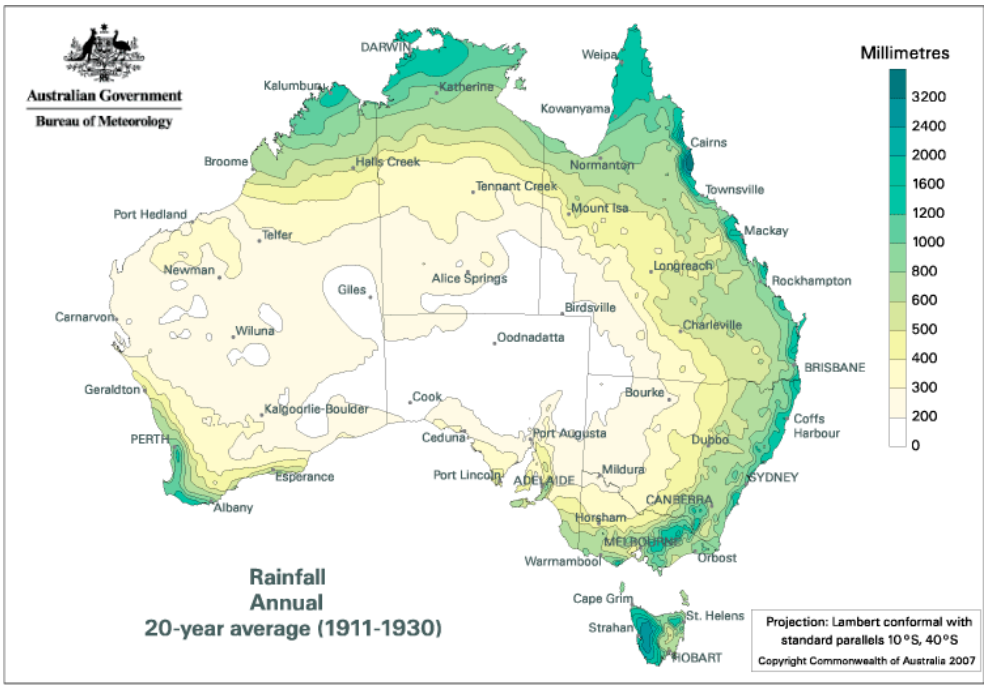

Figure 2: Bi decadal rainfall from 1911 to 1930 (Bureau of Meteorology (BoM))

However, the years from the 1960s have been kinder to the region and Bourke sits at the edge of the 400mm zone as we look at the BoM averaged data from 1960 to 1980. This period would have been the catalyst for introducing the industry to the region in 1968. It is this new rainfall shift that caused farmers to start planting cotton and planting it so far west.

