D7.3 Updated description of the AGRICORE use cases

AGENT-BASED SUPPORT TOOL FOR THE DEVELOPMENT OF AGRICULTURE POLICIES

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Executive Summary

By utilising the most recent advancements in agent-based modelling methods, the AGRICORE project presents a novel tool for enhancing the current ability to simulate the impact of policies dealing with agriculture. Each farm is represented by an agent, which is an autonomous decision-making entity that independently evaluates its own context and makes decisions in accordance with its expectations and existing circumstances. The AGRICORE tool enables the creation of case studies at various geographic scales, from local (NUTS2) to European (NUTS0) levels. The present deliverable is firstly trying to offer a brief and updated description of the activities done so far in each one of AGRICORE's three use cases. The activities focus on the research activities performed for the UCs ex-post impact assessments, which are focused on the identification of information gaps produced after the collection of available data for each use case, the design of participatory research, and the relevant engagement of stakeholders, the conduction of a pilot survey that pre-tested the developed questionnaires and the actual conduction of the participatory research coupled with a brief description of the gathered data, information, and elements for each use case. Secondly, the deliverable presents a spectrum of available scopes of ex-ante and ex-post impact assessments of each use case coupled with a presentation of available indicators. Finally, the deliverable concludes with the selection of the main scopes and indicators suitable for each use case, accompanied by a brief description of a fourth use case that has been designed to test the core of the AGRICORE modelling approach exclusively on FADN data. These scopes and indicators will be used for the impact assessment of the use cases.

Abbreviations

Abbreviation	Full name
AAC	Agricultural Advisory Center (Poland)
ABM	Agent-Based Model
ARMA	Agency for Restructuring and Modernisation of Agriculture
ELGO	Hellenic Agricultural Organization 'DEMETER' (Greece)
ER	Emilia Romagna
FADN	Farm Accountancy Data Network
GAMS	General Algebraic Modeling Language
GR	Generational Renewal
IFAPA	Research institutions such as the Institute of Agriculture and Fisheries
IUNG	Institute of Soil Science and Plant Cultivation (Poland)
KOBiZE	National Centre for Emissions Management (Poland)
KPI	Key Performance Indicators
MIPAAF	Ministry of Agricultural, Food and Forestry Policies (Italy)
NUTS	Nomenclature of Territorial Units for Statistics
OPRACOL	Association of olive oil and table olive producers (Spain - Seville)
POLSUS	Pig Breeders and Producers Association (Poland)
R&D	Research and Development
RDP	Rural Development Programme
REAFA	Andalusian Register of Agricultural and Forestry Holding (Spain)
SIPEA	Information system for organic production in Andalusia (Spain)
SNP	Strategic National Plan
UC	Use case
ZPWiDR	Management Associations of Agricultural Entrepreneurs Owners and Lesse (Poland)

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1 Introduction

1.1 Context of deliverable

By utilising the most recent advancements in agent-based modelling methods, the AGRICORE project presents a novel tool for enhancing the current ability to simulate the impact of policies dealing with agriculture. Each farm is represented by an agent, which is an autonomous decision-making entity that independently evaluates its own context and makes decisions in accordance with its expectations and existing circumstances. The AGRICORE tool enables the creation of case studies at various geographic scales, from local (NUTS2) to European (NUTS0) levels.

Figure 1 summarises the concept of the AGRICORE model, in which each distinct farm is represented as an autonomous decision-making entity (an agent) that independently assesses its own framework and makes decisions in accordance with a rationale derived from its present state and its expectations for the future. Each farm interacts specifically with the other elements of the agricultural structure, in the case of AGRICORE, which consists of other farms, markets, and land. The farms are also a part of their settings, which is considered when assessing the effects on the environment and climate, the socioeconomic effects (rural integration), and the provision of ecosystem services.
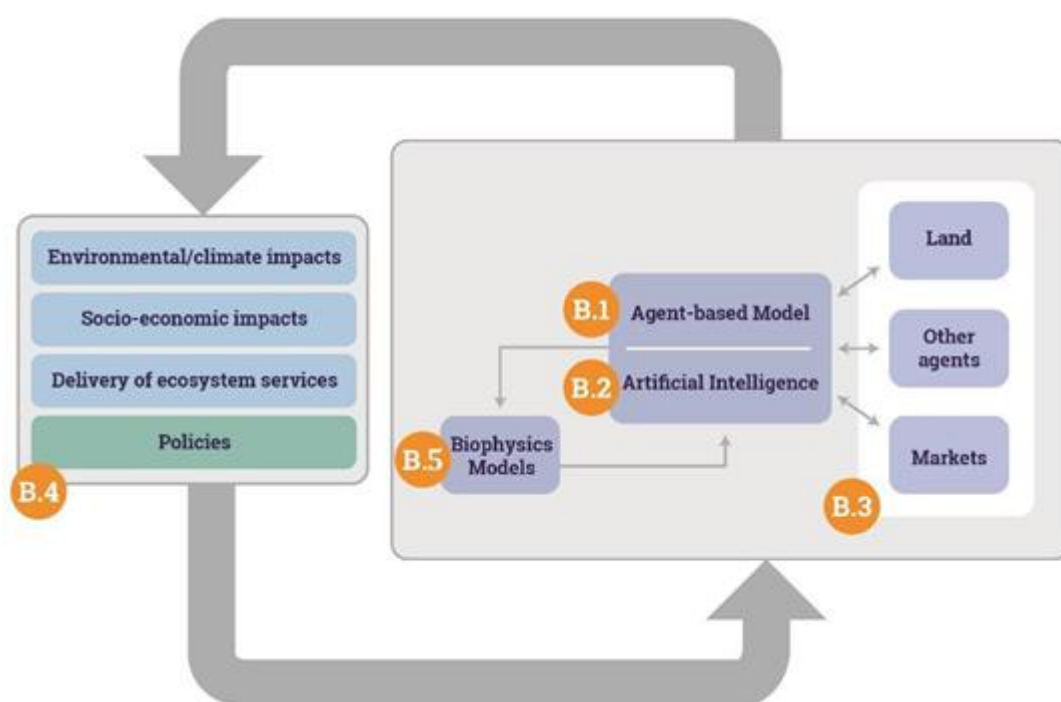
Figure 1. Concept of the AGRICORE project.

The interactions between each farm and its environment (environmental surroundings, level of rural integration, services provided by the ecosystem, permitted uses of the land, etc.) can be simulated using this modelling approach, both in terms of the availability of resources and services as well as the impact on the aforementioned environmental elements. For instance, the land market module is a way of simulating the interactions across farms. In the AGRICORE project, several dedicated modules are implemented to assess the impact of policies on various aspects of agriculture and the environment. One of these modules is focused on environmental and climatic impact assessment and is intended to establish connections between policies and impact key performance indicators (KPIs) on farmers' practices. This module will also incorporate regional

climatic patterns to better understand the bi-directional relationship between farming and the environment. Another dedicated module in AGRICORE is focused on the assessment of policy outcomes on the delivery of ecosystem services. This module will connect the response of agents to specific policies with ecosystem service KPIs in four main areas: supporting, provisioning, regulating, and cultural services. The AGRICORE agent-based modelling approach, in combination with these dedicated modules, will provide a powerful tool for assessing the relationships between policy initiatives and the integration of agriculture in rural systems while taking into account regional heterogeneity in specific KPIs.

A detailed planning and schedule for the execution of the different use cases considered in the AGRICORE project were presented in D7.1, and this deliverable 7.3 is a continuation of that planning in the framework of Task 7.2 - Policy impact assessment scope. The creation of such a plan at the outset of the project will enable avoiding potential problems with data availability (or lack thereof) or associated agents throughout the execution of the use case. The existing established and ongoing cooperation with the stakeholders (EAB, clustering activities, platform dissemination efforts) will, in fact, be expanded. The key participants in the policymaking process, associated researchers, and the agricultural industry will be specifically identified and approached. Second, to guarantee the successful execution of the proposed use cases, various phases associated with them will be continuously monitored. This monitoring will include, in addition to the general risk evaluation and mitigation actions done in the project, specific actions for ensuring the proper execution of the use cases.

In this deliverable, the scopes of ex-ante and ex-post impact assessments performed for three use cases are further defined as part of the demonstration and validation activities planned for the AGRICORE project, namely UC1: M11 – Ecologic agriculture in Andalusia, UC2: M10.1 – Agri-environment-climate commitments in Poland and UC3: M6.1: Start-up aid for young farmers in Greece. The deliverable presents a spectrum of the available scopes of ex-ante and ex-post impact assessments for each UC, a set of the available indicators for each impact assessment and a selection of the main scope(s) and indicators suitable for each UC. Moreover, a description of the activities done so far for each use case is presented in brief. In addition to the aforementioned UCs, a fourth one has been designed. This focuses on the Emilia Romagna region (NUTS-2) in Italy and aims to test the core of the AGRICORE modelling approach in the short-term period (agricultural year).

1.2 Objectives

The main objective of this deliverable is to better define the scope and indicators to carry out the policy impact analyses in each of the use cases. These scopes will be further refined based on the outcomes of the various research activities carried out in the project's early stages, as well as the feedback from the many stakeholders. The work included in this task also covers the identification and selection of the specific indicators that would be considered by the corresponding policymakers for the impact assessment (ex-ante or ex-post) of the specific policies.

KPIs are important tools for farmers, policymakers, and other stakeholders in the agriculture sector to track progress and identify areas for improvement. By measuring and analysing KPIs, farmers can make informed decisions about their practices, and policymakers can design more effective policies and programs that support sustainable agricultural development. The identification and selection of specific indicators for impact assessment is a crucial aspect of policymaking. It involves choosing measurable variables that can be used to assess the effectiveness of a policy in achieving its intended objectives, both before and after its implementation. These indicators can be social, economic, or environmental in nature, and they should be selected based on their relevance to the policy objectives, their reliability, and their

availability. By carefully selecting and tracking the right indicators, policymakers can gain valuable insights into the effectiveness of their policies and make informed decisions about how to refine and improve them in the future. When choosing indicators, it is important to consider their sensitivity, meaning how well they can detect changes in the policy's impact, as well as their specificity, meaning how well they reflect the policy's intended goals. Another important factor to consider is the availability of data since the indicators selected must be measurable using existing data sources or through data collection efforts that are feasible in terms of cost and resources. Moreover, the indicators should be understandable so that they can be effectively communicated to stakeholders and the general public. Finally, the indicators should be actionable, meaning they should provide information that can be used to improve the policy or make adjustments as needed. All in all, selecting the right indicators for impact assessment requires a thoughtful and systematic approach that considers a variety of factors to ensure that the indicators are appropriate and meaningful for the specific policy context.

Therefore, the objective of D7.3 can be divided into several sub-objectives under the framework of Task 7.2 of the AGRICORE project as follows:

- To offer a brief description of the activities, the gathered data, and stakeholders engagement for each utilized use case, namely UC1: M11 – Ecologic agriculture in Andalusia, UC2: M10.1 – Agri-environment-climate commitments in Poland and UC3: M6.1: Start-up aid for young farmers in Greece.

- To present a spectrum of available scopes of ex-ante and ex-post impact assessments for each use case.

- To present a set of available indicators for the impact assessment for each use case.

- To offer a selection of the main scope(s) and indicators for the ex-ante and ex-post impact assessment.

Moreover, these sub-objectives are complemented by the description of the fourth use case in the Emilia Romagna region (NUTS-2) in Italy, which has been designed to test the core of the AGRICORE modelling approach in the short-term period based exclusively on FADN data.

