The sustainability of agri-food systems: is organic production part of the solution?

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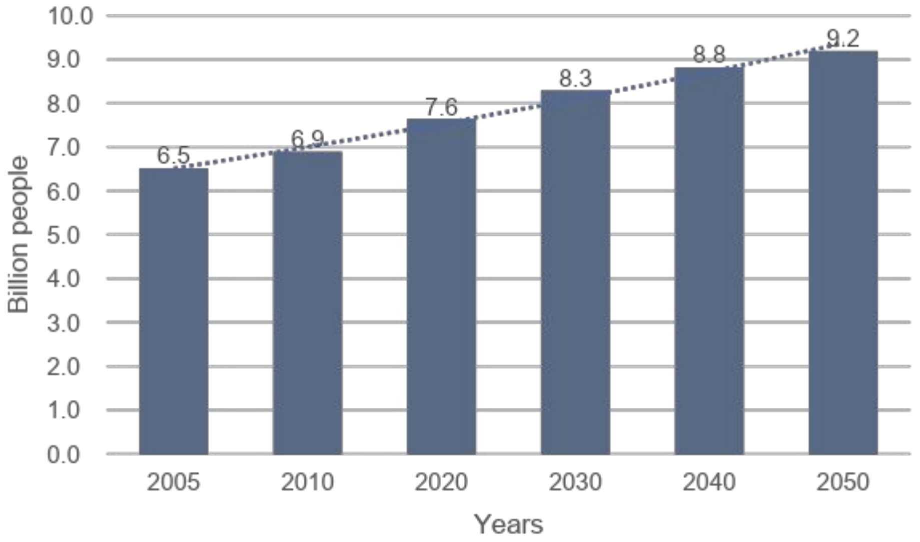
MUST4 WATER

Global population is expected to increase in the short and medium run..



Source: SSP2-baseline scenario

Intensify conventional farming methods to satisfy the growing food demand

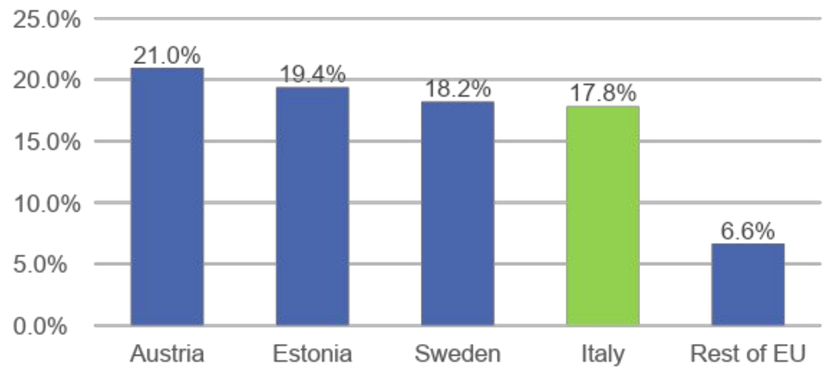
- Climate change driver
- Biodiversity loss
- Soil degradation
- Food insecurity

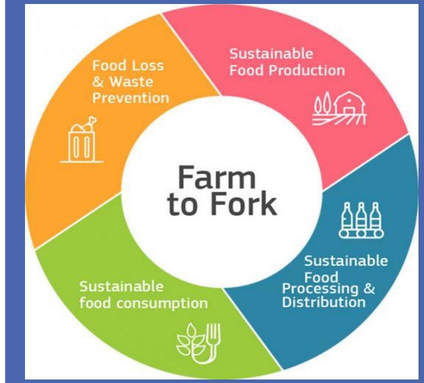
Global quest for a sustainable agri-food system

Organic agriculture offers a tangible but debated path to a sustainable food system

- Utilizes organic seeds, crop rotation and organic fertilizers
- Avoids synthetic fertilizers, chemical pesticides and GMOs
- Prevents sewage sludge

Organic Cropland in 2022 (Source: FAO)





- Framed within the European Green Deal
- Sets an ambitious target of achieving 25% organic utilized agricultural area across the EU by 2030
- Italy has incorporated this goal into the National Strategic Plan

Research questions and contributions

To what extent this effort on organic production could be part of the solution to guarantee the sustainable transition of agrifood systems?

1. Address the role of organic related policy shock in the sustainability of agrifood systems by adopting a simulation model with specific focus on Italy

2. Expand the partial equilibrium framework named SIMPLE (Hertel & Baldos, 2013) to Italy, incorporating the distinction between organic and conventional crop production, and develop a global dataset capturing production, prices, and inputs for both systems.

Evidence in the Literature: socio-economic and environmental effects of organic agriculture

- **A full shift to organic farming may cut food production and competitiveness, risking food security** (Smith et al., 2018; Feuerbacher et al., 2018; Barbieri et al., 2021; Beckman et al., 2022; Kremmydas et al., 2023; Kremmydas et al., 2024)

- **Shifting to organic production could mean higher food prices** (Feuerbacher et al., 2018; Meemken & Qaim, 2018; Beckman et al., 2022; Kremmydas et al. 2024)

- **Lower yields in organic agriculture could have negative effects on land use and GHG emissions** (McGee, 2014; Tuck et al., 2014; Lee et al., 2015; Muller et al., 2017; Calabro & Vieri, 2023; Basnet et al., 2023)

- **Organic agriculture preserves biodiversity and improves food quality** (Bengtsson et al.,2005; Tuck et al., 2014; Shepon et al., 2016; Seufert & Ramankutty, 2017; Meemken & Qaim, 2018; Tscharntke et al., 2021; Rempelos et al., 2021)

