How Do Agri-Environmental Schemes (*AES's*) Contribute to High Nature Value (*HNV*) Farmland: a Case Study in Emilia Romagna

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Summary

The main objective of the paper is to inquiry if the Agri-Environmental Schemes (AES's) included in the Rural Development Plan in Emilia Romagna have played a role in enhancing the Nature Value of regional farmland. High Nature Value (HNV) farmland is a concept that aims to identify the agricultural systems which are hospitable to animal and vegetal species, leading to a level of biodiversity which is particularly high. As a preliminary step, we measured the level and distribution of the HNV in Emilia Romagna at the municipality level, as derived by elaborations on the data of the two last censuses, year 2000 and 2010. Then the relationship between HNV and participation to rural development measures is analyzed in both directions of causality with econometric techniques. First we investigated the relationship between the participation to measure 214 (AES's) of the Rural Development Plan and the HNV in order to explore if the participation is affected by the HNV. Rather than integrated farming or the protection of less favoured areas, ordinary least square models suggest a link between organic farming and HNV farmland: the results indicate that participation to the measure of organic farming in the Rural Development Plan 2007-2013 is significantly dependent upon the HNV in year 2000. Secondly, as an effect of the participation to AES's on the HNV we analyzed the change of HNV between 2000 and 2010 with ordinary least squares and spatial regression techniques. The regression models show that the variations depend upon the farmers' participation to the organic farming measure and the presence of a mountainous territory. With regard to the other measures, integrated farming is not relevant and the participation to the measure for less favoured areas is related to the variation in a negative way.

Keywords: rural development plan, agri-environmental scheme, High Nature Value, statistical indicator, spatial regression.
JEL Classification codes: C43, Q15, Q57.

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1. INTRODUCTION

The rural development plans in Europe, within the provisions of axis two *i.e.* Protection of the environment and the countryside, consider the opportunity to protect and develop agricultural and forestry systems with a High Nature Value. As developed by Andersen *et al.* (2003) the concept of *HNV* farmland is described as: "Those areas in Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports, or is associated with, either a high species and habitat diversity or the presence of species of European conservation concern, or both." This is especially the case when the land's surface is enriched with field margins, hedges, shrubs, bushes or trees whereby scarce birds, insects and wild animals find a place to live and reproduce.

A systematic presentation of the core characteristics of High Nature Value farming has been developed through projects undertaken for the European Environmental Agency (Andersen *et al.*, 2003) and for the European Commission (IEEP, 2007a and 2007b). In these projects, three elements of farmland have been identified that constitute as many requirement of the High Nature Value character:

1. High crop diversity.
2. Low intensity farming.
3. Presence of semi-natural vegetation.

The Guidance Document for the Application of the High Nature Value Impact Indicator points out that low intensity is the most effective feature in preserving biodiversity. Semi-natural vegetation is important but when it is reduced it may be compensated by the crop diversity. However, the Document reminds that high crop diversity alone does not imply *HNV* farming (IEEP 2007b).

In the face of the positive effect of extensive systems it is to be acknowledged that both the process of intensification and the process of abandonment threaten the Nature Value (Onate *et al.*, 2000). As a type of agriculture that provides positive externalities and environmental benefits, High Nature Value farming is currently protected by the regional legislation on rural development. As a matter of fact, the preservation of the High Nature Value calls for the participation of the farmers and this comes at a cost: keeping the low intensity in the agricultural technique may not be the intention of the farmers so that the typical problems of the provision of public goods arise. Thus it is not a surprise that European authorities have intervened since the end of the century: the reason for intervention is that the efficient use of the agricultural land is often at odds with the preservation of natural elements. It can be ascertained that it is a task of the public authorities to design the agri-environmental schemes in an efficient way, so that intended objectives are reached thank to the farmers' participation. In this sense, the goal of putting into lights the relationship between *HNV* and rural development measures can have an important outcome from a normative perspective since the regional authority can tailor rural development measures to the High Nature Values of the municipalities, bringing about a new source of efficiency in the design of the periodic plan.

Even if, at least to our knowledge, there is no available literature on the effects of the rural development measures upon the High Nature Value farmland, however a few works exist in which the measures of the rural development plan are viewed as having some environmental effects. For instance, the review by Kleijn and Sutherland (2003) finds that the *AES's* vary markedly across countries and their effects on biodiversity– which is referred to plants, insects or mammals - too. More specifically, in most studies biodiversity increases with respect to participation but there are also some in which it decreases. Feehan *et al.* (2004) investigate the effects of Irish *AES's* – the Rural Development Protection Schemes - on the level of biodiversity, which is identified with field margin flora and *Carabidae fauna* (ground beetle). These schemes are horizontal - any farmer in Ireland can apply – and the survey is conducted on thirty agreement and thirty non-agreement farms. The results showed that the species variation was higher in non-agreement farms than in agreement farms, the horizontal scheme has not significantly benefited the groups surveyed and biodiversity objectives for High Nature Value areas are more effectively achieved by targeted schemes. Similar results are obtained by Kleijn *et al.* (2000) who conducted a field experiment in the Netherlands and found that biodiversity – intended as plants, birds, hover flies and bees - was not enhanced by the *AES's*.

