Multifunctional farming in Emilia-Romagna region: an analysis through agricultural census data

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Jel codes: Q10, Q12, Q19

Abstract

This study presents a new approach to evaluate the level of multifunctionality at farm level adapting the H index of entropy proposed by Shannon (Shannon, 1963; Horowitz, 1970). Using the information gathered from the VI General Agricultural Census of 2010, the study offers a realistic snapshot of the intensity of the multifunctional character of farms located in Emilia-Romagna region. The findings of this explorative analysis suggest that it is possible to identify two opposite farm profiles. On the one hand, small "conventional" farms characterized by a multifunctionality index equal or close to zero recognized by Andersen et al. (2013) as "pensioners". On the other, large farms in which entrepreneurs (and their families) are generally younger and more receptive to innovative ideas. Among these typologies there are numerous farms characterized by moderate levels of multifunctionality. The approach developed here contributes to fill the gap regarding the measurement of the intensity of multifunctionality at farm level.

Keywords: *multifunctionality, Shannon index, microdata, farm..*

Résumé

Dans ce travail, nous allons parcourir une nouvelle approche pour l'évaluation du niveau de la multifonctionnalité des exploitations agricoles en adaptant l'indice de biodiversité de Shannon (indice H') (Shannon, 1963 ; Horowitz, 1970). En utilisant des données extraites du VI[e] recensement général de l'agriculture (2010), cette étude donne un aperçu réaliste de l'intensité du caractère multifonctionnel des exploitations situées dans la région Emilie-Romagne. Les résultats de cette analyse suggèrent qu'il est possible d'identifier deux profils opposés d'exploitations. Les petites exploitations «conventionnelles», d'une part, caractérisées par un indice de multifonctionnalité égal ou proche de zéro, comparées par Andersen et al. (2013) à des «retraités». Et d'autre part, les grandes exploitations dans lesquelles les entrepreneurs (et leurs familles) sont généralement plus jeunes et plus ouverts aux idées novatrices. Dans cette catégorie, il y a de nombreuses exploitations caractérisées par un niveau modéré de multifonctionnalité. L'utilisation de cette approche permet de réduire l'écart existant dans la mesure de la multifonctionnalité au niveau des exploitations.

Mots-clés: multifonctionnalité, indice de Shannon, micro-données, exploitations agricoles.

1. Introduction

1.1. Multifunctional agriculture

Among the definitions of multifunctional agriculture, that provided by the OECD is the most recognized worldwide. In addition to contributing to the production of food and fibres, agricultural activities "shape the landscape, provide environmental benefits such as land conservation, the sustainable management of renewable natural resources and the preservation of biodiversity, and contribute to the socio-economic viability of many rural areas" (OECD, 2001). Similarly, according to Bohman *et al*. (1999), agriculture carries out functions related to four issues: environment, food security, rural development and animal welfare. We can identify three main approaches to multifunctionality: economic, political-institutional and normative. The economic approach focuses on the agricultural production of goods and the evaluation of related externalities (Vatn, 2002; Van Huylenbroeck *et al.*, 2007). According to the political-institutional perspective, multifunctionality serves as a paradigm of post-productivist agriculture and complies with the changing needs of society as issued by the common agricultural policy (CAP). In contributing to the socio-economic and environmental well-being of communities, multifunctionality must be incentivised through the rural development policy (RDP) measures and appropriate public actions in order to improve rural economic growth and employment in agriculture (Daily *et al.*, 2000; Hollander, 2004; Potter and Tilzey, 2005, Clark, 2005; Uthes *et al.*, 2011). The normative approach focuses primarily on farming strategies employed to increase levels of multifunctionality, techniques used to measure degrees of multifunctionality (Wilson, 2008; Dibden and Cocklin, 2009) and the spatial analysis of multifunctionality (Wilson, 2010).

1.2. Conceptual framework of multifunctionality

According to the normative approach, multifunctionality can be considered as the direct expression of productivist and non-productivist thoughts and actions of farmers (Hollander, 2004; Holmes, 2006; Wilson, 2008). In this perspective, also Piorr and Viaggi (2015) point out the relevance of the optimal level of study to represent the multifunctionality and Wilson (2001) highlights the fact that the farm should be considered the minimum reference unit when studying multifunctionality (Figure 1).