1.3 Structure

According to the contents of Task 7.2, the present deliverable is structured in six parts as follows. The first part focuses on the introduction to the deliverable and its connections with relevant tasks and deliverables of the AGRICORE project. The second section includes a brief revised description of each of the use cases, together with a summary of the related activities so far, the conduction of the pilot survey and the participatory research, the collected data as well as the stakeholders' engagement. The third part of the deliverable is setting the available scopes of ex-ante and ex-post impact analysis for each use case. Furthermore, the fourth part is setting the available indicators for impact assessment. Section 5 summarises the inclusion of the selection of the main scope and indicators for the ex-post and ex-ante analysis, and the sixth part is the conclusions.

1.4 Deliverable connections

Deliverable 7.3 belongs to Task 7.2 of the AGRICORE WP7 – Use case demonstrations. Following the activities foreseen for the realisation of the AGRICORE project, the present deliverable is connected with other deliverables in two ways. On the one side, a clear connection can be traced with the deliverables of the WP5 (Policy impact assessment). Deliverables 5.4 - Environmental and climate impact assessment module as well as Deliverable 5.5 - Socio-economic impact

assessment module are relevant to the activities of the present deliverable and relevant task (7.2). Moreover, on the other side, the present deliverable is directly connected with Task 7.5 – Building of use cases and the subsequent deliverable 7.6 – Report on the use case building as well as with Task 7.6 – Ex-ante and ex-post impact assessment and the respective Deliverable 7.7. Finally, this deliverable is closely related to D7.2, which is also submitted in M48, because both deal with similar content but under different frameworks.

2 Revised description of the use cases

In this section, a revised description of the contents of each use case is presented, considering the advancement and research activities carried out so far. Firstly, for each use case, the analysed measure is briefly described, coupled with its requirements and provisions for each farmer. Secondly, for each use case separately, a summary of the activities done so far is presented. The activities focus on the research activities performed for the UCs ex-post impact assessments, which are focused on the identification of information gaps produced after the collection of available data for each use case, the design of participatory research and the relevant engagement of stakeholders, the conduction of a pilot survey that pre-tested the developed questionnaires and the final conduction of the participatory research coupled with a brief description of the gathered data, information and elements for each use case.

2.1 UC1: M11 – Ecologic agriculture in Andalusia

2.1.1 Brief overview of the use case

The use case focused on Andalusia is based on the analysis of the impact of the regional measure M11, which focuses on a support measure for the cultivation of organic olive groves. Andalusia is used as the main focus, as it is one of the most representative regions of the olive sector both nationally and internationally, representing 14% of the cultivation areas in the world.

Measure M11 is made up of several sub-measures, among which the following stand out: measure 11.1.2, benefiting the conversion from conventional to organic olive groves and measure 11.2.2, where the maintenance of organic olive grove cultivation is rewarded. The conditions and requirements for accessing this measure have already been described in previous deliverables (D7.1), although the most important ones are [2]:

- To be an active farmer.
- Be registered in SIPEA (Information -system for organic Production in Andalusia) and REAFA (Andalusian Register of Agricultural and Forestry Holdings).
- Have at least one hectare under cultivation.

This measure has had, until now, three calls defined in a time frame between 2014 and 2021. To be more precise, the measure had a call in 2015 [2], another in 2018 [3], which only contemplated measure M11.2.2. and a last call in 2021 [4], delayed from 2020 due to the Covid-19 situation.

One of the objectives of the project concerning this use case is to make an ex-post analysis (2014-2017) and an ex-ante analysis (2018-2020). As written in previous deliverables (D7.1 and D1.7), the ex-post analysis is done through participatory research, carefully defined and planned for later interpretation. In the case of the ex-ante analysis, it will be carried out after the design of the AGRICORE tool in order to evaluate the policy impact and the accuracy of its outputs.

2.1.2 Summary of activities so far

Within the ex-post analysis of this use case, participatory research has been highlighted, which consists of two fundamental parts. On the one hand, the collection of the required information included in European, national, regional and even provincial databases. On the other hand, the development and implementation of questionnaires addressed directly to farmers, whose main objective was to collect all the information not available in the databases, which is important for establishing a framework for the situation.

In the first approach, the main information gaps to be filled with the data gathered through the survey campaign were:

- Risk aversion.

- Geolocation of coordinates and plot area.

- Biomass level.

- Crop age.

- The working calendar for the cultivation of the real olive grove.

- And the operating costs.

The design and development of the survey campaign were rigorously defined in D1.8.

2.1.3 Conduction of pilot survey

ECOVALIA was in charge of conducting the pilot survey campaign through a small proportion of the target population. As a result, the following conclusions were drawn:

- The questionnaires were too long, especially to answer them by phone as was first proposed.

- Some questions needed more visual explanation in order to be fully interpretable.

- Most of the farmers were not aware of some of the questions described, such as belonging to a protected area or RAMSAR area.

These findings were taken into account when conducting the participatory research.

2.1.4 Conduction of participatory research

After the pilot campaign, the planning of the survey campaign was revised, and the surveys were modified in accordance with the conclusions described above so that the survey campaign was carried out in person, ensuring that there was visual support and that all the questions were well interpreted. On the other hand, the length of the questionnaires was reduced so that the interview did not last more than 20 minutes. Finally, alternative answers were defined for those questions that the farmer was not able to answer, including the possibility of a double answer from the technical advisors as part of a corrective measure for the risk of loss of information.

As mentioned above, the distribution of the surveyed population was defined based on two criteria. The first is to have registration of organic crops in SIPEA in the 2014-2018 timeframe. According to this platform, the number of surveys of organic farmers was established, representing 10% of the organic olive farming registrations in the aforementioned timeframe, which translates into approximately 200 surveys. Secondly, in Andalusia, there is an action plan on the Andalusian olive grove that positions and characterises the type of exploitation according to structural variables (Andalusian Olive Grove Master Plan), among which the plantation density and the average slope of the land where it is located stand out. According to these variables, 6 different typologies are distinguished, among which, from the participatory research, 4 typologies have been defined, combining in one type 3-4 and in another type 5-6 due to their limited representativeness in the system and their similarity between the variables. This was taken as the second criterion to define the distribution of the surveyed farmers, resulting in 105 surveys of typology 1, 22 surveys of typology 2, 46 surveys of typology 3-4, and 16 surveys of typology 5-6.

The survey design was based on the model presented in previous years by Carlos Parra [1] in order to be able to establish a historical relationship between the results. In addition, other

sections have been added, such as innovativeness or risk aversion. The survey is based on 10 sections, which are listed as follows:

- Section 1: Information about the participatory research itself.

- Section 2: Personal details of the interviewee.

- Section 3: Farm data.

- Section 4: Data on the farm dedicated to organic olive groves.

- Section 5: Dedication of the interviewee to agriculture.

- Section 6: Dissemination process. Phases from awareness to adoption or rejection.

- Section 7: Balance of the conversion to organic.

- Section 8: Measurement of innovation on your farm through a multi-item scale.

- Section 9: Average Risk Aversion on your farm.

- Section 10: Respondent's attitude towards organic farming as an innovation.

The surveys were carried out by our own sectoral technicians from CAAND and technicians associated with other agricultural entities (OPRACOL and other olive farming cooperatives).

2.1.5 Description of gathered data, information and elements

As mentioned before, the sample population for the Andalusian Use Case was composed of 200 olive farmers, approximately 10% of farmers who converted to organic production between 2014 and 2017. Moreover, an additional set of 100 surveys were conducted on conventional olive farmers in order to compare their profiles and obtain enriched datasets. Both sample populations were surveyed according to the same distribution based on the type of olive farm described in D7.1.

The survey campaign started in September 2021 and lasted until approximately July 2022. In this period, 189 surveys were addressed to farmers with organic olive holdings and 106 to farmers with olive holdings in conventional production, which fits with the initial objectives of the survey campaign. These surveys have been grouped by the type of olive exploitation according to the typology defined in the Master Plan for the Andalusian Olive Grove [5] (Table 1). The surveys were carried out by technicians with knowledge of the farms deployed in the previously selected areas, according to the type of olive grove. Several cooperative organisations took part in the campaign.

Table 1. Number of organic olive grove surveys according to the typology defined in the Master Plan for the Andalusian Olive Grove.

ORGANIC OLIVE GROVE	Type	Nº conversions	Surveys
1. Low-yield olive grove	1	1053	105
2. High-slope olive grove	2	220	22
3. Extensive olive grove with a density of ≤150 olive trees/ha	3-4	461	46
4. Extensive olive grove with medium density			
5. Intensive olive grove	5-6	164	16
6. Super-Intensive olive grove			

The surveys were carried out in person, and the following procedure was established. The respondent is informed about a brief description of the project, its objectives and the purpose of the collected data. Furthermore, the respondent is informed that the survey is completely

anonymous (first section of the questionnaire) and that the information collected will be used for the purposes indicated in the Grant Agreement of the project. Once this has been read, if the person surveyed agrees, the survey is carried out, thus accepting their consent to do so. In parallel to the survey campaign, the monitoring has been carried out during the 10 months of the survey campaign, with a monthly review with the technicians responsible for the action. Controls were carried out by telephone, and documentation was continuously received for preliminary analysis.

The details of the information obtained and the results are presented in D7.4, but in summary, the relevant information has been obtained for the tool. There is only one section of information that has not provided the expected information. This is section 7, on the balance of operating costs, which is not of vital importance for the tool due to the access to FADN data. The interpretation of the development of the surveys shows a certain tendency for farmers to restrict information by not giving costs or benefits, any economic attempt to give their answer. Others are not even aware of the costs of their production.

2.1.6 Engagement with stakeholders

Almost from the beginning of the project, the search for potential stakeholders began. These are entities or organisations that, in one way or another, are directly or indirectly affected by the results of this project. Beyond the results, many of them have collaborated directly in the collection of information necessary for the construction of the modules. Other organisations have collaborated directly with access to information that is not restricted but difficult to access in public databases. Therefore, a table of collaborating organisations and/or entities was established. The table can be found in D7.1 of this project, but in summary, the most relevant figures interested in the tool are listed below:

- Regional Ministry of Agriculture, Fisheries, Water and Rural Development (policymakers).
- Research institutions such as the Institute of Agriculture and Fisheries (IFAPA) (researchers).
- Organic certification bodies (field technicians).
- University of Seville (researchers).
- Agricultural associations (ECOVALIA, OPRACOL, OLIPE) (farmers).

The commitment of the stakeholders has come from their collaboration with the project. This commitment has been a link between different types of administrations and CAAND, which have established close contact in order to continue with the objectives of the project, even when the collaborative action has come to an end. Once the contact and the lines of collaboration have been established, some of them already finalised, an extra-official confirmation via e-mail describing the commitments acquired with the tool will be drawn up with the WP8 leader colleagues, which could contain the following points, for example impact checks on changes in subsidies, or the probabilities of new users of the subsidy, or the establishment of different scenarios to check the variability of the market price of some agronomic products, commitment to feedback on information obtained or opinions on the matter, etc.

2.2 UC2: M10.1 – Agri-environment-climate commitments in Poland

2.2.1 A brief overview of the use case

The Polish agricultural area amounts to almost 16 million hectares, which is approximately half of Poland's territory, with 90% of them standing in good agricultural condition. The Polish agricultural sector consists of almost one million and a half farms, with an average area of 10 hectares. Only half a million hectares are under organic farming. Nearly 62.5% of the Polish

agricultural land is classified as areas with natural constraints, and slightly more than 10% of Poland´s greenhouse gas emissions come from the agricultural sector. Moreover, almost 20% of arable land faces environmental challenges, most of them related to water and/or wind erosion and nitrate pollution. Regarding livestock, almost half of the livestock units are cattle, and the other half is divided mainly between pigs and poultry. Finally, in the socio-economic aspect, there are 2.4 million workers on farms. In the rural areas, where the farms are located, the distribution of the population's age is 15% people over 64 years old and 16.4% people under 15 years old.

