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# Multi-farm economic analysis of perennial energy crops in Central Greece, taking into account the CAP reform

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## ABSTRACT

This study analyses farm level economic impacts of biomass production from perennial crops including *Arundo donax* L. (arundo), *Miscanthus x giganteus* (miscanthus), *Panicum virgatum* L. (switchgrass) and *Cynara cardunculus* L. (cardoon). Regional biomass supply curves are estimated with a dynamic, multi-farm, mathematical programming model. Micro-economic data for the model are generated from farm surveys covering 52 farms containing a total of 400 parcels, in Central Greece. The study also examines the potential effects of the Common Agricultural Policy reform in 2003 on regional biomass supply. Simulations show that the policy reform toward decoupled subsidies lowers the cost of biomass between 15 and 25 euro per tonne. Switchgrass appears to be the most attractive option, followed by cardoon and miscanthus. Due to high specific machinery cost, arundo is never preferred. Relative to the agricultural policy setting of Agenda 2000, the biomass potential increases more for farms of small economic size and farms with a higher share of cotton.

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## 1. Introduction

Limited fossil fuel resources, concerns about climate change, agricultural and rural development opportunities, and technical progress in biomass processing have increased researchers' and policymakers' attention to bioenergy. While the long-term role of bioenergy within the diverse suit of renewable energy sources remains uncertain, several studies suggest at least a transitional role [8]. In Europe, the political

belief in bioenergy is reflected by several directives and proposals to promote bioenergy issued by the European Commission over the last decade. These include:

- White Paper on Energy
- Directive 2003/30 on promotion of liquid bio-fuels for transport
- Directive 2001/77 on promotion of electricity generated by renewable energy sources

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- Directive 2003/87 on trading system of greenhouse gases rights etc.
- Special subsidy of 45 €/ha for energy crops (Council Regulation (EC) 1782/2003)
- Directive 2009/28/EC on the promotion of the use of energy from renewable sources

Energy from the biomass of perennial crops can increase energy self sufficiency and may offset emissions of greenhouse gases from fossil fuel combustion. The EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources sets the following targets for the year 2020:

- Greenhouse gas emission reductions of at least 20% relative to 1990 levels;
- Energy efficiency improvements of 20%;
- Renewable energy share of at least 20%;
- Biofuel share of 10% in transport fuels.

Despite considerable political support and technical progress in bioenergy supply chains, private market uptake has been below expectations. Possible reasons include a currently low carbon credit price and the lack of economics in many engineering based bioenergy studies. Schneider and McCarl [12] show substantial differences between engineering based technical and economic potentials of energy crop systems where the latter account for both direct and opportunity costs. The opportunity costs of bioenergy are affected by the farmer's revenue from conventional crop production and may include the impacts of agricultural policies. The latest Common Agricultural Policy (CAP) reform for the period 2006–2013 [Council Regulation (EC) 1782/2003] partly decouples the farm subsidies from specific production activities. Previous research in Greece [6,7] shows that the 2003 CAP reform may decrease the direct cost of biomass up to 50%.

The main objective of this study is to present analytical dynamic modelling approach for the analysis of energy crop production potentials under changing CAP. To illustrate the approach, a case study is performed which uses detailed, newly collected farm survey data from 52 farms in Central Greece.

## 2. Methodology

The assessment uses technical and economic data collected from a representative sample of farms. These data are processed with a cost analysis model to obtain consistent micro-economic data for both conventional and energy crops, for each parcel of all farms. A fully dynamic multi-farm mathematical model is developed which integrates the processed farm survey data and estimates the marginal costs of biomass for various biomass targets and for a set of agricultural policy scenarios.

### 2.1. Sample of farms

The sampling of farms considered two main criteria:

1. Economic size, measured in ESU (European Size Unit). Three basic categories were included: a) small farms

(2–16 ESU), b) medium farms (16–40 ESU) and c) large farms (>40 ESU).

2. Farm type, based on the estimated income from each crop. The farms were categorised into a) *cotton farms* with 2/3 or more of the farm income coming from cotton production, b) *arable farms* with the income coming from diverse arable crops (less than 2/3 for each one) and c) *mixed farms* with joint production of arable crops, trees and/or vegetables.

For each of the 9 combinations of economic size and farm type, farm population data from the Hellenic Statistical Authority (EL.STAT) were used to randomly select farms for the sample.

### 2.2. Questionnaire

For each farm in the sample, a questionnaire was completed, based on the information from individual interviews with the leader of each farm. The questionnaire included the following main parts:

1. General information about the people involved in the main production activities of the farm
2. Subsidized area (according to the rules of the latest CAP) by crop and subsidy type
3. Characteristics of each parcel of the farm (location, area, land rent, irrigation characteristics, source of water, irrigation fee etc.)
4. Crop specific data for every parcel (cultivated area, irrigation, yield etc.)
5. Product prices, wage rates, raw materials prices
6. Own mechanical equipment of the farm with information on machinery type, age, purchasing price, economic life, annual maintenance and insurance, annual operation etc.
7. Building and construction of the farm (construction cost, year of construction, maintenance and insurance cost, relative use for each product)
8. Crop cultivation practices for each parcel, concerning operation details, such as timing, machinery usage, efficiency and fuel consumption, raw materials, rented operations etc.

### 2.3. Cost analysis

An independent cost analysis for all conventional and energy crop production options is performed for each parcel. The total production cost for each crop is decomposed into a number of activities<sup>2</sup> which sufficiently describes all required tasks for plant instalment and cultivation [3]. Each operation is characterized by its *timing* (both duration per hectare and seasonality within each year) and its requirements for *labour*, *equipment* and *materials*.

*Mechanical equipment* may be hired if own machinery endowments are insufficient or absent. Rental rates for hired equipment are based on actually paid rents or computed as the sum of expenses from depreciation, interest, maintenance, insurance and fuel. Own mechanical equipment

<sup>2</sup> ABC (Activity Based Costing) analysis.

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