Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale: politiche e strategie per la sostenibilità e la resilienza
Marina di Orosei (NU), 21-22 settembre 2023.
Società Italiana di Economia Agraria

TESAF Dipartimento Territorio e Sistemi Agro-Forestali
Università degli Studi di Padova

PhD program:
Land, Environment, Resources and Health (LERH) - 36th Cycle -
University of Padua

22nd September 2023

Comparative assessment of the land footprint and regulating ecosystem services embodied in the Italian's consumption of vegetable oils: an environmental trade-off analysis among substitute goods

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European Commission

Research project financially supported by the Joint Research Centre (JRC) of the European Commission (EC)

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- Background and justification
- Problem statement and research objectives
- Methodology
- Main results
- Concluding remarks

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Background and justification (1/4)

XXI century deforestation drivers

- Since 2000, **5 Mha/yr** of global forest lost (FAO, 2020)
- **95%** within **tropical regions** (50% in Brazil and Indonesia) (Pendrill *et al.*, 2019)
- **75%** due to the **expansion of agriculture** and forest plantations (Curtis *et al.*, 2018)
- **60%** to produce beef, soybeans, and oil palm fruits (Pendrill *et al.*, 2019) → **Forest risk commodities (FRCs)**
- **30-40%** traded globally (Pendrill *et al.*, 2019)
- **Embodied Deforestation** in global supply chains (Cuypers, 2013)

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Background and justification (2/4)

EU responsibilities and the role of palm oil

- EU outsources, on average, **40%** of its agricultural consumption (food + energy) (Bruckner *et al.*, 2019)
- Main importer of beef, up to **30% of global imports of palm oil and soybeans** (Lawson, 2015)
- Since 1990 the **largest importer of FRCs per-capita** (Heflich, 2020)
- Share of palm oil on the EU's embodied deforestation: from **10%** (1990-2008) to **42%** (2017) (Cuypers, 2013; WWF, 2021)
- At least **50%** of the EU supermarket products contain palm oil derivatives (Brack *et al.*, 2016)
- Since 2000, **Italy** has covered **15%** of the EU27 palm oil imports (Faostat, 2023)

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Background and justification (3/4)

EU regulation on deforestation free products (EUDR)

- **Main objective:** to minimize the EU contribution to deforestation and forest degradation embodied in trade
- **When:** will enter into force in 2024
- **How:** by imposing a mandatory due diligence for all the operators placing FRCs (cattle, cocoa, coffee, oil palm, soy rubber, and wood products) within the EU market or exporting them outside the EU borders
- **Potential adverse impacts:** To cause consumption and environmental trade-offs among alternative products and countries of production

The EUDR full text is available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1115&qid=1687867231461

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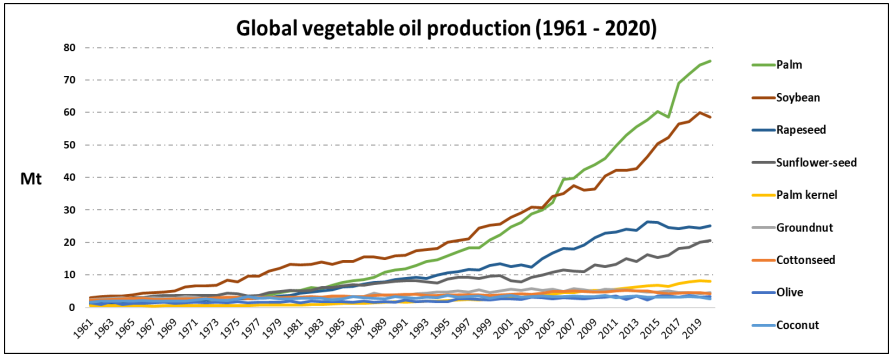
Background and justification (4/4)

The global vegetable oil sector



- Production (2020): **palm oil (37.4%)**, **soybean oil (28.8%)**, rapeseed oil (12.4%), and sunflower oil (10.1%)
- Projections: **+12%** by 2032 (OECD&FAO, 2023)
- Foodstuff (60-65%), bioenergy (10-15%), oleochemicals, animal feed (i.e., oil cakes) (OECD&FAO, 2023)

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Problem statement

The EU's consumption of palm oil and soybean-based products is a relevant deforestation drivers globally.

