Sustainabilty of Bt maize in Spain (1998-2021)

An economic, social and environmental analysis

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Outline

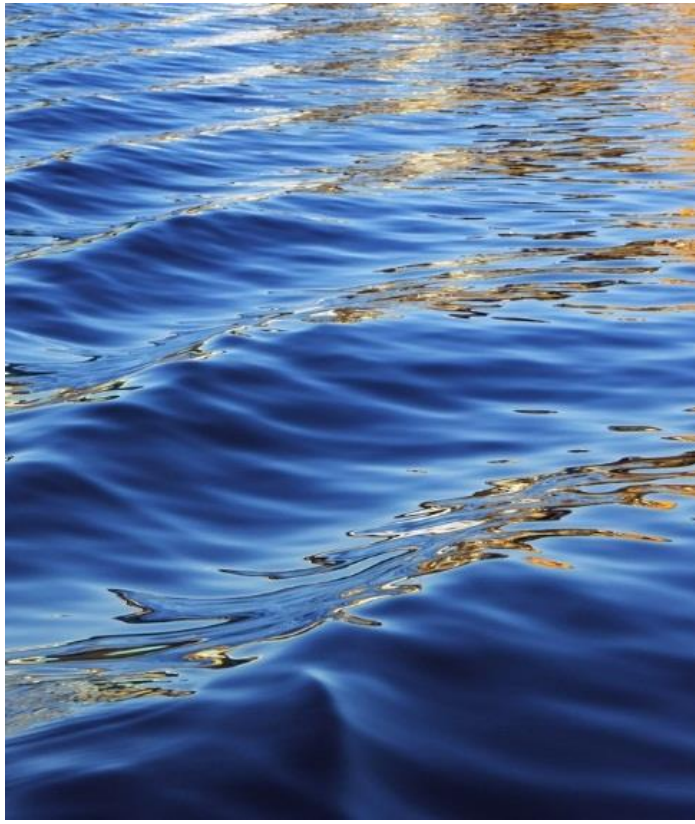
The EU's Green Deal growth strategy and the adoption of Biotech crops

Contributions of Bt maize cultivation to sustainability

- Benefits to farmers
- Environmental benefits
- Benefits to foreign trade
- Benefits to rural communities

Conclusions

The EU's Green Deal growth strategy and the adoption of Biotech crops



The EU's Green Deal growth strategy and the adoption of Biotech crops

Human activity and nature are interconnected - need to find sustainable solutions

The EU's Green Deal growth strategy

- Achieving economic growth whilst increasing resource efficiency leading to zero net emissions of greenhouse gases by 2050

The EU's Farm to Fork strategy

- Reducing the environmental impact in food systems to achieve a sustainable agri-food supply chain
- "*New innovative techniques, including biotechnology and the development of bio-based products, may play a role in increasing sustainability, provided they are safe for consumers and the environment while bringing benefits for society as a whole*"

The EU's Green Deal growth strategy and the adoption of Biotech crops

Rapid adoption rates are associated with a range of aspects

Characteristics of the uses of the innovation

- Innovation perceived as relative advantageous and compatible to the adopter's needs

Characteristics of the innovation itself

- The easier the innovation is to understand and use the more likely is that it will be adopted.

