Sci Eng Ethics (2016) 22:509–524
DOI 10.1007/s11948-015-9653-1

ORIGINAL PAPER

Attitudes of Agricultural Experts Toward Genetically Modified Crops: A Case Study in Southwest Iran

Mansour Ghanian[1] · Omid M. Ghoochani[1] · Miranda Kitterlin[2] · Sheida Jahangiry[1] · Kiumars Zarafshani[3] · Steven Van Passel[4] · Hossein Azadi[4,5,6]

Received: 13 September 2014 / Accepted: 14 May 2015 / Published online: 5 June 2015

Abstract The production of genetically modified (GM) crops is growing around the world, and with it possible opportunities to combat food insecurity and hunger, as well as solutions to current problems facing conventional agriculture. In this regard the use of GMOs in food and agricultural applications has increased greatly over the past decade. However, the development of GM crops has been a matter of considerable interest and worldwide public controversy. This, in addition to skepticism, has stifled the use of this practice on a large scale in many areas, including Iran. It stands to reason that a greater understanding of this practice could be formed after a review of the existing expert opinions surrounding GM crops. Therefore, the purpose of this study was to analyze the predictors that influence agricultural experts' attitudes toward the development of and policies related to GM crops. Using a descriptive correlational research method, questionnaire data was collected from 65 experts from the Agricultural Organization in the Gotvand district in Southwest Iran. Results indicated that agricultural experts were aware of the environmental benefits and

✉ Omid M. Ghoochani
Mehrab.omid@gmail.com

✉ Miranda Kitterlin
mkitterl@fiu.edu

1 Department of Agricultural Extension and Education, Khuzestan Ramin Agriculture and Natural Resources University, Ahvaz, Iran

2 Chaplin School of Hospitality and Tourism Management, Florida International University, Miami, FL, USA

3 Department of Agricultural Extension and Education, Razi University, Kermanshah, Iran

4 Centre for Environmental Sciences, Hasselt University, Hasselt, Belgium

5 Department of Geography, Ghent University, Ghent, Belgium

6 Economics and Rural Development, Gembloux Agro-Bio Tech, University of Liège, Liège, Belgium

possible risks associated with GM crops. The majority of participants agreed that GM crops could improve food security and accelerate rural development, and were proponents of labeling practices for GM crops. Finally, there was a positive correlation between the perception of benefits and attitudes towards GM crops.

Keywords Food security · Genetically modified crops · Agricultural development

Introduction

An extraordinary period of agricultural growth occurred during the 1960s and 1970s that resulted in increased food production that saved millions of people from sickness, hunger, and death; this period has come to be known as the 'Green Revolution' (Pingali and Raney 2005; Uphoff 2012). Thanks to the agricultural advances created under the banner of the Green Revolution the number of people in danger of malnutrition worldwide has decreased significantly over the past four decades (Butz and Wu 2004; Uphoff 2012). Global population growth, on the other hand, has doubled during this time (Apelian 2007). It is estimated that the world population will increase to 8 and 9 billion people by 2050 (Bloom 2007, 2010; Sharma 2012). Further, it is estimated that approximately one billion people still lack adequate access to food (Butz and Wu 2004; United Nations 2008), yet the amount of land devoted to farming has stayed about the same (Bloom 2007, 2010). Thus, the critical question remains: How will these people be fed?

Gene Revolution

Now the world is experiencing its second agricultural revolution: the "Gene Revolution" (Pingali and Raney 2005; Azadi et al. 2015). Centered on modern biotechnology, the Gene Revolution carries with it a highly debated controversy over the associated opportunities and threats. Biotechnology, as understood here, refers to any technological application that uses biological systems, living organisms, or derivates thereof, to make or modify products or processes for specific use (Healy 2002; Koester 2012). Organisms that have been genetically modified (GM) by genetic engineering are referred to as genetically modified organisms (GMOs) (Amin et al. 2011; Van Eenennaam 2005; Stilwell and Van Dyke 1999).

GM Crop Benefits and Opportunities

Some scholars believe that biotechnology can play an important role in accelerating a country's transformation into a highly industrialized nation (Amin et al. 2005, 2006, 2011; Arantes-Oliveira 2007; BIOTECHCORP 2010). Large-scale planting of GM crops began in 1996 (Ronald 2011; Que et al. 2010), and its application intermittently increased to 134 million hectares by 2009 (Kimenju et al. 2013). By 2010, 148 million hectares (10 % of world's arable lands) were already covered by GM crops in 29 countries (Lusser et al. 2012; ISAAA 2010), including 19 developing countries and 10 industrialized nations (ISAAA 2012).

Proponents of the biotechnology-driven Gene Revolution and GM crops advocate that this practice could be tailored to meet the needs of food shortages and attainment of food security around the world (Butz and Wu 2004), and that biotechnology may provide solutions to the current problems of conventional agriculture (Ghasemi et al. 2013; Runge and Jackson 2000). Additionally, the abundance of pesticides currently used in food production not only threatens the farm environment, but also destroys useful organisms in the soil (Bao-Rong 2006). GM crops reduce the need for herbicides and pesticides while simultaneously reducing production costs; this, in turn, increases yield, may provide a more favorable farming environment, and encourages environmental sustainability (Carter 2007; Grunert et al. 2001; Uzogara 2000; Moon and Balasubramanian 2001; Fritz et al. 2003; Huang et al. 2004; Chen and Li 2007; Martinez-Poveda et al. 2009; Soregaroli et al. 2003).

Further, GM crops offer a higher resistance to dry and excessive wet weather, increased shelf-life, and improved flavor, nutritional value, and color (Ghasemi et al. 2013; World hunger 2003; Yohe et al. 2009; Buah 2011). These crops act as a renewable resource, and may aid in pharmaceutical products and the delivery of vaccines via biopharmaceuticals (i.e. edible plant vaccines) (Carter 2007; Nap et al. 2003; Hosseini et al. 2012). Finally, GM crops have the potential to revolutionize agriculture worldwide, particularly in developing countries, in ways that would substantially reduce malnutrition, increase rural income, and improve food security, while also reducing environmental pollutants (Bao-Rong 2006; Goyal and Gurtoo 2011). For these reasons and more it has been proposed that the GM crop practice is not only of great value, but a moral obligation (Carter 2007).