The main purpose of the paper is to enquiry about how the agri-environmental schemes (measure 214 of the rural development plan) contribute to the High Nature Value of farmland in Emilia Romagna, what can bring useful information for the design of the rural development plans. In order to do that, a statistical indicator is developed that measures the High Nature Value farmland of a municipality. Actually, the indicator of *HNV* may be related in different ways to the uptake of the rural development measures. On the one hand it may be an explanatory variable in the model of participation: in this case the expectation is that the frequency of participation to the measure is higher in the municipalities where the High Nature Value farmland is higher. On the other hand it may act as a dependent variable: the High Nature Value farmland of a municipality is dependent upon the farmers' participation to the rural development measures. Both models have to be interpreted from an economic point of view: *HNV* can provide incentives to farmers' participation and on the aggregate participation should increase *HNV*. With respect to the existing literature, observed results exist for the first model and extensive systems are often found to favour participation. In order to achieve the main objective of the relationship between *AES's* and *HNV*, a second goal is pursued namely the development of an indicator of the High Nature Value farmland that can be applied at municipality level.

The paper is structured in the following way. Section two presents the methods that are followed; section three describes the case study and the data that are used; section four provides the results; section five a discussion of the results; in section six conclusions are drawn together with some suggestions for further research.

2. METHODS

It is intuitive to acknowledge that the development of a statistical indicator for the High Nature Value farmland allows avoiding the problem underlined by Finn *et al.* (2009), who note that the difficulty in assessing the environmental performance of *AES's* lies in the absence of measurable objectives. However, a basic pre-requisite for the analysis that follows is to make a distinction between the concept of High Nature Value farmland and the indicator that measures it. The character of High Nature Value farmland is typical of an area where agriculture is the prevalent land use, whereas the indicator can be calculated for any type of area, more or less devoted to rural activities. For instance it can be acknowledged that alpine meadows are typical High Nature Value farmland – and the indicator should have an extremely high value – whereas if the indicator is calculated for an urban area – although it certainly have no typical High Nature Value – yet the statistical indicator has a meaning and its measurement drops to an extremely low value.

The methodological procedure builds upon the work by Paracchini and Britz (2009) and can be divided into three steps:

1. Calculation of the High Nature Value farmland indicator;
2. Identification of the measures of the rural development plan;
3. Regression analysis.

As regards the calculation of the High Nature Value farmland, it is to be acknowledged that there are statistical indicators that measure the High Nature Value of the farmland in a specific region, for example the farmland bird index which counts the species of birds that populate the region. Within the Common Monitoring Evaluation Framework - that the EU has established in order to control the performance of rural development programs – three indicators refer to the High Nature Value: a baseline indicator, a result indicator and an impact indicator. Member states and regional authorities are the recipients of these provisions: actually, every member state is expected to monitor and maintain its High Nature Value territory. The baseline indicator is called “Biodiversity: High Nature Value farmland and forestry”: measuring the hectares of utilized agricultural area of High Nature Value it is applied at the start of a rural development plan as a stated objective. The result indicator is called “Area under successful land management contributing to biodiversity and High Nature Value farming and forestry”: it measures the total area of *HNV* farming and forestry under successful land management. The impact indicator, “Maintenance of *HNV* farmland and forestry”, reports the changes in *HNV* farmland and forestry both in qualitative and quantitative terms: it is applied at the end of the rural development plan.

We have developed a new indicator building upon two of the three elements that constitute the requirements for High Nature Value farmland– that is crop diversity and low intensity farming – whereas the third element – i.e. semi-natural vegetation - is replaced by the livestock density. Actually, this is an admitted operation since it can be ascertained that the utilization of semi-natural vegetation by livestock is a typical characteristics of High Nature Value systems. Another procedure has been followed by Pointereau *et al.* (2010), who build the indicator using the crop diversity component, the low intensity component and a third component based on landscape elements. Instead, Paracchini and Britz (2010) use four components: the crop diversity, the low intensity farming, the stocking density and the land use intensity for olive groves.

More specifically, in a delimited geographic region like the territory of a municipality, the indicator of High Nature Value proposed is made up of two components whose weight depends upon the land use, whether it is grassland or not:

1. Non grassland: a Shannon index for crop diversity ("crop rotation index") multiplied for an indicator of farming intensity ("management intensity index").
2. Grassland: an indicator for livestock density ("stocking density index").

The first sub-indicator, the crop rotation index multiplied for the management intensity index, is indicated as *HNV1* and the second sub-indicator, the stocking density index, as *HNV2*.

The Shannon index is described by the following formula: $H = -\sum_{i=1}^{N} p_i \cdot log\ (p_i)$, where p is the fraction of a crop's area over the total utilized area and log is the logarithm with base number N. It has the property to give values that are bounded in the 0-1 range. The index is unity when the N crops are equally partitioned, that is when p equals 1/N for all i's. It takes the value of zero when only one crop prevails. In the formulation of *HNV*1 sub-indicator the Shannon index is multiplied for an intensity of management index, represented by the index of nitrogen surplus. The second sub-indicator is called *HNV2* and refers to the grassland. It is equal to the logarithm of the stocking density, which is defined as the ratio between total livestock units and areas with meadows and pasture. Finally, the weighted average of *HNV1* and *HNV2* determines the indicator *HNV* as table 1 summarizes.

$$HNV = HNV1 \cdot NG/UAA + HNV2 \cdot G/UAA \quad (1)$$

Where NG is the share of utilized agricultural area with no grassland and G is the share of utilized agricultural area with grassland.

