Cotton

Global consumption of cotton causes around 220MtCO_2e of global emissions, with both production and final consumption being highly concentrated, typically in different countries. The flow of embodied emissions in cotton between producer and consumer countries opens up new consumption-based reduction opportunities that could significantly improve on production focused techniques to reduce emissions.

Key facts

- **Highly concentrated production**
  Cotton is a specialist crop contributing to major global supply chains, and its production is highly concentrated in a few countries.

- **Significant GHG emissions**
  Global cotton production generates emissions of around 220MtCO_2e (around 0.8% of global CO_2 emissions), and the industry consumes around 4% of the world's nitrogen-based fertilisers. Cotton lint has emissions of up to 12tCO_2e/t associated with its production; these emissions vary significantly by country of production.

- **Emission reduction opportunities**
  Emissions from cotton production can be reduced considerably using a range of measures mostly available today, including fertiliser application rates, uptake of GM cotton and tilling methods.

- **Consumption-based levers**
  Despite the technical potential to reduce emissions significantly, there is currently limited drive to reduce emissions in the cotton sector. A consumption-based view adds a new dimension, identifying the global sources of emissions arising due to EU cotton consumption. This view reveals new opportunities to reduce emissions from this sector, including new drivers for fertiliser and pesticide optimisation.

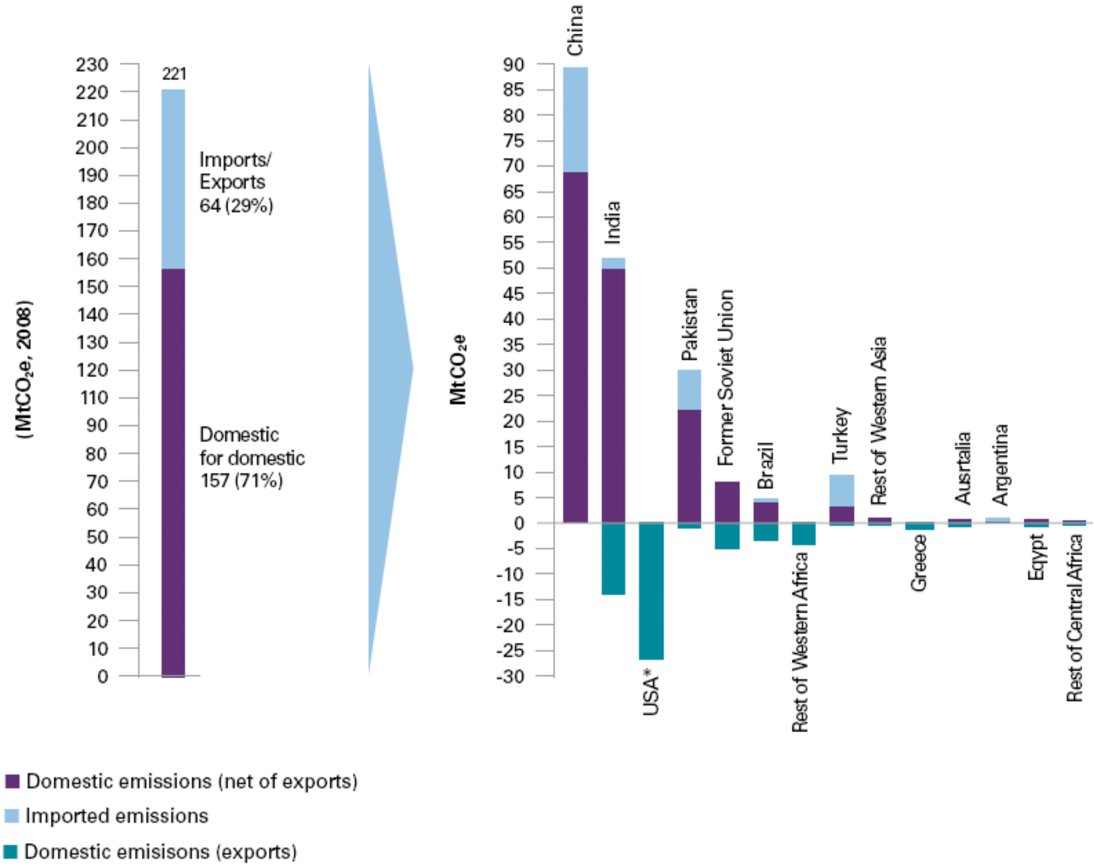
Implications for business

- **Engaging consumers**
  Final consumption of cotton occurs across a range of consumer products, including clothing, furnishings and other home wares incorporating fabrics. A focus on enabling businesses to identify and procure lower carbon cotton would enable suppliers to offer final products such as clothing and home wares containing lower carbon cotton. This could drive demand for lower carbon, sustainably managed cotton through the supply chain and reward the ultimate producer, which in turn could help smallholding cotton farmers to reduce the overall carbon footprint (and costs) of their operations significantly. Product carbon footprinting is one mechanism that could be used to link consumption of final goods with production of commodity cotton.

