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Major factors preventing release of Bt-Maize variety in Kenya

George Nyongesa Mondoh
The University of Adelaide

Abstract
Maize is the staple food in Kenya, therefore its production is an important activity by both small and large scale farmers. Maize farming provides human food, animal feed and income to farmers. Other than erratic rainfall patterns and poor soils in Kenya, pests are a major constraint to maize production. Maize production in Kenya has declined over the past years due to crop damage by stem borers. The country's maize demand is currently higher than the local production, to bridge the deficit, the Kenyan government has resulted to importing maize grain. This has necessitated the development of an insect resistant maize variety expressing Cry 1Ab toxins (Bt-Maize) by Kenya Agricultural Research Institute (KARI) and its partners. However this variety is yet to be released to Kenyan farmers. The release of Bt-Maize in Kenya would be beneficial to farmers by reducing the cost of using pesticides and damage caused by pests especially the stem borer and thus increase maize yields towards attaining food security. This paper will therefore highlight the major factors that are impeding the release of Bt-maize in Kenya and also put forward recommendations that could be adopted to hasten the release of Bt-maize to Kenyan farmers.

Introduction

Kenyans have the highest rates of per capita maize consumption as food in the world, at 103kg per annum (De Groote 2002). Maize is consumed and prepared differently virtually at every meal. A shortage of maize in Kenya could have catastrophic effects like the 1982 famine. The current production capacity is at 2.5 million tonnes per annum, whereas the annual consumption is 3.06 million tonnes (Mabeya & Ezezika 2012). Maize is not only a major source of nutrition, but is also a source of income in Kenya to both small-scale and large-scale farmers. A greater percentage of maize production is mainly by small-scale farmers (75%) (De Groote et al. 2005). However these small-scale farmers lack the capacity to produce efficiently to meet the nation's needs.

Both the small-scale and large-scale farmers are faced by varying constraints like erratic rainfall patterns, poor soils, weeds and pests, however some constraints are common e,g pests like the maize stem borers (Nyoro 2002). One of the major contributors to a decline in maize yield is the stem borer, which are responsible for annual losses amounting to 13.5% i.e 417,000 tons of maize valued at US$90 million (Kimenju, Simon Chege & De Groote 2008). *Chilo partellas* and *Buseola fusca* are the most important species, responsible for 80% of the loss caused by stem borers (Murenga et al. 2011).

In-order to manage the maize stem borer in Kenya, pesticides such as Bulldock have been used (Mabeya & Ezezika 2012). However this practice was not only expensive to farmers but also posed health and environmental risks. The International Centre of Insect Physiology and Ecology (ICIPE) therefore introduced a chemical free control method, "the push and pull cropping system", which involves the use of napier grass and *Desmodium* plants (Khan et al.

2011). The *Desmodium* sp. repel the stem borers from the main cereal crop that they are intercropped with, the napier grass in turn attracts the stem borers (Khan et al. 2011). This system did not achieve the desired result since it was slowly adopted by farmers and required livestock to utilize the *Desmodium* and capacity building for farmers to run it (Murenga et al. 2011).

In line with high losses due to stem borers and poorly effected control measures, Bt maize was introduced in Kenya through the Insect Resistant Maize for Africa (IRMA) project in 1999 with Kenya Agricultural Research Institute (KARI) and CIMMYT acting as the key implementing partners (Mabeya & Ezezika 2012). Funding was mainly sourced from Novartis foundation, which later on merged with AstraZeneca to form Syngenta, which later transformed to the Syngenta Foundation for Sustainable Agriculture (SFSA) replacing Novartis foundation, but continued to fund IRMA (Mabeya & Ezezika 2012). The insect resistant varieties were mainly developed using both conventional breeding and Bt-technology.

Bt maize are mainly transformed maize varieties expressing soil bacterium *Bacillus thuringiensis* (Bt) genes (Mugo, Stephen 2003). Bt maize varieties produce endo-toxins that specifically act by perforating the guts of lepidopteran stem borers thus acting as a natural defence system for plants against pests (Betz, Hammond & Fuchs 2000). This mechanism has been demonstrated not to have any adverse effects on human guts due to the absence of receptors for the endotoxins (Betz, Hammond & Fuchs 2000). Therefore Bt-maize has been proved to be a safe and effective product, having undergone rigorous testing for food and safety, providing environmentally friendly and effective control of targeted pests, with resistance durability of more than seven years (James 2003). Bt-maize has recorded successes in pest control especially stem borers, farming cost reduction and increase in yields (5% in temperate growing areas and 10% in the tropical areas of Kenya) (Murenga et al. 2011). In South Africa, Bt crops have been demonstrated to increase yields and reduce cost for small-scale farmers (Huesing & English 2004). Subsequently, the reduced use of pesticides is beneficial to the environment and to human health as well.

Despite the known benefits and success in field trials associated with Bt-maize, the maize variety has still not been commercialised in Kenya. Currently to meet required maize demand, the Kenyan government has resorted to importing maize from neighbouring countries, creating financial strain on the government. This paper will therefore, aim to highlight the major factors that are inhibiting the commercialisation of Bt-maize in Kenya as well put forward recommendations towards speedy commercialisation of the variety.

