African Journal of Biotechnology Vol. 10(23), pp. 4767-4776, 1 June, 2011
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 ©2011 Academic Journals

Full Length Research Paper

Farmers, consumers and gatekeepers and their attitudes towards biotechnology

Simon C. Kimenju[1]*, Hugo De Groote[1], Charles Bett[2], and Japhether Wanyama[3]

[1]International Maize and Wheat Improvement Center (CIMMYT), P. O. Box 1041 - 00621 Nairobi, Kenya.
[2]Kenya Agricultural Research Institute (KARI), Katumani Research Centre, P. O. Box 340-90100 Machakos, Kenya.
[3]Kenya Agricultural Research Institute (KARI), Kitale Research Centre, P.O. Box 450 Kitale, Kenya.

Accepted 13 January, 2011

In 1999, a project to develop insect resistance maize for Africa was launched. Social scientists from this team used participatory rural appraisals, consumer studies, a baseline and gatekeeper survey to study the awareness and attitudes towards biotechnology among farmers, consumers and gatekeepers. Farmers' awareness of biotechnology was very low (12.7%). Awareness on genetically modified (GM) crops among consumers was also found to be low, although it was higher among urban consumers (38%) than among rural ones (31%). Radio was the main source of information. A large majority of consumers agreed to statements expressing the benefits of biotechnology such as increasing productivity. However, they had environmental and health concerns. Half of the urban consumers expressed concerns about the environment, in particular, loss of biodiversity. In contrast, awareness about GM was found to be high for the gatekeepers (87% for millers, and 79% for supermarkets). A majority of gatekeepers in the food industry were concerned that GM food could cause allergic reactions or antibiotic-resistant diseases. Almost all consumers were willing to purchase GM maize meal at the same price. Of those in the industry, more than two thirds, were hesitant to use them preferring to make the decision on a case-by-case basis.

Key words: Biotechnology, genetically modified (GM), consumer, attitudes, gatekeepers.

INTRODUCTION

Transgenic crops have been adopted at a high rate, going from 1.7 million hectares in 1996, to 134 million hectares in 2009. This was true for both the developed and developing countries (De Groote et al., 2009). However, the use of genetically modified (GM) varieties remains controversial, largely driven by negative perceptions from Western consumers, in particular European. This position has been inappropriately exported to Africa through various channels of influence (Paarlberg, 2008; Paarlberg, 2000; Paarlberg, 2002). However, a regulatory framework is needed, which includes benefits, costs, and concerns of the particular country. Very little is known about the awareness and attitudes of African consumers and other stakeholders towards GM food. The Insect Resistant Maize for Africa (IRMA) project, which is using both GM and conventional technologies, therefore took the initiative to assess awareness and attitudes of three stakeholder groups: farmers, consumers, and gatekeepers.

To bridge the information gap on attitudes of consumers and gatekeepers, from 2003, IRMA begun a series of surveys on acceptance of GM food by consumers and their gatekeepers in Kenya. This paper presents a review and synthesis of the main results of stakeholders' perceptions, as collected during participatory rural appraisals (PRAs), farmer and consumer surveys, and a study of the

*Corresponding author. Email: s.kimenju@cgiar.org. Tel: +254 (0) 20 722 4621.

Abbreviation: GM, Genetically modified; **IRMA**, Insect Resistant Maize for Africa; **PRAs,** participatory rural appraisals; **CIMMYT,** International Maize and Wheat Improvement Centre; **KARI,** Kenya Agricultural Research Institute; **AEZ,** agro-ecological zones; **DT,** dry transitional; **Bt,** *Bacillus thuringiensis*.

food industry gatekeepers. This review draws from the original data, some of which have already been published.

Background

In 1999, the International Maize and Wheat Improvement Centre (CIMMYT) and the Kenya Agricultural Research Institute (KARI) launched the IRMA project, to develop insect resistant varieties using both conventional methods and genetic engineering.

Insect pests are major constraints to maize production in Kenya. Farmers estimate that stem borers cause crop losses of 12.9% throughout the country, amounting to 0.39 million tons of maize, with an estimated value of US$ 76 million (De Groote, 2002). An experimental crop loss study estimates the 13.5% or 400,000 tons annually (De Groote et al., 2004) to have a value of US$ 80 million dollars. If the new resistant varieties would provide a good control of stem borers, as *Bacillus thuringiensis* (Bt) maize has done in other countries, under standard assumptions, the benefits would be an economic surplus calculated at US$ 208 million over 25 years (66% of which is consumer surplus) as compared to a cost of $5.7 million (De Groote et al., 2003).

In addition to breeding, biotechnology and entomology, the project had an economic component. A team of economists and other social scientists from CIMMYT and KARI complemented the breeding efforts by providing an analysis of the maize production systems, farmers' practices and preferences, to help breeders incorporate farmers' needs and preferences into their breeding programs.

