# Assessing and communicating the risks and benefits of GM cassava in Kenya

Harvey James, Corinne Valdivia, William R. Folk, Dekha Sheikh, Festus Murithi, Violet Gathaara, Milton Kengo, Charles Bett and Grace Mbure

Kenya has yet to allow the commercialisation of genetically modified (GM) crop production,[1] so it is important to understand how smallholder farmers and other stakeholders would be affected if cassava, a major food security crop, were to be approved as a GM crop. To this end, scientists from the University of Missouri and the Kenya Agricultural and Livestock Research Organization (KALRO) conducted stakeholder interviews and developed a case study using participatory research methods in a two-year project between 2012 and 2014. The aim of the project was to answer two specific questions:

1. What are the intended and potential unintended consequences of introducing GM cassava in Kenya?
2. How can the risks and benefits of introducing GM cassava be communicated to smallholders and other affected stakeholders?

*Food security is a significant problem in Sub-Saharan Africa ... and cassava is part of the solution*

Outcomes include understanding how the introduction of GM cassava might impact various stakeholders as well as identifying practical ways of involving stakeholders, especially women, in making informed

decisions; describing the state of knowledge and shared interests to serve as a basis for groups who are in a position to influence policy; and developing strategies for communicating effectively to stakeholders the potential risks and benefits of introducing GM cassava. Recent studies of the state of biotechnology in Africa have identified these aspects as key needs.[2]

This chapter gives an overview of and conceptual foundation for the project, together with a summary of its key findings and conclusions.

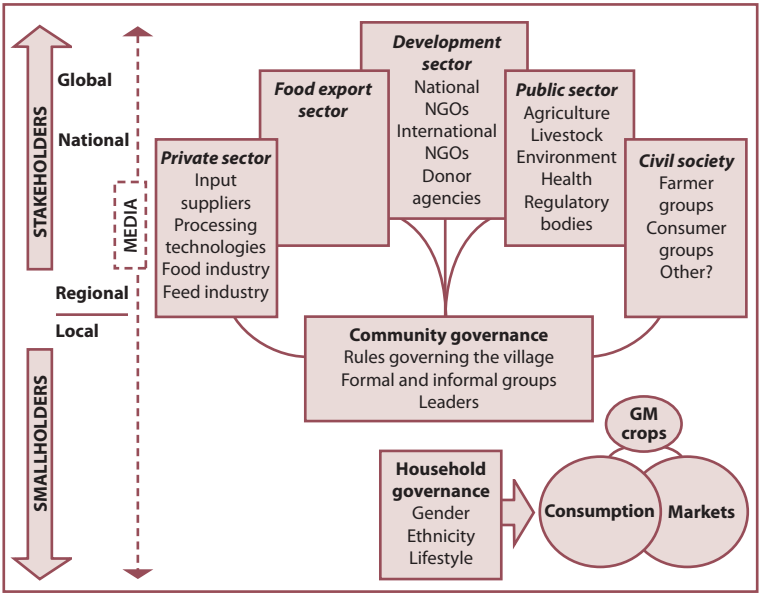
## Background

Cassava is an important food security crop for smallholder farmers in Sub-Saharan Africa. It can be stewed, boiled or processed into chips and flour, and its starch can be processed into tapioca and other food products, including flour. Cassava can also be used as a biofuel and animal feed. It is a drought-tolerant, low-input crop, and can remain unharvested for long periods of time. Food security is a significant problem in Sub-Saharan Africa for approximately one out of three people,[3] and cassava is unquestionably part of the solution. However, cassava production is threatened by two viruses: cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). The Donald Danforth Plant Sciences Center in St Louis, Missouri, USA, in cooperation with KALRO, is developing a GM cassava resistant to both CMD and CBSD.[4]

*Participatory approaches contribute to building knowledge, changing perceptions, identifying barriers and creating coalitions among stakeholders*

There are two important factors affecting the debate about GM crops generally, and in Kenya specifically, which form an important basis for our study. The first involves the

**Figure 1. Range of stakeholders expected to be affected by the introduction of GM cassava in Kenya**




preferences and perspectives of stakeholders affected by the introduction of GM crops, especially smallholder farmers. The second is how the introduction of GM crops will affect smallholder farmers, other stakeholders and all members of society. Stakeholders include not only smallholders but other individuals and organisations in the community, national and international arenas (Figure 1). It is in this context that the introduction of GM cassava poses some risk. For example, the development of viral resistance to the GM traits can be predicted though the length of time required for it to emerge cannot. Consequently, if markets and the consumption of cassava are significantly

altered, care must be taken to ensure that these altered markets are transitory and do not further destabilise food security in the event that the benefits of GM cassava are of short duration. Furthermore, the emergence of viral resistance could lead to increased risk of disease in the plants, as has been observed with gene silencing of papaya ringspot virus.[5]

The breadth of relationships between smallholders and other stakeholders exemplifies why multiple levels of stakeholders must be considered in this assessment, and the role of the media in affecting public perception of GM crops is significant.[6] It is important to identify these stakeholders and determine how they would be affected, especially those in a position to enable or veto the effective adoption of GM cassava by smallholders, and to engage them in dialogue.