The M10 action, being part of the EU and national strategic legal frameworks, deals with promoting practices contributing to sustainable land management and protecting landscape diversity, valuable natural habitats, and endangered species of birds. In the M10 "Agri-environment-climate commitments", two sub-measures can be distinguished, and the Polish Use Case study is focused mostly on analysing the effects of sub-measure 10.1 "Payments for Agri-Environment-Climate Commitments". Up to 2020, nearly 430 thousand applications were submitted to the sub-measure. The total amount of subsidies paid to farmers was equal to 1,085 million EUR. As is shown in Table 2, the subsidies the farmers could obtain range from ~100 EUR/ha up to ~500 EUR/ha after fulfilling commitments specific to each of the 5 packages.

The support under the measure may be used by a farmer conducting agricultural production in natural areas, i.e. non-agricultural land, on which there are certain types of natural habitats or bird nesting habitats[6]. So far, six application campaigns have been carried out by the end of 2019[7]: from March 15 to July 10, 2015 (Campaign 2015), from March 15 to July 11, 2016 (Campaign 2016), from March 15 to June 26, 2017 (Campaign 2017), from March 15 to July 10, 2018 (Campaign 2018), from March 15 to June 25, 2019 (Campaign 2019), and in 2020. The number of farms being beneficiaries of the M10 action compared to the entire population of farms in Poland, on average (according to ARMA and FADN), is 99,891, which is about 14% of the total number of market farms (746,000), and 7,01 % of all farms in Poland (~ 1.4 million).

Table 2. Rural Development Program of Poland for 2014-2020. Measure 10.1: Agri-environment-climate commitments.

M10.1 Payment for Agri-Environment-Climate Commitments	Up to 2016	Up to 2017	Up to 2018	Up to 2019	Up to 2020
Budget (million EUR)	217	405	604	857	1085
Package				Subsidy	
1. Sustainable agriculture				86 €/ha	
2. Soil and water protection				97-140 €/ha	
3. Preservation of orchards with traditional varieties of fruit trees				423 €/ha	
4. Valuable habitats and endangered species of birds in Natura 2000 areas				129-280 €/ha	
5. Valuable habitats outside Natura 2000 areas				129-280 €/ha	

The AGRICORE Polish Use Case analyses the M10.1 measure influence on Poland, especially focusing on the enhancement of the ecosystem services and on the environmental and climate impacts. The ex-post analysis is planned for the period between 2014 and 2017, and the ex-ante impact analysis will be done for the period 2018-2020. To perform such analyses, the data from the Central Statistical Office of Poland, the agency for Restructuring and Modernisation of Agriculture (ARMA), and some secondary data from relevant publications will be used. The available data will be supplemented with the information available at the national and regional levels and by the execution of participatory research actions.

2.2.2 Summary of activities so far

Like the Andalusian Use Case, in the Polish Use Case, activities have focused on participatory research. The main purpose of these has been the collection of the necessary information, which

was not present in databases at the European, national and regional levels. Thus, for the development of the questionnaire, the following information gaps were detected:

- Risk aversion

- Innovativeness willingness

- Age, gender, education of decision-makers responsible for strategic decisions

- The legal form of entity

- Risk aversion of decision-makers

- Total number of employees

- Previous experiences of farmers resulting from participation in M10 action

- Type of the main production

- Size of farms

- The minimum size of plots

- Revenues obtained from agriculture that guarantee farmer's families' maintenance

- Ecosystem components existing on the farm being friendly for M10 action participation

- Size of parcels

- Location of a farm in relation to Nature 2000 areas

- Size of arable land area

- Special areas existing on the farm

- The profitability of participation in the M10 action

- Social/cultural impact being a barrier/chance to access M10 action

- Bureaucratic/institutional factors being barrier/chance to access M10 action

In D1.8, the first draft of the questionnaire, as well as the surveyed population, were defined and described. The design and development of the participatory research aimed to select a representative sample of the Polish farms' population to be surveyed.

2.2.3 Conduction of pilot survey

The pilot survey was conducted among a set of farmers and agricultural advisors from various regions of Poland, especially those with whom IAPAS and PBS had contact and cooperation in previous projects and other activities. The objective was to adapt the structure and the content of the questionnaire according to the detected issues in order to make it understandable to the participants. Firstly, the conduction of the pilot survey reinforced the initial idea of carrying out the survey campaign telematically due to the Covid-19 pandemic situation in Poland. Secondly, following the remarks of the pilot surveyors, some questions were modified or shortened to improve their clarity and to make them quicker to answer. Their remarks were also useful for the conduction of all stages of participatory research.

At this stage of the pilot surveys, some valuable comments from the stakeholders were obtained concerning the barriers for farmers to participate in the M10 action. They mainly referred to the problems of instruments being insufficiently suited to the varied conditions of farms in Poland, such as the type of production and specialisation, and the unprofitability coming from complying with certain obligations, such as the cropping plan, dates of sowing, catch crops use, bureaucracy and others.

2.2.4 Conduction of participatory research

The primary goal of the Polish Use Case is to analyse the effect of the M10 on the whole territory of Poland. Therefore, to ensure unbiased sampling for a population of farms in Poland, the Central Advisory Board in Brwinów was consulted, and based on their experience and the farmers' e-mail addresses list available to them, the questionnaires were distributed to the farmers from all voivodeships of Poland. To ensure that the responses were representative of the whole agricultural sector in Poland, several farm characteristics were compared to the existing statistical data. They are gender, age, the distribution of farms in 16 voivodships, and the percentage of the farms participating in M10 action from the total number of farms in Poland. Furthermore, it was assumed that the minimal return of the questionnaire survey guaranteeing the representativeness of selected features of the population of farms in Poland was 300.

The main change from the initial plan of the Participatory Research conduction was adjusting the way the survey responses were gathered to electronic distribution. The first stage of survey distribution did not fulfil the assumed minimal return level, and therefore, several activities were undertaken to gain new potential respondents. Invitations to fill in the survey were sent in the middle of October 2021 and resent two times, at the beginning of December 2021 and February 2022. The progress in the received responses was: 63 by 9th November 2021, 115 by 14th December 2021, and 260 by 11th March 2022. Due to the fact that the number of responses was still below the expected value (300 responses), it was decided to take additional measures: coordinators of Polish partners in LIFT H2020 were contacted to obtain the e-mail addresses of the farmers, who were surveyed in this project. In addition, it was decided that PBS and IAPAS will participate in the AGROTECH agricultural fair in Kielce (18-20 March 2022) to survey farmers directly. Several dozen responses were then gathered. Until now, **316** filled-in questionnaires have been obtained, which means that the assumed minimum of returns was reached.

The survey is based on 6 sections, which are listed as follows:

- Section I Information Card for the Questionnaire Under The Agricore Project on Participation In The Rural Development Program of The Polish Ministry of Agriculture and Rural Development for 2014-2020 (Measure M10 - Agri-Environment-Climate)

- Section II. Questions concerning the entity participating in the survey

- Section III. Questions for farmers beneficiaries of measure M10.1

- Section IV. Questions for farmers who are not beneficiaries of measure M10.1 or have withdrawn from measure M10.1

- Section V. Questions for farmers who intend to apply for funds under measures similar to measure M10 in the future

- Section VI. Supplementary material requirements to participate in activity M10

2.2.5 Description of gathered data, information and elements

The content of the questionnaire included the following groups of questions: characterisation of household's resources, household's location, natural and local ecological conditions, characterisation of the production type and level of income from farming, changes in land areas, special areas, types of agrotechnical systems, a level of mechanisation in a context of the possibility of environment and biodiversity protection, plans of machinery investment. Separately, two sets of questions were prepared for farmers being and not being beneficiaries of M10.1. They included a request for explaining the reasons for participation or not in M10 and questions about difficulties related to M10 commitments fulfilment. Moreover, the questions concerning the willingness of the farmers to participate in future agro-environmental measures were included in this part of the survey. The last part of the questionnaire was intended to assess

the level of innovativeness and risk aversion of a farmer using multi-point scale that considered many factors like: erosion control actions; use of irrigation practices on water-scarce farms; treatments preventing from air pollution by external factors; treatments preventing from soil pollution by external factors or soil degradation as a result of improper soil management; assuring animal breeding standards taking into account proper organic waste management and processing of methane; disease and/or pest control by plant cover and/or antagonistic fungi; innovation in automatic and/or smart field operations and/or smart animal production systems; use of integrated equipment for bunching, chopping and management of postharvest residues; use of mobile applications, including weather forecasting or machinery monitoring as an aid to agronomic practice; use of drones and other equipment for precision farming; implementation of business lines that represent alternative sources of income (eco-tourism, cosmetics, etc.); and conducting training courses for all an availability of Polish FADN types of personnel.

To reach the aims of the Polish Use Case, it is also necessary to use the information from different national-level databases, especially from the Polish FADN (Farm Accountancy Data Network). However, it occurred that obtaining representative sets of data from these sources was a big challenge. In 2021 and 2022, a number of efforts to obtain necessary data for the Polish Use Case were made. They consisted of countlessly repeated e-mails, telephone calls, and direct meetings with Dr Eng. Joanna Pawłowska-Tyszko, Head of the Department of Accounting for Agricultural Holdings (affairs of Polish FADN), Institute of Agricultural and Food Economics, National Research Institute, Warsaw, Poland. However, they were unsuccessful, and it was not possible to obtain appropriate micro farm data because of confidentiality and animosity requirements in sharing the data of the Polish farmers. To enable the sharing of this data, personal permission from the representatives of each of the ~12 thousand households would have to be obtained, which is not possible. Also, for the Polish Use Case, unstandardised input data are required, which need a special order to be sent to the corresponding services' staff of the Polish FADN authority, and it is not free of charge due to the laboriousness of the dataset modification process.

Hence, after direct negotiations with FADN responsible staff, only the data for around 140 variables in aggregated form (averages) for four macro-regions and/or voivodships could be delivered. Considering a very big spatial differentiation of natural conditions in Poland, e.g. in the context of the soil quality (so-called mosaicism of soils), such datasets are not useful for the AGRICORE ABM simulations, as they are not sufficient for the generation of the Polish synthetic population. Therefore, the mitigation actions were undertaken to obtain the needed data for Poland directly from the EU-FADN, and now, speeding up this request has become crucial.

2.2.6 Engagement with stakeholders

From the beginning of the project's performance, the search for its potential stakeholders began. These include entities or organizations that are directly or indirectly interested in the results of this project in one way or another. In addition to the results, many stakeholders collaborated directly in gathering the information necessary to build the modules. Other organisations have collaborated to access information that is not restricted but difficult to access in public databases. As a result, a table of cooperating organisations and/or entities was created, which can be found in D7.1 of this project. The most significant collaborations and data provision have come from the stakeholders listed below.

