

AGENT-BASED SUPPORT TOOL FOR THE DEVELOPMENT OF AGRICULTURE POLICIES

# NEWSLETTER

### Issue 7: June 2024

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In the complex landscape of agricultural policy, one powerful tool helping policymakers make informed decisions is Agent-Based Modeling (ABM). This advanced simulation technique provides valuable insights into how individual behaviors and decisions of farmers, consumers, and other stakeholders can influence the entire agricultural system.

#### What is Agent-Based Modeling?

Agent-Based Modeling is a computational method that simulates the actions and interactions of autonomous agents to assess their effects on the system as a whole. These agents can represent individual entities like farmers, consumers, companies, or regulatory bodies. Each agent follows a set of rules and makes decisions based on its own objectives and the information it receives from its environment.



### **1. Understanding Agent-Based Modeling: Shaping Agricultural Policy**





### How Does ABM Work in Agricultural Policy?

<u>Agents and Rules:</u> In the context of agricultural policy, agents might include farmers, agricultural businesses, consumers, policymakers, and environmental organizations. Each agent operates according to specific rules or behaviors. For instance, farmers might make decisions based on crop prices, weather conditions, and subsidies.

<u>Environment:</u> The environment in ABM represents the agricultural landscape, including fields, markets, weather systems, and infrastructure. It also includes policies and regulations that influence agent behaviours.

<u>Interactions</u>: Agents interact with each other and with the environment. For example, farmers sell to consumers, purchase supplies from businesses, and respond to government policies. These interactions can be influenced by factors like market demand, environmental conditions, and policy changes.



### Why is ABM useful in Agricultural Policy Assessment?

ABM helps policymakers to understand how different factors and policies impact the agricultural system as a whole. This approach is particularly valuable in addressing the complex challenges of modern agriculture:

<u>Economic Impact</u>: By modelling the economic behaviors of farmers and consumers, ABM can help predict how changes in subsidies, taxes, or trade policies might affect agricultural markets and rural economies.

<u>Environmental Sustainability:</u> ABM can simulate the impact of agricultural practices on the environment, helping to design policies that promote sustainable farming while maintaining productivity.

<u>Social Dynamics:</u> ABM can assess how policies influence social factors, such as rural employment, community cohesion, and the adoption of new farming technologies.



### Real World Examples

<u>CAP Reforms:</u> The Common Agricultural Policy (CAP) is a cornerstone of EU agricultural policy. ABM can be used to simulate the effects of CAP reforms on farm incomes, land use, and environmental outcomes. By modeling different scenarios, policymakers can evaluate the potential impacts of proposed changes before implementation.

<u>Climate Change Adaptation:</u> ABM is employed to study how farmers might adapt to climate change. Simulations can model responses to changing weather patterns, water availability, and extreme events, helping to develop policies that support resilience in the agricultural sector.

<u>Market Dynamics</u>: By modeling the behavior of farmers and consumers, ABM can predict how market dynamics respond to policy changes, such as trade agreements or shifts in consumer preferences towards organic products.



#### ABM & AGRICORE

Agent-Based Modeling can be a vital tool in shaping agricultural policy. By simulating the behaviors and interactions of individual agents within the agricultural system, ABM provides insights into the complex dynamics that drive agricultural productivity, economic viability, and environmental sustainability. The AGRICORE tool we which we have been developing for the last 4 years targets to provide an effective instrument for the assessment of agricultural policies within the EU. With its innovative features and modules, we aim to create a toolbox for policymakers shaping evidence-based agricultural policies.



# 2. Synthetic Population Generation within AGRICORE



Synthetic population generation is a crucial process in the context of Agent-Based Modeling (ABM), particularly when simulating complex systems. Synthetic population generation involves creating a statistically representative set of agents that mimic the characteristics and behaviors of a real-world population. These synthetic agents are assigned attributes based on real-world data, such as age, gender, income, location, and other relevant factors. The aim is to produce a virtual population that accurately reflects the diversity and distribution of the actual population being studied.

In Agent-Based Modeling, the accuracy and validity of the simulation depend heavily on the quality and representativeness of the agents. Synthetic populations are essential because they provide a realistic foundation for simulations, ensuring that the modeled interactions and behaviors reflect real-world dynamics. This is especially important in policy-making, where decisions based on ABM can have significant real-world impacts.



AGRICORE's synthetic population generation (SPG) module, uses a Bayesian network learning algorithm to model visible and hidden relationships between agent attributes based on data fusion outputs, FADN data, and other sources. This process ensures a representative synthetic population, where individual agents cannot be identified with actual farms or farmers, providing realistic and validated data for simulations.



