CARBON FOOTPRINT OF THE GRAPEFRUIT SECTOR IN SPAIN

ailimpo

GRAPEFRUIT FROM SPAIN

SUSTAINABLE DEVELOPMENT GOALS

www.ailimpo.com/en
www.thelemonage.eu

0.INTRODUCTION

According to MAPA data, 2,432 hectares of grapefruits were cultivated in 2019. Of these, 251 are organically farmed.
As far as grapefruit production is concerned, according to AILIMPO data for the 2019/20 season, 82,159 tonnes were be produced.

Once harvested, the fruit can be marketed for fresh consumption or for processing.

In the 2019/2020 season, a total of 11,702 tonnes of grapefruits were sent to processing, while 67,102 tonnes went to the fresh market. The main destination for fresh produce was EU countries, followed by the domestic market and non-EU countries (table 1).

Table 1. Quantities of grapefruits traded by destination. 2019/20

Destination	Tonnes
EUROPEAN UNION COUNTRIES	57,094
NON-EU COUNTRIES	3,008
DOMESTIC MARKET	7,000
TOTAL FRESH	**67,102**
PROCESSING	**11,702**
LOSSES	3,355
TOTAL	**82,159**

Source. AILIMPO

1. PURPOSE AND REASON FOR THE REPORT

In recent times, a new concept has emerged in supplier-customer-consumer relations in the agri-food sector: **the need and requirement to be SUSTAINABLE**. This is a new work and relationship approach throughout the supply chain.

In 2015, the UN adopted the 2030 Agenda for Sustainable Development. This is an opportunity for countries and their societies to embark on a new path to improve the lives of all, while leaving no one behind. The Agenda has 17 Sustainable Development Goals (SDGs), ranging from eliminating poverty **to combating climate change**, education, women's equality, environmental protection and the design of our cities.

Therefore, sustainability is a challenge for **economic and agri-food development**.

AILIMPO has been playing a key role for years in preparing the sector to adapt to the challenges of sustainability. The pivotal strategy of this vision for the future of the Spanish grapefruit sector is its sustainable operating model based on three key pillars: financial, environmental and social.

Sustainability, as a driver of innovation and the future, is therefore part of the new vision of the sector promoted by AILIMPO and requires the commitment and collaboration of all the players in the value chain integrated in the interbranch association: producers, cooperatives, exporters and processing plants.

