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The perception of biotechnology in agro-forestry: The opinion of undergraduates and researchers

Elisabetta Raparelli[a,*], Sofia Bajocco[a], Giuseppe Scarascia Mugnozza[b]

[a] Consiglio per la ricerca e l'analisi dell'economia agraria – Council for Agricultural Research and Economics, Research centre for Agriculture and Environment, CREA-AA, I-00184 Rome, Italy

[b] University of Viterbo, Department for Innovation in Biological, Agro-food and Forest Systems, DIBAF, I-01100 Viterbo, Italy

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ABSTRACT

Genetically modified organisms (GMOs) cropping promoted by different researchers, and the subsequent crisis regarding the safety of food derived from them, has resulted in strong public mistrust towards the authorities, both scientific and political. The aim of this work is to investigate the perception of Italian undergraduates and researchers towards the introduction of GMOs in agro-forestry. The factors determining attitudes towards GMOs were examined by means of 66 questions divided into three units: Knowledge, Opinon, Trust. Anagrafic and socio-cultural information were also analyzed. Data was processed through a multivariate analysis approach. The hierarchical clustering on undergraduates and researchers allowed to distinguish clusters of respondents skilled in biotechnology from those skilled in off-topic disciplines. Principal component analysis and K-means demonstrated that the positive or negative opinion toward GMOs, as for undergraduates, does not depend on their knowledge, but it is associated with the level of trust in the institutions. On the contrary, for researchers, it is related to their expertise level, without any linkage to trust in the institutions. This type of study may represent a key step for understanding the social, economic and scientific components underlying the choices of citizens, communities and society about GMOs.

1. Introduction

The modification of the genetic structure of agricultural raw materials and food products is one of the most debated subjects of our times, and one of the most controversial areas of research. More and more attention is paid to the related risks and environmental impact of human activities and the application of the achievements of scientific research. Many international organizations are involved in risk assessment and safety of genetically modified organisms (GMOs). New technologies and the products of biotechnology are increasingly difficult to understand for consumers, because they perceive risks in a different way to experts (Grunert, 2002; Cichocka et al., 2010).

GMOs cropping promoted by different researchers, and the subsequent crisis regarding the safety of food derived from them, has resulted in strong public mistrust towards the authorities, both scientific and political. (MacQueen, 1967). With regards to the purchasing of food, the decision of consumers is not affected by the latest scientific findings, but rather by other factors, i.e. environmental, ethical, socio-economic, emotional, political (McFadden and Lusk, 2016). Many studies have been about how consumer in general perceive risk. One study (Tversky and Kahneman, 1986) shows that losses have greater impact than gains on consumer attitudes. People weigh risk information as more important than benefit information, thus the difficulty of selling benefits against possible risks (Wunderlich and Gatto, 2015).

The European citizens, while being open to the prospect of a growing adoption of biotechnology, are overall opposed to the use of GMOs (Levidow and Marris, 2001).

The results provided by Eurobarometer (Conner et al., 2003; Fonseca et al., 2013) which is a "system of public opinion surveys regularly conducted in the European Union", on the use of GM products over 20 years (1991, 1993, 1996, 1999, 2002, 2005 and 2010) suggest that the views of consumers on GMOs in the EU have evolved becoming more opposed to genetically modified products.

In 1991, 74% of EU citizens agreed that the search for genetic engineering in plants was useful and should be encouraged (Delwaide et al., 2015). In the 2005 Eurobarometer survey, only 27% of respondents supported GM foods. Moreover, the majority of EU citizens think that GM foods are risky, not useful and morally unacceptable, and disagrees with the idea that the development of GM foods should be encouraged (Gaskell et al., 2000; Gaskell et al., 2011). The latest

* Corresponding author.
E-mail address: elisabetta.raparelli@crea.gov.it (E. Raparelli).

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Eurobarometer on Biotechnology of 2010 confirmed this negative approach.

To the contrary (Knight et al., 2007), reported that European consumers are willing to consume GM foods if the product is cheaper and provides an environmental benefit (for example, fruit without pesticides). Moreover, a study conducted in Switzerland, showed that consumers treat genetically modified food as any other kind of food (Aerni et al., 2011). Constantly highlighted in all the studies is that the attitude of European consumers towards GM food differs between EU Member States (Burton et al., 2001; Löfstedt and Vogel, 2001). For example, in the Eurobarometer Report of 2010, the percentage of participants who agreed that the development of GM food should be encouraged, ranges from 10% in Greece, Bulgaria and Lithuania to 35% in the UK and the Czech Republic (http://europa.eu/rapid/press-release_IP-07-807_it.htm).

National and European surveys also found that many consumers still do not have enough knowledge of this subject, in order to make a definitive judgment on it (Hallman et al., 2004). In light of this scenario, it is necessary to reinforce institutional and scientific communication so that public opinion, which is beginning to develop different and sometimes conflicting positions, is aware of all information related to the sector (Bubela et al., 2009).

