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Agriculture and Agricultural Science Procedia 8 (2016) 307 – 316

Agriculture and Agricultural Science Procedia

Florence "Sustainability of Well-Being International Forum". 2015: Food for Sustainability and not just food, FlorenceSWIF2015

Conservation of landrace: the key role of the value for agrobiodiversity conservation. An application on ancient tomatoes varieties.

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Abstract

Agricultural biological diversity (agrobiodiversity), is a small component of biodiversity, and presents two levels: genetic resources for food and agriculture and ecological services. All the components contribute to sustain the key functions of agro-ecosystems. It is commonly acknowledged that biodiversity is jeopardized by erosion, whereas there is less awareness about agrobiodiversity loss, although this has very negative short and long-term consequences for producers and consumers. In particular, important for conserving agrobiodiversity is the protection of landraces (LRs). The disappearance of LRs, also called by the farmers local or primitive varieties, means both genetic and cultural erosion. For this reason, in-situ LRs conservation is essential, as well as the ex situ one. The main objective of the present work is the evaluation of agrobiodiversity and of its role for the local community, by means of the Contingent Valuation. The attention is focused on the tomatoes landrace "Pomodoro di Mercatello", a variety once widely cultivated in some areas within the province of Perugia and now kept alive by a farmer who still grows and sells it.

Peer-review under responsibility of Fondazione Simone Cesaretti

Keywords: Agrobiodiversity, Landraces, Genetic erosion, Contingent Valuation

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Peer-review under responsibility of Fondazione Simone Cesaretti
doi:10.1016/j.aaspro.2016.02.025

1. Introduction

Agricultural biological diversity (agrobiodiversity), is a small component of biodiversity (Schroder et al., 2007). It refers to the variety and variability of living organisms, relevant to food and agriculture in the broadest sense, and the knowledge associated with them (Qualset et al., 1995; Brookfield and Stocking, 1999; Jackson et al., 2007). Agrobiodiversity has two levels: genetic resources for food and agriculture and ecological services. All the components contribute to sustain the key functions of agro-ecosystems (Brookfield and Stocking, 1999).

It is commonly acknowledged that biodiversity is jeopardized by erosion, whereas there is less awareness about agrobiodiversity loss (Negri, 2005), although this has very negative short and long-term consequences for producers and consumers. In particular, important for conserving agrobiodiversity is the protection of landraces (LRs); LRs can be defined as variable plant populations adapted to local agroclimatic conditions which are named, selected and maintained during the time by the traditional farmers to meet their social, economic, cultural and ecological needs (Teshome et al., 1997). The disappearance of LRs, also called by the farmers local or primitive varieties, means both genetic and cultural erosion (Negri, 2005).

Landrace conservation may be ex- situ and in- situ. Ex situ activities are currently being carried out in plant genetic resource networks (Negri, 2005), but key elements of genetic resources cannot be captured and stored off-site. Thereby, in-situ conservation is considered as essential as ex situ (Narloch et al., 2011), and it is often locally carried out by single farmers. According to Teshome et al. (1997), in the absence of farmers manipulations, landraces may not exist in the ecological dynamics that are known today. Therefore, landraces and farmers are interdependent for their survival.

The main objective of the present work is the evaluation of agrobiodiversity and of its role for the local community. The attention is focused on the tomatoes landrace “Pomodoro di Mercatello”, a variety once widely cultivated in some areas within the province of Perugia and now kept alive by a farmer who still grows and sells it.

The paper is organized as follows: after a brief introduction on the method used for the evaluation (Contingent Valuation), a short description of the landrace evaluated and its current production are presented. The main results of the analysis and discussion are reported; general conclusions close the paper.

2. The method: contingent valuation

The method applied for the appraisal is Contingent Valuation (CV - Davis, 1963). CV has been widely used for environmental evaluation since the ‘60s and it still is one of the most largely applied methods in this field (Carson, 2011). Although this method presents some limits, it is possible to control distortion, using the suggestions proposed by the so-called NOAA Panel (Arrow et al., 1993) and applying the analysis as proposed in Hanemann (1984 and 1989). CV allows for the assessment of both use and non use values (Smith, 1993).

