# Life Cycle Assessment of Processing Tomato Production in Extremadura-Alentejo

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## INTRODUCTION

Life Cycle Assessment (LCA) is an environmental assessment tool standardised by ISO 14040 and 14044. ISO 14040 defines LCA as the procedure for determining the environmental aspects and potential impacts associated with a product, process or service; from the procurement of raw materials, through production, use, end-of-life treatment and recycling. ISO 14044 sets out the requirements and guidelines for carrying out an LCA. The LCA consists of four interrelated stages. These stages are: definition of the objective and scope, inventory analysis, impact assessment and interpretation.

Extremadura is the region with the largest area under cultivation for industrial tomatoes, covering some 20,000 ha, making it one of the region's most important crops.

## OBJECTIVES

- To determine the life cycle assessment of tomato cultivation for industrial use in Extremadura (Spain) and Alentejo (Portugal).
- To evaluate the impact categories with the greatest weighting in the life cycle assessment.
- Recommendations for reducing the environmental impacts generated by the production of tomatoes for industrial use in Extremadura and Alentejo.

## MATERIALS AND METHODS

The life cycle assessment was conducted using SimaPro software (version 9.6), incorporating the different processes that constitute the crop production cycle, including the irrigation system, fertilisers, plant protection products, crop management practices, and permanent structures. These processes were modelled based on data collected through surveys conducted with selected processing tomato producers in Extremadura (Spain) and Alentejo (Portugal) regions.

+ ecoinvent + Product Environmental Footprint + SimaPro

## RESULTS

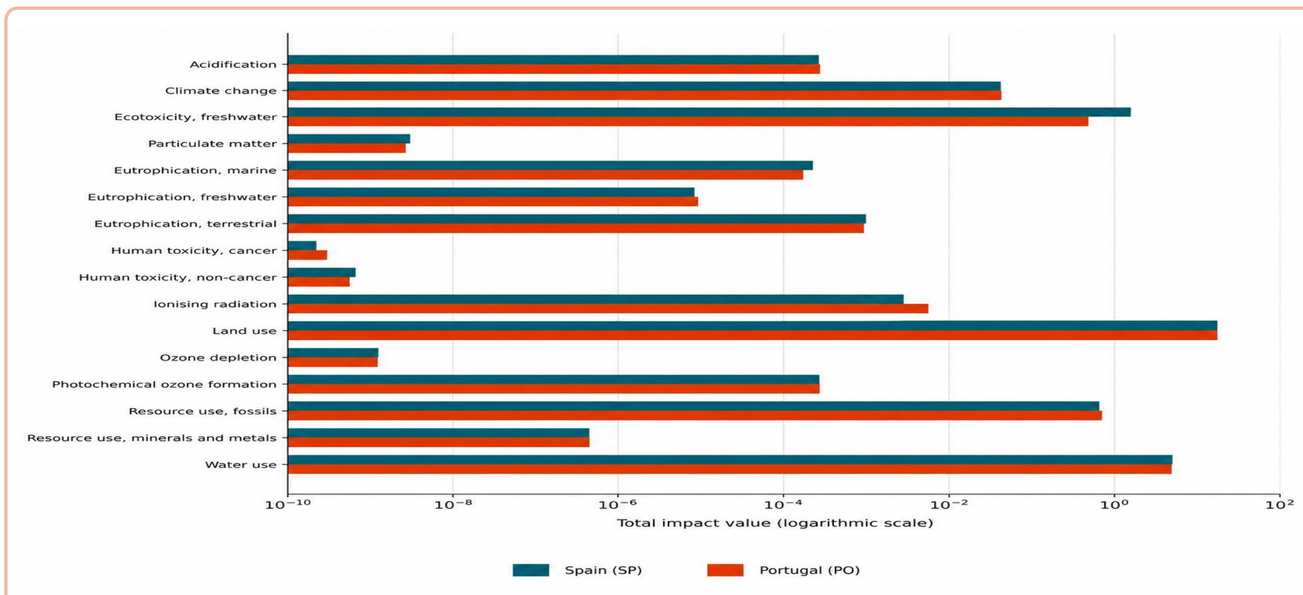



**Figure 1.** Assessment of impact categories on processing tomatoes in Spain (SP) and Portugal (PO)

The graph compares, on a logarithmic scale, the total environmental impact of processing tomato production in Extremadura, Spain (SP) and Alentejo, Portugal (PO) across different LCA categories.

The highest impacts are observed in land use, with very similar values between the two countries, indicating a comparable weighting of land use.

