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Farmers' Intention towards Energy Crops Adoption under Alternative Common Agricultural Policy: An Empirical Analysis in Andalusia, Spain

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Abstract: The Common Agricultural Policy (CAP) reform, currently being debated among the European Member States, is likely to strengthen the role of renewable energy production in the European Union. This research aims at analyzing the farmer's decisions towards the on-farm adoption of energy crops under alternative policy scenarios. Firstly, farmer's stated intention for the period 2013-2020 is expressed under a scenario with the current CAP scheme and, secondly with the complete abolishment of the CAP support. A discrete choice model (Probit) is used with the aim of underling determinants of farmer's decisions. A sample of 201 farm-households belonging to Andalusia (Spain) is analyzed. Firstly, the CAP influence on energy crops adoption for the coming years seems to be negligible. Meanwhile farmers might be more sensitive to market signals. Secondly, in the event of CAP liberalization a larger number of farmers would exit from the sector leaving farmlands available for new users. Finally, also in line with the innovation adoption literature variables such as off-farm labor factors, farm typology specializations, size of farmland, farmer's age and education are relevant in the adopting process.

Key words: energy crops; adoption of innovation; farmer's behavior; European Union; policy
JEL codes: Q18, Q4

1. Introduction and Objective

The use of biomass as an energy source has undergone a revival in industrial societies during the last 15 years. With the fast growth in human populations worldwide, global energy consumption is beginning to exhaust conventional fossil energy resources. In addition, the release of CO_2 from the burning of fossil energy has led to global climate change. An increased use of biomass for energy is therefore considered a potential solution as it offers moderate to strong greenhouse gas (GHG) saving compared to the use of fossil energy. Last but not least, biomass discussion is driven by rural development as it can promote job creation and improve competitiveness (Fischer et al., 2005).

For biomass to play a significant role in the world's energy future, dedicated energy crops are essential (Evans et al., 2010). Energy crops on farmland can produce biomass from fast-growing species in high densities and can be collected in short cycles. Biomass plants take advantage of secure biomass sources, available in

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constant supply and at low cost. However, growing energy crops is a non-traditional land use option (i.e., crop farming) which may fall into the adoption of innovation issue (Villamil et al., 2008). Although energy crops might result in profitable activities, farmers' decisions are a key constraint to on-farm adoption (Giannoccaro & Berbel, 2012; Sherrington et al., 2008).

Literature on innovation adoption mechanisms have emphasized the positive effect of the Common Agricultural Policy (CAP) on the adoption of innovation as a driver of farm's investment behaviour (Viaggi et al., 2011), as well as the adoption/diffusion of new technologies (Bartolini et al., 2010). Temporal patter and predictability of policy (e.g., maintaining payments for a long-term such as 5-20 years) led to the reduction of both income uncertainty and exposure to price fluctuations, fostering propensity for early investment (Sherrington et al., 2008).

Common Agricultural Policy (CAP) is currently being debated among the European Member States. The expected process of CAP reforming after 2013 is likely to strengthen the role of innovation in the European Union as a further step towards a bio-economy strategy (European Commission, 2010). Nevertheless, up to now the attention paid to CAP's role in farmers' decision process towards the adoption of energy crops has been scarce. One difficulty is related to the recent development of dedicated crops for energy purposes and the variety of local conditions. In addition, energy crops cause some ethical concerns related to the likely food, water and land competition that they may face (Evans et al., 2010).

In this context, this paper considers farmer's stated responses to CAP liberalization and identifies the extent to which these plans would be influenced by the introduction of CAP abolishment from 2014. The stated responses are analyzed in order to stress the influence of a change between 2009 CAP continuity and CAP removal on the farmer's decision to adopt or not adopt on-farm energy crops. The abolishment hypothesis, as a counter-factual scenario, provides an insight into the influence of the current policy on farmer's decisions. As a consequence, the role of agricultural policy in the promotion of energy crops is identified. Moreover, determinants of different farmer's preferences are investigated by means of econometric analysis.

The research is based on the stated preferences theory and uses a sample of 201 farm-households in Andalusia (Southern Spain) carried out in 2009.

The remainder of the paper is set as follows: in Section 2, a literature review is presented, while in Section 3, the study area and sample descriptions are provided, followed in Section 4 by the methodology. Section 5 illustrates the results, and finally concluding remarks are proposed.

2. Influence of the Common Agricultural Policy on Energy Crop Adoption

The Common Agricultural Policy is presumably the most important policy intervention in the agricultural sector and food supply chain within the European Union. Every seven years a new policy course is agreed upon by all European Member States. In the last reform, single farm payments (SFP) were introduced in 2006 and based on average payments claimed over the three-year reference period of 2000-2002.

