Attitude of Evros' s Farmers for the Genetically Modified Trees

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Abstract. Genetically modified trees are now one more expression of human intervention in nature. As for other people is a suicidal mood at the cost of profit maximization, for others is an inevitable trend for the survival of continuing growing world population that gathers several advantages, a survey of those directly involved in the primary sector, farmers, and deemed necessary. The implementation of this research includes the completion of 100 questionnaires from farmers in the region of Evros. Then, using the widely used Excel and SPSS software packages are processed research results with the discovery of useful correlations. The results show that in the region of Evros opinions of farmers who have negative attitude to the cultivation of genetically modified forest trees is much more (70) versus those with positive (30). Both trends express their concern on different characteristics, the systematic mapping of which is attempted in this work. The intension to cultivate genetically modified trees in relation to the demographic characteristics of the farmers, the farm size, the farm size and the type of cultivation are also investigated.

Keywords: Genetically Modified Forest Trees, Evros, Farmers, Analysis of attitudes.

1 Introduction

Biotechnology is characterized as the technology of biological processes using organisms, or parts of their processes for the manufacture or production of useful or commercially exploitable substances and to provide services for the benefit of man (Thieman and Palladino, 2008). According to the Convention on Biological Diversity, biotechnology is defined as any technological application uses biological systems, living organisms or

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their derivatives to create or modify products for specific use (Convention on Biological Diversity, 1992). This definition includes medical and industrial applications as well as the tools and techniques used in agriculture and food production (FAO, 2004). The term denotes a wide range of processes, from the use of earthworms for protein production by the production of human genes, such as growth hormone. In biotech products include pharmaceutical proteins, foods, detergents, etc., while a variety of applications including the services of waste water and waste as a medical diagnosis, or achievements of gene therapy (EuropaBio, 2012). Biotechnology today, builds on the achievements of modern molecular biology and uses a number of techniques, including genetic engineering (recombinant DNA), Methods and tissue engineered cell cultures on a large scale, the polymerase chain reaction, etc. It has numerous applications in health sciences, environmental protection (eg use in waste management), agriculture, livestock and industry. Together with biomedical technology, which the development of technologies with applications in medicine, biotechnology sometimes called *biological engineering* (Walter and Menzies, 2010). In fact the term biotechnology includes a broad set of tools and application of these tools. *Genetic engineering* only started in 1982 when (Palmiter et al., 1982) created the first genetically modified or otherwise *transgenic* mice. Genetic engineering may be new but the creation of new agencies with modified genetic material, can be done relatively quickly.

Agricultural biotechnology concerns mainly *Genetically Modified Trees (GMT)* and is particularly interesting since the first seeds of GM in America planted. The commercial sale of genetically modified food began in 1994, when Calgene brought first marketed the slow ripening tomato (Clive, 1996). According to the World Health Organization (WHO), Genetically Modified Trees are trees whose genetic material (DNA) has been altered in a way not found in nature. This technology is often called modern *biotechnology* or *gene technology* and sometimes recombinant DNA technology or genetic engineering (WHO, 2002). According to Sedjo (2004) a plant comprising introducing a gene using an approach beyond sex (nonsexual) considered bioengineered plant and designated as a transgenic. Among the various techniques used to generate transgenic plants, Agrobacterium transformation is the most widely used tool, representing 80% of the transgenic plants produced (Broothaerts et al., 2005). The term GM crops refer to crop plants created with the latest technologies used molecular biology and which plants intended for consumption by humans or animals. The modification is done in laboratory conditions and its goal usually is to support them in a desirable feature, for example resistance to herbicides or improved nutritional content (Varzakas et al., 2007a).

Over the last two decades there have been significant developments in biotechnological applications. The overall coverage in a survey (Sedjo, 2004) and the working paper (Preliminary review of biotechnology in forestry, 2004) present that the cultivation of GM foods and crops include dynamic technology, potential risks to public health and safety of ecosystems, powerful economic lobbies, impact on small surface areas and small farmers, nutritional promises and scandals, political strategies, European directives and easy identification of citizens with actual or potential problems and injustices arising from their use. Furthermore, the use of GM forest trees in commercial plantations would contribute to increased forest productivity, improved pulp for paper, 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). While these practices may perhaps increase profits for wood and paper products firms, the high economic, ecological and social costs associated with industrial tree plantations are paid by those living in and around large scale plantations and by society at large (Carman et al 2006).