Water use and ecotoxicity, particularly freshwater, show higher values in Spain, with aquatic ecotoxicity standing out as a key differentiating factor. Portugal shows relatively higher impacts in categories such as resource use, fossil fuels, ionising radiation and certain eutrophication categories.

Overall, the graph shows that both systems have similar environmental profiles, although with significant differences depending on the impact category analysed.

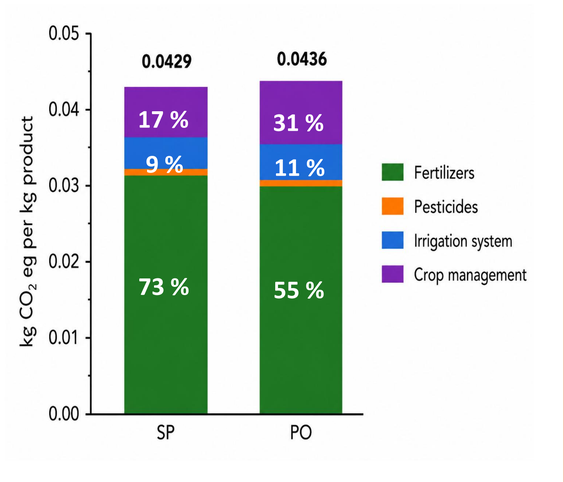



**Figure 2.** Total and relative carbon footprint and process contribution on processing tomatoes in Spain (SP) and Portugal (PO)

The total carbon footprint was very similar in both regions: 0.0429 kg $CO_2$ eq $kg^{-1}$ in Spain and 0.0436 kg $CO_2$ eq $kg^{-1}$ in Portugal. Fertilizers were the main contributor to the carbon footprint, especially in Spain, where they accounted for 73% of the total impact compared with 55% in Portugal. In Portugal, the impact was more evenly distributed, with a higher relative contribution from irrigation and crop management. In the key impact categories, fertilizers dominated climate change, freshwater eutrophication, and resource use, confirming their central role in the environmental profile of industrial tomato production. Pesticides were particularly relevant for freshwater ecotoxicity in Spain, reaching 59.4%. Finally, land use was almost entirely associated with crop management in both regions, accounting for 98.8% of the impact.

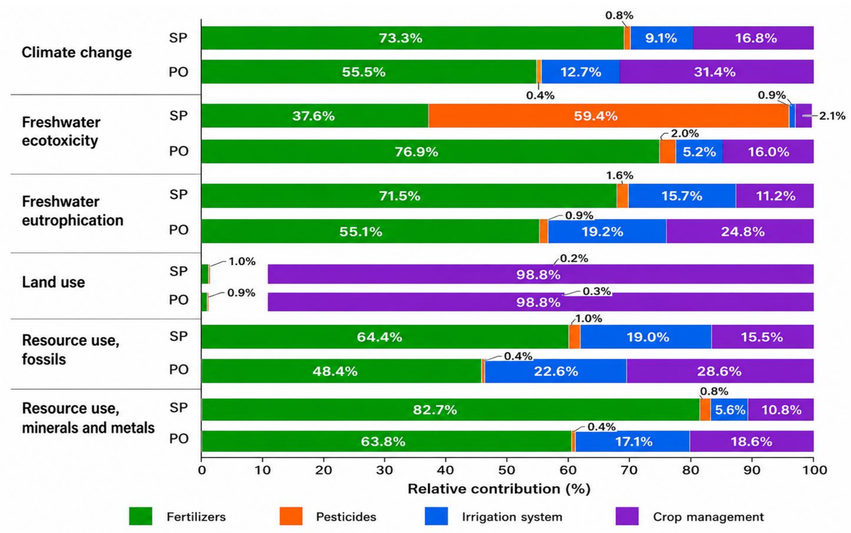



**Figure 3.** Dominant processes in key environmental categories on processing tomatoes Spain (SP) and Portugal (PO)

## CONCLUSIONS

- The carbon footprint in processing tomato was slightly lower in Portugal than in Spain, mainly due to the lower use of nitrogen fertilizers during crop development.
- Freshwater ecotoxicity was also lower in Portugal, associated with a reduced use of nitrogen fertilizers and a lower application of plant protection products.
- The environmental profile of industrial tomato production was very similar in both territories, reflecting comparable crop management and processing systems.
- The main differences between regions were related to fertilization practices and, to a lesser extent, to crop management operations.
- Water use and irrigation system contribution showed similar values in both territories, indicating comparable irrigation requirements and technological conditions.

## ACKNOWLEDGEMENTS

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