- **Knowledge and technology**
  Investment in improved management techniques, including tilling practices and the development of soil carbon sequestration techniques, could be an important component of maximising the potential to reduce emissions in cotton. This is likely to require public support and may significantly benefit from international coordination in order to share knowledge and reduce costs.

Cotton production is highly concentrated in a few countries

Cotton production emissions by country, and the import and export of emissions in traded cotton



[1] Top 15 cotton producers represent 97% of global production.
Source: TradeMap data for exports and imports, 2008; Mundi production data, 2008; country-specific CT analysis.

* Trade Map data suggests that exports of cotton from the USA exceed domestic production and imports. For illustration purposes USA exports have been adjusted to equal domestic production, meaning that no cotton produced in the USA goes to further value add in the USA.

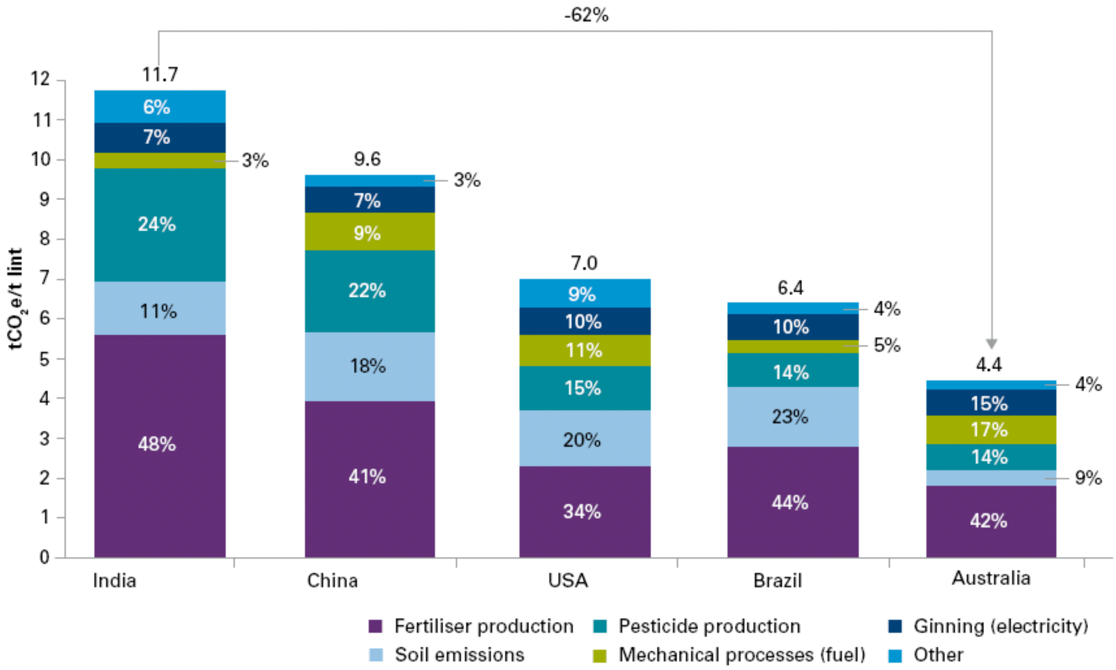
The production of cotton is highly concentrated in a small number of countries, typically developing countries; the conversion of cotton to final products such as clothing also often occurs in developing countries. Around 30% of CO_2e emissions associated with cotton production are embodied in the international trade of cotton as raw cotton (this excludes the trade of cotton in finished and semi-finished goods such as clothes), prior to the cotton being subject to further transformation into textiles, clothing and other final consumer products which are also significantly traded. The USA and India are the world's largest exporters of cotton, while China is the world's largest importer of cotton. Most of this cotton is then turned into clothing and other materials for consumption in developed countries.