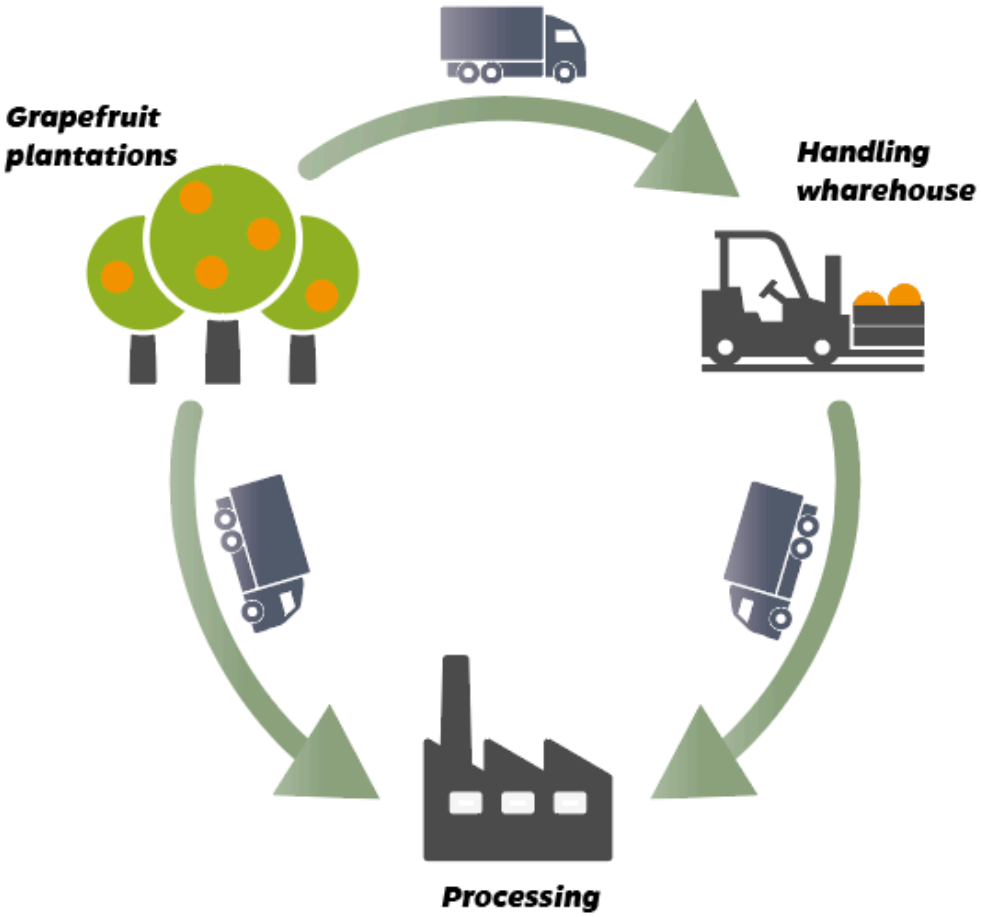
The National Greenhouse Gas Inventory shows that the agricultural sector in Spain is responsible for 11.9% of total emissions. For this reason, our companies must develop strategies to reduce emissions by promoting renewable energies to the detriment of fossil fuels, investing in R&D+I and working across the board with the international community to achieve global commitments on climate change.

According to the Sectoral Guide on SDGs in the Agri-Food Sector published by the Global Compact Spanish Network (UN GLOBAL COMPACT), in relation to the Climate Action Target, **the challenge identified in our country is to promote the calculation and reduction of the environmental footprint, with the main indicator being the quantification of the greenhouse gases generated by the sector (CARBON FOOTPRINT).**

Therefore, in this report on the Carbon Footprint of the Grapefruit Sector, we address UN Sustainable Development Goal (SDG) 13, which aims to take urgent action to combat climate change and its effects.

2. METHODOLOGY USED

Grapefruits are produced on farms and then transported to handling warehouses (where the fruit is packed and sent to the markets for fresh consumption) or to industry (where they are processed into juice, essential oils and dehydrated grapefruit peel). In the handling process, part of the fruit is discarded, being redirected from the packaging warehouses to processing.



From the farm until it leaves the handling warehouse or processing plant for customers, there are a number of CO_2 fixations and emissions. The aim of this report is to quantify them in order to produce the sector's Carbon Footprint.

For this purpose, the methodology described below has been used.

CO_2 fixation on farms

This section has analysed the carbon fixation transferred to CO_2. The data obtained in the IVIA study (Iglesias, J.C et al. 2012) were used for this purpose by adapting them to grapefruit cultivation.

We have considered the difference between organic and conventional cultivation as the net CO_2 fixations are higher in the former as a result of lower nitrogen fertiliser inputs. An input of 240 kg of N/ha per year has been considered in conventional cultivation (figure established in the Region of Murcia Code of Good Agricultural Practices) while in Organic Agriculture we have taken into account the maximum authorised value of nitrogen (170 kg of N/ha per year). By transferring the data on nitrogen inputs to the Ministry of Ecological Transition's Carbon Footprint Calculator, organic cultivation achieves a CO_2 fixation that exceeds those that are conventionally farmed by 0.43 t/ha per year as a result of lower nitrous oxide emissions.

We have taken into account a planting pattern of 6x4 metres (i.e. 410 trees per hectare) to calculate the fixation data per tree.