GM Crop Criticisms and Concerns

Despite the numerous benefits attributed to the use of GM crops, some concerns remain. Examples of the hypothetical threats presented by GM crop use are as follows: the possibility of unwelcome effects on other organisms, the creation of super weeds, gene flow to untargeted varieties, hygiene concerns (i.e. allergenicity, especially in children), environmental pollution, cross-pollination, potential creation of new viruses and toxins, limited access to seeds due to the patenting of GM plants, the threat to crop genetic diversity, religious/cultural/ethical concerns, and the fear of unforeseen consequences (Zarrilli 2005; Bazuin et al. 2011; Nap et al. 2003; Whitman 2000; Ghasemi et al. 2013; Peterson et al. 2000; Qaim and Matuschke 2005; Zarrilli 2005; Rao et al. 2006; Uzogara 2000; Yohe et al. 2009; Ruane and Sonnino 2006; Withman 2000; Azadi and Ho 2010). It stands to reason that the aforementioned trepidations have a direct impact on consumer acceptance of GM foods (Ghasemi et al. 2013). Consumer resistance has been found to act as a primary barrier to the diffusion of GM foods (Heiman et al. 2000), thus impeding the advancement of GM crop practices (Angulo and Gil 2007; Chen 2008; Chen and Li 2007; Kim 2012). Accordingly, many researchers investigated the effects of consumers' attitudes toward the acceptance of such crops (Angulo and Gil 2007; Chen and Li 2007; Chen 2008; Kim 2012; Prati 2012). However, it should be noted that the consumers' resistance might be based on somewhat uninformed judgments

and the possibility of hypothetical threats (Zwick 1998). Moreover, it is assumed that those who are actively involved in biotechnology debates are also well-informed. It allows for research to go beyond simple questions designed for citizens who are hardly familiar with agricultural biotechnology and its environmental, health and socioeconomic risks and benefits. It can be assumed that stakeholders are well-informed and have a significant influence on those citizens who are not or hardly informed about this technology. It would be beneficial to know more about the perceptions of the actual farmers who eventually grow transgenic crops, and those of consumers who eventually consume GM food in developing countries. In Iran, few studies have been conducted to investigate the experts' attitudes towards GM crop utilization. Hosseini et al. (2011) investigated agricultural experts' perceptions toward advantages and constraints in the application of GM crops and found a negative relationship between perceptions of respondents toward the application of these crops and economic, managerial, social, policy-making and environmental constraints. Naeemi et al. (2010) studied the attitudes of biotechnology experts in the Tehran province towards the application of GM crops. Their attitudes towards using these crops showed a positive correlation with ecological, socio-economic and health-hygiene aspects of GM plants. Similarly, Ghasemi et al. (2013) studied agricultural professionals' perceptions toward GM foods in Southwest Iran. They found that majority of the agricultural experts had little awareness about GM foods and perceived only few benefits or threats about GM foods. Such investigations originate from a different nature and can be rather time-consuming. Nevertheless, it seems particularly important when producers and consumers in developing countries become more aware and have more personal experience with food and crops derived from genetic engineering (Aerni 2002).

Summary and Research Questions

Similar to many other developing countries, GM crops were introduced in Iran in an attempt to improve production yield. However, due to governmental skepticism, the crops are not yet cultivated and produced at a large scale, thus they cannot be presented at market (Ghasemi et al. 2013). Assessing the attitude of innovators such as agricultural NGOs and leading farmers that have the ability to either bring this innovation to society or to inhibit the diffusion of this innovation is imperative. One of these GM crop gatekeepers in Iran is the agricultural expert; these experts will either recommend an innovation to farmers or act as inhibitors to a practice. Thus, the purpose of this study is to explore the attitude of agricultural experts toward GM crops in Southwest Iran. This purpose combined with a review of the existing literature led to the development of the following research questions: (1) What do agricultural experts perceive to be the benefits of GM crops? (2) What do agricultural experts perceive to be the risks of GM crops? (3) What is the general attitude of agricultural experts towards GM crops? (4) What is the attitude of agricultural experts towards labeling of GM crops? (5) What is the relationship between agricultural expert attitudes towards perceived benefits and risks of GM crops?

Materials and Methods

Research Framework

Vänninen et al. (2009) define an attitude as "favorable or unfavorable disposition susceptible to transient influences…a complex mental state involving beliefs, feelings, values and dispositions to act in certain ways" (p. 107). In this regard, attitude can be used to explain why some people support particular social policies or ideologies while others oppose them. Possibly the most accepted underlying theory of the formation of consumer attitude is the Fishbein Multi-attribute Model (Costa-Font et al. 2008). Under this framework, which also referred to as the 'bottom-up' formation of attitudes, an attitude towards a product is defined based on knowledge about the product itself as well as its attributes (Grunert et al. 2001). More specific to the topic of this study, Bredahl et al. (1998) argues that a consumer's attitude towards GM foods is determined by their perception of risks (consumer's unfavorable attitude) and benefits (consumers' favorable attitude) of applying gene technology to produce food products. Therefore, consumer attitude is shaped by their perceived risks and benefits associated with the product and process (Costa-Font et al. 2008). This idea that risks and benefits of genetic engineering are important determinants of consumer attitude is one that is supported in numerous studies (Bredahl 2001; Chen and Li 2007; Frewer and Shepherd 1995; Hamstra 1991, 1995; Shaffer et al. 2006; Sparks and Shepherd 1994), with perceived risks contributing a negative influence over attitude (Azzam 2013; Costa-Font and Gil 2009; Morrow 2009), and perceived benefits making a positive influence on attitude (Arvanitoyannis and Krystallis 2005; Chen and Li 2007; Costa-Font and Gil 2009). Bredahl et al. (1998) suggests an explicit distinction between beliefs about risks and benefits associated with the application of genetic engineering in food production. On the basis of this research framework, a conceptual model is presented in Fig. 1.

