AGRO-BIODIVERSITY: AN ECONOMIC EVALUATION OF BENEFITS PROVIDED TO REGIONAL COMMUNITY BY THE APULIAN OLIVE LANDRACES[1]

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1. Introduction

Life of every species living on Earth is ensured by ecosystem services, hence the importance of biodiversity, recognized as the most important natural resource of our planet, and the interest of humanity to ensure its preservation. As part of biodiversity, the agro-biodiversity is considered especially threatened by intensive agricultural practices and the introduction of genetically modified organisms on the market. Within the European context, Italy would be among the most endowed countries in terms of agricultural biodiversity and this is because it continues to be strongly linked to small farmers and to the territory. As part of Southern Italy which is typical of the Mediterranean area, Apulia has the highest number of agricultural workers among the regions and has clearly revealed the tremendous impact that agriculture has especially on regional economy and community welfare. It has a biological heritage created over centuries by local farmers who have selected and cultivated many historical varieties, creating agriculture able to guarantee the equilibrium of ecosystems, biological diversity and environmental stability. In light of these thematic and territorial contexts, it was thought that it might be useful to estimate, through an economic approach, the preferences of Apulian community to support any measures of protection and conservation of typical local varieties with particular reference to the specific case of olive[2]. The results of a survey design carried out in Apulia were used, choosing among methodological approaches for a variant of contingent valuation: the "choice

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[2] The scientific literature currently existing in Italy on agro-biodiversity is very little and in some way fragmented both in terms of territorial extension and species analyzed. Only some new studies (Biasi R., Brunori E., Smiraglia D., Salvati L. 2015; Figliuolo G., Cerbino C. 2014) have provided new insights on the subject, though not on the economics of biodiversity.

experiment[3].” It was, therefore, evaluated and measured, using a random parameters model, the willingness to pay (WTP) by the Apulian citizens regarding the benefits produced by typical olive varieties, highlighting a certain behavioral heterogeneity of respondents depending of the proposed interventions. Findings have implications for debates concerning the conservation of Mediterranean species and associated costs and benefits in order to design ad hoc conservation on-farm programmes.

2. The territorial context of reference

Italy would be the European country with the greatest wealth of biodiversity and this for the extraordinary geomorphological conformation, for the climatic diversity and the multiple environmental types ranging from semi-desert of the South to those of the North alpine habitats. It is a historical biodiversity, related to the alteration of landscape and culture of each region, and is composed of a spontaneous biodiversity obtained from the selection, also in synergy with specific adaptations, to environmental diversity.

However, the use of increasingly massive intensive agriculture has made even more urgent the need to protect biodiversity, and particularly agro-biodiversity or “agricultural biodiversity” which is understood to be the biodiversity resulting from agricultural crops and the livestock species selected by the farmer / breeder over the centuries. This selection was made based on agronomic, livestock and climate needs, etc., such as increased productivity (fruits, wood, meat, milk, wool, etc.), the best resistance to pathogens and to biotic and abiotic stresses, the best adaptation to the local climate, etc., Moreover, it is believed to be especially sensitive to uncontrolled spreading of genetically modified organisms[4] on the market. The main characteristic of the extraordinary Italian agro-biodiversity is mainly driven

[3] In recent surveys on the varieties of olives, grapes and fruit in Puglia cf.: INEA, 2013; Calabrese G., Tartaglini N., Perrino V. E., Veronico G. 2012; Elia A., De Pascale S., Inglese P. 2008.

[4] Italy affected by the emergence of deterioration of its biological heritage, from the beginning, it has been heavily involved in all the initiatives developed at the protection of biodiversity both at international level and at European Union level. In this regard, it should be confirmed that in 2004 our country has ratified the FAO International Treaty on RGVAA and, in Article 3, it says that the competency for the activation of the provisions of the Treaty is entrusted to the Regions and Autonomous Provinces. As part of the Rural Development Programmes (RDP) 2000-2006 and 2007-2013, significant funds were made available to the regions and autonomous provinces to enable initiatives of recovery, conservation and evaluation and the granting of aids to farmers who commit themselves to cultivate local varieties registered in regional registries. Moreover, Apulia has introduced the goal of protecting agricultural biodiversity even in its own programming for rural development.