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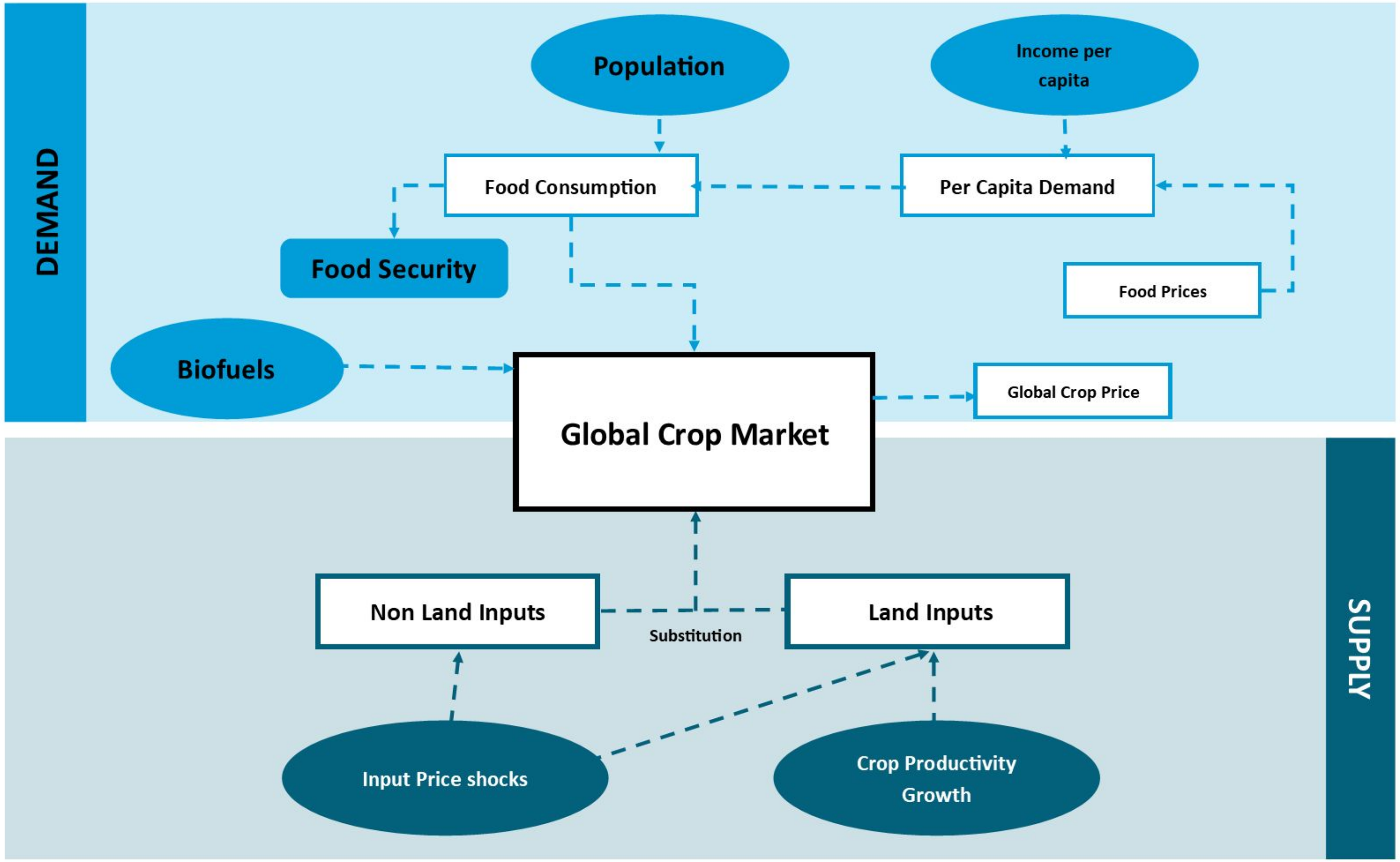
Simplified International Model of agricultural Prices, Land Use and Environment(SIMPLE)

- SIMPLE is a partial equilibrium model which comprehensively captures the key socioeconomic factors influencing cropland use and production for 16 regions of the world.

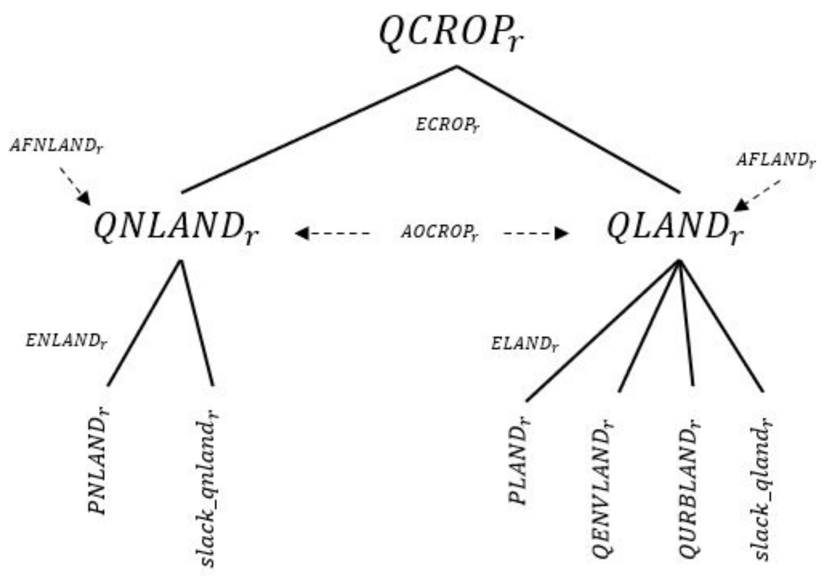
- This model combines both economic and biophysical variables.

