Sustainability of greening measures by Common Agricultural Policy 2014-2020 in new climate scenarios in a Mediterranean area

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Summary

Sustainable management of natural resources and climate action together form one of the three objectives of the Common Agricultural Policy (CAP) 2014–2020. They are addressed by replacing the existing direct payments under Pillar 1 with a basic payment topped up by an additional payment conditional on farmers undertaking “agricultural practices beneficial for the climate and the environment”, under a policy referred to as greening.

In this study, the impact of greening was assessed using a Discrete Stochastic Programming model that describes the farm production in a Mediterranean agricultural area in different climate scenarios. The results show that greening is not beneficial throughout the study area. Some farm types are particularly affected because of the recent price increase for maize silage for biogas. However, greening appears to have a positive impact on chemical use, particularly nitrogen.

The application of the measures greening in the current climate scenario seems to have a more significant impact respect to the future climate scenario.

Keywords: greening measures; agricultural supply analysis; mathematical programming; sustainability

JEL Classification codes: C61, Q01, Q18
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1. INTRODUCTION

Since the 1990s, the European Union 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. This culminated with the EU 2020 strategy document which promotes the contribution of agriculture to smart (knowledge and innovation), sustainable, and inclusive growth (European Commission, 2010; European Commission, 2011).

In particular, sustainable management of natural resources and climate action together form one of the three objectives of the CAP post-2013, and are addressed by replacing the existing direct payments under Pillar 1 with a basic payment topped up by an additional payment conditional on farmers respecting certain “agricultural practices beneficial for the climate and the environment”. This so called ‘green payment’ (henceforth, greening) is financed from 30% of the national direct payment envelopes, and among other things requires crop diversification and maintenance of existing areas of permanent grassland. The novelty of this approach lies in its attempt to define and fund mandatory green standards applicable across the EU, which can be administered as a Pillar 1 direct payment (Matthews, 2013).

It is important to assess the potential impact of these factors on markets, and on the environmental and welfare outcomes for the agricultural sector, and so continue the tradition of the many economic studies undertaken to measure the effect of the CAP reforms (Judez et al, 2001; Gohin, 2006; Balkhausen et al, 2007; Bartolini and Viaggi, 2013; Donati et al, 2013). Many analyses of the impact of farm policy reforms have been conducted using mathematical programming models, which can be grouped into three categories according to how they represent farm heterogeneity in time and space. These include farm-type models, regional models, and hybrid approaches (Britz et al., 2012).

In the present study, we assessed the impact of greening using a Discrete Stochastic Programming (DSP) model. We studied an irrigated area that is representative of many Mediterranean areas because of the structural characteristics of the farm types, and the types of cultivation practiced. Milk production from cows makes an important contribution to farm income in the area, and is based on similar methods to those practiced in the Po Valley. The wide variety of farm types involved in the area facilitated evaluation of the impacts of greening.

The results show that for the area as a whole there is no compelling data supporting the application of greening. In particular, this policy interferes with the management of dairy cow farms, which constitute only a small proportion of the area, although they are economically significant. These farms are particularly affected because they are structured to produce large amounts of corn silage for livestock feed, but with the recent increase in the price of maize silage for biogas there has been a tendency to increase cultivation beyond the limits of greening. The conflict between the expansion of maize for biogas and the greening
constraints can appear to represent an incongruity 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 have a positive impact on chemical use, particularly nitrogen. The application of the measures greening in the current climate scenario seems to have a more significant impact respect to the future climate scenario.

2. MATERIALS AND METHODS

2.1. Greening measures by CAP 2014-2020

The European Council and the European Parliament have recently published the new regulations of the CAP for the period 2014-2020. The regulations concern: the support for rural development by the European Agricultural Fund for Rural Development (No 1305/2013); the financing, management and monitoring of the common agricultural policy (No 1306/2013); the rules for direct payments to farmers under support schemes within the framework of the common agricultural policy (No 1307/2013); the common organisation of the markets in agricultural products (No 1308/2013).

One of the main new features is that of payment for agricultural practices beneficial for the climate and the environment (greening payment). This payment which will link 30% of the currently available national envelope to the implementation of particular sustainable farming practices.