However, the implementation of the EUDR could cause consumption trade-offs among different oils and associated environmental impacts in terms of LU change, and natural ecosystem degradation.

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Research objectives (ROs)

RO1: To analyse the EU27 **trade network** of the top four vegetable oils (i.e., palm, soy, rapeseed and sunflower oil)

RO2: To model the EU **land footprint** associated with the trade of the four vegetable oils and their by-products (i.e., oil cakes) differentiated by producing and consuming countries

RO3: To assess the **trade-offs** between provisioning and regulating ecosystem services associated with the consumption of the four vegetable oils

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Methodology (1/3)

1. Trade network analysis (Sun et al., 2023)

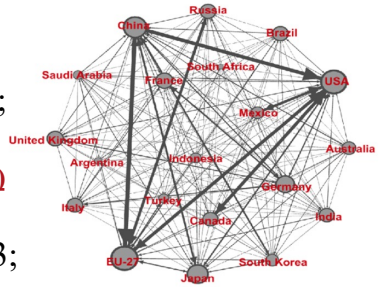
Aim: To identify the position and functions of each node (i.e., trade partner) in the EU27 trade network for each product;

Main data input: Bilateral trade data matrix (Faostat);

Main output: Network's properties and centrality measures:

- Density (ND);
- Out-degree centrality (O-DC);
- betweenness centrality (BC);

(a way to detect potential re-export hubs)



Main tool: Networkx in Python 3;

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Methodology (2/3)

2. Land footprint modelling (De Laurentis et al., 2022)
(Biophysical accounting model + Re-allocation model)

Aim: **To quantify** agricultural lands embodied in the **EU27 apparent consumption (production + imports –exports)** of vegetable oil by country of primary production;

Main data input: Production and bilateral trade data + country specific time varying coefficients (e.g., yields, extraction rates);

Main tool: Pandas in Python 3;

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Methodology (3/3)

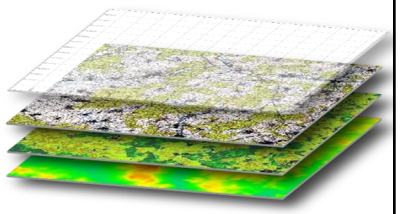
3. Spatial Analysis (Hoang et al., 2022)

Aim: To assess productivity and ecological trade-offs by countries and products, by **overlaying spatially explicit environmental information with country's agricultural areas**;

Main data input: High resolution maps (10-km^2 grid cells)

- Global oil crops agricultural areas (Yu, et al., 2020);
- Global biodiversity conservation ranking (B) (Jung et al., 2021);
- B + global carbon and water regulation conservation ranking (BCW) (Jung et al., 2021);

An ecological conservation score - 1 (max); 100 (min) - was assigned to the terrestrial units (100 km^2) producing the oil crops at country level.



Main tools: Qgis 3.30.3 + Python 3's packages;

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Results (2/5)

The EU27 and Italian primary crops top suppliers

Table 2: Producing countries sourcing at least 1% of EU27 apparent consumption for soybeans, sunflower seed, rapeseed, oil palm fruits (% on total apparent consumption) between 2000 and 2020.

