



Simulation of the impact of greening measures in an agricultural area of the southern Italy



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ABSTRACT

Together, sustainable management of natural resources and climate action form one of the three objectives of the 2014–2020 Common Agricultural Policy. This objective is being addressed by replacing the existing direct payments under Pillar 1 with a basic payment, combined with an additional payment conditional on farmers undertaking agricultural practices beneficial for the climate and the environment, a policy referred to as *greening*.

In this study, the impact of *greening* was assessed using a hybrid model calibrated using positive mathematical programming. The model describes the macro-types of farm production in a Mediterranean agricultural area.

The results show that *greening* was not beneficial throughout the study area and only some farm types have been particularly affected. However, greening appears to have a positive impact on curtailing the use of chemicals, particularly nitrogen, and on crop diversity.

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1. Introduction

Since the 1990s, the European Union (EU) has progressively and structurally reformed the common agricultural policy (CAP), which today includes two pillars that have specific objectives and tools. The CAP reform process was accompanied by a re-specification of the objectives of the CAP in line with the EU 2020 strategy document, which promotes agriculture's contribution to smart (i.e. encouraging knowledge and innovation), sustainable, and inclusive growth (European Commission, 2010,2011).

The sustainable management of natural resources and climate action together form one of the three post-2013 objectives of the CAP, and are addressed by replacing the existing direct payments under Pillar 1 with a basic payment, supplemented by an additional payment conditional on farmers respecting certain 'agricultural practices beneficial for the climate and the environment'. This so-called 'green (henceforth, *greening*) is financed in part (30%) from national direct payment envelopes, and requires, among other things, crop diversification and the maintenance of existing grassland. The novelty of this approach lies in its attempt to define and fund EU-wide mandatory green standards through Pillar 1 direct payments (Matthews, 2013). The greening comprise three basic

elements: diversifying cultivation, the maintaining of permanent grassland and the maintaining of the ecological focus areas.

The new CAP's integration of more environmental concerns has increased the demand for tools to help assess the impact of decisions on agriculture and on its economic and physical environment (Gohin, 2006; Balkhausen et al., 2007). Economic models can provide these types of evaluation using available agricultural information for the entire EU. Specifically, the micro-economic approach of mathematical programming models allows the technical aspects of agricultural production to be taken into account (Godard et al., 2008). To deal with these challenges conventional policy analysis models have to be adjusted (Buysse et al., 2007). Within the current agricultural economics mathematical programming toolkit, two main types of programming models can be distinguished: Normative Mathematical Programming (NMP) and Positive Mathematical Programming (PMP). PMP calibrates mathematical programming models to observed behavior during a reference period using the information provided by the dual variables of the calibration constraints (Howitt, 1995; Arfini and Paris, 1995; Paris and Howitt, 1998; de Frahan et al., 2007).

Many analyses of the impact of farm policy reforms have been conducted using mathematical programming models, which can be grouped into three categories farm-type models, regional models, and hybrid approaches according to how they represent farm heterogeneity in time and space (Britz et al., 2012). Farm-level modelling allows the behavior of individual farms to be modelled.

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However, in practice, only a limited number of representative farms are modelled (Ittersum van et al., 2008; Louhichi et al., 2010). This is due to a lack of information regarding individual farms, as well as a need to preserve empirical tractability. Models that operate at regional levels are more suited for representing the aggregate behavior of a region, but poorly address farm and field-level heterogeneity. Hybrid models combine the strengths of farm and regional-level approaches, accounting for economic feedback loops and for heterogeneity at the representative farm level (Britz et al., 2012).

The objective of the present paper is to evaluate the impact of *greening* in an irrigated area using a hybrid model calibrated by the PMP methodology. The study area is an irrigated area of the Mediterranean located in Italy's west-central Sardinia. The Water User Association (WUA) of Oristano constructed, operates, and maintains the drainage systems in this region, and provides irrigation water. This area is representative of many Mediterranean areas because of the structural characteristics of the farm types, as well as the types of cultivation practiced. The wide variety of farm types involved in the area facilitated evaluation of the impacts of *greening*.

The model used represents the various farm types operating in the area, with each representative farm type weighted to represent agricultural activity as a whole.

The model was calibrated using PMP methodology; in particular, the Röhm and Dabbert approach (2003) was used for the forage crops produced on the farms and for animal feed.