The following hypotheses were formulated for this study:

H1 When agricultural experts perceive more risks about GM crops, they are less interested in recommending them.

H2 When the experts perceive more benefits for GM crops, they are more interested in recommending them.

In order to answer the questions and test the hypotheses developed in this study a correlational survey study was conducted to determine agricultural experts' attitudes

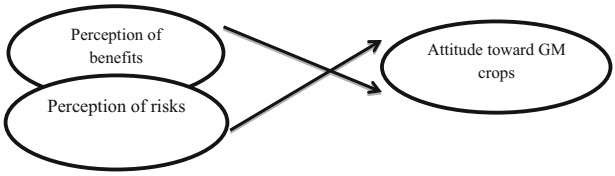

Fig. 1 The underlying conceptual model of research (Shaffer et al. 2006)

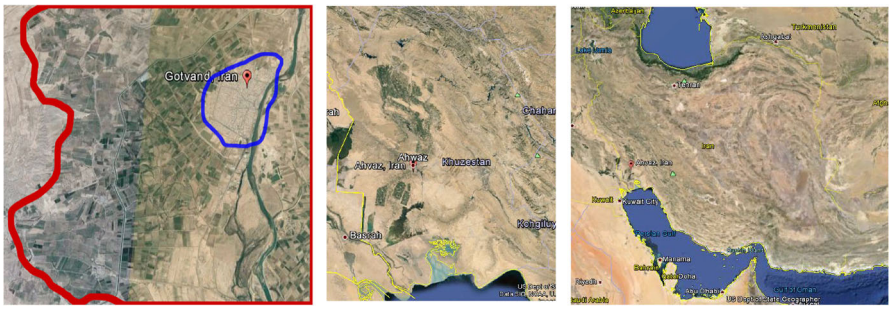

Fig. 2 The location of Gotvand district in Iran (The *right figure* Iran. The *center figure* Khuzestan province. The *left figure* Gotvand district and its arable lands)

toward GM crops. The population of this study consisted of agricultural experts[1] working in the Agricultural Organization of the Gotvand district in the Khuzestan province located in Southwest Iran in 2013 (Fig. 2). Khuzestan in general and Gotvand in particular are known for strategic crops in Iran. Accordingly, this study is novel in that no study has yet been conducted in the Khuzestan province on GM crops and foods using a stakeholder approach with focus on agricultural experts.

A total sample of 65 experts was selected randomly using completely random sampling method by Krejcie and Morgan's (1970) sample size table (N = 75). The data was collected using a researcher-made questionnaire. "Perception of benefits", "perception of risks" and "attitude toward GM crops" were respectively assessed by 15, 9 and 16 continuum scales (ranked from 1: Fully disagree to 5: Fully agree). The constructs were first developed based on the literature review. Then, the validity of the questionnaire was confirmed by a panel of the faculty members at the Department of Agricultural Extension and Education of Ramin University. Afterwards, a pilot test was conducted to determine the reliability of the questionnaire. The reliability of the questionnaire was tested using Cronbach's alpha coefficients estimated at 0.72, 0.76 and 0.84 for the indicators of "perception of benefits", "perception of risks" and "attitude toward GM crops", respectively.

Results

Respondents' Demographic Attributes

Table 1 presents a cross-section of the agricultural experts studied in this research. As seen in Table 1, the agricultural expert sample included 29 men (45.3 %), and 35 women (54.7 %). The majority of the respondents were over 28 years of age (62.5 %), and 75.3 % of respondents held a bachelor's degree, while 24.6 % held master's degrees. The majority of participants (65 %) had more than 4 years of work experience.

[1] The agricultural experts are those who work in the agricultural organization and they are high educated (university level) specialized in a specific discipline/crop.

Table 1 Participant demographics

Demographic attributes	Category	Frequency	Valid percent
Gender	Male	29	45.3
	Female	35	54.7
	No response	1	–
Education	Bachelor	49	75.3
	Master	16	24.6
Job experience (year)[a]	>4	39	65
	≤4	21	35
	No response	5	–
Age (year)[a]	>28	40	62.5
	≤28	24	37.5
	No response	1	–

[a] Categorized by mean score

Perception of Benefits

The results of the agricultural experts' perceptions toward the benefits of GM crops are shown in Table 2. As seen in the table, agricultural experts generally considered there to be high benefits associated with the use of GM crops.

As shown in Table 2, expert participants indicate that they felt the use of GM crops could reduce environmental pollution, as well as accelerate agricultural development. Participants also reported that global sales of GM seeds are growing. Statements that "GM crops are as safe as conventional crops" and "GM crops are healthy and harmless" were reported as being ninth and tenth priorities, respectively. Responses indicate that the most important benefits of GM crop cultivation are the environmental aspects as well as applicable ways to attain agricultural development. This finding is similar to that of Aerni (2001), who found that stakeholder attitudes supported biotechnology as a powerful tool to address

Table 2 Perceived benefits of GM crops

Perceived benefits	Mean	SD	CV	Rank
Developing GM crops can help reduce environmental pollution	3.11	1.174	0.3774	1
Producing GM crops is the most applicable way for agricultural development	3.43	1.295	0.3775	2
Global sales of GM seeds are growing	3.52	1.330	0.3778	3
GM crop products can alleviate starvation around the world	3.22	1.262	0.391	4
GM crops can increase agricultural production	3.42	1.342	0.392	5
GM crops are distinguishable from non-GM crops by gene sequencing	3.22	1.288	0.400	6
GM crops can decompose in the environment the same as non GM crops	3.21	1.355	0.422	7
GM crop cultivation increases yield, preserve forests and pastures	3.15	1.394	0.442	8
GM crops are as safe as the conventional crops	2.73	1.285	0.470	9
GM crops are healthy and harmless	2.75	1.356	0.493	10