Thus, while multifunctionality can be considered as an inherent characteristic of every farm (Vandermeulen *et al.*,

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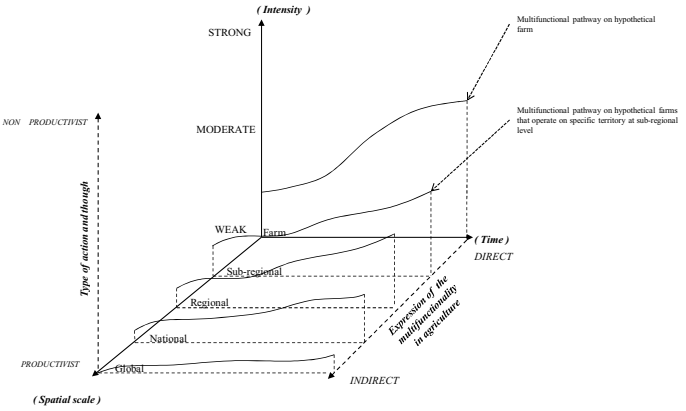
Figure 1 - *Multifunctional pathway and spatial scale of multifunctionality in agriculture.*



Source: Adapted from Wilson (2008, 2009).

2006), we can identify strong and weak levels of multifunctionality resulting from entrepreneur choices and environmental conditions (Figure 1). Strong levels of multifunctionality are typical of rural farms that employ not-productivistic methods. According to Van der Ploeg and Roep (2003), the broadening and deepening of farm activities have generated new forms of farm income and new job opportunities (Banks *et al.*, 2002; Knickel and Renting, 2000; Knickel *et al.*, 2004); at the same time, this has been coupled with an increased production of public goods and services. This multipurpose path is certainly affected by factors, external (e.g. policy and market conditions, and environmental conditions) or internal with respect to farms (e.g. structural conditions as endowment of land and labour) as well as by farm household factors (e.g. ideological and cultural aspects of farmers and their families). Sensitivities to issues such as environmental sustainability, production efficiency and intensity, agricultural product and food quality, landscape protection and cultural and historical heritage preservation are reflected in farmer lifestyle choices and business strategies. Given their radical nature, strict approaches to multifunctionality are rarely realised and are often considered as an extreme ideal rather than as a real goal (Wilson, 2008). Moderate approaches to multifunctionality instead involve a conscious reorganization of production factors based on trajectories of broadening and deepening that do not require a radical change of thought and lifestyle by the farmer. Weak multifunctionality, according to the multi-functional perspective, involves the joint and unintentional production of goods and externalities without conscious farm reorganization. Among these approaches, strict approaches to multifunctionality are not only the most extreme, but are considered the best, and Lowe *et al.* (1997) recognize their moral value.

1.3 .Objective

Social and political recognition of agriculture's multifunctional role has raised the need to measure this characteristic. While some works have presented methodological frameworks of multifunctionality assessment (De Groot, 2006; De Groot *et al.*, 2010; Paracchini *et al*., 2011), others have presented indicators to be included in valuation models (Lehtonen *et al.*, 2005; Vatn *et al.*, 2006; Mittenzwei *et al.*, 2007). Several studies use the national, regional or sub-regional dimension as spatial units. Studies that measure multifunctionality at the farm level are rare, and most are based on interviews data (Waarts, 2005; Andersen *et al.*, 2013). Research conducted in this area appears in contrast with a growing interest in normative approaches (Burkhard *et al.*, 2009; Wilson, 2009), as it is at the farm level that multifunctionality arises. Thus, it is at farm level that the multifunctionality should initially be analysed.

Adapting the *H* index of entropy proposed by Shannon (Shannon, 1963; Horowitz, 1970) this paper presents an approach to evaluate the level of the multifunctionality of each farm holding for a first exploratory analysis. The availability of a real picture of the farms' multifunctionality in Emilia-Romagna region will be a useful starting point for future analysis as well as a baseline to evaluate the effect of the future RDP measures and actions promoted at local level.

