EFFICIENCY OF AGRO-FORESTATION SUBSIDIES TOWARDS ITALIAN FARMS

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Since the early 1990s, the European Union (EU) has financed lots of measures aimed at promoting agro-forestry activities on farms and through the MacSharry's reform it has put in place actions with the predominant purpose of changing the European agricultural production model. To evaluate the role and impact of the subsidies allocated by the Common Agricultural Policy (CAP) towards farmers, the European Union has set up a survey, called Farm Accountancy Data Network (FADN) which is the main source of microeconomic data in a sample of European farms. It has been able to assess several aspects about the impact of the Common Agricultural Policy. The main goal of this analysis was to investigate in a quantitative approach the efficiency of agro-forestation subsidies allocated by the EU over the period 2000-2011. The methodology has used a non-parametric model, Data Envelopment Analysis (DEA), applied to different types of farms pivotal to estimate technical, economic and allocative efficiency. Italian farms have been stratified in function of their orography, their size of surface, technical cluster. The findings have pointed out that Italian farmers have partially used interventions of agro-forestry, showing a great diversity in technical efficiency during the period of observation. The orography and the farm size have had a significant impact on technical efficiency and allocative efficiency.

Keywords: Common Agricultural Policy, rural areas, FADN, Data Envelopment Analysis.
Parole chiave: Politica Agricola Comunitaria, aree rurali, RICA.

http://dx.doi.org/10.4129/2cis-ng-eff

1. Introduction

During the last 10 years in the XX century the role of primary sector is completely changed as a consequence of a new function of the countryside; in fact, people have stimulated it in order to protect the environment and in getting better socio-economic standard living conditions in rural space. Thus, the agriculture has shifted from a productivist model towards a post productivist model (Ilbery, 1998) characterized by specific features, intrinsic and extrinsic values both in terms of agri-cultural production and also in terms of ecological activity throughout the promotion of multifunctionality (Galluzzo, 2009; Galluzzo, 2010).

The foremost effect is to assign towards agriculture a compelling function of public good able to cope and peg lots of positive externalities with the ambition to reduce the marginalization of rural territories in many European countries (Galluzzo, 2012a).

The main consequences of this transition model in the primary sector have been a growth of awareness by public institutions to protect the rural space giving financial funds and subsidies aimed at reducing agricultural over-productions through actions such as afforestation and diversification in the primary sector.

The second pillar of the Common Agricultural Policy has defined some principles to improve the rural development through the multifunctionality, that implies for farmers planning and putting into practice different activities in order to protect the rural space both in environmental terms and also in socio-economic terms, with the consequence to increase the sense of belonging to a rural community and not to be excluded by processes of local governance (O'Hara, 1998). In the same time the main role of rural development has been to better general living conditions in rural and in urban areas, both satisfying local needs (Wilson and White-head, 2012) and also allowing an holistic protection against climate change, by afforestation, in a new model of integrated and endogenous development in the countryside specifically after the reinforcement of rural and environmental issues due to the transition in an agricultural post productivist model (Heley and Jones, 2012).

In particular, the agro-forestation, by different actions put into place since the 1990s by the European Union, has produced positive impacts on the transition from an agrarian productivist model to a post-productivist one, reducing negative effects of overproduction and chan-ging or rather reshaping the countryside landscape in many Italian regions as well with the diffusion in the last 20 years of afforestated surfaces in small plane areas and in hilly territories (Galluzzo, 2012b), improving the level of financial subsidies (Camaioni and Sotte, 2009).

In Italy since the 1990s there has been an increase of funds allocated by the European Union to promote the afforestation in particular in rural stayed behind rural areas where strips of arboreous crops have been fun-damental both in agrarian hydraulic systems and also in the consolidation of slopes, becoming typical elements of