Soybeans	Sunflower seeds	Rapeseeds	Oil palm fruits
BRA (44.9%)	UKR (24.6%)	FRA (17.3%)	IDN (46.5%)
ARG (32.0%)	ROM (11.9%)	DEU (16.7%)	MYS (31.0%)
USA (9.9%)	SPA (10.8%)	POL (10.4%)	PNG (7.2%)
PRY (4.9%)	FRA (9.5%)	AUS (10.4%)	GTM (3.8%)
IND (1.5%)	ARG (8.6%)	UKR (8.0%)	HND (3.8%)
CAN (1.4%)	HUN (8.2%)	CZE (5.0%)	COL (3.1%)
UKR (1.3%)	BGR (7.8%)	CAN (4.6%)	THA (1.0%)
	RUS (7.3%)	ROM (3.9%)	ECU (1.0%)
	MDA (2.2%)	RUS (3.4%)	
	ITA (1.8%)	HUN (3.0%)	
	SVK (1.2%)	GBR (2.3%)	
		LTU (1.8%)	
		SVK (1.7%)	
		DEN (1.6%)	
		BGR (1.5%)	
		SWE (1%)	

Countries names follow Alpha-3 codes ISO 3166-1

EU27

Primary crop eq.	LF (Mha)	% on Total
Soybeans	140.8	41.6%
Rapeseed	91.3	26.3%
Sunflower seed	84.2	24.9%
Oil palm fruits	24.5	7.1%
Total	**340.8**	**100.0%**

Italy

Primary crop eq.	LF (Mha)	% LF on Total
Soybeans	21,3	49.2%
Rapeseed	3,7	8.5%
Sunflower seed	12,4	28.5%
Oil palm fruits	6,0	13.8%
Total	**43,4**	**100.0%**

Italy covered 12.7% of the EU27 apparent consumption

42 countries supplied >=99% of the EU27 embodied LF

Top 5 Italian suppliers:

- **Soybeans**: ARG (52.4%), BRA (21.8%), PRY (7.9%), ITA (6.3%), USA (5.1%);
- **Sunflower seed**: UKR (34.5%), RUS (19.3%), ITA (14.9%), HUN (8.4%), ROM (6.8%);
- **Rapeseed**: CAN (19.4%), FRA (16.6), RUS (12.2), DEU (10.3), UKR (5.7%);
- **Oil palm fruits**: IND (64.2%), MYS (23.5%), PNG (5.7%), GTM (1.7%), THA (1.4%);

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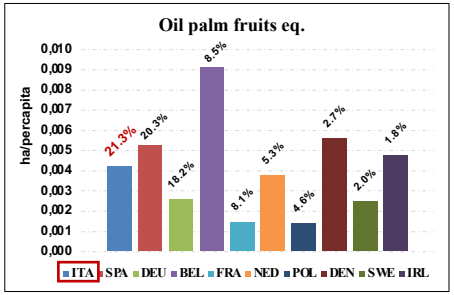
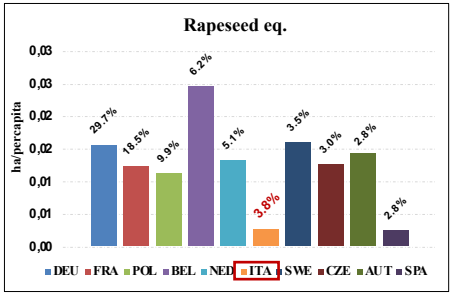
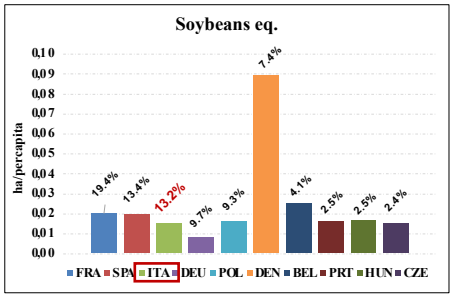
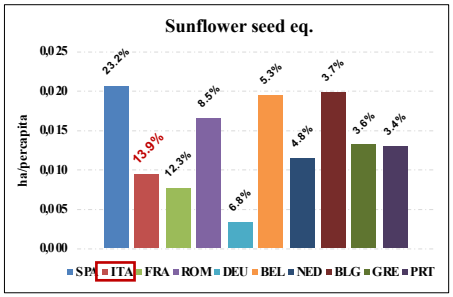
Results (3/5)

Top ten EU27 consumers (%) and per-capita land footprint (ha)