Initially, the main chapter of the CAP, the so called Pillar I, now provides payments for income support that are decoupled from production. In principle, a decoupled subsidy does not influence production decisions by the farmers and permits free market determination of prices. In fact, the payments were re-coupled to land and so would continue to have an impact on land management decisions and inevitably, production (Lobley & Butler, 2010).

The second component of the CAP, the so called Pillar II covers several tens of measures organized into three axes plus the Leader. Some measures are designed to provide compensatory payments for disadvantaged areas (LFA), while agro-environmental schemes (AES) include supports for organic agriculture and other environmental services. Moreover, within the second pillar, several policy instruments are developed to promote on-farm energy production. Mechanisms of co-funding investment in energy plants (measure 121 or measure 311) or payments for energy crops (measure 214) are implemented.

Despite such relevance for the EU bio-economy goals, the specific interplay between farm characteristics, market, local regulation and the CAP in the adoption of energy-related crops is still poorly studied. A small number of studies are available on CAP influence on the adoption of new crops, such as energy crops. At a glance, CAP effects vary due to a number of factors such as appropriate knowledge of alternative crops, cost of changing production or lack of a real biomass market. Moreover, the CAP itself varies among the European Member States.

Lychanaras and Schneider (2007) set out a simulation model in order to assess the regional biomass supply from dedicated crops within the Thessaly region (Greece). They found that the effects of payment decoupling were relevant. Indeed, with the full decoupling subsidy, the break-even point for short rotation crops entrance decreases by 50% in comparison with past CAP regimes.

Similarly, Lychanaras and Schneider (2011) carried out a policy simulation of four alternative scenarios for the Kopaida region (Greece). Again, CAP decoupling would reduce the cost of biomass production between 15 and 25 EUR per ton. In the same context, small and medium farms were more willing to replace a part of conventional crops with energy crops. Moreover, specialized farms in mixed field crops would adopt energy crops later than farms with a more specialized orientation, especially cotton farms.

Farm specialization has also been found as relevant farm-features by Bartolini and Viaggi (2012), in Emilia Romagna (Italy). They analyze farmer's planned behavior for the future CAP reform (2013-2020) focusing on on-farm adoption of energy crops or renewable energy technology. They found that around 50% of farmers specializing in field crops and permanent crops are willing to adopt energy crops in the event of a complete CAP abolishment scenario. Conversely, around 30% of farm, specialized in mixed crops, show the intention not to take into account the energy crops adoption with the CAP abolishment. With the reference to farm specialization, Giannoccaro et al. (2013) have found that farms specializing in arable farming systems are more likely to adopt energy production due to the increased flexibility in crops mix substitution and less connection with other farm production (e.g., need to produce feed for animals).

Impacts of direct subsidies for energy crops were analyzed by Nilsson et al. (2006) in Poland. They found that the main concern is related to the inadequacy of the amount of subsidy (45 EUR/ha), insufficient for promoting energy crop adoption.

Although, specific literature concerning on-farm adoption of dedicated energy crops is still scarce, some structural as well as personal variables are expected, being related to an adoption attitude in line with the innovation adoption literature. It is well known that the younger the farmers, the more likely they are to adopt innovations (Rogers, 1995), as are farmers who have better and longer education histories (e.g., Fernandez-Cornejo et al., 1994). Economic literature has highlighted the effects of risk and expectation as relevant determinants of alternative decision-making strategies towards innovation. For example, Ridier (2012) has pointed out that risk adverse farmers are more willing to adopt new short rotation coppice, with high fluctuation and uncertainty in commodities prices. Energy crops might be considered to be a risk reducing crop through diversification.

According to Ostwald et al. (2012), the motivational factors of energy crops adoption among Swedish farmers change with the specific energy crops. Moreover, Giannoccaro and Berbel (2012) analyzed farmers' intentions towards the adoption of energy crops in Andalusia (Spain). Essentially, they recognize several farm features that affect the energy crops adoption. Among these factors, the off-farm labor factor has a negative impact on adopting energy crops because of the competition between on-farm management and off-farm employment. The same item was also found to be relevant for miscanthus' adoption among farmers in Illinois (US) (Villamil et al., 2008).

Finally, it is largely documented that farm structural features (e.g., farm size) have strong influences on the farmer's adoption process (e.g., Breustedt et al., 2008). Generally, the adoption of energy crops would be more likely on larger farms.