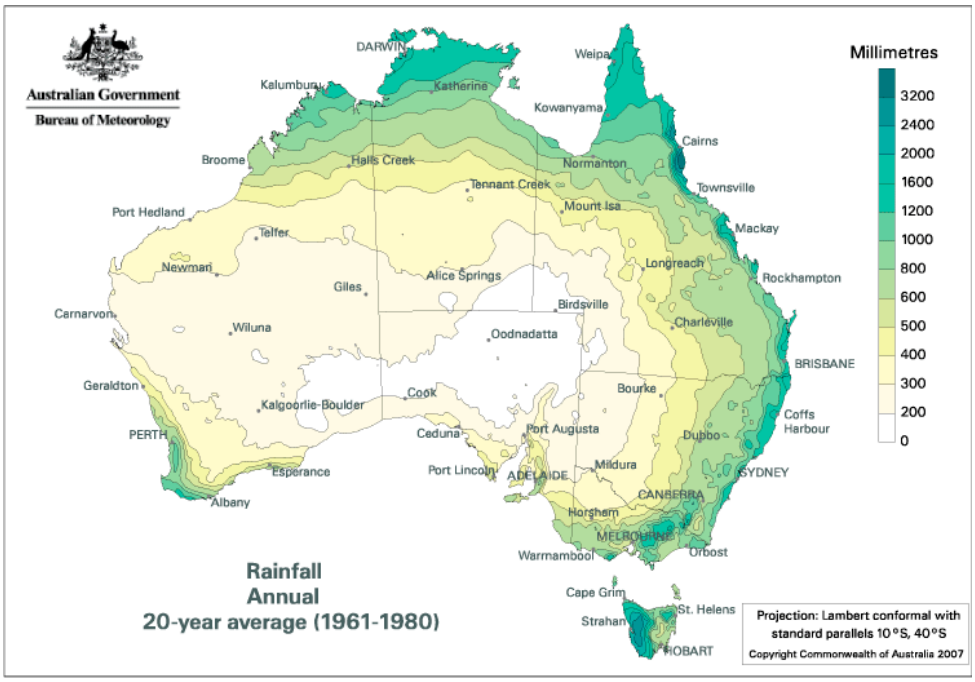

Figure 3: Bi decadal rainfall from 1961 to 1980 (Bureau of Meteorology (BoM))

However, in recent years with data from 1986 to 2005 we see a movement back towards the 300mm zone. As we move into the mid 2010s, and beyond, we hear of bumper crops in 2012-13 across the Australian industry.

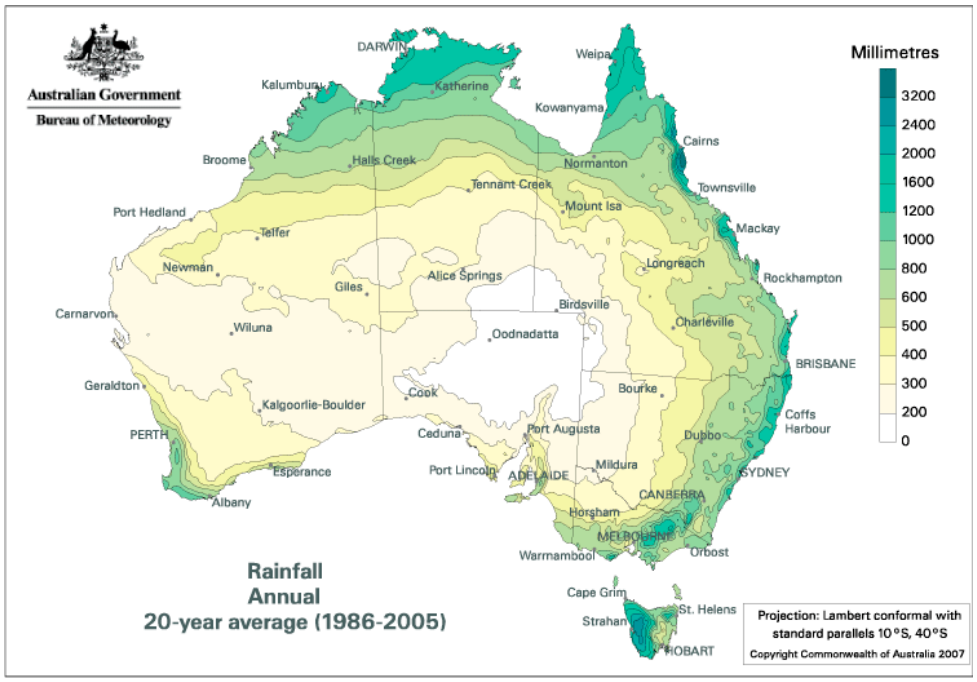

Figure 4: Bi decadal rainfall from 1986 to 2005 (Bureau of Meteorology (BoM))

The Goyder line

The Surveyor General of South Australia, in the mid 1860s, George Goyder, studies vegetation in the outback of that state and concluded that rainfall was a limiting factor to reliable agriculture in the State. He produced a line which coincided to about 250 mm of annual rainfall. (Whitaker Richard, June 2009) That line has been extended through NSW and shows the line pass through country well east of Bourke.