Regulatory framework for GM crops in Africa

The project started before a regulatory framework was in place. Despite large potential benefits, the use of GM varieties remains controversial, largely driven by negative perceptions from European consumers. Many reviews by national and international science organizations, and reviews synthesizing the scientific knowledge on GM crops on human health show a wide consensus among the scientific community that currently available GM foods are as safe to eat as their conventional counterparts and suitable for human consumption (FAO, 2004; ICSU, 2004). Despite the available scientific evidence that GM food is safe to eat and that GM crops have not demonstrated any negative effect on the environment, a large number of studies show that consumers in developed countries consistently show a preference for non-GM food (Costa-Font et al., 2008; Lusk et al., 2005). In the US, GM crops have been basically deregulated (ICSU, 2004; Paarlberg, 2000). In Europe, potential benefits are small; consumers are worried about the quality and safety of their food system, and are well organized. In addition, trade barriers offer protection for local farmers (Demont et al., 2004). As a result, a regulatory system has been established as a precaution (McMahon, 2003).

In Africa, with the stagnating food crop yields, potential gains are much more important. Nevertheless, regulatory agencies are vigilant due to mostly European concerns. The political elite have strong cultural ties with Europe, where many have been educated, visited on vacation and received medical treatment, and from where they receive important news and information services. Therefore, with help from some donors and international agencies, most African countries have, or are in the process of, copying the European regulatory framework (Paarlberg, 2008).

The European precautionary principle is derived from their low potential benefits and high consumer risk perception. But in Africa, the potential benefits are much higher than in Europe. Moreover, given the food security situation in this continent, African consumers, most of whom are also farmers, are likely more concerned about sufficient food, than about perceived risks. Unfortunately, very few studies have been conducted on African farmers and consumers' concerns on GM and risk perceptions despite the fact that these groups will largely determine if these benefits will be achieved.

In addition, the gatekeepers (managers, industrial or retail sellers) are an important group in the chain, and they make important decisions on which products to stock in their stores. In Kenya, as in other developing countries, not much is known about the attitudes of the gate keepers towards GM technology.

Consumers' acceptance of GM food

Despite the available scientific evidence that GM food is safe to eat and GM crops have not demonstrated any negative effect on the environment, a large number of studies show that consumers in developed countries consistently show a preference for non-GM food over GM food. In a meta-analysis of 25 studies on consumer demand for transgenic food, Lusk et al. (2005) found that European consumers placed a higher value on non-GM food than consumers from North America. They were willing to pay, on average, 29% more for non-GM food than U.S. consumers, making labelling policies and non-tariff trade barriers more likely in the European Union than in the United States.

Only few studies have quantified consumer preferences in developing countries, but these studies clearly indicate a more positive attitude than in developed countries. In Beijing, for example, consumers were willing to pay a premium of 38% for GM rice (Li et al., 2002). The high level of acceptance of biotech products in China can been ascribed in part to government policies, and some to cultural and political history (Smale et al., 2009). Similarly, Indian consumers (in New Delhi and Patna)

were willing to pay a small premium for biotech chapattis (Anand et al., 2007) even if no information was provided, which increased slightly with "producer friendly" information. A study of urban consumers in Nigeria found that 90% of the respondents were aware of genetically modified products. Unlike other studies, two thirds disapproved of the use of GM technologies in cowpeas (Kushwaha et al., 2008).

Several factors have been found to determine acceptance of GM food by consumers. Of importance is awareness and information. In a review of impact of biotech on consumers (Smale et al., 2009) , the impact of information on the preferences expressed by consumers were found to be crucial irrespective of the region of study. They conclude that attitudes of consumers change significantly as they absorb new information, and particularly negative messages. Hence, framing of questions appears to be of paramount importance in these surveys. Risk and benefit perceptions are also important. The most reluctant consumers of GM foods are typically those relatively more risk conscious and exhibiting attitudes favouring sluggish technology innovation in the food sector (Costa-Font et al., 2008). In Nigeria, those respondents who were most concerned about the ethics of genetic transformation were also more likely to disapprove of such products (Kushwaha et al., 2008).

METHODOLOGY

Activities of IRMA social scientists

To analyze the economics of insect resistant maize, help guide the breeding effort, and study stakeholders' attitudes towards GM technology, the IRMA team of social scientists conducted participatory rural appraisals (PRA), a baseline farm household survey, surveys of urban and rural consumers, and a survey of the food industry's gatekeepers. As much as possible, the surveys covered the six maize producing agro-ecological zones (AEZ) of Kenya as defined by earlier surveys (Hassan, 1998).

Participatory rural appraisals

The main goal of the PRAs is to understand the maize production systems, and constraints, in particular pest problems, as perceived by farmers. They were conducted in each of the six agro-ecological zones (Figure 1). For each zone, five villages were selected, but the selection procedure differed slightly by zone. Either a 2- or 3-stage sampling procedure was used. In principle, a list of the divisions (administrative units below district level) was established for each zone, and 3 divisions were selected randomly in the first stage. For each division, a list of the sub-locations was established, and two villages selected randomly. The selected village was visited to explain the purpose of the meeting to the village elders and authorities, and to set the date for the visit. The multi-disciplinary team visited the village for one day to conduct focused group discussions. The discussions were held in the local language and covered mainly the farming systems, maize production and its constraints, following a pre-tested guideline. Where possible, discussions were held separately with men and women.