Italian traditional agricultural landscape of plain and upland territories (Sereni, 2010). During the last 20 year time, there has been an increase of funds allocated by the European Union, which have increased from 251 million of euro, over the late 1990s, to 1,635 million allocated during the time 2000-2006; in these last 7 years (2007-2013) the total assigned funds has been 2,430 million of euro even if the 22% of this amount is specifically allocated to finance the long-time measures carried out in the early 1990s in order to put into action measures of reforestation (Vagnozzi and Giarè, 2000; Cesaro, 2002; Pettenella, 2009). In order to assess the impact of financial subsidies and supports allocated by the European Union aimed at promoting reforestation we have used quantitative methods focused in a medium term of 12 years during two seven year time of implementation of regional Rural Development Plans (2000-2006 and 2007-2011) using the Farm Accountancy Data Network (FADN) database. In this case one has taken into account as variable the financial supports paid in favour of reforestation measures and financial aids specific to the Rural Development in order to estimate their impact both in function of the orography of farms and also in function of their size in terms of the Utilizable Agricultural Surface and in function of predominant technical productive system (Galluzzo, 2013). The need to evaluate an integrated efficiency, tightly correlated both to the measures aimed at supporting rural development and also towards some actions specifically dedicated in favour of agro-forestry found in the FADN an unique unified and consistent database in all different member states of the EU particularly after the increase in the financial funds allocated by the European Union over the time 2000-2006 and in the subsequent seven year time 2007-2013 (Marongiu *et al*., 2012).

2. Aim of the research

The main purpose was to estimate in a quantitative input oriented model whether the efficiency of farms has been influenced by subsidies paid to implement rural development some of them specifically devoted to agro-forestry.
The next stage was to stratify Italian farms belonging to the FADN sample in function of their orography, size of surface and productive technical system (OTE) such as: farms specialized in sowable land, farms specialized in fruit and vegetables, farms specialized in permanent crops, farms specialized in herbivorous breeding, farms specialized in granivourous breeding, farms with arboreous and herbaceous crops, farms with mixed animal breeding and crops.
The analysis took into account the net income and costs arising from the farm activity (Marongiu *et al*., 2012) considering the utilizable agricultural surface (UAS), in terms of land capital plus investments on it, input in terms of financial funds allocated by the European Union (Veveris *et al*., 2007) and also by the second pillar of the CAP utilizing specific measures in favor of reforestation in limited portion of the Italian agricultural surface.

3. Methodology

There are two approaches to assess the efficiency: a parametric or deterministic approach, which needs a function of production and other parametric variables, and a non-parametric model or DEA, that stands for Data Envelopment Analysis (Farrell, 1957) aimed at defining in function of the distance from the frontier of an hypothetical function of production an index of technical inefficiency (Bielik and Rajcaniova, 2004; Forsund *et al*., 1980; Bauer, 1990).
In the non-parametric model deviations from the frontier of function are caused by inefficiencies and they are not connected to errors (Bojnec and Latruffe, 2007). The technical efficiency is described as the capabilities of farms to maximize the output minimizing the used inputs or vice versa in function of the constraints in the business choices in terms of disposable input or output even if the results in these two approaches are similar (Bojnec and Latruffe, 2007). According to many authors, the model of quantitative analysis and estimation of the efficiency is tightly linked to a specific frontier of production or rather to a parametric function of production (Farrell, 1957; Charnes *et al*., 1978; Battese, 1992; Coelli, 1995). In this paper the efficiency has been estimated by a non-parametric input oriented model, called Data Envelopment Analysis (DEA), applied to a constant return to scale using the software PIM-DEA.
The non-parametric linear model throughout the Data Envelopment Analysis was introduced for the first time in 1978 (Charnes *et al*., 1978) and it is useful in estimating the relative efficiency in each Decision Making Units based on a different combination of inputs and outputs (Hadad *et al*., 2007) with the aim of minimizing input used (Doyle and Green, 1994).
The next stage of the quantitative analysis has utilized a multiple regression model, estimating the parameters by Ordinary Least Square, with the purpose to investigate if some independent variables such as total costs, subsidies allocated by the EU and the total agricultural surface have acted on the dependent variable such as woodland surface and produced output of farmers. The estimation of the parameters has used the open source software GRETL 1.8.6. In its algebraic form of matrix, the multiple regression models can be so expressed (Verbeek, 2006; Asteriou and Hall, 2011; Baltagi, 2011):

$$y = X\beta + \varepsilon \quad (1)$$

where y is a dependent variable, β are parameters and ε is the error but both are vectors with n-dimensions X is an independent variable which has dimension n x k.