- **The Polish Ministry of Agriculture and Rural Areas Development**
- **Polish FADN**
- **Agency for Restructuring and Modernisation of Agriculture (ARMA)**
- **Agricultural associations:**
    - Association of Employers – Land Leases (ZPWiDR)

- o The Pig Breeders and Producers Association „POLSUS" Northern District based in Bydgoszcz Association

    - o Polish Club Farmer of the Year

    - o The Polish Society of Organic Farmers

- **Research Centres:**

    - o The Agricultural Advisory Center (AAC) in Brwinów

    - o The National Centre for Emissions Management (KOBiZE)

    - o Institute of Soil Science and Plant Cultivation (IUNG)

    - o The Institute of Technology and Life Sciences in Falenty, Poland

    - o The National Research Institute of Horticulture in Skierniewice, Poland

    - o National Chemical-Agricultural Station

    - o IAPAS researchers

    - o PBS researchers and students

The activity of the stakeholders resulted from their cooperation on the project. Such involvement allowed the combining of the interests of relevant representatives of the administration with agricultural organisations in order to continue achieving the project's goals, even after the end of the joint operation. Once contacts and lines of cooperation have been established, some of which are already finalised, an informal acknowledgement will be made describing the commitments acquired through the AGRICORE tool, such as controlling the impact of changes to grants or the likelihood of new grant users joining, or, e.g. decision and commitment to providing feedback on opinions or expertise obtained on a given issue, etc.

2.3 UC3: M6.1: Start-up aid for young farmers in Greece

2.3.1 Brief overview of the use case

The Greek Use Case analyses the sub-measure 6.1 "Start-up aid for young farmers", which is included in the national programme for the period 2014-2020. Particularly, this use case analyses the impact of the M6.1 application in Greece, focusing on the socio-economic aspects. The ex-post analysis will be done for the period 2014-2017, and the ex-ante impact analysis will be done for the period 2018-2020.

Over the last few years, the number of young farmers in several European countries has decreased due to technological, social and economic changes. Because of the aforementioned fact, the European Union Common Agricultural Policy (EUCAP) has been more active in targeting generational renewal, providing member countries with funding instruments to support young farmers in the setting up, viability and future sustainability of their activity. The young farmer payment is given to farmers of no more than 40 years old who are setting up, for the first time, an agricultural holding and as head of the holding or who have already set up an agricultural holding during the 5 years prior to their first application to the scheme.

The main national priorities of young farmer schemes for Greece are the enhancement of farm viability and the competitiveness of all types of agriculture. Particularly, Sub-Measure 6.1, "Start-Up Aid for Young Farmers," of the 2014–2020 Greek Rural Development Programme targets the restructuring of the agricultural sector and the modernisation of the rural population. Unambiguously, the modernisation of the industry is a key factor in attracting the relatively higher-educated and skilled youth of future generations. For instance, it is more likely for higher-

educated and skilled young farmers to adopt new technologies and innovative farming techniques (smart farming). Moreover, certain factors, such as access to finance, land and knowledge, in combination with higher-educated and skilled farmers, can increase the so-called competitiveness of farms.

In this context, the Young Farmers Aid Program aims to enhance the competitiveness of agricultural holdings through age renewal and the creation of farmer entrepreneurs who, with the end of the support, will have adequate supplies and sustainable holdings. To this extent, Sub-measure 6.1 of the Rural Development Programme 2014-2020 aims to provide the key that can help unlock the access to finance, land, and knowledge that the new generation requires when setting up and operating their businesses.

The criteria for persons to be eligible for Sub-measure 6.1 "Start-Up Aid for Young Farmers" (refer to the second call for the period of 2016–2021) according to the MRDF (2021) are presented in the following figure (Figure 2).

Figure 2. Entry eligibility conditions.

The criteria for the level of available financial aid to young farmers are presented in Figure 3.

Figure 3. Level of the available premium amount to young farmers.

The level of subsidy ranges from 17.000 to 22.000 euros, and it is differentiated according to the type of activity and the type of area of their residence. Particularly, the minimum subsidy of 17,000 euros could be increased to 19,500 euros in case of exclusively livestock production or in the case where the permanent residence of the beneficiary is located in a mountainous and less favoured area. In the circumstance that a beneficiary meets the aforementioned criteria in combination, s/he grants the maximum level of 22,000 euros.

2.3.2 Summary of activities so far

The Greek Use Case employed a combined approach regarding the activities conducted so far. Firstly, considering the pivotal importance of a sample that is as representative as possible, we requested access to the non-public data provided by the beneficiaries of Sub-measure 6.1 on their applications through the Ministry of Rural Development. This fact allowed us to have a comprehensive picture of the real population of the beneficiaries. Secondly, in-depth interviews were conducted with executives of the managing authority of the "Rural Development Program 2014-2020" and also with trainers of young farmers seminars and young farmers' unions. The third approach was a questionnaire survey aiming to directly identify the attitudes and perceptions of the young farmers. The questionnaire was distributed to beneficiaries and non-beneficiaries of the measure. Like the other two use cases, this questionnaire allowed for gathering data that were not included in the available databases, which, for the Greek Use Case were:

- Young farmer's motivation.

- Beliefs about Young Farmers Scheme.

- Beliefs about the farming sector in general.

- Beliefs concerning Young Farmer's future in Agriculture.

2.3.3 Conduction of pilot survey

The questionnaire was pre-tested on a limited sample of young farmers, who agreed to complete it and comment on its comprehensibility and clarity of questions, technical performance, and usefulness of instructions. During this process, the average time for the questionnaire completion was also checked. Particularly, the pilot survey was conducted in the region of West Macedonia (NUTS II) in March 2021 on a sample of 30 young farmers who were beneficiaries of Sub-measure 6.1 "Startup aid for young farmers". The selection of the respondents was made by using a convenience sample. The execution of the pilot survey led to modifications and adaptations of the questionnaire, which referred mainly to the clarification of some of the questions. The need to reduce the extension of the questionnaire arose from the above-mentioned process.

2.3.4 Conduction of participatory research

In-depth interviews with stakeholders were performed in 2021, which aimed at the collection of qualitative data. The interviews were carried out through open-answer questions which included points relevant to the previous experiences of the stakeholders from the implementation of young farmers schemes and also questions in which the interviewee had to note down opinions and estimations for the main profile of the young Greek farmer, the problems they encounter, as well as the estimated perspectives for their future. The aim of these interviews was to describe the implementation of the young farmers' policy measures and the recognition of possible problems linked to the "satisfaction" of the young farmers. The results of the qualitative survey were utilised for the formatting of the questionnaire employed in the subsequent quantitative survey.

The synthesis of the sample is described in the following lines. A percentage of 81% of the sample includes young farmers who are beneficiaries of Sub-Measure 6.1, selected over the total population of 13.905 beneficiaries in Greece. The rest of the sample (19%) originates from the population of non-beneficiaries. This strategy (difference in proportion) is justified on the basis that the young farmers who are beneficiaries of Sub-measure 6.1 are the main recipients of the relevant policies' effects, and consequently, their opinions matter more than the non-beneficiaries opinions. Furthermore, the sample of the beneficiaries was related to the size of the real population of beneficiaries among the 13 Greek regions according to the NUTS 2 classification (see Figure 4). The non-beneficiaries are allocated in the sample in accordance with the allocation of the beneficiaries since there is no detailed data for the spatial allocation of their population.
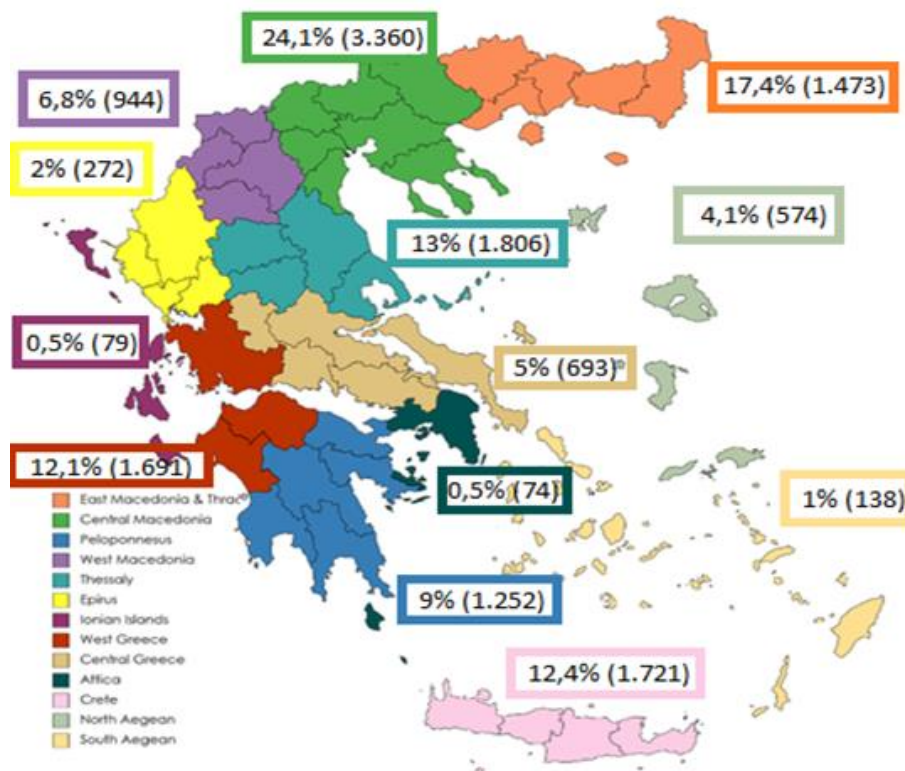
Figure 4. Spatial allocation of beneficiaries' population among the 13 Greek regions (NUTS II).

The quantitative survey was held from 1 January to 30 May 2022. Questionnaires were applied to 445 farmers, of which 433 were evaluated as reliable. 352 of the respondents were young farmers who were beneficiaries of Sub-measure 6.1, whereas 81 of them were farmers who were not interested in participating or farmers who were interested in participating in Sub-measure 6.1 but somehow did not proceed. It should be emphasised that the total of the respondents met all the criteria to be eligible for the Sub-measure. The largest part of the questionnaire was made up of structured questions with preconceived answers to guarantee that all questions were asked in a fixed manner and to make it possible to analyse the data in a statistically sound way. The questionnaire was distributed to beneficiaries and non-beneficiaries of the measure, and it is divided into 3 sections, which required about 10 minutes to complete. The sections are:

1. Socioeconomic data.

2. Technical and accounting aspects of agricultural holdings.

3. Young farmers' attitudes, beliefs and perceptions in the case of beneficiaries and non-beneficiaries of Sub-measure 6.1 "Startup aid for young farmers".

2.3.5 Description of gathered data, information and elements

In the framework of the Greek Use Case, the gathered data include:

- The latest available Greek Farm Accountancy Data Network (FADN) data for the period 2014-2018, which are presented in the D1.8 "Use Case Participatory Research Actions".

- The nonpublic data provided by the 13.905 applicants for participation in the Young Farmers Scheme in Greece in 2016.

- Primary qualitative data collected through interviews with stakeholders, which include issues relevant to their previous experiences from the implementation of young farmers schemes and also their opinions and estimations for the main profile of the young Greek farmer, the problems that young farmers encounter according to their knowledge, as well as the recognition of possible problems linked to the "satisfaction" of the young farmers from their participation in relevant measures.

- Primary quantitative data collected through the questionnaire survey, which deals with young farmer's motivation to be engaged in Sub-measure 6.1 "Startup aid for young farmers", their perceptions about Young Farmers Scheme, their beliefs about the farming sector in general and lastly, their perceptions concerning young farmer's future in Agriculture.

The combination of the abovementioned data, information and elements aims to generate a synthetic population for the Greek Use Case that will be used in the design of the AGRICORE tool. The results obtained from the analysis of these data and their interpretation are presented in D7.4.