The working group led by Professor Athanasios Tsaftaris (2004), the former Minister for Rural Development and Food, among other findings, discovers a reluctance of Central Macedonia farmers in dealing with the agro-biotechnologies. The Greeks generally have negative attitudes towards the cultivation and consumption of GM trees and products, and there seems to be consensus among politicians and citizens in their opposition to genetically modified (Kousis, 2009). Greece has, so far, chosen the cultivation of GM trees mainly because of the small agricultural clergy, the geomorphological features, different microclimates and soil conditions favor the biological and integrated crop (Varzakas et al., 2007b).

Furthermore, the application of GM technologies to trees has raised a number of potential public concerns. Many of these concerns, although not all, are the same raised for GM annual crop plants, including the potential for spread of antibiotic or herbicide resistance genes to other non-target species from GM trees; the potential for long – distance pollen spread over many years from long – lived trees, the potential for adverse effects on biodiversity from forests of GM trees; and any unexpected effects (Gartland et al 2003).e

Public acceptance in particular is influenced by environmental, public health and socio-cultural concerns, which have been raised mainly by opinion influencing groups. Concerns often focus on potential genetic flow between GM and wild trees and consequent implications for the natural environment, increased use of broad spectrum herbicides, more pesticide resistant forest trees, negative effects on forest tree fitness, potential higher vulnerability of forest trees to viral and other diseases, increased soil decomposition, adverse effects on biotrophic processes in host ecosystems, flowering suppression and cultural adaptation to altered biodiversity conditions due to transgene escape (El- Lakany 2004,Van Frankenhuyzen and Beardmore 2004, Williams 2006, Sedjo 2006, Farnum et al. 2007, FAO 2008, 2010). In the Eurobarometer survey, (European Community, 2010) becomes apparent the opposition of the Greeks towards GM crops. While a small, relatively, a majority of Europeans (54%) believes that genetically modified foods are not good for them and their families, in Greece the percentage of those who oppose reaches 78%. The Greeks, in 89%, believe that it is fundamentally unnatural. Furthermore, 85% expressed huge concerns on security issues. As the former Minister of Rural Development and Food as Professor of Genetics and

Biotechnology at AUTH, expressed concern for possible adoption of personal views in formulating national agricultural policy (Journal Ling, 2012). On the other hand, according to Tsourgiannis *et. al.* (2013), (2014), (2015a), (2015b) it appears that there might be potential buyers of products derived from GM trees and more particular for wood products, woody biomass energy products and paper products originating from transgenic plantations in Greece. Indeed, most of these potential consumers willing to purchase transgenic wood products base their buying decisions on economic issues (Tsourgiannis *et. al.* 2013, 2014, 2015a, 2015b). Taking into consideration that most of these products are not directly linked with human health impacts, there is a potential for development of a market for such products, particularly in current times of economic depression.

The Peter Coventry (2001) argued that the Forest Council in the US should allow the certification of GM tree plantations as "well managed" by the effects of GM trees with reduced lignin in soils in relation to the physical produced. The Zolotov (2003) mentions the success of GM maize crops in the United States and expresses concern about the low rates of crops in Europe. Despite initial skepticism about whether biotechnology in forestry can also be related to environmental issues, including the effects on organisms associated with tree living and ecosystems, are presented and benefits from genetic modification of lignin (Axelsson et al., 2010). The reasons for not widespread commercial use of biotechnology research presented in 90 specific US (Strauss et al., 2009).

The transgenic biotechnology can help the forest improvement programs, but can also simultaneously be of concern for the safety of the environment. Today there is an urgent need to establish a European platform to build on this knowledge of GMT (Gallardo et al., 2011). Due to the negative public opinion about the GMT, the Strif and Broshe (2001) proposed to focus the efforts of the whole enterprise in producing trees which are not intended for consumption by humans or animals. For example, crops for the manufacture of fibers such as cotton or flax.

Developments in the field of GMT in plant industry have led to increased crop production and yield in turn have increased the use of genetically modified (GM) foods in the human food chain. The use of genetically modified foods for human consumption has raised a number of fundamental issues such as the ability of genetically modified foods cause potentially harmful immunological side effects like allergic hypersensitivity (Prescott and Hogan, 2006). Kuiper and Kleter (2003) do compare the safety of conventional food with respect to genetically modified food.