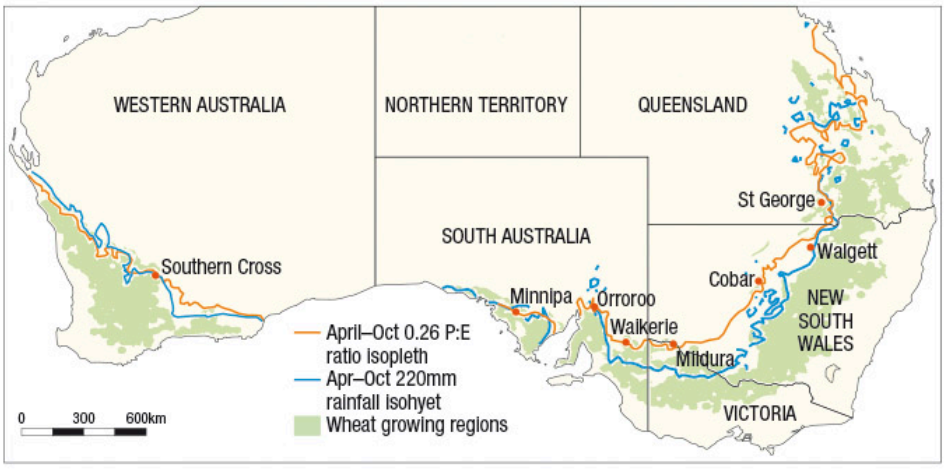

Figure 5: Map shows economic lines for growing crops based on rainfall (Leonard Emma , March 2016)

The argument is that climate change could re-impose this long held line established by Goyder. Goyder established the line for the crops of the day including wheat. The above map shows a red line that relates to an economic limit for growing wheat. It shows the price to earning ratio of 0.26 P.E. This gives an appropriate viability for planting wheat.

We are evaluating the growing of cotton. Being a summer crop it enjoys hot conditions but rainfall is still a limiting factor for the crop. Also you will see from the map above a blue line that represents winter rainfall of 220mm. This line in 2016 is well east from the Bourke area and cotton needs good winter rain to ensure that there is a good moisture reservoir within the soil for the spring planting season.

Why are yields still going up?

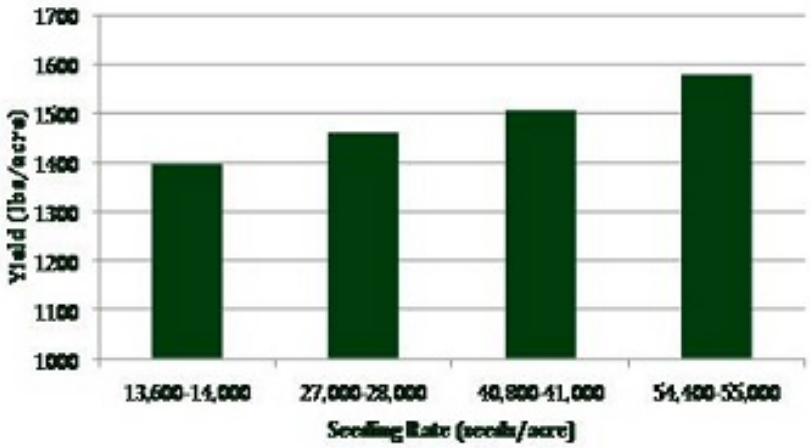

Figure 6: Average cotton yield by seeding rate. Source: Monsanto Learning Center Scott, MS 2011, 2012, 2013, and 2014, (Monsanto, 2016)

Even though rainfall is tending to contract in recent years, crowing efficiencies are increasing in the industry. Farmers are using the water resource more sustainably and working to keep winter rain moisture in the soils. As a result, cotton crop yields are maintained and even growing.

Irrigation farming in Bourke Shire

Cotton farming began in Bourke in 1968 as rainfall was adequate and irrigation was possible from the Darling River.

Many if not all of Bourke's farms are irrigated. That means that the farms are free from the vagaries of the weather.