The compulsory requirements of this measure are in addition to the cross compliance constraints, which are intended to protect basic environmental conditions within which agriculture operates. The constraints comprise three basic elements:

I. diversifying cultivation, by growing at least two crops, where the arable area of the farm exceeds 10 ha, and at least three crops where it exceeds 30 ha, and limiting the main crop to 75% of the arable area and the two main crops to 95% of the area;

II. maintaining permanent grassland (at national or regional or farm level)

III. maintaining at least 5% of the arable area of farms larger than 15 ha as ecological focus areas (field margins, hedges, trees, fallow land, landscape features, biotopes, buffer strips, afforested area).

A "crop" means any of the following: (a) a culture of any of the different genera defined in the botanical classification of crops; (b) a culture of any of the species in the case of Brassicaceae, Solanaceae, and Cucurbitaceae; (c) land lying fallow; (d) grasses or other herbaceous forage.

Winter crop and spring crop shall be considered to be distinct crops even if they belong to the same genus.

The Commission adopted delegated regulation [C(2014) 1476 final ] to recognize other types of genera and species and establish the rules concerning the application of the precise calculation of shares of different crops. The delegated regulation establishes that for the purpose of the calculation of the shares of different crops as provided for in Article 44(1) of Regulation (EU) No 1307/2013, the period to be taken into account shall be the most relevant part of the cultivation period taking account of the traditional cultivation practices in the national context. Member States shall inform farmers of that period in due time.
Within the total arable land of the holding, each hectare shall be taken into account only once in one claim year for the purpose of the calculation of the shares of different crops.

The system provides a greening equivalency, whereby environmentally beneficial practices already in place are considered to replace these basic requirements. For example, organic producers or farmers joining other agro-environmental schemes will not have to meet additional requirements, as their practices are accepted as already providing a clear ecological benefit. To avoid double funding under these conditions, the payments through Rural Development programs must take into account the basic greening requirements.

2.2. Study area and data

The study area is located in central-west Sardinia (Italy), and covers about 54,000 ha of agricultural land. The Land Reclamation and Irrigation of Oristano (WUA) constructed, operates, and maintains the drainage systems in this region, and provides irrigation water. Since the mid-2000s, WUA has operated the Eleonora d’Arborea dam, which holds approximately 450 million m³ (Mm³) of water, 120–130 Mm³ of which is available for farming. This water is distributed to 36,000 ha comprising 26 irrigation districts, which are clustered into four categories according to the technological characteristics of the irrigation network. The first category includes districts where the farms receive water under high pressure. However, the model divides these districts into two sub-categories to specifically differentiate the productivity and irrigation issues of dairying farms in the Arborea zone. Another category uses a similar system, but provides the farms with low-pressure water. In the districts of the fourth category, the water resource is located at a higher altitude than the area it serves, and water is transported to farms through open channels under gravity. The remaining 18,000 ha are rain-fed and not served by the irrigation facilities of the WUA.

The major cropping systems are based on cereals (particularly wheat and corn) and forage (particularly alfalfa, clover, and ryegrass). In addition, large areas are devoted to vegetable crops (particularly artichoke, watermelon, and tomatoes); rice, fruit (especially citrus), olives, and vineyards are also very important. Farming that occurs outside of the WUA is predominantly non-irrigated, but in limited areas some crops are irrigated using farm wells. Of the total land outside the WUA, 55% is dedicated to pastures, tares, woods, and set-aside. With respect to the livestock industry, cattle breeding for dairy milk production is very important in the Arborea region, which has an organized local system for collection, processing, and packaging of milk. The sheep milk sector is also an important component of the economy of the area, and involves almost 372,000 sheep and a number of milk processing plants.

The agricultural production of the study area was reconstructed with reference to the situation in 2010. This year was chosen because of the availability of data from the sixth General Census of Agriculture; these data were integrated with FADN data, and data from the records of the WUA. The production conditions for the various crops and livestock were defined on the basis of interviews with farmers and agronomists from private and public institutions, and from information from cooperatives in the area. The phases of cultivation were reconstructed, and data were collected on the use of chemicals, crop irrigation requirements, and production. Similarly, the feed requirements of the various categories of livestock were specified, the feeding rations, and the products obtained. The prices of inputs and products were also reconstructed.
2.3. Basic structure of the economic model

The economic model used is a supply territorial farm-type model, and represents the productive system of the study area based on 13 types of farms. Table 1 lists the farm types and shows some of their main technical and economic characteristics.