Table 1. Components of indicator *HNV*.

Indicator	Input	Referring to:
*HNV*1	Crop variety	Non Grassland
*HNV*1	Nitrogen surplus	Non Grassland
*HNV*2	Stocking density	Grassland
HNV	*HNV*1-*HNV*2	Grassland – Non grassland

The indicator *HNV* is bounded within the zero-one range. It takes the value of zero in cases when there is no variety or there is intensive management in the no grassland area coupled with high stocking density in the grassland area and it takes the value of one when variety is high and management is extensive coupled with a low stocking density.

With respect to the identification of the measures of the rural development plan, we chose to concentrate upon measure 214 about agri-environmental schemes, which covers a substantial part of the RDP budget and is organized in several sub-measures which are expected to have a relationship with the *HNV*.

In particular the following analysis will focus upon measure 214/1 – integrated farming - , measure 214/2 – organic farming -, and measure 214/9 – Protection of natural and semi-natural areas and of agricultural landscape.

The variable indicating participation refers to the cumulated frequency of the years 2007-2010: in each municipality it is equal to the number of farms that participated to the measure in any of the four years divided by the total number of farms within the municipality.

Third and final step of the modelling procedure is the regression analysis. Two directions of causality are possible, namely the effect of the *HNV* on the farmers' participation to the *AES's* and the effect of the participation to the *AES's* on the *HNV*.

In the literature it is admitted (Wynn *et al.*, 2001) that extensive systems favour entry into agri-environmental schemes and High Nature Value farmland are typical examples of extensive systems. More precisely, the results of the work by Wynn *et al.* (2001) reveal that in Scotland the farmers that do not uptake the agri-environmental schemes have higher stocking densities, a higher proportion of cropping land and a lower proportion of rough grazing. This result suggests to build a model in which the uptake of the measure is the dependent variable and the High Nature Value is one of the explanatory variables. Together with the High Nature Value other explanatory variables are present, following the empirical results that were obtained by Wilson (1997). In this work the investigation concern the Environmentally Sensitive Areas (ESA) schemes in Wales, namely in the Cambrian Mountains. The survey was conducted in 1993-1994 on 176 farms eligible for the ESA scheme. As a method, a questionnaire was used which allowed searching for significant correlations between relevant factors and participation. Attitudinal variables, such as age, education and length of residency, were found to play a role in entering the scheme. Other important variables were found to be the farming philosophy (utilitarian, neutral or conservationist) and the existence of semi-natural habitats. With regard to the farmers' characteristics, Wilson (1997) found that age and education are important for the explanation of the uptake in the ESA Schemes. With regard to the structural aspects, the size of the farm was identified as a significant variable.

As far as the determinants of the participation are concerned, Wynn *et al.* (2001) find that age and information about the scheme were significant variables. Other variables such as farm's size, tenure position or the presence of a successor were not found to be significant. Instead, Wilson and Hart (2000) remark that the structural variables - farm's type, farm's size or tenure position - are likely to be important for explaining the participation to agri-environmental schemes and that "environmental concern" may accompany the financial motivation of the farmers. In the logit model by Hynes and Garvey (2009), consistently with Wynn *et al.* (2001), the authors found that age is a significant variable and the younger farmers are more eager in entering the schemes.

The second relationship we investigate regards the effect of participation to *AES's* on the *HNV* and at this purpose a model is presented for the difference in the indicator *HNV* between the year 2010 and year 2000. The variable DELTA_*HNV* is modelled as to be dependent upon the participation to the measures, taking into consideration the possibility of spillovers. The methodology that is applied is the spatial econometrics, a technique which allows taking into account the spatial correlation among the municipalities. These are the variables that are used:

HNV_2000	High Nature Value in year 2000
DELTA_HNV	Difference HNV_2010-HNV_2000
UAA_L5	Percentage of farms with UAA below 5 hectares
UAA_5_30	Percentage of farms with UAA between 5 and 30 hectares
UAA_M_30	Percentage of farms with UAA above 30 hectares
AGE_L40	Percentage of farmers with age below 40
AGE_40_54	Percentage of farmers with age between 40 and 54

AGE_M54	Percentage of farmers with age above 54
PRIMARY EDU	Percentage of farmers with primary education
H.S. DIPLOMA	Percentage of farmers with a high school diploma
UNIVERSITY DEGREE	Percentage of farmers with a degree
V214_AZ1	Percentage of farmers participating to measure 214 action 1
V214_AZ2	Percentage of farmers participating to measure 214 action 2
V214_AZ9	Percentage of farmers participating to measure 214 action 9
PLAIN	Binary variable for plain territory
HILL	Binary variable for hilly territory
MOUNTAIN	Binary variable for mountainous territory
DENS_AB	Density of inhabitants