This work aims to analyze the position towards GMOs of Italian undergraduates and researchers and to identify the role of the different factors associated to positive and/or negative attitudes towards genetic engineering, through targeted questionnaires, relating them with the anagraphic characteristics of the sample interviewed. The extent of "social acceptability" of biotech crops was assessed in relation to variables such as demographics, knowledge of the meaning, perception of the relationship between nature and science, attitudes toward the limits of human intervention in nature and the environment, the perception of the effectiveness of the regulation (trust in institutions and regulatory policies and their implementation).

2. Data

2.1. Questionnaires

The questionnaire was drawn up based on the work of Dermitzaki (2009); the original draft was semplified and adapted to the agro-forestry sector.

Data collection is based on a structured questionnaire with closed questions and answers developed using the Likert scale (Likert, 1932). This technique consists mainly in developing a number of statements (technically defined item) that express a positive or negative attitude in respect to a specific object. The total result of these judgments is likely to define with reasonable precision the attitude of the subject towards the object. For each item a scale of agreement/disagreement is presented, usually five-mode. Respondents are asked to indicate their degree of agreement or disagreement with the views expressed in the statement.

The questionnaire is divided into sections that address the knowledge of respondents on the use of forestry GMOs, their relative positions to the problems and their moral, ethical and bioethical concerns.

The questionnaire consists of 66 questions and is divided into three units:

- Unit I Knowledge: degree of knowledge on issues regarding science, technology and biotechnology companies.
- Unit II Opinion: location and views on nature, the environment, biotechnology and genetic engineering.
- Unit III Trust: trust in the rules governing those arguments and trust in the institutions/organizations which undertake the regulatory activities.

Anagrafic and socio-cultural information, in terms of gender, age, provenance, type of degree, political orientation and religious beliefs, were also analyzed.

2.2. Sample

The questionnaire was distributed, according to the method of the sample survey, using as reference the population of the following sample of Italian undergraduates and researchers.

Undergraduates from the University of Rome and of Tuscia of Viterbo in the following disciplines: Agronomy (A_U); Food Science and Nutrition (FS_U); Economy (E_U); Biology (B_U); Medicine (M_U); Law (L_U); Philosophy and Letters (PL_U); Political Science (PS_U). Seventy questionnaires were manually distributed for each option, for a total of 560 questionnaires. Out of 560 questionnaires distributed, 303 undergraduates responded.

Researchers from the Council for Agricultural Research and Economics (CREA) and from the National Research Council (CNR) graduated in different disciplines: Biology (B_R); Forestry (F_R); Chemistry (C_R); Physics (P_R); Geology (G_R); Natural sciences (NS_R); Agronomy (A_R); Foreign languages (FL_R). The questionnaires were sent by e-mail (350 questionnaires to CREA and 50 to CNR). Out of 400 questionnaires sent, 123 researchers responded.

The data was coded and entered into a database. The output is a data matrix consisting of 426 observations (i.e. the answers) and 132 variables (i.e. the questions), divided among the four sections of the questionnaire.

3. Methods

For each of the three units of questionnaire (i.e. Knowledge, Opinion and Trust), a Hierarchical Cluster Analysis (HCA) of the answers was performed jointly for undergraduates and researchers, in order to identify groups of disciplines with similar answers (Forgy, 1965) HCA is one of the most used data mining procedures for determining the intrinsic grouping in a set of data and identifying sub-populations of related objects with similar behavior with respect to some user-defined property (Podani, 2007). The HCA gradually builds a partition of observations based on their similarity, measured using a similarity or dissimilarity coefficient. The algorithm first gathers all the most similar observation pairs, then progressively aggregates the other observations or observation groups according to their similarity until all the observations are in a single group. The HC produces a binary clustering tree (dendrogram), which represents a hierarchy of partitions and whose root is the class that contains all the observations. The contingency table obtained starting from the disjunctive matrix separately for undergraduates and researchers and divided by disciplines was used as input of the HCA. We used Euclidean distance to measure similarity, and the Ward method as linkage criterion (Ward, 1963). The original database of the responses was transformed into a disjunctive matrix (binary), aggregated as a contingency table and used as input data (standardized by centering) of the HCA (Schiemann, 2003).

Then, starting from the original database, separately for undergraduates and researchers, a Principal Components Analysis (PCA) was carried out for each of the three units of questionnaire considered, in order to identify the most significant components of the multivariate system of the responses to the questionnaires (Abdi and Williams, 2010; Jolliffe, 2002). PCA is a mathematical procedure that uses orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components (PCs). It is a method to study the structure of the data, with emphasis on determining the patterns of covariances among variables. Among its multiple purposes, we used PCA to identify variables which are responsible for the variation in the data and to create a few orthogonal variables that contain most of the information in the data and that simplify the identification of groupings in the observations. (Legendre and Legendre, 1998).