INTEGRATING ECONOMIC OPTIMIZATION AND LIFE CYCLE ASSESSMENT IN ITALIAN WHEAT FARMING: A WEB-BASED INTERFACE

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INTRODUCTION

The ECOWHEATALY project focuses on the power of policies to provide economic incentives to farms that switch from less sustainable to more sustainable wheat production techniques in both good economic times and in times of crisis. (Fig. 1). Sustainable agriculture is essential in addressing climate change and food security, but farmers often adopt green practices based on economic rationality rather than environmental awareness. To increase awareness of the environmental footprint of wheat production, we developed a free web interface showing the environmental impacts of input use under profit-maximizing conditions for Italian durum wheat farms.

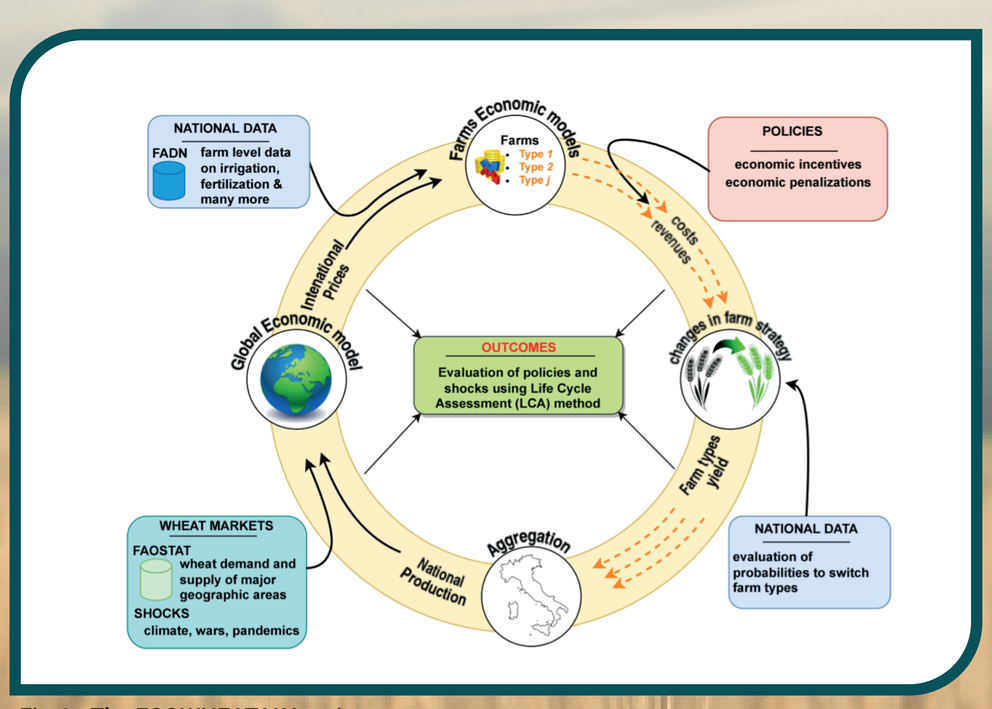

Fig.1 - The ECOWHEATALY project

MATERIALS and METHODS

The tool estimates input levels (fertilizer, herbicide, insecticide) that maximize profits based on local conditions (province, altimetry, market prices). (Fig. 2 and 3). These estimates rely on economic optimization using data from ~20,000 farm observations (RICA, 2008–2022). Parameters are calculated at the province-altimetric level and used by the interface to generate profit-maximizing input combinations. Results are then processed through a Life Cycle Assessment (LCA), using the ReCiPe 2016 method, to estimate environmental impacts.

