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Sunflower: A very high value crop?

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Executive summary

This work attempts to present a detailed picture of the sunflower cultivation in Greece in comparison with its most competitive crops, in terms of costs, benefits, income, employment and expertise. Thus, the economic effectiveness, of sunflower cultivation at farmers' level, is thoroughly examined, the indirect benefits (crop rotation, social, environmental, foreign exchange, energy dependence) of sunflower chain assessed and finally both direct and indirect benefits generated for the region are estimated.

The primary objective of the first chapter of this study is to assess the significance of sunflower processing industry for the Greek producer. Specifically, the objective of the current research endeavour is *twofold*: *first, to evaluate the role of the sunflower processing industry and its significance for the economy, society and Greek producer and second, to assess the reflection of experts and producers as regards the importance of sunflower cultivation*. **According to the results, sunflower is the best practical and cost-effective crop although wheat can also provide acceptable benefit/cost ratio.** However, the most important reason of sunflower cultivation relates to its ability to be cultivated in dry conditions and to the important effects of crop rotation between sunflower and maize or wheat. **The most effective crop rotation is between sunflower and wheat. Crop rotation between sunflower and wheat (or corn) increases regularly the yields of all crops of about 8% to 10% ensuring an additional annual mean net income of 145 €/ha. On the other hand the indirect benefits can be evaluated and quantified to a total amount of 43,900,000 €/year for the Greek economy, as follows:** *a) reducing carbon dioxide emissions=7,000,000 €/year, b) reducing of sulfur dioxide=300,000 €/year, c) reducing of energy dependence=1,500,000 €/year, d) employment benefits=900,000 €/year, e) social benefits=200,000 €/year and f) foreign exchange benefits=34,000,000 €/year.* However, only 70% of these indirect benefits come from the cultivation of sunflower as the rest 30% come from the cultivation of oilseed rape.

Furthermore, an attempt was made (in the second chapter) to generate the probable economic impacts at regional and country level due to sunflower cultivation withdrawal. **In this hypothetical case significant income losses are expected for both farmers and regional economy especially in the Region of Eastern Macedonia-Thrace (Table 1).**

Table 1. Sunflower case in Region of Eastern Macedonia-Thrace (REMT)

Net benefits at farmers level (per ha)	€42.5-€150.0
Net benefits at average farm (average farm: 4ha)	€170.0-€600.0
Net benefits (direct) at regional level (REMT)	€4.558 million
Indirect benefits at regional level (REMT)	€8,056 million
Both direct and indirect benefits at regional level (REMT)	€12,614 million
Sunflower withdrawal loss at regional level (REMT)	€3.777 million
Both direct and indirect effects of sunflower withdrawer	€11,833 million
Multiplier effects on benefits of sunflower withdrawer	€23,666 million

Considering not only the direct loss of farmers' income but also the indirect loss of the whole economy, generalization results of loss further increasing (Figure 2.3.2.1) and taking into account t**he multiplier's effect** (total benefit garnered by the society, if this additional income will spend within the regional or national economy) **the whole benefits are doubled. Therefore, any change in the status of sunflower cultivation, will cause huge loss of income (Figure 2.4.1).**

Table 2. List of Abbreviations

ABAF	Accounting Books of Agricultural Farms
CHP	Combined Heat and Power
ELSTAT	Greek Statistical Authority
FQD	Fuel Quality Directive
GHG	Greenhouse gas emissions
IACS	Integrated Administration and Control System
MS	Member States
RED	Renewable Energy Directive
REMT	Region of Eastern Macedonia-Thrace
RES	Renewable Energy Sources
SAPS	Single Area Payment Scheme
SBIBE	Hellenic Biofuels and Biomass Association
YPEKA	Ministry of Environment, Energy and Climate Change

Finally, farmers' reflections on sunflower cultivation were measured in two selected areas, where the most of sunflower cultivation is concentrated (Central Macedonia and Thrace). Based on the findings of the survey, noteworthy is that farmers are very satisfied from their involvement in sunflower cultivation and their collaboration with the industry. The results derived from the analysis of farmers' perceptions are very in line with the technical analysis developed in the previous sections of the study.

Chapter 1

Significance of sunflower processing industry for the Greek producer

1.1 Introduction-objectives

Energy issues were found in the spotlight recently, affecting substantially national economies at European and global level. Climate change combined with the rising cost of fossil fuels and the unfavorable prospect of reducing their inventories, have turn the interest in Renewable Energy Sources (RES). The exploration of alternative energy sources emerged mainly from the 1973 oil crisis, with particular attention being given to the possibility of using biomass as the basis for fuel production. Policymakers have quickly visualised the role bioenergy can play in mitigating climate change through reducing greenhouse gas (GHG) emissions, and they devised various financial support tools to biofuel sector. However, according to Baker (2007), the cultivation of crops for bioenergy production condemned developing several counter arguments (soil degradation, biodiversity loss, stress on water resources and trade-off with food supply).

The alternative energy sources focused mainly on biomass and biofuels. In the broadest sense, biomass includes any material derived from living organisms and it comprises any type that can be used to produce solid, liquid or gaseous fuels. Generally speaking biomass refers to residual forms (agricultural biomass, animal biomass, biomass from forests and municipal waste) related mainly to biomass that is left on the field after any agricultural work, but also in biomass that is left as a byproduct of many various forms of pretreatment plants. On the other hand, biofuel refers to liquid fuels from biomass and can be used in the transport sector. The most common in trade are biodiesel and bioethanol. Biodiesel is produced mainly from oil seeds (such as sunflower, rapeseed, etc.) and is usually used in admixture with diesel fuel in diesel engines, whereas bioethanol is produced from sugar-containing, cellulosic and starch crops usually used in mixture with gasoline (Berndes et al., 2003).

Results from the analysis of the EU market of biomass, bio-energy sources and energy from biomass show a very dynamic situation, having rapidly evolved especially since 2003 (European Commission, 2006). This rapid increase in the adoption of energy crops for bioenergy production has implications for business, civil society and the environment. It has also led to greater attention being paid both to the potential opportunities offered by bioenergy and to the negative direct and indirect effects of bioenergy production, particularly using current technologies (IRGC, 2008). **Hence, the production of biofuels appears as a prospect for creating new career development opportunities to diversify income and employment in rural areas**. However, the economic viability of energy crops for biomass production is still uncertain, under the current market conditions, though the need for crops diversification is evident, as the farm income decreased due the fall in prices and reducing subsidies, and because of the high input costs, environmental degradation and high environmental outputs (Kampman et al., 2012).

The Common Agricultural Policy (CAP) have oriented towards energy crops production, as they enabled producers to diversify their crops and improve their income. The recent CAP reforms introduced the decoupling of aids from production, which resulted in turning extensive farming to a not viable farming. The intensification of agriculture has also caused considerable depletion of water resources and soil degradation and the use of pesticides and fertilizers contributed to environmental pollution as well as to reduce farm income. The introduction of energy crops would be a key element both to offer a new perspective for agriculture and secondly a new solution to the global energy problem. **Given the multiple benefits of energy utilization of biomass and the peculiarities of the Greek agricultural sector, these crops represent an attractive solution for producing fuels increasing the competitiveness of rural areas and boosting employment and environmental protection**.

Thus, since the needs for energy are increasing in the EU, increasing dependency on energy imports, EU Member States (MS) should ensure sustainable and competitive energy sources and reduce dependence on fossil fuels. Energy crops can provide solutions to these issues. The advantages of the adoption and production of energy crops offer high returns, less requirements in irrigation and nutrients and more environmental friendliness (Geronikolou et al., 2004). Furthermore, energy crops are promoted by the EU through a specific policy context; Nevertheless, such policies are designed to pursue different objectives like agricultural support, rural development, reduced dependence on foreign energy sources, environmental rehabilitation, and climate change mitigation. These multiple and diverse objectives require an integrated and coherent policy approach to be achieved.

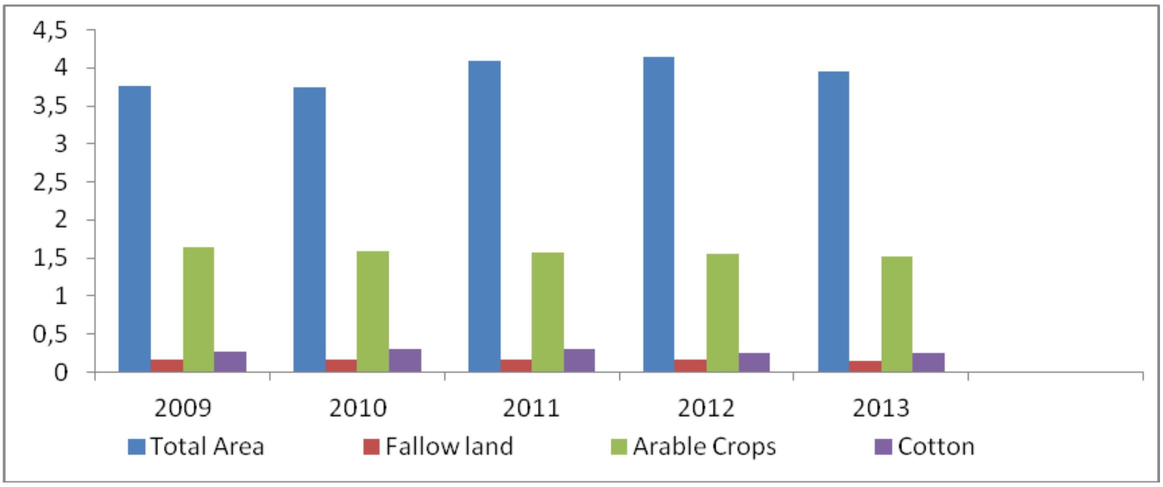
Based on the aforementioned issues, the present study aims to assess the importance of Sunflower as an energy crop in the Greek agriculture. Specifically, the objective of the current research endeavour is *twofold*: *first*, to evaluate the role of the sunflower processing industry and its significance for the economy, society and Greek producer and *second*, to assess the reflection of experts and producers as regards the importance of sunflower cultivation. The cultivation of sunflower is associated with the operation of the domestic industry, which undertakes the processing and manufacturing of biodiesel and offers assistance in cultivating, establishing and promoting agriculture under contracts. The next section will provide an overview of the market and EU policy regarding energy crops and bioenergy.

1.2 Overview of the market and the EU policy

Sunflower (Helianthus) is an annual plant, which belongs to the family of *Compositae* and the most important crop species is the annual Sunflower (*Helianthus Annuus*). Sunflower is considered one of the most important oil crops both globally and in Europe, as the oil is edible containing unsaturated fatty acids, vitamins, minerals elements, and fat-soluble vitamins, and it is used in human nutrition and for the preparation of biofuels (Lois and Anastopoulos 2006). The cultivation of sunflower is mainly concentrated in the northeastern part of Greece and it is grown as a source of vegetable oil nutrition (in a percentage of 40%-50%), but also as raw material for biodiesel production. One hectare of sunflower produced on average 1,500-3,000 kg/ha in non-irrigated areas and 3,000-4,500 kg/ha in irrigated areas (Faostat, 2015), with a corresponding 430-750 liters of biodiesel production (Danalatos et al., 2007). **The sunflower is considered as one of the prevailing energy crops for the Greek conditions as it produces competitive yields of seed/oil, from which high quality**

biofuels can be produced. Furthermore, the pie produced as a by-product from the cold pressing of the seed is an excellent animal feedstuff and plant residues left on the field after harvesting may be collected, compressed into pellets and used as solid fuel. The indirect advantages of the cultivation include that the product is a "clean" fuel, providing significant environmental benefits. Farmer's preference for sunflower cultivation is typical as the crops records an increase in the recent years, mainly due to contracts that ensure a secure and stable farm income (Zafeiriou et al., 2014).

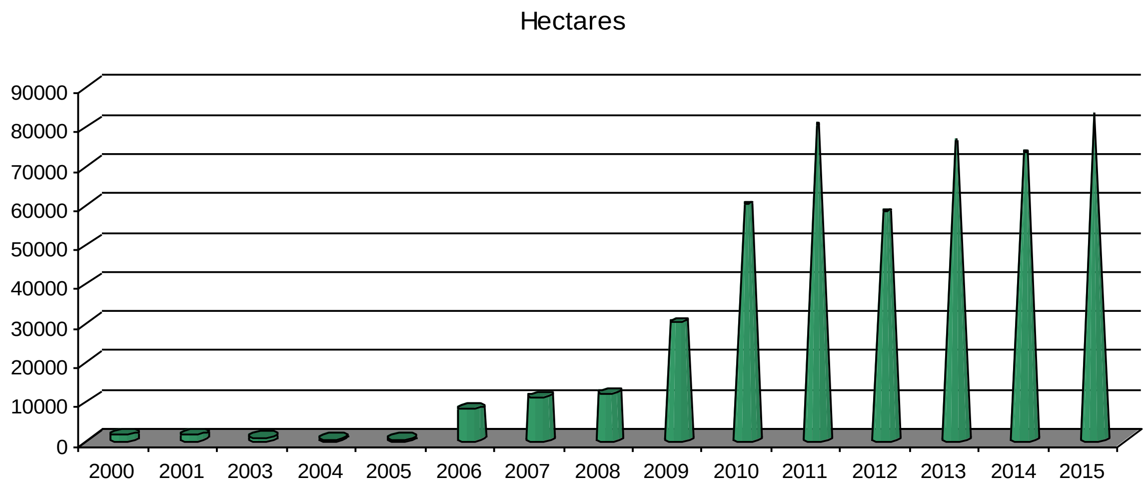
Currently, the land use for agriculture in Greece is about 4 million hectares and accounts for 40% of the total area, of which 35% is arable crops, 4% is cotton cultivation, the orchards and the olive groves represent approximately 30%, around 5.5% involves the measure of set-aside, while the remaining percentage corresponding to fruit and vegetables, herbs, vines and other crops.



Source: Eurostat, 2015

Figure 1.2.1. Land use in Greece (millions ha)

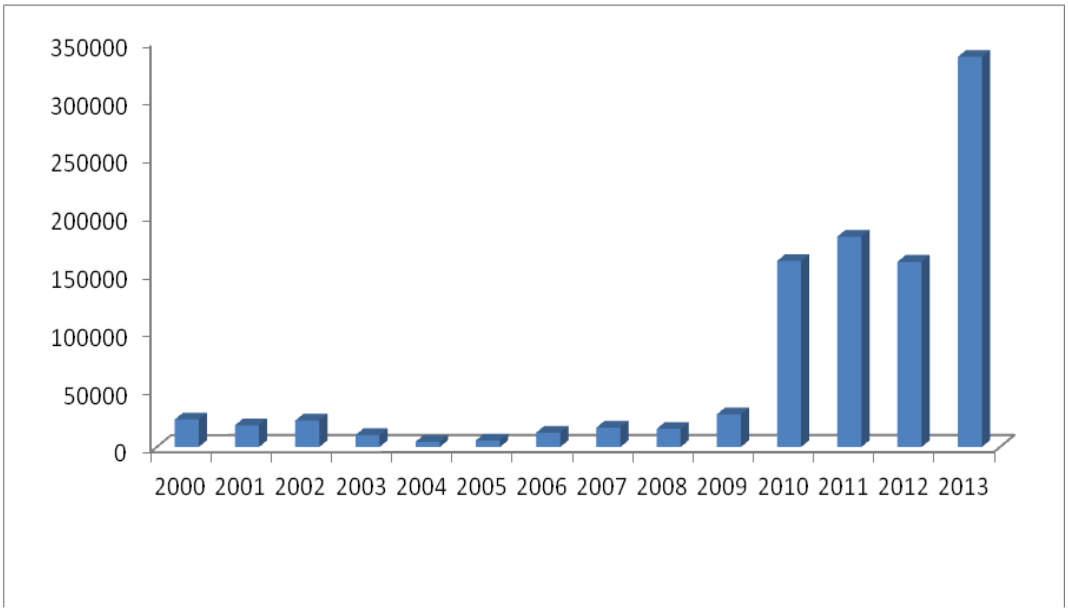
The development of new technologies to increase the efficiency of energy crops, along with the possibility to grow energy crops on low-medium efficiency farm land (given the need for green energy sources that do not pollute the environment and do not increase the greenhouse effect), highlight the key role of energy crops as an integral part of sustainable agriculture. The cultivation of sunflower has increased especially between 2009 and 2011 (Figure 1.2.2), which may be due to the increased producer prices through contracts and the relatively low production costs compared to crops such as wheat and corn. Since then, the trend is stable reflecting the satisfying levels of producer prices (set at 0.35€/kg in 2014) through contracts.



Source: Eurostat, 2015

Figure 1.2.2 Area of sunflower cultivation in Greece from 2000-2014

Accordingly, as it illustrated in the following Figure 1.2.3, the production of sunflower seed reached 181,000 tonnes in 2011 and climbed to 336,600 tonnes in 2013.