Farmers ranked the major constraints they face in maize production, as well as the major pests they encounter. In total, more than 900 farmers, men and women, participated in 43 group discussions from April to November 2000 (Table 1).

IRMA baseline survey

Farmers, as adopters of new technologies, are key players in the GM debate. It is therefore important to know their practices and adoption levels of improved technologies, but also attitudes towards new technologies. To measure these factors, a country-wide baseline survey was conducted. To select the farm households for the baseline survey, a two stage stratified sampling design was used, with the agro-ecological zones as strata and the sub-locations as first-stage units. In the different AEZs, 16 sub-locations were randomly selected proportionate to size, and in each sublocation households were selected with simple random sampling, leading to a representative sample of 1850 maize farmers.

The survey took place in 2002, and data were collected using a pretested structured questionnaire in personal interviews, covering personal and farm characteristics, farmers' knowledge of and access to modern varieties and chemical fertilizers, access to credit and extension through personal interviews. Farmers were also asked about their awareness on biotechnology, GM technology and tissue culture.

Consumers' surveys

Consumers' opinion is the key element of the GM debate. There is no use in developing crop technologies if the consumers, both urban and rural, are not interested in the food that they produce.

At the end of IRMA II, two consumer surveys have been conducted to gauge perceptions and acceptance of GM foods (Table 1), with both urban and rural consumers. The first survey took place in 2003 in Nairobi, where a total of 604 consumers were interviewed, at three different points of sale: Supermarkets, kiosks, posho mills (Kimenju and De Groote, 2008). From a list of supermarkets obtained from Kenya's Central Bureau of Statistics, 15 supermarkets were randomly selected: 10 large ones (with more than three local branches), and 5 small ones. For the kiosks, seven estates (administrative subdivisions of Nairobi) were selected from a list of city estates, and three kiosks randomly selected per estate. Twenty-one posho mills were randomly selected from the 16 estates known to house them, and the number selected in each was proportional to the total number in the estate. At each point of sale, enumerators approached every third consumer who came along for a possible interview. In total, 604 consumers were interviewed: 183 at supermarkets, 210 at kiosks, and 211 at posho mills.

The second survey, this time of rural consumers, was undertaken in January 2006, in eastern Kenya. For this survey, the sub-locations from the the dry transitional (DT) zone selected for the baseline survey were maintained, and a subset of the rural households was randomly selected from the 2002 baseline survey (De Groote et al., 2005) was maintained. All sub-locations fall in two districts, Machakos and Makueni. The surveys were carried out in January 2006, covering 140 households in Machakos and 60 households in Makueni.

In these studies, awareness of GM crops was assessed by asking whether the respondents had read or heard about biotechnology and GM crops in general, and about Bt maize, Bt cotton, and virus-resistant sweet potato in particular. Respondents were also asked questions about their sources of information on GM crops and about their attitudes towards GM food, except for the study in Eastern Kenya.

Attitudes were determined by reading statements and asking respondents for their opinion, on a 5-point scale from 1 = 'totally disagree' to 5 = 'totally agree', with 3 as a neutral mid-point. These statements covered five types of perceptions: benefits, health risks,