2. Materials and Methods

2.1. Study area and data

The Emilia-Romagna region is located in the north of Italy and is characterized by vast plains of highly industrialized and productive agriculture and by mountainous areas, where modern production technologies are less abundant. According to VI General Agricultural Census data for 2010, the Emilia-Romagna region includes 73,466 farms. Most are located in the plains (62.7%), and the rest are found on hills (26.1%) or in mountain areas (11.2%). On average, each farm covers 18.53 hectares, while the cultivated land is equal to 14.49 hectares. Throughout the region, average farm sizes are relatively uniform, cultivated lands are 12.36 hectares in mountain areas, 13.03 hectares on hill and 15.47 hectares in the plains. About the distribution of cultivated lands, census records reveal a certain level of variability, with approximately 34,000 farms cultivating less than five hectares and approximately 4,000 farms cultivating more than 50 hectares.

Data about the farmers sharply reflect their perspectives and the present state of Emilia-Romagna agricultural activities. Indeed, farmers are 61 years of age on average, and so-called "young" farmers (less than 40 years of age) manage only 6,625 farms, accounting for 9.0% of the total. Farmers who are older than 65 years manage 48.5% of farms, and elderly farmers (more than 75 years of age) comprise 20.2% of the total number of farms. An analysis of farmer education levels confirms the presence of risks associated with low levels of entrepreneurship. Farmers with a primary school education or with no degree account for 39.3% of the population. A total of 28.2% of the farm-

ers have completed lower levels of secondary school, 26.1% have completed higher grades of secondary school and only 6.4% carry a tertiary education.

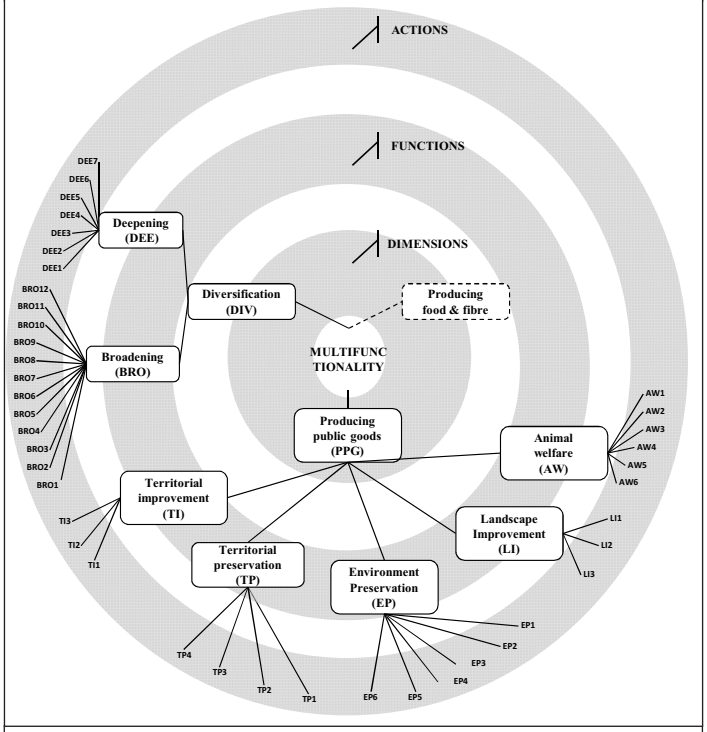
In this paper, we examine a condensed set of micro-data gathered from the VI General Agricultural Census of 2010. The dataset includes the universe of surveyed farms that are active in Emilia-Romagna region (73,466 observations). Following the analytical framework outlined below, many variables were selected, with 41 of them corresponding to possible strategic multifunctional actions and with the rest pertaining to farm features.

2.2. Analytical framework

Multifunctional approaches to agriculture involve the use of functions associated with primary activities of food and fibre production. Joungeneel *et al.* (2008) cite ecological, cultural and recreational functions as additional functions. On each farm, implemented actions are geared toward the production of marketable goods and services (food, feed, services) and of unmarketable goods and services of public interest (wildlife, landscape, the promotion of rural culture) and the adoption of these actions are affected by external and internal factors, reflecting the multifunctional nature of each farm.