Taking into account the abovementioned literature, a survey to farmers was designed with the aim of assessing CAP influence towards energy crops adoption in coming years.

3. Data

3.1 Study Area

This research refers to Andalusia, the Southern region of Spain. Andalusia is among the largest and most populated regions of Spain, with an agricultural area of about five million ha, equivalent to 57% of the total area extension (Department of Agriculture and Fisheries, 2010).

Figure 1 Map of Spanish Administrative Regions

Source: http://www.vivereamadrid.it/.

Andalusian climate conditions basically exhibit a Mediterranean feature with rainy winters and, warm and dry summer seasons. The average annual rainfall is 560 mm, but dry periods are fairly common. Accordingly, irrigation turns out to be the most relevant factor for profitable agriculture. Indeed, while 25% of the total cultivated area is irrigated land, more than 60% of total agricultural GDP is due to irrigated crops. With regards to farm size, a classical dualism between the number of farmers and farm size stands out. Most farmers (60%) cover a very small share of farmland (7.5%).

In general arable land amounts to 32% of total farmland, on which a rain fed system consisting of winter cereals and sunflowers prevails. In other arable land where water is easily accessible, cotton and sugar beet are usually grown. Nevertheless, the last CAP reform in 2006 has led to a considerable decrease in the prevalence of both crops. Indeed, a few years later, such crops displayed a reduction of 44% with respect to previous prevalence. On the other side, permanent crops are quite extensive (33%) with olive tree systems being the most relevant. In addition, citrus, fruit and grapes are extensively cultivated. Moreover, a system of permanent grasslands accounting for 26% of total utilized area is devoted to livestock rearing. Finally, fresh cut crops (i.e., irrigated horticulture) and other secondary field crops cover a small percentage of the total farmland (Department of Agriculture and Fisheries, 2010).

3.2 Survey Description

The survey was carried out in the context of the CAP-IRE project (Assessing the multiple Impacts of the Common Agricultural Policies (CAP) on Rural Economies) in the spring season of 2009. Farm-households across 3 main provinces of Andalusia (Jaen, Cordoba and Seville, accounting for 57% of farmland and 52% of farm-households) were canvassed through a questionnaire. 201 face-to-face interviews were conducted. The questionnaire was composed of the following sections: (1) Household information; (2) Farm information; (3) Strategic behaviour about a number of issues also concerning energy crops adoption. The questionnaire covers stated intentions about the farm household's planned behaviour in the next 10 years, including the intentions towards the adoption of energy crops with the rest of the external driver factors being constant. Namely, constant circumstances with regards to prices, employment opportunities and other conditions (e.g., water availability) were assumed to be stable at January 2009 levels. The questions were formulated considering two different policy scenarios: one with the existing (at year 2009) CAP (i.e., Baseline) and the other one with the whole abolishment of the CAP and other related policy instruments. This second hypothesis was called "Liberalization" scenario.

First of all, the planned decision on intention to stay in agriculture within the next years was asked. Questions about the intention to continue with farming activity were formulated as a discrete choice (yes vs. no) under both CAP and Liberalization hypotheses. If the farmer's reply was to abandon the sector, then the question on adoption was skipped and the interview ended. Only for those farmers who would continue, the intention towards on-farm adoption of energy crops was asked. The question about preferences for the on-farm adoption was arranged as a qualitative question, where each household was asked under both CAP scenario, if they expected to adopt any energy crops or not over the next ten years. Alternatively, farmers' responses such as in the case of they did not answer and they did not know what they would do were coded as "no answer" and "uncertain" respectively.

In order to obtain a sample as representative as possible of the farmers community, farmer's age, farm size, and typology of crop specialization were taken into account for the sampling procedure.

The Table 1 shows the characteristics and representativeness of the sample.

As Table 1 shows, the sample covers about 20 thousand hectares, with a prevalence of plain zones and only one third being located in hilly or mountainous areas. Arable crops are the principal farm specialization in the sample accounting for 46% of farms considered. Such groups include specialist COP producers (i.e., winter cereal, sunflower and leguminous crops usually cropped in annual rotation) and other general field crops. Then, there are farms specialized in permanent crops, such as the olive tree, citrus and other orchard fruits. Finally, livestock represents the least prevalent farm specialization. As a whole, the sample included a numbers of farms for each typology of specialization in line with the study area figure.

Turning to farm size, we organize the sample in three main sizes of farmland, namely the smallest one covering farms with less than 5 hectares, an intermediate dimension being between 5 and 50 hectares, and finally there is an upper level with farm size being larger than 50 ha. Similarly, the amount of farmland operated by each farm-class is defined. As Table 1 shows, figures between the study area and sample diverge, with class of farm size below 5 ha being underrated.