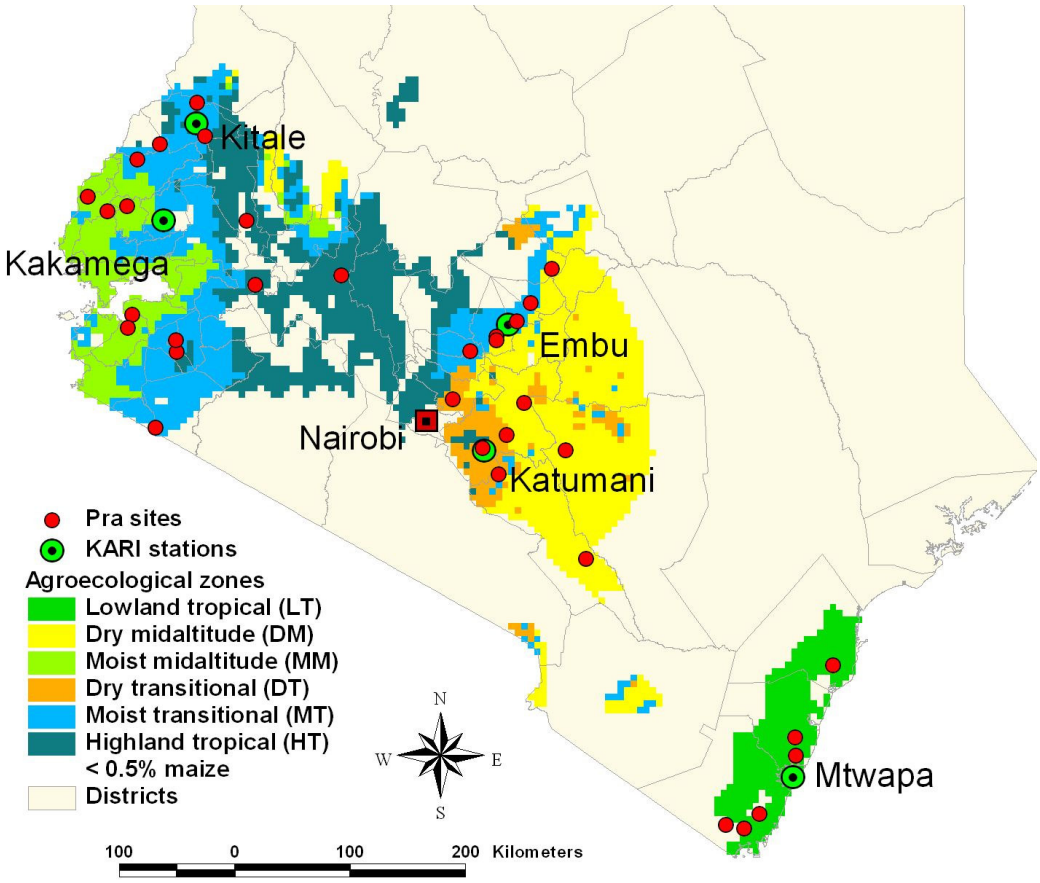

Figure 1. Sites of the participatory rural appraisals.

Table 1. Sample size of different IRMA surveys.

Respondent	Site	Year	Place	N
Farmers-PRA	Six maize AEZ	1999	Rural	900
Farmers-Baseline survey	Six maize AEZ	2002	Rural	1850
Consumers	Nairobi	2003	Posho mills	183
			Kiosks	210
			Supermarkets	211
	Machakos	2006	Rural	140
	Makueni	2006	Rural	60
Gatekeepers	Seven urban centres	2007-2008	Supermarkets	24
			Milling companies	15

environmental risks, ethics, and equity concerns. Information was also collected on demographic and socioeconomic characteristics.

Consumers were also asked, in contingent valuation style questions, if they would be willing to buy GM maize flour at the same price as the conventional maize flour they were buying at that time.

Gatekeepers' survey

Decisions in the food industry and agribusiness are often taken by the industry's "gatekeepers": influential managers or industrial and retail buyers who decide on the purchase of goods and can be considered as "expert consumers" (Sternquist, 1994). Gatekeepers decide on behalf of their companies which products to buy, so their impact can be very important. Their livelihood and survival in their businesses depend on anticipating consumer demand accurately and making decisions on what is likely to move off the supermarket shelves or restaurant tables quickly (Knight and Paradkar, 2008). Their decisions are, however, strongly influenced by their perception of consumer perception (Knight et al., 2008). While several studies of gatekeepers have been conducted in Europe and Asia,

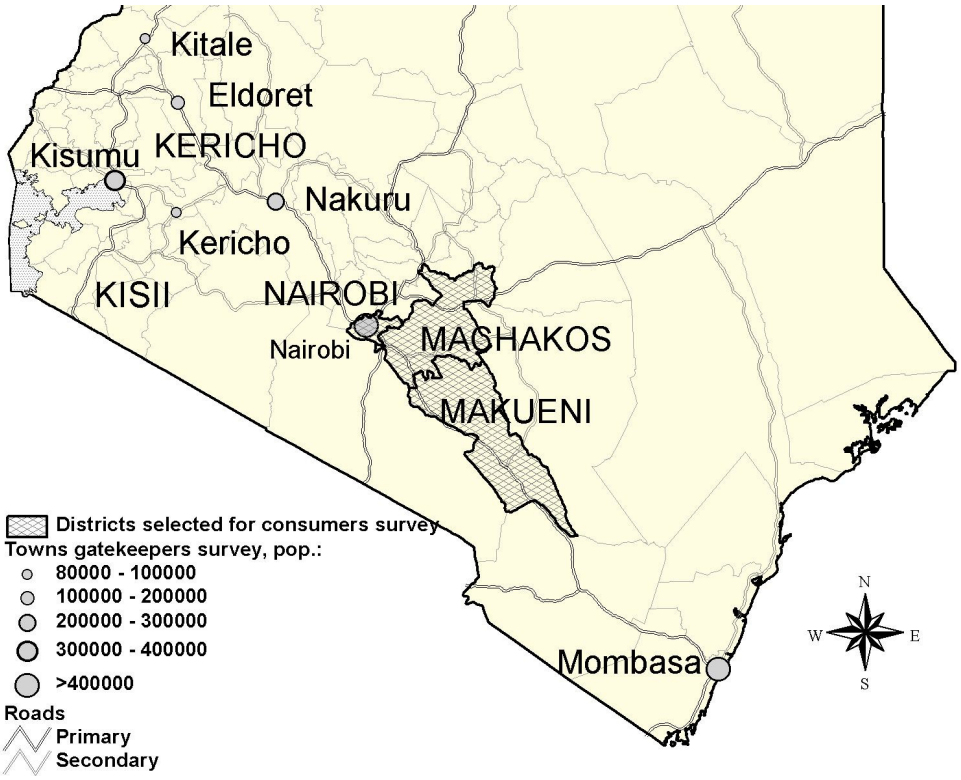

Figure 2. Map of the selected towns and districts.