by the prosperity of the South which is typical of the Mediterranean area[5]. In this context, the Apulian reality is involved with an area of 19.55 million square meters, which has the highest number of agricultural workers[6] among the regions, amounting to 103.272, a clear demonstration of how agriculture is a highly determining factor for the economy of the region. The origins of this wealth in terms of agro-biodiversity date back to ancient times and are the result of two opposing trends. On the one hand, the geographical position of Apulia looking towards the East has clearly favored the contact between different cultures and peoples, trade and so also the exchange of cultivated plants with other Mediterranean countries. On the other hand, the isolation of Apulian agricultural communities, originated by the alternation of mountains, hills and valleys, has contributed to the creation of many local varieties within rather restricted territories. With reference to tree-species, a recent comparison of materials, stored in ex-situ collections with the germoplasm cited in historical bibliographies, has highlighted both a significant consistency of the Apulian olive biodiversity, with some 40 varieties, and the need of searching additional 45 local varieties that are cited in bibliographies but not yet identified[7].

After such a descriptive analysis on the thematic and territorial contexts, in this work an economic approach will be matched to the theme of agro-biodiversity aimed at the evaluation of the economic benefits provided by agro-biodiversity to the community in order to define suitable conservation programmes[8].

3. Material and methods of a survey design

3.1. The choice experiment

As a public good, the total value of agro-biodiversity is not expressly defined by the market. Because the individual farmers tend to react to their private net benefits based on market dynamics, ignoring the benefits arising from the conservation of the same one and paid to the community, it is appropriate to use an economic approach to assess the services provided by the agro-biodiversity so accurately tracking changes in both natural and social well-being. The current paradigm, therefore, is based solely on the concept of utility that society derives from the real

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[5]Reidsma P., Tekelenburg T., Van den Berg M., Alkemade R. 2006; Hammer K., Gladis T., Diederichsen A. 2003.

[6] INEA, 2013.

[7] *Ivi.*

[8] In terms of economic evaluation of agro-biodiversity cf: Meinard Y., Grill P. 2011; Mendelssohn R. 2001.

or potential and direct or indirect use of environmental, ecological and socio-cultural services of agro-biodiversity, and on the principle of satisfaction of expressed preference in order to estimate the value of the environmental public good simulating a market, even if this is non-existent. This approach is the basis of the choice experiment (Choice Experiment - CE), a variation / extension of the best-known conjoint analysis (CA). It is a method of expressed preferences (or declared) by the interviewed consumers able to estimate the total economic value (TEV), including the use and non-use values, the latter often predominate over the former in the case of environmental goods such as agro-biodiversity. In operational terms, a simulation is performed, that outlines a hypothetical market, as realistic as possible. The status quo is presented together with a detailed description of hypothetical changes (scenarios), after which the maximum willingness to pay (Willingness To Pay - WTP) for the conservation or improvement of the quality of that good is requested to the consumer. More specifically, in the second section, in the application of the CE to the respondents, it is presented a questionnaire containing a certain number of sets of choice (choice sets) consist of a number of profiles or alternatives (scenarios), defined by different combinations of features protection policy (attributes) and their respective levels. More specifically, in the application of the CE to the respondents, it is presented a questionnaire containing in the second section a certain number of sets of choice (choice sets) which consisting of a number of profiles or alternatives (scenarios), defined by different combinations of features of protection policy (attributes) and their respective levels. So, the respondent is asked to select the best profile for each set of choice. The method is a structured mechanism so that you can obtain information about the attributes and socio-economic variables that most influence the choices of respondents. With regard to economic evaluation developed in this case study, the respondents were asked to choose the best scenario from each choice set and so its WTP which is expressed as an intervention spending (contribution) that the respondent should support each year over 10 years for the protection of environmental resources considered (Table 1), based on environmental, economic and socio-cultural considerations. The attributes and their levels were chosen on the basis of the regional agro-biodiversity and characteristics of the different types of estimates.

In this study, we used a 3-alternative design (with the “no option”) and the alternatives were unlabelled in order to better investigate the role of attributes by citizens.