A consumption-based view of cotton farming gives a new perspective on the importance of emissions reduction from the sector, across different geographies. For example, the UK and most other European countries have no cotton production, but each imports significant quantities of cotton in the form of clothes and other goods, and therefore has an interest in upstream cotton emissions reduction.

A focus on bottom-up consumer demand, combined with behavioural change by small holding cotton farmers, is likely to deliver significantly reduced emissions in the cotton sector. This consumer demand could be supported via a number of mechanisms, from specific carbon footprinting of cotton products (e.g. as carried out by Continental Clothing) through to the incorporation of lower carbon management practices in existing cotton production support programmes (e.g. the Better Cotton Initiative, or Organic Cotton).

There are significant differences in the carbon intensity of production of cotton between different countries

Greenhouse gas emissions from cotton lint (tCO_2e/t cotton lint), by country



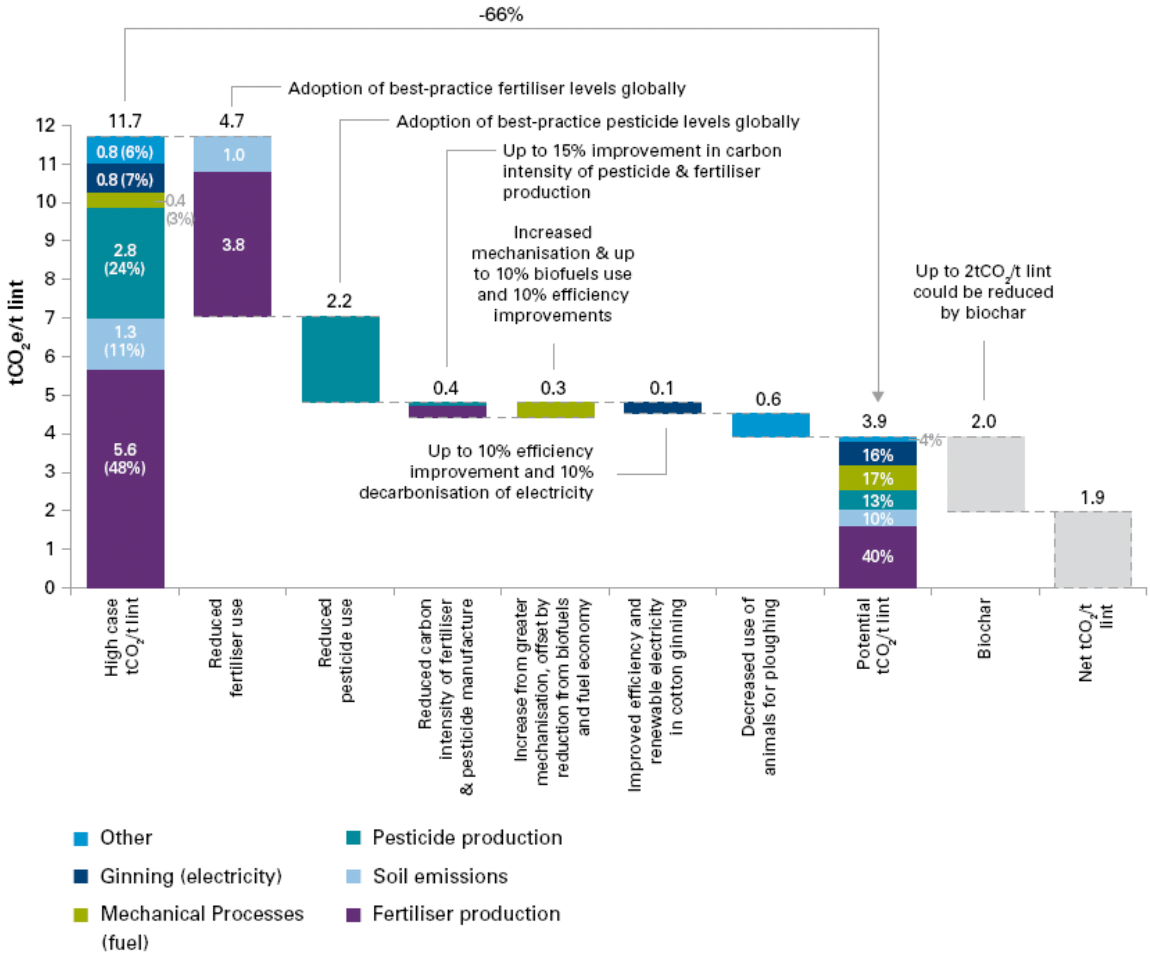
Note 1: Soil emissions are NOx emissions, principally from fertiliser application; emissions from fertilisers and pesticides are from production.
Source: Peter Grace (2009), Queensland University of Technology.

