# A Preliminary Review on the Adaptation of Crops and Ecosystem Services to Agricultural Policy and Climate Change

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**Abstract.** The use of different methodologies of integrated impact assessment in agricultural production is a powerful tool in the hands of scientists to evaluate various factors. Integrated impact assessment with model development has been proposed by various studies as a mean of enhancing the management of complex systems. The aim of this paper is to present the preliminary review on the integrated impact assessment of the CAP changes and climate change on agricultural production, in order to determine the adaptation of farmers to possible policy changes.

**Keywords:** impact assessment; adaptation; CAP; climate change.



## 1 Introduction

Assessing the impacts of climate change on agricultural production has always been a difficult field of study. In addition, farmers' adaptation to the rules of cross-compliance affects the management of the agricultural holdings. The structure of cross-compliance will become even stricter for the period 2021-2027. At the same time, the obligations arising from Regulation 1306/2013 on the environment concern all crops, but in particular the crops of the region of Central Macedonia and therefore a wide range of ecosystem services.

Climate change is exacerbating the ecosystem as a whole (Munang, Thiaw, Alverson, Liu, & Han, 2013) and therefore the results of the applied policies have been evident in Europe (Nelson et al., 2013). The results of the EU policies has been a reduction in greenhouse gas emissions between 1990 and 2004 for all sectors of the economy and especially for agriculture (Bessou, Ferchaud, Gabrielle, & Mary, 2011). The European Council agreed in 2007 on a comprehensive energy and climate strategy to reduce greenhouse gas emissions by 30% compared to 1990. However, Greece has managed to reduce greenhouse gas emissions only by 2.8% compared to 1990 (European Commission, 2016). Therefore, the path of Greek agricultural adaptation is still in its infancy and the time frame is minimal.


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The aim of the research is an integrated impact assessment of the CAP changes and climate change on agricultural production, in order to determine the adaptation of farmers to possible policy changes. The research will be implemented in the region of Central Macedonia in Greece. The research aims to present different cultivation models and adaptation level to climate change and CAP changes. Initially, a number of climate change scenarios will be proposed based on the data of the Intergovernmental Panel on Climate Change (IPCC) and a number of General Circulation Models (GCM model), while ecosystem service indicators (e.g. biomass derivatives, stocks, stocks) will be identified and quantified. In this paper the preliminary review on the integrated impact assessment methods and models and also the phases and work packages of the applied research are presented.

## 2 Integrated Impact Assessment

European common agricultural policy, which focuses on increased productivity, must evolve and lead in a different direction, with the development of a multi-functional body (Holman, Brown, Janes, & Sandars, 2017). The use of different methodologies of integrated impact assessment in agricultural production is a powerful tool in the hands of scientists to evaluate various factors. Integrated impact assessment with model development has been proposed by various studies as a means of enhancing complex management systems (Harris, 2002; Parker et al., 2002; Parson, 1995). For impact assessment, the use of methods such as bio-economic models, environmental risk mapping, life cycle analysis, multiple factor systems, and environmental impact assessment are well-documented methods.

However, the use of a bio-economic farm model is the strongest and most widespread methodology for integrated data evaluation in the agricultural sector (Kirchner et al., 2015). In the literature, bio-economic models may exist under different names such as ecological-economic or by combining the terms environment and economy (Janssen & van Ittersum, 2007). A great advantage of the methodology is the recognition of possible trade-offs between environmental and economic objects (Ruben, Moll, & Kuyvenhoven, 1998), which facilitates and accelerates the process of impact assessment. They also include useful aspects that are not taken into account in the policy-making process (Pacini, Wossink, Giesen, & Huirne, 2004) and allow the assessment of policies based on pressure policies (eg quotas, subsidies) or producers' trade policies (e.g. x. direct taxes, cross-compliance) (K. Falconer & Hodge, 2000). The variety of the results is another advantage of the methodology, as it can be modified depending on the interest group (policy makers, farmers, or other stakeholders). The ways to present the results are in the form of indicators (Pacini et al., 2004; Zander & Kächele, 1999), in the form of resilience (K. Falconer & Hodge, 2000; Pannell, 1997), in the form of boundary analysis and in the form of cost-effectiveness ratio (Katherine Falconer & Hodge, 2001). Therefore, the implementation of a bio-economic farm model is a modular process and can be used to simulate the response of farms and ecosystem services to changes in policy and climate change.

