Maths

Water and CO^2 usage for your cotton T-shirt

RecyCOOL Lessons

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Water and CO2 usage for your cotton t-shirt

Description of the lesson
First you will learn about different impacts of cotton – including what is needed to produce a T-shirt, then you will calculate the impacts of the T-shirt.

Objective
Exercising percentage calculation with the example of cotton cultivation:
The water usage and the carbon use of the pesticides used in conventional farming of cotton. The lesson does not cover the full environmental footprint of the t-shirt, only the cotton farming aspect.

After this lesson you will be able to:
- calculate percentages in different ways
- know how much water is used for your cotton T-Shirt – including how much water is saved if it is organic cotton
- calculate the reduced cotton footprint of your t shirt if it is made with organic farming methods

Tools and materials:
your own T-Shirt, a calculator

PESTICIDES:

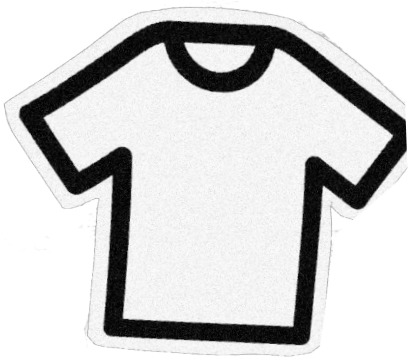
Pesticides are chemical substances that are used to kill pests, such as unwanted plants, insects or fungi.

FERTILIZERS:

These give nutrition to the soil in the form of a chemical.

CONVENTIONAL:

Is used to describe the opposite of organic. So when farmers use chemical pesticides and synthetic fertilisers.



Do you know the difference between organic and conventional cotton?

Do you think there is a different impact of growing organic and conventional cotton on the environment?

If you answered yes to the second question, what do you think these impacts might be and why?

The production of T-shirts is quite energy-intensive and requires many resources, mostly at the initial stage growing the cotton. How much of these resources are needed, depends on the method of farming. There are two types of farming methods this could be – conventional or organic farming.

When farming organic cotton, most chemicals that kill: insects (insecticides), plants (herbicides) and synthetic fertilisers (giving nutrition to the soil) can not be used. This also prohibits the use of GM (genetically modified) seeds. Allowing the natural regeneration of the soil.

This means that when growing organic cotton, the soil and surrounding environment is much healthier and stores more CO^2 Farmers are using different and more natural methods to deter pests.

One example of a more natural method is intercropping with other crops, for example using chilli plants around the cotton fields being farmed. This deters some harmful insects. It also helps some other insects, that are not harmful, by giving them nectar when the plants flower. And of course – farmers can sell the chillies on the market!. This is another benefit of organic cotton farming, Farmers can cross rotate crops and grow food they can eat and sell for another source of income.

Organic farmers also rotate the planting of different crops over the years. Through this method, the ground stays healthy, needs less fertiliser and less water. A study found out that organic cotton needs 15.000 m^3 water per tonne of cotton of which 95 % is rain water.
A study from 2012 found out that one field of conventional cotton uses 2120 m^3 water from rivers and lakes per tonne of cotton fibre.

By not using chemicals, there are less gases emitted that are bad for the climate. CO^2 is one of these gases that is reduced.
Conventional cotton farming uses 25% of the insecticides used worldwide and 18% of the pesticides used worldwide.

Additionally, with organic cotton, the soil is much healthier and therefore also requires less water and stores up to 25% more CO^2.
Other irrigation methods can also save a lot of water.
The CO^2 use of conventional cotton has been calculated to be 1808kg of CO^2 per tonne of cotton. Textile and International PE found out that the same amount of organic cotton uses 978 kg of CO^2.

DISCLAIMER: The figures on the water consumption of cotton vary greatly. There are several reasons for this:

• There are different types of water consumption, which are often not defined (there is green water, i.e. rainwater, blue water, i.e. water used for irrigation, and grey water, i.e. water already used in products).