Table 1 Characteristics and Representativeness of the Sample

	Andalusia		Sample		Difference
Total Surface	(ha)	%		%	%
Plain	2361900	57.19%	13267.4	66.41%	+9.22%
Hill and Mountain	1767600	42.80%	6711	33.59%	-9.22%
Total	4129500	100%	19978.4	100%	-
Farm specialization	*Farm*				
Arable Land	52050	45.20%	92	45.78%	+0.58%
Permanent	97485	41.20%	82	40.80%	-0.40%
Livestock	23785	13.60%	27	13.42%	-0.18%
Total	155570	100%	201	100%	-
Farm classified by class of size	*Farm*				
0-5	115259	62.55%	42	20.90%	-41.65%
5-50	57996	31.48%	105	52.23%	+20.75%
> 50	11009	5.97%	54	26.87%	+20.90%
Total	184264	100%	201	100%	-
	ha				
0-5	209413	7.40%	90.9	0.45%	-6.95%
5-50	594212	27.41%	20306	11.54%	-15.87%
> 50	1845788	65.19%	17581.5	88.00%	+22.81%
Total	2831240	100%	19978.4	100%	-
Livestock	*Units*				
Cattle	324873	10.52%	1715	11.72%	+1.2%
Sheep and goats	1645406	53.27%	7797	53.29%	+0.02%
Pigs	1118260	36.21%	5120	34.99%	-1.22%
Total	3088539	100%	14632	100%	-

Source: Adapted from Giannoccaro and Berbel (2012).

Moreover, for specialist livestock, the head of animals is compared within each rearing category. As a whole, the sample covers each category according to the total number of animals within the study area.

Finally, the average farmer age in the sample is 54 years, with 56 years being the average of the study area.

4. Methodology

Based on the information provided by the survey, a discrete choice model is fitted to identify key determinants of the willingness to adopt energy crops in the study area. Two empirical regressions are run to detect factors determining intentions to adopt energy crops, either under the Baseline or CAP liberalization hypotheses.

The aims of the econometrics analysis is to assess the determinants of farmer's choices under the two policy scenarios, in order to stress which are the main factors behind the farmer's decision, which factors are recurrent or changing with the policy adjustment. It should be noted that this work aims to assess the influence of the CAP in the adoption of energy crops rather than a quantitative assessment of CAP scenario impacts.

A Probit regression has been performed under both CAP scenarios using data gathered only for those respondents declaring to stay in farming activity over the next years.

Let us put the linear relationship as D = $f(x_1, x_2,...,x_n)$, where D is the farmer's decision to adopt energy crops and x_i is a single factor explaining the farmer's decision. Considering this relationship, the linear probability model is based on the linear regression:

$$D_i = X_i\beta + \varepsilon_i \quad (1)$$

where *D* represents the binary dependent variable (D = 0 if the farmer is not willing to adopt energy crops and D = 1 if he/she is willing to adopt), *X* is a matrix of independent variables (N x K) which represents the set of factors *x* while *β* is the estimated vector (K x 1), *i* is referenced to the farmer in the sample and ε is the stochastic error. Being a probit model (Cameron & Trivedi, 2005), and with the assumption that the error $\varepsilon i \mid xi$ is distributed standard normal, $\varepsilon \approx N(0, 1)$, the probability to observe the corresponding value 1, is then given by:

$$P(D = 1 \mid X_i) = P(D_i^* > 0 \mid X_i) = \Phi(X_i'\beta) \quad (2)$$

where *P* is the probability to observe the event 1 and Φ is the standard normal cumulative density function. In order to obtain a consistent estimation of parameters, the method of maximum-likelihood is used. As a result, the coefficient estimated *β* for the determinants are to be interpreted as the increased probability of adoption compared to a no adoption behavior.

We fitted the model adopting a backward stepwise procedure, in which the definitive variables considered in the model are the results of a screening activity in the initial saturated list of variables. Starting from a model with all the variables, the fit of the model is tested after the elimination of each variable. In this way, the evaluation of the best model is done according to an ability to fit the data. The removal of a variable is able to vary the likelihood ratio chi-square of the model that is the parameters to verify the degree of fit of the model. When the elimination of another variable leads to a decreased likelihood ratio, the analysis is complete and it is not possible to delete some variables from the model.

The independent variables considered as determinants of farmer's behaviour are listed in Table 2.