Within the range established by the IVIA (6.15- 8.77 t CO2/ha per year), we have considered a fixation of 7.4 t CO2/ha per year for conventional farming and 7.83 t CO2/ha per year for organic farming.

Emissions during transport

In relation to transporting the fruit from the farms to the handling warehouses or processing plants (or the fruit that arrives at the warehouses and is finally sent for processing), the footprint has been calculated assessing an average distance of 50 kilometres and taking into account the emission value of 300 gr of CO_2 /tonne per km (for a medium-sized truck, the Intergovernmental Panel on Climate Change (IPCC) estimates emissions in the range of 170-520 grams of CO_2/ tonne per km).

Emissions of CO_2 in handling warehouses and processing plants

In order to obtain data on emissions generated in the handling warehouses and in the processing plants, a survey was carried out and sent to all members within the interbranch association.

With the information collected, we calculated the carbon footprint of the survey data set (using the Ministry for Ecological Transition's carbon footprint calculation tool). As the sample is representative, we extrapolated the emissions data from the warehouses and processing plants surveyed to the sector as a whole, calculating the carbon footprint at each stage.

Finally, with the data from each process, the overall balance of the Sector's Carbon Footprint is drawn up.

3. ANALYSIS OF THE CARBON FOOTPRINT OF THE GRAPEFRUIT SECTOR. EMISSION REDUCTION MEASURES

3.1 Fixed CO_2 at farm level

As indicated in paragraph 2 of this report, for the analysis of the CO_2 fixation of grapefruit plantations, the data from the IVIA study have been taken into account. This study takes into account all emissions related to cultivation. The net fixation of citrus crops is between 6.15 and 8.77 t CO_2/hectare per year.

The following table shows all the information analysed and the calculation of the net CO_2 fixation of grapefruit plantations, taking into account grapefruit production data (source AILIMPO and MAPA) and national surface area data (MAPA), differentiating between organic and conventional cultivation.

Table 2. CO_2 fixation in grapefruit plantations

	CONVENTIONAL GRAPEFRUIT	GRAPEFRUIT ECOLOGICAL	GRAPEFRUIT TOTAL
Production 2019/20 (tonnes)	75,347	6,812	82,159
Area (hectares)	2,181	251	2,432
IVIA balance (t CO_2/ha)	- 7.4	-7.83	
t CO_2 / t of product	-0.21	-0.29	
Emissions total balance (t CO_2/ year)	-16,139.5	-1,965.5	**-18,105**

Source. Prepared inhouse. AILIMPO, MAPA and IVIA data

Therefore, the total CO_2 fixation in grapefruit plantations amounts to 18,105 tonnes per year.

As shown in Table 3, on average, 7.44 tonnes of CO_2/ha per year is fixed, which results in a figure of 18,157 grams of CO_2/tree.
For every kilo of grapefruit produced, the net fixation of the crop is 220 grams of CO_2 per year.

Table 3. CO_2 fixation in grapefruit plantations. Most significant data

CO_2 fixation in the field (t CO_2)	-18,105
Grapefruit area (ha)	2,432
Grapefruit production (tonnes)	82,159
t fixed CO_2/ha	- 7.44
Grams fixed CO_2/tree	**-18,157**
t of fixed CO_2/t grapefruit	**- 0.22**
Grams of fixed CO_2/Kg grapefruit	**-220.36**

Source. Prepared inhouse

The high figures of CO_2 fixation indicated are due to the practices that producers are carrying out, which include the following:

- The shredding and incorporation of pruning residues reduces the evaporation of water from the soil and increases the organic matter in the soil, thereby increasing the CO_2 stored in the soil.
- Since 92% of the grapefruit area has localised irrigation systems with no soil tillage, no fossil fuels are consumed in land development. In addition, non-tillage leads to less mineralisation activity of organic matter, which favours the fixation of more carbon in the soil.
- The optimisation of irrigation and the use of techniques such as moisture probes, mulch nets to reduce evaporation or the Controlled Deficit Irrigation technique lead to reduced water consumption and therefore a reduced need for electricity for irrigation, thus reducing emissions.
- Significant investment has been made in modernising agricultural machinery in recent years. Today's farms are equipped with more modern and efficient tractors that are able to reduce fuel consumption and CO_2 emissions.