The carbon intensity of cotton lint ranges from around 4–12tCO_2e/t lint. This varies considerably with location of production and production methods, with Australian produced cotton resulting in around 4tCO_2e/t lint being emitted, and Indian cotton resulting in around 12tCO_2e/t lint being emitted. Production of cotton in developed countries such as the USA and Australia relies on mechanised farming techniques which have emissions implications for farmers, with emissions arising from the combustion of fuel adding to the emissions from fertiliser and pesticides.

Conversely, cotton farming in developing countries (e.g. China, India) shows low levels of mechanisation, although in China this is changing. However, despite the increased emissions from mechanisation, the emissions intensity of developed country cotton is generally lower, primarily due to more careful management of fertiliser and pesticide application and in the case of Australia, the increased use of genetically modified cotton.

There are significant opportunities to reduce the carbon intensity of cotton production in key producer countries

Opportunities to reduce the carbon intensity of cotton production



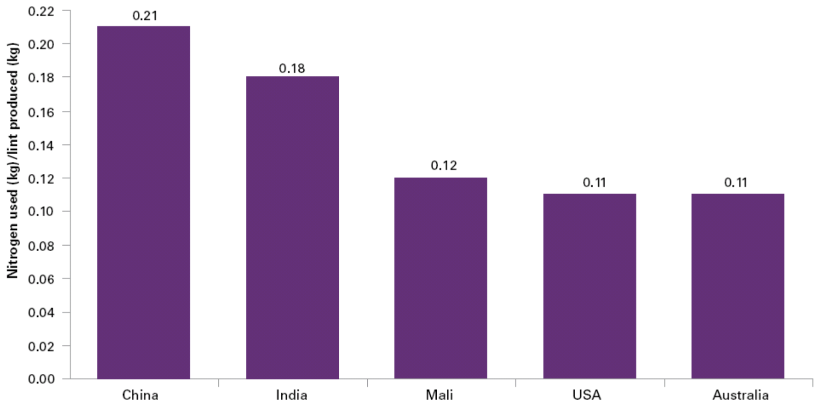
There are a range of options for reducing the carbon intensity of cotton production, with the common theme being altered management practices. They include:

- Optimising fertiliser application on farms
- Reducing/avoiding the use of pesticides
- Increasing energy efficiency in cotton ginning
- Soil carbon sequestration and storage (altered tilling practices and biochar)

Taken together, it is possible to reduce the emissions intensity of the most carbon-intensive sources of cotton production by up to two thirds by 2020 by taking a range of measures which are mostly already established in other parts of the world.