Complicating the discussion is the fact that Kenya is diverse both socio-economically and culturally, with vast differences in urban and rural household consumption patterns, education, access to the media and culture, and the influence these may have. These differences affect the introduction of GM cassava at the household, community and national levels. No less significant are the key factors of gender and power status in and between households,[7] and their role in access to and control of resources.[8]

### Conceptual foundations

The foundation for this protocol is built on a participatory research process and a sustainable livelihoods framework designed to better understand smallholder farmers, their contexts, livelihoods, concerns and capabilities, and how change increases vulnerability and leads to the growth or deterioration of human, natural, social, physical, economic and political capital. The

framework is especially important in analysing how technology can impact the poor.[9] The approach is people-centred and focuses on both tangible and intangible assets and capabilities in developing livelihood strategies, especially in the context of negotiation with social, economic and political structures at the household, local, regional, national and international scales.[10, 11]

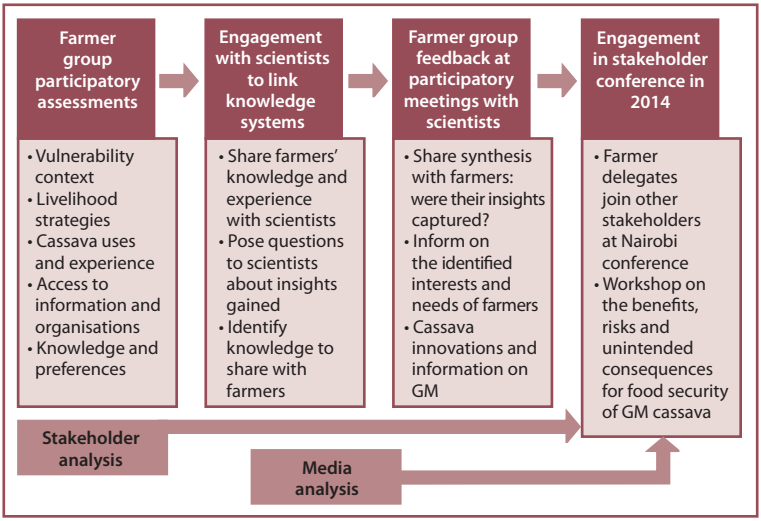
The participatory research method is one where farmers and researchers work together in a two-way communication process. Such approaches contribute to building knowledge, changing perceptions, identifying barriers, and creating coalitions among stakeholders to initiate change.[10] Power relations need to be addressed to ensure that community-based participatory planning processes include all people. Participation as a process seeks to empower through active participation, collaboration or partnership.[12] Gender and power relations are a central concern in agriculture, as women heads of household are often the most vulnerable.[7] Two-way communication is crucial to respecting people's right to be informed and make decisions regarding their livelihoods, and to building or strengthening social networks and human knowledge, as they are resources that foster alliances between key stakeholders and build trust in contexts of uncertainty such as GM technologies.[13]

**The protocol**

An effective protocol develops knowledge about the effects of adopting new technology and then communicates that knowledge to all relevant stakeholders, including smallholder farmers (Figure 2). The protocol is innovative in that a feedback process takes place as knowledge is developed.

*An effective protocol develops knowledge ... and then communicates that knowledge to all relevant stakeholders*

**Figure 2. Communication protocol to build knowledge that enables two-way communication**




The participatory process centres on farmer focus groups. We selected two of KALRO's research centres in locations where cassava is a priority for our focus group discussions: Mtwapa, which is coastal and sub-humid, and Katumani in Machakos in the Eastern Province, which is characterised by dryland conditions. In the coastal region, cassava is consumed as a food security crop. In the Eastern Province, it has been identified as a crop with high potential for processing for markets. We invited smallholder farmers and community leaders from these communities to participate in the discussions and to complete a short questionnaire. Our sample included 115 farmers from the coast, including 82 women, and 94 farmers from the Eastern Province, including 57 women. Several techniques were employed to elicit information.

