Assessing the CAP influence on European farmers' preferences towards the adoption of renewable energy production.

Giacomo Giannoccaro*[a] Fabio Bartolini[b], Meri Raggi[c], Davide Viaggi[d]

[a] STAR Agro-Energy group, Dpt. SAFE, University of Foggia;
[b]Dpt. of Agriculture, Food and Agri-environmental Science, University of Pisa;
[c] Dpt. of Statistic Science, University of Bologna;
[d] Dpt. of Agricultural Science, University of Bologna

g.giannoccaro@unifg.it

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Summary

Despite a large literature about energy production from renewable resources, the specific interplay between farm characteristics, market, local regulation and the CAP in the adoption of energy-related technologies by farmers is still poorly studied. This paper aims at analyzing the farmers' intentions towards the on-farm adoption of energy crops or technologies for renewable energy production under alternative policy scenarios. The analysis is based on the econometric analysis of adoption intentions by a sample of more than 2,300 farm-households interviewed in nine European countries. Stated intentions towards the willingness to adopt energy crops/technology for renewable energy production, are expressed firstly under a scenario with the current CAP post 2013 (Baseline) and secondly under a scenario with the complete abolishment of the CAP support (No CAP). The study confirms that the CAP influences farmers' decision on the adoption of energy crops/technologies for renewable energy production in the next years. Other relevant variables are farm typology specializations, size of owned and rented land and farmer's education and advices. Moreover, scenario effects seem to be uneven among European States likely due to the interconnected effects with national renewable energy market and regulation.

Keywords: Common Agricultural Policy, renewable energy, technology adoption, farmer's behavior, econometric analysis
JEL: Q18 – Agricultural Policy; Food Policy; Q10 General

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[d] Dpt. of Agricultural Science, University of Bologna

1. INTRODUCTION AND OBJECTIVES

The production of renewable energy by agriculture has been largely debated, and is one of the core issues in European Union (EU) Bio-economy strategy (European Commision, 2010). The agricultural sector is the main potential provider of raw materials for bio-energy production and at the same time might develop small-scale renewable energy plants, as an essential step towards a smart-grid energy system.

However, despite growing interest in renewable energy production over the last years, actually renewable energy covers a small share of total European energy market. Across the EU, all Member States have implemented policy instruments aimed at pursuing the EU objectives (i.e. investment subsidies, fuel tax, rebates, renewable fuel mandates and feed-in tariffs).

The scientific literature has provided in-depth discussions of the sustainability of energy production from agriculture and of the impacts of related policies, highlighting either positive or negative impacts, as well as direct or indirect effects (see for example Ignaciuk et al., 2006; Petersen, 2008; Gasparatos 2010; Blandford and Surry 2011; Bartolini and Viaggi 2012).

Presumably, the Common Agricultural Policy (CAP) also represents the major driver of energy production from agriculture, being the main policy instrument for the European agriculture. For istance, 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. Generally, agricultural economics literature has shown positive effects of CAP payments on adoption of on-farm energy production.

This process can also be seen through the lens of energy adoption mechanisms, in which the literature has emphasized the positive effect of the CAP as currently implemented (i.e. decoupled Single Farm Payment and Rural Development Plan) on farmers' adopting process.

The expected process of CAP reforming after 2013 is likely to strengthen the role of innovation in the EU. In the current proposals, one of the main policy aims is: "promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors" (EU Commission, 2011) and to promote the sustainability of the agricultural sector.

Such aim is going to be strengthened in the new RDP regulation where one of strategic objective directly addresses the shifting towards a low emission economy with the promotion of the renewable energy production by agricultural sector.

Despite such large literature, the specific interplay between farm characteristics, market, local regulation and the CAP in the adoption of energy-related technologies is still poorly studied. One difficulty is related to the recent development of this issue and the variety of local conditions. Another can be found in the different technologies related to energy production available, which have, by the way, different economic properties (e.g. some require investments, others do not). Finally, the CAP itself may play multiple roles with respect to energy technology adoption. Literature has highlighted positive effect of first pillar payments in promoting on-farm energy production as a driver of farm's investment behavior (Viaggi et al., 2011), as well as the adoption/diffusion of new technologies (Bartolini et al., 2010) where investments or innovations aimed at providing an efficient use of energy or supplying farm-based energy are central in the agricultural sector (Libbet and Summer 2012). Policy instruments belonging to second pillar allow for reducing the cost of innovation and increasing its (expected) profitability (Bartolini and Viaggi 2012). Temporal patter and predictability of policy (e.g. maintaining payments for a long-term such as 5-20 years) result in the reduction of both income uncertainty and exposure to price fluctuations, fostering propensity for early investment (Sherrinton et al., 2008; Ridier, 2012).