Fertiliser application rates for cotton production vary widely between countries

Nitrogen fertiliser use per kg cotton lint produced, selected countries



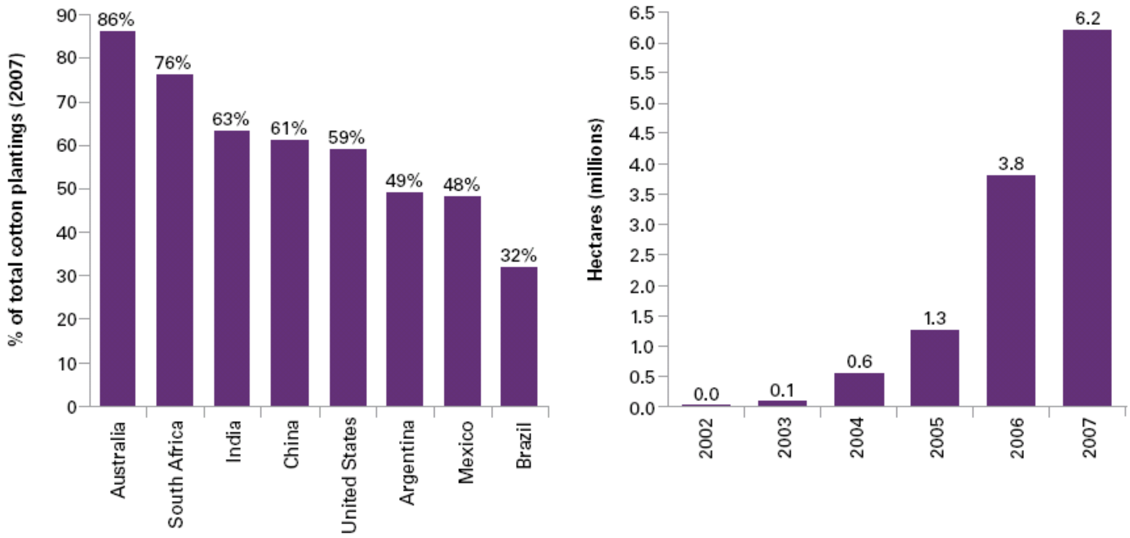
Source: ICAC monthly bulletins, USDA Cotton and Wool Yearbook 2008.

There is an optimal limit to the application rate of N-fertiliser on cotton crops, and substantially different rates of fertiliser application (kg N/ha) and productivity (kg N/kg lint produced) occur in different countries. N-fertiliser usage in China (0.21kg nitrogen/kg lint) and India (0.18kg nitrogen/kg lint) is markedly higher than that in either Australia or the USA (both around 0.11kg nitrogen/kg lint). Despite the different levels of N-fertiliser use, cotton yields are not significantly higher in China or India compared to other countries: this suggests that excess N-fertiliser is being applied in some countries.

Optimising fertiliser application rates could substantially lower N_2O emissions from cotton production. It is estimated that total N-fertiliser use on cotton crops could be reduced by up to 70% in some cases, reducing total emissions per tonne of lint by around 4.7tCO_2 through a combination of reduced process emissions associated with making the fertiliser, and reduced consequential soil emissions from the most carbon intensive sources of cotton production.

Widespread adoption of GM cotton has reduced the need for pesticide application to cotton

(Left) Penetration of Bt cotton by country; (Right) Uptake of Bt cotton in India



Note: Bt Cotton is genetically modified, pest-resistant cotton.
Source: FBAE 2009 (fbae.org/2009/FBAE/website/our-position-bt-cotton.html); Industry interviews; BCG analysis.

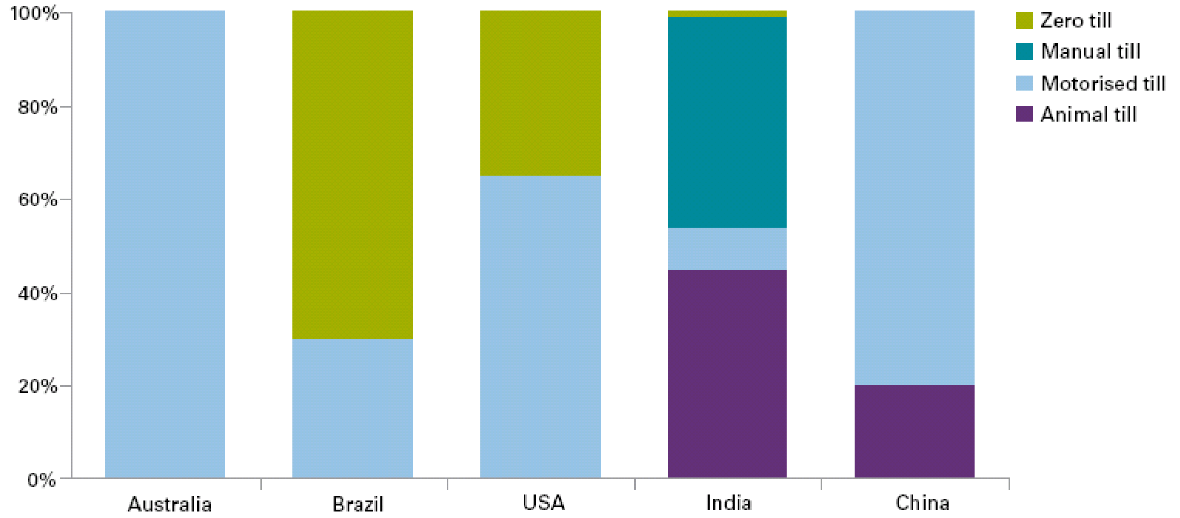
Pesticide use improves crop yield for cotton farmers, but this yield increase comes at a cost and carbon penalty. Two alternative approaches to pesticides are already in use: mixed cropping, where cotton plants are grown alongside other crops that provide habitat for beneficial insect species that predate the cotton pests; and the use of genetically modified (Bt) cotton plants that have been modified to produce a toxin that is effective against many cotton pests (but not against other species).