IRMA social scientists conducted the first gatekeeper survey in Africa.

The major gatekeepers for maize products in Kenya are the milling companies who buy and process maize grain, and the supermarkets who sell the processed maize flour. For this survey, the seven major urban centres (Nairobi, Mombasa, Kisumu, Nakuru, Eldoret, Kitale and Kericho) were maintained (Figure 2). In each of the selected centres, a list of milling companies and supermarkets was established, resulting in 34 milling companies and 140 supermarkets. Because of the high number of companies in Nairobi, 10 were randomly selected in each category there, while in the other centres all companies were included in the selection. This resulted in a list of 32 milling companies and 40 supermarkets. Of the 72 companies selected, 22 agreed to interviews, while 33 agreed to fill in the questionnaire, although only 17 returned the completed questionnaire, leading to a total of 39 responses (Table 1). The survey took place from December 2006 to April 2007, and the results are presented in more detail elsewhere (Bett et al., 2010). Gatekeepers' awareness and attitudes were measured with the same questions as for the consumers.

Information was also collected on demographic and socio-economic characteristics, including age, gender, position in the business, profession and education. Finally, gatekeepers were asked if they would consider using GM products in their company.

RESULTS

Pest problems and the need for Bt maize

The three major constraints to maize production as ranked by farmers during the PRAs, throughout the zones, were cash constraints, lack of technical know-how and extension, and problems with maize seed: high cost, poor quality and low availability. Pest problems usually ranked in the top six constraints (Table 2).

Stem borers are major pest problems that farmers encounter all over the zones (Table 3). They rank in the top three in all the agro-ecological zones. Other major pest problems are weevils (also top 3 in all AEZ), striga, rodents, chaffer grubs, and termites.

Despite the pests being ranked as major constraints, not many farmers reported using pesticides during the baseline survey, only 9.8% overall. This proportion of farmers using pesticides was higher than average in the low tropics (24%) and lowest in the moist mid-altitude zone (0.4%).

Farmers' awareness of biotechnology

During the baseline survey, conducted in 2001, only 12.7% of the farmers were aware about biotechnology (Table 4). In the high potential areas, where more farmers have adopted new technologies, farmers are more aware: up to 18% in the highlands. Awareness of biotechnology was particularly low in the low potential areas like the lowland tropics (9.3%) or the dry mid-altitudes (2.8%).

Awareness about tissue culture was lower than biotechnology in general, 10.8%, again higher in high potential areas, lower in low potential areas. Awareness

Table 2. Farmers ranking of constraints in maize production.

Constraint	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6
Low tropics	Field pests	Cash	Soil fertility	Wildlife	Drought	
Dry mid altitude /semi arid	Rain	Pests & diseases	Cost of inputs	Seed availability	Know-how	
Dry transitional (machakos)	Rain	Know-how	Pests and diseases	Input cost	Poverty	
Moist transitional	Cash	Rain	Know-how	Seed cost	Stem borer	Low fertility
High tropics	Poor seed quality	Seed price	Fertility price	Low maize price	Cash	Pests
Moist mid-altitude	Farm implements	Soil fertility	Cash	Extension (know-how)	Certified seed availability	Pests

Table 3. Farmers ranking of pest problems in maize production.

Pest	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Low tropics	Rodents	Stem borer	Weevils	Beetles	Storage moths
Dry Mid altitude /semi arid	Weevils	Stem borer	Chaffer grubs	Termites	
Dry transitional (machakos)	Weevils	Chaffer grubs	Stem borer	Termites	Squirrels
Moist transitional	Stem borer	Weevils	Squirrels		
High tropics	Stem borer	Weevils	Cutworms	Rodents	
Moist mid-altitude	Striga	Weevils	Stem borer	Termites	Rodents

Table 4. Farmers' awareness of biotechnology, by maize agroecological zone.

Agro-ecological zones (AEZ)	% Aware		
	Biotechnology	Tissue culture	GMO
Low tropics	9.3	5.0	7.0
Dry Mid-altitudes	2.8	1.9	1.4
Dry transitional	13.1	12.1	2.0
Moist transitional	12.5	11.2	2.9
High tropics	18.0	16.6	2.9
Moist mid-altitude	17.6	15.2	4.8
Overall	12.7	10.8	3.6

about GMOs, finally, was even lower, at 3.6%. Here, however, the pattern of high vs. low potential zones did not emerge. Likely, the level of awareness on GM was low across all zones since at that time not much was being discussed in the media and other forums.