In this context, this paper aims at analyzing the farmers' intentions towards the on-farm adoption of energy crops or technologies for renewable energy production under alternative CAP scenarios. We investigate how and which determinants have an impact on crop/technology adoption in different policy scenarios by means of econometric analysis, in particular estimating a discrete choice model.

The analysis is based on a wide survey, where about 2,000 farm-household were interviewed in 2009 in nine European countries. Stated preferences towards the willingness to adopt energy crops/technology for renewable energy production are analysed firstly under a scenario with the current CAP post 2013 (Baseline) and, secondly under a scenario with the complete abolishment of the CAP support (NO_CAP).

The main innovative contribution of the paper is in providing a comprehensive analysis of the interplay between the CAP and determinants of energy technology adoption. Moreover, given the large survey carried out by 9 European States, this research gives the opportunity to assess CAP influence across the broad context of the EU.

In the next section we provide a description of the survey, followed in section 3 by the methodology. Section 4 illustrates the results. Section 5 provides a discussion and section 6 concludes.

2. Survey description

The data used in the analysis are derived from a survey carried out in the context of the CAP-IRE project (Assessing the multiple Impacts of the Common Agricultural Policies (CAP) on Rural Economies, 7fp) in 9 EU countries, including 11 Case Study Areas (CSAs), at the beginning of 2009 (2363 observations). The size of the sample for each CSA is provided in Raggi et al. (2013).

The sample was constructed using a different sampling procedure in each CSA. Considering the list of beneficiaries of Single Farm Payments (SFP) the sample was randomly selected by stratification per amount of SFP and altitude (IT and ES), per specialisation (FR1 and FR2), per location (BG and DE2), per amount of SFP (UK and GR), and per farm structure (PO). A complete sampling procedure is available in Raggi et al. (2009).

The survey contains stated intentions about the farm household strategy in the next 10 years, among which the intentions to adopt energy production technologies/energy crops. The questions were asked considering two different policy scenarios: one with the current (at year 2009) CAP (i.e. Baseline) and the second with the complete abolishment of the CAP[1] and the related policy instruments (e.g. cross compliance). This second hypothesis was called 'NO_CAP' scenario. Except for CAP, all other conditions (prices, labour market, etc) would remain the same as in the first scenario.

Firstly, data were collected on intentions to exit from/stay in agriculture. Farmers were asked whether they would continue farming or exit from the sector under both CAP and NO_CAP hypotheses. If the farmer's answer was to exit from the sector, then the question on adoption was skipped and the questionnaire went to the end section and finished. For those farmers who would continue, the intention towards adoption of technology/crops renewable energy production was asked. The question about preferences towards the on-farm adoption of energy technology/crops for renewable energy production was formulated as a close qualitative question, where each household was asked, under each scenario, if they expected to adopt or not (i.e. Yes or No). In addition, farmers whose responses were not stated (i.e. they did not answer and they did not know what they would do) and 'other' explicit responses were also collected.

3. METHODOLOGY

Based on the information provided by the survey described in section 2, a logit model regression (see Greene, 2003), was fitted to identify key determinants of the willingness to adopt energy technology/crops production systems by the European farmers. Two empirical regressions were run to detect factors determining intentions to adopt energy crops/technologies, either under the Baseline and NO_CAP hypotheses. The comparison of the determinants under the two policy scenarios allows to assess what the main factors behind the decision are and to understand which factors are recurrent and which factors vary in relation to the policy change. In each model, the dependent variable is the answer to the question about adoption on energy crops/technology illustrated in the section above, coded as 1=answer 'yes' and 0=answer 'no'. As a result, the coefficient estimated for the determinants are to be interpreted as the increased probability of adoption as compared to the no adoption behavior. Logit regressions were performed only on the adoption vs. rejection values therefore any other farmer's responses were ruled out in this research.

