Agro-biodiversity of Mediterranean crops: farmers' preferences in support of a conservation programme for olive landraces

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Abstract

The study focused on the willingness to participate in a conservation programme for olive landraces by farmers in Apulia, Italy. The choice experiment approach through a latent class model was carried out in order to investigate different characteristics of farmers which could increase the effectiveness and efficiency of conservation strategies by policy makers.

The analysis identified three groups of respondents, each of which with very different characteristics: capitalist farms with high profit level managed by farmers unwilling to take part in a conservation programme; small and fragmented family farms managed by older farmers fully in favour of the programme; young farmers with low capital input, but willing to engage with a minimum participation in the programme.

Policy implications suggest the need to develop markets able to appreciate the characteristics of the local olive oils, to involve farmers in marketing training programmes for a better placing of local products in the market, to support the young farmers and family farming, to set suitable policies which are able to trigger a more incisive involvement of women in conservation programmes.

Such a holistic approach could generate welfare for all agents of the supply chain, in terms of profit, environment, food security and nutritional aspects.

Keywords: Agricultural biodiversity; Apulia; Choice experiment; Latent class model; Olive landrace.

1. Introduction

A prime role in matters of agricultural biodiversity is held by landraces, i.e. local varieties of domesticated plant (but also animal) species that have adapted to the natural and cultural local environment (Pascual et al., 2013; Krasteva et al., 2009; Scholten et al., 2009). Their cultivation over the centuries in traditional systems enabled the production of food and forage, the minimization of risk and the stabilization of yields, the improvement of soil structure (Brussaard et al., 2007; Mahon et al., 2016), as well as the utilization of agricultural practices based on low levels of technology and inputs (Altieri, 2004; Jackson et al., 2013; Caldeira et al., 2001; Martin et al., 2009; Srivastava et al., 1996; Hammer and Diederichsen, 2009; Veteläinen et al., 2009; Xie et al., 2011), in particular water, fertilizers, pesticides and fuel. Furthermore, in modern agriculture, landraces could be used to develop, through plant breeding, new varieties with increased yield, quality production and resistance to a wider range of biotic and abiotic stresses (Mohammadi et al., 2015; Moreira et al., 2009; Cassman et al., 2003; Ceccarelli, 1996), also in response to the ongoing climate changes (Mercer et al., 2012; Vasconcelos et al., 2013; FAO, 2008), a threat particularly for the agricultural systems in southern Europe (Thuiller et al., 2005).

However, over the last decades, agricultural ecosystems in several areas of the world have increasingly lost their biological diversity based on local landraces for modern intensive cropping systems based on monoculture farming, in order to increase the global food supply through genotypes characterized by high yields, but also by high levels of inputs (Matson et al., 1997; Evenson and Gollen, 2003). The most important anthropogenic cause of this loss is the rapid change in land use, with subsequent reduction of habitat fragmentation and landscape complexity in agro-ecosystems and wild lands, as well as loss of traditional knowledge associated with the cultivation of the typical local varieties (MEA, 2005). This process stems from the economic decisions of sector agents, namely farmers, agribusiness and governments (Perrings et al., 2006), with significant implications for biodiversity conservation strategies in agro-ecosystems. In this regard, private land use decisions by farmers regarding the level of on-farm agro-biodiversity usually depend on food, fuel and fibre markets (Smale et al., 2001) and on the assessment of the private net benefits (Pascual and Perrings, 2007). Moreover, the market does not reward social benefits of crop genetic diversity and farmers have no private incentive to its conservation (Perrings, 2001; Meinard and Grill, 2011; Nunes and Van den Bergh, 2001).

One of the solutions consists of the realignment of private interests of farmers with those of society through a regulatory system, which allows creation of favourable conditions for the investment in agro-biodiversity conservation by farmers (Bellon, 2004; Narloch et al., 2013; Narloch et al., 2015; Wale, 2008; Smale et al., 2003; Bellon et al., 2015; Narloch et al., 2011). On this point, an effective and efficient agro-biodiversity conservation strategy involves (i) a detailed assessment of the financial resources for incentivizing the participation of farmers in on-farm conservation programmes and (ii) the way in which a programme design influences such participation. Indeed, the characteristics of a programme regard different groups of stakeholders (farmers), which typically exhibit different expectations in terms of benefits. Such a diversity of expectations requests information concerning the preferences of these groups, so that decision makers could create strategies able to avoid conflicts generated by non-fair compensations.

The assessment of incentives to farmers quantified on the characteristics of the conservation programmes is desirable as only decisions based on stakeholder's preferences and expectations can be used in agro-biodiversity conservation planning (Ruto and Garrod, 2009). These characteristics (attributes) can be investigated via an economic valuation, whereby monetary values are assigned to changes in the quantity/quality of the measured attributes related to farmer preferences. Information on these preferences enables better informed decision making through the setting of priorities and the highlighting of those attributes that affect stakeholders' benefits. A possible valuation approach could be based on the choice experiment (CE) method which, starting from the farmers' preferences, allows the outlining of better conservation strategies, resulting in policies more focussed to the needs of farmers and consumers. Moreover, such valuations can be used in broader benefit-cost analyses of public investment policies.