The analytical framework used to examine levels of multifunctionality is depicted in Figure 2. While the two dimensions explored are related to the production of marketable or unmarketable goods and services, the functions specified are related to their relevance in European agriculture. For each function, the actions considered are selected based on data available in the 2010 Census of Agriculture. Farms that implement none of the considered actions do not exhibit any multifunctional character, whereas the farms that implement all the actions are fully multifunctional.

Figure 2 - *Analytical framework of farm multifunctionality.*



Source: Own elaboration.

In excluding the production of food and fibres, this analysis focuses on two main dimensions: the production of public goods (PPG), related to the production of non-marketable goods and services, and diversification (DIV), referring to the production of marketable goods and services.

2.2.1. First dimension: public goods production

Within the PPG dimension, we identify five social and environmental functions directed at the revitalization of rural areas (Territorial Improvement - TI), the protection of cultural heritage in the area where a farm is located (Territorial Preservation - TP), the protection of natural resources and biodiversity (Environment Preservation – EP), the preservation of landscapes (Landscape Improvement - LI) and the promotion of animal welfare (Animal Welfare – AW). This dimension and its related functions account for 22 different kinds of action.

The TI function accounts for actions that enhance the origin and quality of food produced in a given area (Masini, 2012). In addition to playing an economic role, this function is primarily focused on improving the reputation of a territory and its population and on the dissemination of knowledge on a region's historical and cultural background. Three actions are associated with this feature: the cultivation of grape varieties for the production of wines of Protected Designation of Origin - PDO or Protected and Guaranteed Designation of Origin – PGDO (TI_1) status, the cultivation of crops with PDO or Protected Geographical Indication - PGI (TI_2) status and the breeding of livestock for the production of PDO and/or PGI food (TI_3).

The TP function accounts for agro-forestry activities that help thwart degradation and hydrogeological instability (ISPRA, 2013). Such actions thus limit negative effects of anthropic pressure on land while consolidating water flood control and slope stabilization networks. Four actions are considered: the cultivation of permanent grassland and pastures eligible for the payment of subsidies (TP_1), the conservation of tillage (TP_2), the cultivation of cover and intermediate crops (TP_3) and crop rotation (TP_4).

The six actions included in the EP function are directed at ecosystem protection and at the minimization of negative externalities resulting from the excessive specialization and intensification of production activities: the controlled grassing of permanent crops (EP_1), the presence of fallow land with or without subsidies (EP_2), the adoption of uncovered pit manure and of best practices of manure management (EP_3), organic farming (EP_4), livestock breeding for organic production (EP_5), and the presence of wooded areas (EP_6).

Farmer decisions that determine the evolution of cropping systems can modify rural landscapes (Sotte and Es-

posti, 2002). The LI function is thus related to potential conservation and recovery actions that are designed to preserve the rural landscape and its historical and cultural value. Three actions are associated with this function: the management of hedges (LI_1), the management of tree lines (LI_2), and the maintenance of stonewalls (LI_3).

Animal welfare (AW) is a social issue of great interest, and consumers are increasingly expressing an appreciation for animal breeding techniques that support animal welfare. This sensitivity is attributed to ethical values, but also to a growing concern for the impact of intensive breeding practices on food safety and quality (Blandford *et al.*, 2002). Six actions are related to this function: animal grazing (AW_1), loose housing with litter for dairy cattle (AW_2), loose housing with litter for other cattle (AW_3), breeding pigs held on partially slatted floors or grills (AW_4), ground-level loose housing with outdoor access for laying hens (AW_5), and ground-level loose housing with outdoor access for broilers (AW_6).

2.2.2. Second dimension: Diversification

The DIV dimension is related instead to farmers' capacities to diversify their activities from the traditional ones. Consistent with Van der Ploeg and Roep's (2003) classification, this dimension is articulated through two different functions: deepening and broadening (Banks, 2002)[1]. The first is related to the development of activities on a farm that are typically performed by other companies of the supply chain (Deepening – DEE). The second is related to the implementation of non-agricultural activities on a farm (Broadening – BRO). This dimension and its related functions cover 19 actions.

Deepening strategies include seven actions: the initial processing of agricultural products (DEE_1), the full processing of vegetable products (DEE_2), the full processing of animal products (DEE_3), wood processing (DEE_4), the production of complete and complementary feed (DEE_5), other processing activities associated with agricultural production, (DEE_6), and direct consumer sales (DEE_7).