Social/political system within which it is taken up

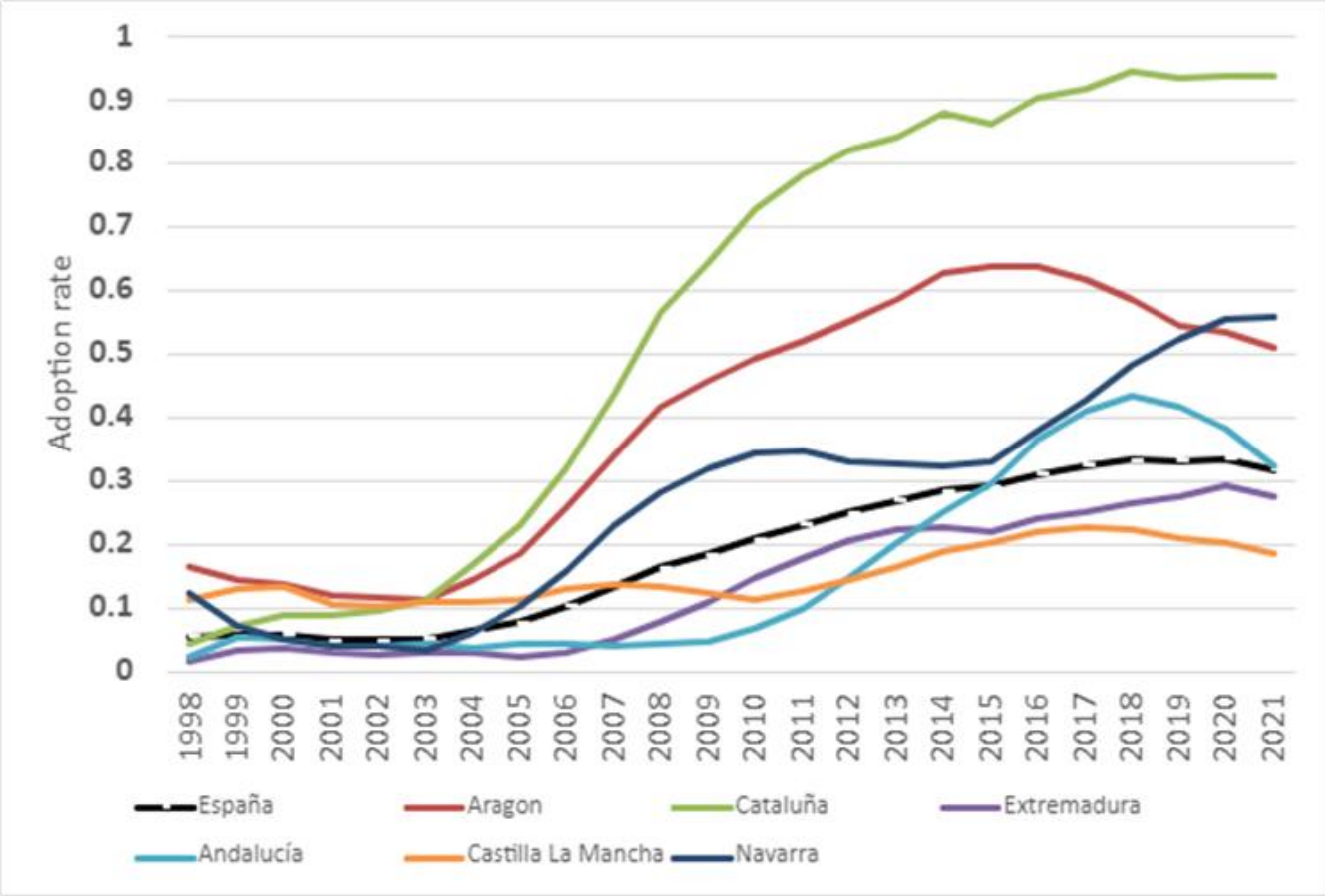
Legal drivers, sector profitability

Communication channels used & time it takes to communicate

- If the innovation can be tried and/or their efficacy observed more likely is that it will be adopted too

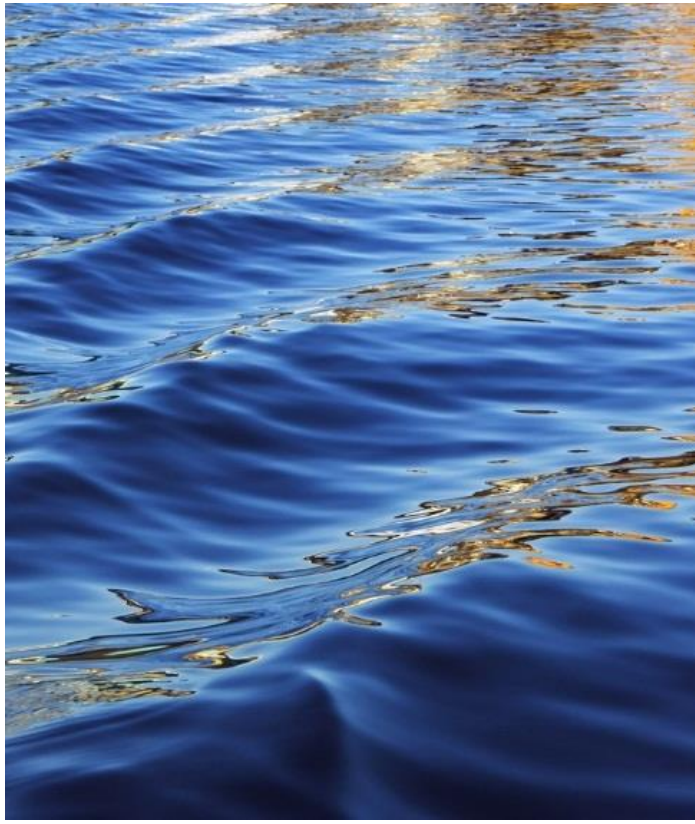
The EU's Green Deal growth strategy and the adoption of Biotech crops