In this regard, the paper investigates i) the farmers' attitude to participate in an on-farm conservation programme for local olive landraces in Apulia, southern Italy, and ii) how the socioeconomic and structural farm characteristics of farmers influence their preferences for the programme. Due to the absence of market observations, we carried out a CE, a questionnaire-based stated preference approach that allows understanding of farmers preferences and the design of new agricultural markets (Lusk and Hudson, 2004; Windle et al., 2005). Based on conjoint analysis and discrete choice theory (Louviere and Woodworth, 1983; Train, 2009), it was applied for the first time for environmental goods (Adamowicz et al., 1994) at the beginning of the 90s. The CE is able to estimate the total economic value (TEV), inclusive of use and non-use values which, in the case of environmental goods such as agro-biodiversity, are often prominent compared to the first ones (Provins et al., 2008). Unlike contingent valuation (Rocchi et al., 2016; Krishna et al., 2013), another stated preference method in which respondents are invited to express themselves on just two alternatives (status quo and hypothetical scenario), the CE is based on more hypothetical scenarios in choice tasks, properly selected from all the possible ones according to statistical design principles. Each choice task is constituted of alternatives, defined by different combination of attributes and respective levels. Hence the researcher asks respondents to choose, for each choice task, the preferred alternative, i.e. the one which gives the greatest relative utility, in order to reveal their preferences (Hensher et al., 2015). The aim is the assessment of the importance (weight) that respondents place on each of the attributes, which define the alternatives. When applied to agricultural producers, CE offers an alternative to the profit maximisation paradigm, particularly in the presence of risk (Barry et al., 2009; Robison, 1982).

Several recent CE studies were carried out on the potential supply of environmental services by farmers (Asrat et al., 2010; Birol and Rayn Villalba, 2006a; Beharry-Borg et al., 2013; Broch et al., 2013; Christensen et al., 2011). In this paper we measured the willingness to accept (WTA), which in a CE study can be less liable to strategic bias (Burton, 2010; Schläpfer and Fischhoff, 2012), overall if respondents have a high degree of familiarity with the good in hand, as well as with the participation to government programmes for the provision of environmental services (Romy et al., 2014).

The paper contributes to the literature in two ways. First, no applied economic study investigated the determinants of farmers' preferences and farms' structure for the conservation of Mediterranean plant species in general, and in Italy in particular. Second, this study adds to the growing literature that employs the CE method to estimate the farmer valuation of Mediterranean agro-biodiversity components (Ndjeunga and Nelson, 2005; Birol et al., 2006b). Findings have implications for debates concerning the conservation of Mediterranean species and associated costs and benefits, allowing verification of the suitability of conservation strategies in force and the designing of future ad hoc and cost-effective on-farm programmes.

2. Olive biodiversity in Apulia

The world olive production is ca. 20 million tonnes yr^{-1} on 9.6 million hectares. In particular, 97% of production and 92% of area are in the Mediterranean countries, among which Italy is the second most important producer (16% of production on 12% of area), behind Spain and followed by Greece (FAOSTAT, 2011).

In Italy, Apulia has 33% (373.000 hectares) of the national olive area and 30% (1 000 000 tonnes) of the national olive production (ISTAT, 2010), confirming its leading role in the olive sector of the country. In this region the olive tree is perfectly adapted to the local climate and produces high quality olive oil (Fontanazza, 2005), thus making this cultivation an important economic and employment resource. Moreover, the high number of farmers and the limited availability of land has led, over the past years, to the establishment of a significant number of small-sized farms of less than 1 hectare (ISTAT, 2010), often based on a family management.

This structural characteristic, indeed common to several territories in southern Italy, fostered an olive oil production based mainly on local varieties, contributing to the maintenance of the regional agro-biodiversity (Corrado et al., 2011). In this connection, Italy holds the largest number of olive collections (17% of 2,629), followed by Spain, Iran and USA. Besides, there are ca. 600 olive cultivars (Bertolini et al., 1998), mostly cultivated in limited local areas, while in Apulia, in the last years, 75 olive landraces have been recognized (Apulia Region, 2015; pp. 697-698) and further 45 are cited in bibliographies but not yet identified (INEA, 2013).

The 2014-2020 Rural Development Programme of Apulia (Apulia Region, 2015) provides funds to farmers in order to incentivize the on-farm conservation, reintroduction and production of cereal, legumes, fruit, olive, vine and horticultural landraces (sub-measure 10.1.4). These varieties are contained in a proper regional register and have been selected on the basis of the genetic erosion risk (two classes). It concerns the speed by which the genomic variety is lost and is calculated with reference to the greater difficulty for farmers in finding the reproductive material and to the lack of demand. The premium per hectare/year is supplied to farmers who undertake to cultivate the local varieties for at least five years. For the olive landraces (listed in the Rural Development Programme, pp. 697-698), the monetary aids are 153 € ha^{-1} (risk level 1) and 161 € ha^{-1} (risk level 2). The payment is calculated on the additional costs and income losses consequent to the cultivation of the local varieties with respect to the ordinary ones.

3 Materials and methods

3.1 The questionnaire

The survey questionnaire was divided into three sections. The first one collected the farmers' opinions about some issues related to the Apulian olive landraces, such as farming technique, market preferences, knowledge about the extinction risk, possible interventions for their conservation, etc. At the end of the first section, respondents were informed about the current state of the genetic erosion of the regional olive biodiversity. Therefore, the importance for its conservation was argued in order to benefit sustainable agriculture, environmental protection, food security and the promotion of the historical and cultural aspects for current and future generations. Illustrative material about some olive landraces was shown.