The full list of variables used, and the way each variable is measured, is shown in Table 1 (See Viaggi et al., 2009 for the questionnaire).

Table 1: Independent variables

	Obs.	Code	Variable description	Coding	Mean	S.D.	Freq.
Farm features	2285	Land_operated	Total land (ha)	<=10			25.9%
				10-27			24.2%
				27-85			24.9%
				>85			24.9%

[1] Where SFP are the income payments included in the first pillar of the Common Agricultural Policy. These payments could be provided on a regionalized or historical basis, the latter being the case in the Case Study.

	2335	Land rent IN (dummy)	Land rent-in	0 = no, 1 = yes	0.68	0.46	-
	2345	Worker full-time (dummy)	Household worker full-time	0 = no, 1 = yes	0.83	0.37	
	2339	Worker part-time (dummy)	Household worker part-time	0 = no, 1 = yes	0.49	0.50	-
	2363	Specialist	Main farm specialisation	1=Cattle 2=Mixed crops 3=permanent 4= COP 5=Grazing 6=Crop & Livestocl 7=Other	–	–	22.2% 15.4% 7.4% 20.3% 16.7% 13.9% 4.2%
	2358	Altitude	Location of the farm with respect to the altitude	1=Plain 2=Hill 3= Mountain			56.9% 34.1% 8.8%
	2356	LFA	Farm location belonging to the Less Favourable Area	1= OUT 2 = IN 3= Partly			47% 44.7% 8.1%
Policy drivers	2167	SFP/SAPS	Single farm payment/ Single area payment scheme received in 2007 (EUR)	1= <=1000 2= 1000 – 6000 3= 6000 – 28000 4= > 28000			15.6% 35.6% 32.3% 16.4%
	2343	Organic production (dummy)	Farm with organic production	0 = no, 1 = yes	0.10	0.30	-
	2324	AES (dummy)	Farmer engaged in Agri-Environmental schemes	0 = no, 1 = yes	0.27	0.45	-
Farmer's features	2334	Age	Age of farm head	year	48.7	13.7	-
	2336	Education	Education level of farm head	None Primary school, High school, Professional master, Degree/Ph.D.	–	–	15% 18.9% 33.8% 20.5% 11.7%
	2348	Extension service (dummy)	Farmer assisted by an extension service	0 = no, 1 = yes	0.57	0.50	-
	2320	Farmer union (dummy)	Membership of a farmer union	0 = no, 1 = yes	0.55	0.50	-
	2290	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%	–	–	11.7% 9.8% 11.4% 15.5% 15.4% 36.2%

Source: own elaboration

In table 1, farm features are related to current farm size in terms of owned land plus land rented-in, which results in total operated land. Initially, 'Land operated' showed a huge variability therefore it was converted into an ordinal variable with four size classes according to the quartile distribution. Renting plays a major role in land availability particularly for annual crops and livestock; about 70% of farms rent-in some land.

Worker full-time and worker part-time refer to the labor 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 across the European regions, namely specialized cattle rearing, mixed crops including general field crops, sometime together with permanent crops or vegetables, specialist in permanent crops such as olive grove systems, other permanent crops, which cover citrus, orchard fruit and vineyards. Then COP farm (i.e. winter cereal, sunflower and leguminous crops usually cropped in annual rotation), livestock systems of grazing animals, followed by systems with livestock and crops, and finally, other no specialized farms.

In addition, there are some spatial features related to the geographic characteristics such as altitude and, location in 'Less Favourable Areas' (LFA).

The following three variables refer to the CAP drivers. The variable used for the policy payment is the amount of SFP/SAPS received by the interviewees in 2007. Since the amount of first pillar CAP payment received by farms varies substantially across areas/specialization systems the sample resulted in a large variance. On average the surveyed farms receive 22 000 EUR per year even if the median value is around 6000 EUR. This variable is managed as ordinal by merging the sample in quartiles. In addition, organic production and agro-environmental schemes are dummy variables related to the policy drivers indicating whether or not a farm is engaged in these CAP measures.

Finally, 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%.

