Consumers' Attitudes Towards the Development of Transgenic Forest Trees and their Products in Greece

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Abstract. This paper aims to examine the attitudes of the consumers in Greece towards the use of biotechnology in forest plantations and their potential purchases of forest transgenic products. Three groups of factors related the consumers' attitude on the use of biotechnology in forest plantations with the potential purchases of transgenic forest products: (a) the potential negative environmental impacts (b) the potential positive impacts on production processes, and (c) economic impacts. Furthermore, this study indicated that consumers who intent to buy paper products derived from Genetically Modified (GM) forest trees, were concerned for the environmental impacts of the GM trees and then on the production process that was followed by economic issues. No significant relationships were found between the consumers who declared that they intent to buy wood and woody biomass energy products derived from GM trees and the importance of the factors that affect their attitudes towards the adoption of biotechnology in forest plantations.

Keywords: Consumer behaviour, Genetically Modified Trees.

1 Introduction

It has been argued that the use of biotechnology in commercial forest plantations would contribute to increased forest productivity, improved pulp for paper and biofuel production, climate change mitigation, preservation of biodiversity and reduction of energy, pesticides and fertilizers utilization (Sedjo 2006, Chapotin and Wolt 2007, FAO 2008, 2010, Hinchee et al. 2009, Flachowsky et al. 2009, Harfouche et al. 2011).

Specifically, the use of GM trees in forest plantations may provide several economic advantages. Aside from increasing the trees' viability and reducing losses to folivores, fungi and bacteria, these types of modifications could also decrease the need for pesticides and consequently affect the costs associated with tree production (Mathews and Campbell 2000). The use of herbicide –resistance trees would also

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allow producers to apply broad –spectrum herbicides to control weeds and therefore reduce the need for traditional and costly methods of weed control (Mathews and Campbell 2000). Furthermore, increased resistance of GM trees to abiotic stress could mean a more efficient growth and therefore, improved productivity (Johnson and Kirby 2001). Also, another economic advantage regarding the establishment of GM forest trees is the reduced amount of time required to develop improved phenotypes (Mathews and Campbell 2000; Pena and Seguin 2001).

On the other hand, the use of biotechnology in forest plantations could lead to a decrease in the perceived social and economic value of natural forests, as the economic gains from these types of forests would not be as large as those received from GM forest plantations (Haynes 2001). A further economic concern relates to the fact that low income wood producers might not be able to have access to GM trees given their relatively high cost (Thomas 2001). Also, Thomas (2001) argued that GM trees might generate profit for certain producers in the private sector while low income producers would become further marginalized. Furthermore, the application of GM technologies to forest trees has raised a number of potential public concerns. Many of these concerns, are similar to those of the GM annual crop plants and are mainly associated with the potential spread of antibiotic or herbicide resistance genes to the native tree genetic pools; the potential for long – distance pollen spread, the potential for adverse effects on biodiversity from GM tree plantations; and any unexpected effects (Gartland et al 2003, El- Lakany 2004,Van Frankenhuyzen and Beardmore 2004, Williams 2006, Sedjo 2006, Farnum et al. 2007, FAO 2008, 2010).

As no food safety issues are involved (although cellulose is sometimes used a filler in foods) the extent to which retail consumers might resist transgenic wood products appeared to depend largely on their environmental and philosophical concerns (Serdjo 2004). Therefore, it is important to know therefore how the attitude of the consumers of potential forest transgenic products in Greece would affect their buying decision. In this context, the aim of this study was to explore the attitudes of the consumers towards the use of biotechnology in forest plantations in an E.U. country, Greece and to profile them according to their willingness to buy products that could derived from GM trees. Further, this work was coordinated within the frame of the European COST ACTION FP0905 that focused on various biosafety aspects, such as analyses of the efficiency of existing gene containment strategies to avoid or to minimize gene flow or evaluation of methods to monitor GMTs in the whole production chain (Fladung et al. 2012, Vettori et al. 2014).

2 Methods

A survey was implemented to identify the factors that affect the consumers' attitudes towards the use of biotechnology in forest plantations. Furthermore, it explored the association between the consumers' attitudes towards the use of biotechnology in forest plantations and their intention to buy products.

Therefore this study examines the rejection of the following research null hypotheses:

- **Ho1:** There are some main factors that do not affect consumers' attitudes towards the use of biotechnology in forest plantations.
- **Ho2:** The factors affecting consumers' attitudes towards the use of biotechnology in forest plantations are not significantly associated with their intention to buy products derived from GM forest trees.
- **Ho3:** The factors affecting consumers' attitudes towards the use of biotechnology in forest plantations are not significantly associated with consumers' classification regarding their buying behaviour towards transgenic tree derived products.