In the second section, respondents were asked to make choices about possible action plans aimed at preserving the local cultivars. For each choice task a question was inserted in order to investigate the certainty of choice on a 0-5 scale. The section ended with a question about the reasons behind the respondents' choice in order to identify protest answers, strategic attitudes, etc.

Finally, the third section contained socioeconomic and structural questions on the farmers and their own farms (sex, age, marital status, education level, farm characteristics, farming experience, gross margin, machinery value, operating costs, etc.).

In this way, the analysis of farmers' attitude in relation to their participation in the conservation programme focused on two aspects (Romy et al., 2014). On one hand the characteristics of the programme, captured as attributes in the choice tasks, on the other the farm and personal characteristics of respondents gathered through the third section of the questionnaire. The latter ones were used in the model specification in order to investigate their influence on the participation programme and to detect any source of heterogeneity.

3.2 The choice experiment and the survey design

In this study, because of the considerable sample size (Flynn et al., 2007), we applied the "pick-one" responses' format which, capturing the first preference, resembles real life decision-making. On the number of alternatives, which has the second largest influence on error variances out of all design dimensions (Caussade et al., 2005), a 3-alternative design (with the "no option") was adopted as it seems to generate more participation compared to a 2-alternative design (Rolfe and Bennett, 2009). The insertion of the "no option" also ensured conceptual validity of the design for the voluntary nature of participation in a payments-for-agro-biodiversity programme. The alternatives were unlabelled (Louviere et al., 2000) in order to better investigate the role of attributes by farmers. Moreover, unlabelled alternatives seem to increase attention of respondents (de Bekker-Grob, 2009).

The attributes and their levels (Table 1) were selected through 4 focus group meetings (each of circa 50 minutes) involving olive oil growers (3) and trade-union organizations (2). The meetings were conducted in four Apulian municipal territories with the highest olive utilised agricultural area (Andria, Bitonto, Cerignola and Ostuni; ISTAT, 2010). The objectives concerned the illustration of the research framing and the definition of the attributes and respective levels for the settlement of a programme bent on the conservation of the olive landraces in Apulia. Noteworthy is the typology of the attributes. In particular, the first two concerned some intrinsic farm characteristics (number of landraces and farm share dedicated to landraces), while the other two related to the characteristics of the hypothetical conservation programme. In this regard, the duration and the option of avoiding the participation were considered by the farmers as crucial elements of the programme. Since the monetary attribute has also a large influence on model outcomes (third largest influence on error variances out of all design dimensions; Caussade et al., 2005; Romy et al., 2014), the compensation levels were anchored to the calculation of the gross margin from the regional olive groves in the period 2010-2015.

Table 1
Attributes and levels used in the choice experiment (the first level corresponds to the status quo).

Attribute	Definition	Levels
Olive landraces	Number of olive landraces cultivated in farm	0, 1, 2, 3
Farm share	Surface of farm used for the conservation programme (%)	0, 25, 50, 100
Duration	Duration of the conservation programme (Years)	0, 5, 10
Avoidance	Option to suspend the conservation programme	No, Yes
Remuneration	Annual payment received (€ ha^{-1})	100, 200, 300, 400, 500

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, while orthogonal designs are more prevalent in the literature, efficient designs have recently emerged leading to smaller standard errors in the model estimation (Bliemer and Rose, 2010; Bliemer and Rose, 2011). Furthermore, efficient designs are easier to find, often enabling much smaller designs in terms of number of choice sets. In this study we produced a D-efficient Bayesian design (Jaeger and Rose, 2008), which allowed the maximization of statistical efficiency by minimising D-error. Therefore, starting from 480 possible alternatives (2^1x3^1x4^2x5^1), besides the "no choice" option, 42 profiles were generated in Ngene (version 1.1.2, ChoiceMetrics, Sydney, Australia). Afterwards, 21 choice tasks were assembled and subdivided in 3 blocks of 7, so that each farmer completed one randomly assigned block (Table 2). The creation of blocks is necessary as a large number of choice sets could cause fatigue for the high cognitive effort of respondents (Weller et al., 2014). Finally, 600 interviews were planned, 200 for each block. They were stratified per province, on the number of olive-growing firms and on the related size classes (ISTAT, 2010).

Another critical aspect in choice modelling concerns the consistency between hypothetical and real choices (Hensher et al., 2012), which are assumed to be identical in theory. For this reason, a supplementary question was inserted at the end of each choice task (Brouwer et al., 2010) for investigating the certainty of the choice on a scale from 0 (very unsure) to 5 (very sure). In this way it is possible to account for the risk that respondents might attach to the choice of an alternative, improving the predictive power in the choice model (Hensher et al., 2012; Romy et al., 2014).

We used this overall design to survey 600 olive oil growers in Apulia in the period January-July 2015. Interviews were conducted face-to-face and lasted circa 40 minutes. Feedback on survey design, attributes and levels was gathered following each survey. However, a total of 587 complete and coherent questionnaires were collected, while 13 were discarded as respondents did not complete the choice tasks or gave protest responses at the end of section two.