4. Results and discussion

The analysis of historic data, published on the European website of Farm Accountancy Data Network, in the semilog multiple regression model has outlined as the dependent variable afforested surface has been correlated in a direct way with the independent varia-

bles total subsidies allocated by the EU to implement rural development, the economic size, the diffusion and cultivation in Italian farms of permanent crops and last but not least financial supports able to promote the rural development in the countryside (Tab. 1). The subsidies in favour of actions about the agro-environment protection scheme do not have any impact on the diffusion of agroforestry surfaces in all analyzed farms in the FADN sample.
The quantitative model has pointed out an inverse correlation between the inputs used in the production process and the subsidies and financial funds paid in favour of disadvantaged areas; this underlines as a large proportion of agro-forested areas have predominately located and scattered in lowland areas than in upland territories which in general are characterized and covered enough with natural woodland and agro-forested areas. These later therefore need of specific financial supports in order to ensure a correct development and a persistence over the time as well.
The linear regression model using the FADN time series pointed out that the output obtained in Italian farms, which have implemented and put into actions measures of rural development correlated to the agroforestry has been positively affected by the subsidies allocated by the European Union in favour of disadvantaged areas, the total income of farmers and by the utilizable agricultural areas (Tab. 2). A negative correlation in the multiple regression model has been found out between the dependent variable produced output and the total subsidies and financial supports paid by the second pillar of the CAP in order to promote and/or implement rural development.
The analysis of the average efficiency in the 19 Italian regions was lower than the value of 100% and the average value of efficiency was equal to 69.35% and only some Italian regions such as Campania, Lombardia and Marche have stressed a value of efficiency near to that value; Molise, Sardegna, Umbria and Trentino have showed the lowest values (Fig. 1).
The analysis of cost efficiency and allocative efficiency has pointed out values much lower than the optimal value equal to 100% and in all the Italian regions the average value is 51.19% and 71.13% for cost efficiency and allocative efficiency demonstrating a greater value in allocative efficiency than in the cost efficiency. Italian regions with the best results in terms of allocative efficiency have been Veneto, Molise and Liguria, while the worst performance has been achieved in Alto Adige and Friuli Venezia Giulia (Fig. 2).
The best values of economic efficiency have been found in one region located in the north of Italy (Lombardia) and in another one located in the south (Campania), while the worst performance has been pointed out in Alto Adige, Trentino and Friuli Venezia Giulia (Fig. 2). At the level of distribution it is possible to highlight how farms belonging to the FADN dataset with an efficiency equal to 100% have been one-third of the total sample with the majority of farms placed below the optimum value even if the average level of economic efficiency has had lower values than the overall technical efficiency and allocative one. Regarding the allocative efficiency, the results have been more flattering to the economic one with over 60% of the sample above the 60% and 20% at a level of efficiency equal to 100%. For the economic efficiency and allocative efficiency less than 10% of the sample has been placed on values of 100% and most of the farms stood at a level below 60%.
A quantitative correlation between economic efficiency and allocative one has pointed out a direct correlation equal to 0.73 with a $p < 0.001$.
The analysis of efficiency in function of orographic location of farms has underlined as the best results are in some of them located in upland and plane areas (Fig. 3). The analysis of efficiency refers to the size of farm, in terms of utilizable agricultural surface (UAS), has showed as farms under 5 hectares have values of overall efficiency equal to 100%. Some farmers with an extension of UAS between 5 and 10 hectares have pointed out values no efficient; farms with a size above 50 hectares of UAS have pointed out in several years level of general efficiency equal to 100%. The analysis of the efficiency in function of the predominant technical productive system (OTE) has shown that the best results have been related to horticultural technical productive system and herbaceous cultivations which have stressed only in one year a value of efficiency lower than 100%. Farms belonging to the OTE with breeding predominately made by herbivorous animals have showed only in 7 years out of 10 a value of efficiency equal to 100%.