The regression analysis is computed with the software SPSS for ordinary least squares models and Geoda for spatial regressions. Thus a linear regression is run in which the dependent variable is the difference in *HNV* and the participation to measure 214 is an independent variable. Since the possibility of spatial association is considered, the structural form of the model is (Le Sage 1999):

$$y = X\beta + \delta W_L y + \varepsilon \quad (2)$$

$$\varepsilon = \lambda W_E \varepsilon + \mu \quad (3)$$

$$with\ \ E(\mu) = 0, E(\mu_i, \mu_j) = 0\ if\ i \neq j.$$

Where:

y	Vector Nx1 of the observations for the dependent variable
X	Nx(k+1) matrix of regressors
W_L	Spatial weight matrix
W_E	Spatial weight matrix
ε	Nx1 spatially correlated residuals
δ	Spatial lag coefficient
β	Vector (k+1)x1 of regressors coefficients
λ	Coefficient reflecting the spatial autocorrelation of the residuals ε

The model (2) is a general framework that encompasses both linear regression and spatial regression models. The linear regression model corresponds to the situation in which δ=0 and λ=0, and ordinary least square estimators are applied. The spatial lag model is reflected in the case when δ is different from zero and λ=0, whereas the spatial error model corresponds to the case in which λ is different from zero and δ=0.

3. CASE STUDY DESCRIPTION, DATA AND PRELIMINARY SPATIAL ANALYSIS

Located in the north of Italy, with a territory that departs from the middle and final course of the Po River to the Apennine Mountains and the Adriatic Sea, Emilia Romagna is constituted of 9 provinces and 348 municipalities. The chief town is Bologna, the other provinces are: Parma, Piacenza, Reggio Emilia, Ferrara, Modena, Ravenna, Forlì-Cesena and Rimini. Geographically, the region is bordered by the Veneto and the Lombardia in the North, by Piemonte and Liguria in the west, by Toscana, Marche and the San Marino Republic in the south. The east border is represented by the Adriatic Sea. As regards the population figures, at 1/1/2012 the inhabitants were 4.459.246, of which 530.015 foreigners. Total area is 22.445,54 squared kilometres, with a resulting density of 198,67 inhabitants per squared kilometer.

The data for the calculation of the High Nature Value farmland are extracted from the database of the National Census of Agriculture, year 2000 and year 2010. In this database the data have been collected at the level of the municipality. The data on the participation have been obtained from the regional register of the beneficiaries of the rural development measures (Regional administration, Agricultural Directorate). It is an ex-post accountability according to which participation is recorded as the number of applications that were effectively financed in a territorial particle. These data have then been elaborated at municipality level. [1]

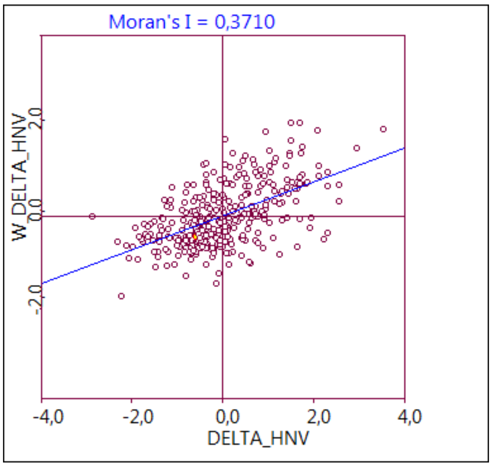
The indexes used have been submitted to transformation in order to be more explicative, namely to be bounded within the zero-one range. Whereas Paracchini and Britz (2009) for the nitrogen surplus used the logarithmic transformation and for the stocking density the squared root, in this work the logarithm is kept for the nitrogen surplus and for the stocking density as well. Then the extreme values of the nitrogen surplus and of the stocking density were assigned either zero or one values: precisely, the fifth and the ninety-fifth percentiles are taken as the threshold for bounding the indicator inside the zero-one range. With regard to the nitrogen surplus, the values below the fifth percentile were chosen to correspond to a value of one for the indicator whereas the values above the ninety-fifth percentile were chosen to correspond to a value of zero for the indicator. The values in between were computed with a regression line that is obtained from the two percentiles and the median, whereby the cumulative frequency is linear with respect to the logarithm of the nitrogen surplus. When this indicator is multiplied for the Shannon index, the indicator *HNV1* is obtained. This procedure is different from that followed by Paracchini and Britz (2009), who simply assign the value zero and one to the extreme values, using a rule of thumb so that the values are bounded in the zero-one range.

In a similar way, the logarithm of the stocking density is transformed into the indicator *HNV2*: the values below the fifth percentile were chosen to correspond to a value of one for the indicator whereas the values above the ninety-fifth percentile were chosen to correspond to a value of zero for the indicator. Then the linear transformation of the regression determined the values of the indicator.

With respect to the evolution of the High Nature Value between the two censuses, the variable DELTA_*HNV* is equal to the difference between the value of *HNV* in 2010 and the value of *HNV* in 2000. In order to illustrate the geographical distribution of this variable, Figure 1 shows its Moran scatter-plot.