In Table 2, determinants are merged into three main categories, namely farm structural features, farmer's related characteristics and finally, policy drivers. Within the first category there are three variables related to farm size, namely "Land owned", "Land rent IN" and "Land_Op". They represent hectares of owned land, land rented in then, overall land operated as a result of the sum among land owned, plus land rented in, minus land rented out. Initially, total land operated showed a huge variability therefore it was converted into an ordinal variable with four size classes according to the quartile distribution.

Worker full-time and worker part-time refer to the labour devoted to the farm household by the family members, respectively with a full-time or part-time schedule.

Farming specialization covers the main agricultural crop systems within the study area, namely specialized olive systems, COP, other general field crops, then permanent crops such as citrus, orchard fruit and vineyards. Lastly, we include livestock systems.

Finally, among the farm features "altitude" is related to the farm location in flat, hilly or mountainous zones.

Moreover, there are farmer's features such as age of farm head, his/her education level, the use of extension services, and membership of a farm union. Also there is the share of farm income with respect to the total household income accounting for six levels ranging from less than 10% to higher than 89%. Due to huge variance and small sample size, farmer's age and education are also merged in two different alternatives, such as "Age group" and "Education group".

Finally, three variables relate to the CAP drivers. The variable used for the policy payment is the amount of SFP per ha. In addition, agro-environmental schemes and organic production are coded as dummy variables indicating whether or not a farm is engaged in these CAP measures.

Table 2 List of Variables Used as Determinant

	Obs.	Label	Variable description	Coding	Mean	S.D.	Freq.
Farm features	200	Land owned	Total land owned (ha)	-	66.13	237.35	-
	199	Land rent IN	Land rent-in	0 = no, 1 = yes	0.43	0.49	-
	199	Land_Op	Total amount of land managed	<= 8 8-24 24-64 > 64	-	-	26.1% 25.6% 23.6% 24.6%
	201	Worker full-time	Household worker full-time	0 = yes, 1 = no	0.38	0.30	-
	201	Worker part-time	Household worker part-time	0 = yes, 1 = no	0.39	0.49	-
	199	Specialization	Main farm specialization	Olive systems COP Field crops Other permanent Livestock & crops	-	-	30.7% 19.1% 26.1% 10.6% 13.6%
	201	Altitude	Location of the farm with respect to the altitude	0 = Plain 1 = hill & montain	0.22	0.42	-
Farmer's features	200	Age	Age of farm head (years)	-	53.91	13.05	-
	200	Age group	Age of farm head (three groups)	1 = <= 40 years 2 = 41-65 years 3 = > 66 years	-	-	17.5% 64.0% 18.4%
	201	Education	Education level of farm head (five levels)	1 = None 2 = Primary school, 3 = High school, 4 = Professional master 5 = Degree/Ph.D.	–	–	53.7% 2.0% 24.9% 10.9% 8.5%
	201	Education group	Education level of farm head (three levels)	1 = none & primary 2 = high 3 = master & degree & Ph.D.	-	-	55.7% 24.9% 19.4%
	201	Extension service	Farmer assisted by an extension service	0 = no, 1 = yes	0.92	0.14	
	201	Farmer union	Membership of a farmer union	0 = no, 1 = yes	0.56	0.50	
	188	Share Gross Revenue	Share of farm income from agricultural activity over total household income (%)	less than 10% 10-29% 30-49% 50-69% 70-89% more than 89%		–	21.8% 19.7% 10.1% 9.6% 9.0% 29.8%
Policy	198	SFP	SFP (EUR/ha)		445.9	385.7	-
	201	AES	Farm engaged in Agri-Environmental schemes	0 = no, 1 = yes	0.18	0.21	-
	201	Organic production	Farms with organic production	0 = no, 1 = yes	0.05	0.38	-

Source: own elaboration.

5. Results and Discussion

First of all, the declared intentions are reported in Table 3, where the two scenarios (Baseline vs. CAP liberalization) are compared.

Table 3 Change in Farmers' Behavior toward Energy Crops Adoption

Farmer's choice		Baseline					
		Reject	Adoption	Uncertain	No answer	Exit	Total
CAP liberalizat.	Reject	64	1	-	-	-	65
	Adoption	2	18	-	-	-	20
	Uncertain	-	-	1	-	-	1
	No answer	-	-	-	1	-	1
	Exit	55	14	-	-	45	114
	Total	121	33	1	1	45	201

Source: own elaboration.