Table 3 Perceived risks of GM crops

Perceived risks	Mean	SD	CV	Rank
Extensive use of GM crops may eliminate indigenous biodiversity	3.562	1.219	0.342	1
GM crops may be the main cause of cross-pollination	3.296	1.243	0.377	2
Legal or illegal importation of GM crops is a threat to the host country's genetic resources	3.63	1.568	0.431	3
Long-term consumption of GM crops is worrisome and has unknown consequences	2.933	1.376	0.469	4
GM crops will be susceptible to pests, after a while	3.016	1.419	0.470	5
Adopting GM crops may lead to unemployment among seed dealers	2.892	1.448	0.500	6
GM crop cultivation may cause skin allergies	2.793	1.404	0.502	7
GM crops may cause allergic diseases among humans	2.646	1.339	0.506	8
GM crops may transfer the modified genes from GM crops to humans after consuming such products.	2.672	1.468	0.549	9

challenges in agriculture, nutrition and environment. Conversely, Han (2006) found consumer attitudes to be hesitant to the practice, indicating a concern for the health aspects of GM crops, with food safety being the most crucial factor when considering GM crops in the market.

Perception of Risks

The agricultural expert respondents' perceptions of risks associated with GM crops (mainly human health and environmental impacts) are shown in Table 3. As shown in the table, mean ranks for all the statements are more than 2.67, indicating a perception of high risks associated with GM crops. The primary concern indicated by participants was the concern that extensive use of GM crops may result in biodiversity loss. The second and third risk concerns included cross-pollination of GM crops and the importing of GM crops threatening the country's genetic resources. Of lesser concern were the ideas that "GM cultivation may cause skin allergies", "GM cultivation may cause skin allergies" and "GM crops may transfer the modified genes from GM crops to human by its consuming the products." These findings confirm the results of Table 2, that agricultural experts are less concerned about the health aspects of GM crops, and drew more attention to environmental aspects of GM crops. These findings are supported by those of previous studies that also found the environmental aspect of GM cops to be considered more important than other risk factors (Aerni 2002; Raney 2006). Other studies, however, report contradicting findings, in which health and hygiene aspects were of greater concern (Dale 1999; Senarath and Karunagoda 2012).

Experts' Attitude Towards GM Crops

The main goal of this study was to investigate agricultural experts' attitude towards GM crops in Iran. Results showed that the agricultural expert participants reported

positive attitudes towards GM crops (M = 46.45, SD = 10.43). Iran is a major importer of agricultural commodities, mainly from India and China as two large producers of GM crops. In this regard, the experts stated that GM crops may find their way to Iranian markets intentionally or unintentionally. A second main feature that was reported was that "the growth of GM crops production around the world, find high acceptance among farmers" could facilitate the import of GM crops to the country. Further, results indicated that experts felt the main which public concern related to GM crop production is the lack of acquaintance with the methods and results of genetic engineering and gene transfer techniques of the plant. Of lesser priority were the ideas that the GM crops importation is not important and traditional plant breeding methods is enough to solve the food problems. It can be seen that their attention to the necessity of importing legislation and it is in line with the first priority of this table. Also, in the view of the agricultural experts, the traditional methods of plant breeding are not accountable for the food problems, and the need to achieve other agricultural alternatives will be felt (Table 4).

Table 4 The attitude of experts towards GM crops

Attitude	Mean	SD	CV	Rank
Iran is an importer of agricultural plants therefore will form part of the GM crops market	3.27	1.133	0.346	1
The high willingness to accept GM crops by farmers around the world can be proved by the growth of GM crops production	3.47	1.236	0.356	2
The most important aspect of public concern in the production of GM crops is the lack of acquaintance with the methods and results of genetic engineering and gene transfer techniques	3.5	1.253	0.358	3
GM crops' production is in line with sustainable agricultural development goals	3.49	1.281	0.367	4
There is no monitoring system of GM crops imports	3.31	1.245	0.376	5
In developing countries like Iran, the resistance of consumers is the main barrier toward the development of GM crops	3.33	1.257	0.377	6
Production of GM crops can make a great revolution in agriculture	3.38	1.300	0.384	7
Like other phenomenon, we have to accept the adverse effect of GM crops, and try to eliminate them	3.40	1.311	0.385	8
Particular attention to the production of GM crops, increase need of material resources and energy	3.14	1.249	0.397	9
There isn't any general agreement about the adverse effects of GM crops	3.2	1.272	0.397	9
Biosafety legislation in the field of plant production can eliminate barriers and advance this innovation	3.08	1.258	0.408	11
Population growth, food shortage and limited resources are the main motivations for GM crop development	3.39	1.393	0.410	12
Every technology and innovation is associated initially with a series of disagreements and challenges. In the production of GM crops this issues seems very natural	3.32	1.411	0.425	13
There is skepticism around the world about using GM crops	2.69	1.209	0.449	14
The GM crops importation legislation is not important	2.86	1.346	0.470	15
Traditional methods of plant breeding are enough to solve food insecurity problem.	2.34	1.493	0.638	16

Table 5 Frequency distribution of the respondents' perception toward the necessity of labeling GM crops

	Frequency	Valid percent	Cumulative percent
Fully disagree	1	1.6	1.6
Disagree	1	1.6	3.2
Don't know	11	17.7	21
Agree	16	25.8	46.8
Fully agree	33	53.2	100
No answer	3	–	–

Necessity of Labeling GM Crops

Each respondent was questioned about their stance on the labeling of GM crops. Results are provided in Table 5. The majority of respondents (79.0 %) indicated some level of agreement with the practice of labeling these crops. This finding indicates that respondents were more willing to separate GM crops from non-GM crops so that consumers could easily distinguish between these two different products. These results are supported by previous findings of other such studies that showed that respondents are supportive of the labeling of GM crops (Amal Bakr and Lukman Ayinde 2013; Ganiere et al. 2004; Senarath and Karunagoda 2012).