[1] The municipalities are 348 since 2009, when seven moved away from Marche region into Emilia-Romagna. In the census 2000 there were 341 municipalities.

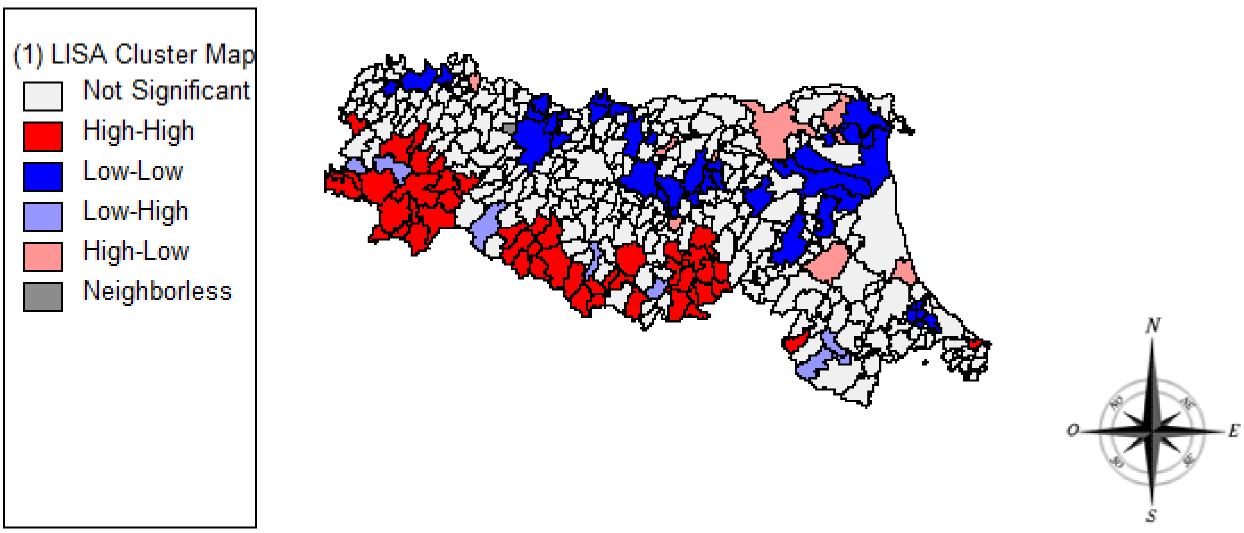
Figure 1. Moran scatter plot for DELTA_*HNV* (N=341, first order q.c.).



The Moran scatter-plot displays the standardized variable and its spatially lagged transformation in a bi-dimensional graph whereas the Moran's Index resumes a global value and in our case suggests a weak evidence of spatial association. The 341 municipalities of the Region are distributed along the blue line, whose slope corresponds to the Moran's I: the variations in *DELTA_HNV* in one municipality coupled with the variations in *DELTA_HNV* in the neighbouring municipality display a significant spatial pattern that is measured by the Moran's I.

In figure 2, the LISA (Local Indicators of Spatial Association) cluster map shows the areas where spatial association for *DELTA_HNV* is significant so identifying geographical clusters. The red-coloured spots indicate those municipalities where a high value of *DELTA_HNV* is spatially associated to a neighbouring high value of the same variable. In blue the municipalities with low values coupled with low values. The map shows the existence of spatial clustering in the southern part of the region, by the Appennines Mountains, and in the north-eastern part.

Figure 2. LISA cluster map for DELTA_*HNV* (N=341, first order q.c.).



4. Results

The outcome of the participation model, for the three AES's that were analysed, is displayed in table 2. The F test is significant in all the three versions confirming the validity of the models. The critical value with 5% significance of the F distribution with 10 (n1: number of regressors) and 330 (n2: number of observations-number of regressors-1) degrees of freedom is less than 1.927 (n1: 10, n2: 100). The F-test in the first model is 5.228, in the second 11.915 and in the third 5.842. Thus in all the three models Ftest> F.05 and the null hypothesis that all coefficients are nil is rejected.

The main insight from these models is that *HNV* is positively related to the participation to organic farming measure. This result should be taken with caution since it is possible that common variables influence both the participation and the *HNV*: for instance the hill and mountain variables, which would then be the most relevant to explain participation. However the multicollinearity test for the independent variables show low variance inflation factors.

Table 2. Regression models for participation to RD measures.