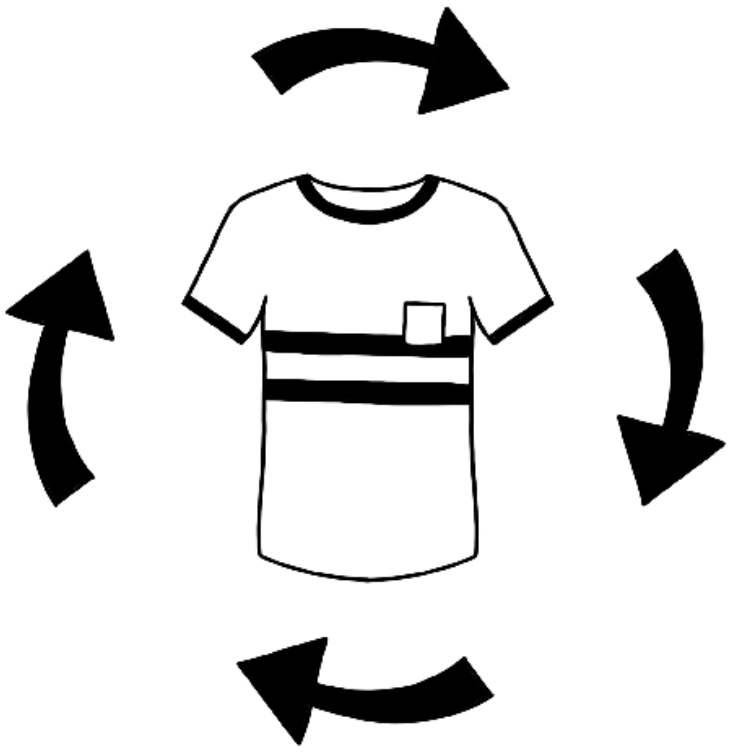
• It's hard to measure and it varies a lot. It really depends on the area where the crops are grown. In some areas, no additional water is needed. But it is also clear that the expansion of cotton growing areas due to high demand is drying up many areas. This is due to cheap irrigation systems, lack of knowledge and pressure on farmers.

• According to Fashion Revolution's Fashion Transparency Index 2022, just 4% of brands disclose their water consumption at raw material level. So, there's almost no visibility into how much water is used to grow the cotton fibres used in cotton t-shirts. (For more information on this topic, please see pg. 103–105 of the report.)

Moreover, collecting accurate data on greenhouse gas (GHG) emissions is crucial for brands and retailers to reduce emissions and meet their decarbonisation targets. And yet, while most environmental impacts occur at the processing and raw material level, the Fashion Transparency Index finds that only 34% of 250 brands reviewed publish their carbon footprint at processing level compared to 26% last year and 22% at raw material level.

The lack of transparency makes it hard to understand at the product level how much water and CO^2 is saved.

We can't really say if the numbers are 100% accurate, but probably there is no such number. What is clear is that organic cotton often saves a lot of water. This is proven by the studies we are quoting in this lesson and that provided us the numbers. The two studies came to similar results which proves that the data is reliable. (Studies: Textile Exchange (2015) Organic Cotton Sustainability Assessment)



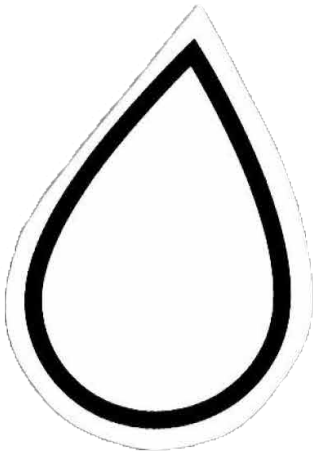
Task

1. Calculate how much water must be extra irrigated to grow 1 tonne of organic cotton.

95% rainwater – means 5 % from other sources
15.000 m3 : 100 x 5 % = 750 m^3

4:20–5:00 different numbers and text:
How much water is needed for 1 T-Shirt that weighs 150 grams and is made of 100% cotton?

1 kg of cotton (1000 g) = 10 000 l of water
(10 000 : 1 000) x 150 = 1500 l of water



2. Compare the use of extra water needed for organic cotton to the water from rivers and lakes for conventional cotton. Give the answer in percentage.

750 m^3 for organic cotton
2120 m^3 for conventional cotton

750 : 2120 x 100 = 35,4

Organic cotton uses around 35 % of the water that is needed for conventional cotton.

5:01–5:38 different text and numbers:
How much water is saved for that same 150 gram T-Shirt if it's made of organic cotton instead of conventional cotton?