Table 1 – *Attributes and levels used in the choice experiment (bold referred to the status quo).*

Attribute	Code	Level coding
Farmers who grow Apulian olive landraces in their farms in order to ensure the presence of typical products on the market, including PDO and PGI (table olives, pickled olives, extra virgin olive oil, olive paste, etc.)	Farmers	**450 (-1)** 1.000 (0) 2.000 (+1)
Protection of regional olive-growing landscape by the Apulian olive farmers through the cultivation of local varieties, preventing their disappearance	Landscape	**No (-1)** Yes (+1)
Possibility for scientific research of preserving Apulian olive landraces in gene banks in order to prevent their disappearance	Research	**No (-1)** Yes (+1)
Availability of Apulian olive landraces for future generations	Future Generations	**No (-1)** Yes (+1)
Contribution, lasting 10 years, to finance the protection of Apulian olive landraces (€)	Contribution	**0**, 5, 10, 20, 50

An important step in the CE survey design concerns the definition of the experimental design, given the excessive number of alternatives resulting from the combination of the selected attributes and their respective levels. In this regard, we carried out a D-efficient Bayesian design, which allows the maximization of statistical efficiency by minimising D-error. Therefore, starting from 120 possible alternatives (2^3x3^1x5^1), besides the “no choice” option, 24 profiles were generated in Ngene (version 1.1.2, Choice Metrics, Sydney, Australia). Afterwards, 12 choice tasks were assembled and subdivided in 2 blocks of 6. The creation of blocks, which is necessary as a large number of choice sets, could cause fatigue for the high cognitive demand on respondents[9], so that each respondent completed one randomly assigned block (Table 2). Finally, 700 interviews were planned, 350 for each block. They were stratified per province, on the number of citizens[10] and were used for investigating 700 citizens, no farmers, in Apulia in the period January-July 2015. Interviews were conducted face-to-face and lasted circa 40 minutes[11].

[9] Weller P., Oehlmann M., Mariel P., Meyerhoff J. 2014.
[10] Istat, 2010.
[11] The survey questionnaire was divided into three sections. The first section collected the opinions of respondents concerning some issues related to typical Apulian olive varieties, such as eating habits, knowledge about the risk of disappearance of such varieties, etc., by testing the importance given by the citizens to the observed environmental resource and the factors necessary for its protection and management. In the second section of the questionnaire on the economic evaluation, respondents were asked to make choices relating to possible regional strategies (action plans) aimed at the preservation and management of Apulian olive landraces, in the specific case of olive, taken as reference. Finally, in the third section a number of socio-economic questions were being provided for finding any correlation between WTP and characteristics (sex, age, marital status, income level, schooling level, working field, etc.) of the respondents.

Table 2 – *Example of choise set used in the face-to-face interviews.*

Attribute	Option A	Option B	No option
Farmers	2.000	450	I do not wish to participate in the regional conservation programme
Landscape	No	Yes	
Research	No	No	
Future Generation	Yes	No	
Contribution	€ 20	€ 10	

3.2. The statistical model

The WTP of the Apulian citizens for estimating the benefits provided by regional agro-biodiversity was estimated using a random parameter logit model (RPLM)[12], used as respondents may have heterogeneity in preferences. As the formulation of the resulting model does not have a closed-form solution for the estimation of the RPLM, simulated methods of maximum verisimilitude are used, so that:

$$P_{ij} = \int_x \frac{\exp\left(x_{ij}^{'}\beta_i\right)}{1+\exp\left(x_{ij}^{'}\beta_i\right)} f\left(\beta \mid \phi\right) d\beta \qquad (1)$$

where (β|ø) is the density function of β with ø refers to a vector of the density function parameters (mean and variance). Under this condition, the probabilities logit is approximated through βi values from f(βi|ø). Because Halton draws are an efficient alternative to the random ones[13], 200 Halton draws method was used in this study. Furthermore, a triangular distribution for the functional form of the functions of the density parameters was used. The estimation model was carried out using the NLOGIT 5 software.

As regards the calculation of WTP, that is the contribution that respondents are willing to pay for each proposed intervention, the following expression was used:

$$WTP_A = -\frac{\hat{\beta}_A}{\hat{\beta}_P} \qquad (2)$$

where WTP_A is the willingness to pay for the attribute A, while $\hat{\beta}A$ and $\hat{\beta}P$ are the estimated coefficients related to each intervention and contribution, respectively. The delta method was used for estimating WTP.

[12] McFadden D. 1974.
[13] Halton, 1960.