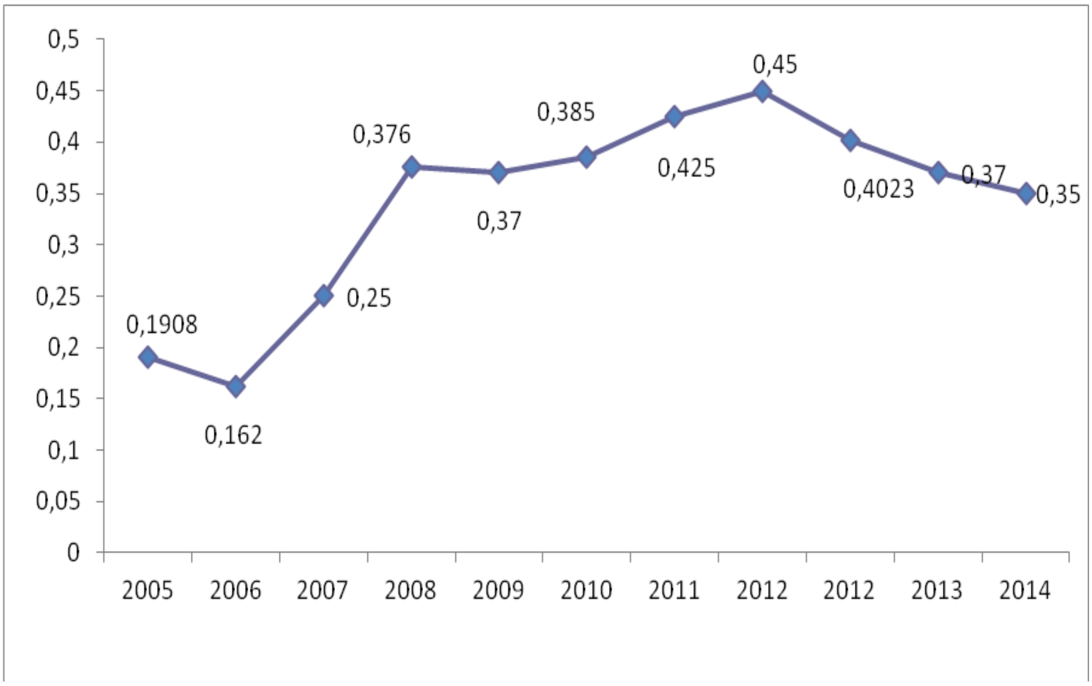


Source: Eurostat, 2015

Figure 1.2.3 Sunflower seed production from 2000 to 2013 (in 1,000 tonnes)

The sunflower seed actually emphasizes the importance of the plant as an industrial and energy crop as it produces one of the best vegetable oil, the sunflower oil. Based on the literature, in a performance of 2,500 kg seed per hectare, 1,200 kg of oil and 800 kg of feedstuff per hectare can be obtained.

Concerning the producer price, for the five years 2000-2005, it remained relatively low (0.17 €/Kg-0.19 €/Kg), and since 2010 it has fluctuated at higher levels of around 0.35 €/Kg- 0.42 €/Kg. For the year 2014, the price was set at 0.35 €/Kg. In the next chart we can see the variation of sunflower producer prices over the last eight years.



Source: Eurostat 2015

Figure 1.2.4 Price evolution (€/Kg) of sunflower between 2005 and 2014 in Greece

A key element of the sunflower is its average oil content of the seed that ranges between 40% and 50%. Table 1.2.1 clearly shows the superiority of sunflower yield in Kg/ha and lt/ha in biofuel, along with the competitive cultivation of rapeseed.

Table 1.2.1 Yields of crops for production of liquid biofuels, in raw materials and fuel

Biofuel	Source	Yield (kg/ha)	Yield in fuel (kg/ha)	Yield in biofuel (lt/ha)
Biodiesel	**Sunflower**	**1,200-2,100**	**400-700**	**430-750**
	Cotton	1,200-1,600	170-230	180-250
	Soya	1,600-2,400	270-410	290-440
Bioethanol	Cereal	1,500-8,000	360-1,900	450-2,400
	Corn	9,000	2,130	2,700
	Sugarbeets	60,000	4,750	6,000
	Sorghum	70,000-100,000	5,530-7,900	6,750-9,000

Source: Kittas et al., 2007

1.2.1 Sunflower biodiesel production and processing plants

According to the Action Plan on Biomass and Biofuels in Greece, there are more than 21 counties that can be used for cultivating energy crops. Meeting energy goals in the country result in the operation of sunflower processing plants and bioconversion, which operate based on contract farming, providing a producer price that is set to 0.35€/Kg. Indicative plants include AgroInvest, P.N PETTAS SA, FYTOENERGEIA and GF Energy. For 2015, plants that will engage in the production of biodiesel count to 17 (Table 1.2.1.1), which, under the provisions of Article 15A of the l. 3054/2002 as in force, were defined as the beneficiaries for the distribution of unchanged form of biodiesel. **However, only 11 of them are processing sunflower** (shown in bold in the Table 1.2.1.1). The processing plants allocated a total quantity of 144,000 kiloliters of biodiesel in unchanged form and the percentage participation of each plant was determined according to the following Table 1.2.1.1 that also illustrates the distributions for the last five years.

Table 1.2.1.1 Beneficiary plants for biodiesel distribution in Greece

	2014-15		2013-14		2012-13		2011-12		2010-11	
	kiloliters	**(%)**	**kiloliters**	**(%)**	**kiloliters**	**(%)**	**kiloliters**	**(%)**	**kiloliters**	**(%)**
MIL OIL HELLAS A.E.	7.143,9	5.1%	6.640,9	4,99%	3.007,1	3.27%	342	0.20%	2.655	1.77%
ΜΑΝΟΣ Α.Ε.	7.355,5	5.25%	5.998,9	4,51%	3.898,6	4.24%	11.483	6.87%	4.465	2.97%
STAFF COLOUR ENERGY A.B.E.E.	4.254,3	3.04%	3.914,2	2,94%	6.437,3	7%	2.796	1.67%	5.284	3.52%
ΒΙΟΝΤΙΖΕΛ ΜΟΝ. Ε.Π.Ε	5.238,4	3.74%	3.189,4	2,40%	3.075, 3	3.34%	7.552	4.52%	761	0.50%
BIOENERGIA	3.714,4	2.65%	3.152,4	2,37%	1.993,4	2.17%	0	0	3.801	2.53%
AGROINVEST S.A.	32.635,9	23.31%	28.307,4	21,28%	19.246,6	20.92%	15.323	9.18	26.155	17.43%
ΠΑΥΛΟΣ Ν. ΠΕΤΤΑΣ Α.Β.Ε.Ε.	23.495,7	16,78%	28.007,5	21,06%	15.323,2	16.66%	27.892	16.70%	38.513	25.60%
ΜΟΤΟΡ ΟΙΛ ΔΙΥΛΙΣΤΗΡΙΑ ΚΟΡΙΝΘΟΥ	2.746,0	1.96%	2.000,7	1,50%	1.242,7	1.35%	1.898	1.15%	5.674	3.78%
ΕΛΙΝ ΒΙΟΚΑΥΣΙΜΑ	14.094,7	10.07%	11.471,4	8,63%	7.704,2	8.37%	32.148	19.20%	19.744	13.15%
NEW ENERGY S.A.	13.305,6	9.50%	10.436,8	7,85%	0	0	0	0	0	0
ΕΛ.ΒΙ. Α.Β.Ε.Ε.	0	0	1.758,1	1,32%	6.437,3	7%	32.148	19.26%	19744	13.15%
AVIN	1.439,8	1.03%	1.689,7	1,27%	0	0	0	0	0	0
ΕΛΛΗΝΙΚΑ ΠΕΤΡΕΛΑΙΑ Α.Ε	1.228,3	0.88%	1.014,8	0,76%	1.3	0	0	0	0	0
ΠΕΤΤΑΣ Α.Ε.	0	0	1.006,7	0.76%	0	0	1.45	0.01%	0	0
ΒΙΟΜΗΧΑΝΙΑ BIODIESEL Α.Ε.	0	0	903,9	0,68%	1.217,0	1.32%	7.552	4.52%	761	0.50%
ΡΕΒΟΪΛ ΒΙΟΚΑΥΣΙΜΑ Α.Ε.	931,7	0.67%	849,4	0,64%	1.242,7	1.35%	0	0	0	0
ΕΠΙΛΕΚΤΟΣ ΕΝΕΡΓΕΙΑΚΗ			737,2	0,55%	1.217,9	1.32%	0	0	0	0
ΕΚΚΟΚΙΣΤΗΡΙΑ-ΚΛΩΣΤΗΡΙΑ ΒΟΡΕΙΟΥ	788,3	0.54%	720,9	0,54%	2.319,1	2,52%	4.448	2.66%	5.892	3.90%
ΤΕΙΛΟΡΣ ΣΥΜΒΟΥΛΩΝ ΚΑΙ ΧΡΩΜΑΤΩΝ Ε.Π.Ε	1.818,3	1.30%	0	0	1.242,7	1.35%	0	0	0	0
ΤΕΙΛΟΡΣ ΕΝΕΡΓΕΙΑΚΗ Α.Ε	1.818,3	1.30%	0	0	0	0	0	0	0	0
ΚΑΤΟΪΛ Α.Ε.Β.Ε.	0	0	0	0	427,1	0.46%	2.837	1.70%	221	0.14%
NEW ENERGY S.A.	0	0	0	0	8.722,9	9.48%	0	0	0	0
ΕΛΛΗΝΙΚΑ ΠΕΤΡΕΛΑΙΑ	0	0	0	0	1.393,4	1.51%	0	0	0	0
GF ENERGY A.B.E.E	17.233,8	12.31%	0	0	10.227,2	11.12%	19.115	11.50%	17.894	11.86%
DP LUBRIFICANTI S.R.L.	0	0	0	0	161,0	18%	239	0.15%	0	0
ΑΔΡΙΑΤΙΚΑ OIL AE	0	0	0	0	0	0	334	0.20%	0	0
ΠΕΤΡΟΙΛ	0	0	0	0	0	0	285	0.17%	0	0
ΕΛΛΑΣ ΟΙΛ ΑΕ	0	0	0	0	0	0	259	0.15%	0	0
MUENZER BIOINDUSTRIES G.M.B.H	0	0	0	0	0	0	133	0.08%	0	0
BIOPOWER ΒΙΟΚΙΝΗΤΙΚΗ	0	0	0	0	0	0	72	0.04%	0	0
GOECO AE	0	0	0	0	0	0	58	0.03%	0	0
ΣΥΝΟΛΟ	140.000,0	100,00%	3.211.677	100,00%	588.193,39	100,00%	166.915,45	100,00%	151.564	100,00%

Source: Government Journal, 2nd Issue, No. 911, 30/12/2014, Calculation of the authors.

1.2.2 European policy for energy crops and biofuels

1.2.2.1 Policy Background

The European Union has taken several steps towards encouraging the adoption of energy crops, in view of the benefits of these crops for the environment, but also for the economy of the Member States. According to the European TERES II programme (The European Renewable Energy Study), it is planned for 2020 that 228 MJ of energy to come from renewable sources, from which 31.1% will come from energy agriculture, 24.5% from biomass and waste, and 15.2% from agricultural and forest residues. It is estimated that approximately 140 million ha of agricultural land should be attributed to energy crops, so as to eliminate problems related to subsidies for agricultural surpluses. Also, in accordance with Article 4 of the Directive 2003/30/EC (YPEKA, 2008), each MS should submit an annual report to the Commission indicating the measures taken to promote alternative forms of energy, the resources used for biomass production from energy crops, and the proportion of biofuels sold in the domestic market (Kampman et al., 2012).

As from 1997, the EU has published The White Paper “Energy for the Future: Renewable Sources of Energy” established the basis for the recent EU RES policy by setting an indicative objective of 12% for the contribution of RES to the EU gross inland electricity consumption to be achieved by 2010. Later on, in another text published in 2002, it was stated that one of the long-term goals of the EU could be the replacement with alternative fuels 20% of petrol and diesel required for road transport in Europe by 2020. A year later, the basic European Directive on Biofuels, the 2003/30EC was published, which has the following key points:

- The terms “Biofuels”, “Bioethanol” and “Biodiesel” are defined
- MS are encouraged to set indicative targets for the use of biofuels, so that by 2010, the replacement of gasoline and conventional diesel at a rate of 5.75% would be possible.
- MS are asked to report annually to the Commission regarding the measures taken to promote the use of biofuels.

Furthermore, the Directive 2003/96/EC allowed for exemptions or reduced levels of taxation to be granted by MS to RES in order to promote the use of alternative energy and fuels, where such measures do not impede the proper functioning of the internal market and they do not bring about distortions of competition. The Biomass Action Plan (COM(2005) 628 final, European Commission 2005) set out measures for promoting the development of biomass through the introduction of market-based incentives and the removal of barriers for the development of the biomass and bio-fuels markets. The main actions included legislation on the use of RES (and of biomass in particular) in the heating and cooling sectors, the promotion of combined heat and power (CHP) generation through biomass, the assessment of current support systems for bio-fuels, the support to second-generation bio-fuels, and the creation of a biofuels technology platform.

1.2.2.2 Policy context for energy crops and biofuels

Currently, the EU policy on bioenergy is formed on the basis of a "package" of measures on climate and energy (Hamje et al., 2014). This package consists of several pieces of legislation, each of them making up a piece of the puzzle to tackle climate change. The goal is by 2020 for the European Union: to save 20% of greenhouse gas emissions (GHG) compared to 1990, to cover 20% of renewable energy consumption and to improve energy efficiency by 20% (this is a non-binding measure).

At the end of 2009, the European Commission issued two Directives that affect the types of energy used in the transport sector and consist key elements of the “energy package”. These were the **Renewable Energy Directive (RED)** and the **Fuel Quality Directive (FQD)** (von Lampe, M. et al., 2014). The RED is a strict directive, which sets two targets that the MS should achieve by 2020:

1. 20% of the overall EU energy consumption should come from renewable energy sources by 2020, mainly regarding electricity, heating and cooling.
2. 10% of the total EU energy consumption in the transport sector must come from renewable sources by 2020. This refers mainly to transport fuel, but can also be achieved through electricity etc.

RED essentially asks MS to create a system, which should be described in their National Renewable Energy Action Plans (NREAPs), to outline the way in which they intend to meet the 10% renewable energy target in transport in 2020, which usually occurs through grants, tax credits and consumption orders.

Until now, these plans have shown that biomass will supply more than half of the EU renewable energy sources by 2020 and more than 8.3% (hence almost 10%) of the target in transport. This basically means a sharp increase in the use of biomass for energy and that growth comes with the risk of serious socio-environmental costs. Demand is also likely to exceed the sustainable level of biomass supply.

The **FQD Directive for fuel quality in transport** deals with the issue of clean and dirty fuels. Until 2020, fuel suppliers must prove that they have mixed their energy fuel mix with cleaner fuels, so that their fuels could be decarbonizing by 6%. This directive aims to address both dirty fossil fuels as well as biofuels that save emissions. The FQD not only sets strict consumption mandates, but also allows different types of fuels to compete for both production costs and saving greenhouse gases.

As concerns issues of sustainability in the implementation of these directives by the MS, the RED Directive has sustainability criteria for raw materials processed into biofuels and bioliquids, whereas any other use of biomass has no sustainability requirements (Table 1.2.2.2.1). In addition, the criteria for biofuels are not strict enough or have not yet fully implemented, while the current sustainability criteria do not ensure savings in greenhouse gas emissions (GHG), as they do not recognize the emissions caused by the Indirect Land Use Change (Indirect Land Use Change-ILUC) (Bowyer 2011). Both targets (for RED and FQD) are expected to be met mainly by increasing the use of biofuels. Although there are sustainability criteria for both the RED and the FQD Directives, nor biofuels or bioliquids, take into account the alternative land use. It is necessary to include alternative land uses on sustainability criteria, while there should be a coherent policy framework for the use of all biofuels from the earth. Regarding biomass that is used in energy for heating, cooling or electricity generation, the Directive RED does not require any kind of sustainability criteria. However, European Commission is obliged to monitor the development and use of biomass to deliver reports on the need to extend the sustainability systems.

Table 1.2.2.2.1 RED and FQD Directives Objectives and Sustainability Criteria

RED and FQD Directives Objectives	RED and FQD Directives Sustainability Criteria	
RED Directive Objectives	GHG impact	Minimum threshold of 35% GHG
• 20% renewables in all energy used by 2020 and a sub- • MS are required to meet a minimum binding target of 10% renewable energy share in the transport sector • All types of renewable energy used in all transport modes are included in the target setting. • MS required required to publish a National Renewable Energy Action Plan (NREAP) • MS are expected to implement measures to achieve these targets • MS responsible for ensuring compliance with the sustainability criteria	Biodiversity	Minimum threshold of 35% GHG emissions saving (50% from 2017, 60% from 2018) Not to be made from raw materials
	Land use	obtained from biodiverse areas (including primary forests) Not to be grown on peatlands
	Good agricultural conditions	Requirement for good agricultural conditions and social sustainability
FQD Directive Objectives		
• 6% reduction in the GHG intensity of fuels traded in the EU by 2020 (2% indicative reduction by 2014 and 4% by 2017) • 2% reduction in the GHG intensity of fuels traded in the EU by 2020 from developments in new technologies, such as Carbon Capture and Storage (CCS) • 2% reduction in the GHG intensity of fuels traded in the EU by 2020 from the purchase of Clean Development Mechanism (CDM) credits under the Kyoto Protocol		

Source: DIRECTIVE 2009/28/EC Of The European Parliament And Of The Council, 2009.