	M. 214/1	*M. 214/2*	*M. 214/9*
CONSTANT	*-0.922*	*-2.462*	*0.108*
	(-1.220)	*(-1.265)*	*(0.957)*
UAA_5_30	*0.031****	*0.056**	*0.005****
	(2.606)	*(1.839)*	*(3.021)*
UAA_M30	*-0.078****	*0.054*	*0.006***
	(-3.813)	*(1.016)*	*(2.013)*
AGE_L40	*0.151****	*-0.007*	*-0.001*
	(3.519)	*(-0.063)*	*(-0.146)*
AGE_40_54	*0.026*	*0.043*	*0.000*
	(0.985)	*(0.625)*	*(0.026)*
H.S. DIPLOMA	*-0.006*	*-0.002*	*-0.001*
	(-0.790)	*(-0.111)*	*(-0.457)*
UNIVERSITY DEGREE	*-0.027*	*-0.264***	*-0.002*
	(-0.618)	*(-2.300)*	*(-0.369)*
HILL	*0.019*	*3.798****	*-0.143****
	(0.053)	*(4.177)*	*(-2.719)*
MOUNTAIN	*-1.125****	*6.201****	*-0.206****
	(-3.407)	*(7.286)*	*(-4.181)*
HNV_2000	*-0.983*	*8.997****	*-0.043*
	(-0.992)	*(3.527)*	*(-0.294)*
R-squared	*0.124*	*0.245*	*0.137*

*Source: calculations based on different sources given in the text. Student's t in brackets: *** statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%.*

The results show that participation to integrated farming is not dependent upon the *HNV*. Actually, the participation is greater in municipalities where the proportion of medium farms (with a UAA between 5 and 30 hectares) is greater and where there are fewer large farms (UAA>30 hectares). The young age (AGE<40) has a positive effect and the mountainous variable has a negative effect.

With respect to organic farming education is an important factor, namely the farmers holding a degree certificate, showing a negative correlation. The proxies for hill and mountain have both positive coefficients, suggesting that in non plain areas the participation is higher. In this case the High Nature Value is a significant variable: on average the participation to the measure is significantly higher in the municipalities where the Nature Value is higher. Like the case of integrated farming, the proportion of medium farms show a positive coefficient but with a significance of only ten percent.

In the case of participation to measure 214/9, the protection of less favored areas, results show that education and *HNV* are not significant. Instead, there is a positive dependence with the variable UAA_5_30, suggesting that in municipalities where the percentage of farms larger than five and stricter than thirty hectares is higher there is a higher participation to the measure. Also the variable for large farms is significant (at five per cent) with a positive sign. The hill and mountain variables are both significant with a negative coefficient, providing evidence that participation to the measure tend to be higher in those municipalities where the plain territory is larger.

In table 3 the results are displayed for the *HNV* variation between the two censuses.

Table 3. Regression models for DELTA *HNV* (linear regression model, spatial lag model, spatial error model).

	OLS	SPATIAL LAG MODEL	SPATIAL ERROR MODEL
	DELTA HNV	*DELTA HNV*	*DELTA HNV*
RHO		*0.4006**** *(6.2665)*	
CONSTANT	*0.1215** *(1.6988)*	*0.06981* *(1.0621)*	*0.0990* *(1.383)*
UAA_530	*0.0000* *(0.0663)*	*0.0004* *(0.3742)*	*-0.0004* *(0.3330)*
UAA_M30	*-0.0007* *(-0.3866)*	*-0.0001* *(-0.061)*	*-0.0007* *(-0.3767)*
AGE_L40	*-0.0063** *(-1.6577)*	*-0.0048* *(-1.3693)*	*-0.0057* *(-1.5094)*
AGE40_54	*-0.0024* *(-1.0113)*	*-0.0020* *(-0.9317)*	*-0.0024* *(1.0314)*
H.S. DIPLOMA	*-0.0007* *(-1.0826)*	*-0.0007*** *(-1.9809)*	*-0.0007* *(-0.9997)*
UNIVERSITY DEGREE	*0.0051* *(1.1974)*	*0.0041* *(1.0507)*	*0.0044* *(1.0314)*
HILL	*0.0210* *(0.6533)*	*0.0164* *(0.5572)*	*0.0149* *(0.4750)*
MOUNTAIN	*0.1013**** *(3.1706)*	*0.07755**** *(2.6178)*	*0.0086**** *(2.6751)*
M214/1	*-0.0008* *(-0.1486)*	*-0.0000* *(-0.0200)*	*0.0002* *(-0.0432)*
M214/2	*0.0071**** *(3.7431)*	*0.0048**** *(2.7183)*	*0.0067**** *(3.5849)*
M214/9	*-0.1121**** *(-3.1584)*	*-0.0626** *(-1.9086)*	*0.1008**** *(-2.8468)*
DENS_AB	*-0.0001**** *(-3.4071)**	*-0.0001*** *(-2.5202)*	*0.0001**** *(-2.4851)*
LAMBDA			*0.3018*** *(2.1561)*
R-SQUARED	*0.239*	*0.3341*	*0.300*

*Source: calculations based on different sources given in the text. Student's t in brackets: *** statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%.*

The linear regression model reveals that integrated farming is not important to account for the variation in *HNV*, while the organic farming measure has a significant coefficient with a positive sign and the measure for less favoured areas has a significant coefficient with a negative sign. The F-test is significant:

the critical value with five percent significance is less than 1.819 (n_1: 13, n_2: 100) and the F-test is 8.590. Thus the hypothesis that the model is invalid can be rejected: at least one of the coefficients is significantly different from zero. With regard to the other variables, the Mountain variable is highly significant with a positive coefficient and the density of inhabitants is significant though the coefficient has an extremely low value. The R squared of the regression model is 0.239.