<table>
<thead>
<tr>
<th>WUA facilities</th>
<th>Represented farms (n)</th>
<th>Farm land (ha)</th>
<th>Family Labour (units)</th>
<th>Net Income (€ 000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialist rice</td>
<td>24</td>
<td>115</td>
<td>2.0</td>
<td>134</td>
</tr>
<tr>
<td>Specialist citrus fruits</td>
<td>68</td>
<td>13</td>
<td>1.7</td>
<td>39</td>
</tr>
<tr>
<td>Specialist dairying A</td>
<td>130</td>
<td>31</td>
<td>4.4</td>
<td>207</td>
</tr>
<tr>
<td>Specialist dairying B</td>
<td>40</td>
<td>32</td>
<td>6.3</td>
<td>177</td>
</tr>
<tr>
<td>Specialist market garden vegetables under glass</td>
<td>46</td>
<td>13</td>
<td>3.5</td>
<td>29</td>
</tr>
<tr>
<td>Mixed cropping - Vegetables</td>
<td>562</td>
<td>22</td>
<td>1.7</td>
<td>36</td>
</tr>
<tr>
<td>Mixed cropping - Rice</td>
<td>55</td>
<td>146</td>
<td>1.2</td>
<td>89</td>
</tr>
<tr>
<td>Mixed cropping - Field crops and permanent crops</td>
<td>100</td>
<td>6</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

Rainfed

| Mixed cropping - Vegetables and permanent crops | 100 | 4 | 1.7 | 11 |
| Mixed cropping - Field crops                  | 94  | 25 | 1.2 | 30 |
| Specialist sheep A                            | 45  | 87 | 2.1 | 53 |
| Specialist sheep B                            | 188 | 41 | 1.5 | 10 |
| Specialist sheep C                            | 129 | 62 | 1.6 | 30 |

Five farm types operate in the rain-fed area, and the other eight are located in the irrigated districts.

The farms types are representative farms obtained making an average of the FADN sample by technical economic order. For the specialist dairying, mixed cropping and specialist sheep types the classification was performed using the cluster analysis.

Identified the representative farms, their number in the various irrigation districts categories of the WUA (high pressure, low pressure, gravity, no WAU facilities) was considered.

Considering that the farms types does not operate in all irrigation districts categories, 25 macro farms types that represent the whole territory in terms of size and economic were obtained. The macro farms are identified in the model by way the sets $md$ (district category) and $ty$ (type farms).

The objective function of the model, $z$, has the following structure:
\[ z = \sum_{j,m,d,ty} P_{j,m,d,ty} \cdot Y_{j,m,d,ty} \cdot x_{j,m,d,ty} + \sum_{tyc} P_{milkc} \cdot Q_{milkc_{tyc}} + \sum_{tys} P_{milk} \cdot Q_{milk_{tys}} \\
+ \sum_{j,m,d,ty} CA_j \cdot x_{j,m,d,ty} + \sum_{md,ty} sf_{p_{ty}} \cdot heleg_{md,ty} \\
- \sum_{j,m,d,ty} P_{inp_{md,ty,inp}} \cdot Q_{inp_{j,m,d,ty,inp}} \cdot x_{j,m,d,ty} \\
- \sum_{j,m,d,ty} Twatha_{j,m,d} \cdot x_{j,m,d,ty} \\
- \sum_{md,ty,t} C_{pump_{md}} \cdot wat_{pump_{md,ty,t}} \\
- \sum_{md,ty,t} Plabext \cdot labext_{md,ty,t} \\
- \sum_{feedc,md,tyc} Palimc_{feedc} \cdot alimc_{feedc,md,tyc} \\
- \sum_{feedsmd,ty} Palims_{feeds} \cdot alims_{feeds,md,ty} \] (1)