2.1 Survey Procedure

The information for the survey was gathered through field interviews following a systematic stratified sampling method (Moser 1958; Errington 1985; Barnett 1991; Oppenheim 2000). According to Errington (1985) the units for survey were randomly selected from the larger population in order to generalize the conclusions. So, every sixth customer that was entering into the survey area was undergoing the interview (McCluskey *et. al*., 2003).

The size of the selected sample was based on Siardos' methodology (Siardos 1997). Particularly, the representativeness of the sample was immunized by checking the sample proportion of the consumers who declared that they would buy forest products of transgenic origin with the consumers in the pilot survey who declared that they would buy these products. More specifically, the proportion of consumers (p) in the pilot survey who would buy at least once a product of transgenic origin, such as woody biomass energy product or woody product was 86%. Therefore, in order to achieve a representative sample, the sample size should have been at least 420 consumers (in order to have z=3 and d=5%). Furthermore, the power analysis that was conducted by using the Gpower software (Faul et.al. 2009) indicated a total sample size of at least 132 consumers for a medium effect size (Cohen 1988) of a power of 0.95. Hence, the sample size of 450 consumers was considered "representative" since it was more than three times the indicated size by the power analysis and the 86% of consumers, who declared that they would buy a transgenic-tree derived product. The productive sample consists of 418 consumers.

2.2 Questionnaire Design

Based on the literature, the factors that affected the development questions involved in the questionnaire were the consumers' behaviour towards GM forest trees derived products and the consumers' attitudes towards the development of transgenic plantations. Furthermore, the questionnaire was designed in order to meet the research's objectives and it was pre-tested in academics, marketing experts and consumers. In order to verify any modifications at the structure of the questionnaire, a pilot survey of 30 consumers was conducted in October of 2011. The results from

this pilot survey indicated that there was need for further modification and therefore, the main survey was conducted between November and December of 2011.

2.3 Statistical Methodology

Multivariate analysis techniques were performed for a total of 418 consumers to reveal the key information contained in the responses. Particularly, Principal Component Analysis (PCA) was used to identify the variables that accounted for the maximum amount of variance within the data in terms of the smallest number of uncorrelated variables (components). The anti-image correlation matrix was used as well as Bartlett's test of sphericity and the measure of sampling adequacy (MSA) in order to check the appropriateness of the data for subsequent factor analysis. The variables that had a high proportion of large absolute values of anti –image correlations as well as MSA less than 0.5 were removed before analysis.

PCA reduced the 8 key attitude variables, which relate to consumers' opinion about the use of biotechnology in forest plantations to a smaller set of underlying factors. An orthogonal rotation (varimax method) was conducted and the standard criteria of eigenvalue = 1, scree test and percentage of variance were used in order to determine the factors in the first rotation (Hair *et al*. 1998). Different trial rotations followed where factor interpretability was compared.

Statistical tests based on the outcomes of the factor analysis presented above were used to test three hypotheses presented in previous section.

3 Results

Principal Components and Factor Analyses (through a varimax rotation) were conducted to identify the key consumers' attitudes towards the use of biotechnology in forest plantations, and the latent root criterion (eigenvalue =1), the scree plot test and the percentage of variance were used to determine the number of factors.

PCA identified three factors that affect consumers' attitudes towards the use of biotechnology in forest plantations (Table 1).

Table 1. Main Factors Affecting Consumers' Attitudes towards the use of Biotechnology in Forest Plantations.

KEY ATTITUDE DIMENSIONS	Factor Loading
Negative Environmental Impacts	
Negative impact on biodiversity conservation	0.829
Negative impact on the environment	0.789
Possibility to harm human health	0.746
Positive Impacts on production process	
Reduction of production losses	0.747
Important for biomass production	0.725
Economic Impacts	
Reduction of production costs	0.861
Increase of return	0.782

KMO MSA = 0.743
Bartlett test of Sphericity = 977.656, P <0.001

In particular consumers' attitudes towards the use of biotechnology in forest plantations were mainly influenced by:

(a) the potential negative environmental impacts of the adoption of such technology that retain negative impacts on biodiversity conservation, the environment and possibility to harm human health,
(b) Potential positive impacts on production processes, such as the reduction of production losses whilst they consider the use of GM technology in forest trees as an important factor for biomass production, and
(c) economic impacts, such as reduction of production costs and increase of the returns from the forest plantations.

Therefore, the hypothesis ***Ho1:*** *"There are some main factors that do not affect consumers' attitudes towards the use of biotechnology in forest trees"* may be rejected.