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

Attribute	Option A	Option B	No option
Olive oil landraces	3	1	Neither A nor B.
Farm share	50%	25%	I do not want
Duration	5 years	10 years	participate to the
Avoidance	No	Yes	regional
Olive oil commercial brand	Yes	Yes	conservation
Remuneration	€ 400	€ 200	programme

3.3 The statistical method

The econometric analysis was carried out through the latent class model (LCM). This approach, originally introduced by Lazarsfeld and Henry (1968), was extended by Goodman (1974) through the development of the maximum likelihood (ML) algorithm (Vermunt and Magidson, 2004).

In this study, LCM allowed the performance of simultaneously sample segmentation and segment-specific estimation of model parameters. The identified segments highlighted different farmers' preferences and sensitivity to the price of the proposed conservation policy in connection with socio-demographic and attitudinal farmers' characteristics, as well as with farms' economic elements, with crucial policy implications (Wedel and Kamakura, 2000). This approach is possible because the LCM considers farmers heterogeneous in their preferences. In particular, it assumes that farmer's behaviour depends on additional factors beyond those that are directly observable (individual and farm characteristics). It captures preference heterogeneity across classes, i.e. segments of respondents, but assumes homogeneous parameter estimates within each class (Greene and Hensher, 2003). However, the LCM does not make any assumption on the form of the underlying heterogeneity, instead it assumes that individuals are implicitly sorted into a series of Q classes, with the classification unknown (i.e., unobserved) for a particular individual.

In formal terms and on the basis of the random utility model (RUM), the utility (U) of a good can be expressed by an indirect utility function consisting of a deterministic component (V), related to observable attributes of the good, and a random error term component (ε), concerning all non-observable features that affect the choices of farmers (Luce, 1959; McFadden, 1973). Hence, for the farmer i and the observed alternative j:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad [1]$$

The farmer i will choose the alternative j if $U_{ij} > U_{ik}$, $\forall$ $j \neq k$, and the probability of this choice is expressed as:

$$\pi_{ij} = \Pr ob\left(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik} \;\; j \neq k, \; \forall k \in J\right) \qquad [2]$$

On the basis of the logit form, the conditional choice probability of finding the farmer i in the class q for the observed alternative j is:

$$\pi_{ij|q} = \frac{\exp\left(\beta_q' x_{ij}\right)}{\sum_{q=1}^{Q} \exp\left(\beta_q' x_{ij}\right)} \qquad [3]$$

where x_i denotes a set of characteristics that are associated with class membership and β_q are specific class-related coefficients to estimate (Boxall and Adamowicz, 2002). The conditional probability that farmer i chooses the alternative j is:

$$\pi_{ij} = \sum_{q=1}^{Q} \pi_{iq} \;\; \pi_{ij|q} \qquad [4]$$

Finally, in order to best explain the choices of farmers, the estimation of the parameter values is carried out through the maximization of the log likelihood function:

$$\ln L = \sum_{i=1}^{N} \ln \left[\sum_{q=1}^{Q} \pi_{iq} \left(\prod_{t=1}^{T_i} \pi_{it|q} \right)^{y_{ij}} \right] \qquad [5]$$

where y_{ij} is one or zero if farmer i chooses the alternative j or not, respectively.

The LCM specifications were estimated using NLOGIT version 5. For the choice of the number of classes, the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and the Bozdogan AIC (AIC3) were used.

On the calculation of the WTA for each attribute, i.e. the price premium that farmers are willing to accept for adopting a specific characteristic of the proposed conservation policy, if the utility is a linear function of all attributes, the WTA for an attribute level in the latent class q was calculated as:

$$WTA_A^q = -\left(\hat{\beta}_A^q / \hat{\beta}_P^q\right) \quad [6]$$

where WTA_A^q was the price premium accepted for the preferred level of attribute A in the class q, while $\hat{\beta}_A^q$ and $\hat{\beta}_P^q$ were the estimated coefficients of the proposed policy and premium attributes. For binary attributes, the marginal implicit price formula became (Hu et al., 2004):

$$WTA_A^q = -2\left(\hat{\beta}_A^q / \hat{\beta}_P^q\right) \quad [7]$$

In order to relax the assumption that WTA is symmetrically distributed (Hole, 2007), 95% confidence intervals for WTA estimates were created by the parametric bootstrapping technique proposed by Krinsky and Robb (1986). It was based on the simulation of a distribution of 1,000 observations for each WTA estimate by figuring out a normal distribution on the basis of coefficients and variances obtained from the models. Results are analogous to those of the delta method.

4 Results

4.1 Sample characteristics

The sample was constituted, on average, of male and married growers, with 3 household members, 9 years of schooling and an experience level of 27 years (Table 3). The farm size was 2.5 hectares, constituted by 3 plots. Olive landraces were present in 32% of farms and in just 25% of them was practiced the organic farming. The machinery had an actual value of 10,000 € ha^{-1}, the gross margin was circa 1,000 € ha^{-1} yr^{-1} and 18% of owners had an off-farm income. In past years, 31% of farmers benefited of EU aids and 1 farm out of 2 was located in areas with intensive agriculture, according to the classification of the Apulia 2014-2020 RDP. Finally, referring to the main three regional macro areas of the olive sector, the sample appeared quite balanced compared to the number of farms (ISTAT, 2010).

On the whole, the variables' ranges showed a considerable variation, concerning both the socio-economic characteristics (level of schooling and farming experience) and some important structural elements of the sampled farms (farm size, number of plots and machinery value). For this reason a LCM was implemented as to better understand the nature of this heterogeneity.