Major factors preventing the release of Bt Maize in Kenya

Research on developing Bt-maize in Kenya began in 1999, however to date the variety has not been commercialised. This only means that the challenges facing maize farmers have not been alleviated and thus production demands are still not met. There are several factors that have led to this delay, which will be discussed in this paper.

Delay in setting up GM regulation laws

The Kenyan government passed into law the biosafety bill in 2009 (Kingiri, A & Ayele 2009), this was virtually ten years after the inception of biotechnology research in Kenya, unlike in South Africa where the same laws were set up in two years (Cloete, Nel & Theron 2006). The absence of GM regulation laws inhibited the commercialisation of any GM product including Bt–maize. Any production of Bt-maize was and is still confined to the biosafety greenhouse at KARI biotechnology centre and field trial sites at KARI-Kiboko (Mugo, S et al. 2004). The major reason for the delay was mainly political, purportedly due to lack of understanding of the new technology by majority of the legislators, also the subsequent elections in 2002 led to entry of new members of parliament who had to be taken through the draft bill afresh causing further delays.

Lack of clarity on the ownership of IPRs of the GM event and patenting of seeds

The ownership of the GM event used in the IRMA was not very clear from the beginning, any commercialisation of a product with these genes would result in a law suit. The Bt genes in the IRMA project were sourced from the University of Ottawa based on a research purpose only agreement (Mabeya & Ezezika 2012), however attempts by IRMA to have the agreement reviewed to permit commercialisation revealed that the ownership of the genes was in the hands of many private companies that were keen to make returns from varieties containing their gene (James 2003). There have also been attempts by some lobby groups to prevent GM seeds from being patented, which have subsequently been opposed by owners of the GM event (De Groote et al. 2004). The lobbyists argue that patenting the seeds could increase the cost of the seeds and thus most small-scale farmers will not be able to afford them, whilst the event owners are more focussed on making profits from their investment, a conflict that has further delayed commercialisation.

Lack of synergy between private and public sector

The public sector was apprehensive about the private sector's involvement in technology development from the beginning of the IRMA project, which was believed could hamper public support and complicate the funding principle i.e the public good of the project (Mabeya & Ezezika 2012). Differences between KARI and CIMMYT were imminent and they threatened project efficiency, accountability and trust between the two organisations; the differences were both at individual and institutional levels i.e competition for the position of project coordinator and general perception of inequality amongst KARI staff (Mabeya & Ezezika 2012). The lack of synergy between the involved sectors and partners led to lack of convergence on common interests i.e the delivery of Bt maize variety. Individual and institutional strengths were also not utilised to enhance trust between the project and community, therefore allowing misconception by the general public on the overall good of Bt maize variety.

Insufficient studies on consumer willingness to pay for GM food

Successful introduction of Bt-maize or any other GM crop in Kenya will depend largely on consumer acceptance. Consumer willingness studies are therefore important in determining awareness levels among the general public and the general concerns that they raise. However these studies have not been done extensively, and those that have been performed only had their focus in Nairobi (Kimenju, Simon Chege et al. 2005). Therefore the response by the rest of the country towards Bt technology remains largely unknown. This has therefore slowed down awareness campaigns because of lack of sufficient data on consumer acceptance. The financial ability of most people living in Nairobi tends to be superior than majority of those living in rural areas. However, 32% of interviewed study participants in Nairobi, indicated that they are unwilling to pay for GM food and this trend is likely to be repeated in rural areas (Kimenju, Simon C 2004). Just like in Japan and Europe consumer acceptance is likely to slow down the adoption of Bt-maize in Kenya (Echols 1998).

Lack of proper awareness creation and acceptability by farmers

Public access to balanced, accurate and timely information about new agricultural biotechnologies has been limited (Kinuthia Kagai 2011). This factor has been blamed on the inability of scientists to adequately engage and communicate with the public, therefore most farmers still have inaccurate information about GM technology and reject it based on circulated stereotypes. Anti-GM organisations, both locally and internationally based took advantage of the gap in communication between the scientists and the general public. Instead of clarifying genuine queries on issues of concern, they took to spreading negative and inaccurate information about health, environmental and other perceived risks associated with GM technology (Kingiri, Ann Njoki 2010). They have therefore succeeded in creating public distrust in the new technology.

Insufficient GM handling capacity

There is a high possibility of adventitious introduction of GM products into conventional food, feed or animal products upon commercialisation of Bt-maize in Kenya. Therefore adequately trained personnel, and cheap and rapid techniques to detect and contain approved levels of GM for environmental release are required. In Kenya, Kenya Plant Health Inspectorate Services (KEPHIS) is the only competent authority for GM regulation and is still in the process of developing guidelines to manage commercial GM production (Kingiri, A & Ayele 2009). However, KEPHIS has limited capacity to undertake its mandate and still utilises RT-PCR protocols alongside qualitative PCR based techniques and ELISA screening strips to detect adventitious spread of GM events into conventional food (Traynor & Macharia 2003). These techniques are not only time consuming but are also low throughput and they thus limit the amount of samples that can be analysed as well as data that can be generated within a specified period, therefore commercialisation of any GM product would probably have undetected adventitious GM material into conventional food products.