5. Conclusion

The FADN dataset allows to have multiple, pivotal findings and information on CAP and specifically about the agroforestation actions arranged by local regional authorities in order to implement the Rural Development Plan in two seven year time of investigation carried out in this research. However, dataset has underlined as the most actions have concentrated in plain areas and hilly ones, which have involved only a small percentage of new farmers, because of the mainly percentage of agroforestation actions started in the early 1990s have drained an awful lot of financial supports allocated by the European Union in the former RDPs in terms of dragging effects in favour of farmers. The goodness of afforestation actions is corroborated by the increase in funds provided in regional budget addressed to implement agro-forestation in a new perspective of respecting the focus area of biodiversity and other priorities defined for the next seven year time of the Rural Development Plan 2014-2020.
Summing up, it should be desirable encouraging a greater participation approach between all stakeholders in the supply chain during the development phase of Rural Development Plan, shortening and streamlining the bureaucratic aspects giving priority in favour future prospects and features of intervention where high are levels of territorial capital, which in connection with the social capital, local knowledge and shared skills might implement to a rural

district in order to produce niche products instead of woods or other sources of biomasses in particular in areas where are located the oldest farms which have decided 20 years ago to be forerunners, putting into action the earliest measures of agro-forestry and becoming nowadays the mentor for young farmers.

Table 1. Main results of the multiple regression model. Dependent variable woodland areas (Source: our elaboration on data http://ec.europa.eu/agriculture/rica/database/database_en.cfm).

Independent variables	*Coefficient*	*Standard error*	*t value*
Constant	8.6297	4.1191	-2.10 *
Ln total inputs	-1.0042	0.0494	-20.31 ***
Ln farm net income	0.2251	0.0188	11.91 ***
Ln total assets	0.9846	0.2607	3.78 ***
Ln total subsidies	0.0760	0.0365	2.06 *
Ln other crops	0.2410	0.0994	2.42 **
Ln environmental supports	-0.3799	0.3416	-1.11
Ln less favoured areas supports	-0.2347	0.1030	-2.30 **
Ln total supports II pillar CAP	0.8578	0.4304	1.99 *
Permanent crops	2.5606	0.1195	21.42 ***
Economic size	0.0058	0.0010	5.52 ***

* denotes significance at 10% level; ** denotes significance at 5 % level; *** denotes significance at 1%.

Table 2. Main results of the multiple regression model. Dependent variable produced output (Source: our elaboration on data http://ec.europa.eu/agriculture/rica/database/database_en.cfm).

Independent variables	*Coefficient*	*Standard error*	*t value*
Constant	1,095.8	2,050.4	0.53
Less favoured areas supports	28.965	4.3740	6.61 ***
Rural development funds	-11.669	1.6707	-6.98 ***
Farm income	1.5004	0.0851	17.60 ***
Utilisable agricultural areas	1,236.1	228.9	5.39 ***