3.2 CO_2 emissions while transporting the product to packaging warehouses and processing plants

There are CO_2 emissions when transporting the product to the handling centres or processing plants.

As indicated in section 2, an average distance of 50 kilometres has been estimated and the emission figure of 300 g of CO_2/km per tonne has been considered. The calculation of total emissions during transport is shown in table 4.

Table 4. Emissions during transport

	2019/20 PRODUCTION (tonnes)	Emissions (grams of CO_2/Km per tonne)	t CO_2/t grapefruit	TOTAL TRANSPORT EMISSIONS (t CO_2/year)
GRAPEFRUIT	82,159	300	**0.015**	**1,232**

Source. Prepared inhouse

As we can see in table 5, the total emissions from transporting grapefruits from the field to the warehouse or processing plant is 1,232 tonnes of CO_2 per year. If this is considered per hectare of crop, the figure is 0.507 t CO_2/ha (1,236 grams of CO_2 /tree). For every kilo of product obtained in the field, transport involves emissions of 15 grams of CO_2.

Table 5. Emissions of CO_2 during transport. Most significant data

Emissions of CO_2 during transport (t CO_2)	**1,232**
Grapefruit area (ha)	2,432
Grapefruit production (tonnes)	82,159
t CO_2/ha	**0.507**
gr CO_2/tree	**1,236**
t of CO_2/t grapefruit	0.015
Grams of CO_2/Kg grapefruit	**15**

Source. Prepared inhouse

The freight transport sector is renewing its fleet. For more efficient vehicles with lower fuel consumption per kilometre driven. This means a reduction in emissions.

3.3 Emissions in handling warehouses

Emissions during the handling process are due to the energy consumption of the machinery used and cooling the product.

The total emissions during this process are 20.61 grams of CO_2/Kg of packaged fruit, which represents a quantity of 1,452 tonnes of CO_2 per year for the grapefruit producing sector as a whole.

The impact of handling on the total grapefruit area amounts to emissions of 0.60 t of CO_2/ha per year (1,456.4 grams of CO_2/tree).

Table 6. Carbon footprint of production destined for the fresh market (packaged in warehouse)

	gr CO_2/kilo of product
Field production	-220.36
Transport (to the packing warehouse)	15.00
Warehouse packaging process	20.61
TOTAL BALANCE	**-184.75**

Source. Prepared inhouse

As shown in table 6, for every kilo of product that is manufactured, the carbon footprint is a net fixation of 184.75 grams of CO_2.

In recent years, significant advances have been made in the handling warehouses in renovating machinery and cold stores. The use of pallet trucks and electric forklift trucks has also become widespread. As a result, there has been a significant reduction in the carbon footprint of these facilities. In addition, some companies in the sector have photovoltaic production facilities, which reduces electricity consumption by using their own 100% renewable energy.

3.4 Emissions of CO_2 in the grapefruit processing plants

The industry processes grapefruits, producing mainly juice, essential oils and dehydrated grapefruit peel.

Emissions in the processing plants are derived from the machinery used, with energy consumption being very high, especially in the evaporation process to obtain the concentrated juice.

The processing plant's annual carbon footprint amounts to 533 tonnes of CO_2, which, when translated into production, results in emissions of 45.5 grams of CO_2/Kg of processed grapefruit.

In total emissions per area, processing has an impact of 0.22 tonnes of CO_2/hectare of crop per year (534 grams of CO_2/tree).
CO_2 fixation per kilo of product processed (table 7) is 159.86 g of CO_2 /Kilo.