Although, specific literature concerning implementation of renewable energy production is still scarce, some structural as well as personal variables are expected being related to an adoption attitude. For instance it is assumed that the younger the farmers, the more likely they are to adopt innovations early in their respective life cycles (Rogers, 1995). Formal education level is also recognized among farmer's human capital linked with the adoption of innovation (e.g. Fernandez-Cornejo et al., 1994). It is assumed here that better and longer educated farmers will increase adoption. On the other hand, it is largely documented that farm structural features (e.g. farm size, land ownership, land renting, farm specialization) have strong influence on the farmer's adopting process (e.g. Breustedt et al., 2008; Villamil et al., 2008; Giannoccaro and Berbel, 2012). Economic literature has highlighted the effects of risk and, expectation and information as relevant determinants of alternative decision making strategy towards innovation. For example Ridier (2012) has pointed out that risk adverse farmers are more willingness to adopt new short rotation coppice, with high fluctuation and uncertainty in commodities prices, even if the income is on average lower. Bartolini and Viaggi (2012) have highlighted how quality of information and uncertainty in future parameters (prices, cost and policy) has the effect to reduce a timely adoption of energy production on farm.

4. RESULTS

This section reports the main survey results about stated intention and determinants of energy production/energy crops adoption. Intended farmers' responses to CAP scenarios, namely CAP continuing (Baseline) versus CAP abolishment (NO_CAP) are shown. The global view of intended decisions towards adoption of renewable energy technology/crops is reported in the Table 2.

It is worthy to note, that in both scenarios, respondents who stated their intention to exit from agriculture are excluded from the analysis. In fact, over a sample of 2,363 farmers, the analysis here is based on 2,000 observations in the case of baseline scenario and 1,412 under NO_CAP scenario.

Table 2: Farmers' intended behavior under CAP scenarios

Farmer's choice	**Baseline**		**NO_CAP**	
	obs.	**freq.**	**obs.**	**freq.**
Adoption	442	22.1%	275	19.5%
Rejection	1466	73.3%	1041	73.7%
Other	5	0.3%	1	0.1%
Do not know	38	1.9%	34	2.4%
Do not answer	49	2.4%	61	4.3%
Total	2000	100%	1412	100%

Source: own elaboration

As table 2 shows, 22.1% (442 observations) of interviewed farmers would adopt on-farm renewable energy technology/crop while 73.2% is the frequency of those would reject it. Others less frequent responses refer to undecided behavior or missed responses. Alternatively, 'other' option is neglegible. Turning to the NO_CAP hypothesis, farmer with the intention to adopt renewable technology/crop energy are 19.5% (275 observations) while those would not adopt account for 73.7% of interviewees. The main difference is between those without an answer with 4.3% being the share of respondents under NO_CAP scenario, slightly higher than Baseline scenario. Finally, differences among responses such as 'other' and 'do not know' are negligible. As a whole, in Table 2 the most frequent class refers to the farmer's rejection, both under Baseline and NO_CAP hypothesis.

Table 3: Change in farmers' behaviors induced by the CAP abolishment

farmer's choice		NO_CAP				
		Adoption	No adoption	Do not know/ No answer/Other	Exit	Total
BASEINE	Adoption	240	54	14	134	442
	No adoption	34	979	24	429	1466
	Do not know/ No answer/Other	1	8	58	25	92
	Total	275	1041	96	588	2000

Source: own elaboration

Findings in Table 3 show that CAP abolishment affects the adoption of renewable technology/energy crop in two ways. Mostly, under completely CAP abolishment several farmers who stated intention to adopt under Baseline, show intention to exit out to farm activity. Such change in adoption is observed for 134 farmers. Only a minority of respondents (54 farmers) states the preference to change farmers' intention under NO_CAP scenario, shifting from adoption to non-adoption. At the same time, 34 are those would adopt only under NO_CAP. Finally, 240 are adopters under Baseline who maintain the same decision under NO_CAP scenario.

Afterwards, findings of logit models are reported (Table 4). We fitted two logit models of the farmer's behaviours, respectively under Baseline and NO_CAP hypotheses. For the logit analysis, the dependent variable was assigned "1" in the event of farmer's stated adoption while "0" was set for the rejection stated intention.