Table 3

Descriptive statistics of the CE variables.

Variable	Code	N.	Mean	Std. Dev.	Min.	Max.
Male (Yes/No)	Male	587	0.71	0.12	0	1
Married (Yes/No)	Married	587	0.72	0.24	0	1
Household size (n.)	Household	587	3.13	0.20	1	5
Level of schooling (year)	Schooling	587	9.56	2.89	5	19
Experience in olive growing (years)	Experience	587	27.30	5.62	2	48
Farm size (hectares)	Farm	587	2.46	2.90	1.14	22.37
Number of plots	Plots	587	3	0.71	1	8
Landraces in farm (Yes/No)	Landraces	587	0.32	0.08	0	1
Organic farming (Yes/No)	Organic	587	0.25	0.12	0	1
Machinery value (€ ha^{-1}) *	Machinery	587	10,230.12	3,447.21	6,290	23,920
Gross margin (€ ha^{-1} yr^{-1}) **	Margin	587	1,074	205.60	617	2,101
Off-farm revenue (Yes/No)	Off-farm	587	0.18	0.02	0	1
Past EU aids (Yes/No)	Aid	587	0.31	0.10	0	1
Olive groves of farmer in intensive agriculture area (Yes/No) ***	Intensive	587	0.49	0.13	0	1
Easy credit access	Credit	587	0.29	0.10	0	1
Foggia area	F	182			0	1
Bari area	B	196			0	1
Brindisi-Taranto-Lecce area	B-T-L	209			0	1

* Another economic variable, namely the recourse to extra-family labour, was investigated but it was kept out by the analysis for the high correlation with the machinery value.

** Gross margin corresponds to revenues minus operating costs, these latter defined as: specific costs (fertilizers, pesticides, water, etc.) and other non-specific operating costs (upkeep of machinery, energy, contract work, taxes on land and buildings, etc.).

*** From the classification of the Apulia 2014-2020 RDP.

4.2 CE results

Consistent with our hypothesis, for which different groups of farmers have different preferences for conservation strategies, the latent class analysis revealed distinct segments, whose number selection was based on several criteria. In particular, BIC was minimised at three segments, while AIC and AIC3 highlighted improvements at four and five segments (Table 4).

Table 4

Measures of model fit for the Multinomial logit (MNL) and Latent Class Models (LCM).

Model	Log-Likelihood	AIC [a]	BIC [b]	AIC3 [c]
MNL	-3928.11	7878.22	3963.17	7889.22
LCM2	-3739.72	7533.44	3825.78	7560.44
LCM3	-3510.56	7107.12	3647.62	7150.12
LCM4	-3475.47	7068.94	3663.53	7127.94
LCM5	-3450.26	7050.52	3689.32	7125.52

[a] Akaike information criterion: -2(LL-P)

[b] Bayesian information criterion: –LL+(P/2) * ln(N)

[c] Modified Akaike information criterion (Bozdogan AIC): -2LL + 3P

However, these last two marginal improvements were very small and the respective models included classes with no significant utility coefficients, unlike the three-segment model selected by BIC. Moreover, Andrews and Currim (2003) pointed out that BIC does not over-fit, unlike AIC. Besides, over-fitting causes greater parameter bias than under-fitting. Hence the model with three classes was selected.

For comparative purposes, a multinomial logit model (MNL) was carried out, in which respondents were treated as a homogenous group and all attributes had a significant effect on choices (Table 5). Noteworthy was the positive sign of the remuneration variable as indicating WTA, in line with expectations. Besides, the ASC (alternative specific constant) was positive and significant, indicating respondents wanted changes in the current state.

On the LCM, instead, the analysis highlighted three groups of farmers. The first one identified respondents with no conservation attitude (LCM1), equal to 32% of the sample. For this group most of attributes and levels were non-significant. The attitude for the conservation programme was expressed just for the cultivation of 1 olive landrace on the 25% of the farm, variables however with a low significance (0.10). On the contrary, this group expressed evident and certain aversion for the involvement of the whole farm in the programme, as well as in the case of a 10-year conservation programme. The only attribute with a high and positive preference regarded the possibility to avoid the participation to the programme. However, the positive and significant ASC pointed out respondents wanted changes in the current state. Looking at the socioeconomic variables of farmers, as well as to the structural characteristics of their own farms, the group included respondents with a good level of farming experience and a considerable farm size, basically not fragmented. Landraces were never cultivated in farm and organic farming was never practiced. These firms were characterized by high machinery value, considerable contribution of extra-family labour and high annual gross margin. The total revenue derived solely by the olive-growing activity in farm. Besides, these firms were located in the northern intensive-agriculture areas of the region, obtained CAP (Common Agricultural Policy) aids in the past and periodically had an easy credit access, mainly for capital renewal. Overall, the group was characterized by intensive farms with high contribution of capital and high production and profit levels, so that they were well placed in market. The cultivation of local landraces was considered as a probable cause of income losses and farmers' strategy was focused on the massive recourse to labour and capital productive factors.

The LCM2 group (52% of respondents), on the contrary, showed a considerable attitude toward the conservation programme, hence with opposite characteristics compared to the first group.

Table 5
Multinomial logit (MNL) and Latent Class Model (LCM) estimates of utility functions.