Evolution of adoption rate (cultivation area) of Bt maize by Autonomous Community (AC)



Source: MAPA (1998-2021)

Contributions of Bt maize cultivation to sustainability



Contributions of Bt maize cultivation to sustainability:

Benefits to farmers

Environmental benefits

Benefits for foreign trade

Benefits to rural communities

Benefits to farmers

Agronomic, economic and convenience reasons

Higher maize yields

- Difference depends on the degree of corn borer infestation
- Globally Bt maize has an average yield 0.55 t/ha higher than that of conventional maize (Areal et al. 2013)
- Spain, up to 1.34 t/ha difference between Bt maize and conventional

Higher maize quality

- Bt maize present a reduced incidence of mycotoxins, which can cause health problems to animals and humans, compared to conventional maize

Yield differences between Bt and conventional maize in Spain

Analyzed area	Increase of Bt maize yield compared to conventional (%)	Reference
Aragón	10,00 (year 1999-2001)	Brookes (2008)
Aragón, Cataluña and Navarra	10,46 (average for 2004-2007)	Brookes (2008)
Aragón	12,00 (average for 2004-2006)	Gómez-Barbero et al. (2008)*
Cataluña	5,97 (average for 2004-2006)	Gómez-Barbero et al. (2008)*
Castilla La Mancha	7,40 (average for 2004-2006)	Gómez-Barbero et al. (2008)*
Ebro Valley (Aragon, Cataluña, Navarra)	12,64 (year 2009)	Riesgo et al. (2012)*

Benefits to farmers

Agronomic, economic and convenience reasons

Economic benefits

- Higher income from higher crop yields and lower costs associated with pesticide use – depends on infestation levels and input and output prices (Global average ~ €53/ha; Spain ~ up to 186 €/ha)

Ease of cultivation

- Bt maize use is not complex compared to conventional maize
- Reduction in the time taken to inspect the maize cobs
- Reduction of the number of insecticide treatments necessary
- Farmers can harvest quicker
- Farmers can collect more straw per hectare for fodder

Environmental benefits

Pesticide use; irrigation water saving and water footprint; use of land and carbon fixation

Pesticide use

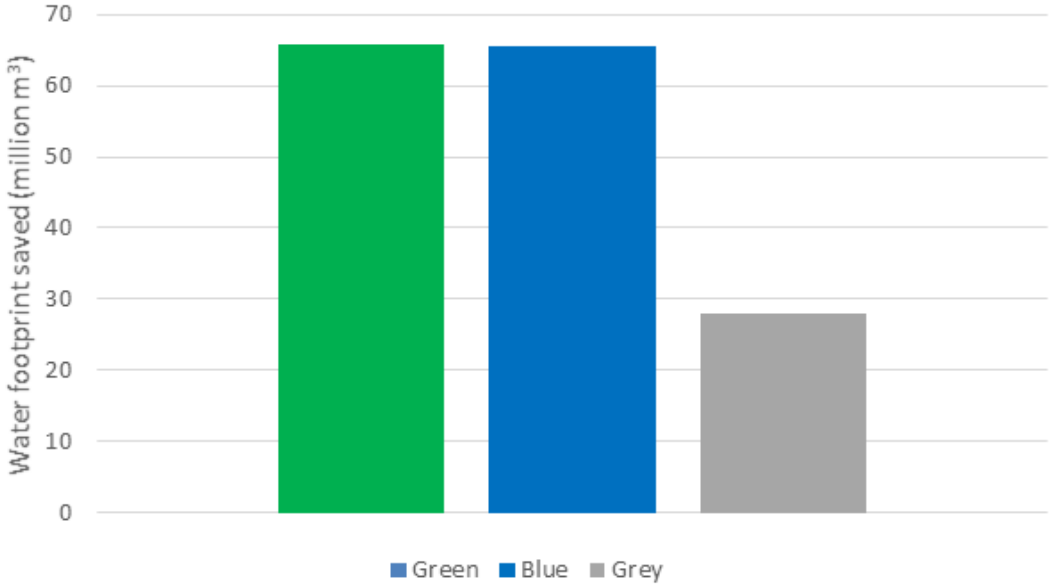
- Bt maize needs less pesticide use -> less emissions -> lower environmental impact
  - Bt maize has led to a 37.7% reduction in the use of insecticides against the corn borer between 1996 and 2010 (Brookes and Barfoot, 2012)
  - Biotech crops tend to perform environmentally better than conventional crops (Areal and Riesgo, 2015)