This low level of awareness of new technologies is not specific to biotechnology: only 3% of respondents were aware about grafting, for example.

Consumers

About half the consumers were aware of biotechnology, although this differed substantially between groups (Table 5). Almost half the consu-

Table 5. Stakeholder awareness of biotechnology and GM crops.

Type	Area or industry	N	Awareness	
			Biotechnology	GM crops
Urban consumers	Nairobi	612	46	38
Rural consumers	Eastern Kenya	400	63	31
Gatekeepers	Milling companies	32	67	87
	Super markets	40	83	79

Table 6. Sources of information on biotechnology (% of respondents aware of biotechnology, by region and group).

Urban	Urban consumers	Rural consumers		Gatekeepers	
	Nairobi	Machakos	Makueni	Millers	Supermarkets
Radio	63	74			
Newspapers	56	28	24		
School/college	35	59	68	20	50
Ministry of Agriculture		26	77	20	10
Friends/other people, work place	24	68	24	25	0
Research		53			
Media	22			40	75
Provincial admin.		4	25		
Television	16				
Food industry				50	0
Brochures				50	0
Agr shows		8	11		
Press, books, journals	13				
Journals/articles	2				
Other					
Number (% of total)	227	126	60	28	32

mers in Nairobi were aware of biotechnology (46%), and more than half in Eastern Kenya (63%). Only a minority of consumers were aware of GM crops, although the level was substantially higher in Nairobi (38%), than in Eastern Kenya (31%).

There were also some significant differences between categories. Women were generally more aware of biotechnology and GM crops than men. Similarly, rural female consumers were more aware of biotechnology and GM crops than their urban counterparts. Generally, awareness of these concepts decreases with age.

Consumers that are aware of biotechnology or GM crops were asked about their sources of information. For consumers, the radio is by far the most important source of information, in all regions except for the district of Makueni. Other important sources mentioned were newspapers, schools, Ministry of Agriculture, friends and other people, research and the media (Table 6). Newspapers were an important source for urban consumers (56% of respondents), but much less so for rural consumers in Eastern Kenya (28%). Schools, on the other hand, were important sources for rural consumers, but not for their urban counterparts.

Government services were also frequently mentioned by rural consumers in Eastern Kenya, although with a substantial difference between districts. In Machakos, where the KARI regional centre is based, research was much more frequently mentioned (53%) than extension (26%), while in the further away district of Makueni, extension was the most important source of information (77%).

Participants in all surveys except in Eastern Province were asked if they agreed or disagreed with a selected number of carefully selected statements, reflecting perceptions and concerns consumers commonly express about GM food, in particularly, benefits perceptions, and environmental, health and equity concerns (Table 7). A large majority of consumers agreed to the statements expressing the benefits of GM technology, such as increasing productivity (81%) and decreasing pesticide residues (79%). Most gatekeepers were also positive towards the benefits, although respondents from the supermarkets were slightly less so.

About half of the urban consumers expressed concerns about the environment, in particular, the effect on untargeted insects and loss of biodiversity. Similarly,

Table 7. Attitudes of consumers and gatekeepers towards GM technology.

Type of perception	Statement	Consumers	Gatekeepers	
		Urban	Millers	Super-markets
Benefits	GM technology increases productivity and offers solution to world food problem	81	67	67
	GM can reduce pesticides on food	79	83	50
Environmental risk	Insect resistant GM crops may cause death of untargeted insects	51	33	42
	GM can lead to a loss of original plant varieties	50		
Health risk	People could suffer allergic reaction after consuming GM foods	40	67	75
	Consuming GM foods can damage ones health	37		8
Ethical concerns	GM food is artificial	50		
	GM is tampering with nature	48	42	50
Equity concerns	GM products are being forced on developing countries by developed countries	36	27	21
	GM products don't benefit small-scale farmers	22	33	38

there were also some health concerns among urban consumers. Here, however, a majority of gatekeepers also had health concerns about GM food; in particular that GM food could cause allergic reactions (67% for millers, 75% for supermarkets). Ethical concerns are mostly found among urban consumers, where about half think GM food is artificial and tampering with nature. Half of the gatekeepers interviewed also agreed with the last statement.

Equity concerns were not very important among the respondents, with about a third of urban consumers and of gatekeepers agreeing to them. A third of urban consumers think GM products are forced on developing countries, while more than a third of gatekeepers think they do not benefit small-scale farmers.

All participating consumers were asked, in a contingent valuation exercise, if they would be willing to purchase GM maize meal at the same price of their preferred, conventional maize meal. Almost all consumers were willing to purchase GM maize meal at the same price. The proportion willing to do so was, however, substantially higher among rural consumers (89%), than among urban consumers (58%).

Those refusing to buy GM maize at the average price were offered a discount (between KSh 5 and 20), and about half of them, both in the urban and rural areas, accepted to pay for GM maize meal at the reduced price. Those respondents who accepted to buy GM maize at the average price where asked if they would buy it at a premium (between KSh 40 and 80). The proportion of urban consumers was high (63%) compared to rural consumers (48%).