Accordingly, the European Commission was invited to review and recommend on GHG emissions related to biofuel production in order to suggest ways to limit the impact of ILUC emissions from biofuels to reduce GHG emissions, to encourage greater market penetration of advanced (“low ILUC”) biofuels. Amendments proposals were made (Table 1.2.2.2.2) since October 2012.

Table 1.2.2.2.2 Amendments proposals for final consumption on first generation biofuels

European Commission (EC) ILUC proposal Oct. 2012	European Parliament (EP) vote, September 2013	Council compromise proposal December 2013
5% cap on 2011 estimated share of first generation biofuels (energy crops not included)	6% cap on final consumption in 2020 of first generation biofuels and DLUC/ILUC energy crops	7% cap on final consumption in 2020 of first generation biofuels and DLUC/ILUC energy crops
No sub-targets for advanced biofuels	2.5% target for advanced biofuels. MS obliged to ensure renewable sources in gasoline to make up 7.5% of final energy in gasoline pool by 2020.	Voluntary sub-targets at MS level for advanced biofuels

Source: Hamje et al., 2014

Subsequently, on 28 April 2015, the European Parliament voted to approve new legislation, the ILUC (indirect Land Use Change) Directive that limits the way MS can meet the target of 10% for renewables in transport fuels by 2020. Specifically, there was a formalized agreement between MS on the delimitation of conventional biofuels to achieve the objectives of the EU 2020 strategy on climate change. The limits related to first generation biofuels, based on crops grown in agricultural areas, and imposed a ceiling of 7% of their membership of the EU target. According to the Directive on renewable energy in 2009, 10% of Energy consumption in transport should be from renewable energy sources by 2020. This new legislation aims to reduce the direct and indirect greenhouse gas (GHG) emissions resulting from the use of agricultural land for energy crops. Disposing part of the agricultural land for biofuel production will reduce the soil available for food production and it will pressure to use more land for food. Therefore, food production could be transferred to other areas that are currently not used for agricultural purposes (indirect land use change - ILUC). Actually, this intends to support the development of the second-generation biofuels, which are produced from non-food sources, and can provide a significant reduction in gas emissions. By setting a limit in conventional biofuels, the EU is oriented towards the decision of abolishing subsidies for crop-based biofuels after 2020. MS will have to adopt the new legislation by 2017 and should be set national targets for advanced biofuels, for which an indicative non-binding target of 0.5% has been set.

1.2.2.3 The Common Agricultural Policy and energy crops

Prior to the implementation of aid decoupling, the EU farmers could grow energy crops in three different regulatory situations (European Commission, 2006): a) on set aside land, benefiting from the set aside payment, b) on non-set aside land, benefiting from both the arable crops area and the aid for energy crops and c) on non-set aside land, benefiting from the arable crops area payment only or even without benefiting from them. The implementation of the decoupling of subsidies in 2003 imposed farmers to grow energy crops on set-aside land, or on non-set aside land, benefiting from the aid for energy crops or any other specific payment. As regards the last introduced Member States, they distributed direct payments on an area basis in the framework of the single area payment scheme SAPS.

Actually, the *CAP Reform in 2003* offered new opportunities in agriculture for the production of alternative crops. The European Regulation (EC) 1782/03 allowed for a decoupled payment 4,5€/ha for energy crops that could be used for biofuel production giving thus an incentive for farmers to alter to energy crops. The aid was given for a maximum guaranteed area of 15 million acres across the EU and only in respect of areas whose production is covered by a contract between the farmer and the biodiesel plant, except in cases where the farmer undertook the exploitation of the oil produced. It is worth mentioning that in 2005 an aid was provided for the development of 5 million acres across the EU. At the same time, a possibility of doing business in the area of biofuel production was offered, through the foundation, for example, of a biodiesel plant and ensuring by priority an exclusion from taxes due to the domestic cultivation of raw materials. Moreover, the Directive 98/70 (EC) determined the quality of biofuel blends which can be marketed and which must lie within the limits of the standards of conventional biofuels. Additionally, aid was provided for those energy crops that do not require lubrication and could claim additional amounts from nitrates programme or organic farming subsidies (CRES, 2006). In 2005, 0.5 million hectares joined this measure of special aid, with a limit to full enjoyment of the aid the 15 million hectares, which rose to 20 million acres after the accession of new members to the EU. Originally, 3.1 million acres were cultivated with energy crops, while in 2012, the cultivation of energy crops covered 28.4 million acres. The specific increase led to the reduction of support and the reduction of land under grain crops and oilseeds for human consumption (von Lampre et al., 2014).

Obviously, energy crops have developed largely at the expense of the corresponding food crops, and also crop substitutions have observed; notably the replacement of cereals by rape (Skarakis 2010). Bearing in mind the aforementioned, the European Commission aims to abolish the Community financial aid of 4,5€/ha for growing energy crops, mainly in order to shift the production of cereals and oilseeds for human consumption.

Within the context of the last *CAP reform (2014-2020)*, there is no financial aid for energy crops, but the farmers are offered incentives for the cultivation of energy crops through direct payments applicable in the new CAP (Bartolini et al., 2015). Within the context of Pillar I that is related to decoupled direct payments, **there are no direct incentives on support to production for bioenergy such as energy crops**. The reformed policy scheme consists of the new "greening" proposal, where 30% of direct payments or direct agricultural aid is tied to "greening" and it is conditional upon the farmers observing three environmental measures on their eligible areas that related to: i) delivery of water and habitat protection by the establishment of ecological focus areas, ii) crop diversification and iii) permanent pasture. Instead of these three practices, the MS may equivalently decide whether a farmer can undertake other practices (e.g. crop rotation instead of crop diversification) (Fleureck 2013).

As for the Pillar II (Rural Development Programme-RPD), the measures have reformed in order to enable rural areas to benefit from renewable energy technologies, including advanced biofuels. Thus, the main policy context referred to measures that support investments and infrastructure, training and innovation. Specifically, strategic measures and focus areas related to RES and bioenergy fall within the scope of (European Parliament 2013):

- Priority 1: Fostering knowledge transfer and innovation in agriculture, forestry and rural areas,
- Priority 2: Enhancing competitiveness of all types of agriculture and enhancing farm viability,

- Priority 5: Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors.

In particular Priority 5, proposes policy measures that will increase efficiency in energy use in agriculture and food processing, will facilitate the supply and use of renewable sources of energy and will reduce nitrous oxide and methane emissions from agriculture. Although the new CAP (2013-2020) does not support directly the cultivation of energy crops, still attention is focused on renewable energy and raw material production, particularly under rural development (European Commission, 2011). **Pillar II offers a toolbox for supporting RES and raw material, subject to proposed conditions of energy efficiency, sustainability and limitation to food crops.** The issue of innovation is highlighted by means of development of new and sustainable uses of biomass, innovative methods of production, collection and processing. Furthermore, broad categories of RPD measures relevant to bioenergy include physical investments, business development, village renewal in rural areas, producer groups, co-operation, training and knowledge dissemination, which may provide indirect support to the development of energy crops.

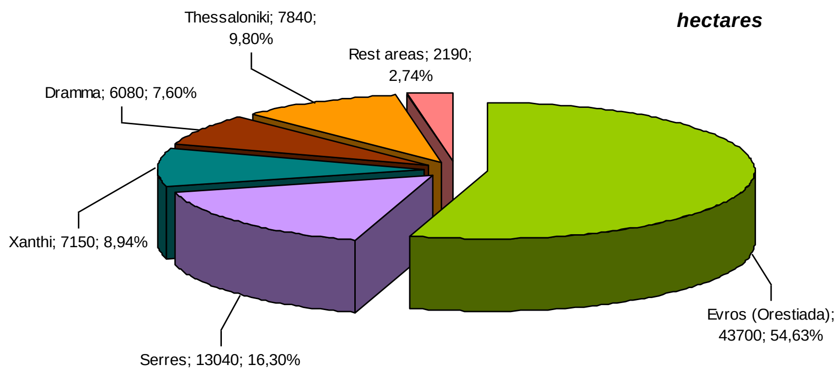
1.3 Comparative analysis

This section presents a comparative analysis of the position and competitiveness of the sunflower cultivation, in comparison with its most competitive crops, in terms of costs, benefits, income, employment and expertise. **The most competitive among the alternative crops of sunflower in Greece are cotton, maize and wheat (Panoutsou, 2008).** Especially in Northern Greece, where sunflower is cultivated almost exclusively (Skoulou et al., 2011), the cultivation of these three competitive crops is also widespread (ELSTAT, 2015) and commonly observed crop rotation among these crops (Giannoulis et al., 2009) confirming the important position of sunflower in crop rotation**. Besides, in this section an attempt is made to estimate and measure the direct and indirect benefits of sunflower cultivation for the producers and the possible losses in case of a hypothetical scenario of abandonment of sunflower cultivation.**

1.3.1 Employment analysis

According to Eurostat (2015) and other national sources (ELSTAT, 2015; IACS, 2014), during the last three years (2013-2015), cultivated annually about 80,000 hectares of sunflower in Greece (3.8% of the total cultivated agricultural land, excluding fallows). Combining data of ELSTAT (2015) and IACS (2014), authors calculated that sunflower cultivation involves approximately 24,000 farmers (primarily family members of the farms, especially in Macedonia and Thrace). On average, in every hectare of sunflower land, involved about 0.3 farmers and taking into account that on each farm involved 1.2 workers on average then **the mean sunflower farm size is 4[1] hectares.** Additionally, according to Hellenic Biofuels and Biomass Association (SBIBE, 2013), we can add directly or indirectly 400 current jobs in the sunflower manufacturing sector, intermediaries and secondary employment. Figure 1.2.2 (p.7) clearly presents that the cultivated land of sunflower increased significantly in 2009 and recently gradually stabilized at around 80,000 hectares. However, it’s worth noting that sunflower cultivation is mainly cultivated in northern Greece. In particular (Figure 1.3.1.1), more than 54% of this total land refers to areas of Municipality of Evros (and particularly in Orestiada) and then to areas of Municipality of Serres (16.3%), Thessaloniki (9.8%), Xanthi (8.9%) and Dramma (7.6%).

[1] 80,000 ha/(24,000 farmers/1.2 farmers) = 4 ha (mean farm size)



Source: IACS, 2014

Figure 1.3.1.1 Cultivation areas of sunflower (2014)

Currently, in Greece, 17 processing units of energy plants operate (Table 1.2.1.1) which are based on the principles of contract farming establishing contracts with the majority of sunflower producers. Some of them specialize in the production of biodiesel (intended to replace conventional diesel) and others in the production of bio-ethanol (intended to replace gasoline). Generally, the sunflower processing (exclusively or not exclusively) involves 11 of these units. According to SBIBE (2013), **Greece produces about 120,000 metric tons of biodiesel (including bio-ethanol) while also imports 19,000-21,000 metric tons per year.** However, it is noteworthy that the production capacity of the Greek processing units exceeds the 680,000 metric tons of biodiesel (including bio-ethanol), that is 5.7 times the current production. For the year 2010, **the EU target of 5.75% of conventional diesel (and gasoline) coming from biofuels satisfied by a very small part (less than 1%) while the next EU target of 10% (for the year 2020) is also unlikely to be fulfilled as the current achieved goal marginally exceeds the 1%[2].**

Despite the shortfall in targets is clear that biofuels, in general, appears to be the new "trend" in the field of energy production and many Greek companies, like the Greek Sugar Industry, the Paper industry “Thrace”, the Selman and the Public Power Corporation, already manufacture or prepare to set up similar processing

[2] About 70% of Greek biodiesel and bio-ethanol production comes from the cultivation of sunflower while almost all the rest 30% comes from the cultivation of oilseed rape (Sidiras, 2014)

units or other experimental plants. Up to the years 2009-2010, there was not sufficient production of energy plants in Greece forcing companies producing biofuels to import raw material mainly from abroad. However, today the production is rather satisfactory although there is still room for further increase. Considering the pressing needs for further increase of bio-energy production It is very likely to take place a parallel increase of the cultivated hectares of energy plants (and especially sunflower) of 25%-30% per year (SBIBE, 2012). In particular, among the most important pressing needs for the increase of bio-energy production are: a) the increased needs for the coverage of the country's energy goals, b) the high dependence rate of Greek economy for the energy (65.6%)[3], c) the EU target of 10% of petrol and diesel coming from biofuels[4], the 400,000 hectares of uncultivated agricultural land and the satisfactory cost-effectiveness of sunflower cultivation. Table 1.3.1.1 presents the comparative generalizations of the current sunflower cultivation in order to meet the EU target (year 2020).

Table 1.3.1.1 Employment analysis of sunflower cultivation (2015-2020)

	Current situation	**EU target (year 2020)**
1. Cultivated land (ha)	80,000	***≈313,000***
2. Cultivated agricultural land by sunflower (%)	3.83	***≈15.00***
3. No of farmers	70,000	***≈275,000***
4. No of other jobs	400	***≈1,570***
5. Imports of biodiesel (metric tones)	19,000-21,000	-
6. Achieved EU target	≈1%	***10%***
7. Biodiesel production including bio-ethanol (metric tones)	120,000	***≈470,000***
8. Spare capacity of processing units (metric tones)	560,000	***≈1,100,000***

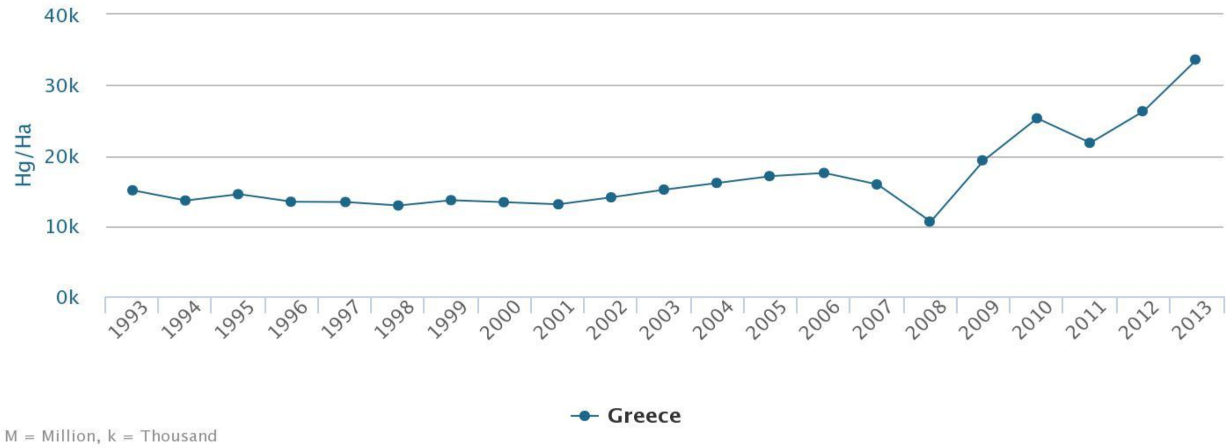
Source[5]: ELSTAT (2015); IACS (2014)

1.3.2 Level of knowledge

Regarding the knowledge level (expertise) of farmers in the cultivation of sunflower it's worth noting that about 70% of them (about 50,000 farmers) have cultivated sunflower systematically for 5 or more years (IACS, 2014; ABAF, 2015). Undoubtedly, this established practical experience is important "capital" factor with multiplier

[3] The mean rate for the EU-28 is 53.3% (Eurostat, 2015)
[4] To achieve this target have approximately 15% of agricultural land to cultivate energy crops (Skaraki et al., 2008).
[5] Calculations of the authors using data from ELSTAT (2015) and IACS (2014)

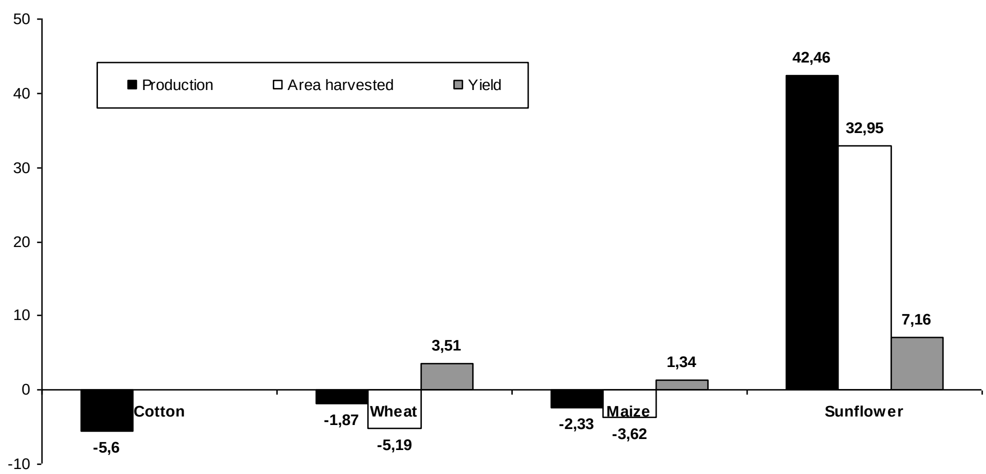
effects as new farmers, engaged in cultivation of sunflower, know where to address for technical help and where to receive information (Anastasiadis, 2012). However, this established experience is still at a stage of further improvement as the yields of sunflower in Greece are still rising (Figure 1.3.2.1), year by year, suggesting somehow management improvement of available inputs (Faostat, 2015).