where \( z \) is the expected gross margin; \( P_{j,m,d,ty} \) are the output prices for each of the \( j \) crops; \( Y_{j,m,d,ty} \) are the crops’ yields; \( x_{j,m,d,ty} \) are the areas of each activity (in hectares); \( P_{milkc} \) is the price of dairy milk; \( Q_{milkc_{tyc}} \) is the milk production in the dairying farm types (tyc); \( P_{milk} \) is the price of sheep milk; \( Q_{milk_{tys}} \) is the milk production in the sheep farm types (tys); \( CA_j \) are the coupled payments under the CAP; \( sf_{p_{ty}} \) and \( heleg_{md,ty} \) are the single farm payment and the eligible area according to the direct payments by CAP; \( P_{inp_{md,ty,inp}} \) and \( Q_{inp_{j,m,d,ty,inp}} \) are the prices and the quantity for the various inputs inp, respectively; \( Twatha_{j,m,d} \) are the water tariffs currently imposed upon various crops, and applied per hectare by the WUA; \( C_{pump_{md}} \) and \( wat_{pump_{md,ty,t}} \) are the costs to pump water from the private wells on the farm and the quantity of water pumped in each period \( t \) (decades), respectively; \( Plabext \) and \( labext_{md,ty,t} \) are the price and the availability of temporary wage labor, respectively; \( Palimc_{feedc} \) and \( alimc_{feedc,md,tyc} \) are the prices and quantities of feeds (feedc), respectively, purchased by the dairying farms; and \( Palims_{feeds} \) and \( alims_{feeds,md,ty} \) are the prices and quantity of feeds (feeds), respectively, purchased by the sheep farms.

The model constraints are defined by the following equations for the land, labor, water, animal feed and the CAP\(^1\).

\[ \sum_{j} R_{land_{j,t}} \cdot x_{j,m,d,ty} \leq A_{land_{md,ty}} \quad \forall m,d,ty \] (2)

where \( R_{land_{j,t}} \) is the matrix of land occupation in the various decades \( t \) for each of the crops \( j \), and \( A_{land_{md,ty}} \) is the total land availability for each macro-farm. The others constraints that refer to land regard the fixed crops, the irrigable land and the land under glass.

\(^1\) In this paper we explain in mathematical way the constraints more relevant or modified respect to the model used in Giraldo et al (2014).
\[
\sum_{jca} R_{\text{labor}}_{jca,md,ty,t} * x_{jca,md,ty} \leq \text{Alabour}_{md,ty,t} \text{ + labext}_{md,ty,t} \quad \forall \text{ md, ty, t} \tag{3}
\]

where \( R_{\text{labor}}_{jca,md,ty,t} \) are the labor requirements for each \( jca \) crop and animal activity and each \( t \) decade. \( \text{Alabour}_{md,ty,t} \) is the fixed labor availability. The constraints consider both the field and stable labor availabilities.

\[
\sum_{\text{mdwua,ty}} R_{\text{water}}_{j,mdwua,ty,tirr} * x_{j,mdwua,ty} \leq \text{Awater} + \sum_{\text{mdw,ty}} \text{watpump}_{mdwua,ty,tirr} \quad \forall \text{ tirr} \tag{4}
\]

where \( R_{\text{water}}_{j,mdwua,ty,tirr} \) are the water requirements for each of \( j \) crops in the irrigation period (tirr decade: from April to October); \( \text{Awater} \) is the availability of agricultural water in the dam in the irrigation period according to the WUA plan. The WUA distributes water from April to October, and in other months can irrigate farms by lifting water from wells: the variable indicates the extent of these uses. In the rain-fed area it is possible to pump water from wells. The possibility of pumping is constrained by the availability, which depends on the number and capacity of the wells.

\[
\sum_{\text{feed}} \text{nualim}_{\text{feed,nuotr}} * y_{\text{feed,md,ty}} * x_{\text{feed,md,ty}} + \sum_{\text{feed}} \text{nualim}_{\text{feed,nuotr}} * \text{alim}_{\text{feed,md,ty}}
\]

\[\geq \text{Rnut}_{md,ty,nuotr} \quad \forall \text{ md, ty, nuotr} \tag{5}\]

where the \( \text{Rnut}_{md,ty,nuotr} \) requirements for various nutrients \( \text{nuotr} \) are satisfied by the farm crops used or purchased feeds, and \( \text{nualim}_{\text{feed,nuotr}} \) is the matrix relative to the nutritional content of each feed. This constraint is different for dairying and sheep farms.