*** denotes significance at 1%.

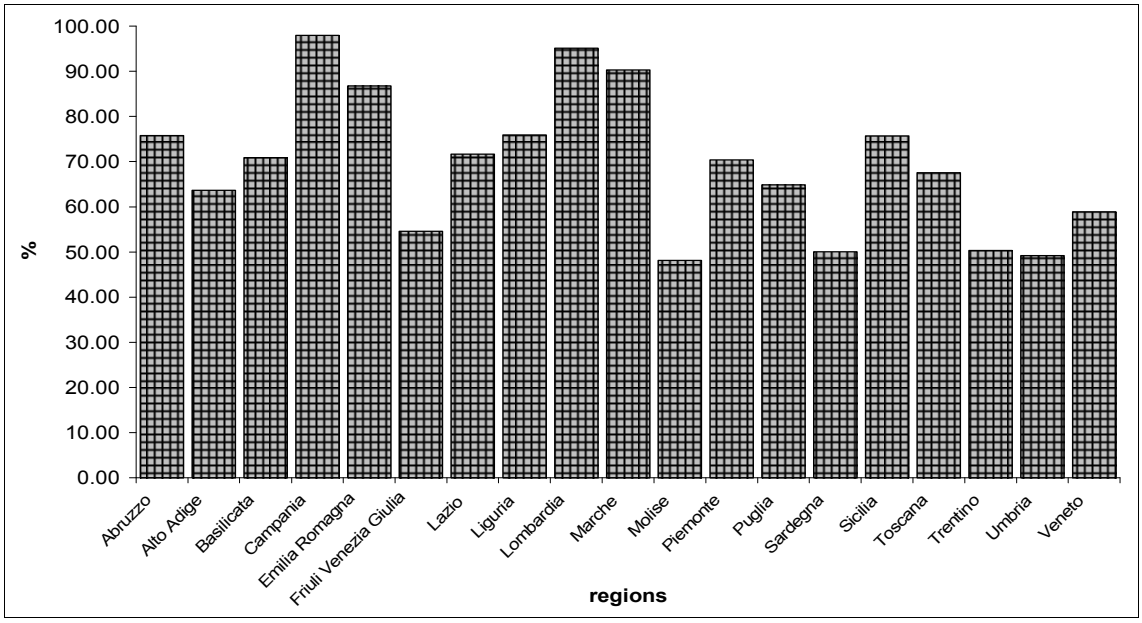

Figure 1. Different level of average efficiency in all Italian regions (Source: our elaboration on data Rica Italia Inea).

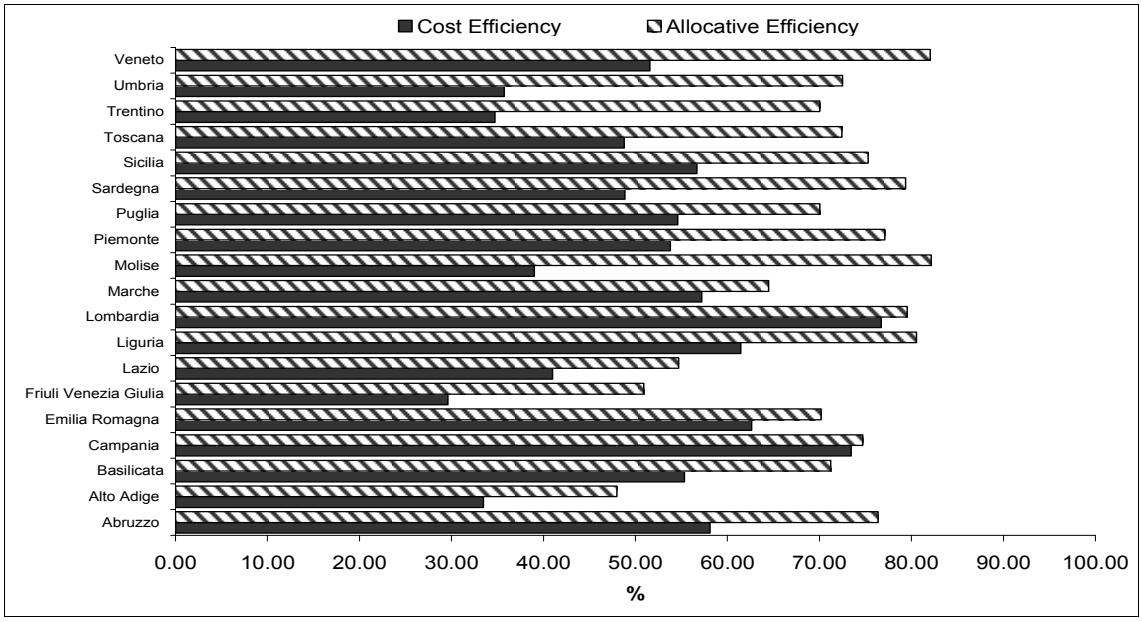

Figure 2. Average of economic and allocative efficiency in all Italian regions over the time 2000-2011 (Source: our elaboration on data Rica Italia Inea).