- It was first developed by Hertel and Baldos (2013)

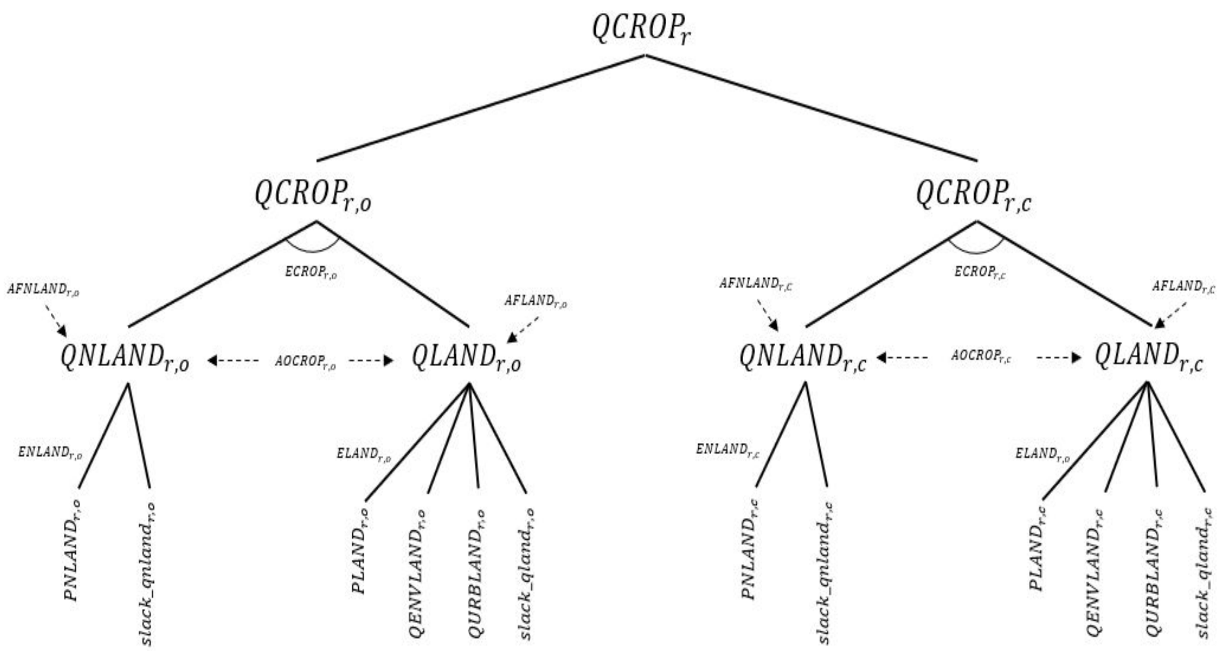


The original SIMPLE framework should be extended to better fit our case of study

Original Crop Production Function

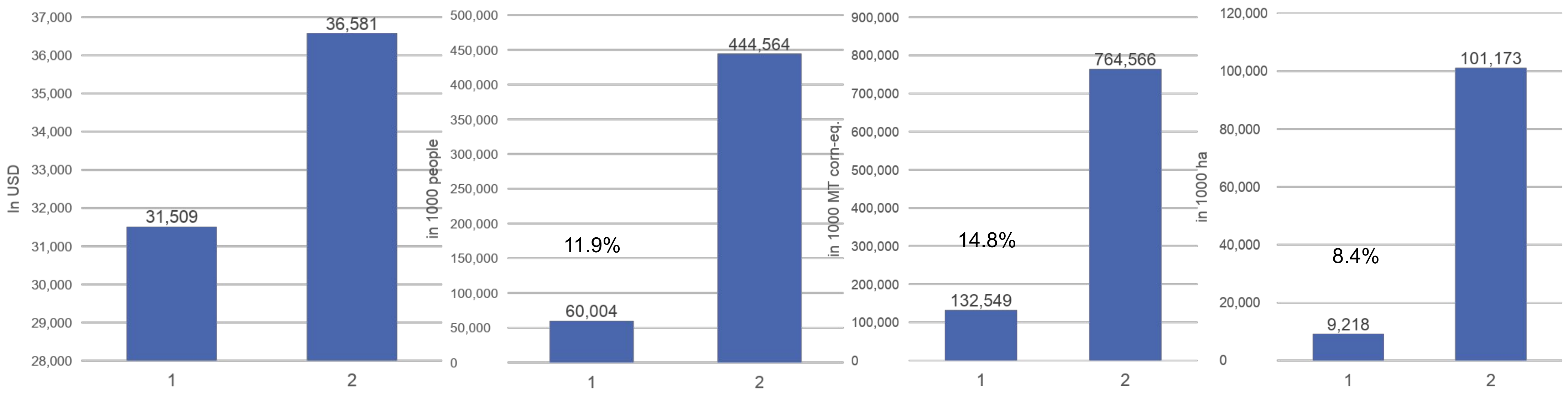


Extension



Data building: Singling out Italy within the original SIMPLE model

- The original SIMPLE framework published by Baldos (2023) divides the world into 17 regions where Italy is included within the EU.
- To single out Italy, we followed the methodology proposed by Baldos (2023) by mainly using agricultural data from FAOSTAT and parameters from the GTAP V11 database.
- The base year for calibration was set to 2017 due to data availability.