To create a realistic simulation of our farming population, we use census data and a method called exponential empirical likelihood to calculate representation weights. These weights help us estimate the number of farmers of each type in the real population, defined by their region and their crops or livestock.

# 2. Synthetic Population Generation within AGRICORE



We generate multiple synthetic samples until we match the estimated number of farmers for each type. Finally, we validate our simulation by comparing key parameters, like cultivated area, production, and livestock numbers, with the actual census data.

### In a nutshell- What was the outcome for the AGRICORE tool?

We've completed the Synthetic Population Generation (SPG) process for the AGRICORE use cases. This process began with creating a Data Warehouse (<u>described in deliverable D2.1</u>), transforming that data with the Data Extraction Module (<u>described in deliverable D2.2</u>), and generating Bayesian networks with the Data Fusion Module (<u>described in deliverable D2.3</u>). Using the algorithms from the <u>deliverable D2.3</u>, we proposed methods to scale up from synthetic samples to synthetic populations. Our key improvement was estimating representation

weights using empirical likelihood, which resulted in a more realistic synthetic population compared to previous methods.





Open sourcing plays a crucial role in promoting transparency, collaboration, and innovation within the agricultural community. By sharing our project outcomes, methodologies, and tools with the public, we contribute to the growth of agricultural research and development. AGRICORE adheres to established open-source frameworks and selects appropriate licensing models to ensure that our components and tools are accessible, usable, and modifiable.

This commitment aligns with our ethical responsibility to contribute back to society, promoting equitable access and fostering the exchange of ideas that can drive transformative change. By making our project components openly accessible, we aim to foster an ecosystem of knowledge-sharing, enabling researchers, farmers, industry professionals, and other stakeholders to leverage and build upon our findings.

#### **Choosing the Development Platform**

Selecting the right development platform is crucial for efficient, collaborative development.





We compared different platforms and ultimately chose GitLab for its alignment with our open-source vision and its robust project management features. GitLab's open-source program and features like Epics, which help in organizing and tracking complex projects, made it the ideal choice.

In our GitLab repository, you can find all the necessary projects for each module of the AGRICORE suite. Initially created privately for development, these projects are published in a public repository once completed and tested.

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### **Key Benefits of GitLab:**

- Open-Source Program: GitLab is an open-source project, fitting well with AGRICORE's vision.
- Epics: A project management feature that helps in organizing and tracking progress on larger, complex features.
- Define Goals and Objectives: Clearly define the overarching goals and scope.
- Group-Related Issues: Associate multiple issues and work items for a unified view.
- Track Progress: Visual representation of progress and milestones.
- Assign Ownership: Clear accountability for progress.
- Monitor Discussions: Dedicated discussion boards for effective communication.





Choosing the right Open source software

AGRICORE is strongly committed to **open sourcing** and open collaboration. In this frame, an intensive study was conducted by various partners involved in developing customized modules and during the second IPR workshops we were able to discuss and explore the concept of open-sourcing and licensing in order to have a clear overview of the use and redistribution of open-source software (OSS) and the **types of licenses** available.







### Choosing the right Open source software

After thorough study and discussions, the consortium has agreed to use the **GNU Affero General Public License (GNU AGPLv3)** for our project. This license offers several key benefits that align with our vision:

- Source Code Protection: Ensures modifications to the code remain open and accessible to the community.
- Extended Copyleft: Applies copyleft conditions even to applications interacting over a network, ensuring server modifications are also open source.
- Enhanced Collaboration: Encourages community contributions, leading to more participation, code reviews, and improvements.
- Free Software Principles: Aligns with the values of the free software movement, promoting user freedom, transparency, and ethics.
- Legal Protection: Clearly defines rights and responsibilities, providing solid legal protection for users and contributors.

In the AGRICORE project, we ensure compliance with these licenses and maintain the integrity of our software, guaranteeing compatibility with free software principles.



#### AGRICORE at XVII EAAE Congress 2023

Our partners from the University of Parma represented us at the XVII EAAE Congress in Rennes, France!

The congress aimed to stimulate discussions on effective policies, innovative strategies, investment priorities, and future-focused educational programs in agricultural economics. The theme **"Connecting science and society"** highlighted the importance of pushing the boundaries of research for societal impact.

From AGRICORE's side, we presented a poster titled "Assessment of CAP Generational Renewal subsidies with ABM." Our goal was to assess the effectiveness of Generational Renewal subsidies in motivating young farmers to enter the agricultural sector by measuring their economic viability as well as to investigate whether the current Pillar 1 and 2 subsidies are sufficient to overcome the financial and/or economical barriers preventing young farmers to start an independent agricultural activity.