1 500 l of water needed for conventional cotton
40% saved by organic farming techniques

1 500 – 0.40 x 1 500 = 900 l of water is needed for 150 gram T-Shirt made of organic cotton
0.4 x 1 500 = 600 l of water is saved

3. How much water from rivers and lakes is needed for the cotton of one T-Shirt that weighs 150 grams and is made of 100% cotton?

1000 kg of cotton needs 750m^3 water. That are 750000 l
1 kg needs 750 l
1000g = 750 l
750 : 1000 x 150 = 112,5 litre.

The cotton used for one T-shirt can use 112,5 litre of water.

5:39-7:15 different text and numbers (is this Q2?):
Not all T-Shirts are 100% cotton. If you look inside your T-Shirt, you can see in the tag how much cotton it actually contains. This shirt is 60% cotton, 30% polyester and 10% elastane, and it weighs around 150 grams. How much water is actually used for the 60% cotton in this shirt?

150 x 0.60 = 90 grams of cotton in this shirt
(10 000 : 1 000) x 90 = 900 l of water in this shirt

If this shirt was made with organic cotton:
900 - 0.40 x 900 = 540 l of water is needed
900 x 0.40 = 360 l of water is saved

4. How much water will be needed to grow a T-Shirt made of conventional cotton?

112,5 litre = 35%
100 % : 35 % = 321,4 litre

Around 321 litre additional water will be needed to grow the cotton for one T-Shirt.

7:16-9:15 different text and numbers:
The total share of cotton around the world in 2016 to 2017 was 0.5%. And there are over 1 million T-Shirts produced every year. Let's estimate that 55% of the material in each T-Shirt is cotton and that every T-Shirt weighs 150 grams. How much water could we save if only organic cotton was used and all fields were irrigated?

1 000 000 x 150 = 150 000 000 grams of T-Shirts or 150 000 kilograms. (In the video there's a mistake in the calculations - only 15 million instead of 150 million grams.)

150 000 x 0.55 = 82 500 kg of cotton is in the T-Shirts (In the video - only 8 250 kg)
82 500 x 10 000 = 825 000 000 l of water is needed (In the video - only 82 500 000 l)

With organic cotton:
825 000 000 - 0.40 x 825 000 000 = 495 000 000 l of water is needed
825 000 000 x 0.40 = 330 000 000 l of water is saved using organic cotton (In the video - only 33 000 000 l of water)