Source: Faostat, 2015

Figure 1.3.2.1 Yield of sunflower commodity in Greece (1993 – 2013)

It's worth noting, in this Figure, that average yields are increasing almost linearly, during the last 5 years (with the exception of 2011), confirming in some way the farmers' systematic preoccupation with the sunflower crop and the recently acquired knowledge and the expertise obtained by farmers. According to the same source, this trend is significantly higher, compared to that of competing crops, suggesting scope for further increase (Figure 1.3.2.2).



Source: Faostat, 2015

Figure 1.3.2.2 Annual growth rates calculated based on the OLS method (1993-2013)

Based on the growth rates, presented in the Figure 1.3.2.2, we can easily conclude that maize, wheat and cotton are well diffused crops (according the generalizations of Rogers adoption-diffusion theory) while, on the other hand, sunflower is still in the beginning of the diffusion process (Rogers, 2010; Loizou et al., 2013). From a practical point of view this note means that the levels of farmers' knowledge and interest, regarding the cultivation of sunflower, are rapidly increasing and if the financial conditions also permit then, sunflower cultivation can be really "skyrocketed" as its diffusion process is still at an early and fast moving stage (Michailidis et al., 2011a). Undoubtedly, the cultivation of sunflower is expected to intensify in the coming years to the point of sufficiently diffused and no longer seen as innovation (Michailidis et al., 2011b). This is an extremely important finding as it indicates the existence of much higher rates of multiplier' change (income and employment) in relation to competing crops (Loizou et al., 2014).

1.3.3 Cost effectiveness

This section presents the cost effectiveness of the cultivation of sunflower compared to its competitive crops (cotton, maize and wheat). The required data collected, for the year 2014, using mainly survey data from the accounting monitoring of several Greek farms, gathered by the Department of Agricultural Economics, School of Agriculture, Forestry and Environmental Sciences, Aristotle University of Thessaloniki (ABAF, 2015). For the purposes of this analysis a representative farm of 1 hectare was selected, for each scenario, from the area of Orestiada, Prefecture of Evros.

The several scenarios analyzed below are the following:

- Scenario 1: Sunflower irrigated cultivation (40% of the total cultivation)
- Scenario 2: Sunflower dry cultivation (60% of the total cultivation)
- Scenario 3: Typical sunflower cultivation (40% irrigated and 60% dry cultivation)
- Scenario 4: Cotton cultivation

- Scenario 5: Maize cultivation

- Scenario 6: Wheat cultivation

Table 1.3.3.1 presents the costs and the benefits, as well as the net revenues (income) and the benefit/cost ratios, for the several selected scenarios.

Table 1.3.3.1 Cost-Effectiveness of sunflower and competitive crops (Comparative Analysis / per ha)

	Scen.1	Scen.2	Scen.3	Scen.4	Scen.5	Scen.6
Cost (expenses)						
Rent (€)	300	90	170	300	300	300
Sowing (€)	40	40	40	40	40	40
Crop care (€)	160	160	160	250	250	200
Seed (€)	60	60	60	140	260	130
Labor (+depreciations) (€)	100	100	100	200	200	200
Weed control (€)	70	70	70	100	70	30
Fertilization (€)	40	40	40	200	400	200
Oil (cultivation) (€)	120	120	120	210	210	180
Irrigation(+oil, electricity network) (€)	120	-	50	360	500	100
Insecticides (€)	-	-	-	100	-	-
Defoliation (€)	-	-	-	40	-	-
Foreign labor (€)	-	-	-	100	-	-
Harvesting (€)	90	90	90	250	150	130
Others (€)	10	10	10	100	100	100
Total costs (€)	***1,120***	***790***	***920***	***2,390***	***2,480***	***1,610***
Fixed costs (€)	300	90	170	300	300	300
Variable costs (€)	820	700	750	2,090	2,180	1,310
Fixed/variable cost ratio	0.365	0.128	0.227	0.143	0.137	0.229
Return (revenues)						
Producer price (€/kg)	0.35	0.35	0.35	0.40	0.16	0.25
Yield (kg/ha)	3,500	2,250	2,750	3,300	12,000	6,500
Gross Production Value (€)	1,225.00	787.50	962.50	1,320.00	1,920.00	1,625.00
Energy subsidy (€)	45.00	45.00	45.00	-	-	-
Gross Income (€)	***1,270.00***	***832.50***	**1,007.50**	**1,320.00**	**1,920.00**	**1,625.00**
Net Income (€)	***150.00***	***42.50***	***87.5***	***-1,070.00***	***-560.00***	***15.00***
Benefit/Cost Ratio	***1.134***	***1.054***	***1.095***	***0.552***	***0.774***	***1.008***
Ranking	*(1)*	*(3)*	*(2)*	*(6)*	*(5)*	*(4)*

The Cost-Effectiveness results of the sunflower cultivation compared to its competitive crops, assuming similar farming conditions, are presented in the Table 1.3.3.1 and Figures 1.3.3.1-1.3.3.4. Estimated production costs ranged from 790 to 2,480 €/ha, while estimated gross income ranged from 832.5 to 1,920 €/ha. Similarly, net income ranged from -1,070 to 150 €/ha. Estimated benefit/cost ratio ranged from 0.552 to 1.134. In the case of sunflower, net income ranged from 42.5

to 150.0 €/ha while the only cost effective competitive crop without subsidy is the wheat (estimated net income equal to 15 €/ha). **The above estimates refer to non-owned farmlands, while in case of owned ones a rent of 90-300 €/ha can be delisted ensuring net higher incomes ranged from 132.5 to 450.0 €/ha.**

Under various scenarios, the estimates were not very encouraging for the cultivation of cotton and maize as subsidies of 1,070 and 560 €/ha respectively are needed (Figure 1.3.3.1) to get the crops in neutral (without profit or loss). It is noteworthy that even in the case of owned farmlands the net incomes of cotton and maize cultivations remain negative without subsidies. On the other hand, results indicate that investing in irrigated sunflower cultivation and crop rotation between sunflower and wheat bring high economic benefits. Such investments could also reduce Greece's dependence on imports of conventional diesel and gasoline. In the following figures 1.3.3.1 and 1.3.3.2 have been distinguished graphically the comparisons of the several economic results and the benefit/cost ratios of the selected scenarios.

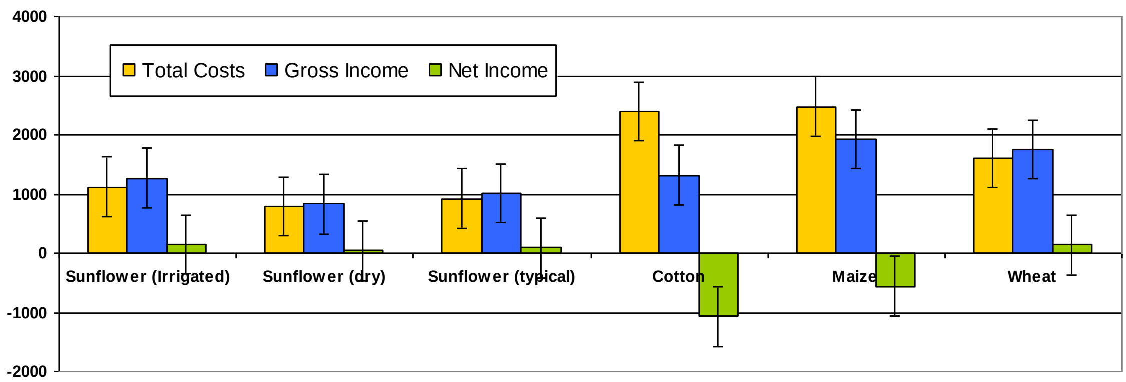


Figure 1.3.3.1 Cost-Revenues of sunflower and competitive crops

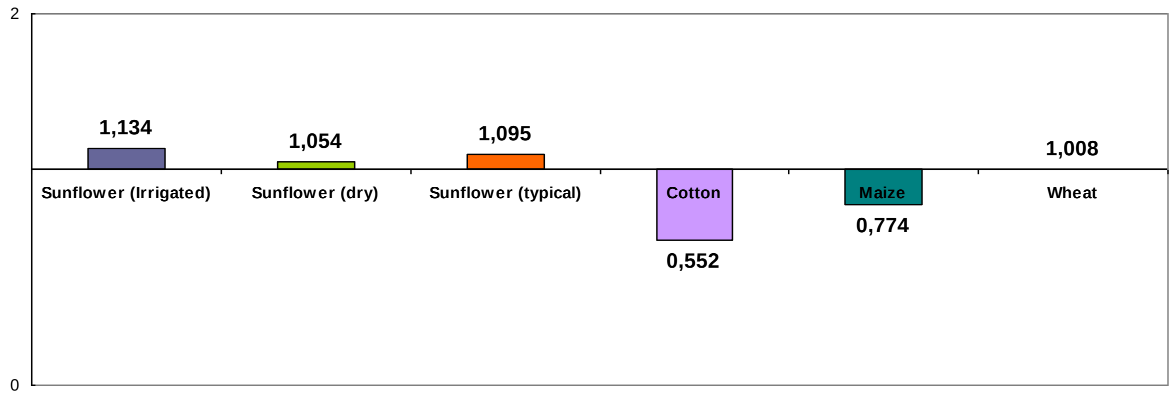


Figure 1.3.3.2 Benefit/Cost ratios of sunflower and competitive crops

Figure 1.3.3.3 and 1.3.3.4 present graphically the fixed and variable costs as well as the fixed/variable cost ratios of sunflower and competitive crops. The contribution of fixed costs (rent) to total costs is particularly high for the sunflower and wheat crops reinforcing the need to cultivate own fields with these crops.

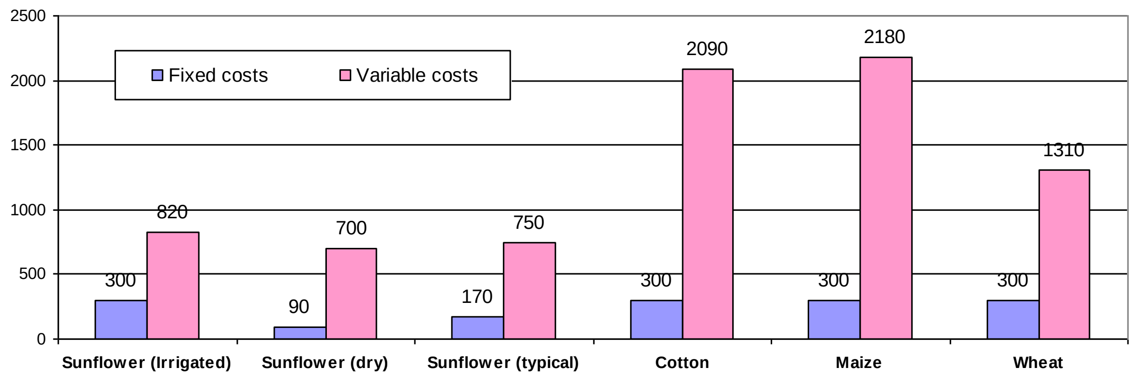


Figure 1.3.3.3 Fixed and variable costs of sunflower and competitive crops

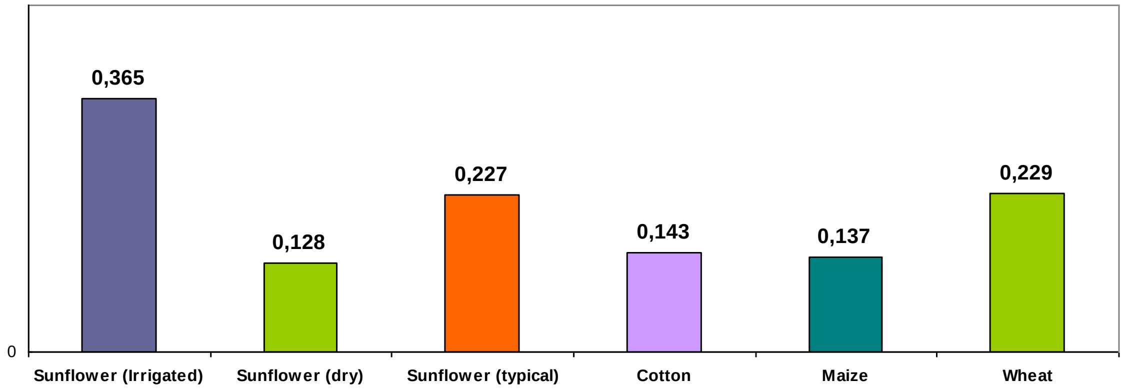


Figure 1.3.3.4 Fixed/variable cost ratio of sunflower and competitive crops

From the above mention Table and Figures can be observed that the baseline scenario (scenario 3) proved beneficial. In this scenario probably the added value comes from the ability to cultivate in dry conditions without irrigation (Table 1.3.3.1). However, the major drawback of this scenario is the low crop yield especially compared to first scenario (irrigated sunflower). All the sunflower scenarios show positive net revenues although smaller than the scenario 1 (irrigated cultivation). The second best choice is the sixth scenario, where wheat is cultivated. **This scenario could be the best in case of sunflower withdrawal (Table 1.3.3.2), meaning that farmer will lose 72.5 €/ha (87.5 €/ha – 15 €/ha) and country will miss around €5,800,000 every year (72.5 €/ha x 80,000 ha).**

Table 1.3.3.2 Comparative presentation of major outcomes (per ha)

	Baseline (Scen.3)	Best alternative (Scen.6)	Difference
Total Costs	920.00	1,610.00	-690.00
Gross Income	1,007.50	1,625.00	-617.50
Net Income (farm level)	87.50	15.00	72.50
Net Income (country level)	7,000,000.00	1,200,000.00	5,800,000.00

1.3.4 Crop rotation

Perhaps of all crops grown in Greece, sunflower requires the most strategy in choosing its place within a crop rotation (National Sunflower Association, 2003). Sunflower grows well under dry conditions and is one of the most deeply-rooted crops. Thus, it is one of the most adept crops at utilizing subsoil moisture. However, there's a double-edged sword to sunflower's ability to use water. Sunflower's advantage in extracting more water from the soil than other crops also means it depletes the soil of water available for the subsequent crop. In several crop sequence experiments, sunflower depleted the largest amount of soil water, and dry pea and lentil the least amount. According to Anastasiadis (2012) and National Sunflower Association (2003), crops which use less soil water generally: a) have shorter active growth seasons; b) are less deeply rooted; c) cover the soil the fastest with leaf area and are grown under no-tillage. That's why with appropriate rotation design, producers can accentuate the positive impacts of sunflower, and minimize the adverse effects (National Sunflower Association, 2003). In general, literature suggests sunflower rotations including: a) winter wheat-sunflower-fallow; b) winter wheat-corn-sunflower-fallow and c) winter wheat-corn-sunflower-grain sorghum-fallow. It may be desirable from a pest management and soil water storage standpoint to alternate the winter wheat-sunflower-fallow rotation with a corn-fallow rotation.

From a techno-economic point of view the most effective crop rotation is between sunflower and wheat (Table 1.3.3.1). According to Kaan and O'Brien (2003) when wheat replaces sunflower the cultivation favored the most in odds while rotation between sunflower and maize favors yields of both crops. More specifically, Zegada-Lizarazu and Monti (2011) calculated that crop rotation between sunflower and wheat (or corn) increases regularly the yields of all crops of about 8% to 10% ensuring an additional annual mean net income of 145 €/ha (calculations of the authors).

1.3.5 Indirect benefits of sunflower

The advantages derived from the cultivation of sunflower and particularly from the use of sunflower biomass for energy production are:

- **Reducing carbon dioxide emissions and preventing of global warming, as the biomass does not contribute to the increase of carbon dioxide because,**

although during the combustion produced CO_2, during the production re-blocked significant amounts of dirt (Vlachos et al., 2014).

- **Avoiding the burden of the atmosphere with sulfur dioxide mainly because the sulfur content of biomass is negligible (Liolios and Nikolaou, 2010).**
- **Reducing of energy dependence (Panoutsou et al., 2008).**
- **Ensuring employment and retention of rural populations in marginalised and isolated areas and other less favoured areas (Sidiras, 2014).**
- **Ensuring foreign exchange benefits from the substitution of diesel and gasoline with biodiesel and bio-ethanol respectively (Rozakis et al., 2013).**

According to the most recent studies (SBIBE, 2013) the above mentioned indirect benefits can be evaluated and quantified to a total amount of 43,900,000 €/year for the Greek economy, as follows: a) reducing carbon dioxide emissions=7,000,000 €/year, b) reducing of sulfur dioxide=300,000 €/year, c) reducing of energy dependence=1,500,000 €/year, d) employment benefits=900,000 €/year, e) social benefits=200,000 €/year and f) foreign exchange benefits=34,000,000 €/year. However, according to Sidiras (2014), only 70% of these indirect benefits come from the cultivation of sunflower as the rest 30% come from the cultivation of oilseed rape. Making a simple reduction we can estimate the following indirect benefits from the cultivation of one hectare sunflower (Figure 1.3.5.1).