If spatial association is taken into account in the spatial lag model, the model's R-squared slightly increases and the δ coefficient is significant, providing evidence of spatial association. Thus spatial association is significant for the variation in *HNV*, meaning that the variation in *HNV* in one municipality affects the variation of *HNV* in neighbouring municipalities. The model suggests that the rural development plans are shaping the *HNV* distribution with the measure 214/2 and 214/9 and that other relevant variables are the proxy for the mountain territory and the density of inhabitants. As a matter of fact the higher is the density of inhabitants; the lower is the variation in the *HNV* between the two surveys.

The Breusch-Pagan test for homoskedasticity and the likelihood ratio test for spatial association are performed. The value of the Breusch-Pagan test is 14.72 whereas the five percent critical value with twelve degrees of freedom is 23.337. Since the test is lower than the critical value it is possible to accept the hypothesis of homoskedasticity.

With regard to spatial association, the likelihood ratio test is 33.69 while the five percent critical value for the chi-squared distribution with one degree of freedom is 5.024. Thus the null hypothesis of absence of spatial association is rejected and it is concluded that spatial association has remained. It may be checked that spatial association remains also with matrixes with second and third order of queen contiguity. Instead, it is found that the spatial error model with matrix with third order of queen contiguity has residuals that are not spatially dependent. From a spatial point of view, the spatial error model performs better: the Breush-Pagan test is 20.61, thus lower than the critical value, and the likelihood ratio test is 2.59, which is also lower than the critical value. Thus in this case spatial association has been entirely captured by the model and it is not left in the residuals.

5. DISCUSSION

In principle, within the European Union the *AES's* should be designed according to the subsidiarity principle: thus the characteristics of the municipalities are fundamentals in order to improve the performances of agri-environmental measures that are designed at regional or national level. Better tailored and better targeted measures can improve the efficiency of the measures, providing a more efficient use of the public resources that are spent.

In the agri-environmental literature, the participation to *AES's* has been investigated for various parts of Europe. For instance the entry of the Scottish farmers into the *ESA* schemes has been investigated by Wynn *et al.* (2001). "Environmentally sensitive area" (*ESA*) is the type of territory which is eligible for rural payments in Scotland. In a multinomial logit model, the result was found that non-entrants have higher stocking densities, a higher proportion of cropping land and a lower proportion of rough grazing. This result is in line with our result that the High Nature Value farmland– and in particular each of its three components- is positively related to the participation. Actually, with a duration analysis Winn *et al.* (2001) found that participation is accelerated in more extensive systems, confirming the existence of a relationship *HNV*-participation to *AES's*. However, in our work it is the participation to the measure of organic farming and not to all types of *AES's*: integrated farming and less developed areas do not appear to be linked to the *HNV*.

Other works confirm this relationship. *AES's* are implemented in Ireland, where the Rural Development Protection Schemes were introduced as a response to EC Regulation 2078/1992. Hynes and Garvey (2009) model the participation of Irish farmers in a dynamic context, with a panel dataset of three hundred farmers observed in eleven years and the result was found that extensive farming systems were more likely to favour entry to the scheme. Similarly, Belenyesi *et al.* (2007) report that in Hungary the High Nature Value farmland is taken into consideration by the experts who design the agri-environmental schemes and Grafen and Schramek (2003) confirm that extensive systems are likely to have a positive relationship with the participation.

In our model, the ordinary least squares method was used to analyse the dependence of the rate of participation to the rural development plan 2007-2013 on the *HNV* in year 2000. In the regression models that are applied to the three considered sub-measures of measure 214, the other independent variables are: age, education, utilised agricultural area and acclivity. The results show that the *HNV* is a significant variable only in the case of the sub-measure of organic farming whereas it is not significant for the participation to the measures of integrated farming and less favoured areas. Thus the municipalities where the *HNV* was higher in year 2000 tended to have a higher rate of participation to the measure of organic farming: actually the conditions to adopt low input systems – e.g. convert to or maintain organic farming - are likely to be more favourable in areas where the *HNV* is higher. This is consistent with the extensive character of the *HNV* farmland, which is independent from an intensive system like integrated farming. On the contrary, organic farming is a prevalent extensive type of farming, which is why it comes to be a good factor in explaining the High Nature Value farmland. Actually, the use of pesticides, deep ploughing and fertilisers – practises that are avoided or reduced by the organic farmers – are all enemies of biodiversity: especially in the arable fields the richness of the micro-fauna is hampered by these activities (McLaughlin and Mineau 1995).

When it comes to explaining the difference in the *HNV* between the two censuses of agriculture, results show the importance of the rural development plans. Participation to organic farming and the proxy for the mountainous land are key variables in determining the variation in the *HNV*. Thus it can be concluded that in Emilia Romagna the rural development plan is effective in shaping the *HNV* with the uptake of the organic farming measure. With regard to the other sub-measures, integrated farming is not significant and the protection of less favoured areas is highly significant with a negative coefficient. Thus for the participation to the organic farming measure there is a positive effect: the difference of *HNV* between 2010 and 2000 is positively influenced by the participation to the organic farming measure. Instead, the participation to less favoured areas negatively influences the *HNV* difference. Among other variables, the density of inhabitants has a negative influence over the *HNV* difference suggesting that the *HNV* tend to increase more in those areas where the density is lower, such as mountainous areas. The variables for small farms have both a significant coefficient, which is slightly lower than zero: it means that the *HNV* tends to increase in those municipalities where the percentage of small farms is lower.