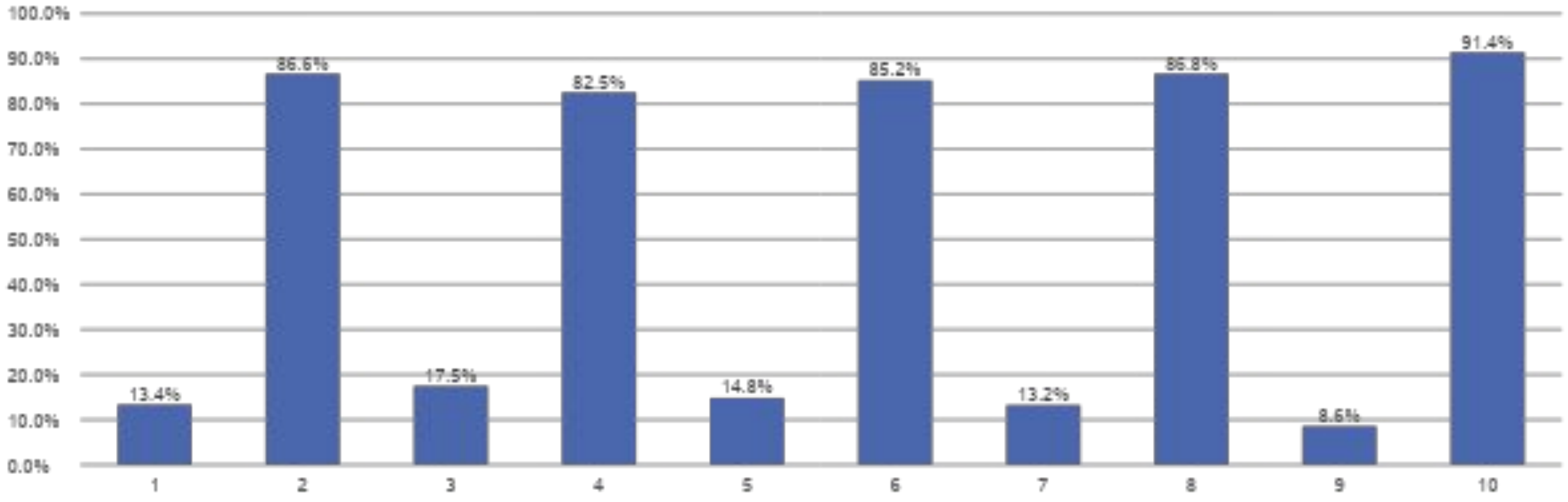


Source: Own elaboration based of FAO (2024). Year 2017.

Data building: Creating the Organic vs Conventional dataset

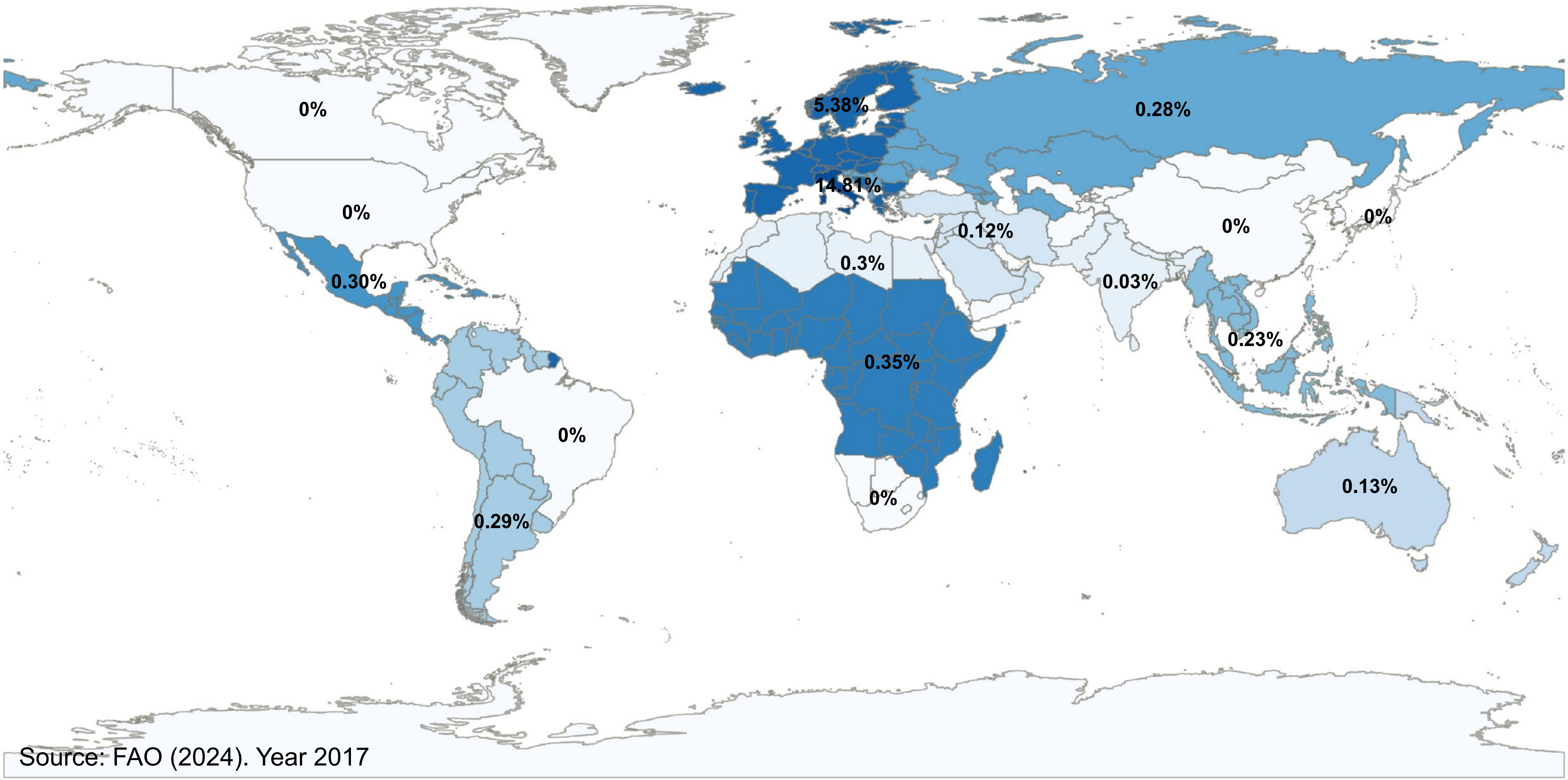
- Following the modifications introduced within the Crop production function in the model, a dataset distinguishing between organic and conventional production for each region was constructed.
- Main datasources included FAO (2024), the EU Farm Accountancy Data Network (FADN) and Eurostat.