Gatekeepers

The gatekeepers were well informed and a large majority was aware of biotechnology, including GM crops (with 87% of respondents from the milling industry and 79% from the supermarkets) (Table 5).

Sources of information, however, differed widely between respondents from the two industry groups. Those from the milling companies mentioned the food industry and brochures as the most important sources of information on biotechnology (50% each), followed by the media (40%) and friends or other people (25%). Respondents from the supermarkets, on the other hand, most frequently mentioned the media (75%), followed by schools (50%).

Attitudes of the gatekeepers were similar to those of urban consumers. Most gatekeepers were also positive towards the benefits, although respondents from the supermarkets were slightly less so. However, most gatekeepers also had health concerns about GM food; in particular that GM food could cause allergic reactions (67% for millers, 75% for supermarkets). More than a third of gatekeepers, finally, think they do not benefit small-scale farmers.

Gatekeepers of both industries were asked if they would be willing to use GM food in their businesses. More than two thirds of respondents, in both types of companies, would want to take that decision on a case-by-case basis. Few respondents would reject GM products off hand, with more negative responses in the milling companies (20%) than in the supermarkets (4%). Similarly, only a small proportion of respondents would accept GM products immediately, with more positive responses from the supermarkets (16%) than from the milling companies (6%).

DISCUSSION

Interviews with farmers at the start of the project show that the IRMA project is addressing an important issue. Insect pests and especially stem borers are ranked as major constraints by farmers in all maize growing zones.

Since only a small proportion of farmers use pesticides, the introduction of the insect resistant maize is opportune and the project has potentially large benefits, especially with seed-based GM technology.

However, farmers have low awareness towards biotechnology in general and GM technology in particular. This would be expected since these surveys were done early in the project when debate on GM technology in Kenya was way below the current levels. The review of consumer studies in Kenya reveals relatively high awareness of biotechnology and GM crops, among the urban consumers in Nairobi, but low levels among the rural consumers in Eastern Kenya. There is, therefore, a need to increase awareness of farmers and consumers, especially rural, so that they can participate in the debate from a well-informed base.

To effectively increase consumer awareness, their sources of information need to be better understood, and these sources used optimally. The results of our studies indicate that, for consumers, the radio is by far the most important source of information on biotechnology, in both urban and rural areas. Newspapers were found to be important for urban consumers, but much less for rural consumers, while schools were important for rural but not for urban consumers. Government services such as agricultural research and extension were important for rural consumers in Eastern Kenya. So far, information dissemination on GM crops by IRMA and other projects has been concentrating on the printed press, television, and printed documents. Clearly, the radio would need much more attention to reach a wider audience. IRMA has, in the past, also provided training to agricultural extension, which should be kept up-to-date.

For gatekeepers from the milling companies the most important sources of information were the food industry, brochures, and the media, while those from the supermarkets also mentioned the media, followed by schools. For milling companies, brochures developed in collaboration with the food industry could therefore be highly effective, although they are also reached through the common media sources.

Most consumers agreed to the statements expressing the benefits of GM technology such as increasing productivity and decreasing pesticide residues, while some raised environmental and health concerns. Environmental concerns, in particular, the effect on untargeted insects and loss of biodiversity, were largely confined to urban consumers. Some health and ethical concerns were also raised by urban consumers and gatekeepers, but equity concerns were generally not very important. Many of the concerns addressed, such as the effect on non-target organisms and the risk of developing anti-biotic resistant diseases, have already been addressed by the scientific community. Clearly, more effort is needed to communicate these results to the larger population.

Almost all consumers were willing to purchase GM maize meal at the same price as their common maize meal, in all surveys and areas, with the proportion being particularly high among rural consumers. This indicates a large willingness to accept GM food by the Kenyan consumer. This acceptance now needs to be communicated to the Kenyan policy makers and regulatory agencies. The gatekeepers, on the other hand, are more reluctant; most want to make the decision to use GM food in their companies on a case-by-case basis. Gatekeepers should therefore be informed of the results of the consumer surveys, through the channels indicated above.

The results of these surveys indicate that the Kenyan consumers and gatekeepers do not share the reservetions of their European counterparts towards GM food. This puts into question the developing of regulatory systems in Africa, based on European perceptions. To obtain a broader understanding of the opinion of the African consumers and gatekeepers, it is important that this type of study is also conducted in other parts of the continent.

ACKNOWLEDGEMENTS

The financial support of the Syngenta Foundation for Sustainable Agriculture through the IRMA project is highly appreciated. We are grateful for the logistical and editorial support provided by the CIMMYT-Nairobi office. We would also like to thank the staff from KARI and CIMMYT for their support. Many thanks to farmers who offered their time to discuss the PRAs and participate in the baseline survey. Finally, we would like to thank the staff of the different maize outlets for their support, and the consumers who patiently answered our questions

REFERENCES

Anand A, Mittelhammer RC, McCluskey JJ (2007). Consumer response to information and second-generation genetically modified food in India. J. Agric. Food Ind. Organ. 5: 1-18.