Soil characteristics

Soils that are typically suited to cotton growing are black or grey clay soils on river flats.

In the Bourke region predominately the grey clay soil is found. The soil is the Darling River flat soils. It is a soil that when it dries forms a hard crust. As it dries it also forms deep cracks, which is considered to be self mulching as humus material gathers in the cracks. (SOILpak – cotton growers, Part E)

To get the soil back into production before planting it is simply a matter of breaking up the crust and if the moisture is still in the soil below the crust there is no major problem for a good crop of cotton. (Optimum planting conditions and seed placement for cotton, 2015, Monsanto Company)

The soil is easily compacted. It is compacted up to 80% on the first pass of a heavy farming machine so some planning needs to be taken when cultivating and planting. (Optimum planting conditions and seed placement for cotton, 2015, Monsanto Company)

Being a light clay, if sufficient drying happens, the soils could be susceptible to wind movement and there is a potential for the loss of productive soil in high wind events.

The question

The question is, is the cotton industry viable in the future in Bourke Shire when considering the effects of climate change on the crop and the industry?

Has the climate changes in the Bourke region over the last 100 years?

When we look at the data from the BoM (figures 2,3 & 4) we can see from the average bi-decadal data a drift of yearly rainfall from under 300 mm to over 400mm. So the question is; has anthropogenic climate change affected rainfall in the region?

Most climate change models expect to see warmer and dryer periods in inland NSW and in the regions of the Darling River. Instead the region has experienced increased rainfall. But as we enter the early part of this new century rainfall is again falling off.

Pacific Dipole Oscillation (PDO) and El Nino Southern Oscillation (ENSO)

In 2002 Australia was in an El Nino cycle and suffered drought conditions in the inland which extended until a good harvest in 2010. This would have helped reduce rainfall averages for Bourke as seen in the above maps. But the jury is out as to whether the anthropogenic effects are causing an intensification of El Nino at his point in time. PDO and ENSO seem to operate on a much shorter time scale than 50 years, which is the signal we see in the rainfall data for Bourke. Anthropogenic effects would tend to reduce rainfall below 1911 levels and this is not evident.

However, with the Indian Ocean Dipole Oscillation (IDO) now in a wet phase with warn waters close to Australia's west coast, moist air is moving across the continent and falling in western NSW. So it is likely and even predicted by the IPCC reports that these systems will not be dominated by anthropogenic

climate change in the near future. (IPCC, 2013, Chapter 12, cited in Australian Climate Influences, August 2016)

However, when we consider temperature trends, we see that over time there is an overall trend of global warming and when you take out the influence of the ocean oscillation effects there is a steady rise in temperature on average.