Broadening covers all productive activities that fall outside of traditional agricultural business activities. Twelve activities are included in this function: agritourism (BRO_1), recreational and social activities (BRO_2), educational farming activities (BRO_3), uses of farm machinery for agricultural contract work (BRO_4), uses of farm machinery for non-agricultural contract work (BRO_5), the maintenance of parks and gardens (BRO_6), livestock services (BRO_7), handicraft activities (BRO_8), production of complete and complementary feed to be reused on the farm (BRO_9), renewable energy production (BRO_{10}), aquaculture (BRO_{11}), and silviculture (BRO_{12}).

2.3. Methodological approach

In measuring farm multifunctionality levels, we adapt the *H* index of entropy presented by Shannon (Shannon, 1963; Horowitz, 1970). For the activities noted above, $a_j \in A \mid j = 1,2, ..., n$ with $n=41$ denoting multifunctional choices a farmer may adopt and with *B* denoting the set of real activated choices $b_j \in B \mid b_j = \begin{cases} 1 & \forall\, a_j > 0 \\ 0 & otherwise \end{cases} \mid j = 1,2, ..., n=42$, and $b_{42}=K=1^{(2)} : A \subset B$ for each farm. $x_i \in X \mid i = 1,2, ..., n$ with $n = 73{,}466$ as the *H* index is computed using the following equation:

$$H = -\sum_{j=1,2,...n}^{\beta} f_j \times [\ln(f_j)] / \ln(\beta) \quad (1)$$

where:

$$f_j = b_j / \left(\sum_{j=1}^{\beta} b_j\right) \forall\ b_j \in B \ \mid \ \sum_{j=1}^{\beta} f_j = 1;$$

$$\beta = \sup\{B\}.$$

The *H* index varies from a minimum of $0 \Leftrightarrow \sum_{j=1}^{\beta} b_j = 1$ to a maximum of $1 \Leftrightarrow \sum_{j=1}^{\beta} b_j = 42.$. An *H* index value of zero denotes that no action has been conducted at the farm level. An *H* index value of one denotes that all possible actions have been activated and that the multifunctionality level is at a maximum.

When expressed on a logarithmic scale, the *H* index tends to emphasize the activation of activities, even if they are in low number. The implied hypothesis states that efforts made by the farmer to activate the *j-th* action are less significant than those executed to activate the (*j-1*)-th action for the progressive layering of experiences and for the improvement of acquired skills.

3. Results and Discussion

3.1. Farm multifunctionality and action implementation

84.6% of the farms located in the Emilia-Romagna region adopted at least one of the considered actions (Table 1). A total of 62.5% of farms *produce public goods,* and over half of these employ two or more actions, with a maximum of 14. *Diversification,* by contrast, is much less common. Only 2.1% of the farms employ actions related to this multifunctional dimension, frequently employing a single action. Farms that adopt actions related to both multifunc-

Table 1 - *Dimensions of multifunctionality.*

Dimension	Farms		Actions				
	n. (10^3)	%	n. (10^3)	%	Min	Mean	Max
Producing public goods	45.9	62.5	98.7	59.1	1	2.1	14
Diversification	1.5	2.1	1.8	1.1	1	1.2	4
Producing public goods and Diversification	14.7	20.0	66.6	39.9	1	4.5	28
No Actions	11.4	15.3	0.0	0.0	0	0.0	0
Total	73.5	100.0	167.0	100.0	1	2.3	28

Source: Own elaboration.

[1] This analysis does not consider re-grounding dimensions related to farm household choices to dedicate a portion of family labour to activities other than farming activities (Pluriactivity) due to limited (dynamic) data available to detect the adoption of such strategies by farmers.

[2] The b_{42} action is a constant ($b_{42}=1$) that measures conditions of non-activation for any action $a_j \in A \mid \sum_{j=1}^{41} a_j = 0.$.