The farm characteristics fitted by the logit regression under Baseline CAP scenario as the major determinants of being in the adoption class are the size of operated land and farms with rented-in land. In the case of Land operated the larger the size, the higher the probability of being in the adoption class. Among farm specialization, with respect to cattle rearing systems, mixed crops, COP and Crop & Livestock emerge being significant. Moreover, altitude shows negative sign for farms in mountain areas.

Table 4: Logit regression

	Baseline				**NO_CAP**			
Variables	Coef.	Std. Err.	z	P>|z|	Coef.	Std. Err.	Z	P>|z|
Land_operated								
10-27	.7621293	.2990524	2.55	.011*	.6121256	.4135525	1.48	.139
27-85	.9033941	.3323646	2.72	.007**	.9201941	.4340105	2.12	.034*
>85	1.055153	.3657101	2.89	.004**	1.180756	.4716759	2.50	.012*
Land_rented_IN	.4100242	.1985809	2.06	.039*	-.0205542	.2430709	-0.08	.933
Worker full-time	-.0323325	.2664874	-0.12	.903	.0196437	.3256005	0.06	.952
Worker part-time	-.2003728	.1581318	-1.27	.205	-.0465021	.2006467	-0.23	.817
Specialization								
Mixed crops	.9203493	.2769027	3.32	.001**	1.338597	.3293195	4.06	.000**
Permanent	.375377	.3779545	0.99	.321	.9470538	.4491171	2.11	.035*
COP	1.042034	.2725913	3.82	.000**	1.350527	.3374961	4.00	.000**
Grazing	.0908342	.2710961	0.34	.738	.2761475	.3466553	0.80	.426
Crop & Livestock	.5889788	.2837173	2.08	.038*	1.103389	.3723257	2.96	.003**
Other	.2494568	.4698204	0.53	.595	.3861413	.5742102	0.67	.501
IdAltitude								
Hill	-.2357249	.1999029	-1.18	.238	-.1354088	.2466643	-0.55	.583
Mountain	-1.282958	.3733661	-3.44	.001**	-1.087442	.5266282	-2.06	.039*
IdLFA								
IN	.3488766	.2022752	1.72	.085	-.1913247	.2508041	-0.76	.446
Partly	.4523479	.2732758	1.66	.098	.3462829	.3456623	1.00	.316
SFP_groups								
1000 – 6000	-.1443695	.3028325	-0.48	.634	-.675444	.3659261	-1.85	.065
6000 – 28000	.3844897	.3237122	1.19	.235	-.1821781	.3933308	-0.46	.643
> 28000	.9883782	.3633592	2.72	.007**	.5173689	.4388983	1.18	.238
Organic_produ	0386331	.2700885	-0.14	.886	.0878984	.4159007	0.21	.833
AES	.1993227	.1726428	1.15	.248	.5138756	.2093736	2.45	.014*
Age	.002216	.0064357	0.34	.731	-.0042111	.0078753	-0.53	.593
Education								
Primary school	.7989075	.3324732	2.40	.016*	.3197108	.4936342	0.65	.517
High school	.9017385	.3192907	2.82	.005**	.5822438	.4529694	1.29	.199
Profess. Master	.7097671	.361805	1.96	.050*	.4617009	.5084063	0.91	.364
Degree/Ph.D.	1.096525	.3570714	3.07	.002**	.598441	.4955292	1.21	.227
Extension_service	.3932909	.1673333	2.35	.019*	.3878029	.2061701	1.88	.060
Farmer_union	-.1336547	.1676304	-0.80	.425	-.4918623	.2178769	-2.26	.024*