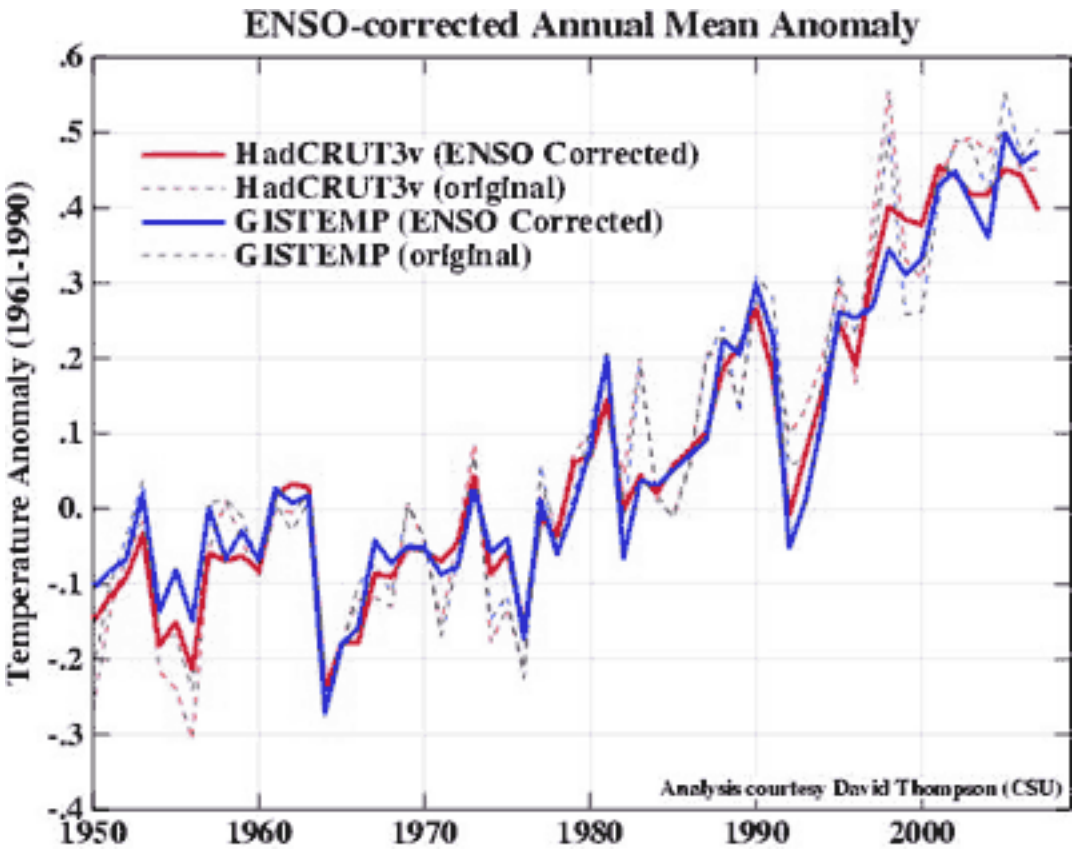

Figure 7: Surface air temperature records with ENSO signal removed. HadCRUT corrections by Thompson 2008, GISTEMP corrections by Real Climate. (Skeptical Science)

Is Bourke a good place to grow cotton?

On all points superficially, Bourke seems an ideal place to grow cotton. A considerable amount of investment has gone into the area for cotton including the Clyde cotton Gin just south of the town.

It has sufficient rainfall and at the right times of the year. It has some rain all year round but particularly after the planting season till the end of November and through the summer. When there is a break in the weather around April/May during the harvest season.

But how will this growing season be affected by the future impacts of climate change?

Micheal Bange (2007) from the CSIRO in his article " The effects of climate change on cotton growth and development" throws a few considerations up for the future of the industry.

Firstly, he suggests that the higher concentrations of CO_2 will enhance the growing cycle of the plant. This may increase yields and may be a contributor to the higher yields in recent record harvests. (Michael Bange July 2007)

Reduced water availability is a consideration for water sharing from the Darling River. This may become a limiting factor in years to come and require the implementation of a harsher water sharing regime in the future. (Michael Bange July 2007)

We can expect an increase in evaporation due to reduced humidity and higher temperatures. The crop in its early stages will need more water and as it grows and develops leaf cover will provide more transpiration further reducing soil moisture. (Michael Bange July 2007)

In a scenario of limiting water to the crop, this would severely inhibit the plant's ability to transpire and would increase the canopy temperatures, potentially damaging the plant and setting the plants back in the production of flowers and fruit. (Michael Bange July 2007)

Conversely, the higher CO_2 levels will enhance the photosynthesis through the green plant materials and as a result lead to more efficient water use for the growth of the plant and potential increase the yield of the cotton produced. For instance by doubling the CO_2 level, potentially there is a 40% increase in photosynthesis which produces more energy for the plant to grow. (Reddy et al 1996 cited Bange 2007)

Higher temperatures at the start and the end of the growing season may prolong and or accelerate growth of the plant and potentially increase yields. This may be starting to happen in the central west of NSW and in the Bourke region now and contribute to good yields. (Michael Bange July 2007)

Conversely a cool period just after planting will set the plant back in its growth cycle or may kill the plant. (Optimum planting conditions and seed placement for cotton, 2015, Monsanto Company)

