Greenhouse Gas Emissions of Three Different Olive Growing Systems in Portugal

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Introduction

The olive tree (*Olea europaea* L.) is one of the most economically important fruit crops in Mediterranean countries. The olive value chain is one of the most important bioeconomic sectors in Portugal. This country has the potential to become the third-largest producer of olive oil over the next decade through its olive groves modernization. However, to attain a more sustainable national olive sector, it is of utmost importance to understand the consequences of this modernization, considering the environmental dimension, during the entire lifetime of the different olive growing systems.

Approach and Results

❖ Goal and scope definition:

- Assess the greenhouse gas (GHG) intensity of traditional rainfed (T), intensive (I) and super-intensive (SI) Portuguese olive growing systems along the entire lifetime of the olive groves;
- Identify the agricultural practices with highest contributions for GHG emissions;
- Time boundary of 50 years, considering 3 cultivation phases;
- Functional unit (FU): 1 hectare (ha) of olive growing area;
- The system boundary (Fig. 1) considered all the input and output flows of materials and energy, since raw materials were extracted up to when the olives are harvested, “from cradle-to-farm gate”. All the inputs were included taking into account their manufacturing processes.

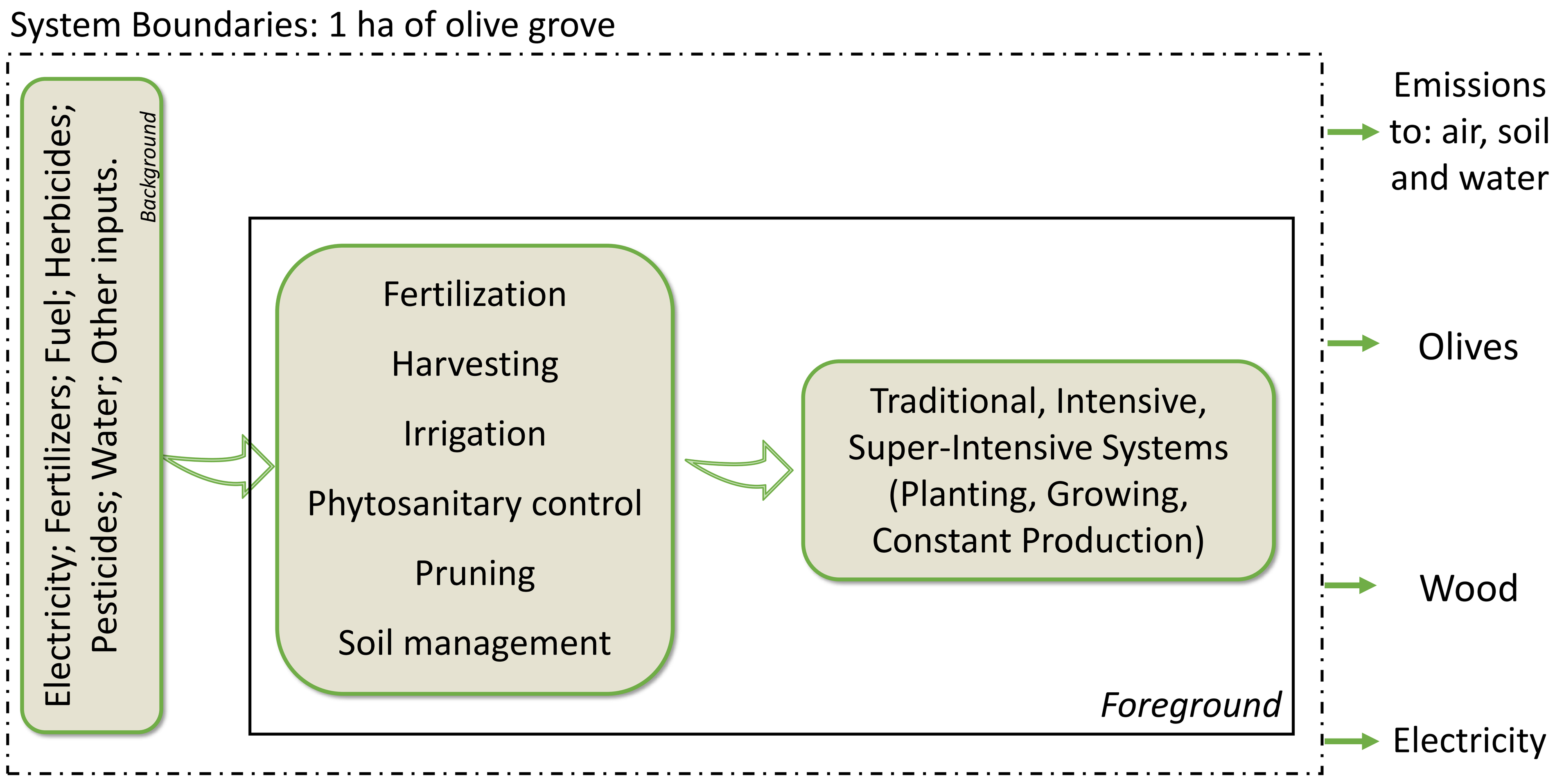

Figure 1. System boundaries of the three studied systems: Traditional rainfed, Intensive, and Super-intensive production systems.