Share_Gross_R								
10-29%	.4377018	.3667136	1.19	.233	.8073793	.4780613	1.69	.091
30-49%	-.0536617	.3750707	-0.14	.886	.4168053	.4784103	0.87	.384
50-69%	-.169185	.3731756	-0.45	.650	.137208	.4757207	0.29	.773
70-89%	.4536048	.3731421	1.22	.224	.4546636	.489245	0.93	.353
more than 89%	.2849882	.3502358	0.81	.416	.2827429	.4586605	0.62	.538
IT (omitted)								
NL	-.9384183	.4237604	-2.21	.027*	.0391648	.5059508	0.08	.938
GR	-1.154885	.4107144	-2.81	.005**	-2.465568	1.110147	-2.22	.026*
PL	-2.462928	.5585767	-4.41	.000**	-1.24652	.625018	-1.99	.046*
UK	-.2496687	.3873678	-0.64	.519	.5483698	.4595217	1.19	.233
ES	-.7989422	.3711149	-2.15	.031*	-.2805592	.4765249	-0.59	.556
BU	.1074677	.3546714	0.30	.762	.5785846	.4381488	1.32	.187
FR	-.2547128	.3530175	-0.72	.471	.5122078	.4322047	1.19	.236
DE	-.947746	.4140844	-2.29	.022*	.2111219	.5445824	0.39	.698
Constant	-3.787947	.7173052	-5.28	.000**	-3.434949	.8698546	-3.95	.000**
	obs. = 1589 No= 1201 Yes=388	LR chi2(41) = 384.66 Prob > chi2 = .0000			obs. = 1106 No= 881 Yes= 225	LR chi2(41)= 291.51 Prob > chi2= .0000		
	Log likelihood= -645.4605	Pseudo R^2= .2296			Log likelihood = -416.98704	Pseudo R^2 = .2590		

Source: own elaboration

Turning to the policy drivers, model results show that farmers who received larger amount of SFP/SAPS (higher than 28000 EUR per year) positively affect the probability to adopt energy production/energy crops. This result is coherent with literature which have identified positive effect of SFP promote innovation adoption due effects on income stabilisation and maintenance of overall farm competitiveness (Bartolini et al., 2010).

Farmers' education, in line with the innovation adoption literature has been also found significant in this research. In general, with reference to those farmers without education, the higher the level the larger is the likelihood to fall into the adoption class. Moreover, farmers with assistance by extension service show major likelihood to be in the adoption class. This fact confirms literature results about effect of social and human capital in affecting probability to adopt innovation by improving information quality and reducing level of uncertainty in the decisions.

Results also confirm that arable farming system (COP or mixed) are more likely to adopt energy production due to the more flexibility in crops mix substitution and less connection with other farm production (e.g. need to produce feed for animals).

Results also show that location affect probability to observe adoption in energy production/energy crops. In particular, farm located in mountain areas negatively affect the adoption, due to natural handicap and expected less networking and quality in extension services received.

Findings show that decision to adopt energy production/energy corps is not affected by labour endowment and, by household labour allocation and income generated by labour allocation between off-farm and on-farm activity. This result does not confirm expectation about the introduction of energy production as labour saving technology.

We also introduced a set of variables related to the European member state, according to the country of each case study. With the reference to Italy (IT) case study (i.e. Emilia-Romagna), the case study of

Noord-Holland Nederland (NL), Macedonia and Thrace Greece (GR), Podlaskie Poland (PL), Andalusia Spain (ES) and, Lahn-Dill-District and Ostprignitz-Ruppin Germany (DE) show minor probability of adoption.

Finally, the parameter for constant is significant and takes the value of -3.787947 for the adoption class while 0.0 implicitly for the reference class.

Let us turn now to the NO_CAP scenario. We performed logit model similarly to previous scenario, introducing all available variables.

Generally, there are slight differences with respect to the logit regression for the Baseline. Indeed, numbers of significant variables show the same effects found in the case of Baseline scenario, such as operated land, farm specialization, altitude, and among countries, Greece and Poland show the same trend. Although these variables have been found significant under both CAP scenarios, Land operated appears significant in the NO_CAP hypothesis only for larger farms (> 27ha), while other farm size categories are not significant. In addition, farm specialization with permanent crops exhibits also major likelihood of adoption under CAP removal. Finally, cases study within countries such as NL, UK and DE show no significance.

On the other hand, there are couples of variables, which are significant under Baseline while do not in the case of NO_CAP. They are land rented-in, amount of CAP payments, farmer's education and extension service. In contrast, other variables emerge being significant only in the case of CAP abolishment, namely AES and farmer union. Results show that under NO-CAP scenario farmers who have been involved in AES have higher probability to adopt energy production/energy crops. In the event of second pillar abolishment, such result might be determined by substitution between areas enrolled in such AES with energy crops/production. In fact, farmers with agro-environmental payments could find less profitable to maintain their agro-environmental commitments without CAP aids, as consequence, these areas being marginal land or area with lower soil quality, might be devoted to renewable energy production.