The development of climate change scenarios will be based primarily on the Intergovernmental Panel on Climate Change (IPCC) database and the creation of General Circulation Models (GCM model) (Holman et al., 2017; Reidsma et al., 2015). Similar methods have been used in Europe to assess the impact of climate change on agriculture (Audsley et al., 2014), water management (Wimmer et al., 2014), floods (Mokrech, Kebede, Nicholls, Wimmer, & Feyen, 2014) and climate assessment policy (Jäger et al., 2014). Simulation of climate change scenarios is part of a process of integrated impact assessment so that we can reduce the range of climate data (El Chami & Daccache, 2015).

## 3 Methodology

The use of an integrated impact assessment model for agricultural and environmental policies is based on different models that work repeatedly to make better use of information. The implementation of a bio-economic farm model allows the preliminary evaluation of technological innovations and policies on a number of different geographical and climatic conditions. The process is started by a market equilibrium model for regulating the supply and demand of agricultural products (Britz, Perez Dominguez, Zimmermann, & Heckelei, 2007; Ewert et al., 2011). Then, with the introduction of data in the Optimization Program (FSSIM), the economic efficiency and the adaptation of the ecosystem services to the changes of the agricultural policy in the past will be measured.

The methodology to be followed in the research is a process that is divided into four phases, since it is a systematic and gradual approach:

1. Defining the aim of the research. In this phase, the process to be followed is described and analyzed. The framework and boundaries of the research as well as the concepts to be studied are identified.

2. Identification and quantification of all models used in the literature and selection of a model for the integrated impact assessment of agricultural crops.

3. Monitoring and evaluating the impacts (environmental and economic) at the regional level of climate change and changing agricultural policy.

4. Interpretation of the results where the results of impact assessment are analyzed.

At the same time, the methodological plan of the research includes 3 main work packages which are distributed during the research, following the above logical phases. The work packages of the project management as well as the dissemination of the results will be applied in parallel with the 3 main work packages throughout the research.

Detailed work packages include:

- WP1 Project Management
- WP2 Literature Review
- WP3 Model selection for the integrated impact assessment of the adaptation of agricultural crops - Data Collection
- WP4 Application of the model - Analysis of the results
- WP5 Dissemination of results

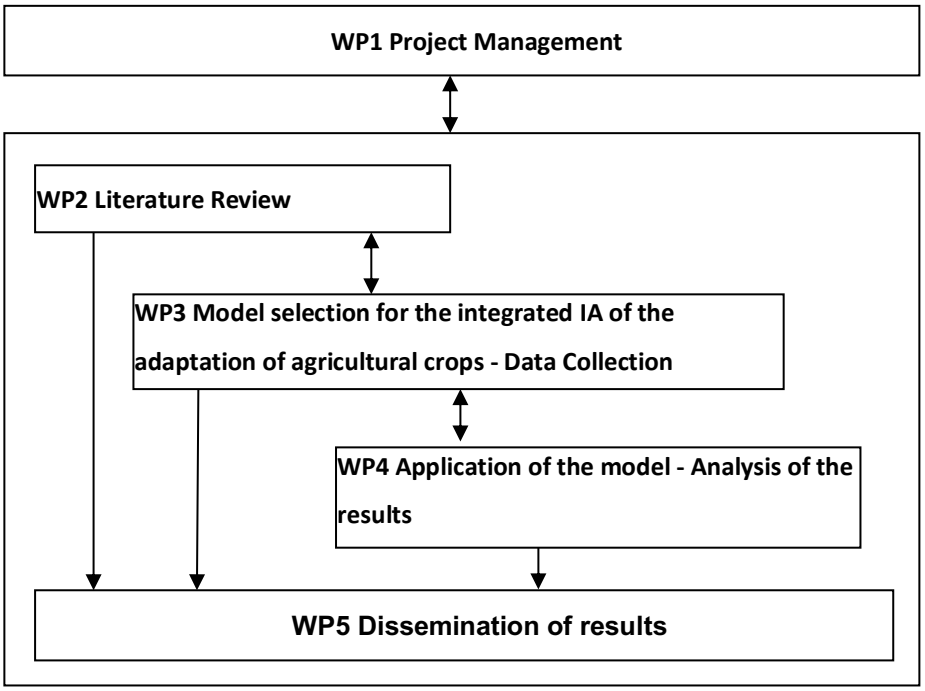


**Fig. 1.** Phases and Work Packages of the project.

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