The model here applied is the dichotomous one, as reported in Hanemann (1984; 1989). In this type of model, the consumer is asked to say yes or no to a precise amount of money for a specific change in the expression of the good. By an operative point of view, each individual has an associated utility function $u(j, Y, s)$, where j is a binary variable representing the environmental good we want to evaluate. If j is equal to 1, the individual can benefit from the good, otherwise not (j=0). Y is the income, while s is the vector representing the socio-economic characteristics of the individual. The model assumes that the utility of each person derives both from the good and from her/his income.

To determine the function of each person, it is assumed that the function u is stochastic, so:

$$u(j, Y, s) = v(j, Y, s) + e_j \qquad (j = 0,1) \tag{1}$$

where ej is the stochastic error and v is the deterministic component of utility. The individual will answer Yes, only if:

$$v(1, Y - x_i, s) + e_1 \geq v(0, Y, s) + e_0 \quad (2)$$

where xi is the value submitted to the consumer. Therefore, because of equation 2, the answer Yes/No is a casual variable, with the following distribution of probability:

$$\Pr(yes \mid x_i) = \Pr[v(1, Y - x_i, s) + e_1 \geq (0, Y, s) + e_0] \quad (3)$$

Assuming $\eta = e_1 - e_0$, equation 4) can be specified with respect to the utility variation as follows:

$$\Pr(yes \mid x_i) = F(\quad v) \quad (4)$$

where $F_\eta(\cdot)$ is the distribution function of η and Δv is equal to:

$$\Delta v = v(1, Y - x_i, s) - v(0, Y, s) \quad (5)$$

Considering the willingness to pay of each individual at least equal to the submitted value ($x_i \leq DaP$) the probability of acceptance can be expressed by:

$$\Pr(yes \mid x_i) = \Pr(WtP \geq x_i) = 1 - G_{WtP}(x_i) \quad (6)$$

Where $G_{WtP}(\cdot)$ is the cumulative distribution function of the causal variable Willingness to Pay (WtP). Comparing equations 4) and 6):

$$G_{WtP}(x_i) = F_\eta(\Delta v) \quad (7)$$

it is clear the linkage between the two probabilities.

Usually the term $F_\eta(\cdot)$ is specified as a normal or logistic function. We assumed the second one, so the parametric evaluation used the logit distribution:

$$\Pr(yes \mid x_i) = = F_\eta(\Delta v) = \frac{1}{1 + e^{\Delta V}} \quad (8)$$

Usually, a linear model for the income is used to solve the model, as reported:

$$U_i = \alpha_j - \beta Y \quad (9)$$

Where α_j is a constant and β is the marginal utility of income. Considering $\alpha = \alpha_j - \alpha_0$ and the previous expressions, it follows:

$$\Delta v = \alpha + \beta x_i \tag{10}$$

Using the10) and the 8) we derived the logit-linear model:

$$\Pr(yes \mid x_i) = \frac{1}{1 + e^{(-(\alpha - \beta x_i))}} \tag{11}$$

Then it is possible to estimate the Willingness to Pay (WtP). The value estimated is the median WtP, which is considered more precise than the average one, using the following equation (Hanemann, 1989; Cooper and Loomis, 1992):

$$\mathbf{DaP_{mediana}} = \frac{\alpha}{-\beta}\ WtP_{median} = \frac{\alpha}{-\beta} \tag{12}$$

3. Case study – the tomato landrace "Pomodoro di Mercatello"

3.1. Main characteristics of Pomodoro di Mercatello

The tomato variety "Pomodoro di Mercatello" is an ecotype having very ancient origins, whose cultivation is exclusively linked to the homonymous village in the municipality of Marsciano (within the Province of Perugia – Central Italy). This variety is still well known by the community, especially in the areas close to the village; it is still produced by a single farm since about 50-60 years, with commercial purpose, while in some other neighboring farms it is produced only for own consumption.

This particular variety is mainly sold directly to the market of Marsciano; despite the rather limited distribution, its placement on the market results quite easy, being its consumption based essentially on trust.

From the morphological point of view this tomato is very similar to the more common varieties, even if presents a thinner cuticle that is its weak point, making it more susceptible to manipulation and to the attack by pathogens (Fig. n. 1).