The parameter for constant is significant and takes the value of -3.434949.

The log-likelihood ratio (LR) tests show that the estimated models, including a constant and the set of explanatory variables, fit the data better compared with that containing the constant only. The pseudo-R2 values are also in line with other related works.

5. Discussion

In this paper, determinants of intention towards adoption of energy production/energy crops are investigated. The paper compares determinants of stated intentions, assuming two alternative CAP scenarios: a baseline with current CAP maintenance and a NO_CAP scenario with complete CAP abolishment. The study largely confirms literature findings on the field on technology adoption and innovation in the energy sector.

In particular, the outcome of econometric model confirms the relevance of several determinants as resulting from the literature (e.g. farm typology specializations, size of owned and rented land and farmer's education and advices). Contrary to expectation, factors such as farmer's age do not appear here. Results confirm that intention about energy production/energy crops adoption are diversified across Case Study Areas and location, and is perceived as relevant production systems in some areas. The positive role of the

SFP on the adoption behavior, already detected in previous studies (Bartolini and Viaggi, 2012; Ridier 2012) is also confirmed.

However, the CAP influence seems to be uneven across European regions. This is likely due to the different instruments in place within the CAP and the way as the CAP, mainly for the first pillar was implemented by each European Member State. In addition, the different interplay with national instruments and local conditions vary among each country. Finally, renewable energy uptake at the time of survey was likely different within Europe, also considering specific national energy patterns.

On the one hand, CAP removal affects indirectly farmers' behavior reducing the numbers of adopter who would exit from the sector if CAP was abolished. Actually, considering those famers declare their intention of adoption only in the event of CAP abolishment, the likely direct effect of CAP on farmer's decision towards adoption of technology/energy crops seems to be negligible.

The study is subject to various weaknesses, mainly due to the specificity of the survey, data availability and Scenario assumption.

Although, in this research a number of variables were considered, it worth mentioning that questionnaire was designed taking into account a broad perspective regarding to CAP influence on farmer's decisions according to the aims of CAP-IRE project. Further variables such as the actual available liquidity of farm-households or farmer's expectation about market price and job opportunity could well be related to the adoption of renewable technology/energy crops. Moreover, in times of market price volatility, renewable energy production might also be considered a diversification strategy enlarging portfolio of activities with the aim of reducing income variability.

The main drawback relates to the fact that the scenarios about the CAP were extreme scenarios including all CAP instruments. While this has the advantage to yield the effect of the policy as a whole, it remains impossible from the study to disentangle the role of different instruments.

Furthermore, energy crops and energy plants are treated as the same category, while mechanisms in the decision making process may be different as well as the role of policy could be diversified between these options. This is also related to particular attention paid by each European Member State on the renewable energy production over last numbers of years.

Finally, this research may suffer from the fact of being based on stated intentions. While this is growingly accepted in the economic literature it must also be admitted that its outcome may suffer from difficulties for farmers in devising their own behavior in sectors where the legal framework and market conditions have been changing suddenly in the latest years.

6. CONCLUDING REMARKS

The study confirms that CAP payment as currently implemented will influence farmers' decision on the adoption of energy crops/technologies for renewable energy production in the next years. Other relevant variables are farm typology specializations, size of owned and rented land and farmer's education and advices. There is also a interplay about the CAP and the other determinants therefore CAP scenario effects might be vary among European regions.

This research gives the opportunity to assess CAP impact on adoption of energy crops/technologies across the broad context of the European agriculture. As the adoption of such technologies within the agricultural sector may contribute to the improvement of European rural economy this also give an insight about the ability of the CAP to contribute to this economic aim through the specific pathway of energy production. Based on this the study also hints at the fact that attention to this issue in the CAP should be strengthened in order to enhance the 2020 bio-energy objectives.

Further developments of this work may be devised in several directions, two of which directly derive from the weaknesses highlighted above. In particular, further survey-based research could investigate the effects of specific CAP policy instruments, particularly in the perspective of the post-2013 CAP reform, and with a specific view on second pillar investment/innovation instruments. In addition, a more detailed range of specific energy related technologies could be considered.

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