Table 2 - *Functions of multifunctionality.*

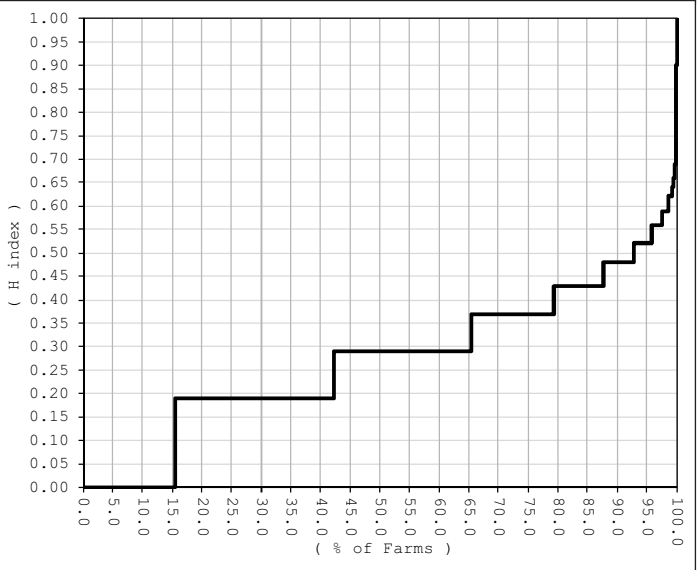
Function	Farms		Actions				
	n. (10^3)	%	n. (10^3)	%	Min	Mean	Max
Environment preservation	45.7	73.5	62.9	37.6	1	1.4	6
Animal Welfare	10.2	16.3	12.8	7.7	1	1.3	5
Territorial preservation	32.4	52.1	37.2	22.3	1	1.2	4
Territorial improvement	15.3	24.6	16.2	9.7	1	1.1	3
Landscape improvement	11.2	18.0	15.1	9.0	1	1.3	3
Broadening	7.2	11.5	9.0	5.4	1	1.3	9
Deepening	12.0	19.2	13.9	8.3	1	1.2	6

Source: Own elaboration.

tional dimensions are more common, representing 20.1% of the examined farms. These farms are more deeply involved in multifunctional approaches of strategic management, and half employ four or more actions, with a maximum of 28.

Considering the seven functions described above, that related to *environment preservation* represents the farmers' main interest. In total, 73.5% of the farms perform this function, accounting for 37.6% of all multifunctional actions realized in Emilia-Romagna region (Table 2). In most cases, farms implement only one action of this type, and only 25% of the farms employ two or more actions. *Territorial preservation* tasks are executed in 52.1% of the farms that implement 22.3% of all actions. The other functions related to *producing public goods* are less relevant. Functions of *territorial* and *landscape improvement* are employed in 24.6% and 18% of the farms, respectively. A total of 16.3% of the farms realize at least one action related to *animal welfare.* Regarding *diversification*, 11.5% and 19.2% of the farms perform *deepening* and *broadening* tasks, respectively, and primarily by employing only one multifunctional action related to these two functions.

Figure 3 - *H index distribution.*



Source: Own elaboration.

3.2. Multifunctionality levels and farm features

Due to the discrete nature of the underlying variable (f_j), the *H* distribution is characterized by a discontinuous pattern depicted in Figure 3. The average *H* value of the Emilia-Romagna region is 0.271 based on a minimum of 0.000 (no multifunctionality) and maximum of 0.901. As expected, most of the farms show low levels of multifunctionality, and 92.8% present an *H* value of less than 0.500.

A more precise depiction of the relationship between multifunctionality levels and farm features is presented in Table 3. Here we can appreciate that as levels of multifunctionality increase, different features follow a regular increasing or decreasing pattern for the considered variable. Thus, average farm acreage is equal to 7.78 hectares for "non-multifunctional farms" but increases to 42.34 for heavily multifunctional farms. Another feature relating to farm multifunctionality concerns a farm's location. A total of 14% of the "non-multifunctional farms" are located in mountain areas. That is, of the 11,297 non-multifunctional farms, only 156 are located in mountain areas, whereas the remaining 11,141 are located in the plains or in hilly areas. By contrast, a large number of highly multifunctional farms are located in mountain areas (28.2%).

We can also observe relevant differences in relation to farmer characteristics. On average, farmers who manage "non-multifunctional farms" are 65 years of age, while those managing heavily multifunctional farms tend to be younger (53 years of age). The latter consistently hold a higher level of education: 9.5% hold an academic degree, while this percentage is 5.6% for farmers who manage "non multifunctional farms".