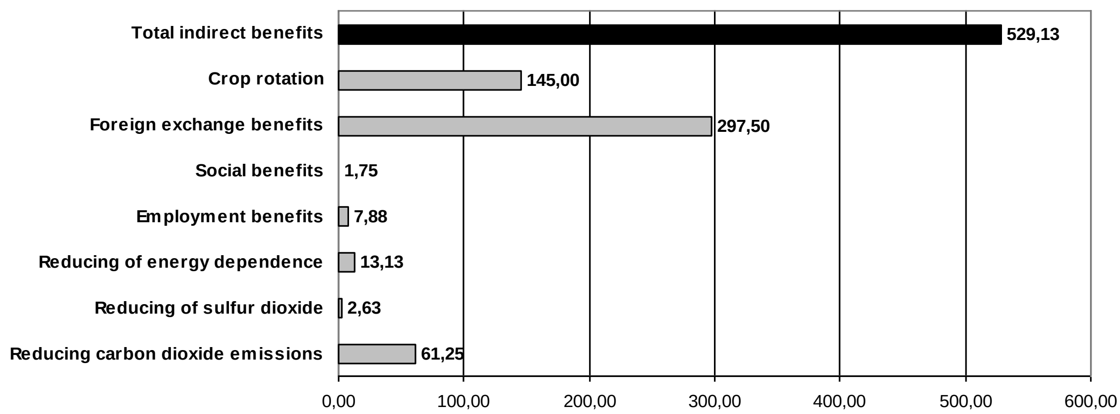


Figure 1.3.5.1 Indirect benefits of sunflower cultivation (€/ha, year 2014)

Besides, the cultivation of sunflower shows great adaptability and can grow in many types of soil, with low inputs (irrigation, fertilization) can achieve satisfactory yields while also offers significant amounts of animal feed (sunflower flour) as alternative product. The sunflower, in general, would be characterized as an "easy" and environmentally friendly cultivation (Table 1.3.5.1).

Table 1.3.5.1 Impacts of energy crops on the environment

Crop	Production size	Irrigation	Fertilizers	Pesticides	Energy needs	Erosion	Soil compaction
Cotton	+	+++	++	++++	+++	++++	+++
Corn/Maize	++++	++++	+++	+++	+++	++	++
Sugar-beets	++++	++++	+++	++++	+++	++	+++
Sunflower	++	++	++	+	++	++	+
Rape	+		+	++	+	+	+

Source: Fontaras et al. (2012) and Panoutsou et al. (2008)

1.4 Conclusions

Conclusively, sunflower is an alternative crop cultivated mainly in northern Greece which can ensure some limited direct economic benefits to farmers. However, **the most important reason of sunflower cultivation relates to its ability to be cultivated in dry conditions and to the important effects of crop rotation between sunflower and maize or wheat**. In the baseline scenario (Scen. 3), the net income per hectare can exceed 87.5€ (Table 1.3.3.1) and can reach up to 150€ in ideal conditions (Scen. 1). Although, this sum could not be considered as very satisfactory is the higher among the competitive crops in the cultivated area. On the other hand, it is worth noting that the income increases even more in the case of privately owned fields as rent cost is large part of the total production cost (11.4%-26.8%). The second best choice, among the competitive crops, is the sixth scenario, where wheat is cultivated. **In case of sunflower withdrawal, this scenario could be the best alternative as farmers will lose 72.5 €/ha (87.5 €/ha – 15 €/ha) and country will miss around €5,800,000 every year (74.5 €/ha x 80,000 ha).** However, the most important benefits of sunflower cultivation are the indirect ones coming mainly from the operation of the processing industry. In particular among the higher indirect benefits of sunflower cultivation are the **environmental, social, employment, foreign exchange, energy independence and crop rotation estimated to 529.13 € per hectare** (Figure 1.3.5.1).

Chapter 2

Wider economic and social importance of Sunflower

2.1 Introduction

In this section the wider benefits arising from the sunflower cultivation and from the operation of the processing industry will be recorded in prefectural, regional and national level. Then a scenario "without sunflower" will be presented to measure exactly what the regional and national economy loses. Besides, all these wider benefits resulting from the entire activity and the secondary activities developed around it (transportation, supplies, technical support, etc.) will be combined with the existence of the processing industry. Subsequently, there will be a reduction of both direct and indirect impacts at prefectural, regional and national level and multiplier effects will be also estimated on employment sector (agricultural and non-agricultural), on income (agricultural and extra-agricultural) and on the Regional and National Product.

2.2 Generalization of the results

2.2.1 Direct benefits

Following, the economic direct results of the several sunflower scenarios (Table 1.3.3.1) will be generated at prefectural, regional and country level (Table 2.2.2.1).

Table 2.2.2.1 Generalization of net income (revenues) at prefectural, regional and country level

Net income	**Scen.1**	**Scen.2**	**Scen.3**
Evros (43,700ha)	6,555,000	1,857,250	3,823,750
Serres (13,040ha)	1,956,000	554,200	1,141,000
Thessaloniki (7,840ha)	1,176,000	333,200	686,000
Xanthi (7,150ha)	1,072,500	303,875	625,625
Dramma (6,080ha)	912,000	258,400	532,000
Rest areas (2,190ha)	328,500	93,075	191,625
Region of Eastern Macedonia/Thrace (52,100ha)	7,815,000	2,214,250	4,558,750
Region of Central Macedonia (22,200ha)	3,330,000	943,500	1,942,500
Greece (80,000ha)	12,000,000	3,400,000	7,000,000

The generalization results of farmers' net income by geographic region are clearly demonstrated in Figure 2.2.2.1. In this Figure, since the most important sunflower production areas in Greece are Evros (Orestiada), Serres, Thessaloniki, Xanthi and Dramma, the direct farmers' benefits, are higher for the Regions of Central Macedonia and Eastern Macedonia-Thrace, in Northern Greece.

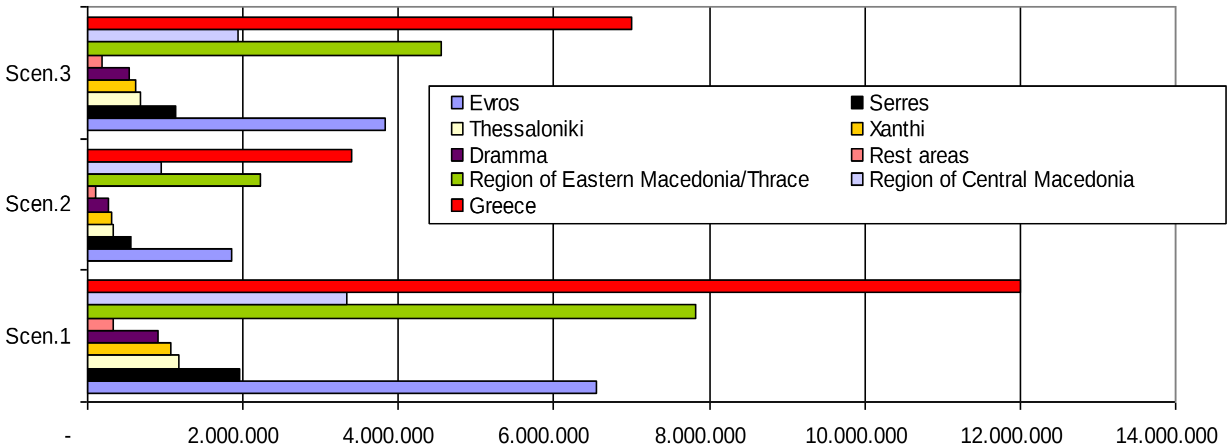


Figure 2.2.1.1 Generalization of net revenues by geographic area

2.2.2 Indirect benefits

Considering the great importance of indirect benefits of sunflower cultivation (Figure 1.3.5.1) for the prefectural, regional and country economy, any generalization effort of these benefits is extremely interesting. However, this generalization effort is not simple work as there are some benefits that correspond on all over the country as a whole and can not be allocated proportionally in each one of the study areas. For example, the foreign exchange benefits, the reduction of energy dependence and the environmental benefits refer to the whole country and particularly to the large urban centres (Liolios and Nikolaou, 2010). That's why in the following generalization effort of the indirect benefits the above mentioned ones excluded from the prefectural and regional levels (Figure 2.2.2.1 and 2.2.2.2). **According to this Figures Prefecture of Evros and Region of Eastern Macedonia-Thrace ensure the lion's share of the indirect benefits, mainly from crop rotation. On the other hand, foreign exchange benefits are the most important impact category at country level** (Figure 2.2.2.3).

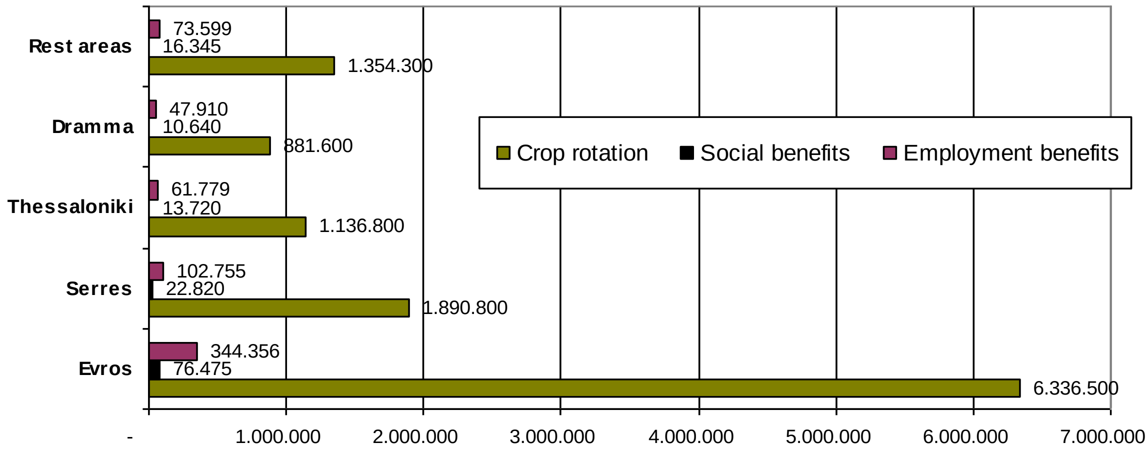


Figure 2.2.2.1 Generalization of indirect benefits by geographic area

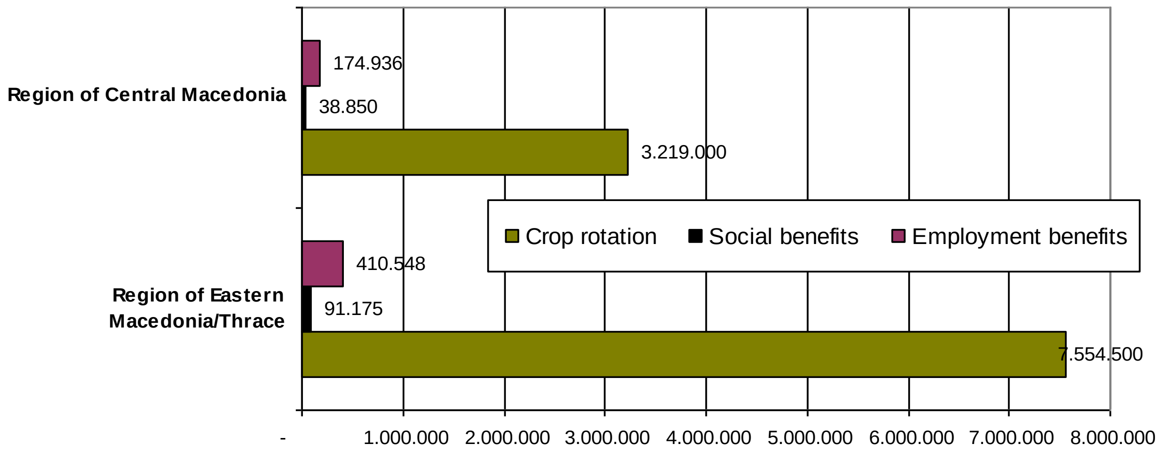


Figure 2.2.2.2 Generalization of indirect benefits by geographic region

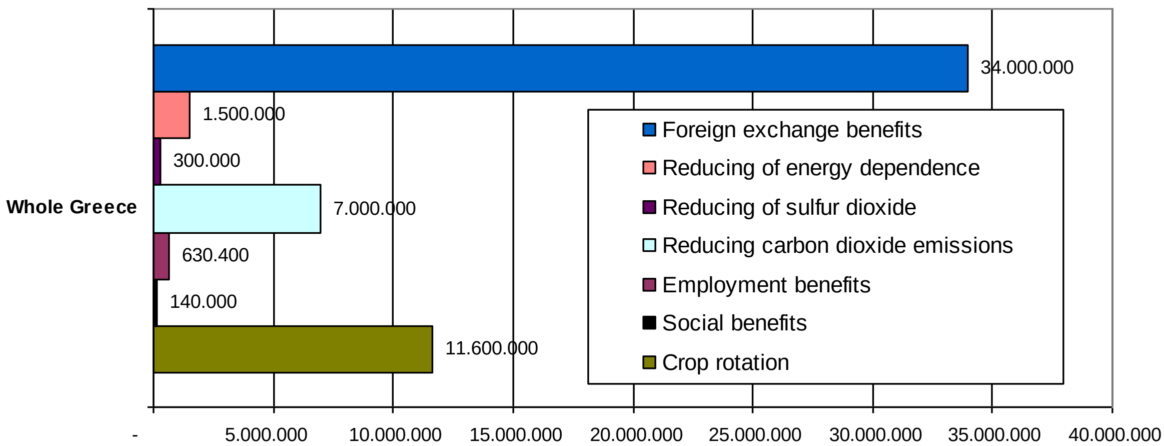


Figure 2.2.2.3 Generalization of indirect benefits at country level

2.2.3 Total benefits (direct and indirect)

Following, the aggregated results the total benefits (both direct and indirect results), of the baseline scenario of sunflower cultivation, will be generated at prefectural, regional and country level as follows (Table 2.2.3.1).

Table 2.2.3.1 Generalization of both direct and indirect benefits at prefectural, regional and country level (€, year 2014)

Net income	**Baseline Scenario (Scen. 3)**
Evros (43,700 ha)	10,581,081
Serres (13,040 ha)	3,157,375
Thessaloniki (7,840 ha)	1,898,299
Xanthi (7,150 ha)	1,651,225
Dramma (6,080 ha)	1,472,150
Rest areas (9,340 ha)	610,269
Region of Eastern Macedonia/Thrace (52,100 ha)	***12,615,973***
Region of Central Macedonia (22,200 ha)	***5,375,286***
Greece (80,000 ha)	***62,170,400***

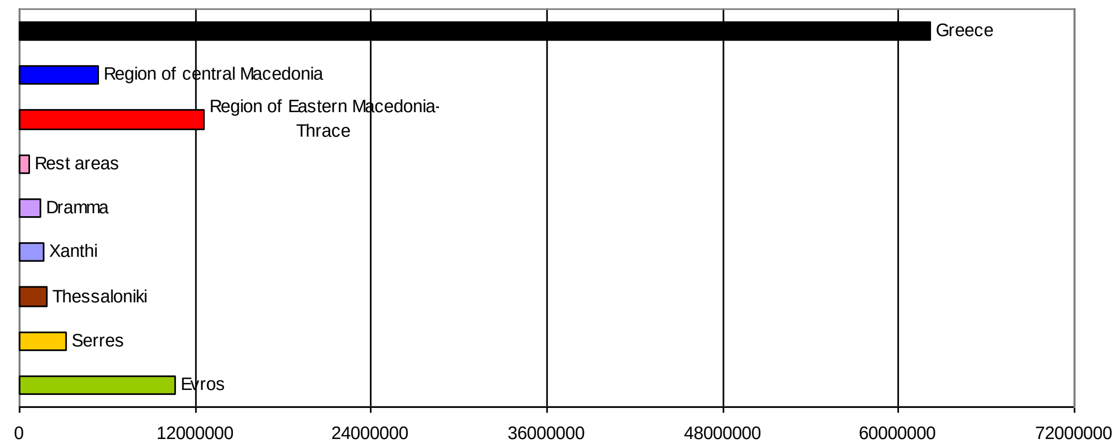


Figure 2.2.3.1 Generalization of both direct and Indirect benefits of sunflower cultivation (€, year 2014)

2.3 Sunflower withdrawal

2.3.1 Producer loss

In the case of a hypothetical sunflower withdrawal the best alternative scenario, based on the economic results, is the sixth one (wheat cultivation). **According to this scenario, a loss of the net revenue by 72.5 €/ha occurs. Then, considering the withdrawal effects of the cultivation of sunflower in a prefectural level, the**

growers of sunflower in Evros will lose a total of approximately €3.168 million of their net income (Figure 2.3.1.2). Additionally, the growers of sunflower in Serres, Thessaloniki and Dramma will lose approximately €0.945 million, €0.568 million and €0.440 million respectively of their net income. In a regional level (Figure 2.3.1.1), the sunflower farmers in the Regions of Eastern Macedonia-Thrace and Central Macedonia will lose approximately €3.777 million and €1.609 million respectively of their net income. Finally, in a national level the growers of sunflower in whole Greece will lose a total of approximately €5.800 million of their net revenues.