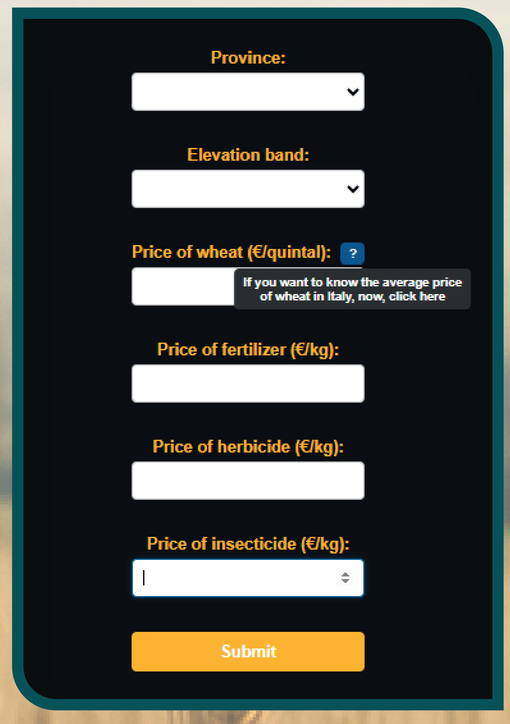

Fig.2 – The Graphical User Interface (GUI) before being filled by the user

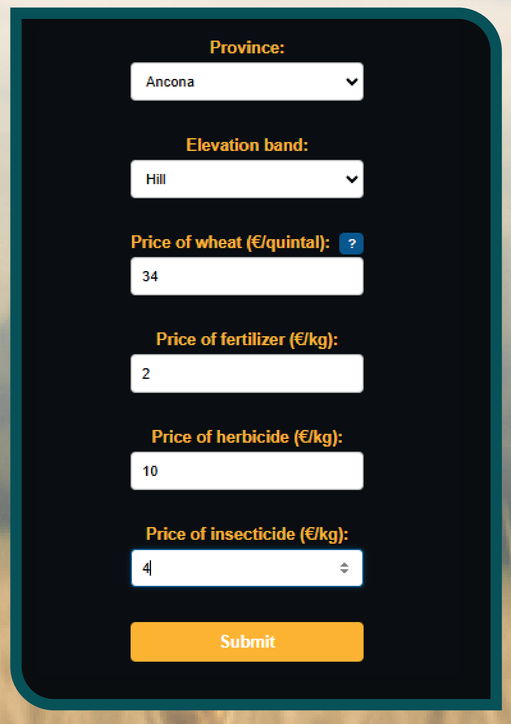

Fig.3 – The filled Graphical User Interface (GUI)

RESULTS and DISCUSSION

The interface provides detailed economic and environmental indicators based on province, altimetric zone, and market inputs. By simulating input levels that maximize profit, it estimates the optimal use of fertilizer, herbicide, and insecticide, along with expected yield and gross margin per hectare.

In terms of environmental impacts, instead, the outputs include:
- Human health, measured in Disability Adjusted Life Years (DALY),
- Ecosystem quality, as annual local species loss.

These indicators are displayed on the results page (Fig. 4–5), enabling users to understand the trade-offs between profit and sustainability. By translating complex metrics into accessible information, the tool supports informed decision-making, while promoting awareness and learning.
This approach ultimately encourages voluntary adoption of sustainable practices, aligning environmental and economic goals through data-driven insights.

Model's output

Estimated yield: 35.59 quintal
Estimated Profil: 972 €
Amount of fertilizer: 110.17 kg
Amount of herbicide: 1.64 kg
Amount of insecticide: 0.4 kg
DALY: 0.0008821667 (about 7:30 hours)
Species lost per year: 0.000004391925

Fig.4 – Model Output

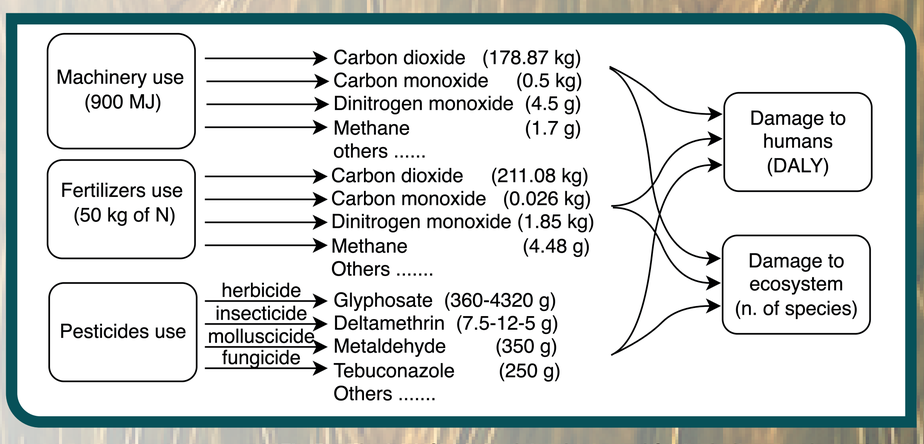

Fig.5 – The LCA framework implemented for including results in the GUI

- Huijbregts, Mark A. J., Zoran J. N. Steinmann, Pieter M. F. Elshout, Gea Stam, Francesca Verones, Marisa Vieira, Michiel Zijp, Anne Hollander, and Rosalie van Zelm. 2016. ReCiPe (2016). A harmonized life cycle impact assessment method at midpoint and endpoint level Report I: Characterization. Technical report RIVM 2016-0104. https://www.rivm.nl/bibliotheek/rapporten/2016- 0104.pdf. Bilthoven, The Netherlands: Dutch National Institute for Public Health and the Environment.
- Huijbregts, Mark A. J., Zoran J. N. Steinmann, Pieter M. F. Elshout, Gea Stam, Francesca Verones, Marisa Vieira, Michiel Zijp, Anne Hollander, and Rosalie van Zelm (2017). "ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level." The International Journal of Life Cycle Assessment 22, no. 2 (February): 138–147.

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