	MNL			LCM1			LCM2			LCM3 (reference class)		
Class probability				0.317			0.525			0.158		
	Coeff.	t		Coeff.	t		Coeff.	t		Coeff.	t	
Utility function												
Olive landraces 1	0.929	7.21	***	0.596	2.10	*	0.823	2.41	**	0.504	2.39	**
Olive landraces 2	0.728	2.32	**	0.792	1.58		1.472	8.49	***	0.862	1.48	
Olive landraces 3	0.380	2.09	*	-0.326	-1.67		1.047	2.38	**	0.262	1.03	

Farm share 25	0.719	2.39	**	0.311	2.05	*	0.114	0.94		0.915	2.55	**
Farm share 50	0.934	2.61	**	0.214	0.22		0.882	3.55	***	0.491	0.52	
Farm share 100	0.201	2.30	**	-1.669	-2.63	**	0.325	2.60	**	0.333	1.13	
Duration 5	0.739	2.28	**	0.757	1.07		0.290	2.28	**	1.265	2.79	**
Duration 10	0.279	1.96	*	-0.902	-2.13	*	0.613	2.32	**	0.201	1.51	
Avoidance	0.634	5.88	***	0.865	5.33	***	-0.012	-2.77	**	0.713	6.91	***
Remuneration	0.004	7.02	***	0.008	2.70	**	0.005	6.25	***	0.004	5.90	***
ASC	1.293	6.43	***	1.182	6.27	***	1.773	7.44	***	1.003	7.20	***
Segment probability function												
Male				0.582	1.05		-0.361	-2.06	*			
Married				0.273	0.72		0.123	0.41				
Household				0.592	1.02		-0.447	-1.09				
Schooling				0.460	2.10	*	-0.237	-2.51	**			
Experience				0.595	2.66	**	0.907	6.24	***			
Farm				0.727	5.55	***	-0.635	-2.60	**			
Plots				-0.830	-6.12	***	0.721	4.02	***			
Landraces				-1.202	-5.81	***	0.879	5.92	***			
Organic				-0.733	-2.30	**	0.793	4.71	***			
Machinery				0.931	1.95	*	-0.872	-2.74	**			
Margin				1.036	6.83	***	-0.557	-3.11	***			
Off-farm				-0.356	-1.26		-0.680	-1.88	*			
Aid				0.442	2.41	**	0.215	4.79	***			
Intensive				0.892	2.44	**	0.183	0.93				
Credit				0.936	1.80	*	-0.450	-2.65	**			
F				0.137	1.95	*	-0.597	-1.14				
B				0.224	2.13	*	-0.492	-0.81				
B-T-L				-0.240	-3.11	***	0.448	2.06	*			
Obs.	4,109							4,109				
McFadden pseudo-R^2	0.22							0.36				

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

The positive and significant ASC revealed the respondents' willingness to change the current state, i.e. in moving from the status quo. The variables concerning attributes and levels were highly significant and bent on the conservation of the olive landraces. In particular, farmers were mainly willing to the cultivation of 2 landraces on the 50% of the farm. The presence of 3 local cultivars on the whole farm, instead, generated a reduction of preferences, while the involvement of just 25% of farm in the programme was not considered important. Interesting was the attribute concerning the programme duration, whose levels caused great interest, overall for the 10-year programme. Finally, the possibility of avoiding the participation to the programme was negatively considered by farmers. About the socioeconomic and structural characteristics, these respondents had good experience in farming and lower years of schooling. It was also interesting to observe the gender variable (sign. 0.10), according to which the female entrepreneurs had a better attitude in the conservation programme.

The farm surface was rather small and fragmented, often cultivated by organic farming. On the contrary, the machinery value and the gross margin were lower and the income derived exclusively from the farming activity. Also these firms, located in the southern provinces of the region, benefited of the CAP aids in the past, but their access to credit was difficult or even absent. Overall, this group was made up of elderly farmers, which managed small family farms and were less prone to farming and technological innovations, so that the contribution of capital was very small. However, these respondents were aware of the problem and were very responsive to the conservation of the typical olive landraces, providing their own land for the conservation of this natural, economic and historical resource.

Finally, the LCM3 group (16% of respondents) was a reference class characterized by farmers with a good inclination towards the change in the status quo through the conservation programme (ASC positive and significant), but clearly preferred lower levels of the proposed attributes. In particular, these farmers were willing to cultivate just 1 olive variety on 25% of their own farms for 5 years, on condition, however, that the participation could be avoided. They were younger farmers with low experience operating in small farms in which olive landraces were cultivated and organic farming often practiced (sign. 0.10). Their agricultural activity was not profitable, so that off-farm earnings represented an important economic component. Besides, these farms benefited of EU premiums in the past, but their access to credit was difficult.

The remuneration variables in all 3 classes were positive and significant, as expected (WTAs). Table 6 shows the benefit measures for the models considered in the study. In this regard, the WTA for the conservation policy was 235 € ha^{-1} yr^{-1} for the MNL model and 291 € ha^{-1} yr^{-1} for the highest utility level in LCM2. For the other two classes, the welfare measure varied from 75 € ha^{-1} yr^{-1} for LCM1 to 126 € ha^{-1} yr^{-1} for LCM3.

Table 6

Mean WTAs (€ ha^{-1} yr^{-1}), with 95% confidence interval in parenthesis.