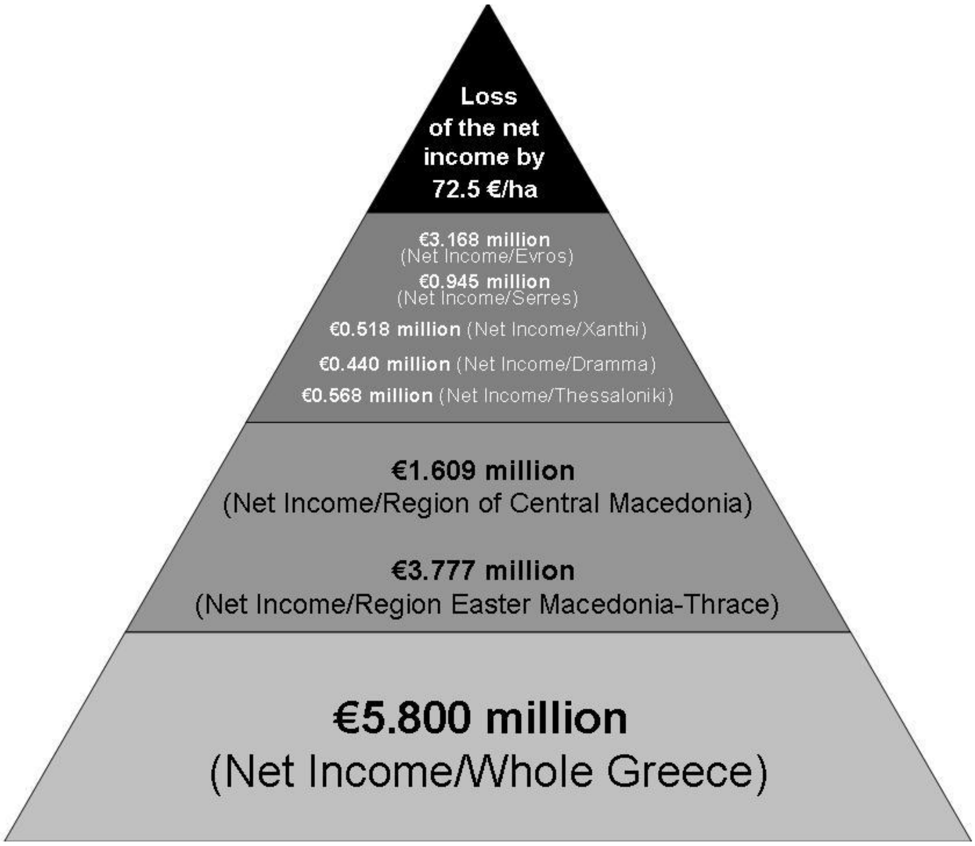


Figure 2.3.1.1 National, regional and Prefectural direct effects of sunflower withdrawal

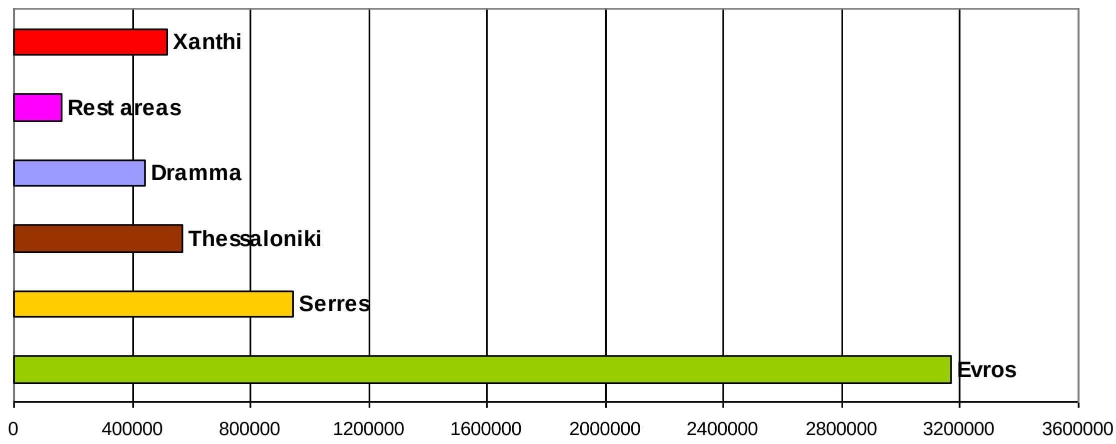


Figure 2.3.1.2 Effects of sunflower withdrawal on Prefectural Net Incomes (€)

2.3.2 Whole economy loss

In this hypothetical case of sunflower withdrawal, taking into account not only the direct loss of farmers' income but also the indirect loss of the whole economy, generalization results of loss further increasing (Figure 2.3.2.1).

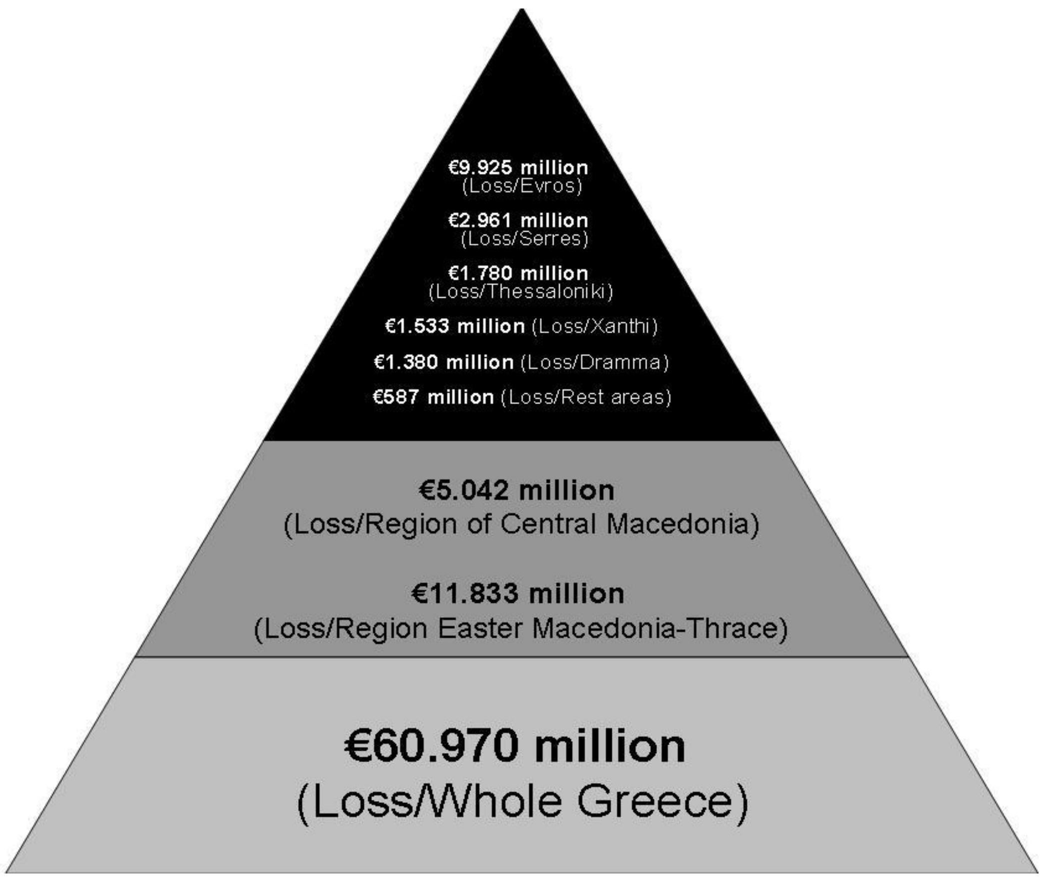


Figure 2.3.2.1 National, Regional and Prefectural direct and indirect effects of sunflower withdrawal

2.4 Multiplier effects

The direct benefits, in practice, although satisfactory they are not really huge. On the other hand, the indirect benefits are remarkable and especially when two additional factors are incorporated, the multipliers effect and the recurring dimension, they can be increased even more. **The multiplier's effect is the total benefit garnered by the society, if this additional income will spend within the regional or national economy. In this case, with an average income multiplier equal to two (Mattas et al., 2014), the whole benefits are doubled. Therefore, any change in the status of sunflower cultivation, will cause huge loss of income (Figure 2.4.1).**

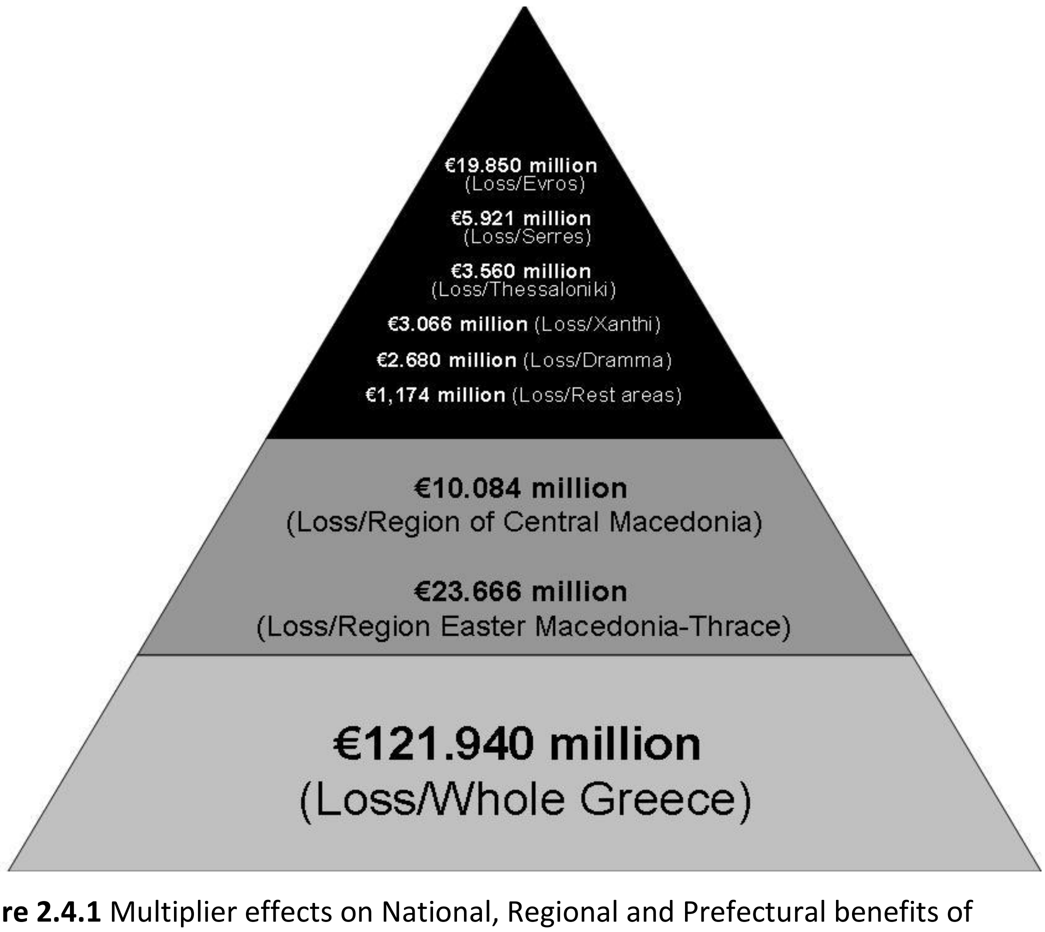


Figure 2.4.1 Multiplier effects on National, Regional and Prefectural benefits of sunflower withdrawal (both direct and indirect)

2.5 Conclusions

From the above analysis it is clear that the withdrawal effects of sunflower cultivation per hectare are more important for the growers of Evros and subsequently for the growers of Serres, Thessaloniki and Dramma (Figure 2.3.1.1). However, considering the extensive indirect benefits coming mainly from the operation of the processing industry and crop rotation or foreign exchange odds in combination with the multipliers effect and the recurring dimension, the cumulative effect in sunflower cultivation, is much higher for the economy of the whole Greece and the regional economies (especially for the regions of Eastern Macedonia-Trace and Central Macedonia).

The cultivation of sunflower, as the best biodiesel producer, offers to the farmer a net income of €42.5-150.0 per ha while the net additional revenues to the whole farmers of the Prefecture of Evros (Orestiada) are equal to €3.168 million an amount satisfactory for the small area of Orestiada. In other words, withdrawal of sunflower will cause loss to the small area of Orestiada around €3.168 million. This amount will be more than doubled, if multiplier’s effect and recurring dimension will measured and will be even more multiplied if taken into account indirect benefits as well.

Chapter 3

Farmers' reflections on sunflower cultivation

3.1 Introduction-objectives

This section aims to determine farmer's knowledge, attitudes and beliefs regarding sunflower cultivation, promotion and perspectives. For this purpose a questionnaire was designed (justified from relevant studies: Papadaki et al, 2000; Voudouri et al, 2005; Mattas et al, 2011), aiming at gathering information about farmers' attitudes and beliefs on sunflower production, the level of satisfaction compared to other products cultivated, and the perspectives for sunflower cultivation in the future. Since the main aim was to record also farmers' views, apart from estimating the economic and market potentials of sunflower cultivation at regional and national level, twenty eight (28) sunflower farmers from two selected areas (Serres and Orestiada-Evros) in Macedonia and Thrace (northern Greece) were participated in the survey. In these regions, the most of sunflower production is concentrated.

3.2 Methodology

The survey design team spent several days interviewing farmers in the two areas. The design and implementation of the survey has basically three steps, as follows:

Questionnaire Development

The survey was carried out on the basis of a self-administered questionnaire. The questionnaire was divided in three major sections. The first section included only socio-economic questions for farmers. Questions about farms/enterprises and crops included in the second section. Finally, the last section focused on beliefs about sunflower cultivation, willingness to continue cultivation even without subsidies or "contract" and potential scenarios about quiting sunflower cultivation.

Survey Sample

The survey covers the two geographical areas namely Serres and Orestiada-Evros region, Greece. In these regions, a large number of farmers cultivating sunflower were notified for the data collection process.

Interview

The duration of each interview was about 15-20 minutes, plus the time required for travelling to the interviewing points (cafes, farmer unions, town halls and communities spaces). Farmers were given all basic information needed to answer the questions, assuring them that individual information will remain confidential. Survey team also explained the purpose of the interview, the objectives of survey and any potentially confusing technical terminology.

3.3 Results-Discussion

3.3.1 Descriptive Statistics

3.3.1.1 Socio-economic data of farmers and farms/enterprises

The number of participating farmers in the survey was twenty eight (28), among those twenty five (25) were males and three (3) were females. Sixteen (16) of the farms were located in Serres and twelve (12) in Orestiada-Evros. (Table 3.3.1.1.1).

Table 3.3.1.1.1. Distribution of farms along the survey areas**.**

Areas	**Number of farms**	**Percentage %**
Serres	16	57.1
Orestiada-Evros	12	42.9
Total	**28**	**100.0**

The youngest farmer was 23 years old and the oldest 60 years old. The average age of the respondents was 45 years old and the majority were married.

53.6% of the respondents were high school educated and only three of them owned a university degree. The average income from agricultural activities was about 24000 euros. The majority of the interviewed farmers have more than 20 years (60.7

percent) experience in agriculture and cultivate sunflower for five to nine years (81.5 percent). The size of households consisted mainly of four and three members at a rate of 42.1 percent and 25 percent respectively.

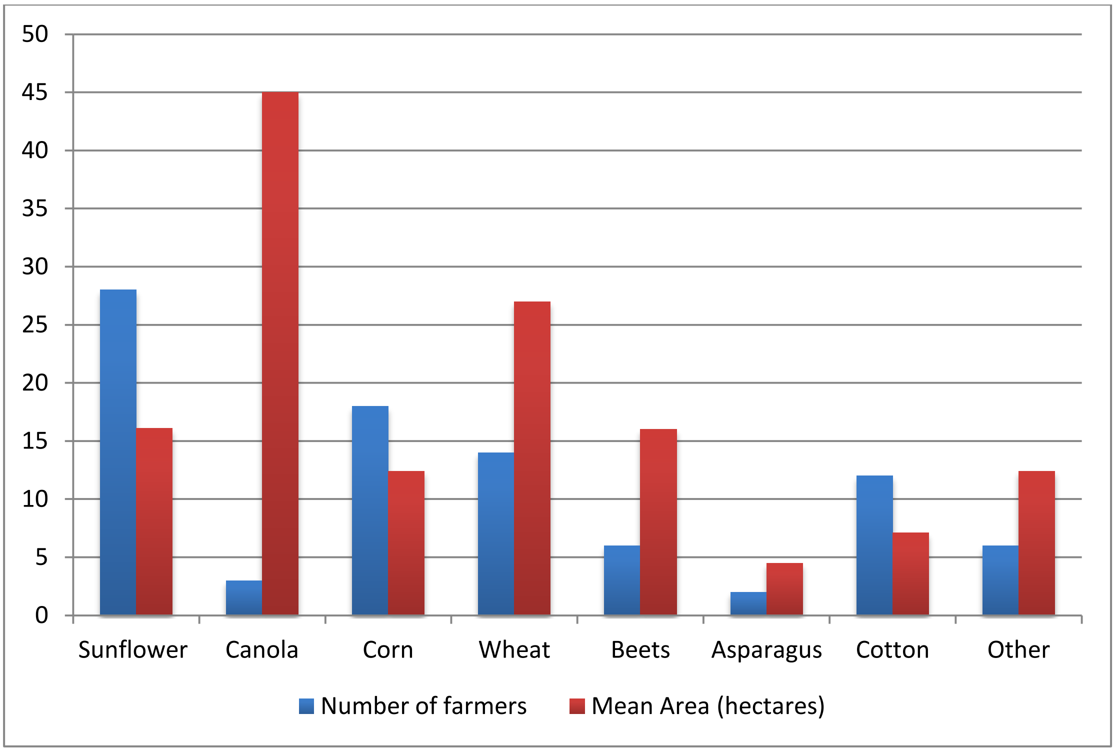
As far as total hectares, 67.9 percent of the farmers cultivated farms less than 40 hectares and 9 farmers cultivated farms of 50 hectares or more. 71.4 percent of the sample owned farms of 20 hectares, and around 30 percent owned farms of 40 hectares or more. Eighty percent of the respondents rented farms of 20 to 45 hectares.