As Table 3 reports, farmer's behaviors can be merged into two wide categories, namely those farmers who would change their intention if the CAP was abolished and, those respondents who would not change whatever the policy in place. 64 out of 201 respondents would never adopt energy crops while 18 of total sample would adopt. At the same time it is worth mentioning that 45 are those who would exit from the sector regardless of CAP scenarios. Turning now to those farmers who would change their choice, the main effect of CAP liberalization is an increase in the number of farmers exiting from the sector. Indeed, 14 of those who would adopt under the Baseline scenario would actually leave the sector if the CAP was removed. While only one respondent would adopt under Baseline and would not under CAP liberalization, two respondents would adopt in the event of policy liberalization. Findings show that CAP influence on farmer's preference to adopt energy crops is negligible. Nevertheless, CAP removal might produce an indirect effect, increasing farm exit from the agricultural sector, also for a number of adopters.

In the next section, results of the probit models are shown. It should be noted that farmers who stated to exit from the activity are initially omitted. In addition, farmers whose responses were not stated (i.e., they did not answer and they did not know what they would do) are ruled out. In the models, the dependent variables are set "0" for those farmers who are not willing to adopt energy crops while the value "1" is for farmers declaring the intention to adopt energy crops.

Table 4 reports the probit model results in the case of farmer's preferences under the Baseline hypothesis. We introduced all available variables (see Table 2) into the probit model. In order to reduce the length of editing, significant as well as the most important determinants are reported.

According to the findings of the probit regression, there is a major likelihood to adopt energy crops if the CAP continues as currently implemented on farms with a larger size of owned land. Indeed, the probit coefficient shows that the larger the farm size, the higher the probability to be in the adoption class. Moreover, household farms where family members do not have off-farm employment show a major likelihood to adopt energy crops. Specialization emerges to be related to farmers' decision, with specialization in COP and general field crops showing major probabilities of adoption, with respect to specialists in olive systems.

Turning to the farmer's features, a determinant of adoption is the age of the farm head. Indeed, the oldest group of the sample is less willing to adopt. Inversely, higher education levels increase the probability to adopt.

On the other hand, it should be remarked that no policy drivers linked to the current CAP scheme will be relevant in the adoption process.

As a whole, the probit model fits quite well, with a Pseudo R^2 of 0.35.

Let us turn now to the CAP liberalization hypothesis. Table 5 reports the results of the probit regression.

Table 4 Probit Regression-Adopters Under Baseline Scenario

Variables	Coef.	Std. Err.	z	P>|z|
Land_owned	0.002603	0.0014968	1.74	0.082*
Land rent IN	0.1300475	0.3069307	0.02	0.983
(no) Worker part-time	0.930578	0.3250464	2.86	0.004***
Specialization				
COP	1.173804	0.5867408	2.00	0.045**
Field crops	1.04947	0.5448866	1.93	0.054*
Other permanent	0.8644702	0.6370627	1.36	0.175
Livestok & crops	-0.8270201	1.140229	-0.73	0.468
Altitude (Plain)	0.0150728	0.6907637	0.02	0.983
Age group				
41-65 years	-0.4656088	0.3591141	-1.30	0.195
> 66 years	-1.350149	0.7080917	-1.91	0.057*
Education_group				
Primary school	1.129196	0.8949341	1.26	0.207
High school	-0.353109	0.4202231	-0.84	0.401
Professional master	0.4283212	0.4391684	0.98	0.329
Degree/Ph.D.	0.9629448	0.5448019	1.77	0.077*
SFP	0.0004803	0.000409	1.17	0.240
Constant	-2.062376	0.6865826	-3.00	0.003**
Log likelihood = -51.424774 Pseudo R2 = 0.3473		Number of obs = 149 LR chi2(15) = 54.72 Prob > chi2 = 0.0000		

Source: own elaboration

Significance at 90%, 95% and 99% respectively with (*), (**) and (***)

Basically, a small number of variables result in significant values, namely size of total operated land, off-farm labor allocation and, farms engaged in the AES. Of these variables two were also significant under the Baseline hypothesis, namely land size and (not)-working part-time. Although farm land has also been found significant under the Baseline scenario, in the case of CAP liberalization the Land_Op is only significant for larger farms (> 64 ha), while other farm size categories are not relevant.

The main difference is for the AES variable. In the event of second pillar abolishment, farmers with agro-environmental payments could find it less profitable to maintain their agro-environmental commitments without CAP aids, therefore these areas, being marginal land or areas with lower soil quality, might be devoted to renewable energy production. Energy crops could be very interesting alternatives on marginal lands, as Campbell et al. (2008) and Bocqueho et al. (2011) emphasize.

On the other hand, there are some variables such as farm specialization, farmers' age and education, which are significant under Baseline while are not in the case of CAP liberalization.