Interesting aspects about genetically modified trees in forests, are the ethical considerations (Gamborg and Sandoe, 2010), the relevant environmental concerns in forests (Fladung et al., 2010), social, legal and regulatory issues related to genetically modified plants (Sedjo, 2010).

The paper is organized as follows. Section 2 describes the approach. Section 3 describes the results for both descriptive statistics and advanced analysis. Section 4 presents discussion about the results together with directions in the future.

2 Approach

This study proposes an approach for analyzing the attitudes of farmers in the region of Evros regarding the Genetically Modified Trees. The research method used was simple random sampling. Information was recorded following an interview with each farmer individually.

The questionnaire consists of three parts. The first part comprises three farmers' attitude questions regarding Genetically Modified Forest Trees with analytical control of many individual factors. The second part includes the recording demographics of farmers. Finally the third part includes the recording of operating data for each of 100 farmers.

The questionnaire includes mainly qualitative data that is data stored in non-numeric form in contrast to quantitative data that are in numerical form. The quality is the data that describe the characteristics or properties held by an object (Strauss and Corbin, 1998). The properties are categorized into classes that can then be assigned a numerical value. There is no significance to these data values, simply object characteristics. In some areas of social research, the distinction between qualitative-quantitative data has led to prolonged disputes where each group supports the superiority of its own data type (Trochim and Donnelly, 2006). The 'quantitative' claim that their data is strictly reliable and scientifically while 'quality' that their are respectively sensitive, detailed and contextual.

Therefore, we suggest the following assumptions:

H1: The cultivation intention is related to the gender of the farmer.

H2: The cultivation intention is related to the age of the farmer.

H3: The cultivation intention is related to the level of education.

H4: The cultivation intention is related to the farm size.

H5: The cultivation intention is related to the type of cultivation.

The analysis performed includes both descriptive statistics and advanced analysis using X^2 test.

3 Results

Here are the results after data processing in Excel software packages 2007 and SPSS 18.0.

3.1 Descriptive Analysis

The sample is 100 farmers in the region of Evros, in the North East Greece. 55 of them are male and 45 are women. 65 are married and for 65 of them farming is their main occupation.

Table 1. Distribution of the sample based on the knowledge of the term GMT.

Knowledge of the term	Number	Percentage
Know	100	100,0

Table 2. Distribution of the sample by the intention of cultivation.

Cultivation intention	Number	Percentage
No	70	70,0
Yes	30	30,0
Total	100	100,0

Table 3. Distribution of the sample by age.

Age	Number	Percentage
20-29	35	35,0
30-44	25	25,0
45-64	35	35,0
65+	5	5,0
Total	100	100,0

60% of the farmers in the sample are younger than 44 years old.

Table 4. Distribution of the sample based on educational level

Education	Number	Percentage
Primary school	25	25,0
Secondary school	15	15,0
High School	40	40,0
University	20	20,0
Master / Doctorate	0	0,0
Total	100	100,0

The distribution of the sample based on educational level is presented at table 4. 80% has graduated in High school or lower and only 20% are graduates of university.

Table 5. Distribution of the sample based on the number of children

Number of children	Number	Percentage
None	30	30,0
1-2 kids	60	60,0
3+ Children	10	10,0
Total	100	100,0

Table 6. Distribution of the sample by age of child

Age of children	Number	Percentage
No children	35	35,0
Small children (0-12 years)	15	15,0
In adolescents (13-18 years)	15	15,0
Large (18+ years)	35	35,0
Total	100	100,0

Table 7. Distribution of the sample by farm size

Farm size	Number	Percentage
<10 acres	25	25,0
11-50 acres	15	15,0
51-100 acres	10	10,0
101-200 acres	50	50,0
Total	100	100,0

Table 8. Distribution of sample by type of cultivation

Type of crop	Number	Percentage
Arable	15	15,0
Vegetables	35	35,0
Orchards	10	10,0
Groves	10	10,0
Forest plantations	30	30,0
Other	0	0,0
Total	100	100,0

3.2 Advanced Analysis

The results of the Chi-Square test regarding the hypotheses of section 2, are presented in this subsection.

Table 9. Cultivation intention in relation to gender

Cultivation of GMT	Female	Male	Total
No	30	40	70
Yes	15	15	30
Total	45	55	100

There is no dependence to gender (value of Pearson Chi-Square= is 0.433, df=1, p-value=0.511).