Organic vs Conventional production for Italy. Year 2017



Source: Own elaboration based on FAO (2024), FADN and Eurostat

Share of Organic Agriculture in the SIMPLE framework

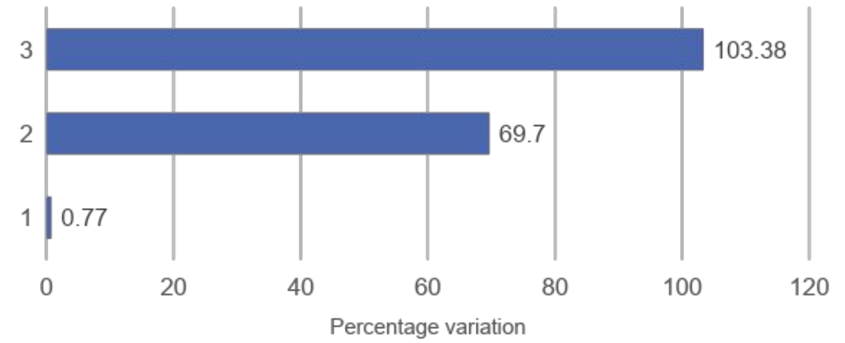


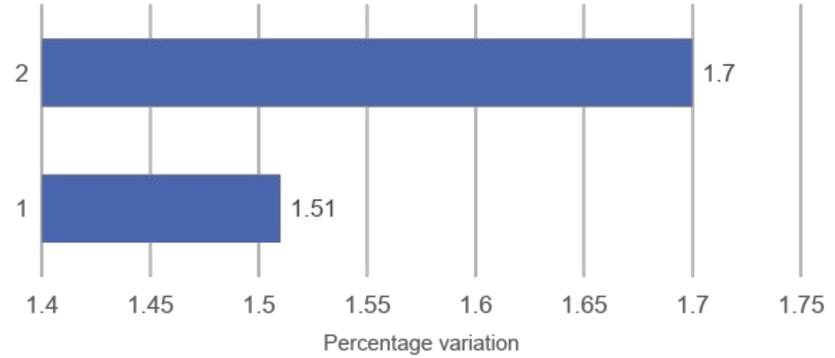
Source: FAO (2024). Year 2017

Simulation Design

1 Baseline Scenario to 2030

- *What would happen to demand and supply of agricultural products by 2030?*
- In order to answer this question we introduce both demand and supply drivers to our model





2 Farm2Fork Strategy Scenario

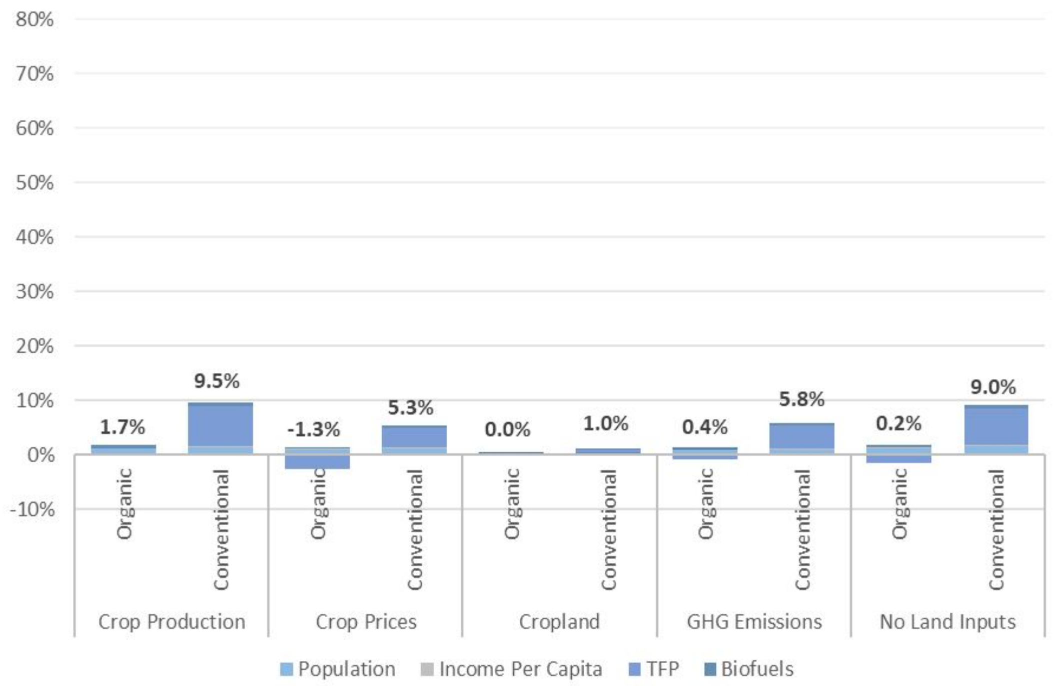
- *What would happen to the Italian Agriculture given an organic transition in line with the F2F strategy?*
- From a technical standpoint, two exogenous shocks are performed in the model:

  1. A positive shock in Italy's organic cropland to reach the 25% target
  2. A negative shock in Italy's conventional cropland to limit it's participation to 75%

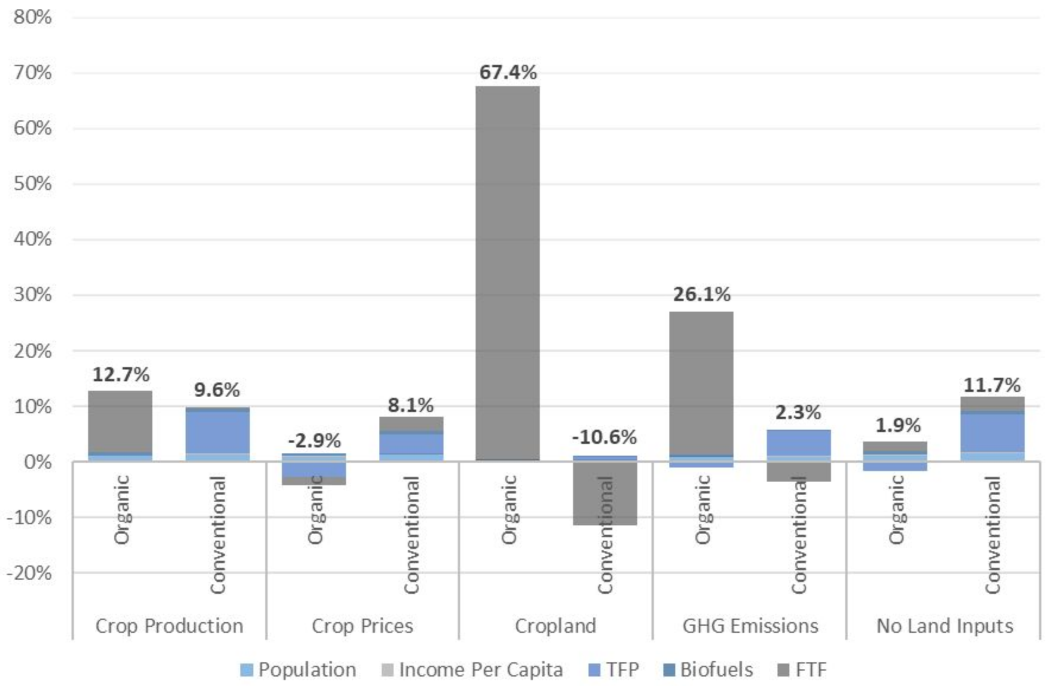
- Total amount of cropland remains constant