Attitude, Benefits and Risks

In order to explore the association between the overall attitude of agricultural experts towards GM crops and perception of benefits and risks, Pearson correlation coefficients were estimated (Table 6).

As shown in Table 6, there is a significant and positive correlation between "attitudes toward GM crops" and "perception of benefits" ($r = 0.675$, $P \leq 0.01$ %). However, there is no significant correlation between the perception of risks and attitude of the respondents. This implies that, regardless of experts' attitude towards GM crops, there are inherent risks in GM technology. This finding is supported by the findings of Han (2006), Chen (2008), Ismail et al. (2012) and Chong (2005), who found that respondents were more optimistic about applying gene technology to food production if they hold positive attitudes toward GM crops. Additionally, Amin et al. (2005) reported that explaining both perception of benefits and risks could significantly influence the respondents' attitude toward GM crops; this may offer an opportunity to inform the public so as to influence attitudes.

Table 6 Association between "attitude toward GM crops", "perception of risks" and "perception of risks" (Pearson correlation)

	Attitude	Perception of risks	Perception of benefits
Attitude	1		
Perception of risks	0.244	1	
Perception of benefits	0.675**	0.169	1

** $P \leq 0.01$

Discussion

This study sought to investigate the agricultural experts' perception towards GM crops in Iran. Overall, results showed that experts hold a positive attitude towards GM crops. Moreover, the correlation analysis revealed that perceived benefits of GM crops influences the experts' attitude. The positive attitude of agricultural experts towards GM crops clearly indicates the open mindedness of policy-makers towards such technologies. Almost all of the respondents believed that it is necessary to separate GM crops from non-GM crops by labeling.

Implications

Several recommendations can be made to improve the policy and practical framework within which promotion of GM crops is practiced. First, GM crops may be considered as a solution to food insecurity. However, in order to achieve this, consumer concerns related to this technology must diffused; one strategy being the government's instigation of more risk assessment studies. The government could take responsibility of monitoring the proper functioning of safety protocols in producing GM crops. There should also be an increase in the transparency of formulating fair laws, as well as more frequent and effective communication with stakeholders. Seeing as how the agricultural experts presented greater concern towards the environmental risk of GM crops, the government should turn greater attention to environmental risk assessment and risk assessment, frameworks should be more transparent. Therefore, the government should emphasize a science-based and case-by-case environmental biosafety assessment prior to the commercial production of any GM crops.

Next, the positive attitude of the agricultural expert participants indicated a readiness to diffuse this technology to farmers. In order to decrease the pressure on the farmers with fewer resources, the agricultural ministry should agree to purchase GM crops from the farmers at a guaranteed price.

Instead of a passive communication strategy which attempts to react to the stakeholders' questions on GM crops, an active communication strategy should be launched in which the government is proactive in taking initiatives and providing stakeholders with valid information on GM crops. Absent or weak communication of research and extension institutions is a significant barrier for the agricultural development of the country. Strengthening the linkage between research and extension institutions and increasing the role of all stakeholders in developing an appropriate technology would accelerate the adoption of this technology by stakeholders. One suggestion is to establish a committee of representatives from the three sectors of Extension, Education and Research (EER committee). This committee would then be charged with monitoring all activities related to GM technology in agriculture.

There is a need for a well defined communication strategy to provide information in such a way that allows individuals to feel adequately and satisfactorily informed about GM crops. This has been supported by previous studies focusing on the hydraulic approach (e.g. Huffman et al. 2004; Gaskell et al. 2000, 2001, 2004). According to Gaskell et al. (2004), public opposition toward GM crops results from

misperception of the risks by public. They have developed a strategy of accurate risk communication from trustworthy sources according to the scientific evaluation, noting that there is no unique risk from GM crops and foods. Mass media should provide programs to describe the benefits and risks of GM crops, as the public is interested in and entitled to this information. Therefore information provided via mass-media should be multi-dimensional. Specifically, the creation of informational television channels for farmers, as well as programs to introduce the advantages and disadvantages of GM crops should be considered. This would establish a comprehensive data base for stakeholders. However, there is much literature on sociological, anthropological and psychological aspects demonstrating that, in contrast with our results on the effect of more information, there are socio-psychological and cultural factors influencing public perceptions toward the risk of GM food (e.g. Finucane and Holup 2005; Finucane 2002; Draper and Green 2002). Importantly, Draper and Green (2002) found that for majority of consumers, the judgments that they tend to trust refer mainly to safety standards. For others, this trust could be extended to include judgments about ethical considerations of availability of a product. In short, things like food choices are framed by cultural, social, and material circumstances (Draper and Green 2002).

The attitude of other stakeholders of GM crops in the country such as farmers (especially progressive farmers), agricultural firms' management, and consumers should be evaluated to establish a more complete understanding of this technology. Finally, with regard to production and importation, GM crops should be separated from non-GM crops through the use of labeling. This could fall under the umbrella of the responsibilities of the aforementioned EER committee.

Limitations and Future Research

This study is not without its limitations. Specifically, the results of this study must be acknowledged as the outcome of a case study, and can only be extended to represent the area of Southwest Iran. Further extensions to other regions are needed to make generalizations on agricultural experts' attitudes in relation to GM crops. Also further studies should be conducted on the attitude of all stakeholders in the food chain to attain a comprehensive view towards this product. Next, as this study did not ask for the influence of the respondents' religious convictions, future studies should collect and analyze such information to find out their possible correlation with the perceived ethics. Last but not least, a complementary qualitative study is needed to deepen our understanding about some contradictions emerging on the environmental impacts of GM cops. Therefore, future studies could apply a mixed-method approach including both qualitative/quantitative measurements to make a triangulation on such multi-faceted attitudes.

References

Aerni, P. (2001). Public attitudes towards agricultural biotechnology in developing countries: A comparison between Mexico and the Philippines. *Science, Technology and Innovation Discussion Paper, 10*, 1–16.