Fig. n. 1. The tomato "Pomodoro di Mercatello"

3.2. Experimental design and questionnaire

Concerning the evaluation, two requests for willingness to pay were introduced: a certain price per kilo in order to identify the use value, and a certain amount to be willing to pay for a “distance adoption” of a tomato plant, in order to identify the non use value. The decision to propose a “one-time payment” seemed to be the most suitable, because assuming annual payment forms, similar to forms of taxation, could have generated a high percentage of protest bias considering the current economic crisis. The payment assumptions (bids) are shown in Table 1.

Table 1 – Bids proposed for Contingent Evaluation

Ecotype name	Use Value			Non-use Value	
	bid1	bid2	bid3	bid1	bid2
Pomodoro di Mercatello	1.2	2	2.8	10	20

Source: our elaboration

As shown in Table 1, three bids were identified for the use value and two for the non use one. This is justified by the type of elicitation chosen, requiring the random administration of differentiated values to different subjects. The experimental design was the "complete balanced" one, that allows to have each proposed bids the same number of times (balance) with a complete combination. Concerning the use value, the price actually charged to the public by the producer was considered the certain lower limit; the other use values were hypothesized on the basis of a survey on not Umbrian varieties which are generally sold, even if in minimal part, on the local markets.

The bids identified were included in the questionnaire, which was divided into three parts. In the introduction, after a brief description of the variety, some questions on biodiversity were proposed, also providing a brief definition. The second part was dedicated to the elicitation of willingness to pay together with the reasons for the refusal, in case of negative answer. The third and last part of the questionnaire was devoted to the collection of "sensitive data" and personal information (income, education, family status, etc.). Some questions about eating habits and lifestyles of the respondent were also included, such as the quantity of fruits and vegetables daily consumed, the health of their lifestyle, the adoption or not of the Mediterranean diet, the weight. This type of information was used to determine the sample characteristics affecting willingness to pay.

The questionnaires were administered by two interviewers, trained on the method, so as to minimize the interactions distortions. This contributed to a good acceptance of the questionnaire from respondents, despite its complexity. Data collection was divided into four months. The final number of questionnaires administered was 475. The number of questionnaires collected were 358 for those concerning information about use value, and 251 for those concerning information about non use value.

3.3. Sampling design

The questionnaire was administered to a sample extracted from the population of the municipality (Marsciano) concerned with the varieties being assessed. The sampling design was the “stage sampling” (Corbetta, 2003). This type of design, used in statistical surveys on a large scale, is one of the techniques ensuring to have probabilistic samples. In the stage sampling the population is divided into several levels, ordered in hierarchy, in which successive extractions are made, with the funnel technique (Corbetta, 2003). Two stages were identified.

First stage: represented by fruit and vegetables stores within the municipality (the categories considered were discounts, supermarkets, traditional shops, markets – Istat, 2013); the first selection was followed by an extraction via random number generation, making sure, once established the sample, not to deviate too much from the market shares covered by each type of store in the area.

Second stage: represented by consumers families, i.e. the clients of the found stores. For the extraction of sample units the technique of “systematic sampling” was used (Corbetta, 2003), scanning the list and selecting the subjects

systematically every given interval. This type of sampling is possible even if lacking of the complete information about the size of the reference population.

4. Main results and discussion

During the surveys, a fair knowledge of the species investigated was revealed. This led to a level of protest bias and a number of questionnaires to be replaced quite low, consistent with the literature; in addition, this factor determined that the declared values were influenced by what might be called "membership effect". This effect leads to assign a higher value to the non use value comparing to the use value.

Four elaborations were performed: two for the use value and two for the non use value. For each type of value, a model based only on the bids - as variables descriptive of the choice - and another one including covariates, were estimated. The results of the two types of model are here separately reported.