❖ Main Results:

- Overall, super-intensive systems showed higher GHG emissions per FU than intensive systems, in planting (1.1-fold), growing (1.8-fold) and constant production (1.4-fold) phases, as well as higher than traditional systems in growing (17.8-fold) and constant production (10.8-fold) phases. In traditional systems, the planting phase presented a higher impact (1.3-fold and 1.2-fold in intensive and super-intensive systems, respectively), essentially due to the higher amount of consumed diesel in the machinery needed for irrigation (water tank and tractor) (Fig. 2);
- Fertilization contributed the most to the GHG emissions, especially in intensive and super-intensive systems, mainly due to the field emissions of fertilizer applications, the production process of each fertilizer and the consumed diesel in the fertilization process (Fig. 3). Moreover, irrigation in planting in traditional systems and harvesting in constant production in traditional and intensive systems were also impactful sources, due to the fuel consumption of the machinery used, and consequently CO_2 emissions from diesel internal combustion. On the other hand, phytosanitary control, pruning and soil management resulted in the lowest Global Warming impacts (Fig. 3).

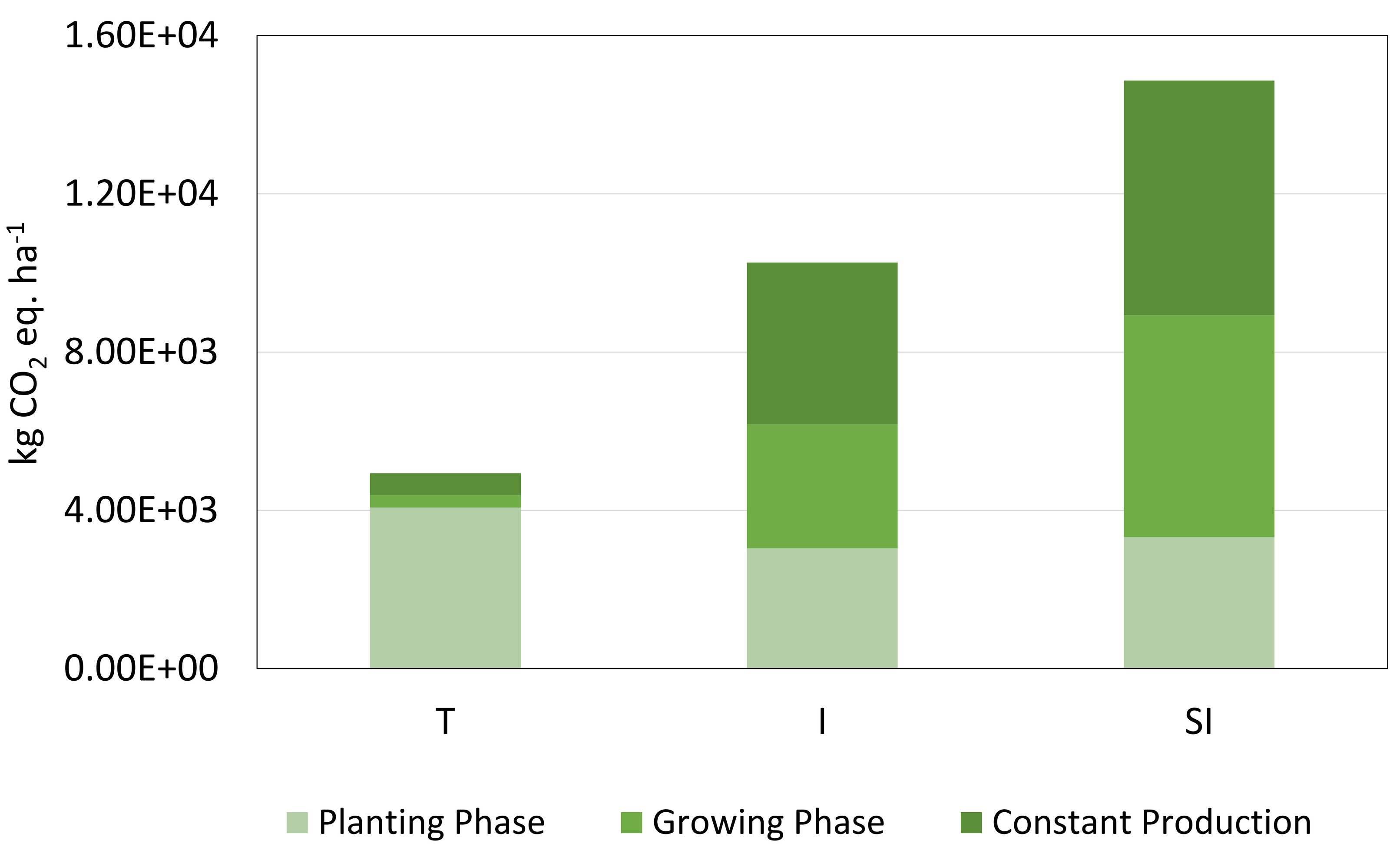

Figure 2. Comparison of the GHG emissions of 1 ha of olive growing area in 3 different olive production systems (T: Traditional, I: Intensive, SI: Super-Intensive) and their cultivation stages, per FU (ReCiPe method at midpoint (H) level, without allocation procedures).