Since its first introduction in 1996, use of Bt cotton has expanded rapidly in most regions; in countries such as India, rapid expansion in recent years has needed little capital investment, but has been supported by biotech companies through information and demonstration. Experience from cotton farming in the USA shows that the introduction of Bt cotton has led to yield increases at (typically) lower net cost to farmers. It is estimated that total pesticide use on cotton crops could be reduced by up to 70% in some cases, reducing total emissions per tonne of lint by around 2.2tCO_2 through reduced process emissions associated with making the pesticide.

However, the use of Bt cotton raises a dilemma for businesses seeking to differentiate cotton on the basis of production techniques: Bt cotton is not permitted under organic certification systems, thereby limiting the potential market for this type of cotton.

Farm tilling methods vary widely by country

Tilling methods by region of cotton production



Source: ICAC survey of production methods.

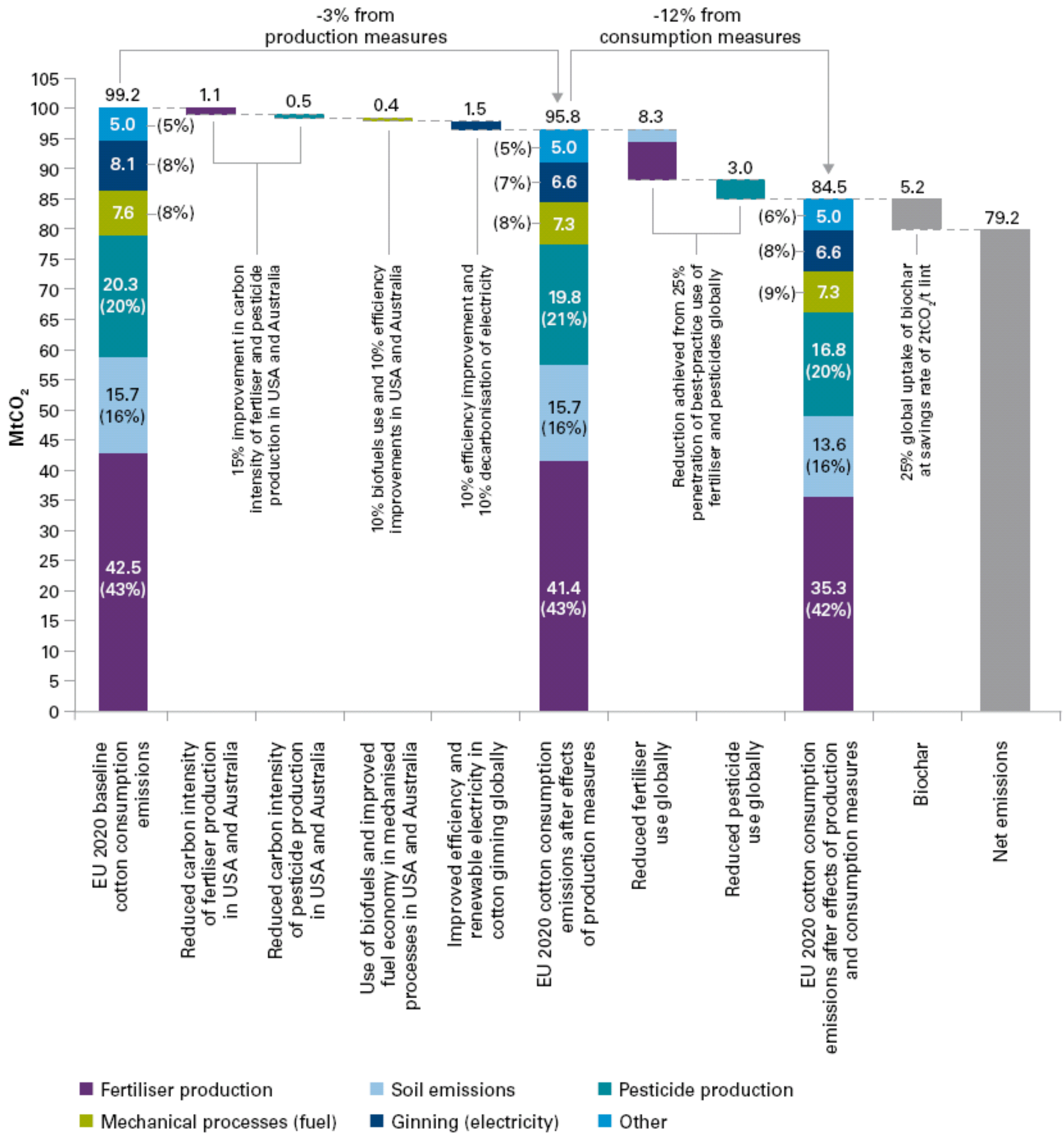
Farm management practices can have a significant effect on the ability of soils to sequester and act as long term stores of biogenic carbon. By altering management practices, the opportunity for soil carbon storage can be increased. The two main opportunities are altered tilling and residue management practices, and biochar.