Aerni, P. (2002). Stakeholder attitudes toward the risks and benefits of agricultural biotechnology in developing countries: A comparison between Mexico and the Philippines. *Risk Analysis, 22*(6), 1123–1137.

Amal Bakr, S., & Lukman Ayinde, O. (2013). Awareness of GM food proliferation in Saudi Arabia: A case study of Makkah city. *Journal of the Association of Arab Universities for Basic and Applied Sciences, 13*(1), 8–13.

Amin, L., Azlan, N. A. A., Ahmad, J. H., Hasrizul, L., Samian, A., & Haron, M, S. (2011). Ethical perception of synthetic biology. *African Journal of Biotechnology*, *10*(58), 12469–12480. http://www.academicjournals.org/AJB

Amin, L., Jahi, J. M., Nor, A. R. M., Osman, M., & Mahadi, N. M. (2006). Uncovering factors influencing Malaysian public attitude towards modern biotechnology. *Asia Pacific Journal of Molecular Biology and Biotechnology, 14*(2), 33–39.

Amin, L., Nor, A. R. M., Jahi, J. M., Osman, M., & Mahadi, N. M. (2005). Factors for a socially acceptable gene technology. *Malaysian Journal of Environmental Management, 6*, 137–146.

Angulo, A. M., & Gil, J. M. (2007). Spanish consumers' attitudes and acceptability towards GM food products. *Agricultural Economics Review, 8*(1), 50.

Arantes-Oliveira, N. (2007). A case study on obstacles to the growth of biotechnology. *Technological Forecasting and Social Change, 74*(1), 61–74.

Arvanitoyannis, I. S., & Krystallis, A. (2005). Consumers' beliefs, attitudes and intentions towards genetically modified foods, based on the 'perceived safety vs. benefits' perspective. *International Journal of Food Science and Technology, 40*(4), 343–360.

Azadi, H., Ghanian, M., Ghoochani, O. M., Khachak, P. R., Taning, C. N., Hajivand, R. Y. et al. (2015). Genetically modified crops: Towards agricultural growth, agricultural development or agricultural sustainability? Food Reviews International (just-accepted). http://www.tandfonline.com/doi/abs/10.1080/87559129.2014.994816.

Azadi, H., & Ho, P. (2010). Genetically modified and organic crops in developing countries: A review of options for food security. *Biotechnology Advances, 28*(1), 160–168.

Azzam, Z. (2013). Managers' perspective towards perceived risks associated with technology based self services: A case of-Jordan Banks. *Interdisciplinary Journal of Contemporary Research in Business*, *4*(11). http://ijcrb.webs.com

Bao-Rong, L. (2006). Identifying possible environmental hazard from GM rice in China to inform biosafety assessment. In *The 9th International Symposium on the Biosafety of Genetically Modified Organisms, Jeju Island, Korea, 24–29 September, 2006: Biosafety research and environmental risk assessment* (pp. 108–112). International Society for Biosafety Research.

Bazuin, S., Azadi, H., & Witlox, F. (2011). Application of GM crops in Sub-Saharan Africa: lessons learned from Green Revolution. *Biotechnology Advances, 29*(6), 908–912.

BIOTECHCORP, Malaysian Biotechnology Corporation. (2010). Malaysian Biotechnology country report 2009/2010.

Bloom, V. M. (2007). Nourishing the planet in the 21st century. BSCS and the Nutrients for Life Foundation. ISBN 1-929614-28-4.

Bloom, V. M. (2010). *Nourishing the planet in the 21st century. Plant science classroom material for high schools in Ontario*. Canada: Nutrients for Life Foundation.

Bredahl, L. (2001). Determinants of consumer attitudes and purchase intentions with regard to genetically modified foods—Results of a cross-national survey. *Consumer Policy, 24*(1), 23–61.

Bredahl, L., Grunert, K. G., & Frewer, L. J. (1998). Consumer attitudes and decision-making with regard to genetically engineered food products: A review of the literature and a presentation of models for future research. *Journal of Consumer Policy, 21*(3), 251–277.

Buah, J. N. (2011). Public perception of genetically modified food in Ghana. *American Journal of Food Technology, 6*(7), 541–545.

Butz, P, W. & Wu, F. (2004). The future of genetically modified crops: Lessons from the green revolution, RAND/MG-161-RC, 113 pp. ISBN 0-8330-3646-7.

Carter, L. (2007). A case for a duty to feed the hungry: GM plants and the third world. *Science and Engineering Ethics, 13*(1), 69–82.

Chen, M. F. (2008). An integrated research framework to understand consumer attitudes and purchase intentions toward genetically modified foods. *British Food Journal, 110*(6), 559–579.

Chen, M. F., & Li, H. L. (2007). The consumer's attitude toward genetically modified foods in Taiwan. *Food Quality and Preference, 18*(4), 662–674.

Chong, M. (2005). Perception of the risks and benefits of Bt eggplant by Indian farmers. *Journal of Risk Research, 8*(7–8), 617–634.

Costa-Font, M., Gil, J. M., & Traill, W. B. (2008). Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy. *Food Policy, 33*(2), 99–111.

Costa-Font, M., & Gil, J. M. (2009). Structural equation modelling of consumer acceptance of genetically modified (GM) food in the Mediterranean Europe: A cross country study. *Food Quality and Preference, 20*(6), 399–409.

Dale, P. J. (1999). Public concerns over transgenic crops. *Genome Research, 9*(12), 1159–1162.

Draper, A., & Green, J. (2002). Food safety and consumers: Constructions of choice and risk. *Social Policy and Administration, 36*(6), 610–625.

Finucane, M. L. (2002). Mad cows, mad corn and mad communities: The role of socio-cultural factors in the perceived riskof genetically-modified food. *Proceedings of the Nutrition Society, 61*, 31–37.

Finucane, M. L., & Holup, J. L. (2005). Psychosocial and cultural factors affecting the perceived risk of genetically modified food: An overview of the literature. *Social Science and Medicine, 60*, 1603–1612.