	MNL	LCM1	LCM2	LCM3
Olive landraces 1	235.4 (119.3, 346.9)	75.7 (39.2, 101.7)	165.5 (94.4, 212.7)	126.1 (54.6, 182.9)
Olive landraces 2	186.2 (99.1, 267.5)		291.4 (211.3, 352.4)	
Olive landraces 3	91.8 (44.1, 130.7)		230.6 (129.8, 311.3)	
Farm share 25	178.3 (91.3, 262.8)	41.6 (22.5, 58.7)		224.6 (127.0, 302.2)
Farm share 50	234.6 (115.0, 324.7)		173.0 (91.7, 268.8)	
Farm share 100	55.6 (23.6, 72.4)	-202.5 (-112.3, -275.7)	80.5 (46.2, 110.4)	

Duration 5	180.9 (95.2, 261.7)		59.6 (28.5, 88.8)	321.8 (161.4, 412.0)
Duration 10	69.4 (38.8, 103.6)	-115.6 (-68.5, -180.9)	118.5 (64.4, 185.7)	
Avoidance	151.6 (72.2, 201.4)	109.0 (53.4, 148.3)	-2.2 (-3.1, -0.5)	182.5 (90.4, 251.6)

4.3 Discussion and policy implications

The analysis highlighted important issues concerning the conservation strategy of the olive landraces in Apulia. Firstly, the valuation approach showed the presence of 3 different groups of stakeholders that managed as many farm types, namely middle-aged farmers in high-intensive farms, aged farmers in family farms, and young farmers in low-capital farms.

Among these groups, sensibility on the olive biodiversity was substantially different. In the large capitalist farms of the northern Apulia (LCM1) the interest in the protection programme was substantially absent, in spite of the positive and significant ASC. Moreover in the first section of the questionnaire, 85% of farmers in the group were aware of the need to pursue conservation strategies for the regional olive biodiversity. So, the aversion to the programme could be justified by the absence of a market concerning the olive oils obtained from the local cultivars. Indeed, these ecotypes are often characterized by lower yields and the respective olive oils are sold within the same commercial channels of products obtained from traditional varieties, so that profit is lower. A solution could follow from the investigation of specific omics and nutraceutical properties of these products or their promotion for the lower environmental impacts required in the cultivation phases, in order to ensure the development of new markets and therefore higher profit for producers. It follows that the study of biological aspects of the olive oils obtained from local varieties, jointly with the development of appropriate marketing plans also based on characterization, traceability and authentication (Pinelli et al., 2003; Reboredo-Rodríguez et al., 2016; Laincer et al., 2016), could contribute to a more profitable involvement of the intensive farms. Hence, it would be appropriate on one hand the development of new research in the biological and transformation fields (characterization of the typical olive oils and analysis of their nutritional properties), on the other hand the carrying out of ad hoc marketing strategies promoted by policy makers and to which farmers must be trained.

Olive growers who managed family farms in the southern Apulia (LCM2) were the most favourable to the participation in the landraces' conservation. Willing to allocate 50% of their own land also for a ten-year programme, their WTA was 291 € ha^{-1} yr^{-1}, higher than the premium quantified by the Apulian 2014-2020 RDP. These results is substantially in line with other studies carried out in Italy (Negri, 2003) and in other countries (Trinh et al., 2003), for which local varieties are mostly grown by elderly farmers in small farms or home gardens through traditional farming systems characterized by a low use of technology and chemical fertilizers.

Finally the young regional farmers (LCM3) had certain sensitivity to the conservation programme of the local olive germoplasm, so that the ASC of this group was highly positive and significant. However they agreed only on the base levels of the proposed attributes. This attitude could derive from the weak economic performance of their own firms, the structural crisis of the Italian olive sector and the high risk level consequent to the absence of an olive oil landraces' market capable to appreciate benefits of products obtained from the local varieties, as pointed out for the LCM1 group.

With regard to the characteristics of respondents and their own farms, the study showed a higher sensitivity of women entrepreneurs operating in family farms in the conservation programme (LCM2), contributing thus to enrich the evidences on the essential role of women in the agricultural enterprises (Hill and Vigneri, 2009; Abdelali-Martini et al., 2008; World Bank, 2009). In particular, their exact impact is often difficult to assess for its high degree of variation across countries and regions, so that policies must be based on sound data and gender analysis (FAO, 2011). On this aspect, this study provides basic information to valuate where and how much the women participation in agriculture can contribute to a better implementation of the conservation policies for the olive biodiversity. In addition, there was a significant influence of land fragmentation on the conservation of local landraces. Non-fragmented farms are characterized by a high provision of capital and inputs (LCM1 group), generating an intensive agriculture more attentive to income aspects rather than to environment, local traditions, etc. Studies in this research field show that such a management approach ensures greater results in terms of economic efficiency (Theesfeld, 2005; Dirimanova, 2006). On the contrary, land fragmentation reduces farm profitability and efficiency, but, on the other hand, fosters crop diversification (Di Falco et al., 2010). This phenomenon is present in the LCM2 group, characterized by small and fragmented farms in which are also cultivated local landraces, often by organic farming. Hence, olive growers of small and fragmented farms are prone to conservation strategies. However, as aforesaid, also farmers in the LCM1 group could be important actors in the conservation programme if suitable marketing plans are developed and farmers are properly trained on them, so as to ensure the participation and the economic efficiency of the capitalist farms in the presence of olive landraces.