Tilling is a standard farming practice where the land is prepared by mechanised or animal powered ploughing or similar activity. By breaking up the surface of the land in this manner, soil is overturned and air is able to penetrate deeper into the soil profile, as well as enabling easy planting of seeds. While beneficial to crop growth, this increases microbial activity in the soil, accelerating the conversion of soil carbon to carbon dioxide. By moving from intensive tilling to no- or low-till methods, soil carbon loss is decreased. Additional benefits are also gained, such as lower erosion and increased soil moisture content. Low or zero till approaches to land management are being increasingly adopted in the cotton sector. There has been significant take-up of these approaches in Brazil and the USA.

The use of biochar (organic material, typically plant waste, which is returned to the soil as a stable form of carbon) could further reduce the net emissions from cotton production through enhanced long-term storage of atmospheric carbon in agricultural soils (rather than reducing the emissions arising directly from the production of cotton). The scale of this opportunity, and the practicality of its widespread implementation, will vary with soil type and management practice. Low-nutrient and severely degraded soils may offer a greater opportunity for soil carbon sequestration using biochar than some other soil types.

Reductions in the carbon embodied in cotton consumed in Europe arise from both production and consumption activities

Opportunities for reducing the embodied carbon in cotton arise from both production and consumption based approaches



Source: Carbon Trust analysis

A consumption approach to emissions reduction in the cotton sector links final consumption of cotton (the ultimate driver of emissions from the global cotton sector) with the production processes that give rise to GHG emissions from the sector. This consumption perspective creates the incentive for achieving lower carbon cotton, and this could help drive significant action across the large base of smaller farming units in the developing world, where emissions per unit of lint produced are higher. The major sources of emission reduction would be in reduced fertiliser and pesticide emissions (from both production-related emissions and soil emissions arising in use), and in driving greater energy efficiency and more rapid uptake of low carbon sources of electricity for cotton ginning. In addition, the carbon sequestration and storage benefit of biochar and conservation tillage could significantly add to the overall emissions impact of the sector.

We estimate that global emissions from cotton production in 2020 will be around 300MtCO_2e, based on a business as usual scenario of: no reduction in emissions based on current climate change action, and; an annual growth rate of around 2.7% above today's level of global emissions for cotton of around 220MtCO_2e. Under this scenario, total emissions associated with consumption of cotton in the EU would be around 100MtCO_2e (using the EU's proportion of global consumption emissions from clothing as a proxy for EU cotton consumption emissions). It is further assumed that the EU purchases a mix of cotton which reflects the global average of cotton production, with a global average emissions intensity of around 9.5tCO_2e/t lint.

Overall, whilst production approaches may result in a reduction in emissions associated with EU consumption of around 3.4MtCO_2e (around a 3% reduction), further consumption-based approaches (such as reducing emissions from fertiliser and pesticide production) could deliver additional reductions of around 12%. This demonstrates that consumption-type approaches could be significantly more effective, potentially improving current reduction estimates by around three fold in the case of cotton.

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