Results

1 Baseline results for Italy

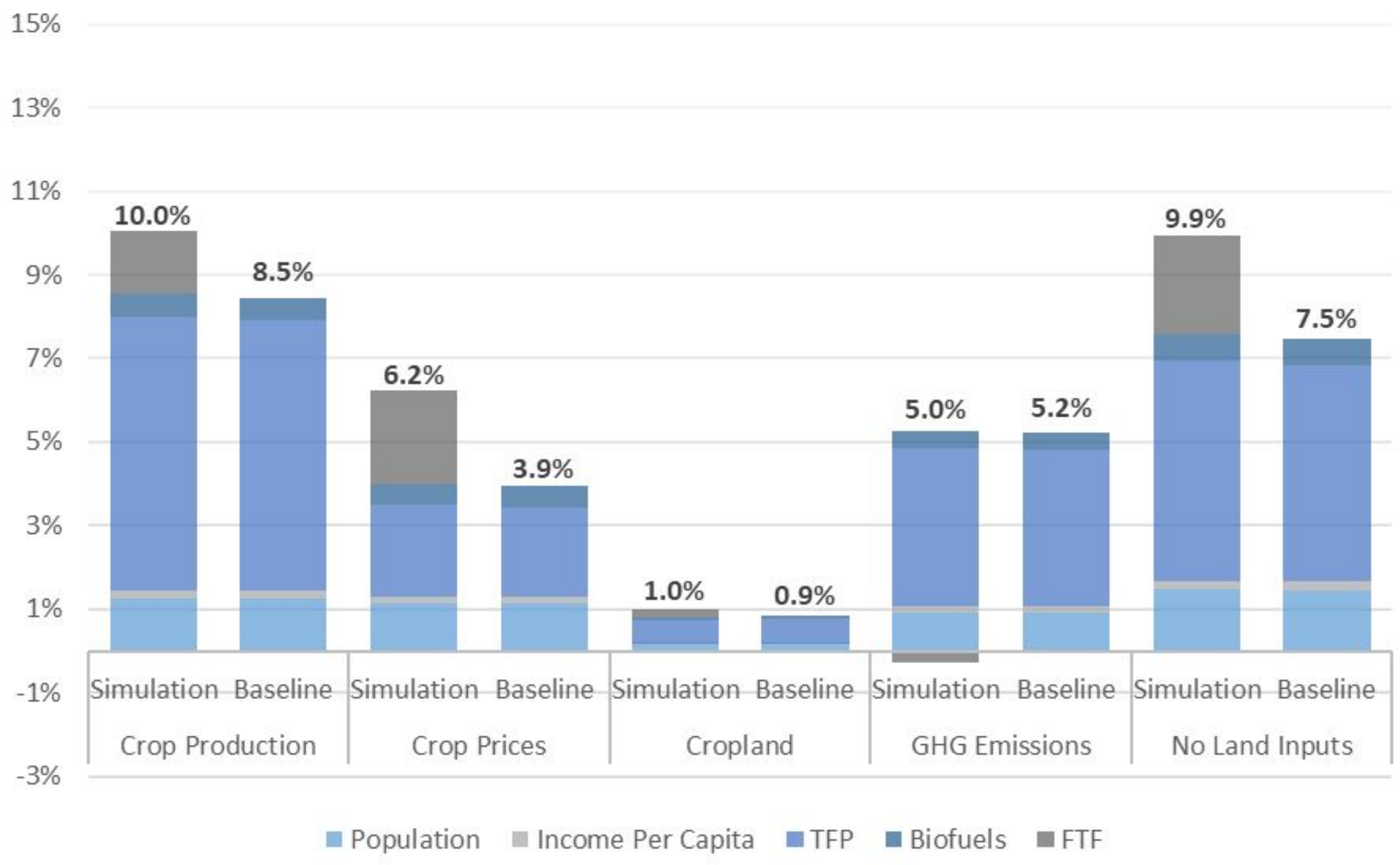


2 F2F Simulation results for Italy



Results

1 Results Comparison between baseline and F2F simulation at aggregated level



Main findings

- **The EU is promoting organic practices** to meet societal demands for high-quality, safe, and nutritious food produced sustainably, setting specific land targets for the coming decades.
- **Organic practices are seen as a concrete solution** by policymakers and practitioners to address sustainability challenges.
- In this paper we have developed an extention of the SIMPLE model developed by Baldos & Hertel (2013) so as to study the potential impacts of implementing the Farm to Fork Strategy in Italy by 2030.

- Results show that:
    - Expanding organic land under the EU strategy will enhance food physical access by increasing crop production.
    - However, it may negatively impact economic access due to higher prices.
    - Environmental impact remains uncertain, as the slight reduction in GHG emissions contrasts with increased land and non-land use. **This trade-off raises concerns**, highlighting the complexity of sustainability in organic expansion.