Environmental benefits

Water footprint (total volume of freshwater used to produce maize)

- *Blue water – surface and groundwater consumed*
- *Green water – rainwater consumed*
- *Grey water – water needed to assimilate the load of nitrogen fertilisers used in crop production based on water quality standards*

Water footprint saved per year in Spain (1998-2021)



Environmental benefits

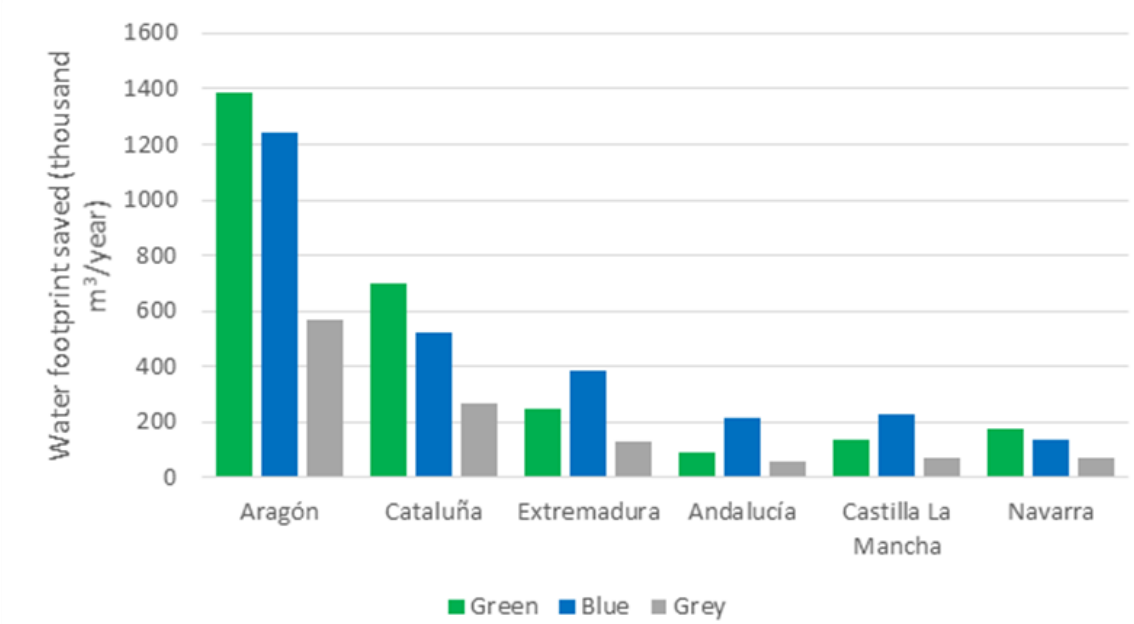
Annual water savings are equivalent to supplying water to a population of 58,932 inhabitants per year

Annual water savings in Aragón and Cataluña, equivalent to an annual urban supply for almost 37,218 people

The blue water footprint saved by Bt maize (1998-2021) in

- Aragón is equivalent to the annual water supply of Zaragoza for one year
- In Cataluña is equivalent to the annual water requirements of both Tarragona and Lleida