Table 10. Cultivation intention in relation to age

Cultivation of GMT	Age				Total
	20-29	30-44	45-64	65+	
No	20	10	35	5	70
Yes	15	15	0	0	30
Total	35	25	35	5	100

There is dependence to age (value of Pearson Chi-Square= is 30.612, df=3, p-value<0.001). Younger farmers are less negative to the cultivation of GM forest trees.

Table 11. Cultivation of GMTs in relation to level of education

Would you cultivate GMTs?	Level of education				Total
	Primary school	Secondary school	High School	University	
No	25	10	20	15	70
Yes	0	5	20	5	30
Total	25	15	40	20	100

There is dependence to level of education (value of Pearson Chi-Square= is 18.651, df=3, p-value<0.001). It is worth to notice that farmers with basic education and university graduates are the most negative to the cultivation of GMT.

Table 12. Cultivation of GMTs in relation to farm size

Would you cultivate GMTs?	Farm size				Total
	<=10 acres	11-50 acres	51-100 acres	101-200 acres	
No	5	10	10	45	70
Yes	20	5	0	5	30
Total	25	15	10	50	100

There is dependence to the farm size (value of Pearson Chi-Square= is 43.651, df=3, p-value<0.001). Farmers who own less or equal to 10 acres, responded that would cultivate GMT in 80%.

Table 13. Cultivation of GMTs in relation to the type of cultivation

Would you cultivate GMTs?	Type of cultivation (crop)					Total
	Arable	Vegetables	Orchards	Groves	Forest plantations	
No	5	20	10	5	30	70
Yes	10	15	0	5	0	30
Total	15	35	10	10	30	100

There is dependence to the type of cultivation (value of Pearson Chi-Square= is 31.406, df=4, p-value<0.001). Farmers. Farmers who cultivate arable and vegetables are these who mostly would accept the cultivation of GMTs.

Table 14. Distribution of cultivation factors in median and percentile points (quartiles)

Factor	25%	Median	75%	Cronbach's Alpha
Q2a	2,50	3,50	4,00	
Q2b	1,00	3,50	4,00	
Q2c	1,00	3,50	5,00	
Q2d	1,75	3,00	3,00	
Q2e	1,00	2,50	3,00	0.854
Q2f	1,00	2,00	3,25	
Q2g	1,00	1,00	2,00	
Q2h	1,00	1,00	1,25	
Q2i	1,00	1,00	1,00	

The Cronbach's Alpha value is 0.854.

We create a new variable which is the average value of all factors of table 15. Its mean value is 2.17 (standard deviation 0.69).

Table 15. Relation of cultivation with gender

	gender	N	Mean
cultivation	Female	15	2,5926
	Male	15	1,7407

Males seem to be more positive about cultivation compared to Females (t=4.271, df=14, p-value=0.001).

Table 16. Relation of cultivation with type of cultivation

	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	Upper Bound
Arable	5	1,8889	,00000	1,8889	1,8889
Vegetables	20	2,3056	,25964	2,1840	2,4271
Orchards	10	3,1667	,99553	2,4545	3,8788
Forest plantations	30	2,6667	,00000	2,6667	2,6667
Other	70	2,4444	,89224	2,1113	2,7776
Total	70	2,4841	,76678	2,3013	2,6670

The willingness of farmers not to cultivate genetically modified products depends on the type of crop ($F_{4,65} = 3.555$, $p = 0.011$). Those with orchards are on average from 0.13 to 2.4 higher willingness not to cultivate genetically modified compared with those with arable (p-value = 0.018). Similarly those who have Orchards have, on average, from 0.1 to 1.7 higher willingness to cultivate non-GM compared to those with Vegetables (p-value = 0.0028).

Table 17. Relation of cultivation with farm size

	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	Upper Bound
<10 acres	5	2,5556	,00000	2,5556	2,5556
11-50 acres	10	3,3333	,81985	2,7468	3,9198
51-100 acres	10	2,4444	,35136	2,1931	2,6958
101-200 acres	45	2,2963	,74724	2,0718	2,5208
Total	70	2,4841	,76678	2,3013	2,6670

The willingness of farmers not to cultivate genetically modified products depends on the farm size ($F_{3,66} = 6.130$, $p = 0.001$). Those who have croplands from 11 to 50 acres have, on average from 0.04 to 1.7 units, higher willingness not to cultivate genetically modified comparatively with those who have from 51 to 100 acres (p-value = 0.033). Similarly those who have croplands from 11 to 50 acres have, on average from 0.4 to 1.7, higher willingness not to cultivate genetically modified comparatively with those who have from 101 to 200 acres (p-value = 0.001).