2.3.6 Engagement with stakeholders

Following the aims of the Greek Use Case, the next stakeholders have been chosen so far:

- Greek Ministry of Rural Development and Food (Policymaker)

- Greek Government, Special Service for the Implementation of the Rural Development Program 2014-2020 (Policymaker)

- Panhellenic Union of Young Farmers (Farmers)

- Payment and Control Agency for Guidance and Guarantee Community Aid (Policymaker)

- Greek National Rural Network (Policymaker)

- ELGO - DEMETER - Hellenic Agricultural Organization- Demeter (Consultancy and advisory agency)

- East Macedonia Regional Unit Administration (Policymaker)

- Ergoplanning SA (Consultancy and advisory agency)

They are mainly executives of the managing authority of the "Rural Development Program 2014-2020" and also trainers of young farmers seminars and young farmers' unions. A detailed description of their engagement (reason for selection, key person for contact, contact status and approach, type of collaboration and expected impact on them) is provided in Table 28 of D1.8 and in Table 13 of D7.1.

3 Set of available scopes of ex-ante and ex-post impact analysis based on the research activities already done

3.1 UC1: Ecologic agriculture in Andalusia

As mentioned above, participatory research has two fronts for obtaining information. On the one hand, all the information available in public databases and on the other hand, surveys carried out directly in the sector to obtain information that is absent in the literature.

Based on this scheme, the Regional Government of Andalusia (*Junta de Andalucía*), together with the European Union, monitors and evaluates the results of the Rural Development Programme of Andalusia 2014-2020. To date, the latest publication of this report is from 2019, which compiles data up to 2018, so we can reflect its impact in the ex-post analysis [8].

This evaluation report is analysed based on responses to questions associated with RDP measures that have been conducted across the board with surveyed operations. In terms of the responses received, there is no defined number of responses corresponding to Measure 11 (M11) specifically, but a set of responses (1755) associated with agri-environment measures (M10, M11 and M13) were found.

In their evaluation report, they catalogue the responses to questions associated with different areas of interest or scopes. Thus, 30 associated questions revolve around the impact generated by the RDP on different actions:

1. Supporting innovation, cooperation and development of the knowledge base in rural areas.

2. Support for strengthening the links between agriculture, food production and forestry for research and innovation, and also for better management and environmental performance.

3. Support for lifelong learning and vocational training in agriculture and forestry.

4. Improving the economic performance, restructuring and modernisation of assisted farms, in particular by increasing their market share and agricultural diversification.

5. Support for the entry of suitably trained farmers into the agricultural sector and, in particular, for generational renewal.

6. Improving the competitiveness of supported primary producers by integrating them further into the agri-food chain through quality schemes, adding value to agricultural products, promoting local markets and short distribution channels, producer groups and inter-branch organisations.

7. Support for risk prevention and risk management at the farm level.

8. Support for the restoration, preservation and enhancement of biodiversity, Natura 2000 areas, areas with natural or other specific constraints and high nature value farming systems such as European landscapes.

9. Support for the improvement of water, fertiliser and pesticide management.

10. Support for the prevention of soil erosion and the improvement of soil erosion management.

11. Contribution to more efficient use of water in agriculture.

12. Contribution to more efficient use of energy in agriculture and food processing.

13. Contribution to the supply and use of renewable sources of energy, by-products, waste, residues and other non-food raw materials to support the development of the bio-economy.

14. Contribution to reducing GHG and ammonia emissions from agriculture.

15. Supporting carbon conservation and sequestration in the agricultural and forestry sectors.

16. Support for diversification, creation and development of small businesses and job creation.

17. Support for local development in rural areas

18. Improving accessibility to, use and quality of information and communication technologies (ICT) in rural areas.

19. Synergies between priorities and areas of interest.

20. Achievement of objectives set out in Article 59 of Regulation (EU) No 1303/2013 and Article 51(2) of Regulation (EU) No 1305/2013.

21. Achievement of the objectives set out in Article 54(2) of Regulation (EU) No 1305/2013.

22. Achievement of the headline target of the Europe 2020 strategy to increase the employment rate of the population aged 20-64 to 75 %.

23. Achievement of the Europe 2020 headline target of investing 3 % of EU GDP in research and development and innovation.

24. Contribution to climate change mitigation and adaptation, reduction of greenhouse gas emissions, increase in the share of renewable energies and increase in energy efficiency.

25. Contribution to the reduction of the number of Europeans living below the national poverty line.

26. Contribution to the improvement of the environment and biodiversity in order to halt the loss of biodiversity and the degradation of ecosystem services and to restore ecosystem services.

27. Promoting competitiveness in agriculture.

28. Ensuring sustainable management of natural resources and climate action.

29. Achieve balanced territorial development of rural economies and communities, including the creation and preservation of employment.

30. Promoting innovation.

Analysing all these areas, we have made a selection of all those in which the M11 is represented. In other words, the study that has been carried out in this area has taken into account the opinion through surveys of beneficiaries of Measure 11 of the RDP.

The areas available in the evaluation for M11 are:

• Support for the restoration, preservation and enhancement of biodiversity, Natura 2000 areas, areas with natural or other specific constraints and high nature value farming systems such as European landscapes.

• Support for improved management of water, fertilisers and pesticides.

• Support for the prevention of soil erosion and improvement of soil erosion management.

• Contribution to reducing greenhouse gas and ammonia emissions from agriculture.

• Supporting conservation and carbon sequestration in the agriculture and forestry sectors.

• Synergies between priorities and focus areas.

• Contribution to climate change mitigation and adaptation, reducing greenhouse gas emissions, increasing the share of renewable energies and increasing energy efficiency.

• Contribution to the improvement of the environment and biodiversity to halt the loss of biodiversity and the degradation of ecosystem services and to restore them.

- Ensuring sustainable management of natural resources and climate action.

- Encouraging innovation.

3.2 UC2: Agri-environment-climate commitments in Poland

The implementation of Measure 10 is aimed to contribute to the implementation of the objectives of the Nitrates Directive and the Water Framework Directive with attention to the positive impact on water quality. The implementation of the requirements is intended to enable rational and effective management of mineral components and limit their losses, which aims to reduce the pressure of nitrogen and phosphorus pollution of surface waters (runoff) and underground waters (leaching), which in turn contributes to the achievement of the objectives set out in the Water Framework Directive. Additionally, the territorial focus has been strengthened, including the specific needs of Natura 2000 areas (including areas of special protection for birds), national parks, areas exposed to pollution from agricultural nitrates (OSN), areas exposed to erosion factors and areas with low humus content in the soil.

The impact generated by the M10 revolves around the 3 main areas:

1. The promotion of key mitigation practices contributing to the improvement of the sector's resilience to climate change:
    - Preservation of permanent grasslands (all packages),
    - Improvement of the balance of organic matter, especially through crop rotation (Package 1),
    - Introduction of the catch crops as a soil cover in particularly vulnerable areas, areas at risk of erosion, and areas with low humus content (Package 2),
    - Optimization of fertilization, e.g. through a fertilization plan (Package 1), to reduce air pollution by limiting the release of nitrogen oxides into the atmosphere related to excessive and irrational use of nitrogen-containing fertilizers,
    - Extensification of production inside and outside the Natura 2000 areas (Package 4 and 5),
    - Preservation of old traditional orchards (Package 3),
    - Preservation of plant and animal genetic resources (Package 6 and 7).

2. Contribution of action to prevent soil erosion:
    - Promotion of the proper crop rotation, crop diversification, and catch crops,
    - Preservation of permanent grasslands, landscape elements, afforestation of areas susceptible to erosion,
    - Maintenance of agricultural land management in accordance with the principles of good agricultural practice.

3. Contribution to the implementation of Natura 2000 objectives:
    - Protection of the valuable natural habitats and bird species in Natura 2000 areas,
    - Supporting the specific valuable habitats and endangered bird species,
    - The restoration of natural habitats by removing expansive species and alien invasive species,
    - Preservation of meadow habitats protected under the Habitats Directive in the bird special protection areas and the areas of EU Community importance,

- o Preservation of bird habitats in agricultural areas in the bird special protection areas and the areas of EU Community importance,

- o The restoration of natural habitats and habitats of species by improving water conditions,

- o The restoration of natural habitats by removing the seedlings of trees and shrubs from non-forest areas,

- o The restoration of natural habitats through reed mowing,

- o Protection of valuable habitats of traditional farming in regions with a mosaic structure of agriculture,

- o Protection of valuable habitats with a high share of permanent grasslands,

- o Protection of valuable habitats with the presence of wetlands whose a large part is located in Natura 2000 areas.

3.3 UC3: Start-up aid for young farmers in Greece

Measure 6.1 "Start-up aid for young farmers in Greece" of the 2014–2020 Greek Rural Development Programme targets the restructuring and modernisation of the agricultural sector and the rural population of Greece. In particular, as stated in the Rural Development Programme 2014-2020 for Greece, compiled by the Greek Ministry of Rural Development and Food and approved by the EU Commission, the measure is overall linked with the development of entrepreneurship in rural areas as well as the creation and the maintenance of significant employment levels that ensure the viability of rural areas and rural populations.

The main direction of the measure revolves around three specific guidelines:

- Targeted support for competitive and export-oriented economic sectors such as the agricultural sector.

- Creation of viable employment levels in the rural areas and in the particular interception of unemployment with emphasis on the unemployment of the young population (under 40 years old).

- Social and economic revitalisation of the rural communities with emphasis on the areas under physical or natural constraints.

Based on the Rural Development Programme 2014-2020 for Greece, the scope of the measure can be associated with twenty-nine (29) specific areas – targets:

1. Augmentation of the physical and economic size of agricultural holdings of Greek agriculture with overall scope for the improvement of agricultural labour productivity.

2. Improvement of efficiency and effectiveness of water use in agriculture.

3. Limitation of soil erosion on agricultural and forest land.

4. Increasing the added value of produced agricultural products.

5. Promotion and integration of innovation in the production and processing of agricultural products.

6. Mitigation of the risk associated with land abandonment, especially in areas that are mountainous or facing natural constraints.

7. Ensuring the age renewal in agriculture.

8. Conservation of biodiversity in agricultural and forest land.

9. Addressing the observed low levels of professional education and relevant skills of those employed in the agricultural sector.

10. Reversal of the re-investment conditions in agriculture.

11. Improvement of the attractiveness of rural areas and viable investment attraction in agriculture.

12. Mitigation of risks associated with the quality of water due to agricultural activities.

13. Improvement and empowerment of the role of producers in the food value chain.

14. Fostering the creation of effective transferring mechanisms for the relevant R&D activities and technical support through consulting with the agricultural sector.

15. Fostering the capacity of agricultural and forest land to bind carbon emissions.

16. Tackling poverty and the phenomenon of social exclusions in rural areas.

17. Saving energy and exploiting renewable sources' potential in agriculture.

18. Containment of and further reductions in agriculture-produced greenhouse emissions.

19. Support the agricultural sector from natural disasters.

20. Improvement and preservation of areas that are characterized as areas of high natural value and special rural landscapes.

21. Improving the economic and/or environmental performance of economically viable agricultural holdings.

22. Upgrading basic infrastructure to improve the quality of life for the residents of rural areas.

23. Fostering digital transformation of rural areas and improvement of access to high-speed networks.

24. Highlighting the cultural and natural richness as well as the local identity of the rural areas.

25. Managing agricultural and forest land in areas that are characterized as protected.

26. Unleashing the development potentials of the rural areas.

27. Improvement of the basic infrastructure in rural and forest areas.

28. Supporting the agricultural sector with small agricultural enterprises with modern and innovative financial instruments.