Water footprint saved per year by Autonomous Community



Environmental benefits

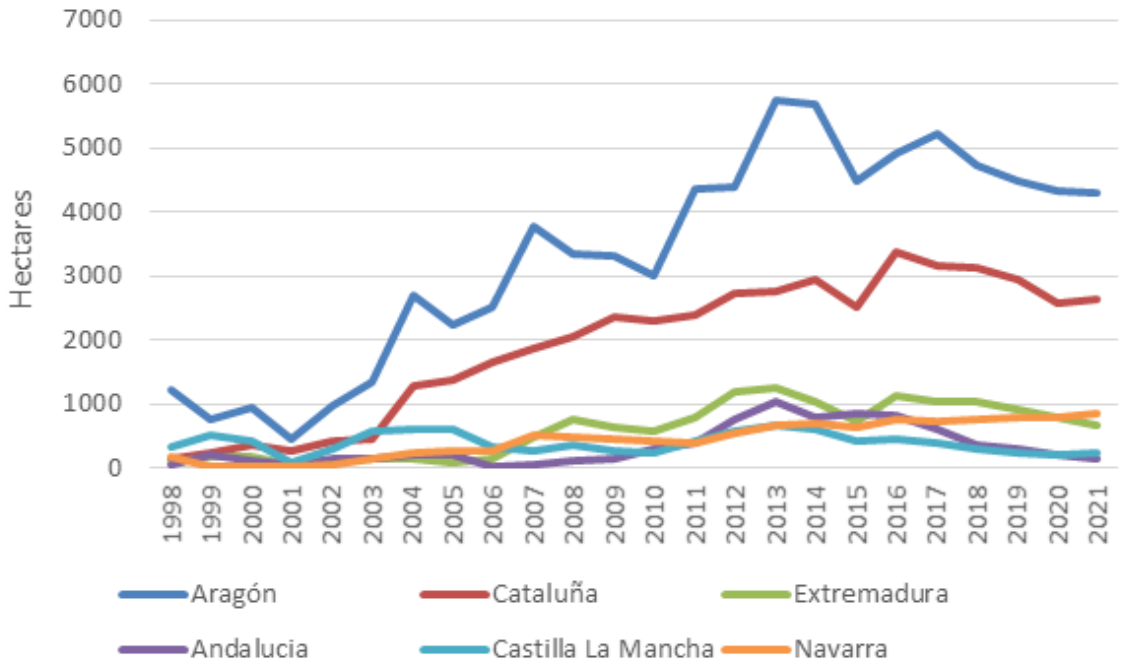
Use of land

Achieving the Bt maize output obtained using conventional maize would require more land

A total of 8,788 ha extra of conventional maize would have been required to achieve the same levels of Bt maize output in the areas affected by the European corn borer only during the year 2021

Spain, 1998-2021: 166,934 ha of conventional maize required to compensate the additional production volumes generated by the cultivation of Bt maize

Surface of conventional maize to compensate the increase in the yield of Bt maize



Environmental benefits

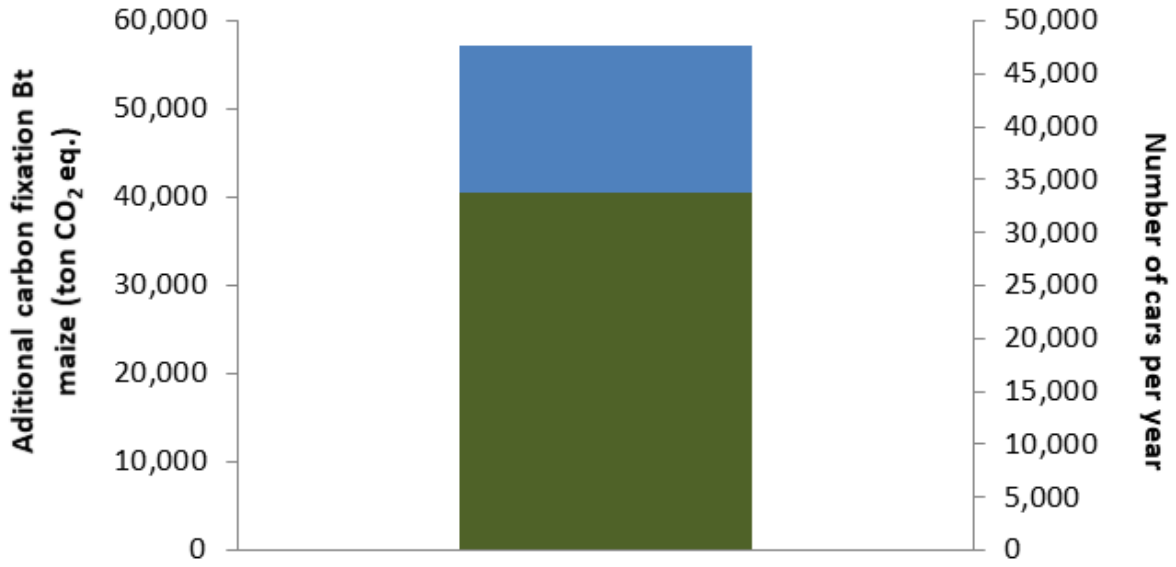
Carbon fixation

Spain (1998-2021): Bt maize carbon fixation of 1,370,185 ton CO2 (annual average of 57,091 ton CO2)