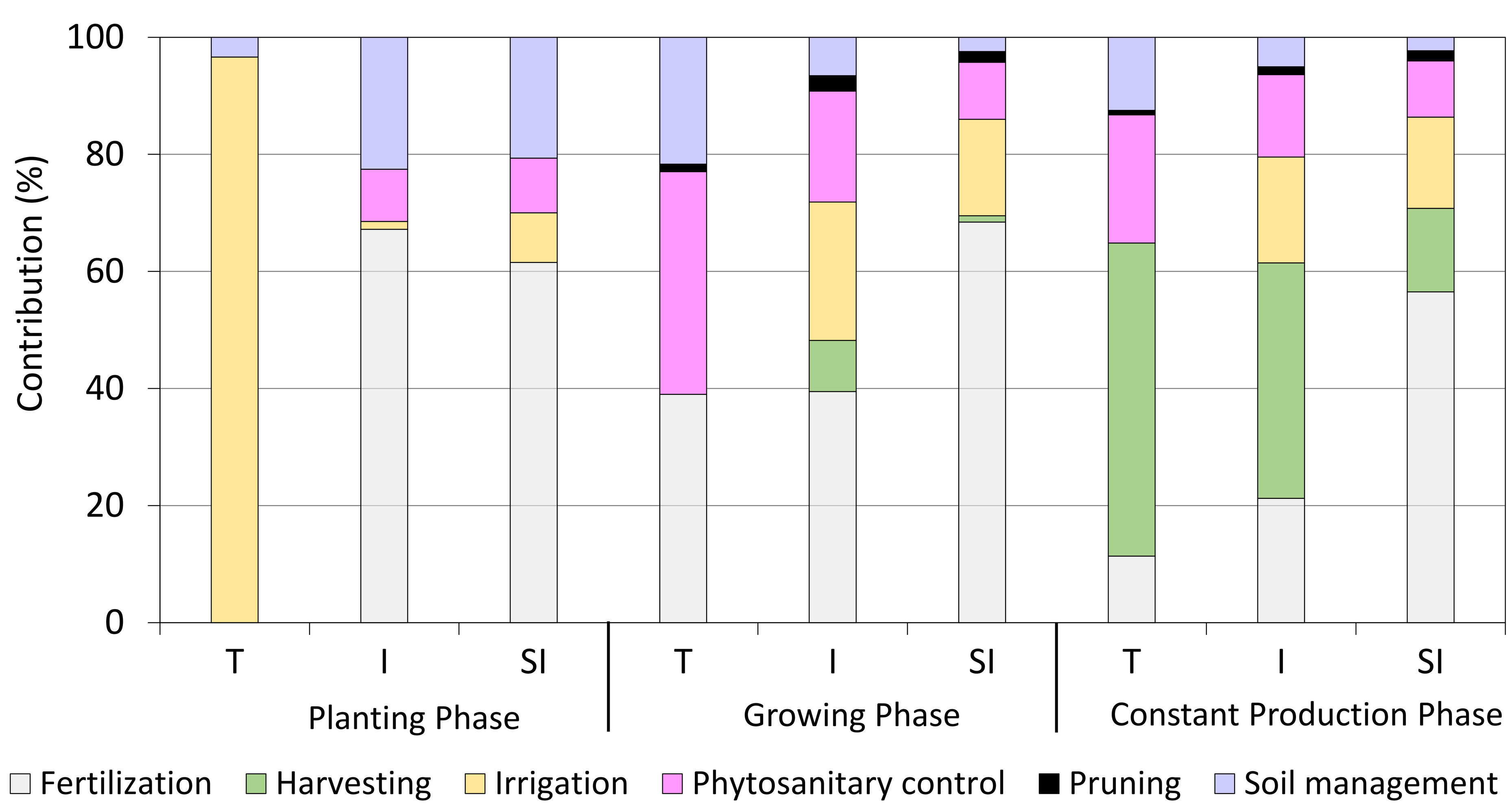

Figure 3. Contribution of the agricultural practices to GHG emissions of 3 different olive productions systems (T: Traditional, I: Intensive, SI: Super-Intensive), for each olive cultivation stage, per ha, at Portugal (ReCiPe method at midpoint (H) level, without allocation procedures).

Conclusions

❖ Super-intensive production systems resulted in the highest Global Warming impacts, especially in constant production cultivation phase;

❖ Fertilization, irrigation and harvesting were the agricultural practices with more impact along the whole olive groves life cycle. Therefore, their reduction and optimization should be a priority towards a more environmentally sustainable olive sector .

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