Table 7. Carbon footprint in production for processing

	gr CO_2/kilo of grapefruit
Field production	-220.36
Transport (to processing plant)	15.00
Transformation process	45.50
TOTAL BALANCE	**-159.86**

Source. Prepared inhouse

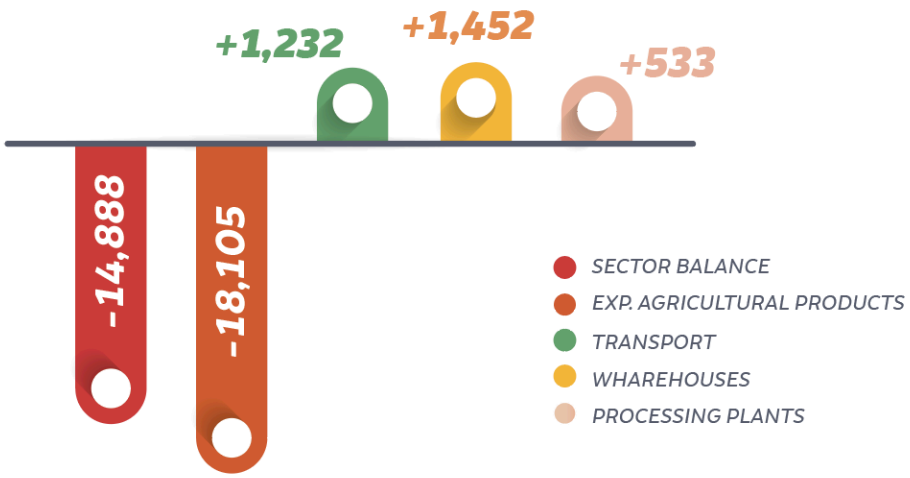
With regard to improvements made in recent years to reduce emissions, processing plants have opted to produce renewable energies (photovoltaic) with the aim of reducing dependence on fossil fuels. Modernising facilities and machinery and using electric forklifts and pallet trucks to transfer goods clearly reduce their carbon footprint.

3.5 Grapefruit sector carbon footprint balance

As shown in the previous sections, the overall balance is fully influenced by the carbon fixation that takes place on farms.

As shown in chart 1, the grapefruit sector is prominently a CO_2 fixer. The total balance reflects an uptake for the sector as a whole of 14,888 tonnes CO_2/ year. Trees on farms are capable of capturing 18,105 tonnes/ year (net of crop emissions), while transport, handling in warehouses and processing emit a total of 3,217 tonnes of CO_2 per year. The industry processes grapefruits, producing mainly juice, essential oils and dehydrated grapefruit peel.

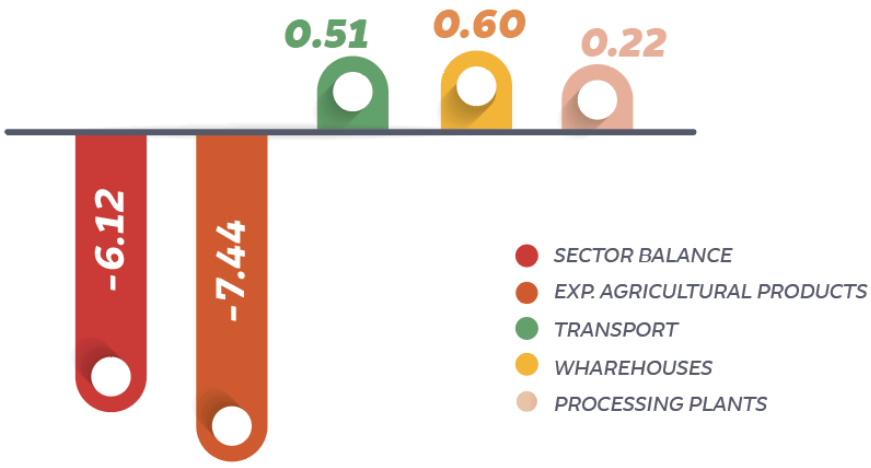
Chart 1. Carbon footprint of the grapefruit sector (tonnes of CO_2)