Table 5 Probit Regression-adopters under CAP Liberalization

Variables	Coef.	Std. Err.	z	P > |z|
Land rent IN	-0.4629982	.5136357	-0.90	0.367
Land_Op				
8-24	0.8580442	0.8018108	1.07	0.285
24-64	1.248007	0.8505328	1.47	0.142
> 64	1.784906	0.9532452	1.87	0.061*
(no) Worker part-time	2.02511	0.6708409	3.02	0.003***
Specialization				
COP	0.2579961	0.8812532	0.29	0.770
Field crops	-0.6715304	0.9423655	-0.71	0.476
Other permanent	-0.0260326	0.9230747	-0.03	0.978
Livestok & crops	0.4767835	1.265312	0.38	0.706
Altitude (Plain)	-0.9772564	0.8936531	-1.09	0.274
Age group				
41-65 years	-0.7594926	0.6189643	-1.23	0.220
> 66 years	-0.3356613	0.7393703	-0.45	0.650
SFP	-0.0003836	0.0013814	-0.28	0.781
AES	1.311596	0.6483546	2.02	0.043**
Constant	-2.698901	1.103362	-2.45	0.014**
Log likelihood = -21.060023 Pseudo R2 = 0.5432		Number of obs = 84 LR chi2(15) = 50.09 Prob > chi2 = 0.000		

Source: own elaboration

Significance at 90%, 95% and 99% respectively with (*), (**) and (***)

6. Concluding Remarks

In this paper, the influence of the Common Agricultural Policy on the adoption of energy crops is investigated. The paper compares farmers' stated intentions, assuming two alternative CAP scenarios: a baseline with current CAP maintenance and CAP liberalization with complete CAP abolishment.

According to the main results, CAP payments are not significant. Although literature on CAP influence has identified positive effects of SFP in promoting innovation adoption, model findings are in line with the results of Bartolini and Viaggi (2012) who found only a slight relevance of the current CAP role in farmers' adoption process of energy/technology crops. Actually, for the case study of Andalusia it seems that CAP payments will not affect farmers' decision towards energy crops adoption. On the other hand, in the case of a CAP abolishment farms currently involved in Agro-Environmental Schemes might be more willing to adopt energy crops. The commitment of environmental services, mainly within marginal areas, is profitable only with financial support therefore energy crops might represent a valuable farming alternative.

Instead, determinants such as farmers' education, farmer's age, as well as the size of farmland in line with the innovation adoption literature have been found to be significant in this research. Results also confirm that arable farming systems (i.e., COP and general field crops) are more likely to adopt energy production probably due to more flexibility in crop pattern substitution. Again, the size of farmland emerges to be related to adoption behavior, with larger farm less conditioned by a CAP removal. Finally, a special mention is for the off-farm labor factor. A large number of southern Spanish household members have jobs off-the-farm. Farming activities and practices that create scheduling conflicts between on-farm management and off-farm employment discourage any farming and crop changes. This aspect of compatibility is discussed in the literature.

On the other hand, the main CAP influence is related to the farmer's decision to continue with farming activity after 2013. Moreover, among those who would adopt energy crops under the baseline scenario, many of them would abandon farming activity if the CAP support was eliminated, leaving farmlands available for new investment/users.

Despite the R2 values being in line with statistic goodness, it is worth noting that models were performed on a small number of observations, with some sample biases. As a consequence, the results should be considered as preliminary findings enabling future research.

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References:

Bartolini F. and Viaggi D. (2012). "An analysis of policy scenario effects on the adoption of energy production on the farm: A case study in Emilia-Romagna (Italy)", *Energy Policy*, Vol. 51, pp. 454-464.

Bartolini F., Floridi D. and Viaggi D. (2010). "Assessment of present, trends, mechanism and impact of the CAP on structural change and innovation", available online at: http://www.cap-ire.eu.

Bocqueho G., Jacquet F. and Reynaud A. (2011). "Determinants of miscanthus adoption: An empirical investigation among French farmers", in: *The 5th "Journees de recherches en sciences sociales"*, Dijon, France, December 8-9.

Breustedt G., Muller-Scheesel J. and Latacz-Lohmann U. (2008). "Forecasting the adoption of GM oilseed rape: Evidence from a discrete choice experiment in Germany", *Journal of Agricultural Economics*, Vol. 59, No. 2, pp. 237-256.

Cameron A. C. and Trivedi P. K. (2005). "Binary outcome models", in: Cameron A. C. & Trivedi P. K. (Eds.), *Microeconometric: Methods and Applications*, Cambridge University, pp. 465-475.