Frewer, L., & Shepherd, R. (1995). Ethical concerns and risk perceptions associated with different applications of genetic engineering: Inter-relationships with the perceived need for regulation of the technology. *Agriculture and Human Values, 12*(1), 48–57.

Fritz, S., Husmann, D., Wingenbach, G., Rutherford, T., Egger, V., & Wadhwa, P. (2003). Awareness and acceptance of biotechnology issues among youth, undergraduates, and adults. *AgBioForum, 6*(4), 178–184.

Ganiere, P., Chern, W., Hahn, D., & Chiang, F. S. (2004). Consumer attitudes towards genetically modified foods in emerging markets: The impact of labeling in Taiwan. *International Food and Agribusiness Management Review, 7*(3), 1–20.

Gaskell, G., Allum, N. C., Bauer, M. W., Durant, J., Allansdottir, A., Bonfadelli, H., et al. (2000). Biotechnology and the European public. *Nature Biotechnology, 18*(9), 935–938.

Gaskell, G., Allum, N. C., Wagner, W., Hviid Nielsen, T., Jelsoe, E., Kohring, M. et al. (2001). In the public eye: Representations of biotechnology in Europe. In G. Gaskell & M. Bauer (Eds.), *Biotechnology 1996–2000: The years of controversy*. London: Science Museum Publications.

Gaskell, G., Allum, N., Wagner, W., Kronberger, N., Torgersen, H., Hampel, J. et al. (2004). GM foods and the misperception of risk perception. *Risk Analysis, 24*(1), 185–194.

Ghasemi, S., Karami, E., & Azadi, H. (2013). Knowledge, attitudes and behavioral intentions of agricultural professionals toward genetically modified (GM) foods: A case study in Southwest Iran. *Science and Engineering Ethics, 19*(3), 1201–1227.

Goyal, P., & Gurtoo, S. (2011). Factors influencing public perception: Genetically modified organisms. *GMO Biosafety Research, 2*(1), 1–11.

Grunert, K., Lahteenmaki, L., Nielsen, N., Poulsen, J., Ueland, O., & Astrom, A. (2001). Consumer perception of food products involving genetic modification: Results from a qualitative study in four Nordic countries (Work. Rep. No. 72). MAPP, Aarhus.

Hamstra, A. M. (1991). Biotechnology in foodstuffs: Towards a models of consumer acceptance. Research Report 105, SWOKA, Institute for Consumer Research: The Hague.

Hamstra, A. M. (1995). *Consumer Acceptance of Food Biotechnology: The relation between product evaluation and acceptance*. Den Haag: SWOKA.

Han, J. H. (2006). The effects of perceptions on consumer acceptance of genetically modified (GM) foods (Doctoral dissertation, Chonnam National University).

Healy, M. P. (2002). Information based regulation and international trade in genetically modified agricultural products: An evaluation of the cartagena protocol on biosafety. Wash. UJL & Pol'y, 9, 205. http://digitalcommons.law.wustl.edu/wujlp

Heiman, A., Just, D. R., & Zilberman, D. (2000). The role of socioeconomic factors and lifestyle variables in attitude and the demand for genetically modified foods. *Journal of Agribusiness, 18*(3), 249–260.

Hosseini, S. J. F., Dehyouri, S., & Eslami, A. (2011). The advantages and constraints in application of transgenetic crops in Iran. *Annals of Biological Research, 2*(6), 97–101.

Hosseini, J., Ehsani, V., & Lashgarara, F. (2012). Exploiting the application of genetically modified crops by farmers in Iran. *American Journal of Scientific Research, 2011*(7), 138–144.

Huang, J., Bai, J., Pray, C., & Tuan, F. (2004). *Public awareness, acceptance of and willingness to buy genetically modified foods in China*. Newark: Rutgers University.

Huffman, E., Rousuy, M., Shogrenz, J. F., & Tegene, A. (2004). Consumer's resistance to genetically modified foods: The role of information in an uncertain environment Wallace. *Journal of Agricultural & Food Industrial Organization*, *2*(8). http://purehawkesbay.org/wp-content/uploads/2011/05/consumer-resistanceWHuffmanMRousu-JShogren-Abebayehu.pdf

International Service for the Acquisition of Agri-biotech Applications (ISAAA). (2010). ISAAA Briefs 42. Global status of commercialized biotech/GM crops: 2010. No. 42—2010.

International Service for the Acquisition of Agri-biotech Applications (ISAAA). (2012). ISAAA Press release.

Ismail, K., Soehod, K., Vivishna, S., Khurram, W., Jafri, S. K. A., & Bin Ramily, M. K. (2012). Genetically modified food and consumer purchase intentions: a study in Johor Bahru. *International Journal of Business and Social Science, 3*(5), 197–207.

Kim, R. B. (2012). Consumer attitude of risk and benefits toward genetically modified (GM) foods in South Korea: Implications for food policy. *Engineering Economics, 23*(2), 189–199.

Kimenju, S. C., Groote, H. D., Bett, C., & Wanyama, J. (2013). Farmers, consumers and gatekeepers and their attitudes towards biotechnology. *African Journal of Biotechnology, 10*(23), 4767–4776.

Koester, V. (2012). The Nagoya protocol on ABS: Ratification by the EU and its member states and implementation challenges. Studies, (03/12).

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*, 607–610.

Lusser, M., Raney, T., Tillie, P., Dillen, K., & Cerezo, E. R. (2012). International workshop on socioeconomic impacts of genetically modified. JRC scientific and policy reports. Crops co-organised by JRC-IPTS and FAO Workshop proceedings.

Martinez-Poveda, A., Molla-Bauza, M. B., Campo Gomis, F. J. D., & Martinez-Carrasco, M. L. (2009). Consumer-perceived risk model for the introduction of genetically modified food in Spain. *Food Policy, 34*(6), 519–528.