Bett C, Ouma JO, De Groote H (2010). Perspectives of Gatekeepers in the Kenyan Food Industry towards Genetically Modified Food. Food Policy 35: 332-340.

Costa-Font M, Gil JM, Traill WB (2008). Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy. Food Policy 33: 99-111.

De Groote H (2002). Maize Yield Losses from Stemborers in Kenya. Insect Sci. Appl. 22: 89-96.

De Groote H, Overholt W, Ouma JO, Mugo S (2003). Assessing the impact of Bt maize in Kenya using a GIS model.Paper presented at the 25th International Conference of the International Agricultural Economics Association Conference, Durban, 16-22 August, Durban, South Africa.

De Groote H, Bett C, Okuro JO, Odendo M, Mose L, Wekesa E (2004). Direct estimation of maize crop losses due to stemborers in Kenya, preliminary results from 2000 and 2001., p. 401-406, *In* Friesen DK, Palmer AFE, eds. Integrated Approaches to Higher Maize Productivity in the New Millennium. Proceedings of the 7th Eastern and Southern Africa Regional Maize Conference. CIMMYT, Mexico, D.F.

De Groote H, Owuor G, Doss C, Ouma J, Muhammad L, Danda K (2005). The Maize Green Revolution in Kenya Revisited. J. Agric. Dev. Econ. 2: 32-49.

De Groote H, Gunaratna NS, Kebebe E, Lyimo S, Ouma JO, Kyazze FB, Friesen D (2009). Indicators of Project Performance and Analysis of Potential Impact. A Survey of Potential Impact of Quality Pro-

tein Maize (QPM) on the Nutrition, Health and Well-being of Farm Households and the Impact of the QPMD Project on QPM Awareness and Adoption in Target Areas in Ethiopia, Kenya, Tanzania and Uganda. Report prepared for the Canadian International Development Agency (CIDA). CIMMYT, Addis Abeba, Ethiopia.

Demont M, Wesseler J, Tollens E (2004). Biodiversity versus Transgenic Sugar Beets: The One Euro Question. Eur. Rev. Agric. Econ. 31: 1-18.

FAO (2004). The state of food and agriculture 2003-2004. Agricultural Biotechnology: Meeting the needs of the poor. Food and Agriculture Organization of the United Nations, Rome.

Hassan RM, (ed.) (1998). Maize technology development and transfer: A GIS application for research planning in Kenya, pp. 1-230. CAB International/CIMMYT/KARI, Wallingford (United Kingdom).

ICSU (2004). New Genetics, Food and Agriculture: Scientific Discoveries – Societal Dilemmas. International Council for Science.

Kimenju SC, De Groote H (2008). Consumer willingness to pay for genetically modified food in Kenya. Agric. Econ. 38: 35-46.

Knight J, Paradkar A (2008). Acceptance of genetically modified food in India: perspectives of gatekeepers. Br. Food J. 110: 1019-1033.

Knight JG, Holdsworth DK, Mather DW (2008). GM food and neophobia: connecting with the gatekeepers of consumer choice. J. Sci. Food Agric. 88: 739-744.

Kushwaha S, Musa AS, Lowenberg-DeBoer J, Fulton J (2008). Consumer Acceptance of Genetically Modified (GM)—Cowpeas in Sub-Sahara Africa. J. Int. Food Agribusiness Marketing 20: 7-23.

Li Q, Curtis KR, McCluskey JJ, Wahl TI (2002). Consumer Attitudes Toward Genetically Modified Foods in Beijing, China. AgiBioForum 5: 145-152.

Lusk JL, Jamal M, Kurlander L, Roucan M, Taulman L (2005). A meta analysis of genetically modified food valuation studies. J. Agric. Resour. Econ. 30: 28-44.

McMahon JA (2003). Food Safety and the Precautionary Principle. EuroChoices 41: 42-46.

Paarlberg R (2008). Starved for science: how biotechnology is being kept out of Africa Harvard University Press, Cambridge, MA.

Paarlberg RL (2000). Governing the GM crop revolution Policy Choices for developing Countries. Food, Agriculture, and the Environment Discussion Paper 33. International Food Policy Research Institute, Washington, D. C.

Paarlberg RL (2002). The real threat to GM crops in poor countries: consumer and policy resistance to GM foods in rich countries. Food Policy 27: 247-250.

Smale M, Zambrano P, Gruerè G, Falck-Zepeda J, Matuschke I, Horna D, Nagarajan L, Yerramareddy I, Jones H (2009). Measuring the economic Impacts of Transgenic Crops in Developing Agriculture during the First Decade. Approaches, Findings, and Future Directions. Food Policy Review 10 IFPRI, Washington DC.

Sternquist B (1994). Gatekeepers of consumer choice: a four-country comparison of retail buyers. International Review of Retail, Distribution and Consumer Research 4: 159-176.