Campbell J. E., Lobell D. B., Genova R. C. and Field C. B. (2008). "The global potential of bioenergy on abandoned agriculture lands", *Environmental Science and Technology*, Vol. 42, No. 15, pp. 5791-5794.

Department of Agriculture and Fisheries (2010). "Regional statistics", available online at: http://www.juntadeandalucia.es/agriculturaypesca/portal/index.html.

European Commission (2010). "The knowledge based bio-economy (KBBE) in Europe: Achievements and challenges", Clever Consult BVBA (Belgium), available online at: http://www.bio-economy.net/reports/files/KBBE_2020_BE_presidency.pdf.

Evans A., Strezov V. and Evans T. J. (2010). "Sustainable considerations for electricity generation from biomass", *Renewable and Sustainable Energy Reviews*, Vol. 14, pp. 1419-1427.

Fernandez-Cornejo J., Daberkow S. and Huang W. H. (1994). "The adoption of IPM techniques by vegetable growers in Florida, Michigan and Texas", *Journal of Agricultural and Applied Economics*, Vol. 26, No. 1, pp. 158-172, available online at: http://ageconsearch.umn.edu/bitstream/15441/1/26010158.pdf.

Fischer G., Prieler S. and Van Velthuizen H. (2005). "Biomass potentials of miscanthus, willow and poplar: Results and policy implications for Eastern Europe, Northern and Central Asia", *Biomass and Bioenergy*, Vol. 28, No. 2, pp. 119-132.

Giannoccaro G., Bartolini F., Raggi M. and Viaggi D. (2013). "Assessing the CAP influence on European farmers' preferences towards the adoption of renewable energy production", in: *AIEAA (Italian Association of Agricultural and Applied Economics) Second Congress*, June 6-7, 2013, Parma, Italy.

Giannoccaro G. and Berbel J. (2012). "The determinants of farmer's intended behavior towards the adoption of energy crops in

Southern Spain: An application of the classification tree-method", *Bio-based and Applied Economics*, Vol. 1, No. 2, pp. 199-212, available online at: http://ageconsearch.umn.edu/bitstream/141969/2/10554-21318-1-PB.pdf.

Lychnaras V. and Scneider A. (2007). "Dynamic economic analysis of perennial energy crops—effects of the cap reform on biomass supply in Greece", Research Unit Sustainability and Global Change, Hamburg University, Germany Working Paper FNU-132, available online at: http://www.mi.uni-hamburg.de/fileadmin/fnu-files/publication/working-papers/FNU132_GreeceBioen.pdf.

Lobley M. and Butler A. (2010). "The impact of CAP reform on farmers' plans for the future: Some evidence from South West England", *Food Policy*, Vol. 35, pp. 341-348.

Lychnaras V. and Schneider U. (2011). "Multi-farm economic analysis of perennial energy crops in Central Greece, taking into account the CAP reform", *Biomass and Bioenergy*, Vol. 35, pp. 700-715.

Nilsson L., Pisarek M., Buriak J., Oniszk-Popawska A., Ericsson K. and Jaworski L. (2006). "Energy policy and the role of bioenergy in Poland", *Energy Policy*, Vol. 34, pp. 2263-2278.

Ostwald M., Jonsson A., Wibeck V. and Asplund T. (2012). "Mapping energy crop cultivation and identifying motivational factors among Swedish farmers", *Biomass and Bioenergy*, Vol. 50, pp. 25-34.

Raggi M., Sardonini L. and Viaggi D. (2013). "The effects of the Common Agricultural Policy on exit strategies and land re-allocation", *Land Use Policy*, Vol. 31, pp. 114-125.

Ridier A. (2012). "Farm level supply of short rotation woody crops: Economic assessment in the long-term for household farming systems", *Canadian Journal of Agricultural Economics*, Vol. 60, pp. 357-375.

Rogers E. (1995). *Diffusion of Innovations* (4th ed.), New York: The Free Press.

Sherrington C., Bartley J. and Moran D. (2008). "Farm-level constraints on the domestic supply of perennial energy crops in the UK", *Energy Policy*, Vol. 36, pp. 2504-2512.

Viaggi D., Bartolini F., Raggi M., Sardonini L., Sammeth F., Gomez Y. Paloma (2011). "Farm investment behavior under the CAP reform process", Publications Office of the European Union, Luxembourg, p. 142.

Villamil M. B., Heinze Silvis A. and Bollero G. A. (2008). "Potential miscanthus' adoption in Illinois: Information needs and preferred information channels", *Biomass and Bioenergy*, Vol. 32, pp. 1338-1348.