Regarding cultivated crops, aside from sunflower, 64.2 percent of the farmers cultivated corn, 50 percent wheat and 42.8 percent cotton (Table 3.3.1.1.2 and Figure 3.3.1.1.1).

Table 3.3.1.1.2. Distribution of crops along the survey areas

Crops	**Number of farmers**	**Mean Area (hectares)**
Sunflower	28	16.1
Canola	3	45
Corn	18	12.4
Wheat	14	27
Beets	6	16
Asparagus	2	4.5
Cotton	12	7.1
Other	6	12.4

Figure 3.3.1.1.1. Distribution of crops along the survey areas



Fifty percent of the surveyed farmers were self-employed in a permanent base on their farms and 64.3 percent of them had seasonal assistance by another member of their household. 53.6 percent of the farmers receive an extra help and support by foreign workers in order to complete the cultivated crop period. Fifty percent of the participants used one or two employees at a permanent base. Eighty percent of the farmers employed less than 5 seasonal workers, while 7.1 percent had more than 10 seasonal workers to help them during farming period.

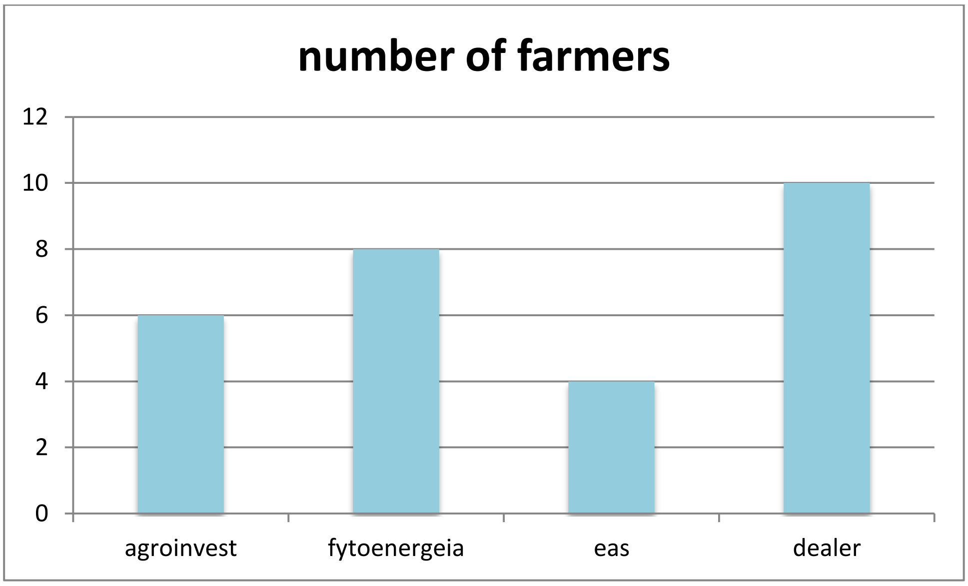
3.3.1.2 Perceptions about sunflower cultivation

The second part of the questionnaire was dedicated to record farmers' perceptions about sunflower cultivation, promotion and attitudes. Based on farmers' answers, 35.7 percent sell sunflower to private dealers, 28.5 percent to fytoenergeia, 21.4 percent to Agroinvest and 14.2 percent to agricultural cooperative union (EAS) (Table 3.3.1.2.1 and Figure 3.3.1.2.1).

Table 3.3.1.2.1. Sunflower traders

Sunflower trader	Farmers
Agroinvest	6
Fytoenergeia	8
EAS ()	4
Dealer	10
Total	28

Figure 3.3.1.2.1. Sunflower traders.



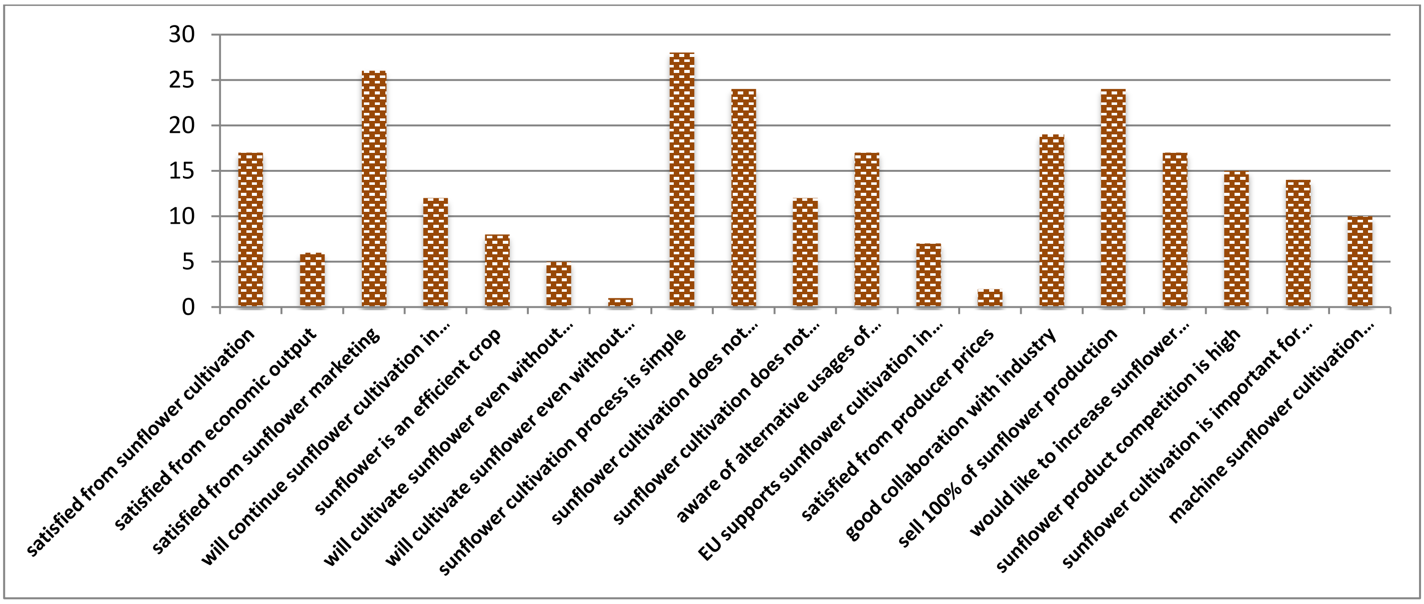
The majority of participated farmers stated they do not receive subsidy for sunflower cultivation (60.7%). Among those who receive subsidy the average amount is equal to 32400 euros, depending on the quantity produced. Twenty six farmers stated they signed contract for producing and market sunflower and around eighty percent are highly satisfied from contract conditions.

In the next section of the questionnaire farmers were asked to express their beliefs and perceptions about their involvement in sunflower production (Figure 3.3.1.2.2).

Based on their answers, 60.7 percent are satisfied from their involvement in sunflower cultivation and 92.8 percent are satisfied from marketing and selling conditions. All farmers agreed that sunflower cultivation is simple and the great majority (85.7 percent) stated that sunflower cultivation does not demand specific knowledge.

Sixty percent of the farmers were aware of alternative usages of sunflower product, whereas seventy percent stated that have excellent collaboration with the sunflower industry. Respondents expressed a willingness to increase cultivated area of sunflower in the years to come.

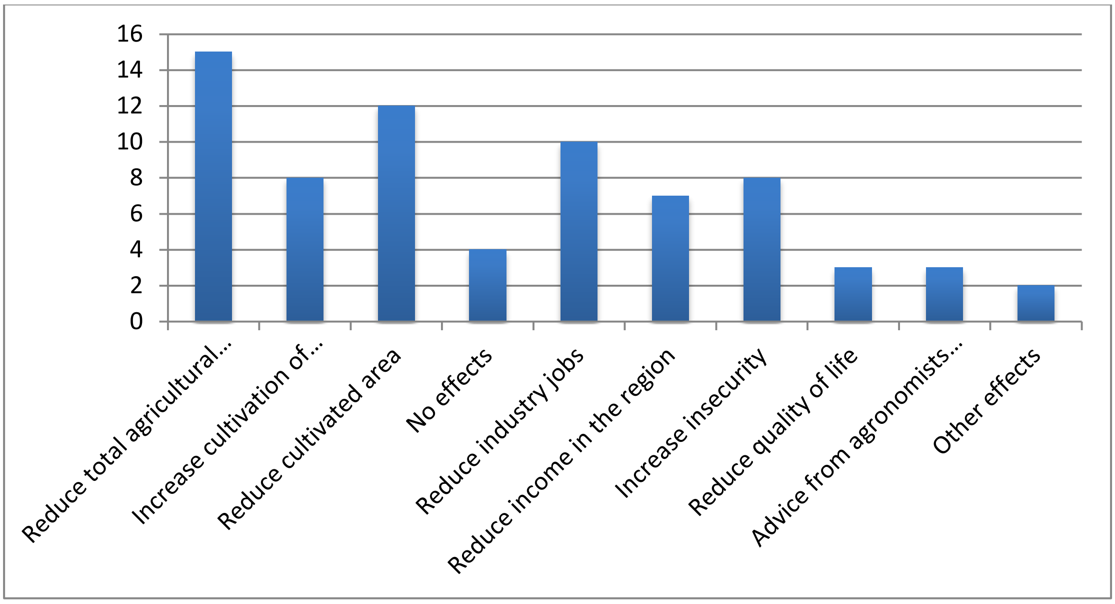
Figure 3.3.1.2.2. Attitudes towards sunflower cultivation



3.3.1.3 Perceptions about potential impacts in case of cultivating sunflower does not exist

In this section of the survey, farmers were asked to express their perceptions and potential effects in a scenario that they do not have the possibility to cultivate the sunflower crop. The results appear in Figure 3.3.1.3.1. According to farmers' statements, the expected impacts due to stopping sunflower cultivation are: loss in agricultural income (53.5 percent), reduction of cultivated area (42.8 percent) and loss of jobs in the related industry (35.7 percent). In addition, shifting to alternative crops will increase the insecurity (28.5 percent) and the loss of income at regional level (25 percent).

Figure 3.3.1.3.1. Perceptions about potential impacts of stopping sunflower cultivation



3.3.2 Correlation Statistics

A way of studying the relationship of sunflower cultivation and farmers' socioeconomic profile and beliefs is correlation statistics. The Correlation Coefficient indicates both the existence of a relation and also the significant of these relations.

The statistical analysis of socioeconomic data and farmers' beliefs resulted in the following findings (Tables 3.3.2.1 and 3.3.2.2):

a) Correlation between *age* and perceptions indicated that older farmers are more satisfied from sunflower cultivation, producer prices, collaboration with the industry, sell the total quantity produce every year, and would like to increase the total cultivated area. In addition, older farmers believe that sunflower cultivation does not demand specific knowledge, is supported by the EU and the product competition in the market is high.

b) Regarding farmers’ education level and perceptions related to sunflower cultivation, noteworthy results are the following: higher educated farmers will continue sunflower cultivation in the future, believe that the cultivation process is simple and does not demand specific knowledge, are aware of alternative usages of sunflower seed and satisfied from producer prices. Moreover, higher educated respondents believe that EU supports sunflower cultivation in their region and that machinery use in cultivation process increases yields.

c) Household size and perception on sunflower cultivation provides significant correlations in the below mentioned items: the higher the size of the household the stronger the willingness to cultivate sunflower even without a contract. Farmers living in large households are more satisfied from sunflower market, believe that sunflower cultivation does not demand specific knowledge and does not pollute the environment. They also believe that sunflower cultivation is a solution for rotation, EU supports it in their region and sell the total quantity they produce.

d) Annual income of farmers is also correlated to their perceptions on sunflower cultivation. Specifically, respondents with a high annual income are more satisfied from sunflower cultivation, believe that sunflower cultivation process is simple, know the alternative usages of sunflower seed and are more willing to produce sunflower even without subsidy. Respondents with a higher annual income are satisfied from producer prices, would like to increase the total sunflower cultivated area and perceive machinery use increases sunflower production yields.

e) Farmers who are involved in agriculture for many years are more satisfied from the economic output derived from sunflower production and the market. Also they are more willing to cultivate sunflower even without a contract sign, since they consider that sunflower cultivation does not demand specific knowledge and also they sell the total production every year.

f) Respondents involved for many years in sunflower cultivation are more willing to continue in the future, believe that cultivating sunflower does not demand specific knowledge and are aware of the alternative usages of sunflower seed. Moreover, those involved for many years in sunflower production believe that EU supports sunflower cultivation in their region, are more satisfied from producer prices, have fruitful collaboration with the industry and sell the total quantity produced every year.

g) Farmers own higher sized enterprises are more satisfied from the sunflower market, stated that sunflower is an efficient crop and are more willing to continue sunflower cultivation in the future, even without receiving subsidies. They also believe sunflower cultivation does not demand specific knowledge and machinery cultivation provides higher yields; also, farmers with larger enterprises are more aware of alternative usages of sunflower seed.

Table 3.3.2.1. Correlation between socioeconomic variables and perceptions regarding sunflower cultivation

Perceptions towards sunflower cultivation	**Gender**		**Age**		**Education**		**Family members**		**Annual income**	
	Pearson correlation	**Sign***	**Pearson correlation**	**Sign***	**Pearson correlation**	**Sign***	**Pearson correlation**	**Sign***	**Pearson correlation**	**Sign***
satisfied from sunflower cultivation	2.470	0.481	54.667	0.236	4.456	0.879	16.313	0.362	**55.417**	**0.043**
satisfied from economic output	0.283	0.868	37.545	0.230	2.948	0.815	8.809	0.556	29.830	0.275
satisfied from sunflower marketing	0.321	0.956	57.536	0.163	13.936	0.125	31.025	**0.009**	50.125	0.109
will continue sunflower cultivation in the future	10.310	**0.016**	72.513	**0.013**	15.699	**0.073**	22.085	0.106	33.044	0.737
sunflower is an efficient crop	11.813	**0.008**	60.648	0.104	5.356	0.802	16.167	0.371	48.533	0.141
will cultivate sunflower even without subsidy	3.391	0.495	72.520	0.159	9.751	0.638	22.500	0.314	**68.160**	**0.066**
will cultivate sunflower even without contract	0.456	0.928	53.741	0.264	7.926	0.542	26.471	**0.033**	42.057	0.340
sunflower cultivation process is simple	0.200	0.963	21.123	0.174	6.604	**0.086**	5.813	0.325	**22.830**	**0.044**
sunflower cultivation does not demand specific knowledge	2.325	0.508	76.926	**0.005**	24.450	**0.004**	24.963	**0.050**	29.641	0.283
sunflower cultivation does not pollute the environment	1.392	0.846	89.303	**0.020**	9.885	0.626	45.389	**0.001**	59.167	0.230
aware of alternative usages of sunflower	1.163	0.884	68.519	0.327	21.341	**0.046**	18.656	0.544	**57.055**	**0.031**
EU supports sunflower cultivation in my region	13.500	**0.019**	101.795	**0.051**	24.191	**0.062**	37.025	**0.057**	74.556	0.195
satisfied from producer prices	7.473	**0.058**	66.696	**0.038**	19.131	**0.024**	13.762	0.544	**50.933**	**0.096**
good collaboration with industry	2.320	0.313	45.281	**0.060**	1.538	0.957	8.852	0.546	34.000	0.135
sell 100% of sunflower production	0.844	0.656	47.250	**0.040**	10.125	0.119	32.935	**0.000**	26.448	0.439
would like to increase sunflower cultivated area	4.723	0.311	81.500	**0.069**	12.219	0.428	26.042	0.164	**75.389**	**0.007**
sunflower product competition is high	2.671	0.445	61.546	**0.091**	12.146	0.205	20.428	0.156	44.494	0.251
sunflower cultivation is important for rotation	5.850	0.211	67.000	0.250	9.260	0.681	32.365	**0.040**	63.489	0.132
machine sunflower cultivation provides higher yields	6.857	**0.077**	53.889	**0.103**	14.921	**0.093**	14.301	0.503	**50.783**	**0.052**