4. Multivariate analysis: evidence and deductions

The sample[14], characterized by a good statistical representation of the reference population (t-test significant at 5% for the variables of sex, married, age and schooling level), was constituted of subjects: 48% male, with an average age of 40, 65% married and, on average, with a high school diploma, with few of them employed in agriculture, with the annual household income amounted to18,000€, with 3 household members, 48% residing in urban centers with a population greater than 50,000, 19% residing in municipalities with a high olive growing vocation and 17% of them were farm owners.

On the whole, the variables' ranges show a considerable variation, concerning the socio-economic characteristics of the respondents. In order to capture this diversity, it was implemented a RPLM (Table 3) that is jointly presented with a mixed logit model (MXLM) only for comparative and exploratory purposes. From this it is possible, especially, to see how all the variables turn out to be highly significant (1%), demonstrating and confirming, therefore, the willingness of community to intervene for the protection and enhancement of the regional olive biodiversity. The alternative specific constants (ASC) also show a positive sign, indicating the intention of respondents to change the situation defined by the status quo, in line with expectations. It is also noted, as the signs of the variables related to the proposed interventions generate high interest, while the variable related to the monetary contribution has a negative sign, so that the WTP increases with decreasing the amount proposed. Regarding RPLM, for the choice of the random parameters the approach of Hensher et al. (2015[15]) was followed, which considers the significance of the obtained standard deviations from the implementation of different models of RPLM with different parameters. In addition, the model has a better fitting than the MXLM, as shown by LL, BIC, AIC and pseudo-R^2 indexes.

Although all the attributes were highly significant, the analysis showed, however, some heterogeneity among respondents depending of the proposed interventions. In particular, preferences appear to be substantially homogeneous in terms of research funding and the possibility of ensuring the resource in question to future generations, however, preferences towards supporting farmers and the protection of the landscape were more heterogeneous. With regard to the latter, it was decided to go to look for each of them at some socio-economic variables.

[14] A total of 679 complete and coherent questionnaires were collected, while 21 were discarded as respondents did not complete the choice tasks or gave protest responses at the end of section two.
[15] Hensher et al 2015.

Table 3 – *RPLM about restoration and redevelopment interventions.*

	MXLM				RPLM			
	Coefficient		Err.stand	z	Coefficient		Err.stand	z
					Nonrandom parameters in utility functions			
Farmers	0,548	***	0,048	6,59				
Landscape	1,470	***	0,092	8,64				
Research	0,883	***	0,085	5,57	1,115	***	0,064	7,92
Future Generation	0,682	***	0,033	6,28	1,369	***	0,186	4,79
Contribution	-0,018	***	0,006	-4,02	-0,012	***	0,009	-7,03
Asc1	1,303	***	0,057	3,94	1,241	***	0,091	5,12
Asc2	1,541	***	0,019	4,73	1,690	***	0,178	7,70
					Random parameters in utility functions			
Farmers					0,882	***	0,203	6,68
Landscape					2,390	***	0,328	9,25
Farmers					*Heterogeneity in mean - Parameter: Variable*			
Age					0,303	**	0,048	2,49
Schooling					0,261		0,172	0,80
Income					0,031		0,121	0,17
City > 50.000 citizens					0,768	***	0,052	5,88
Municipality with olive surface> 50%					0,600	**	0,028	2,68
Farm owner					0,428	**	0,158	2,30
Farmer household member					0,205	***	0,094	4,11
Farming ancestors					0,404	*	0,042	2,16
Consuming local products					0,882	*	0,194	2,00
Landscape								
Age					0,103		0,114	1,12
Schooling					0,297	**	0,014	2,33
Income					0,004	*	0,002	2,15
City > 50.000 citizens					0,841	***	0,021	5,89
Municipality with olive surface> 50%					0,514	*	0,041	2,01
Farm owner					-0,796	*	0,038	2,15
Farmer household member					0,092		0,005	1,77
Farming ancestors					0,169		0,028	0,94
Consuming local products					0,661	*	0,219	2,04
					Distns. of RPs. Std.Devs or limits of triangular			
Ns Farmers					0,417	***	0,021	7,13
Ts Landscape					0,215	***	0,172	5,47
Observations	4074				4074			
LL	-2371,33				-2013,50			
AIC	3210				2608			
BIC	2104				1831			
Mc Fadden pseudo-R^2	0,277				0,363			