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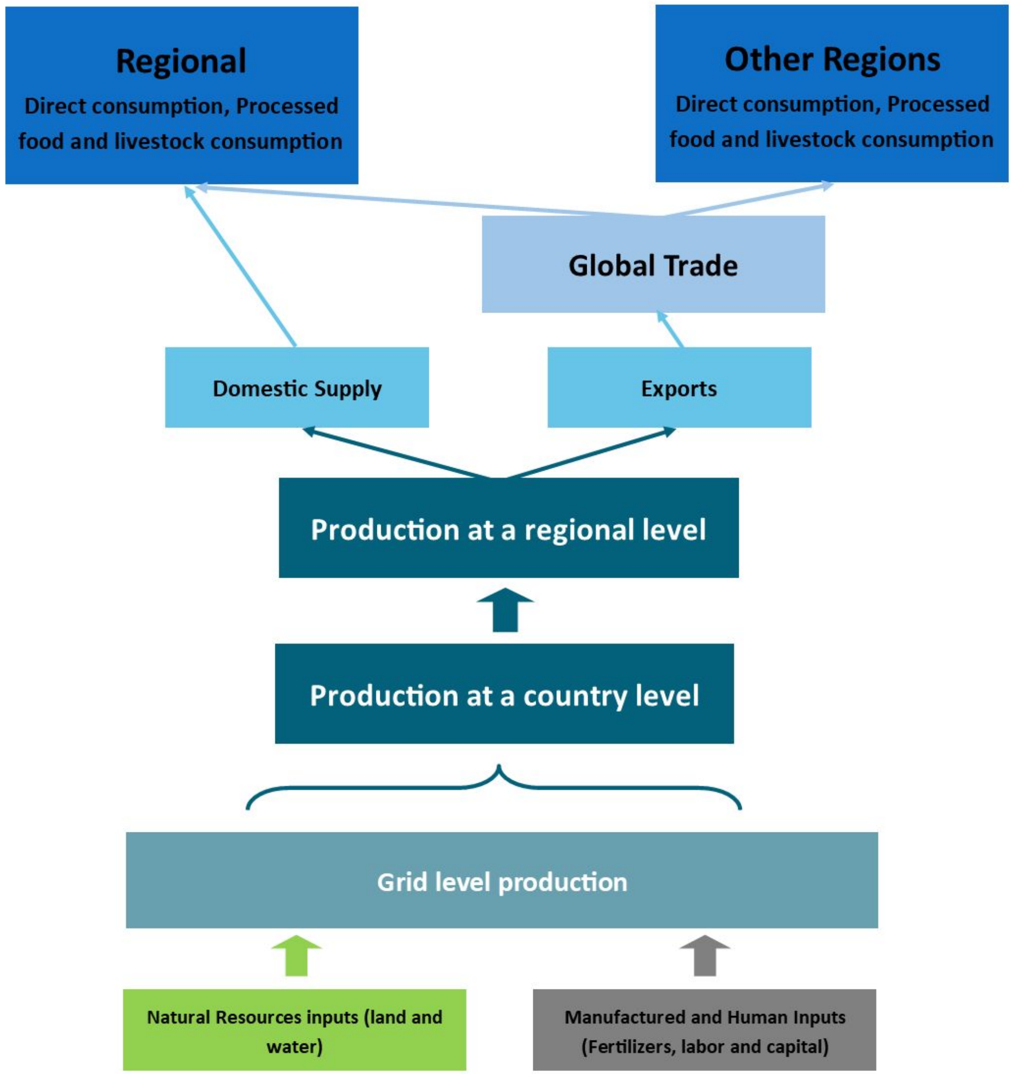
Development of SIMPLE-G-IT

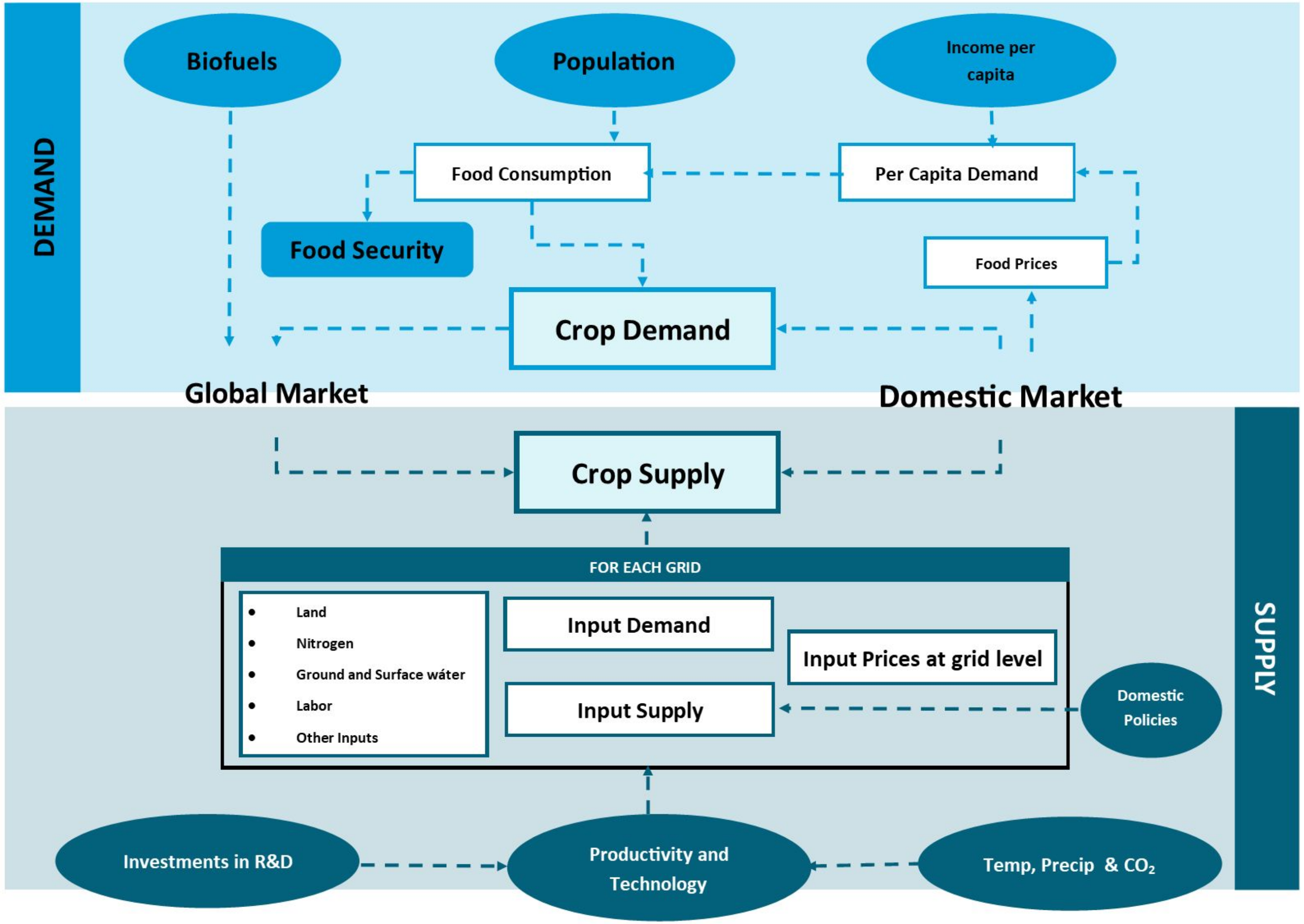
- Taking the SIMPLE-IT model as a reference, the next step in our research is the development of the gridded version of this model.
- Said variation will be able to capture the geospatial heterogeneities of Italy that are affecting local crop production, prices and input use.
- As a consequence, this version of the model incorporates local demand for water for agricultural uses.