3.3. The twofold side of multifunctionality

The different levels of multifunctionality are an expression of the farmers inclination towards multifunctional agricultural practices in order to stabilize and implement the farm household income and the implementation of multifunctional actions in the Emilia-Romagna region shows how many farms are consistently shifting towards the new rural paradigm cited by van der Ploeg and Marsden (2009) as well as Horlings and Marsden (2012).

Through the analysis, we can indeed identify two farm profiles that coexist. Among them, there is a fuzzy reality with farms characterized by a moderate level of *H* index values.

On the one hand, some small "conventional" farms generate indexes of multifunctionality that are equal or close to zero. Andersen et al. (2013) recognize these farms as "pen-

Table 3 - *Cut of value of H index to farm size class.*

H index	Farms n. (10^3)	Average UAA (Hectares)	Age of the farmers	Farm location (% of farms in mountainous areas)	Level of instruction (% of graduate)
0	11,3	7.78	65	1.4	5.6
0,19	19,7	9.70	63	4.8	5.5
0,29	17,1	11.07	61	13.2	5.9
0,37	10,2	15.17	59	13.7	6.5
0,43	6,2	20.74	58	19.1	7.5
0,48	3,7	24.20	56	21.9	8.4
0,52 - 1	5,3	42.34	53	28.2	9.5

Source: Own elaboration.
Legend: UAA = Utilized Agricultural Area.

sioners". In these cases, the farmer has reached retirement age and does not intend to take any multifunctional action, viewing such approaches as "different" from agricultural procedures and continuing the production of conventional goods using conventional techniques. This group mainly manages *part-time* farms, where agricultural activities are not the main source of farm household income. Farm positioning on the plains or in hilly areas, high levels of soil fertility and a wide variety of available services, facilitates the achievement of acceptable economic performance for even smaller farms managed by farmers who offer limited professional experience.

By contrast, large farms are identified in which multifunctional principles are viewed as highly profitable. For these farms, environmental and territorial protection and enhancement are considered central to strategic farm planning. Such entrepreneurs (and their families) are generally younger and more receptive to innovative ideas and to paradigms of multifunctional agriculture, and their more advanced educational background facilitates this attitude. While farmer's personal beliefs facilitate this behaviour, the relatively high number of farms located in mountain areas shows that such choices are often made due to the typically low technical and economic performance. The non-productivist approaches employed on these farms are thus facilitated by the failure of conventional farming techniques executed in marginalized areas. In such cases, accession to the non-productivist paradigm has been more radical, and such processes may be irreversible.

4. Conclusion

The research points out as larger and better-endowed farms, located in hilly or mountain areas, frequently managed by younger and better-educated farmers are characterized by the higher degree of multifunctionality. This result suggests that these farmers are particularly motivated through a self-perception as actors embedded in the regional development context. This highlights a proactive role of these farmers and their behaviour is motivated by commitment and investment in the future, if supported by adequate measures of rural development policy. For these reasons, the multifunctionality can have an important impact regarding the rural development through a synergic interconnection among local actors enhancing the potentialities of the rural system in order to meet the societal demands.

The production of public goods and the on-farm diversification strategies (e.g. deepening and broadening), seem to be tools to link primary production with the rural economy through adopting the concept of multifunctionality. In this perspective the development of functions oriented to improve the reputation of the area assuring food quality and food security, seems to be able to stimulate the economy of the entire agri-food system.

An in-depth knowledge of the characteristics of the territory is anyway essential to better contextualize the RDP measures. The availability of analytical tools, such as the index proposed here, to evaluate the level of multifunctionality starting from the farms seems to be useful for the politicians, in order to evaluate the effectiveness of adopted policies.

The picture presented here about the distribution of multifunctionality in Emilia-Romagna farms does not capture the drivers that lead farmers to multifunctional behaviour, a research path that could be pursued in future research activities. In this light, the availability of micro-information regarding the level of multifunctionality seems to be an appropriate starting point for future work regarding the adoption of spatial econometric analysis as well as to carry out analysis oriented to capture the drivers of farmers' behaviour.

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