29. Supporting farmers with modern and effective tools that will intercept or manage risk in agriculture.

4 Set of available identified indicators for impact assessment per use case

4.1 UC1: Ecologic agriculture in Andalusia

The set of available indicators is also based on the same dynamics as above, in which, according to the assessment questions that have been established and the criteria of judgement that have been given to carry out the assessment, a series of common indicators have been provided. In this case, all available indicators that measure the areas related to Measure 11 have been gathered. These are presented in Table 3 with the following information: the judgement criteria (DEFINITION OF CRITERIA) that have been determined for the assessment of this area and the result indicators (INDICATOR) that have been used for each judgement criterion. This table has been designed and modified from Table 19 (Evaluation Matrix) of the document evaluating the results of the Andalusian RDP (2014-2020), selecting the critical points where Measure 11 has been taken into account [8].

Table 3. Available KPIs for the impact assessment of the Andalusian Use Case.

Indicator	Definition of criteria	Ex-ante/Ex-post
Percentage of forest area protected by risk prevention actions	Actions carried out that have enabled biodiversity to be maintained, preserved or restored	Ex-ante/Ex-post
Amount spent on actions carried out that have made it possible to maintain, preserve or restore biodiversity		Ex-ante/Ex-post
Number of farms that have developed activities to enhance their natural value		Ex-ante/Ex-post
Number of actions in the network of livestock trails, greenways or similar		Ex-ante/Ex-post
Population affected by plans for the development of municipalities in rural areas, affecting Natura 2000 sites and other areas of high natural value/management plans for NPAs and other areas of high natural value/land use planning		Ex-ante/Ex-post
Number of holdings in organic farming: maintenance and conversion		Ex-ante/Ex-post
Number of holdings according to LFA typology		Ex-ante/Ex-post
Number of subsidised hives		Ex-ante/Ex-post
Number of management contracts supporting biodiversity and/or landscapes		Ex-ante/Ex-post
Number of activities to balance the functions performed by forests and to provide ecosystem services		Ex-ante/Ex-post
Percentage of subsidised Average Livestock Unit (LU) of registered endangered breeds		Ex-ante/Ex-post
Percentage of agricultural land under management contracts supporting biodiversity and/or landscapes	The area where actions favouring biodiversity are	Ex-ante/Ex-post
Area under organic: maintenance and conversion		Ex-ante/Ex-post
Area of farms where agricultural activity has been encouraged or its abandonment has been prevented		Ex-ante/Ex-post
Area under beekeeping		Ex-ante/Ex-post
Forest area restored		Ex-ante/Ex-post
Area of sustainable crop systems		Ex-ante/Ex-post
Area of ecologically oriented mountain systems		Ex-ante/Ex-post

Forest area where activities have been carried out to balance the different functions performed by the forests and to provide ecosystem services	carried out has been maintained or increased	Ex-ante/Ex-post
Number of hours of environmental training by type	Capacities for the maintenance, preservation or restoration of biodiversity have been generated	Ex-ante/Ex-post
Number of participants in environmental training/demonstration and information/advice activities		Ex-ante/Ex-post
Amount of training/demonstration activities and environmental information/advice		Ex-ante/Ex-post
Percentage of training / training activities / hours of environmental training / counselling out of the total		Ex-ante/Ex-post
Percentage of agricultural land under management contracts to improve water management	Actions carried out have led to improving water management or maintaining conditions that contribute to water quality	Ex-ante/Ex-post
Amount spent on actions taken to improve water management to improve or maintain conditions that contribute to water quality		Ex-ante/Ex-post
Number of farms in organic farming: maintenance and conversion		Ex-ante/Ex-post
Number of farms according to LFA typology		Ex-ante/Ex-post
Number of management contracts supporting the improvement of water management		Ex-ante/Ex-post
Area in ecological: maintenance and conversion	The area where actions have been taken to improve water management in order to improve or maintain conditions that contribute to water quality has been maintained or increased	Ex-ante/Ex-post
Area of sustainable arable crop systems		Ex-ante/Ex-post
Area of sustainable woody crop systems		Ex-ante/Ex-post
Area of ecologically oriented mountain systems		Ex-ante/Ex-post
Percentage of agricultural land subject to management contracts to improve soil management and/or prevent soil erosion	Actions carried out that have led to improved soil management	Ex-ante/Ex-post
Number of management contracts to improve soil management and/or to prevent soil erosion		Ex-ante/Ex-post
Number of farms that have developed demonstration activities and environmental information/advice		Ex-ante/Ex-post
Percentage of forest area protected by risk prevention actions	Actions carried out have prevented soil erosion	Ex-ante/Ex-post
Ecological surface area: maintenance and conversion		Ex-ante/Ex-post
Area of sustainable arable crop systems		Ex-ante/Ex-post
Area of sustainable woody crop systems		Ex-ante/Ex-post
Area of ecologically oriented mountain systems		Ex-ante/Ex-post
Area of holdings where agricultural activity has been encouraged or its abandonment has been avoided		Ex-ante/Ex-post
Subsidised area on which the soil structure is potentially improved (amendments, pruning residues, burying, etc.)		Ex-ante/Ex-post
Subsidised area on which vegetation cover is to be left		Ex-ante/Ex-post
Livestock load (number of heads, species and age)		Ex-ante/Ex-post
Reduction of methane and nitrous oxide emissions	Area with agricultural practices that reduce GHG emissions increases	Ex-ante/Ex-post
Sustainable production area		Ex-ante/Ex-post
Organic production area		Ex-ante/Ex-post
Reduction of ammonia emissions		Ex-ante/Ex-post

Reduction of greenhouse gas emissions	Greenhouse gas and ammonia emissions from agriculture have been reduced	Ex-ante/Ex-post
Total forest area contributing to carbon conservation and sequestration (direct effect)		Ex-ante/Ex-post
Total forest area contributing to carbon conservation and sequestration (indirect effect)	Carbon sequestration and conservation have been promoted	Ex-ante/Ex-post
Total agricultural area contributing to carbon conservation and sequestration		Ex-ante/Ex-post
Total area contributing to carbon conservation and sequestration		Ex-ante/Ex-post
Emissions from agriculture: greenhouse gas emissions and ammonia emissions	The RDP has focused on climate change mitigation and adaptation in the agriculture, forestry and food sector	Ex-ante/Ex-post
Percentage of reduction of tonnes of Greenhouse Gases		Ex-ante/Ex-post
RDP agricultural and forestry area contributing to GHG reduction		Ex-ante/Ex-post
Farmland Bird Index (FBI)		Ex-ante/Ex-post
High Nature Value Agriculture (HNVA)	Biodiversity and ecosystem services have been impacted	Ex-ante/Ex-post
Percentage of area with biodiversity impact in relation to UAA and regional forest area (main and secondary)		Ex-ante/Ex-post
Ecological surface area with respect to the total regional UAA		Ex-ante/Ex-post
Water catchment in agriculture		Ex-ante/Ex-post
Water quality	Riparian ecosystems have been protected from agricultural activities (ecological flow) and pollution	Ex-ante/Ex-post
Percentage of area supported for the improvement of water use efficiency in relation to the total UAA		Ex-ante/Ex-post
Percentage of water savings by regional farms with respect to regional consumption		Ex-ante/Ex-post
Soil organic matter in cropland	The soil resource that is vital for ecosystems has been protected and soil loss has been halted	Ex-ante/Ex-post
Soil erosion due to water action		Ex-ante/Ex-post
Area of operations that include practices that decrease erosion		Ex-ante/Ex-post
Emissions from agriculture	Greenhouse gas and ammonia emissions from agriculture have been reduced	Ex-ante/Ex-post
Agricultural land bird index	The rate of farmland birds has increased or been maintained	Ex-ante/Ex-post
Agriculture with high nature value	Percentage of cropland AVN increased or maintained	Ex-ante/Ex-post
Water quality	Water quality has improved	Ex-ante/Ex-post
Area of actions driving fertiliser reduction		Ex-ante/Ex-post
Soil organic matter in arable land		Ex-ante/Ex-post
Area of actions promoting crop rotations	Soil organic carbon content has increased	Ex-ante/Ex-post
Surface area promoting the improvement of soil organic matter (chopping of residues, fallow land, the inclusion of leguminous plants, burying of residues, direct sowing, maintenance of vegetation covers, etc.)		Ex-ante/Ex-post

		Ex-ante/Ex-post
Surface area of actions that promote the maintenance of vegetation covers		Ex-ante/Ex-post
Soil erosion by water action	The share of the agricultural area affected by soil erosion caused by water has been reduced	Ex-ante/Ex-post
Area of forest improvement		Ex-ante/Ex-post
Introduction of new production techniques	Encouraging innovation by boosting the internal capacity of actors to develop their knowledge and innovation and by encouraging cooperation to experiment and make use of new ideas	Ex-ante/Ex-post
Production and exploitation of new products		Ex-ante/Ex-post

4.2 UC2: Agri-environment-climate commitments in Poland

The challenges in disseminating the concept of ecosystem services (ES) under EU regulations have led to the creation of numerous measures and indicators for assessing their level as well as tools for mapping and modelling. However, the interdisciplinary nature of the ES concept, including both agricultural production and the state of the environment, as well as its landscape and aesthetic values, means that the ES measures and indicators represent different ways of describing the matter to be analysed. Problems with an objective assessment of ecosystem services resulting from limited availability of the data, models and tools and a context of their usage were the reason to make an attempt to define solutions that can, in a limited way, support an assessment of ES development in Poland. The proposal of the below indicators is to demonstrate the possibility of shaping the level of individual types of ecosystem services in particular categories by regulating indicators that can be established under the Common Agricultural Policy. Presented ways of measuring particular factors include both qualitative and quantitative assessments. It was assumed that the research would lead to the identification and delivery of key performance indicators (KPIs), the universal ones that can be included in the module for modelling ecosystem services.

Presented indicators were grouped into EU subsidy indicators, agricultural productivity indicators, agricultural production space valuation indicators, soil quality indicators, natural environment quality assessment indicators and cultural ecosystem services indicators. The indicators were taken directly or calculated independently, mainly using the databases of the Central Statistical Office, Warsaw and the publications of IUNG-PIB in Puławy. The list of indicators is included in Table 4.

Table 4. Available indicators concerning eco-services.