Some tests were carried out in the analysis of the models, in order to evaluate the goodness of the coefficients and of the estimates obtained (measures of fit), and especially to understand the information potential of the available data. The first informal control is the number of iterations required for the convergence of each model. The estimated models have used the method of Maximum Likelihood, that is based on a process of iterative estimation. Too high values of iterations mean the presence of some error: according to Hensher et al. (2005), the maximum number of iterations allowed for models with low complexity should not exceed 25. A further control is the measurement of the coefficient of determination of a linear regression (Rsqd) that indicates how much of the variability of the phenomenon is explained by the model, expressed in a scale between 0 and 1. In nonlinear models, such as the logit used in this analysis, Rsqd values are always low. In these cases we can use an alternative to Rsqd, the pseudo-Rsqd, among which the most used is the Rsqd McFadden adjusted, which is the complement to 1 of the likelihood ratio of the estimated model with respect to the reference model, and varies between 0 and 1. Good values are around 0.4. Another statistic that is calculated is the AIC, a coefficient which measures the quality of the estimation of a model taking into account both the goodness of fit and the complexity of the model: the AIC value should be as low as possible. Moreover, for each model the values of maximum Log- Likelihood (LL) are given. Also for this parameter, the lower is the value, the better the estimate. Finally, the sensitivity was reported, i.e. how many times the model predicted a positive response to the bids proposed, being this actually positive, and the specificity, i.e. how many times the model predicted a negative answer, being this actually negative. In addition to these parameters the percentages of correct and incorrect estimates (correct and wrong predictions) associated with each model were reported. They are very important because the logit model is the expression of the probability of accepting or not a proposed value.

4.1. Basic model

In the basic model all the variability is explained by the bids proposed for the use or non use value.

In table 2, the main statistics of the basic model for the use value are reported. The two variables in the model – i.e. the bid proposed and the constant - are both particularly significant. In general, the model is able to predict correctly both the negative response and the positive one (sensitivity and specificity up than 60%); the percentage of right predictions is 66%.

The good results obtained are probably due to the high level of consciousness about the product Pomodoro di Mercatello and to the direct experience of consumption. The revealed WtP is higher than the real market price of the tomatoes, and it is equal to 2.38 euros for a kilo of tomatoes.

Table 3 shows the main statistics of the basic model for the non use value: the lower number of good questionnaires available for these elaborations is the cause of the lower fit of the models for estimating the non use value. As for the basic model, the variable bid has the expected sign and it is significant, as the constant. The model has a good capacity of prediction. However, the value of R-sqd adjusted is very low. On the contrary, in the covariate model both the AIC and the BIC decrease (not reported in the Table). A lower value of the AIC gives a higher level of adjustment and complexity of the model. The WtP derived from the model is equal to 14.49 euros.

Table 2 - basic model, use value

n. observations	358
n. iterations	6
n. parameters	2
R-sqd *adj*	0.2215879
LL	-162.4916
AIC	1.3069
Constant	5.044***
Bid	-2.120***
Sensitivity	66.67%
Specificity	63.28%
Correct predictions	66.39%
Wrong predictions	33.61%

Table 3 - basic model, non use value

n. observations	251
n. iterations	5
n. parameters	2
R-sqd *adj*	0.065765
LL	-186.7583
AIC	1.24545
Constant	1.794***
Bid	-0.124***
Sensitivity	0.6667
Specificity	0.6328
Correct predictions	0.6494
Wrong predictions	0.3506

4.2 The covariate models

The two covariate models, one for the use and the other for the non use value, were estimated using a stepwise regression. The covariates used are the personal characteristics of the interviewed (for instance: age, gender, level of instruction, number of members of the family unit, lifestyle, type of diet, etc.) and the knowledge about biodiversity and the variety Pomodoro di Mercatello, as derived from the questions in the first part of the questionnaire.

Table 4 shows the results of the covariate model for the use value.

This extended use value model includes four covariates, three with a positive and one with a negative sign. Among the positive ones, there is the variable related to the income, having a positive correlation with the proposed

bid; therefore the higher is the income the higher the willingness to pay. Moreover, there is a positive correlation between the WtP and the variable related to people having children under the age of 14 years. In fact, parents of school-age children tend to give greater importance to food for their children and are willing to pay more for it.