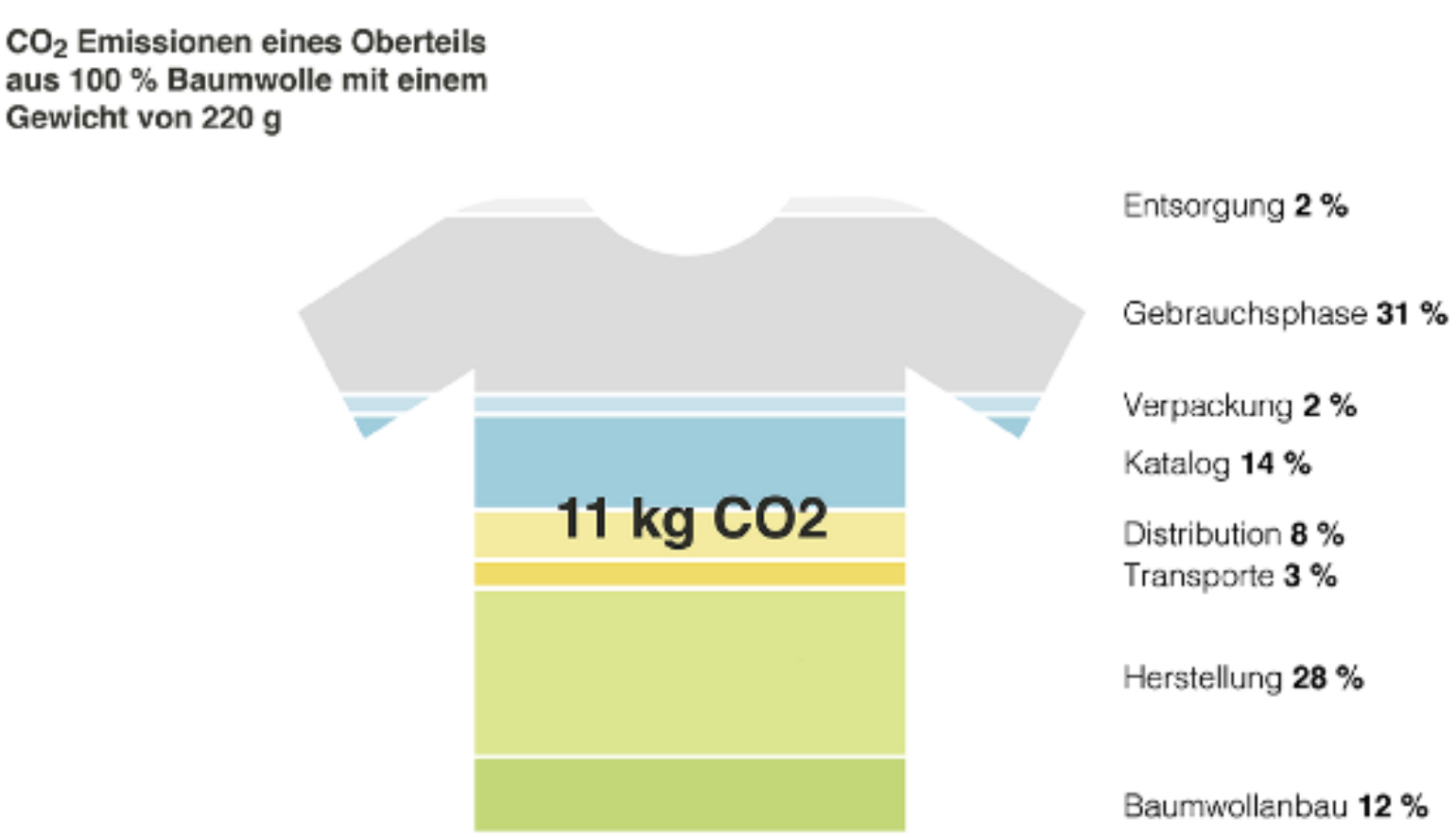


Photo credit: Polarstern

5. How many percent CO2 saves one kilogram of organic cotton?

Conventional cotton: 1808 kg / tonne = 1,8 kg / kg cotton
Organic cotton: 987 kg / tonne = 1 kg / kg cotton

1 : 1,8 x 100% = 55,55 %
100% – 55,55 = 44,45 %

Organic cotton saves around 45 % of CO^2

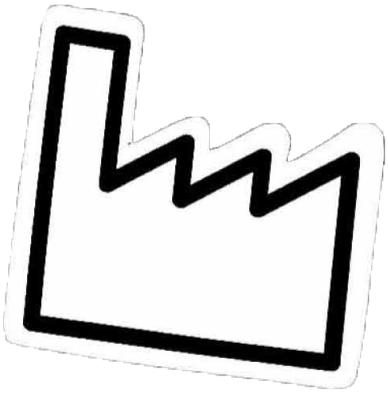
Reflection

Do you consider the difference between the amount of water needed for growing organic cotton and conventional cotton significant?

Can you think of the benefits and advantages of growing organic and conventional cotton – and compare them?

Do you think organic cotton also needs a lot of water?

What does this mean for us? Now that you know how much water is need to grow only one cotton T-shirt, will you buy less T-Shirts?



Resources

Bündnis für nachhaltige Textilien. Textilbündnis-Mitglieder beziehen über die Hälfte der weltweit verfügbaren Bio-Baumwolle. 2019. Available at: https://www.textilbuendnis.com/textilbuendnis-mitglieder-beziehen-ueber-die-haelfte-der-weltweit-verfuegbaren-bio-baumwolle/#:~:text=Wie%20viel%20Bio-Baumwolle%20gibt,gerade%20einmal%200%2C5%20Prozent.

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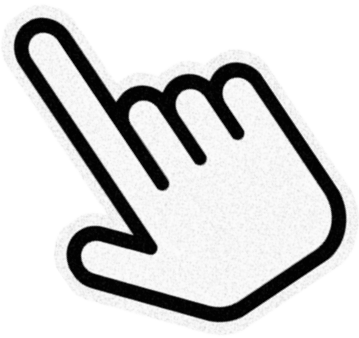
Attachments

German: https://www.youtube.com/watch?v=rX3zSKdVxUo

English: https://www.youtube.com/watch?v=vyWlguh8-ml

Further reading about water crisis:
https://www.fashionrevolution.org/tag/cotton/

Further reading about misinformation:
https://www.transformersfoundation.org/cotton-report-2021



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