SIMPLE-G phylosophy

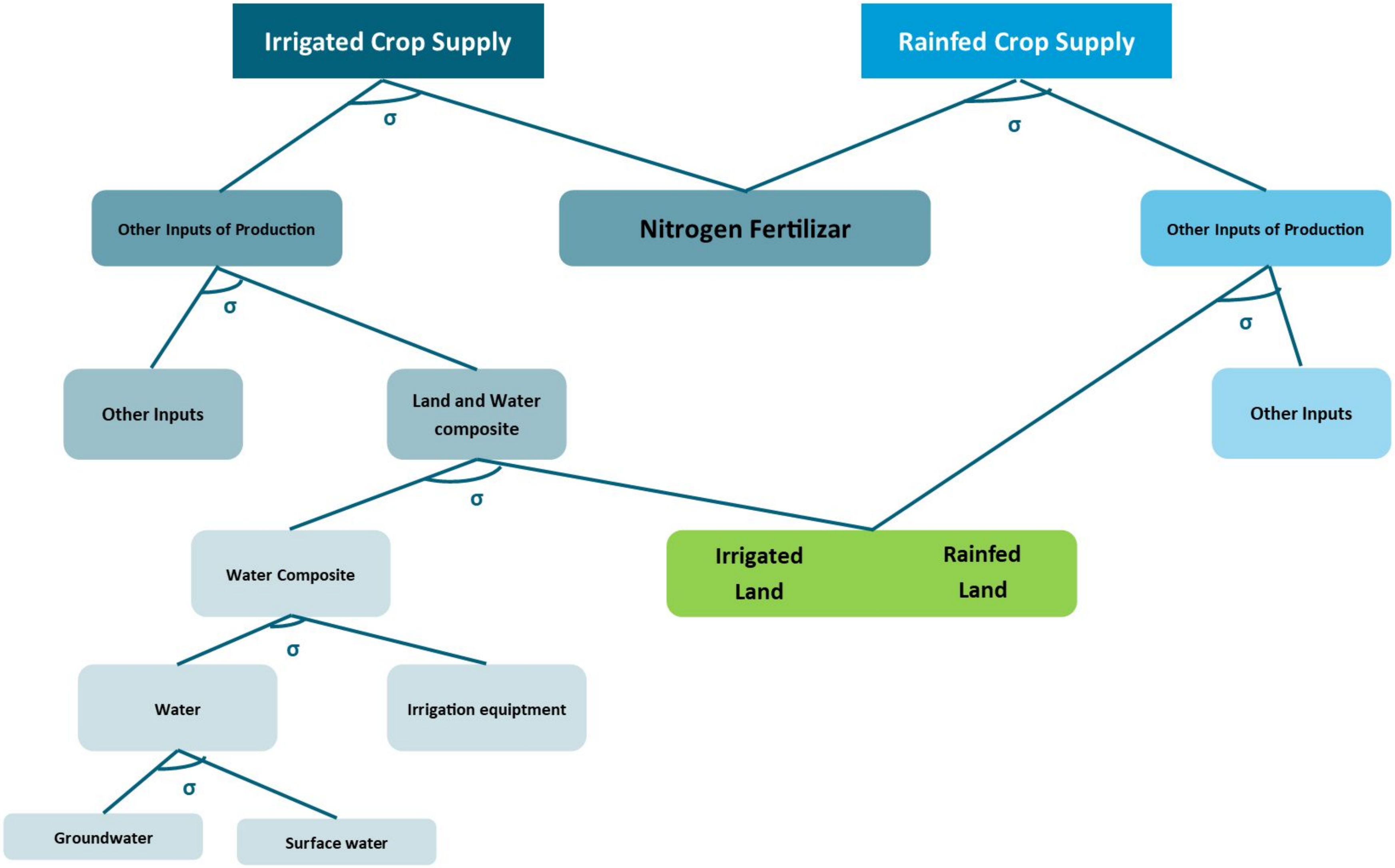


- Recognizes that global forces are driving local sustainability stresses
- Yet the character of these stresses and solutions vary by locality
- Local responses can have global consequences
- Georeferenced analysis that incorporates local heterogeneities is key
- Additionally, the economic analysis should be complimented with biophysical estimates such as cropland use, yields, water usage and fertilizers applications, among others

SIMPLE-G structure



SIMPLE-G production function at a grid level



Development of SIMPLE-G-IT

Benchmark data

Varible	State
Land Area and Value	Done
Crop production, yields and values	Done
Surface and groundwater withdrawls	Data Available
Value of water	Under exploration
Fertilizer application and value	Done
Other non-land inputs	Data Available

Behavioural parameters

Parameter	State
Cropland supply elasticity	Under development
Groundwater supply elasticity	
Surface water supply elasticity	
Substitution elasticities	
Transformation elasticities	