*Participants appreciated that their knowledge and concerns were captured and addressed through feedback*

Large group discussions led to the development of a timeline of the events that affect food security. The use of cards to capture the experiences of individual participants allowed us to distinguish between vulnerable and non-vulnerable groups, and to assess the role of cassava and how its use differs for each group. Because many decisions on production, processing, consumption and marketing vary between men and women, we also conducted focus groups addressing men and women separately so as to understand their vulnerabilities and coping methods, how integrated they were in the markets, how many organisations they used and which information they trusted.

We then engaged with more than 20 scientists and other stakeholders in semi-structured interviews in Kenya. This involved cassava scientists including those working with GM cassava, government officials in Kenya, representatives of non-governmental organisations (NGOs), and farmer groups associated with cassava production. The purpose of the interviews was to provide context and a baseline understanding for the focus group meetings with smallholder farmers. Interviews were transcribed with detailed notes but were not voice recorded.

We held a follow-up activity, termed farmer feedback session, at each site after the data from the focus groups were analysed. These sessions offered an opportunity to share findings and research activities, confirm and ratify responses, answer questions about GM cassava and respond to the farmers' concerns about post-harvest processing and marketing. Scientists used leaflets, posters, videos, samples of healthy and diseased plants, and demonstrations on value-

added products to share their research and expertise. Participants appreciated that their knowledge and concerns were captured during the process and addressed through feedback.[13]

Finally, we organised a stakeholder meeting in Nairobi in 2014, the purpose of which was to bring together farmers, scientists, policy makers and other stakeholders to discuss the potential risks, benefits and possible unintended consequences of introducing GM cassava in Kenya. The programme consisted of opening remarks and introductions, presentations of results and findings from the farmer feedback meetings, and a general discussion involving represented stakeholder groups about the challenges of meeting the food security needs of smallholder farmers and the potential benefits and concerns related to GM foods.

**Lessons learned and knowledge created**

Our general findings are that smallholder farmers are not well informed about GM crops but do not oppose their commercialisation. However, based on the small and differing pieces of information they receive, they have some concerns about the effects of GM crops when used for human consumption. Nonetheless, the more that farmers know about GM crops, the less concerned they are about the technology. Moreover, connectedness and access to information vary depending on degree of vulnerability. In this context, connectedness means having access to markets and information such as newspapers and extension agents. Vulnerability means being at greater risk in the case of extreme changes in weather, disease outbreaks, or other problems not faced by households

*Smallholder farmers are generally not well informed about GM crops but do not oppose their commercialisation*

**Table 1. Summary of responses in Eastern Province regarding information about GM crops**

| Location | Have you heard about GM crops? | Where did you hear about GM crops? | Whom do you trust about GM crops? | What have you heard about GM crops? |
|---|---|---|---|---|
| **Itithini** | • 12 of 18 men<br>• 6 of 27 women | • Farmers with a greenhouse<br>• Newspaper stories about GM maize, which was to be imported | • Doctors who have assessed GM crops<br>• Scientists from KALRO<br>• Researchers<br>• Officers from Ministry of Agriculture and Administration | • GM crops will be tested<br>• GM crops do not cause cancer<br>• One thing changed into another<br>• Two plants crossed to make one |
| **Mbuvo** | • 4 of 19 men<br>• 3 of 30 women | • Radio<br>• Debate in parliament | • Scientists from KALRO | • Is not good<br>• Is good for human consumption<br>• Makes crops mature faster; will make humans age faster<br>• Maize has been grafted like mangoes<br>• Due to famine, used for family planning |

with adequate reserves or sufficient cash to acquire food and meet their needs through market access. Farmers in less vulnerable groups are more connected, while those in more vulnerable groups are less connected.

Table 1 summarises findings about GM crops for farmers in two locations in Eastern Province. Farmers in Itithini engage in several risk-mitigating

activities, such as selling baskets, wood carvings or sand, which makes them relatively more connected to markets and less vulnerable. Farmers in Mbuvo, in contrast, are more exposed to extreme weather conditions and are less connected to markets. The table shows that the degree to which farmers are connected and have access to information affects their perceptions about the risks and benefits of GM cassava and its adoption, with connectedness improving the quality of information farmers obtain and understand. While acknowledging that they do not have enough information to make definite decisions about the use of GM cassava, smallholder farmers indicated that the sources of information they would trust include researchers from KALRO and extension officers in the Ministry of Agriculture. Extension agents, however, are wary of the political will behind the introduction of GM crops. Moreover, because of the cultural significance of religion for Kenyans, the acceptability of GM crops among Christian and Muslim community leaders also matters, as we found from farmers in the coastal region.