Choice of host variety

In Kenya there exists diverse maize varieties that have been developed based on environmental suitability and both farmer and consumer preferences (Muhammad & Underwood 2004). The Bt maize seed variety may be neutral to the scale of farm operation, but some important aspects of its technology may favour adoption within local varieties, which must be addressed in order for research investment to pay off (Andow & Hilbeck 2004). Therefore the choice of host variety to insert the Bt-gene is also a limiting factor towards commercialisation because the chosen variety may not meet the requirements of the entire population, and more time and funding is still required to incorporate Bt-genes in a widely accepted maize variety.

Discussion

Maize production is an important activity in Kenya because of the high per capita consumption at 103kg per annum (De Groote 2002). However, maize production has been hampered by constraints like poor soils, erratic rainfall patterns and pests (Nyoro 2002). Pests such as the stem borer are responsible for 13.5% of losses in maize production in Kenya. Despite the use of pesticides and the push and pull farming system, losses due to stem borers still persist since most small scale farmers are unable to afford or lack capacity to set up the said measures. Therefore Bt-maize, which utilises endotoxins from Bacillus thuringiensis (Bt) to provide a natural defence system for plants against stem borers, remains to be the only lasting solution for Kenyan maize farmers.

Since GM crops are here to stay and we are being forced into a global world of trade and food aid in, which some have commercialised GM crops whilst others have not, Kenya should therefore work towards resolving the factors impeding commercialisation in order to maintain Kenya as a competitive trade destination. Unlike South Africa, Kenya is still struggling with commercialisation of Bt-maize, due to various factors highlighted in the previous section. Some of these factors have been resolved while others remain unresolved or are in the progress of resolution. One of the major steps taken towards commercialisation of Bt-maize in Kenya was the enactment of biosafety regulation laws in 2009 (Kingiri, Ann N & Hall 2012), which allowed for the creation of the National Biosafety Authority (NBA) a regulatory body that is mandated to work with partners interested in biotechnology research and commercialisation of GM products (Kingiri, Ann N & Hall 2012). Another issue that has since been resolved is the IPR ownership by the introduction of MON810 event from Monsanto (Mabeya & Ezezika 2012). This has since clarified the ownership of the gene and therefore in the event of commercialisation there would be no law suits arising from companies that are unknown to the partners.

There are several maize varieties in Kenya designed to suit the diverse environmental conditions, in terms of rainfall patterns and soil fertility (De Groote et al. 2002). Identifying a neutral variety that is suitable for the diverse conditions in Kenya still remains a challenge. Many years of research and breeding will have to be put in to come up with a Bt-maize variety suitable to grow under the diverse conditions in Kenya. There is need to use marker assisted selection and back-crossing breeding techniques to introduce the Bt-gene into majority of the maize varieties in a shorter period to avoid farmer and consumer dissatisfaction. Partnerships with more experienced organisations will not only provide latest techniques but also funding directly or indirectly.

Continuous studies on consumer willingness to pay for GM crops across the entire nation will provide sufficient data on the progress of GM acceptability in Kenya, thus providing a basis for more vibrant GM awareness campaigns by both scientist and social scientists to counter the anti-GM effects set up by GM antagonists. Having a vast majority of the Kenyan population understand the mechanism of action in GM crops to yield their benefits will greatly increase acceptability not only by farmers but also by the consumers.

The commercialisation of Bt-maize in Kenya could have adventitious spread of Bt-genes to conventional food, therefore constant monitoring is required. Only KEPHIS has the capacity

to conduct monitoring on commercialised GM products, however their capacity is limited in terms of skilled staff and technology. Therefore there is need to acquire high-throughput analytical techniques and to partner with institutions that have more skilled staff on GM monitoring and regulation like KARI and local universities. The formation of the NBA in 2010 was a major boost in GM handling capacity building. Partnerships with organisations from countries that have successfully commercialised GM crops are necessary for capacity building in terms of training of staff and acquisition of new technologies as well as funding.
There is need to maximise synergy between the public and private sector in order to achieve the set goals and objectives towards commercialising Bt-maize in Kenya. Partnerships in agbiotech are mainly from diverse backgrounds with each organisation varying in their set of strengths and harmonizing the diversity of the partners more often leads to the project's success. Lack of synergy between the partners leads do distrust by the community irrespective of the end benefits of the project. Therefore the identification of individual and institutional strengths is inherent for the purpose of synergy building, which not only builds public trust but also encourages a united focus in the project.

Conclusion

In Kenya, Bt-maize are more likely to benefit small-scale farmers to increase yields and reduce cost of production as compared to other methods used in controlling maize stem borers. Environmental and health risks will also decrease through use of Bt-maize to counter stem borers. The projected increase in yields will reduce the financial strain posed on the government through the importation of maize to meet the national annual needs, this will in turn avail surplus funds, which could be channelled to fund other public projects. An increase in yield could also be translated to attaining food security, increased income for small scale farmers and job creation as well as attracting new investments in agriculture and farming. In an increase in maize yield could also enable Kenya to venture towards generation of biofuels.

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