The CAP constraints concern the maximum number of entitlements (\( \text{Nent}_{md,ty} \))

\[
\text{heleg}_{md,ty} \leq \text{Nent}_{md,ty} \quad \forall \text{ md, ty} \tag{6}
\]

### 2.4. Discrete Stochastic Programming model

The model (1) – (6) has been modified to obtain a Discrete Stochastic Programming (DSP) model that allows to consider the various uncertainty elements about the crops yields and the water requirements.

The DSP model can be formalised as follows:

\[
\max_{x,za,zy} z_{\text{dsp}} = \sum_{s} P_{s} * (G_{s} * x - Cza * za - Czy * zy_{s})
\]

subject to

\[
A * x \leq B
\]

\[
A_{s} * x \leq B + za_{s} \quad \forall \ s
\]

\[
N * y_{s} * x + zy_{s} \geq R \quad \forall \ s
\]

\[
x \geq 0, \ za_{s} \geq 0 \text{ and } zy_{s} \geq 0 \quad \forall \ s
\]

\[
\text{where } z_{\text{dsp}} \text{ is the expected total gross income; } P_{s} \text{ are the probabilities of the } s \text{ states of nature; } G_{s} \text{ are the gross incomes for each activities and } s \text{ states of nature; } x \text{ are the cropping activities; } Cza \text{ and } Czy \text{ are the}
\]


costs associated to each za_s and zy_s adaptation actions defined for each s states of nature (e.g. pump water from the private wells, feed purchase); A is the matrix of the technical coefficients and B are the resources availabilities (land and labor); A_s is the matrix of the technical coefficients for each s states of nature (water requirements); N is the matrix relative to the nutritional content of each feed; y_s are the yields of the forage crops for each s states of nature; R are the nutrients requirements.

In our model we considered six types of states of nature. The first and second regard respectively the pasture and grazed herbage yields in the autumnal period. The third referees to pasture yields in the spring period. The fourth regard the herbage hay yields. The fifth interests the water requirements of the ryegrass with relative influence on the yields. The last type referees to the ETN event on the June – August period and affects the water requirements of the summer crops and the alfalfa and corn silage yields.

The PMP methodology was implemented to calibrate the (7) model to the observed situation then a first calibration and validation procedure (Ittersum et al, 2008; Louhichi et al, 2010).

2.5. Modelisation of greening measures

To simulate the application of the three measures of greening, a variable was included in the model (dx_{dj,md,ty}) that considers the rules laid down for the different crops by Reg. 1307/2013 and delegated regulation.

\[ dx_{dj,md,ty} = \sum_{j \in \text{dj}(dj,j)} x_{j,md,ty} \quad \forall \, jd, md, ty \]  

where \( \text{dj}(dj,j) \) is a mapping which groups crops according to established rules.

The delegated regulation states that the shares of different crops must be calculated during the most relevant part of the cultivation period, given the traditional cultural practices in the national context. In our case study was chosen the first decade of June.

Two constraints regulate diversification. The first requires that in farms with arable land exceeding 10 hectares, each crop may not exceed 75% of the arable land in the selected period (tsel).

\[ \text{Rland}_{jd,tsel} \times dx_{dj,md,ty} \leq 0.75 \times \text{Arland}(md, ty) \quad \forall \, jd, md, ty, tsel \]  

where \( \text{Rland}_{jd,tsel} \) is the matrix of land occupation and \( \text{Arland} \) is the arable land in each macro farm.