Table 3.3.2.2. Correlation between enterprise variables and perceptions regarding sunflower cultivation

Perceptions towards sunflower cultivation	**Years involved in agriculture**		**Years sunflower cultivation**		**Total hectares**		**Sunflower cultivated area**	
	Pearson correlation	**Sign***	**Pearson correlation**	**Sign***	**Pearson correlation**	**Sign***	**Pearson correlation**	**Sign***
satisfied from sunflower cultivation	59.692	0.120	29.026	0.219	73.923	0.163	41.851	0.606
satisfied from economic output	45.182	**0.061**	22.708	0.122	49.848	0.189	39.073	0.124
satisfied from sunflower marketing	76.536	**0.002**	21.468	0.161	**81.000**	**0.063**	34.286	0.877
will continue sunflower cultivation in the future	47.733	0.484	**48.430**	**0.002**	**81.650**	**0.057**	53.089	0.191
sunflower is an efficient crop	50.949	0.251	27.865	0.266	**74.608**	**0.097**	**57.914**	**0.094**
will cultivate sunflower even without subsidy	70.875	0.259	34.725	0.339	**106.458**	**0.050**	**80.986**	**0.037**
will cultivate sunflower even without contract	60.963	**0.099**	20.094	0.691	66.444	0.359	41.970	0.601
sunflower cultivation process is simple	21.887	0.147	7.500	0.484	25.708	0.218	21.887	0.111
sunflower cultivation does not demand specific knowledge	67.364	**0.034**	**42.800**	**0.010**	**84.000**	**0.040**	**60.421**	**0.062**
sunflower cultivation does not pollute the environment	70.707	0.264	30.314	0.552	97.788	0.144	51.418	0.777
aware of alternative usages of sunflower	76.282	0.140	**46.969**	**0.043**	**101.096**	**0.099**	65.208	0.301
EU supports sunflower cultivation in my region	83.386	0.237	**57.511**	**0.036**	112.295	0.189	84.491	0.212
satisfied from producer prices	59.631	0.121	**34.811**	**0.071**	74.105	0.104	45.206	0.463
good collaboration with industry	35.531	0.224	**26.602**	**0.046**	51.469	0.106	38.475	0.138
sell 100% of sunflower production	42.000	**0.072**	**29.705**	**0.020**	51.750	0.144	28.500	0.544
would like to increase sunflower cultivated area	56.028	0.622	**44.965**	**0.064**	91.683	0.186	65.694	0.286
sunflower product competition is high	52.482	0.304	21.710	0.597	77.296	0.106	39.004	0.723
sunflower cultivation is important for rotation	69.700	0.184	29.033	0.617	94.350	0.130	59.250	0.503
machine sunflower cultivation provides higher yields	40.911	0.387	**36.789**	**0.046**	**72.000**	**0.028**	42.400	0.214

3.4. Conclusions

The task of the present survey was to record attitudes and perceptions of farmers on sunflower cultivation, and also to record what could be the probable impacts in case of stopping cultivating sunflower. For this purpose personal interviews in a small sample of farmers (28) was conducted in two areas where sunflower is widely cultivated. Analyzing farmers' survey data the derived conclusions are described in the following lines.

Sunflower cultivation is a contract farming activity, since the majority of farmers stated they sign contracts with sunflower processing enterprises, and as a result they sell the total quantity produced every year. **Noteworthy is that most of the respondents are very satisfied from contract conditions and their collaboration with the industry**.

Farmers are also satisfied from their involvement in sunflower cultivation, since they believe it is a simple process, without high requirements in knowledge and expertise. They also stated that sunflower cultivation is a low cost activity compared to alternative crops, which provides relatively high producer prices and secures a standard level of income.

Considering all the above mentioned advantages of cultivating sunflower, the majority of surveyed farmers express their willingness to continue being involved in this activity and additionally to increase sunflower cultivated area in the future.

Farmers asked to identify potential impacts in the case of abandoning the cultivation of this crop. Based on their answers, the most crucial impacts mentioned were the following: income loss, reduction in cultivated area, loss of jobs in the processing industry, increase in insecurity and income loss at regional level.

Statistical analysis conducted to identify potential correlations between sociodemographic data and perceptions about sunflower cultivation derived some useful highlights. Older and higher educated farmers are in general more satisfied from their involvement in sunflower cultivation, producer prices and collaboration with the industry.

Household size and annual income is also positively correlated with beliefs and perceptions about sunflower cultivation. Higher size of household and higher income from agriculture increases farmers' willingness to continue being involved in this activity even without receiving subsidy.

Positive reactions also derived acoording to years involved in agriculture, total cultivated area and the magnitude of sunflower cultivated area. Farmers being involved in agriculture for long time, those with large sized enterprises and farmers who cultivate sunflower for many years are more satisfied from their involvement in the supply chain of sunflower product and more willing to continue their involvement in the future.

Generally speaking, the farmers' perceptions section demonstrates that results derived by the technical analysis (previous sections) are very well in line with the beliefs and perceptions of the farmers in the region of Macedonia and Thrace.

References

ABAF, 2015. Accounting Books of Agricultural farms. Department of Agricultural Economics, Faculty of Agriculture, Aristotle University of Thessaloniki.

Anastasiadis, A. 2012, Sunflower. Agrotipos: Athens

Baker, M., Biofuels are Famine Policy: Food Shortages are Hitting, Executive Intelligence Review, 33 (23), 8 June, 2007, http://www.larouchepub.com/other/2007/3423 iofuels_shortages.html

Bartolini F., Angelini L.G., Brunori G., Gava O. (2015). "Impacts of the CAP 2014–2020 on the Agroenergy Sector in Tuscany, Italy", Energies, 8, pp. 1058-1079; http://dx.doi:10.3390/en8021058

Berndes, G., Hoogwijk, M. and van den Broek, R., (2003). The contribution of biomass in the future global energy supply: a review of 17 studies, Biomass and Bioenergy, 25, 1-28

Bowyer C., 2011. Anticipated Indirect Land Use Change Associated with Expanded Use of Biofuels and Bioliquids in the EU – An Analysis of the National Renewable Energy Action Plans", Institute for European Environmental Policy. Available at www.ieep.eu

[Commission of the European Communities, 2008] Proposal for a Directive of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources, Brussels, 23 January, 2008

http://ec.europa.eu/energy/climate_actions/doc/2008_res_directive_en.pdf

Center for Renewable Energy Sourses (CRES), 2006. Energy crops for the production of liquid and solid biofuels in Greece. Report, available at http://www.cres.gr/kape/publications /download.htm

Danalatos NG, Archontoulis SV, Geronikolou L, Papadakis G, 2005. Irrigation and N-fertilization effects on growth and productivity of three sunflower hybrids in an aquic soil in central Greece. In: M.J Pascual- Villalobos, F.S. Nakayama, C.A. Bailey, E. Correal and W.W. Schloman, Jr. Proceeding of 2005 Annual Meeting of the Association for Advancement of Industrial Crops: International Conference on Industrial Crops and Rural Development 17−21 September 2005, Murcia, Spain, pp 129−138.

ELSTAT, 2015. Structural research of agricultural and livestock farms for the year 2013. Greek Statistical Authority, Accessed on http://www.statistics.gr/portal

/page/portal/ESYE/BUCKET/A0401/PressReleases/A0401_SPG03_DT_3Y_00_2013_01_F_GR.pdf

Eurostat, 2015. Agriculture statistics - family farming in the EU. Accessed on http://ec.europa.eu/eurostat/statistics-explained/index.php/Agriculture_statistics_-_family_farming_in_the_EU.

Eurostat, Agricultural Statistical Yearbook, 2014.

Eurostat, Agricultural Statistical Yearbook, 2015.

European Commission (2006). “Study on implementing the energy crops CAP measures and bio-energy market” Final Report, Department Of Agricultural Economics And Engineering University Of Bologna p.270, retrieved from http://ec.europa.eu/agriculture/eval/reports/bio_energy/index_en.htm on June 5th 2015.

European Commission (2011). “Common Agricultural Policy towards 2020” Impact Assessment, Commission Staff Working Paper, Accompanying the document, Proposals for a Regulation Of The European Parliament And Of The Council, available at: http://ec.europa.eu/agriculture/policy-perspectives/impact-assessment/cap-towards-2020/report/full-text_en.pdf

European Commission, 2013. Agricultural Policy Perspectives Brief, Overview of CAP Reform 2014-2020.

European Commission (2005), Biomass action plan, Communication From The Commission, Brussels, 7.12.2005 COM(2005) 628 final.

European Parliament (2015), Fuel quality directive and renewable energy directive, P8_TA-PROV(2015)0100.

European Parliament, Council of the European Union (2009). “Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing”, Directives 2001/77/EC and 2003/30/EC, available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0028.

Europeam Parliament (2013). REGULATION (EU) No 1305/2013 Of The European Parliament And Of The Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council

Regulation (EC) No 1698/2005, Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF .

FAOSTAT, 2015. Analytical databank of world agricultural production. Accessed on http://faostat3.fao.org/browse/Q/*/E

Fleureck M., (2013) The Common Agricultural Policy and Bioenergy, Directorate for Agriculture and Rural Development, European Commission Brussels, Presentation for the AEBIOM conference, 18 June 2013.

Fontaras, G., Skoulou, V., Zanakis, G., Zabaniotou, A. & Samaras, Z. 2012, "Integrated environmental assessment of energy crops for biofuel and energy production in Greece", Renewable Energy, vol. 43, pp. 201-209.

Geronikolou L., Danalatos N. G., Kalavriotou P., Archondoulis S., Papadakis G., 2004. An experimental study of sunflower oil production in Greece to be used as an alternative fuel. Proceedings 2nd World Biomass Conference- Rome, 10-14 May 2004.

Giannoulis, K., Archontoulis, S., Bastiaans, L., Struik, P., & Danalatos, N. (2009). Performance of cropping systems including sunflower as mono-crop and in intensive rotation with winter wheat in central greek plains. In 17th European Biomass Conference, Hamburg, Germany. Proceedings.

Hamje H.D.C., Hass H., Lonza L., Maas H., Reid A., Rose K.D., Venderbosch T. (2014). “EU renewable energy targets in 2020: Revised analysis of scenarios for transport fuels”, JEC Biofuels Programme, European Commission.

Zafeiriou, E., Arabatzis, G., Tampakis, S., Soutsas, K., 2014. The Impact Of Energy Prices On The Volatility Of Ethanol Prices And The Role Of Gasoline Emissions. Renewable and Sustainable Energy Reviews 33, 87-95.

IACS, 2014. Analytical statements of Integrated Administration and Control System (IACS), Hellenic Ministry of Rural Development and Food, Athens.

International Risk Governance Council IRGC, 2008. Risk Governance Guidelines for Bioenergy Policies, Policy Brief, Geneva, p.68.

Kaan, D.A. and O’Brien, D.M. 2003. An Economic Evaluation of Alternative Crop Rotations Compared to Wheat-Fallow In Northeastern Colorado. Working Paper accessed on http://www.colostate.edu/dept/aes/Pubs/pdf/tb02-1.pdf

Kampman B., van Grinsven A., Croezen H. Sustainable Alternatives For Land-Based Biofuels In The European Union Assessment Of Options And Development Of A Policy Strategy, Delft, CE Delft, December 2012

Kittas, Th. Gemtos, S. Fountas, Th. Bartzanas (2007). Biofuels and energy crops. Renewable energy sources – Their position to the energy landscape in Greeece and in Thessaly region. TEE– ΚΔΘ, Larisa, 29th November-1st December.

Liolios, A. & Nikolaou, K. 2010, "Environmental impact assessment of alternative fuel use plans in urban buses of Thessaloniki", Journal of Environmental Protection and Ecology, vol. 11, no. 1, pp. 1-6.

Loizou, E., Michailidis, A., & Chatzitheodoridis, F., 2013. Investigating the drivers that influence the adoption of differentiated food products: The case of a Greek urban area. British Food Journal, 115(7), 917-935.

Loizou, E., Chatzitheodoridis, F., Polymeros, K., Michailidis, A. & Mattas, K. 2014. "Sustainable development of rural coastal areas: Impacts of a new fisheries policy", Land Use Policy, vol. 38, pp. 41-47.

Lois, E., Anastopoulos, g., 2006. Biodiezel And Bioethanol Use As A Substitute Of Diesel And Gasoline. National Polytechnical University of Athens, Department of Chemical Engineering, Laboratory of fuels and lubricants.

Mattas, K., Tsakiridou, E., Botonaki, A. and Tsiboukas, K. (2011): «A retrospective view of EU's cotton production and future perspectives», *Outlook on Agriculture,* Vol. 40(1), pp. 39-44.

Mattas, K., Tsakiridou, E., Michailidis, A., Tsiamparli, E., & Mattas, K., 2014. Economic assessment of Pendimethalin herbicide use in selective crops (cotton, processing tomato & onion) (No. 166116). Accessed on http://ageconsearch.umn.edu/bitstream/166116/2/Pendimethalin%20Report%20170414.pdf

Michailidis, A., Koutsouris, A. & Nastis, S. 2011a. "Adoption of sustainable irrigation practices in water scarce areas", Bulgarian Journal of Agricultural Science, vol. 17, no. 5, pp. 579-591.

Michailidis, A., Partalidou, M., Nastis, S.A., Papadaki-Klavdianou, A. & Charatsari, C. 2011b. "Who goes online? Evidence of internet use patterns from rural Greece", Telecommunications Policy, vol. 35, no. 4, pp. 333-343.

National Sunflower Association, 2003. Accessed on http://www.sunflowernsa.com/magazine/details.asp?ID=307&Cat=8.

Panoutsou C, 2008, Bioenergy in Greece: Policies, diffusion framework and stakeholder interactions, Energy Policy, Vol: 36, pp: 3674-3685, ISSN: 0301-4215.

Panoutsou, C., Namatov, I., Lychnaras, V. & Nikolaou, A. 2008, "Biodiesel options in Greece", Biomass and Bioenergy, vol. 32, no. 6, pp. 473-481.

Papadaki-Klavdianou, A., Giasemi, E. and Tsakiridou, E. (2000): «Environmental attitudes of Integrated Pest Management greenhouse producers in Greece», *International Advances in Economic Research*, *Vol. 6(2), pp. 306-315*.

Rogers, E. M. (2010). Diffusion of innovations. Simon and Schuster.

Rozakis, S., Haque, M.I., Natsis, A., Borzecka-Walker, M. & Mizak, K., 2013, "Cost-effectiveness of bioethanol policies to reduce carbon dioxide emissions in Greece", International Journal of Life Cycle Assessment, vol. 18, no. 2, pp. 306-318.

SBIBE, 2012. Biofuels: one more missed opportunity? Hellenic Biofuels and Biomass Association. Accessed on http://www.sbibe.gr/documents/ARTHRA/Biofuels%20by%20Folias%20Green%20Issue.pdf

SBIBE, 2013. Biofuels: with an eye to 2020. Hellenic Biofuels and Biomass Association. Accessed on http://www.sbibe.gr/sviveconference/documents/PRESENTATIONS/Folias%20final.pdf

Sidiras, D.K. 2014, "GIS based simulation of the biodiesel penetration in European Union markets: The case of Greece", Biomass and Bioenergy, vol. 65, pp. 101-111.

Skaraki, G.N., Korres, G. and Pavli, O.I. 2008. Energy crops-biofuels. Hellenic Ministry of Rural Development and Food, Athens.

Skarakis, G., (2010), "Evolutions In The Biofuels Sector And Their Perspectives in Greece", *Agriculture-Livestock*, Issue 1/2010, pp. 26-29.

Skoulou, V., Mariolis, N., Zanakis, G. & Zabaniotou, A. 2011, "Sustainable management of energy crops for integrated biofuels and green energy production in Greece", Renewable and Sustainable Energy Reviews, vol. 15, no. 4, pp. 1928-1936.

YPEKA 2008, Hellenic Republic, Ministry of Environment, Energy and Climate Change, General Secretary of Energy and Climate Change, General Secretary of Energy, Secretary of Oil Policy, "5th Annual Report for the Promotion of Biofuels or Other Renewable Fuels in Greece for the Period 2005-2010", Article 4 of the Directive 2003/30/EK), available at: http://www.ypeka.gr/LinkClick.aspx?fileticket=rUa18pYyKKc%3D&tabid=292 , in Greek.

Vlachos, C.E., Mariolis, N.A. & Skaracis, G.N. 2014, "A comparative greenhouse gas emission analysis of oilseed crops for biodiesel production in Greece", Journal of Agricultural Science, vol. 152, no. 2, pp. 263-273.

von Lampe, M. et al. (2014). Fertiliser and Biofuel Policies in the Global Agricultural Supply Chain: Implications for Agricultural Markets and Farm Incomes, OECD Food, Agriculture and Fisheries Papers, No. 69, OECD Publishing. http://dx.doi.org/10.1787/5jxsr7tt3qf4-en.

Voudouri, I., Baourakis, G., Tzimitra-Kalogianni, I and Tsakiridou, E. (2005): «Best Practice Model for Organic Farming and Marketing», *New Medit, Vol. IV(3)/2005, pp.22-26*.

Zegada-Lizarazu, W., & Monti, A. (2011). Energy crops in rotation: A review. Biomass and Bioenergy, 35(1), 12-25.

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