Source. Prepared inhouse

The data per unit area show that the average balance on farms is negative at 7.44 tonnes of CO_2/hectare, while the impact of emissions in the other phases on the surface area is 0.51 t CO_2/ha in transport; 0.60 t CO_2/ha in the handling warehouses and 0.22 t CO_2/ha in processing plants. In total, for the sector as a whole, the average net CO_2 fixation is 6.12 tonnes/ha. (chart 2).

Chart 2. Carbon Footprint balance per unit area (tonnes of CO_2/hectare)



Source. Prepared inhouse

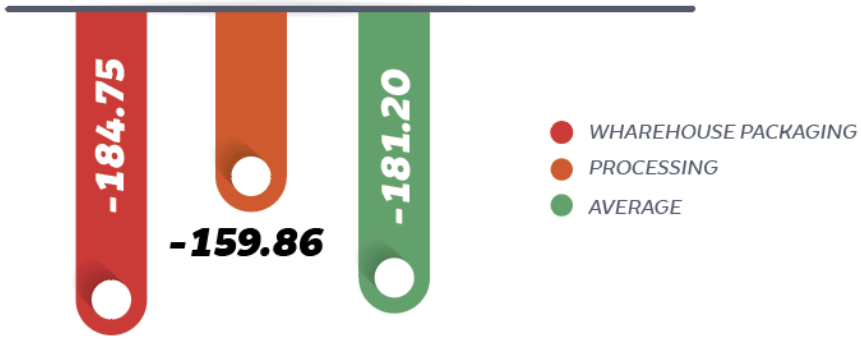
Net carbon fixation per tree is 14,930.6 grams of CO_2.

As for the balance of the carbon footprint per kilo depending on its destination (packaging warehouse or processing plant), the following chart shows that, in the case of fruit destined for processing, the net fixation is 159.86 grams of CO_2/kilo of grapefruit, while in the case of fruit intended to be sold fresh the figure is 184.75

grams of CO_2/kilo of grapefruit. Since the quantity of grapefruits destined for storage is much higher than the quantity processed, the average net fixation is 181.2 grams of CO_2/kilo of fruit.

The lower net fixation of fruit destined for processing is a consequence of the higher energy consumption in processing grapefruits.

Chart 3. Quantity of fixed CO_2 according to the production destination (grams CO_2/kilo of grapefruit)



Source. Prepared inhouse

4. RECOMMENDATIONS FOR INCREASING NET CO_2 FIXATION

Although the sector is clearly an atmospheric CO_2 fixer and its carbon footprint is extremely favourable, there are aspects that would encourage greater fixation in the future. Therefore, in the following table, we indicate a number of recommendations in each of the areas analysed in this report that would lead to an improvement in its carbon footprint.

Farms	Transport	Handling warehouses and Processing plants
Continuing to innovate in irrigation efficiency and optimisation of water and fertiliser use (especially nitrogen fertilisers).	Continuing the renewal of vehicle fleets for others with lower emissions and even using alternative energies to fossil fuels.	Conducting energy audits and carbon footprint analysis.
Increasing soil organic matter through the use of soil amendments or by planting green cover crops and incorporating them into the soil.	Training goods drivers in efficient driving.	Selection of electricity suppliers with Guarantee of Origin that offer a high percentage of renewable sources (even 100%).
Promotion of organic farming. The limitation of nitrogen fertilisation to organic amendments, the limited use of phytosanitary treatments and the maintenance of a better soil structure have an impact on a higher CO_2 fixation in the soil and the generation of lower emissions.		Investments in renewable energy.
Promotion of biological and biotechnological control to reduce the number of phytosanitary treatments.		Where appropriate, replace cooling systems with those using gases that do not affect global warming.
Selection of electricity suppliers with Guarantee of Origin that offer a high percentage of renewable sources (even 100%).		Renewal of vehicle fleets for less polluting vehicles (hybrid or electric).
On-farm renewable energy generation to cover the electricity needs of irrigation facilities.		Continue to renew equipment with more efficient machinery.
Continue modernising agricultural machinery.		Energy recovery from organic waste.