The second constraint concerns the farms with over 30 hectares of arable land, and requires that the sum of the two main crops does not exceed 95% of the arable land.

\[ \text{Rland}_{jd,tsel} \times dx_{dj,md,ty} + \text{Rland}_{djd,tsel} \times dx_{djd,md,ty} \leq 0.95 \times \text{Arland}(md, ty) \quad \forall \, jd, djd, md, ty, tsel \quad \text{with} \, jd \neq djd \]  

The constraint on maintaining permanent grassland has been specified at the farm level, waiting to specific decisions in this regard: in particular, the grazing land should not decrease more than 5%.

\[ x_{\text{past},md,ty} \geq 0.95 \times x_{\text{past},md,ty}^0 \quad \forall \, md, ty \]  

doing \( x_{\text{past},md,ty}^0 \) is the pasture area observed in the reference period.

5% of the arable land was allocated to "ecological focus area" in the more intensive farm types (specialist dairying and mixed crops with vegetables) with more than 15 hectares of arable land.
2.6. Simulated scenarios

The model was calibrated to the situation observed in 2010 considering the current climate conditions and the relative yields and water requirements of the crops (Current climate). This scenario were transformed to the policy and market condition observed in the 2013. This involved the decoupling of aid for rice, processed tomatoes, and premium quality durum wheat, and also taking account of the recent relative price increase for corn silage for biogas; this is henceforth termed the CAP 2013 scenario. The greening measures were applied to the CAP 2013 scenario; this is referred to as the Greening scenario. The impact of greening was assessed by comparing the Greening scenario respect the CAP 2013 scenario.

In the future climate scenario (Future climate) were considered the probability distributions changes related to: pasture and grazed herbage yields in the autumnal period; pasture yields in the spring period; herbage hay yields; water requirements and yields of rye grass; water requirements of the summer crops and the alfalfa and corn silage yields. Also the impact of temperature and humidity (THIndex) on milk quality and quantity, and heads mortality is considered.

The greening measures have been applied in this scenario and was compared with the Greening scenario of the Current climate.

3. RESULTS

3.1. Greening in the current climate scenario

The application of the greening measures in the Current climate scenario, compared to the 2013 CAP scenario, determines in general a reduction of corn silage for biogas and rye grass (Table 2).

Table 2. Cropping patterns (ha), water use (000 m$^3$), labour use (000 h) and nitrogen use (000 kg) for CAP 2013 and Greening in the current climate scenario and Greening in the future climate scenario. Absolute values and percentage changes. Total area.

<table>
<thead>
<tr>
<th></th>
<th>Current climate</th>
<th>Future climate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAP 2013</td>
<td>Greening</td>
</tr>
<tr>
<td>Arable land</td>
<td>41,280</td>
<td>-3.2</td>
</tr>
<tr>
<td>corn silage for biogas</td>
<td>4,617</td>
<td>-40.7</td>
</tr>
<tr>
<td>corn silage feed</td>
<td>2,881</td>
<td>16.9</td>
</tr>
<tr>
<td>alfalfa</td>
<td>1,121</td>
<td>48.5</td>
</tr>
<tr>
<td>ryegrass</td>
<td>5,700</td>
<td>-29.2</td>
</tr>
<tr>
<td>herbage</td>
<td>9,709</td>
<td>9.1</td>
</tr>
<tr>
<td>Permanent grassland and permanent pasture</td>
<td>12,020</td>
<td>0.0</td>
</tr>
<tr>
<td>Total water</td>
<td>102,581</td>
<td>-3.7</td>
</tr>
<tr>
<td>Total labour</td>
<td>5,054</td>
<td>-0.1</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>10,311</td>
<td>-5.8</td>
</tr>
</tbody>
</table>

This reduction concerns in particular the specialist dairying farms and simultaneously there is an increase in the corn silage feed and alfalfa.

In general, the production of herbage increases since it is not affected by the greening constraints.
Note also the maintaining permanent grassland. In the CAP 2013 scenario, these areas were increased in the specialist sheep farms considering the decoupling of quality durum wheat premium and consequently the economic convenience reduction of this crop.

The cropping patterns changes cause a further reduction of the water use which had already suffered a significant reduction in the CAP 2013 scenario due to the direct payments decoupling and the consequent extensification.

The labour use remains unchanged while the nitrogen use decreases significantly with possible positive consequences for the environment of the area.

Regarding the economic results, the application of the greening measures causes a reduction of net income equal to 2.6% (Table 3).