Furthermore, we were able to connect with our sister project MINDSTEP proceeding, thus, with our clustering activities and research efforts.



#### AGRICORE at XVII EAAE Congress 2023





## AGRICORE Seminar "Research results for improving the Agri-environment-climate policy"

A seminar was held by UTP/PBS in Poland presenting the concept, goals, methodologies and research results of AGRICORE against the background of contemporary challenges facing agriculture. The meeting was attended by representatives of agricultural practice: representatives of agricultural organizations, including agricultural advisory services, as well as agricultural entrepreneurs and farmers.





Launch of our Agricultural Research Data Index Tool

The AGRICORE consortium is happy to announce that the **Agricultural Research Data Index Tool (ARDIT)** is fully operational! ARDIT is a platform to index characterizations of datasets that can be used for the analysis and study of the agri-food chain. These **characterizations of datasets** (or dataset catalogues) can be incorporated by registered users through web-based forms built on the basis of the AGRICORE-DCAT 2.0 ontology, which allows characterization down to the level of the variables contained in each dataset. ARDIT has a body of editors who verify the proposals for new additions and correct existing ones. The characterization of each dataset has a comments section where registered users and editors can suggest and discuss corrections or changes, thus allowing peer review of the ARDIT tool.





#### Launch of our Agricultural Research Data Index Tool

ARDIT has two well-defined objectives. The first one is to deliver an **open data portal** where researchers can publicly access an index of available agricultural data sources. The platform serves the metadata of the datasets and the links to their origin or download URLs. The second objective is to use this tool within our project to provide data necessary to fill the attributes of the farm agents that compose the synthetic populations used in the ABM.

#### You can register and use freely our ARDIT tool under: https://ardit.agricore-project.eu/login

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discuss corrections or changes, thus allowing peer review of the ARDIT tool.	Sign in
The AGRICORE Project is an H2020 Programme project (Grant Agreement No 816078) that aims to design a simulation tool based on heterogeneous agents (down to the farm	Don't have an account? Sign up
level) to analyse the potential impact that different public agricultural policy alternatives would have on them. The ultimate goal is to improve the Common Agricultural Policy (CAP) design process through a suite of impact assessment tools that are detailed yet	Access as guest
simple and transparent, incorporating the affected sectors in their construction and validation.	
This project has received funding from the European Union's HORIZON 2020 research and innovation programme under Grant Agreement NO 816078.	



### Research lessons to inform future CAP Reform-A cluster approach

AGRICORE had the honor of being an invited speaker at the esteemed event "Research lessons to inform future CAP Reform", organized by our sister project BESTMAP.

At the event, Lisa Baldi from the University of Parma provided a comprehensive overview of AGRICORE's groundbreaking research initiatives. She delved into our innovative modelling approach, showcasing how we navigate diverse datasets, access essential agricultural data, and develop scenarios crucial for informed decision-making in agricultural policy and practice.





### Research lessons to inform future CAP Reform-A cluster approach

Moreover, Lisa introduced attendees to the Agricultural Research Data Index Tool (ARDIT), a powerful resource driving our research endeavors.

The event served as a platform for collaboration and knowledge exchange within the AGRIMODELS Cluster. It was a privilege to share experiences and insights, furthering our collective mission to shape the future of agriculture through research and innovation.





### Smart Agrifood Summit 2024

AGRICORE recently participated at the <u>Smart Agrifood Summit</u> <u>2024</u>. This international event, known for its focus on innovation, training, and entrepreneurship, provided us with a great platform to showcase our advancements in agricultural policies impact assessment.

Our partners at CAAND played a pivotal role in our representation at the summit. Through distributing informative flyers and engaging with interested attendees, we were able to communicate the results and achievements of the AGRICORE project. The enthusiasm and interest we received from the audience reaffirmed the significance of our work in policy impact assessment and modeling.





#### Smart Agrifood Summit 2024

One of the highlights of our participation was establishing a significant connection with the co-founder of <u>TecnoAlgae</u>, a startup recognized for its commitment to sustainability with the "most sustainable startup" award. This collaboration opens up new avenues for synergistic efforts towards creating a more sustainable future for agriculture.





The AGRICORE project builds on the strong knowhow and expertise of its partners in the addressed scientific and industrial areas. The consortium is comprised of 11 European partners from 6 countries. AGRICORE is a well-balanced project between industry and academia ensuring and speeding up the successful implementation of all the actions towards its fruitful results.







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#### **4 Universities**

#### 4 SMEs

1 Research and Technology Organisation

**1 Large Company** 

1 regional farmer association



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