Moon, W., & Balasubramanian, S. K. (2001). Public perceptions and willingness-to-pay a premium for non-GM Foods in the US and UK. *AgBioForum, 4*(3–4), 221–231.

Morrow, B. H. (2009). Risk behavior and risk communication: Synthesis and expert interviews. Final Report for the NOAA Coastal Services Center, 53.

Naeemi, A., Pezeshki Rad, Gh., Namdar, R., & Shabanali Fami, H. (2011). An investigation on different aspect of transgenic plant application: The perception of biosciences experts in Tehran province. *Journal of Food, Agriculture and Environment*, *9*(3&4), 1030–1035.

Naeemi, A., Pezeshki Rad, Gh., & Ghareyazi, B. (2010). An Investigation of Biotechnology Experts' Attitudes in University Centers of Tehran Province towards the Use of Transgenic Plants. *Environmental Sciences, 7*(2), 141–154. (In Persian)

Nap, J. P., Metz, P. L., Escaler, M., & Conner, A. J. (2003). The release of genetically modified crops into the environment. *The Plant Journal, 33*(1), 1–18.

Peterson, G., Cunningham, S., Deutsch, L., Erickson, J., Quinlan, A., Raez-Luna, E. et al. (2000). The risks and benefits of genetically modified crops: A multidisciplinary perspective. *Conservation Ecology, 4*(1), 13.

Pingali, P., & Raney, T. (2005). From the green revolution to the gene revolution: How will the poor fare? ESA working paper No. 05–09. The Food and Agriculture Organization of the United Nations.

Prati, G., Pietrantoni, L., & Zani, B. (2012). The prediction of intention to consume genetically modified food: Test of an integrated psychosocial model. *Food Quality and Preference, 25*(2), 163–170.

Qaim, M., & Matuschke, I. (2005). Impacts of genetically modified crops in developing countries: A survey. *Quarterly Journal of International Agriculture, 44*(3), 207–228.

Que, Q., Chilton, M. D. M., de Fontes, C. M., He, C., Nuccio, M., Zhu, T. et al. (2010). Trait stacking in transgenic crops. pat, 24236, 5.

Raney, T. (2006). Economic impact of transgenic crops in developing countries. *Current Opinion in Biotechnology, 17*(2), 1–5.

Rao, V. P., Veeraraghavaiah, R., Hemalatha, S., & Joseph, B. (2006). Course title farming systems and sustainable agriculture. Course No: AGRO 303.

Ronald, P. (2011). Plant genetics, sustainable agriculture and global food security. *Genetics, 188*(1), 11–20.

Ruane, J., & Sonnino, A. (2006). Results from the FAO Biotechnology Forum. Background and dialogue on selected issues.FAO Research and technology paper 11.FAO, Food and agriculture organization of the united nation.

Runge, C. F., & Jackson, L. A. (2000). Negative labeling of genetically modified organisms (GMOs): The experience of rBST. *AgBioForum*, *3*(1), 58–62. Available on the World Wide Web: http://www.agbioforum.org

Senarath, S. N., & Karunagoda, R. P. (2012). Consumer attitude towards labeling of genetically modified foods in Sri Lanka. *Tropical Agricultural Research, 23*(3), 283–288.

Shaffer, P. A., Vogel, D. L., & Wei, M. (2006). The mediating roles of anticipated risks, anticipated benefits, and attitudes on the decision to seek professional help: An attachment perspective. *Journal of Counseling Psychology, 53*(4), 442.

Sharma, R. (2012). Ensuring the success of feed the future: Analysis and recommendations on gender integration. Global agricultural development initiative issue briefs are published by The Chicago Council on Global Affairs. http://www.thechicagocouncil.org/UserFiles/File/GlobalAgDevelopment/Issue_Briefs/GADI%20Issue%20Brief%20-%20FtF%20and%20Gender%20Integration%20-%20FINAL.pdf

Soregaroli, C., Boccaletti, S., & Moro, D. (2003). Consumer's attitude towards labeled and unlabeled GM food products in Italy. *International Food and Agribusiness Management Review, 6*(2), 111–127.

Sparks, P., & Shepherd, R. (1994). Public perceptions of the potential hazards associated with food production and food consumption: an empirical study. *Risk Analysis, 14*(5), 799–806.

Stilwell, M., & Van Dyke, B. (1999). *An activist's handbook on genetically modified organisms and the WTO*. Washington: Center for International Environmental Law.

United Nations. (2008). Organic agriculture and food security in Africa. United Nations Conference on Trade and Development. UNEP-UNCTAD capacity-building task force on trade, environment and development. United Nations Environment Programme. New York and Geneva.

Uphoff, N. (2012). Supporting food security in the 21st century through resource-conserving increases in agricultural production. *Agriculture and Food Security, 1*(1), 18.

Uzogara, S. G. (2000). The impact of genetic modification of human foods in the 21st century: A review. *Biotechnology Advances, 18*(3), 179–206.

Van Eenennaam, A. L. (2005). Genetic engineering and animal feed. Publication 8183.Genetic engineering fact sheet. University of California.

Vänninen, I., Siipi, H., Keskitalo, M., & Erkkilä, M. (2009). Ethical compatibility of GM crops with intrinsic and extrinsic values of farmers: A review. *Open Ethics Journal, 3*, 104–117.

Whitman, D. B. (2000). *Genetically modified foods: Harmful or helpful?* Cambridge Health Abstracts.

World Hunger. (2003). Bread for the world institute. Agriculture in the global economy. 13th Annual Report on the State of World Hunger.

Yohe, J. M., Christiansen, K., & Frederick, J. (2009). INTSORMIL sorghum, millet and other grains CRSP 2009 Annual report.

Zarrilli S. (2005). *Genetically Modified Organisms: A New Dilemma For Africa*. The African Technology Development Forum. http://www.atdforum.ora.

Zwick, M. (1998). *Perception and attitudes towards risks and hazards of genetic engineering within the German public*. Discussion Paper.