Overall, the relevance of results lies in the importance that farmers give to the local landraces in the Mediterranean area, providing useful information for increasing the effects of proper on-farm conservation programmes. Indeed, the value of local varieties is not limited just to the private farmer's profit, but it concerns also a wide set of quasi-public benefits, i.e. positive externalities, in term of production, environment, food safety and cultural heritage (Pascual et al., 2013; FAO, 2010; Varshney et al., 2010). In this respect, findings allow for the advancement of further considerations on some environmental issues, i.e. water stress tolerance and pest resistance, that in the region are playing an important role overall in recent years. On the first aspect, Apulia is the fifth most important agricultural region in Italy in terms of irrigated area and volumes of water used for crops (ISTAT, 2010). This implies a substantial water demand which, however, is not being satisfied by the several regional consortia as their provided volumes are equal to just 31% of uses and 23% of the total estimated demand (INEA, 2009). Such a structural condition compels most of farmers to make use of groundwater which, if exacerbated, entails negative alterations of soil and crops characteristics, with consequent risk of desertification. Indeed, this threat is shared with other southern Italian regions and Mediterranean countries (Sikaoui et al., 2007) and the evaluation of possible water saving strategies is essential for ensuring the optimal use of allocated water. Hence, the implementation of suitable conservation programmes for local olive landraces could preserve and foster related olive farming practices characterized by a higher water-use efficiency. The second aspect concerns an important and recent regional matter, namely the need of carrying out effective and efficient pest control strategies in the light of the rapid spreading of *Xylella fastidiosa* subsp. *Pauca*. It is a quarantine bacterium able to cause the death of olive plants, initially detected in the olive trees of the Lecce province and now spreading toward the north of the region (Martelli et al., 2016). Recent and pioneer studies on the most widespread olive varieties in the affected area (Leccino and Cellina di Nardò) have effectively highlighted interesting differences between these cultivars on the resistance to the pathogen (Saponari et al., 2016; Saponari et al., 2014). Besides, the experimentations involving local landraces are about to start and its results could be used by decision makers and farmers in the prospect of a positive solution of this serious situation which is threatening the olive sector not only in Italy but also in the entire Mediterranean area. Obviously, a crucial role will be held by research, supported by farmers which have already expressed a positive consensus on that matter. Finally, the results could suggest proper considerations on the use of the super-intensive olive orchards in Apulia and, more in general, in the Mediterranean areas characterized by a rich agricultural biodiversity. Based on more productive and exotic varieties (Arbequina, Arbosana and Koroneiki), this system typology is being promoted in Apulia in recent years as, through the higher density of plants per hectare (ca. 1,700) compared to the traditional systems (ca. 400), it allows similar yield but a reduction of operating costs (ca. -20%), increasing profits. However, it is characterized by higher input quantities (water, pesticides and fuel) and environmental impacts (De Gennaro et al., 2012). Furthermore, it could simplify the mosaic structure of the agricultural ecosystems at the basis of the typical regional landscape, whose complexity is recognized as crucial for the on- and off-farm conservation strategies (Jackson et al., 2013; Perrings, 1998). Besides, it could trigger the conversion to monoculture and, if extended on large areas, this crop system could worsen pest control strategies and amplify pest damage in crops (Matson et al., 1997; Bianchi et al., 2006). Hence, a deeper decision making should be made on the opportunity to resort to such a productive solution on regional scale in the light of the risk to which olive biodiversity, in addition to environmental and landscape preservation, could be exposed.

5 Conclusions

The LCM singled out three very different groups of farmers, namely capitalist (in large and high-profit farms), aged (in small and family farms) and young (in small and low-capital farms) olive growers with very different levels of sensibility to olive landraces conservation. Outcomes highlighted that age, schooling level, gender and experience of farmers strongly affect the structural, management and productive characteristics of olive firms in terms of farm size, varieties cultivated, level of productive factors (labour, machinery, pesticides, fertilizers, water, etc.), profit, access to credit, use of organic farming, etc. These aspects, in turns, influence the farmer's propensity to the conservation programme, so that the final degree of participation results from the combination of the aforesaid characteristics. Being this the starting point, really very heterogeneous, anyway there are concrete possibilities to converge all olive growers in an effective and efficient conservation strategy through targeted interventions based exactly on the mentioned structural, management and productive aspects. Hence, the general need to include socioeconomic characteristics of farmers, as well as economic elements of their own farms in studies bent on the setting of agro-biodiversity conservation programmes, should be strongly considered by policy makers.

For the aim of this study and according to outcomes, a proper conservation strategy in the examined area should provide for (i) the development of new markets able to appreciate the characteristics of the typical olive oils, ensuring higher profits to olive growers; (ii) the boost of genetic and transformation research fields in order to study the nutraceutical properties of local products which could be used in market strategies based, for example, on specific brands; (iii) the involvement of farmers in marketing training programmes for a better placing of local products on market; (iv) the support for the young farmers and family farming; (v) the setting of suitable policies which are able to trigger a more incisive involvement of women in conservation programmes and, in general, in the agricultural entrepreneurship.

These issues, if duly confronted, could reduce the risk of genetic erosion in the region and even determine a diffusion of local varieties on a large scale, generating a widespread welfare for all the actors of the supply chain, in terms of higher profits for farmers and oil millers, improved environmental conditions for community, as well as a better food security and safety for consumers, also with positive repercussions on the preservation of the Mediterranean Diet principles.

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