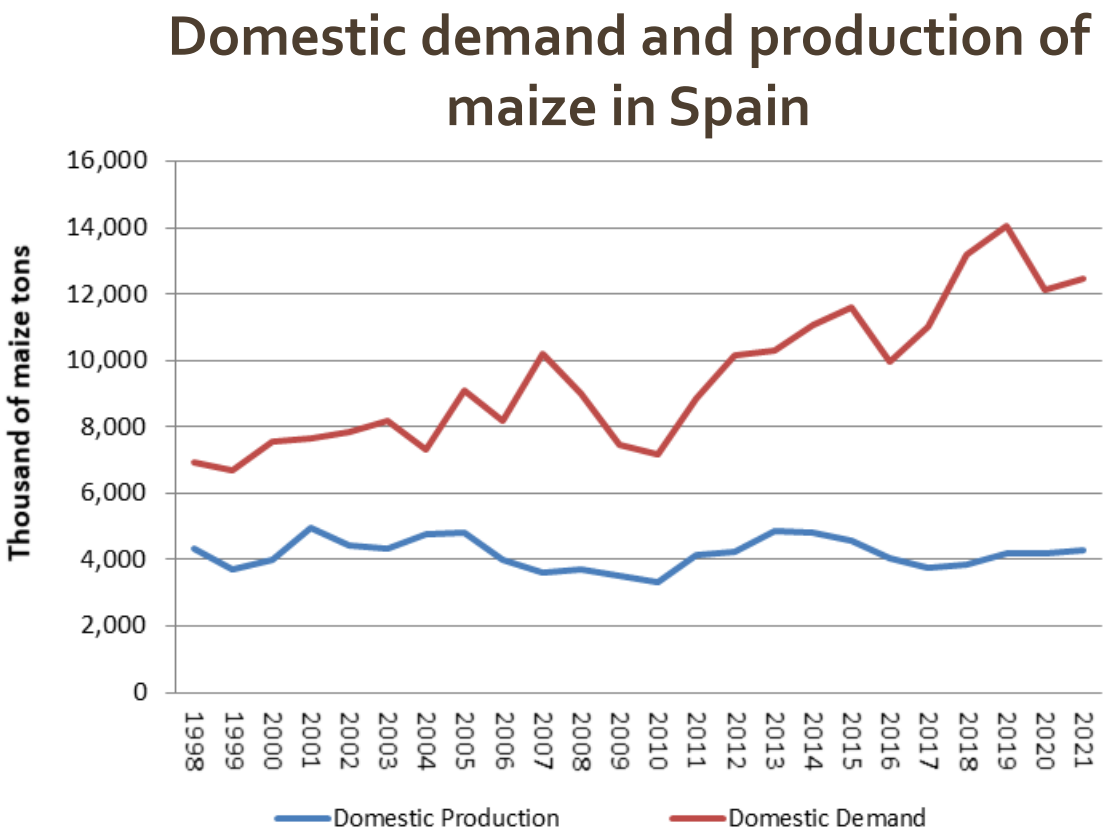
Spain (1998-2021): Bt maize has contributed to compensate the emissions of over 9,103 million km travelled by vehicles