Table 3. Economic results for CAP 2013 and Greening in the current climate scenario and Greening in the future climate scenario. Absolute values (000 €) and percentage changes. Total area.

<table>
<thead>
<tr>
<th></th>
<th>Current climate</th>
<th>Future climate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAP 2013</td>
<td>Greening</td>
<td></td>
</tr>
<tr>
<td>Revenues total</td>
<td>204,556</td>
<td>-3.2</td>
<td>-1.8</td>
</tr>
<tr>
<td>revenues crops</td>
<td>114,750</td>
<td>-5.6</td>
<td>-0.7</td>
</tr>
<tr>
<td>revenues animal</td>
<td>89,806</td>
<td>0.0</td>
<td>-3.1</td>
</tr>
<tr>
<td>Direct payments</td>
<td>31,626</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Costs</td>
<td>126,478</td>
<td>-3.4</td>
<td>1.4</td>
</tr>
<tr>
<td>input</td>
<td>62,210</td>
<td>-3.4</td>
<td>-0.3</td>
</tr>
<tr>
<td>WUA water</td>
<td>2,158</td>
<td>-11.0</td>
<td>-2.4</td>
</tr>
<tr>
<td>water pumping</td>
<td>274</td>
<td>0.1</td>
<td>2.3</td>
</tr>
<tr>
<td>extra labour</td>
<td>7,179</td>
<td>-3.6</td>
<td>-1.1</td>
</tr>
<tr>
<td>feeds</td>
<td>30,382</td>
<td>-7.1</td>
<td>9.3</td>
</tr>
<tr>
<td>other costs</td>
<td>24,276</td>
<td>1.8</td>
<td>-2.5</td>
</tr>
<tr>
<td>Gross Margin</td>
<td>109,704</td>
<td>-2.0</td>
<td>-4.9</td>
</tr>
<tr>
<td>Net Income</td>
<td>81,417</td>
<td>-2.6</td>
<td>-6.6</td>
</tr>
</tbody>
</table>

This reduction affects the specialist dairying farms and minimally the mixed cropping with vegetables farms (Table 4).

The decrease of net income is determined in particular by the reduction of revenues crops resulting from the corn silage for biogas. However, there was also a reduction in costs and in particular of feeds given the increased of corn silage feed and alfalfa.
Table 4. Net Income per each typologies for CAP 2013 and Greening in the current climate scenario and Greening in the future climate scenario. Absolute values (000 €) and percentage changes.

<table>
<thead>
<tr>
<th>Typology</th>
<th>Current climate</th>
<th>Future climate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAP 2013</td>
<td>Greening</td>
</tr>
<tr>
<td>Specialist rice</td>
<td>3,299</td>
<td>0.0</td>
</tr>
<tr>
<td>Specialist citrus fruits</td>
<td>2,666</td>
<td>0.0</td>
</tr>
<tr>
<td>Specialist dairying A</td>
<td>26,990</td>
<td>-6.2</td>
</tr>
<tr>
<td>Specialist dairying B</td>
<td>7,091</td>
<td>-6.4</td>
</tr>
<tr>
<td>Specialist market garden vegetables</td>
<td>1,311</td>
<td>0.0</td>
</tr>
<tr>
<td>vegetables under glass</td>
<td></td>
<td>-0.1</td>
</tr>
<tr>
<td>Mixed cropping - Vegetables</td>
<td>20,125</td>
<td>-0.1</td>
</tr>
<tr>
<td>Mixed cropping - Rice</td>
<td>5,702</td>
<td>0.0</td>
</tr>
<tr>
<td>Mixed cropping - Field crops and permanent crops</td>
<td>1,284</td>
<td>0.0</td>
</tr>
<tr>
<td>Mixed cropping - Vegetables and permanent crops</td>
<td>1,019</td>
<td>0.0</td>
</tr>
<tr>
<td>Mixed cropping - Field crops</td>
<td>2,700</td>
<td>0.0</td>
</tr>
<tr>
<td>Specialist sheep A</td>
<td>1,902</td>
<td>0.0</td>
</tr>
<tr>
<td>Specialist sheep B</td>
<td>1,902</td>
<td>0.0</td>
</tr>
<tr>
<td>Specialist sheep C</td>
<td>5,427</td>
<td>0.0</td>
</tr>
</tbody>
</table>

3.2. Greening in the future climate scenario

In the Future climate scenario, there is a yields reduction of corn silage, alfalfa, hay herbage and pasture. Vice versa increase the herbage and ryegrass pasture yields.