It is to be remarked a limitation of the indicator, which has been built according to the variables that were found in the National Census of Agriculture at the level of municipality. Thus the indicator does not distinguish the extension of the land in the different municipalities and it is unique for the different types of *HNV* farmland. In fact, three typologies of High Nature Value Farmland have been identified (Andersen, 2003) and these are not reflected in the composition of the indicator. Furthermore it would be of interest to consider the *HNV* in relation to the land: in fact in this analysis the *HNV* is calculated for a whole administrative unit that is a municipality, disregarding the size of the territory. Then in the regression models the *HNV* of a municipality is conditional upon a list of variables including the classes of utilised agricultural area. This is certainly a limit of the model and a subject for further research is to investigate the variation in *HNV* when the indicator takes into consideration the extension of the land. The literature has already introduced an index that is focused at the farm level and represents the effect of the *AES's* upon their direct beneficiaries, namely the individual farmers: the Agri-Environment Footprint Index, a methodology based on the aggregation of environmental indicators through the use of multi-criteria analysis and stakeholders' participation (Purvis *et al.* 2009, Mauchline *et al.* 2012). Thus it could be an argument for further research to apply the methodology to farm level data: if data about real or representative farms are available with respect to crops' variety, nitrogen surplus and livestock density, then it is possible to calculate the *HNV* with the detail of the farm level.

6. CONCLUSIONS

The paper has investigated if the concept of High Nature Value farmland can bring useful information for the design of the rural development plan, with specific regard to the measure 214 regarding the *AES's* and to the region Emilia Romagna. First result is that it is possible to develop a statistical indicator that is applied at a municipality level, so that the High Nature Value farmland is referred to the single municipality level (LAU1). This indicator takes into consideration the total utilised agricultural area of the municipality on the basis of a distinction between grassland and non-grassland, the crop variety, the intensity of the management and the livestock density. The second result regards the type of the relationship between uptake of the rural development measures and the indicator *HNV*. In this relationship the *HNV* in year 2000 affects participation to the *AES's* and the *HNV* difference between 2010 and 2000 is affected by participation.

In the participation model the linear regression shows that the participation to the measure of organic farming is related with the *HNV*: thus in those areas where the *HNV* is higher there tends to be a higher farmers' participation to organic farming.

Then the results suggest that *AES's* do have a role in shaping the distribution of the High Nature Value farmland in Emilia Romagna as it is measured by the difference of the *HNV* indicator between the two censuses, year 2010 and year 2000. The regression models have shown that while the participation to integrated farming, which is an intensive type of agriculture, is not related to the change in *HNV* of a municipality, nonetheless the participation to organic farming, which is an extensive type of agriculture, is positively related to the change in *HNV*. With respect to the protection of less favoured areas the coefficient of the participation to measure 214/9 is significant and negative: the rural development measure concerning the support to less favoured areas is likely to have been shaping the distribution of the High Nature Value farmland in a negative way. In other words, the *HNV* differential from 2000 to 2010 is inversely related to participation, which means that in municipalities where participation to the measure for less developed areas was higher there was a lower increase in *HNV*.

In terms of policy implications these results would represent an argument in favour of subsidising farmers' conversion to organic farming practices. Since participation to the measure of organic farming is expected to have a positive effect on the *HNV* variation, the existence of a positive externality is to be acknowledged and economically rewarded. Actually for the Regional Administration it is admittedly easier to identify areas where organic farming is diffused rather than identifying those areas that have high nature values of the farmland.

A procedure to identify the High Nature Value farmland consists in setting a threshold to the indicator: above the threshold there is presence of High Nature Value, and below there is not. The research problem is then how to fix the threshold (Pointereau et al. 2010). In fact, policy makers tend to regard as High Nature Value farmland those areas that are in marginal conditions, with an agricultural land use but which is distant from intensive cropping. These are sometimes found in so-called less-favoured areas, i.e. those areas that are targeted by agri-environmental payments according to measure 214/9. However, in this work the distribution of the HNV in Emilia Romagna has been calculated with a statistical procedure that does not take into account actual areas identified by regional authorities as High Nature Value Farmland. It is then possible that a mismatch exist between the highest values from our procedure and the provisions of the Emilia-Romagna Region. A possible extension of this research is to study if the actual HNV areas identified by the rural development plan coincide with the areas identified by the indicator by setting a threshold to the values.

Another possible extension of this research is to investigate the effect of the participation to *AES's* with each of the three components of the *HNV* indicator. Actually, according to the very method in which it is developed, the indicator of High Nature Value is dependent upon the crop's variety, the nitrogen surplus and the livestock density: these components are likely to play a basic role in the development of the agri-environmental schemes, and they are often referred to as indicators of environmental value (Primdahl *et al.* 2003).

7. Aknowledgments

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