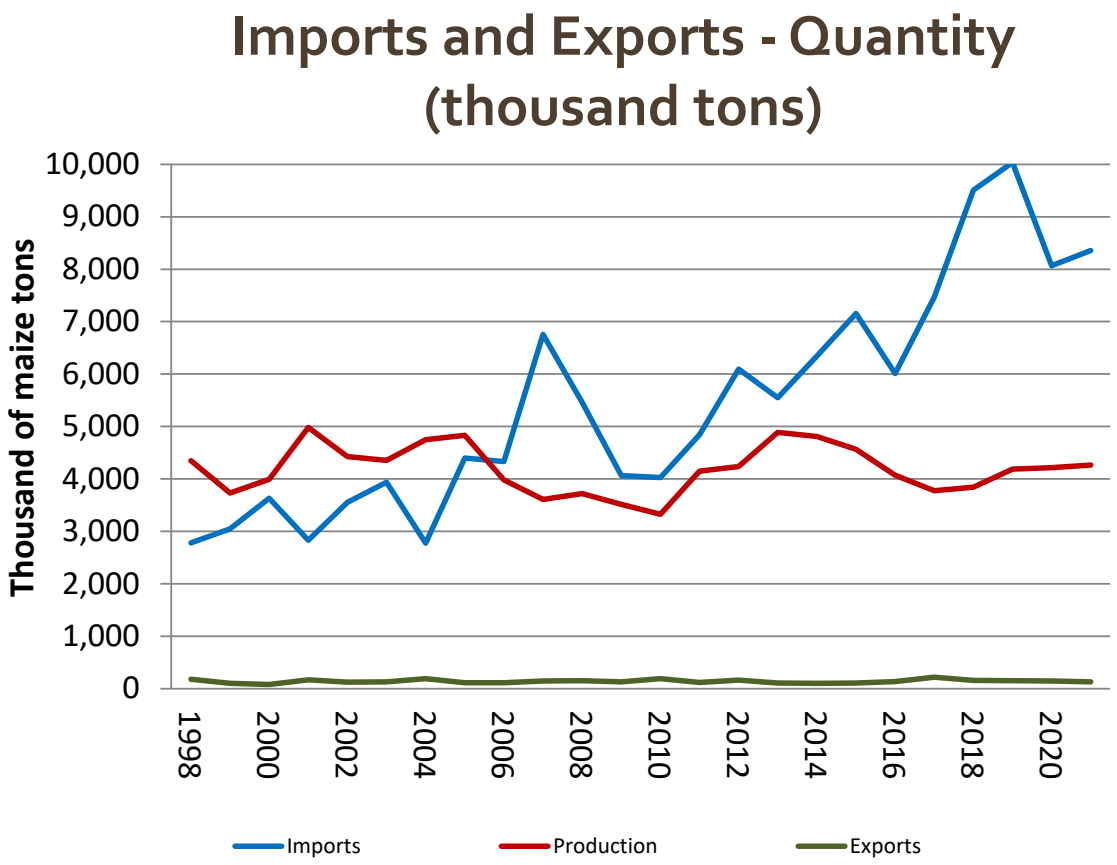
Annually, Bt maize has contributed to compensate the emissions produced by 33,821 vehicles

Additional CO_2 fixation of Bt maize and annual equivalent number of cars



Benefits for foreign trade

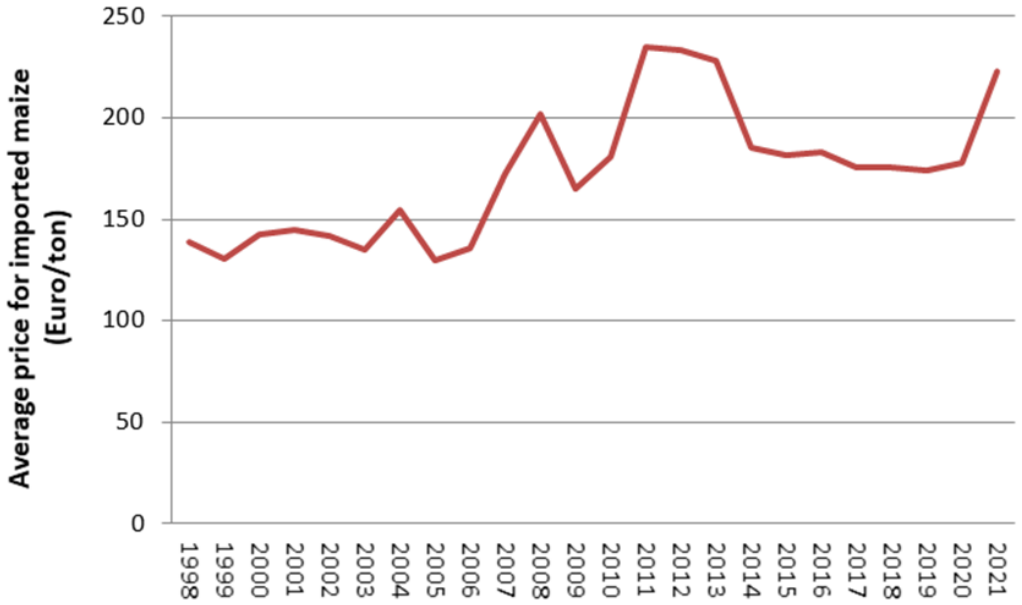




Source: Own compilation from Eurostat (1998-2021), HS2,4,6 and CN8 maize classification (1005)