***: sign. 1%; **: sign. 5%; *: sign. 10%.

This has highlighted how citizens, who are more willing to pay to support "custodian" farmers of Apulian olive landraces - characterized from high average age, residing in densely populated urban centers and with a utilized agricultural area (UAA) mainly devoted to olive growing and farm owners - have at least one member of the family dedicated to agriculture and are descended from farming people and consume food from typical regional varieties, while preserving local food traditions. As regards the protection of the rural landscape, however, the willingness to pay increases if citizens are educated, have a high income, are residents in large urban centers with a UAA mainly devoted to olive grove, are farm owners and consumers of typical regional olive products. Basically, in the first case they are citizens very close to the agricultural sector, even though they do not fully practice the profession and such closeness would tend to give more importance to the most microeconomic aspects (support to farmers) and then business. In the second case, they are citizens less close to the agricultural sector and such distance would tend to strengthen the interest in landscape and territorial aspects, which is amplified where olive growing is very widespread in the municipal territory of residence.

More generally, then, the consumption of olive products from local varieties tends to increase the interest in the proposed protection strategies.

It is interesting to observe as a whole how the coefficients calculated for each intervention and indicating the utility highlight a certain ranking in the preferences. In fact, the highest preferences are especially for operations related to the landscape and the lowest ones for the support of operators in the sector, while in the middle rank preferences for future generations and for scientific research.

The RPLM model, whose indicators revealed a better fit than the MXLM model, allowed as to proceed to the calculation of WTP (Table 4). Therefore, with regard to the contribution to be paid over the next 10 years, the WTP ranged from 67€ for interventions for "custodian" farmers and 207€ for those related to landscape preservation of the Apulian countryside.

Table 4 – *Average WTP for restoration and redevelopment (95% confidence intervals).*

Attribute	WTP €/year x 10 years
Farmers	67,20 (35,10-104,89)
Landscape	205,70 (108,23-292,77)
Research	87,93 (48,71-133,02)
Future Generation	120,81 (61,59 -177,92)

5. Conclusions

In this work the proposed approach to genetic erosion problem in the region has enabled us to evaluate and measure the economic resources available by Apulian citizens to participate in an agro-biodiversity conservation programme, exploring how some features of the programme can affect their availability. The utility of information obtained from this research is in the verification of suitability/validity of the conservation strategy in force, as well as in the possibility of providing support and suggestions as part of measures for future programmes. In particular, respondents believe that modern agriculture is causing the disappearance of Apulian olive landraces and the European Union's agricultural policy must provide for the payment of contributions to the Apulian farmers to continue to cultivate them. In addition, special importance is given by the respondents to the link between typical olive products and various aspects related to food health, environmental protection and historical-cultural regional identity. Regarding the strategy to be adopted for the protection of Apulian olive landraces, respondents deem necessary, in addition to the aforementioned regional / national subsidies to local farmers, measures for the promotion of food quality marks (PDO and PGI products) and sale of olives and typical Apulian oil on local markets (neighborhood markets, minimarket, supermarkets, hypermarkets, etc.). The evaluation exercise carried out in this study showed an important method based on a bottom-up approach, as it plans to involve the public opinion in identifying the best strategies for the protection, conservation and management of Apulian olive landraces. Valid information was provided to support the decision maker who should basically implement an agro-biodiversity management which should be environmentally sustainable, economically equitable, socially responsible and culturally sensitive. This is to protect the integrity of the environmental resource, taking into account, at the same time, the local activities and traditions.

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SUMMARY

Agro-Biodiversity: An Economic Evaluation of Benefits Provided by Apulian Olive Landraces to the Regional Community

The most important anthropogenic cause of the loss of agricultural biodiversity is the rapid change in land use and the subsequent transformation of habitats, a process stemming from the economic decisions of sector agents, with significant implications for biodiversity conservation strategies in agro-ecosystems.

The paper focuses on the olive sector of Apulia, Italy, one of the most important in the regional agriculture in terms of added value. In particular, it concerns the conservation of the local olive landraces based on the socioeconomic characteristics of regional citizens. Recognition of the social, economic and structural heterogeneity in community is important for estimating accurately predicting benefits and costs of agro-biodiversity management in the Mediterranean area. The paper allows studying these aspects by measuring, through a random parameter logit model, the monetary willingness of citizens of Apulia to participate in an on-farm agro-biodiversity conservation programme and by exploring how some programme attributes influence their willingness. This information can then be gathered in order to verify the suitability of the conservation strategy in force and to provide tailored references for future programmes.

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