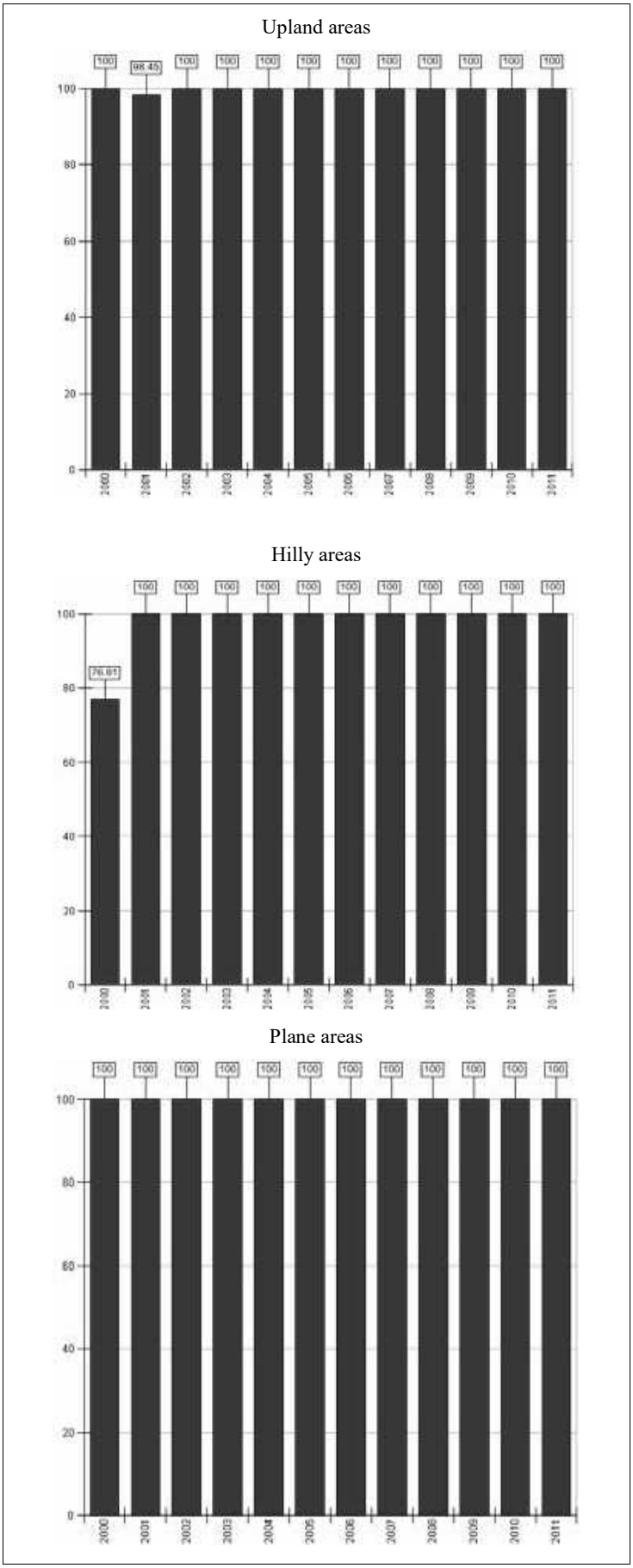

Figure 3. Evolution over the time of efficiency in function of the orography of farms belonging to FADN sample (Source: our elaboration on data Rica Italia Inea).

RIASSUNTO

Efficienza dell'agro-forestazione nelle imprese agricole italiane

Fin dai primi anni 1990, l'Unione Europea (UE) ha finanziato molteplici misure volte a promuovere le attività agro-forestali nelle aziende agricole e attraverso la riforma del MacSharry ha cambiato il modello produttivo agricolo europeo.
Per valutare il ruolo e l'impatto dei sussidi stanziati dalla Politica Agricola Comunitaria (PAC) verso gli agricoltori, l'Unione europea ha istituito un'analisi campionaria, denominata Rete di Informazione Contabile Agricola (RICA), che è la principale fonte di dati micro-economici per studiare le aziende agricole europee, valutandone alcuni aspetti della Politica Agricola Comunitaria.
L'obiettivo principale dell'analisi è stato quello di indagare con un approccio quantitativo l'efficienza dei sussidi erogati con gli interventi di agro-forestazione nel periodo 2000-2011 nei confronti delle aziende agricole.
La metodologia ha utilizzato un modello non-parametrico, definito *Data Envelopment Analysis* (DEA), al fine di valutare l'efficienza tecnica, economica e allocativa dei contributi erogati alle imprese agricole del campione. Le aziende italiane sono state stratificate in funzione della loro orografia, delle loro dimensioni in termini di superficie agricola e del loro ordinamento tecnico-produttivo.
I risultati hanno evidenziato come gli agricoltori italiani abbiano utilizzato in maniera tecnicamente efficiente i sostegni a favore dell' agro-forestazione, anche se permane una significativa diversità in termini di efficienza tecnica tra le regioni italiane.
L'orografia e la dimensione agricola, in termini di superficie aziendale coltivabile, hanno avuto un impatto significativo sulla efficienza tecnica complessiva e sulla efficienza allocativa.

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