The characteristics of the dual value of forage crops in the presence of feeds purchased on the market are addressed and discussed from a methodological standpoint, and measures of *greening* and relative aspects are defined mathematically.

The results show that, for the area as a whole, there are no compelling data supporting the effectiveness of new CAP instrument. *Greening* particularly interferes with the management of specialist dairying farms, which constitute a small but economically significant proportion of the area. Specialist dairying farms are particularly affected because they are structured to produce large amounts of corn silage for livestock feed; recent increases in the price of corn silage due to the increased production of biogas have pushed farmers to increase cultivation beyond the limits of *greening*. The conflict between the expanded production of maize for biogas and *greening* constraints may represent a conflict between the mechanisms of the *greening* policy and the new CAP objectives of developing the cultivation of biomass for energy production. However, *greening* appears to be successful in decreasing the use of chemicals, particularly nitrogen¹ and on crop diversity.

The next sections will present the materials and methods of the paper. First, *greening* measures used in recent studies will be presented. The methods of the present paper specifically the two PMP approaches used for the model calibration will then be given. The final part of the materials and methods focuses on empirical analysis, with a description of the study, the economic model, and the modelling of *greening* measures and simulated scenarios. After the description of the results, the paper terminates with the discussion and conclusions.

2. *Greening* measures: characteristics and literature review

The European Council and the European Parliament have recently published the new CAP regulations for 2014–2020. These regulations concern supporting rural development through the European Agricultural Fund for Rural Development (No.

1305/2013); the financing, management, and monitoring of the CAP (No. 1306/2013); the rules for direct payments to farmers under support schemes within the framework of the CAP (No. 1307/2013); and the common organization of the markets for agricultural products (No. 1308/2013).

One of the main new features of the 2014–2020 regulations is payment for agricultural practices that are beneficial for the climate and the environment (henceforth, *greening payment*). This payment earmarks 30% of the currently available national envelope for the implementation of sustainable farming practices.

The requirements of this measure are in addition to *cross-compliance* constraints, which are requirements intended to protect the basic environmental conditions necessary to agriculture. These constraints comprise three basic elements:

1. diversifying cultivation by growing at least two crops on farms where the arable land exceeds 10 ha, and at least three crops where arable land exceeds 30 ha, and by limiting the main crop to 75% of the arable land and the two main crops to 95% of the arable land;
2. maintaining permanent grassland at the national, regional, or farm level;
3. maintaining at least 5% (7% from 2017) of the arable land of farms larger than 15 ha as ecological focus areas; these areas may take the form of fallow land, terraces, landscape features, buffer strips, hectares of agro-forestry, strips of eligible hectares along forest edges, areas with short-rotation coppice, afforested areas, areas with catch crops or green cover, or areas with nitrogen-fixing crops.

The system provides for *greening equivalency*, whereby environmentally beneficial practices already in place may be used instead of these basic requirements. For example, organic producers or farmers who participate to (or who are involved in) agro-environmental schemes will not have to meet additional requirements, as their practices are accepted as already providing clear ecological benefits. To avoid double funding under these conditions, payments made through rural development programs must take into account the basic *greening* requirements.

2.1. Literature review

Since 1985, there has been a gradual integration of environmental objectives and motivations into the CAP; at the same time, there continues to be a mismatch between the scale of the environmental challenges facing EU farmland and the scale of the policy response (Allen and Hart, 2013).

The integration of environmental concerns with the CAP has been characterised by a gradual shift in emphasis toward more targeted, regionally defined, and programmed approaches; these approaches are generally embodied in agro-environmental measures and in Pillar 2, and are supported by cross compliance. While these elements all remain in the current proposals, a major new element the introduction of green direct payments via Pillar 1 has come into play. Their introduction is coupled with a net reduction in the Pillar 2 budget over the upcoming programming period (Hart and Little, 2012). In formulating its proposed revisions of the post-2013 CAP, the European Commission opted to pursue further integration mainly through Pillar 1, through the introduction of a 'green' payment for farmers who follow a specified set of mandatory farm practices (Matthews, 2013). EU investments in research and development activities are required for the successful implementation of *greening* practices (Singh et al., 2014).

Several studies on the possible impact of *greening* in Europe have been conducted in recent years. Some studies have a qual-

¹ Units of nitrogen fertilizer (N).

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