The variable related to the knowledge about the tomato ("know") has a negative sign. This result, even if could be considered anomalous, was interpreted with the fact that people who usually consume these tomatoes are not simply willing to pay, but they really pay for them. Thus, the value expressed by them is a real and not a hypothetical one. The sign of the other variables is coherent with literature. Interesting is the case of PRD variable: people who know about the presence of measures, within the Programme of Rural Development (PRD), preventing genetic erosion, have also a higher willingness to pay. This may express the awareness that the protection of some species from erosion requires not only the private contribution but also the public one.

Table 4 – covariate model, use value

n. observations	358
n. iterations	6
n. parameters	6
R-sqd *adj*	0.2830082
LL	-173.931
AIC	1.25756
Constant	3.3882***
Bid	-2.4671***
Know	-0.5843*
PRD	2.3035***
Income	0.1961*
sons	0.5797*
Sensitivity	86.40%
Specificity	65.39%
Correct predictions	78.77%
Wrong predictions	21.23%

The model has a quite good capacity of prediction, in particular in case of affirmative responses. The WtP is equal to 1.37 euros for kilo, considering only the bid, but people who are positive for the variable PSR have a WtP of 2 euros.

The statistics for the non use value covariate model are reported in Table 5.

In this case, contrary to the use value covariate model, the variable "Know" has positive sign. This indicates that people who consume and also already know this variety of tomato, consider more important the non use value, in comparison with the use value; therefore, they have a higher willingness to pay for the conservation and preservation of the good itself, for future generation.

At the same time, they have a strategic behavior about the willingness to pay for direct use, declaring a lower value in comparison with the real price.

Considering the general fit of the model, the sensitivity of the model is low, almost equal to the 50%. However, the good value of specificity allows to increase the number of the correct predictions. The WtP, considering only the bid, is equal to 9.85 euros.

Table 5 – covariate model, non use value

n. observations	251
n. iterations	6
n. parameters	4
R-sqd *adj*	0.1155977
LL	-179.1976
AIC	1.04044
Constant	1.3686**
Bid	-0.1406***
Know	0.4943*
Bio	1.1437***
Sensitivity	52.85%
Specificity	83.59%
Correct predictions	68.53%
Wrong predictions	31.47%

4.3 Some summarizing considerations

The values of WtP (from 1.37 to 2.38 euros) for the tomato Pomodoro di Mercatello are higher than the price actually charged in the market, for both the typologies of models (basic and covariate).

The differences among the various WtP are around 20-30 cents, according to the various covariates, arriving at being 93 cents higher when people are aware of the conservation measures provided within the Rural Development Programme (RDP).

In general, it can be said that all the models produced results that are totally or partially satisfactory. Distinguishing between use and non-use values, the performance of the models related to the latter are lower. The reason is due to the greater difficulty required in understanding the non use value in comparison to the use one. The use value is, in fact, a concept that is more easily discernible and understandable to the interviewer compared to the non use one, as well as being similar and comparable to the common experiences of purchase.

5. Conclusions

The economic evaluations performed in the present study allowed to identify, for the landrace “Pomodoro di Mercatello”, an use value and a non use value.

The knowledge of the people interviewed concerning this variety of tomato definitely influenced the data collection, as shown by the low number of "protest bias" and by the emergence of the “membership effect”. This effect comes from the perception of the value of the variety in strict connection with the territory, and leads to assign a higher value to the value of non use.

The values of WtP found for the tomato Pomodoro di Mercatello were higher than the price actually charged in the market. The high WtP suggests the possibility to adopt strategies for the valorization of these types of products, like their promotion by means of marketing plans or the creation of specific brands, aiming to develop a niche market.

The commercial valorization of the products coming from varieties at risk of genetic erosion is also advocated by the recent Report "Agricultural Genetic Resources - from conservation to sustainable use" (COM 2013, 838 final),

in which it is stated that greater emphasis should be given to incentives and measures supporting the conservation and sustainable use of variety at risk of erosion, in combination with marketing strategies that promote economic sustainability of quality local products and short supply.

The high non use value, suggest the need for a support granted also for very small surfaces, or even for single plant, in order to ensure that the variety is preserved for future generations. Therefore, contributions to the protection of varieties at risk of genetic erosion, should be always included in agricultural payments policies.

Another crucial aspect is that of quantifying the level of risk of genetic erosion, according to the different vegetal, animal and microbiological species in a certain area, in order to create intervention priorities.

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