Benefits for foreign trade

Annual average price of imported maize in Spain (1998-2021)



Real value of averted imports, by ACs

Autonomous Community	Value of averted imports (Euro in 2021)
Aragón	151.389.864
Cataluña	77.196.259
Navarra	19.688.636
Castilla La Mancha	17.778.567
Andalucía	16.262.674
Extremadura	31.342.358
TOTAL	*313.658.357*

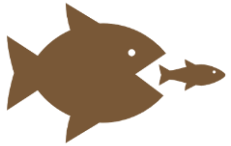
The value of maize imports averted by Bt maize adoption in Spain for the period 1998-2021 accounts for nearly 314 million euros

Source: Own analysis of data from Eurostat (1998-2021)

Benefits to rural communities

EU's Farm to fork strategy

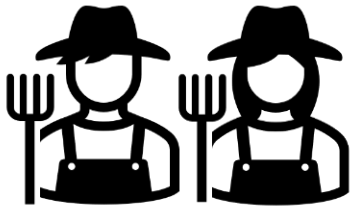
Increasing resource efficiency

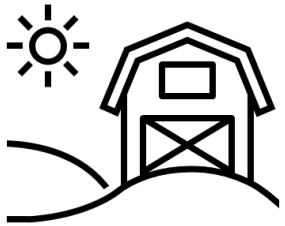


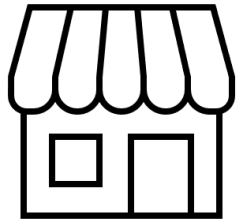
Competitive agriculture

Reducing pressure on the environment

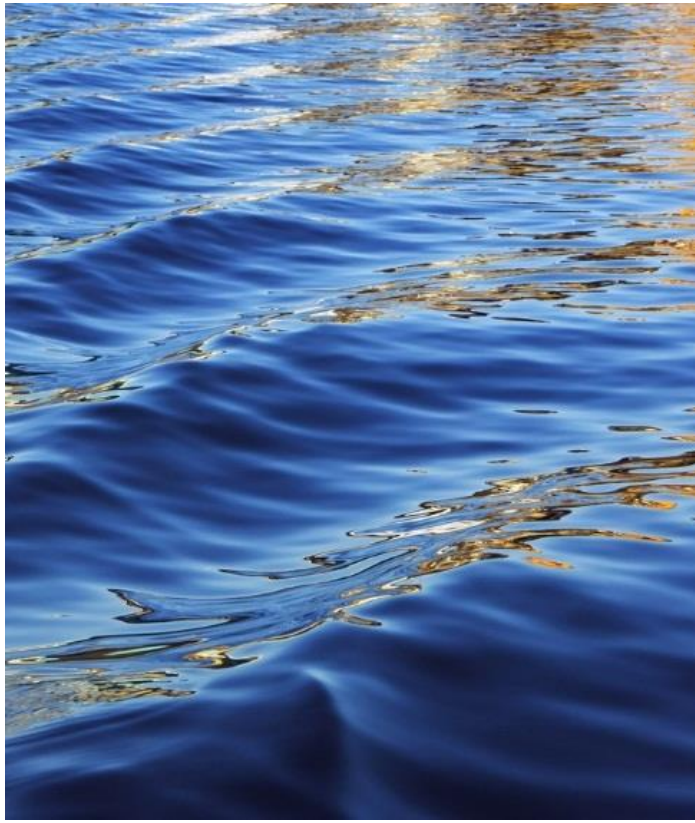
Benefits to rural communities







Conclusions



Conclusions

Bt maize and biotech technology can contribute to achieving the EU's Green Deal growth strategy aims of increasing growth and resource efficiency

Since the commercialisation of Bt maize in the EU, farmers' adoption of Bt maize has provided benefits to farmers and to society as a whole in line with the EU's Biodiversity and the Farm to Fork strategies of the EU's Green Deal

The adoption of Bt maize cultivation contributed to agronomic, economic, environmental and social sustainability in Spain

- Increasing resource efficiency (water and land use),
- Increasing carbon fixation and reducing pressure on the environment and natural resources (social benefits)
- More competitive agriculture - Retaining rural population
- Reduce maize imports with a value of approximately 314 million euros

Bt maize has contributed and will continue to contribute in the future to achieve a more sustainable agriculture in those areas where corn borer is present

Bt maize and biotech can be a complement to other sustainable production alternatives to achieve sustainability objectives included in the EU's Green Deal