Table 18. Distribution of non cultivation factors in median and percentile points (quartiles)

Factor	25%	Median	75%	Cronbach's Alpha
Q2p	2,50	4,00	5,00	
Q2q	1,00	1,00	2,00	
Q2r	1,75	2,50	3,25	
Q2s	1,00	2,00	3,25	
Q2t	2,00	3,00	4,00	0.820
Q2u	1,00	3,00	3,25	
Q2v	1,75	3,00	4,00	
Q2w	1,00	3,00	3,25	
Q2x	1,00	1,00	1,00	

The Cronbach's Alpha value is 0.820. We create a new variable which is the average value of all factors of table 18. Its mean value is 2.48 (standard deviation 0.77).

Table 19. Relation of type gender with the possitiveness about non cultivation

	q4a	N	Mean	Std. Deviation
q2second	Female	30	2,6852	,70399
	Male	40	2,3333	,78567

Males and females does not differ according to possitiveness about non cultivation compared to Females. (t=1.937, df=68, p-value=0.057)

Table 20. Relation of type of cultivation with the willingness of farmers to cultivate GMT

	N	Mean	95% Confidence Interval for Mean	
			Lower Bound	Upper Bound
Arable	10	2,6667	2,5829	2,7505
Vegetables	15	2,1481	1,7648	2,5315
Forest Plantations	5	1,2222	1,2222	1,2222
Total	30	2,1667	1,9091	2,4242

The willingness of farmers to cultivate genetically modified products depends on the type of crop ($F_{2.27} = 13.764$, $p = 0.001$). Those who cultivate arable are on average from 0.7 to 2.1 higher willingness to cultivate genetically modified compared with those who cultivate forest plantations (p-value = 0.001). Similarly those who cultivate vegetables are on average from 0.3 to 1.5 higher willingness to cultivate genetically modified compared with those who have forest plantations (p-value = 0.001).

Table 21. Distribution of attitude factors vs the use of biotechnology (quartiles)

Factor	25%	Median	75%	Cronbach's Alpha
Q3a	2,00	2,50	4,00	
Q3b	1,00	3,00	4,00	
Q3c	2,00	3,00	3,75	
Q3d	1,00	3,00	3,00	
Q3e	2,25	3,50	4,00	
Q3f	3,25	4,00	5,00	0.915
Q3g	1,00	5,00	5,00	
Q3h	4,00	5,00	5,00	
Q3i	3,25	5,00	5,00	
Q3j	1,00	3,00	3,00	
Q3k	1,00	3,00	3,75	

4 Discussion and Conclusions

The aim of this study was to investigate the attitudes of farmers regarding the GMT. From the beginning there was the limitation of the number of responses. All the responders come from the same area (Evros). So possible generalized conclusions would be unreliable.

Nevertheless the value of the study in precious as it is the first study in Greece which examines the farmers attitudes towards the use of biotechnology in forest tree sector. In this research confirmed the continued negative attitude of the majority of farmers in relation to the cultivation of GMT, which has been recorded by the relevant survey reports Eurobarometer (European Commission - EC, 2010). In general, elder people with low education, mainly female, with large scale farms seems not to be in favour of cultivating transgenic trees whilst most of the younger, high educated, mainly male, small scale farmers are more positive towards the cultivation of GM trees.

In a constantly changing world, the persistence of the established notions of the past creates rigidities and barriers to future challenges. On the other hand the respect of values and tradition is essential for any organization. Somewhere there must be "balance" one for cultivation or not GMT.

According to Mc Donell et al (2010), the current decade will be important for researchers of trees. Conducting such research could contribute to better information on a subject that for others considered "taboo" and other necessary development. Furthermore the potential developers of such forest tree plantations and paper, wood and woody biomass energy products should structure their marketing and promotion according to the farmers profile that this study developed. Additionally a campaign that will aim to inform public about the use of biotechnology in forest tree sector and its advantages and disadvantages should take place.

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