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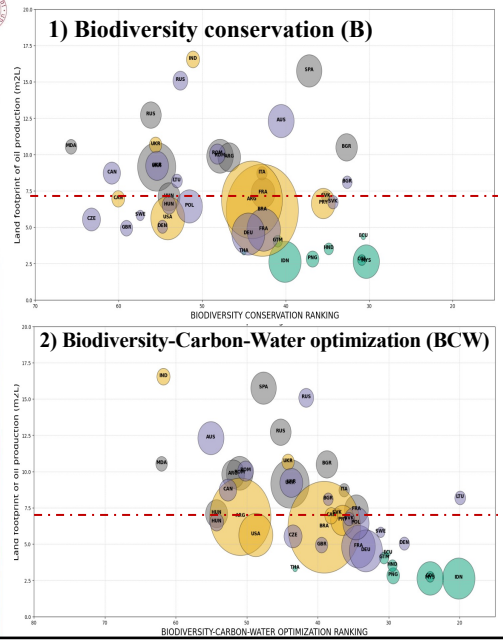
Results (4/5)

Trade-offs between oil yield (m^2/L) and ecological conservation



*Note: **size** of bubbles relative to countries' weight on the European embodied land footprint (LF)*

In general: **the lower the LF, the higher (B) and (BCW)**

Differences across:

- **Countries**

especially for LF values: broad range of (B) and (BCW) scores (e.g., LF<7.3 – dashed red line -)

- **Products**

Palm (green) higher mean x_i values

Soybeans (yellow) overall centrality

Rapeseed (violet) and **sunflower** (grey) perform differently, even if reducing their variance from (B) to (BCW)

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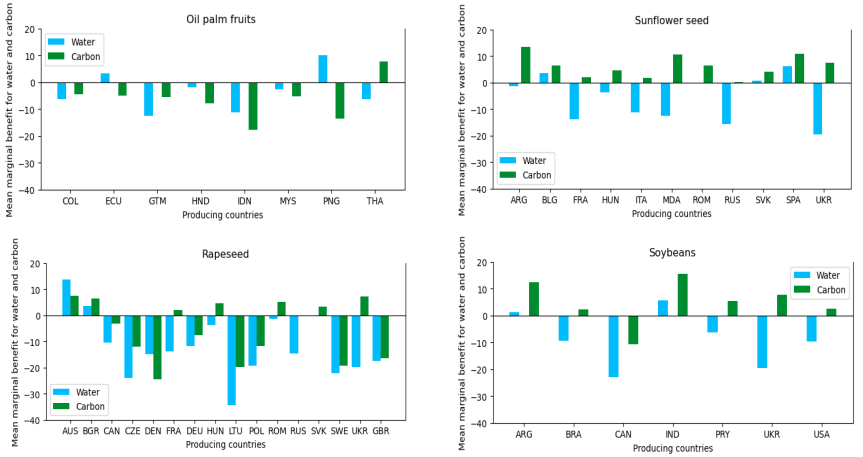
Results (5/5)

Mean additional ecological benefit of Carbon and Water



- **Increasing (negative bars)** and **decreasing (positive bars) trends** in the mean ecological values emerged across products and countries when carbon (green bars) and water regulation (blue bars) were added to the baseline of the biodiversity conservation target;
- This analysis stresses **the relative importance of each country-product for each ecological conservation target**;

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Concluding remarks

- Agricultural-driven global land use change → **trade-offs between provisioning** (e.g., food-energy security) **and regulating ecosystem services** (e.g., carbon and water regulation)
- **Producing countries** perform differently both in terms of **land footprint (LF)** per unit of product, **and embodied ecological impacts**
- **Among vegetable oils: Palm oil** performs **better** in terms of **LF** but **may be worse** in terms of potential **ecological impacts**
- **Substitution** of palm oil with other vegetable oils **may have a greater impact in terms of global LF and uncertainty regarding the overall ecological impacts**
- EU policies on sustainable consumption should shape the EU market, by **addressing the embodied impacts of future LUC activities across consumption alternatives in relation with <u>specific conservation targets at subnational level</u>**

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Thank you for your attention!

Any questions or comments?

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