Increased temperatures during boll filling will reduce the crop quality by increasing risk of micronaire problems. (Michael Bange July 2007)

However, an increase of extremely hot days will hamper growth and damage yield by shutting down photosynthesis above 35 degrees C and warm nights continue maintenance respiration to keep the plant cool but use valuable resources that should be used during the day with photosynthesis to grow the plant. This can increase square and boll shedding. It can reduce seed numbers per boll and this loss of fruit may cause the plant to grow rank. (Michael Bange July 2007)

There are three consequences of heat stress. The first is, because the heat affects the pollen at flowering and creates a beaked boll thus reducing boll size and yield at harvest. Secondly, the bolls freeze and do not fully form and as a result there is a drop in yield. Thirdly, bolls exposed to days with temperatures in excess of 32 degrees C tend to have less ability to grow the length fibre that the plant genetic allows them to, thus reducing the quality of the yield. (Michael Bange July 2007)

Bange (July 2007) also suggests that climate change will bring an increase of cooler days. Days under 11 degrees C are called cool shock days. These days can delay flowering by 5.2 days on each occasion, further setting back the crop yield.

Bange (July 2007) continues and suggests that more research is needed to properly assess the potential for impacts on crop yield and health as climate change begins to affect the industry.

What are the implications of reliance on irrigation water?

Implications are that the water from the upper catchment in Queensland needs to be regulated so Bourke users can use a fair share of the valuable resource. In a scenario with a 10% reduction in rainfall, a 35% reduction in stream flow in the Murray Darling system is predicted. (Jones et al. 2001 cited in Garnaut Review, (2014) chapter 5)

As more irrigated water is put on the land from the river there will be a price to pay for an increase in salinity over a period of time. However, presently in Bourke in 2016 some of the water used by the crop is rain water, but that rainfall may not be there in a climate change future and much more reliance will be needed on the irrigation systems to grow the crop.

Rain would be the best way to build that moisture up needed for seeding. Irrigation takes more work and much of the water would be evaporated off from the soil before it can reach a depth in the soil where radiation from the sun or heat exchange from the atmosphere cannot reach it.

Increases in salinity in the soil will become a limiting factor in the production of cotton.

But efficiencies are climbing in water use. The industry is proud of the technological gains in production to water use ratio. It is currently about 3 time better than anywhere else in the world. (Australian Cotton Industry Overview, 2016)

Re-framing the question

So the question is not so much, is the industry viable, but is it prepared to cope with the effects of climate change in the medium term? Can farmers work together to ensure a reliable water supply for the industry? Within Bourke Shire, it may be that certain farms may need to shut down and others become more efficient.

A reliable water supply from the river is essential in the future.

Research into hybrid plants and seeds could help the viability of the industry further.

Monsanto, have supplied the industry with seed since 1928 and have recently developed a "round up ready" genetically modified plant that can withstand the effects of glyphosate so that the crop can be sprayed and weeds eradicated without tilling, producing less stress on the plants. (Round up Ready Flex Cotton, Technical Manual; Monsanto, Monsanto in Australia and New Zealand)

In fact, most of the yield gains in the industry in recent years is due to seed technology.

Conclusion

This work on the subject of assessing a viable cotton industry in Bourke Shire and across the entire cotton growing area in Australia is just a beginning. Climate change impacts are here to stay for the medium term and adaptation is the best way to ensure the survival of the industry in Bourke Shire.

Bourke is one of 152 communities around Australia that rely on the income from the cotton industry through employment and enterprise. Without the industry many of the regional towns will struggle to survive. Bourke is no exception.

Cotton provides Australia with one of its most valuable agricultural exports and as such, unless the industry can suitably adapt to the effects of climate change, this valuable export earning will be reduced. Technological development must be continued to reduce water use and at least maintain yields.

Water sharing between the States is crucial for this industry to survive and to ensure a reliable supply of water which is the most limiting factor with a changing climate future.

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