Also summer crop irrigation requirements increase. However, this increase has no relevant impact because the water is not a limiting factor in the area and the water payment system is defined per hectares.

The changes yields in the Future climate scenario compared to Current climate scenario with the same respect of the greening measures, resulting in a further reduction of corn silage for biogas in the specialist dairying farms (Table 2). Instead increases the land devoted to corn silage feed to satisfy the animal nutritional requirements. The alfalfa is replaced by ryegrass.

In the specialist sheep farms the pasture yield reduction, the greening constraint and the decoupled direct payments system leads to an increase of the pasture to satisfy the sheep nutritional requirements.

The water, labour and nitrogen uses do not suffer significant changes.

The general worsening of yields implies a reduction in net income due to the revenues crops reduction and in particular to increases of feeds (Table 3).

In fact, the livestock farms are the most interesting considering that in the future scenario the summer heat waves lead to a reduction in the milk quality and quantity and increased of heads mortality.

4. DISCUSSION

In many irrigated Mediterranean regions the production of silage corn for biogas has in recent years become of economic interest because of the price increase, and there is also interest in the elimination of direct aids to industrial tomato crops and, to a lesser extent, wheat and rice. Our model results showed that
Specialist dairying and Mixed cropping farms (both irrigated types) react strongly to the corn silage price rise by increasing production; for Specialist dairying farms biogas corn also partially replaced silage corn for livestock feed. These results are consistent with changes over the past three years, as shown through many stakeholder interviews, but they not yet been statistically documented in the literature.

This change exposes the Specialist dairying farms to the constraints of greening, but these farms already have a large part of their area devoted to the cultivation of corn for livestock feed, and thus easily reach and exceed the threshold for excessive specialization culture.

Also the Mixed cropping with vegetables are interested by the constraint related to the diversification that determines the reduction of land allocated to corn silage.

In both types, the most intensive above 15 hectare, the measure relating to the EFA could act and determine the reduction of arable land.

The application of the measures greening in the current climate scenario seems to have a more significant impact respect to the future climate scenario. This is because in the future scenario, the general worsening of some crops yields large cultivated in the territory and involved by greening (such as corn silage) leads to greater crop diversification and extensification of the cropping patterns.

5. CONCLUSIONS

In this study the impact of greening was assessed using a supply territorial farm-type model.

This model design, and in particular the dimensional differentiation, is essential for this kind of analysis, because many farms types (those under 10 ha of arable land) are exempted from greening.

The model is also territorial in the sense that there is competition for some resources (such as water and external labor) among the various farm types. Analyzing this is also useful for assessing policy impacts at a territorial scale, because some farms types could be involved indirectly. Another fundamental model characteristic is the specification of social (such as family and external labor) and environmental indicators (chemical inputs, and pressure on water resources, both collectively owned and private wells), which facilitated assessment of the impact of the new policy on sustainability throughout the territory.

The results of the modeling suggest that the greening measure has some contradictory effects. First, many farms in Italy are below the application threshold and therefore will not be affected. Those above the threshold will be affected, but production specialization can be maintained because the revenues lost and the additional costs resulting from greening may be greater than the premium, particularly in the early years of application of the policy, when the penalty is lower. In this sense the choice between the two greening payment options (flat rate or proportional to the SPS) and the convergence of decoupled payments are important. Also choice of the sectors concerned and the consequent coupled payments amount is very important since it can lead to productive choices that encourage or less the compliance with the greening measures.

The analysis showed that greening might thwart strategy objectives such as the 2020 bioenergy development, and thus markedly contradicts European policy goals.

However, despite these negative aspects, greening appears to have a positive impact on chemical use, particularly nitrogen.
AKNOWLEDGMENTS

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REFERENCES