Indicator	Definition	Ex-ante/Ex-post
EU subsidies for investment	Value of Rural Development Programme subsidies for investments in PLN /1 ha of Agricultural Land	Ex-ante/Ex-post
EU subsidies for M. 10	Value grant of M.10 in thousand PLN per person	Ex-ante/Ex-post
Agricultural productivity concerning cereals	The share of cereals in the structure of crops %	Ex-ante/Ex-post
	The share of cereals and rape in the sown structure %	Ex-ante/Ex-post
	Cereal yields in dt/ha (t*10^{-1})	Ex-ante/Ex-post
Agricultural productivity concerning root crops and vegetables	The share of potatoes, sugar beet and vegetables in the sown structure %	Ex-ante/Ex-post

Agricultural productivity concerning animals	Animal cast at Large heads index/100ha	Ex-ante/Ex-post
	Unit milk yield in thousand litres	Ex-ante/Ex-post
Agricultural productivity of land	Commodity production in thous. PLN/ha of Agricultural Land	Ex-ante/Ex-post
Inputs concerning land	Mineral nitrogen fertilisation in kg/ha of Agricultural Land	Ex-ante/Ex-post
Agricultural production space valuation	Index of agricultural production space valorisation (points)	Ex-ante/Ex-post
	Valuation index of Agricultural Land (0-1)	Ex-ante/Ex-post
	Indicator of the agroecological potential of agriculture (1-5)	Ex-ante/Ex-post
Assessing the quality of soils	% share of soils with a favourable pH above 5.5	Ex-ante/Ex-post
	% of soils with favourable fertility P	Ex-ante/Ex-post
	% of soils with favourable fertility K	Ex-ante/Ex-post
	Organic matter content in %	Ex-ante/Ex-post
	Soil humus index % of Agricultural Land	Ex-ante/Ex-post
	Gross Nitrogen Balance Income - expenditure in kg/ha of Agricultural Land	Ex-ante/Ex-post
	Soil coverage with vegetation per year % of Arable Land	Ex-ante/Ex-post
Assessing the quality of the natural environment	Forest cover (area%)	Ex-ante/Ex-post
	Share of grassland % of Agricultural Land	Ex-ante/Ex-post
	Protected areas with special natural values (% of the area)	Ex-ante/Ex-post
	Share of areas with agricultural production difficulties due to nature protection % of Agricultural Land	Ex-ante/Ex-post
	Area of Agricultural Land in organic farms thous. ha	Ex-ante/Ex-post
	Renewable Energy Sources share in energy production%	Ex-ante/Ex-post
	Number of days with exceeded daily concentrations of PM10	Ex-ante/Ex-post
	Assessment of air quality (% of respondents)	Ex-ante/Ex-post
Cultural ecosystem services valuation	Number of natural monuments per 1000 inhabitants	Ex-ante/Ex-post
	Share of nature reserves in the total area	Ex-ante/Ex-post
	Area of nature reserves per 1000 inhabitants	Ex-ante/Ex-post
	Number of agritourists per 1000 inhabitants	Ex-ante/Ex-post
	Number of agritourism nights per 1000 inhabitants	Ex-ante/Ex-post

4.3 UC3: Start-up aid for young farmers in Greece

Agriculture is a complex and dynamic industry that requires the use of various indicators to measure and track its performance. Social and economic indicators are metrics used in agricultural research to assess the impact of agricultural policies, programs, and projects on society and the economy. These indicators provide a comprehensive understanding of the socioeconomic effects of agriculture, including aspects such as poverty reduction, food security, income generation, and rural development. The selection of appropriate social and economic indicators is crucial to effectively evaluate the impact of agricultural initiatives and inform decision-making processes.

The following are some of the reasons why these indicators are important:

1. Evidence-based decision-making: The use of social and economic indicators helps to provide evidence-based decision-making for agriculture, allowing for the identification of successful initiatives and the implementation of policies that are more likely to achieve their intended objectives.

2. Improved understanding of the impact of agriculture: The collection and analysis of data on social and economic indicators provide a deeper understanding of the multiple dimensions of the impact of agriculture, including its effect on poverty reduction, food security, income generation, and rural development.

3. Monitoring and evaluation: Regular monitoring and evaluation of social and economic indicators are necessary to track progress and assess the impact of agricultural initiatives over time.

4. Improved accountability: The use of social and economic indicators increases transparency and accountability in agricultural decision-making, allowing for better evaluation of the use of resources and the impact of agricultural policies and programs.

5. Evidence-based advocacy: The results of research using social and economic indicators can be used as evidence to advocate for the prioritization of agricultural initiatives that have a positive impact on society and the economy.

Overall, the use of social and economic indicators is essential for the effective design, implementation, and evaluation of agricultural policies and programs and for ensuring that agriculture makes a positive contribution to society and the economy. The following table (Table 5) contains a list of 34 socio-economic indicators related to the agricultural sector. Each indicator represents a specific aspect of the agricultural sector. These indicators provide a comprehensive overview of the agricultural sector and its various aspects, such as labour force, productivity, land use, income, and profitability. Researchers, policymakers and stakeholders in the agricultural sector can use this information to identify the strengths and weaknesses of the sector, evaluate the impact of different policies and programs, and make informed decisions about the future of agriculture.

Table 5. Available socio-economic indicators for the Greek Use Case.

Indicator	Definition	Ex-ante/Ex-post
Agricultural population	Number of people engaged in agricultural activities in a specific area or sector	Ex-ante/Ex-post
Age structure	Distribution of population by age group	Ex-ante/Ex-post
Farm Labor Force	Number of workers engaged in agricultural activities	Ex-ante/Ex-post
Employment rate	Percentage of the total population that is employed in the agricultural sector	Ex-ante/Ex-post
Unemployment rate	Percentage of the labour force that is unemployed	Ex-ante/Ex-post
Labour productivity in agriculture	Output per unit of labour in the agricultural sector	Ex-ante/Ex-post
Agricultural holdings	Number of farms or agricultural properties in a specific area or sector	Ex-ante/Ex-post
Agricultural area	Size of land used for agricultural activities in a specific area or sector	Ex-ante/Ex-post
Type of area where the farm is located	Type of land that the farm is located	Ex-ante/Ex-post
Level of evolvement in decision-making in the farm management	The extent that farm manager makes decisions on her/his own	Ex-post
Livestock units	Number of livestock in a specific area or sector	Ex-ante/Ex-post
Age structure of farm managers	Distribution of farm managers by age	Ex-ante/Ex-post
Agricultural training of farm managers	Level of education or training of farm managers	Ex-ante/Ex-post
Agricultural factor income	Income generated from agricultural activities	Ex-ante/Ex-post

Total factor productivity in agriculture	The efficiency of production in the agricultural sector	Ex-ante/Ex-post
Gross fixed capital formation in agriculture	Investment in fixed assets in the agricultural sector	Ex-ante/Ex-post
Land productivity	Output or yield per unit of land in a specific area or sector	Ex-ante/Ex-post
Ratio of young/elderly managers	The ratio of young to elderly farm managers	Ex-ante/Ex-post
Agricultural entrepreneurial income	Income of agricultural entrepreneurs	Ex-ante/Ex-post
Income per family worker compared to the wages of employees in the whole economy	The ratio of income of family workers in agriculture to the wages of employees in the whole economy	Ex-ante/Ex-post
Gross land productivity	Output or yield per unit of land, including land used for non-agricultural activities	Ex-ante/Ex-post
Net land productivity	Output or yield per unit of land, after deducting land used for non-agricultural activities	Ex-ante/Ex-post
Land intensity	The ratio of the agricultural area to total area	Ex-ante/Ex-post
Agrarian Intensity	Ratio	Ex-ante/Ex-post
Policy payment incidence	Distribution of policy payments among different types of farms or farmers	Ex-ante/Ex-post
Variable cost incidence	Distribution of variable costs among different types of farms or farmers	Ex-ante/Ex-post
Net labour profitability	Profit generated from agricultural activities after deducting labour costs	Ex-ante/Ex-post
Net household profitability	Profit generated from agricultural activities at the household level	Ex-ante/Ex-post
Farm Labor intensity	The ratio of labour input to output in the agricultural sector	Ex-ante/Ex-post
Livestock Labor intensity	The ratio of labour input to output in the livestock sector	Ex-ante/Ex-post
Household labour incidence	Distribution of labour among different household members	Ex-ante/Ex-post
Tenant age	The average age of tenants in the agricultural sector	Ex-ante/Ex-post
Gender Balance	Distribution of male and female farmers or farm managers	Ex-ante/Ex-post
Embarking on non-agricultural activities	Percentage of farmers or farm managers who engage in non-agricultural activities	Ex-ante/Ex-post

5 Selection of main scope and indicators for the ex-ante and ex-post impact assessments

5.1 UC1: Ecologic agriculture in Andalusia

As has been mentioned on several occasions, the ex-post analyses are supported by participatory research, which, in turn, consists of two main routes: the bibliographical and/or documentary phase and the phase of questionnaires designed with questions to be able to resolve information that was not detailed in the documentary phase. Of the previously described areas available in the documentary phase, questions related to the following have been developed:

- Support for the restoration, preservation and enhancement of biodiversity, Natura 2000 areas, areas with natural or other specific constraints and high nature value farming systems such as European landscapes.

- Support for improved management of water, fertilisers and pesticides.

- Support for the prevention of soil erosion and improvement of soil erosion management.

- Contribution to reducing greenhouse gas and ammonia emissions from agriculture.

- Supporting conservation and carbon sequestration in the agriculture and forestry sectors.

- Ensuring sustainable management of natural resources and climate action.

- Encouraging innovation.

Regarding the selected indicators for the Andausian Use Case, they were already described in previous deliverables (D5.4), and they were selected according to the aspects that the measure tries to generate an impact on (listed above). Since the measurements of KPIs depend on the simulation outputs to a large extent, and the ABM module is being developed in parallel, it is not possible to provide a definitive list of KPIs. For this reason, the following selection is a maximal set of KPIs, which are interesting for the impact assessment of the use case and will be tried to calculate with the available data, but the final list could not be known until later stages of the development of the AGRICORE suite. Therefore, this list will be updated in the following deliverables.

- Land conversion and habitat loss:
    - Soil cover (the area under wheat, maize, etc.)
    - Share of the area with specific soil cover
    - The area with conventional tillage
    - Share of the area with conventional tillage
    - The area under organic farming
    - Share of the area under organic farming
    - Change in the area under organic farming
    - The area converted into organic
    - The area of arable land
    - Share of the area of arable land
    - The area of recently abandoned arable land
    - The area of irrigated arable land

- o Share of the irrigated arable land area
- o Change in the irrigated arable land area
- o The area of arable land not being irrigated
- o Share of the arable land not being irrigated
- o Change in the arable land not being irrigated
- o The area of pasture land
- o Share of the area of pasture land
- o The area of recently abandoned pasture land
- o Agricultural areas under Natura 2000
- o Cropping patterns
- o Tillage practices
- **Wasteful water consumption:**
  - o Water used for irrigation
  - o Water retention capacity of soil
- **Soil erosion and degradation:**
  - o Soil erosion
  - o Soil fertility change
  - o Soil organic matter change
  - o N surplus
  - o P surplus
- **Pollution:**
  - o Nitrate leaching
  - o Mineral N fertilizer use
  - o Mineral P use
  - o Mineral K use
  - o Pesticide use
  - o Ammonia emissions
- **Climate change:**
  - o CH_4 emissions
  - o N_2O emissions
  - o CO_2 emissions
- **Biodiversity:**
  - o Crop diversity
  - o Livestock patterns
  - o Livestock Units per ha
  - o Livestock diversity

In the ex-ante analysis, the aim is to contextualise all the areas and indicators selected through the AGRICORE tool and to make a comparison of data involving the study carried out with the information obtained from the AGRICORE tool.

5.2 UC2: Agri-environment-climate commitments in Poland

For the Polish Use Case, the selection of the main scope and indicators for the ex-ante and ex-post impact assessments have been carried out through participatory research, based on mainly bibliographical and/or documentary review, including the information gathered from available databases. From the available topics recognised in the documentary phase, the following ones were selected as the main ones for the ex-ante and ex-post impact assessments:

- Improvement of the balance of organic matter, especially through crop rotation.

- Optimisation of fertilisation, e.g. through a fertilisation plan, to reduce air pollution by limiting the release of nitrogen oxides into the atmosphere related to excessive and irrational use of nitrogen-containing fertilisers.

- Extensification of production inside and outside the Natura 2000 areas (Package 4 and 5).

- Promotion of proper crop rotation, crop diversification, and catch crops.

- Preservation of permanent grasslands, landscape elements, and afforestation of areas susceptible to erosion.

- Maintenance of agricultural land management in accordance with the principles of good agricultural practice.

It is necessary to underline that regarding the selected indicators for the Polish Use Case, they were already described in previous deliverables (D5. and D5.6), and they were selected according to the aspects that the measure tries to generate an impact (listed above). Since the measurements of KPIs depend on the simulation outputs to a large extent, and the ABM module is being developed in parallel, it is not possible to provide a definitive list of KPIs. For this reason, the following selection is a maximal set of KPIs, which are interesting for the impact assessment of the use case and will be tried to calculate with the available data, but the final list could not be known until later stages of the development of the AGRICORE suite.