Moreover, the non-paramateric Friedman Test was performed to explore the association between the factors that affect the consumers' attitudes towards the use of biotechnology in forest plantations in Greece and their intention to buy each category of GM forest products; specifically, (a) paper-, (b) wood-and (c) woody biomass energy products. Hence, this study indicated that consumers who intent to buy paper products derived from GM forest trees, were mainly concerned for the environmental impacts of the GMTs and then on the production process that was followed by economic impacts (Table 2). No significant relationships were found between the consumers who declared that they intent to buy wood and woody biomass energy products derived from GM trees and the importance of the factors that affect their attitudes towards the adoption of biotechnology in forest plantations.

Table 2. Importance of the factors affecting consumers' attitudes towards the use of biotechnology in forest plantations

Factors affecting consumers' attitudes towards the use of biotechnology in forest plantations	**Consumers who intent to buy paper products that could be derived from GM forest trees (x2=6,829, df=2, P<0,05)**	**Consumers who intent to buy wood products that could be derived from GM forest trees (x2=2,31, df=2, N.S)**	**Consumers who intent to buy woody biomass energy products that could be derived from GM forest trees (x2=0,109, df=2, N.S)**
Environmental Impacts	2,1	2	2,02
Impacts on production process	2,05	2,04	1,99
Economic Impacts	1,85	1,96	1,99

Therefore, the research hypothesis **H2:** *"The factors affect consumers' attitudes towards the use of biotechnology in forest plantations are not significantly associated with their intention to buy GM forest products"* may be rejected.

Tsourgiannis *et. al.* (2015) identified four groups of consumers according to their potential buying behaviour towards forest products derived from transgenic-trees : (a) consumers who were interested in the product's quality, (b) consumers who were orientated towards lower prices, (c) consumers who were influenced by labelling and curiosity issues and (d) consumers who were interested in health safety issues and the environmental impacts. In this study the Friedman one way non parametric test was employed in order to explore which factors affected consumers' attitudes towards the use of biotechnology in forest plantations in Greece that have an impact on each group of consumers (Table 3).

Table 3. Importance of the factors affecting consumers' attitudes towards the use of biotechnology in forest plantations for each group of consumer

Key attitude dimensions	**Group of Consumers**			
	Consumers who are interested in the product's quality (x^2=1.440, df=2, N.S)	**Consumers who are orientated towards lower prices (x^2=2.391, df=2, N.S)**	**Consumers who are influenced by labelling and curiosity issues (x^2=9.260, df=2, P <0.05)**	**Consumers who are interested in health safety issues and the environmental impacts (x^2=2.319, df=2, N.S)**
Negative Environmental Impacts	2.12	2.00	2.21	2.21
Positive Impacts on production process	2.00	2.04	1.89	1.89
Economic Impacts	1.88	1.96	1.90	1.90

The test indicated that most of the consumers who were influenced by the labelling and curiosity issues paid attention mainly on the environmental impact that the adoption of biotechnology might have in the forest tree sector and then on

economic issues and lastly on the positive impact on production processes. No significant association was found between the other three groups of consumers and the importance of the factors that affect their attitudes towards the adoption of biotechnology in forest plantations.

Hence, the hypothesis **Ho3:** *"The factors affect consumers' attitudes towards the use of biotechnology in forest plantations are not significantly associated with consumers' classification regarding their buying behaviour towards transgenic tree derived products"*, may be rejected.

4 Discussion - Conclusions

This study investigated the main factors that affect the attitude of potential consumers towards the utilization of transgenic trees and their products and influence their willingness to buy those products. It showed that consumers' attitudes towards the use of biotechnology in forest plantations were mainly affected by the impact of that technology might have on the environment, biodiversity, and human health, as well as by its positive impact on production processes and economic impact.

This study supports the findings of other studies according to which consumers were mainly affected in their preferences towards transgenic trees and their potential products, from their environmental and philosophical concerns. Consumers appeared positively orientated towards the use of biotechnology in forest plantations, probably because the products derived from forest trees are not food and therefore they were considered less dangerous to human health.

A limitation however of this survey needs to be mentioned. The adopted statistical methodology although it explored the factors that affect consumers' buying behaviour, which is useful for marketing analysis and strategy development can not measure the demand of a product or determine the importance of the characteristics of a product that affect consumers' behaviour. These measurements can be made with the use of other statistical techniques such as conjoint analysis and contingent valuation.

Nevertheless, the current study is of value, since according to our knowledge, this is the first attempt to explore the consumers' attitudes towards the development of transgenic trees and their products, as well the factors that affected their attitudes towards the adoption of such technology in forest plantations. According to the results of the study the potential developers of such forest tree plantations and paper, wood and woody biomass energy products should structure their marketing and promotion mix and focus on environment protection, and economic efficient production methods. Furthermore, campaigns that will aim to inform public about the use of biotechnology in forest plantations and its advantages and disadvantages should take place.

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