5. CONCLUSIONS

The calculation of the environmental footprint of our activity, and in this case of the Carbon Footprint, is part of the sustainability policy of the AILIMPO interbranch association in the environmental area as well as contributing to UN Sustainable Development Goal (SDG) number 13, on urgent measures to combat climate change and its effects.

Spain's grapefruit plantations have a large capacity to capture atmospheric CO_2. As a result, the net fixation of the crop amounts to 18,105 tonnes of CO_2 per year.

Although the sector emits CO_2 in the course of its business at an amount of 3,217 tonnes of CO_2 (1,232 during transport, 1,452 in handling and packaging warehouses and 533 in processing plants), **we conclude that its net carbon footprint is 14,888 tonnes of CO_2 per year.**

Therefore, **the grapefruit sector in our country actively contributes to the fight against climate change by being a real carbon sink.**

ACKNOWLEDGEMENTS

This work has been possible thanks to:

- **FRUTAS BERI, S.A.**
- **GRUPO ROSEGAR, S.L.**
- **TOÑIFRUIT, S.L.**
- **EL LIMONAR DE SANTOMERA, S.C.**
- **FRUTAS NATURALES, S.A.**
- **SOCIEDAD COOPERATIVA AGRÍCOLA DEL SURESTE (SURESCO)**
- **FRUTOS Y ZUMOS, S.A. (FRUSA)**
- **MIGUEL PARRA E HIJOS S.A. (LEMON KING)**
- **CITROMIL, S.L.**
- **RIVERBEND ESPAÑA, S.A.**

BIBLIOGRAPHY

- Guide for calculating an organisation's carbon footprint and developing an organisation's improvement plan. Ministry for Ecological Transition.
  https://www.miteco.gob.es/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/guia_huella_carbono_tcm30-479093.pdf

- Inventory of greenhouse gases in Spain 2020. Ministry for Ecological Transition and the Demographic Challenge.
  https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/Inventario-GEI.aspx

- Iglesias, D.J. et al. 2012. La huella de carbono de las plantaciones de cítricos (The Carbon Footprint of Citrus Plantations). 2012. Vida Rural magazine (15/10/2012) pp 30-35.
  https://www.mapa.gob.es/ministerio/pags/Biblioteca/Revistas/pdf_Vrural%2FVrural_2012_352_30_35.pdf

- Carvajal, M et. al. Investigación sobre la absorción de CO_2 por los cultivos más representativos (Research on CO_2 uptake by the most representative crops) (CEBAS-CSIC).
  http://www.lessco2.es/pdfs/noticias/ponencia_cisc_espanol.pdf

- Sectoral guide on SDGs. Agri-food sector.
  https://www.pactomundial.org/2018/04/guia-sectorial-en-ods-sector-agroalimentario/

- IPCC. Transport Emissions.
  https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter8.pdf

SOURCES

- AILIMPO website.
  https://www.ailimpo.com/en/

- Ministry of Agriculture, Fisheries and Food (MAPA) Statistics Website.
  https://www.mapa.gob.es/es/estadistica/temas/estadisticas-agrarias/agricultura/default.aspx

- Carbon footprint calculators. Ministry for Ecological Transition and the Demographic Challenge.
  https://www.miteco.gob.es/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/calculadoras.aspx

- UN. Sustainable Development Goals (SDGs).
  https://www.un.org/sustainabledevelopment/

- www.agricultorescontraelcambioclimatico.es