Therefore, the mentioned list of the selected indicators for the Polish Use Case will be updated in the following deliverables.

Environmental and climate indicators:

- Land conversion and habitat loss:
    - Soil cover (the area under wheat, maize, etc.)
    - Share of the area with specific soil cover
    - Change in the area with specific soil cover
    - The area with conventional tillage
    - Share of the area with conventional tillage
    - Change in the area with conventional tillage
    - The area of arable land
    - Share of the area of arable land
    - Change in the area of arable land

- o The area of recently abandoned arable land
- o The area of pasture land
- o Share of the area of pasture land
- o Change in the area of pasture land
- o The area of recently abandoned pasture land
- o Agricultural areas under Natura 2000
- o Share of the agricultural areas under Natura 2000
- o Change in the agricultural areas under Natura 2000
- o Forest area
- o Share of the forest area
- o Change in the forest area
- o Cropping patterns
- o Tillage practices
- Wasteful water consumption:
  - o Water retention capacity of soil
- Soil erosion and degradation:
  - o Soil erosion
  - o Soil fertility change
  - o Soil organic matter change
  - o N surplus
  - o P surplus
- Pollution:
  - o Nitrate leaching
  - o Mineral N fertilizer use
  - o Mineral P use
  - o Mineral K use
  - o Pesticide use
  - o Ammonia emissions
- Climate change:
  - o CH_4 emissions
  - o N_2O emissions
  - o CO_2 emissions
- Biodiversity:
  - o Crop diversity
  - o Livestock patterns
  - o Livestock Units per ha

    o Livestock diversity

Ecosystem services indicators:

- Agricultural production space valuation:
    - o Index of agricultural production space valorization (points),
    - o Valuation index of Agricultural Land (0-1)
    - o Indicator of the agroecological potential of agriculture (1-5)
- Cultural ecosystem services valuation:
    - o Number of natural monuments per 1000 inhabitants
    - o Share of nature reserves in the total area
    - o Area of nature reserves per 1000 inhabitants
    - o Number of agritourists per 1000 inhabitants
    - o Number of agritourism nights per 1000 inhabitants
- The quality of the natural environment and soils:
    - o Gross Nitrogen Balance Income - expenditure in kg/ha of Agricultural Land

In the ex-ante analysis, the aim is to contextualise the areas and indicators selected in the Polish Use Case with alternative agricultural policies.

5.3 UC3: Start-up aid for young farmers in Greece

The ex-post analyses for the Greek use case have been carried out through participatory research that is based on two phases. The first phase consisted of utilising FADN data as well as data provided by the applications submitted by the young farmers for their participation in measure 6.1, and the second phase was the design of the questionnaires with questions carefully selected to fill the missing information gaps. In detail, the Greek use case for the ex-post analysis is utilising:

- The latest available Greek Farm Accountancy Data Network (FADN) data for the period 2014-2018, which are presented in D1.8 Use Case Participatory Research Actions.
- The data provided by the 13.905 applicants for participation in the Young Farmers Scheme in Greece in 2016, which are presented in D1.8 Use Case Participatory Research Actions.
- The data gathered through the conduction of participatory research with the utilisation of questionnaires that consist of the following variables.
    - o Socio-economic variables
    - o Financial and accounting variables
    - o Beneficiaries and non-beneficiaries of setting up measure evolution

From the available topics pinpointed for the ex-ante and ex-post analyses, the following can be highlighted as the ones that constitute the selected ones:

- Augmentation of the physical and economic size of agricultural holdings of Greek agriculture with overall scope for the improvement of agricultural labour productivity.
- Increasing the added value of produced agricultural products.
- Ensuring the age renewal in agriculture.

- Addressing the observed low levels of professional education and relevant skills of those employed in the agricultural sector.

- Improvement of the attractiveness of rural areas and viable investment attraction in agriculture.

- Tackling poverty and the phenomenon of social exclusions in rural areas.

- Improving the economic and/or environmental performance of economically viable agricultural holdings.

- Unleashing the development potentials of the rural areas.

- Supporting the agricultural sector with small agricultural enterprises with modern and innovative financial instruments.

- Supporting farmers with modern and effective tools that will intercept or manage risk in agriculture.

Regarding the selected indicators for the Greek Use Case, combined with the indicators presented in Deliverable 5.5 are the following:

- Gross land productivity

- Net land productivity

- Land intensity

- Agrarian Intensity

- Policy payment incidence

- Variable cost incidence

- Net labour profitability

- Net household profitability

- Farm labour intensity

- Livestock labour intensity

- Household labour incidence

- Tenant age

- Regional dispersion of young farmers

5.4 Additional Italian UC

Worldwide, livestock is responsible for 16.5% of all anthropogenic GHG emissions, mainly in the form of methane (CH4), carbon dioxide (CO2), nitrous oxide (N2O), and ammonia (NH3), coming from fodder cultivation, enteric fermentation, manure management, and nitrogen deposition and application [9][10].

This UC is designed to assess the structural, production, environmental, and economic impact of an increasing tax on climate change gas emissions related to milk production under the current CAP payment system.

The analysis is performed using the short-period module of the AGRICORE Agent-Based Model (ABM) based on Positive Mathematical Programming (PMP). The integration between ABM and PMP makes it possible to simulate farmers' strategies considering the interaction between them, the territorial specificity, and the heterogeneity of farms in the presence of little information on

production costs. It also makes it possible to add a social and cultural perspective to the economic factors.

5.4.1 The sample

The sample investigated is limited to farms located in the Emilia-Romagna NUTS-2 region. It refers to the 2020 Italian FADN (RICA) observation that counts 710 farms. The dataset includes information on their geographical location (region, province, altitude, and agrarian zone), agricultural practices (conventional or organic), household characteristics (age and gender of the farm holder and the number of potential farm holder's successors), land use, specific production costs per crop (cost of seeds, fertilisers, pesticides, energy, and water), gross total product, and CAP payments. Based on FADN data, Table 6 shows the number of farms in the Emilia-Romagna region in 2020 by type of farming. Moreover, it is necessary to highlight that the "agrarian region" spatial definition is a peculiarity of the RICA and further segments Italian provinces (NUTS3) based on their geographical location and altitude range. Considering this, Figure 5 illustrates the distribution of farms by altitude.

Table 6. Number of farms in the Emilia-Romagna 2020 FADN by type of farming.

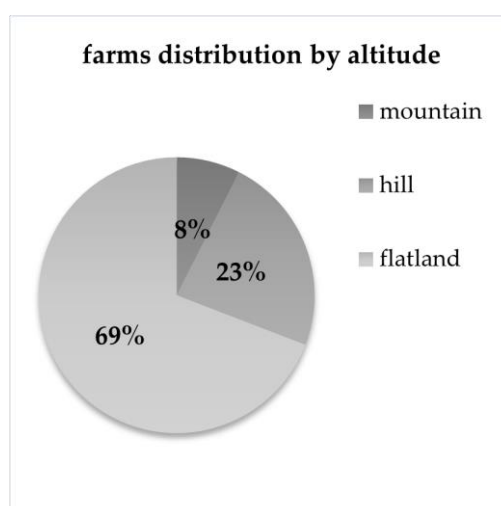| Farm Technical Orientation	Type of farming	Sample	Weighted Sample
Arable crops	1	310	15,351
Horticulture	2	8	411
Permanent crops	3	160	9084
Dairy cattle	450	91	3306
Other herbivores	460;470;481;482;484	24	2308
Granivores	5	30	677
Polyculture	6	67	3371
Mixed farming	7	2	33
Mixed (crop–livestock)	8	18	919
Total		710	35,459

Figure 5. Farms distribution by altitude.

The livestock sector in Emilia-Romagna accounts for 11.4% of the livestock units bred in Italy; in more detail: 10% bovines, 12% swine, and 18% poultry, representing 15.2% of the national animal production value (2357.3 million EUR) [11]. Emilia-Romagna also produces 16% of Italian

milk: in 2020, cow milk production stood at 2,029,257 tonnes, placing the region in second place for milk production, after Lombardia (44%).

Cheese production is strongly rooted in the region: in 2020, 89.2% of the milk produced in the area between the Po and the Reno rivers was allocated to the production of 140,000 tonnes of Parmigiano Reggiano and 325,700 tonnes of regional milk (0.016%) was used to produce 24,000 tonnes of Grana Padano cheese [12].

Consequently, due to its strong agro-industrial vocation, the ER region is responsible for 10.4% of Italian livestock-related GHG emissions (2,059 thousand tonnes) and for 9% of the national ammonia emissions (23,114.8 tonnes of NH3) [13]. The amount of CO2eq emitted per tonne of crop can be calculated on the basis of the estimated emissions per hectare or per livestock unit (LSU) using the ICAAI methodology (Impronta Carbonica dell'Azienda Agricola Italiana) developed by CREA-PB on the basis of the IPCC guidelines for establishing a national inventory of greenhouse gas emissions [14][15][16].

Besides carbon emissions and nitrogen production, water consumption is also evaluated using the water footprint data calculated by Hoekstra and Mekonnen [17], as the sum of:

- green water, which is water naturally embedded in the rhizosphere and available for plant assimilation;

- blue water, which is surface water or groundwater for irrigation;

- grey water, which is the volume of water necessary to dilute ecotoxic compounds to restore specific quality standards.

6 Conclusions

AGRICORE is a novel project that utilises advanced agent-based modelling methods in order to simulate the impact of agricultural policies. By representing each farm as an autonomous decision-making entity, the AGRICORE model can assess the impact of policies on various aspects of agriculture, the environment, and rural integration. The project includes dedicated modules that evaluate the impact of policies on environmental and climatic factors and ecosystem services. A detailed planning and schedule for the execution of the different use cases considered in the AGRICORE project were presented in D7.1 and updated in D7.2. This deliverable 7.3 is a continuation of that planning in the framework of Task 7.2 - Policy impact assessment scope. The creation of such a plan at the outset of the project will enable avoiding potential problems with data availability (or lack thereof) or associated agents throughout the execution of the use case.

In conclusion, the deliverable presents a revised description of the contents of each use case considering the advancement and research activities carried out so far. Initially, for each use case, the analysed measure is briefly described, coupled with its requirements and provisions for accession by each farmer. Secondly, for each use case separately, a summary of the activities done so far is presented. The activities focus on the research activities performed for the UCs ex-post impact assessments, which include the identification of information gaps produced after the collection of available data for each use case, the design of participatory research and the relevant engagement of stakeholders, the conduction of a pilot survey that pre-tested the developed questionnaires and the actual conduction of the participatory research coupled with a brief description of the gathered data, information, and elements for each use case.

Moreover, the scopes of ex-ante and ex-post impact assessments performed for the three use cases are further defined as part of the demonstration and validation activities planned for the AGRICORE project. A spectrum of the available scopes of ex-ante and ex-post impact assessments for each UC is presented, together with a set of the available indicators for each impact assessment and a selection of the main scope(s) and indicators suitable for each UC. In addition to the aforementioned UCs, a fourth one has been designed to test the core of the AGRICORE modelling approach in the short-term period (agricultural year).

7 References

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For preparing this report, the following deliverables have been taken into consideration:

Deliverable Number	Deliverable Title	Lead beneficiary	Type	Dissemination Level	Due date
1.8	Use Case Participatory Research Actions	CAAND	Report	Public	M18
5.5	Socio-economic (integration of agriculture in rural society) impact assessment module	UNIPR	Other	Public	M42
7.1	Use case planning and set of involved stakeholders	CAAND	Report	Public	M25
7.2	Report on use cases advances	CAAND	Report	Public	M48
7.4	Results on participatory research activities	CAAND	Report	Public	M48