Importantly, there are also gender differences in access to knowledge, types of connections to organisations and the level of assets, especially for vulnerable groups. For example, women who are connected have more access to self-help programmes than to institutions developing new technologies, while vulnerable men who are connected often lack the resources to act on new information. Interestingly, decisions about the cassava varieties appropriate for production, processing and value addition are made by women, while harvesting and marketing in large quantities are often male activities.

*Some farmers are concerned about the perception of cassava as a "poor man's crop", which they believe could affect its marketability*

*GM cassava has the potential to improve the livelihoods of smallholder farmers by providing crops free from disease and with improved nutrient content*

There are also geographic differences. In Eastern Province, many farmers are connected to organisations seeking to foster the commercialisation of GM cassava. However, farmers are concerned about the perception of cassava as a "poor man's crop", which they believe could affect its marketability. In coastal regions where cassava is consumed as a food security crop, GM cassava would have to be the "right" variety – starchy, early maturing, not bitter, pest resistant and nutritious. Farmers are particular about the varieties of cassava they grow and consume. GM cassava that is clean – free from mosaic or brown streak disease – but that is not the type farmers traditionally use or need will not be accepted.

Scientists and other stakeholders believe that GM varieties of cassava will produce crops that are free from disease, resulting in higher yields, and will have greater nutritional content, thus improving the degree of food security for smallholders. However, increased productivity could alter the power relations between men and women, as more output might encourage men to sell the crops in markets, giving them – rather than women – access to much-needed cash. There is also concern about how GM cassava might affect management practices, since it is not clear that it can be incorporated into existing intercropping systems and because it requires a different set of farm inputs from those of conventionally grown cassava. An additional concern is the role of intellectual property rights. There are important social norms that support the sharing of clean cassava among Kenyan farmers, and there could be significant cultural repercussions if such norms are not respected when considering who controls access to GM crops in Kenya.

**Summary**

The introduction of GM cassava has the potential to improve the livelihoods of smallholder farmers by providing crops free from disease and with improved nutrient content. But there are risks, such as potential viral resistance and unforeseen changes in marketing and farm management practices, as described above. Accurate information about the benefits and risks associated with GM cassava need to be communicated to smallholder farmers and other stakeholders. An effective communication protocol translates knowledge in a way that takes account of the characteristics and context of the user. Thus, it requires a unique communication process which acknowledges that smallholder farmers' decisions, such as the choice to adopt GM crops, may also introduce risks that can threaten their ability to survive. In this context a two-way process makes it possible to develop and clarify knowledge that is trusted by smallholder farmers so that risks are minimised and smallholder livelihoods improved. It also acknowledges that farmers are often marginalised from mainstream institutions and often do not have a voice in the development of knowledge intended for their benefit.[13]

The communication approach as conceived and implemented in this project brought stakeholders together in ways that sought to strengthen the human, social and political capital of smallholder farmers as they engage with researchers and other involved parties. While women and men expressed their concerns about consuming more cassava, variety preferences and increasing productivity with no clear market

*The communication approach in this project brought stakeholders together in ways that sought to strengthen the human, social and political capital of smallholder farmers*

outlets, the research needs to focus on how to communicate about genetic modification, the farming practices and management approaches required, and what other stakeholders need to know, such as the consumption and environmental effects of introducing GM cassava in Kenya.

**References**


1. **Kameri-Mbote, P. (2011).** Regulation of GMO crops and foods: Kenya case study. Manuscript.
2. **Chambers, J.A., Zambrano, P., Falck-Zepeda, J., Gruere, G., Sengupta, D. and Hokanson, K. (2014).** *GM Agricultural Technologies for Africa: A State of Affairs.* African Development Group and International Food Policy Institute, Washington, DC, USA.
3. **Rosenthal, D.M. and Ort, D.R. (2012).** Examining cassava's potential to enhance food security under climate change, *Tropical Plant Biology* 5(1): 30–38.
4. **Taylor, N.J, Halsey, M., Gaitán-Solís, E., Anderson, P., Gichuki, S., Miano, D., Bua, A., Alicai, T. and Fauquet, C.M. (2012).** The VIRCA project: Virus resistant cassava for Africa, *GM Crops and Food: Biotechnology in Agriculture and the Food Chain* 3(2): 93–103.
5. **Kung, Y.-J., You, B.-J., Raja, J.A.J., Chen, K.-C., Huang, C.-H., Bau, H.-J., Yang, C.-F., Huang, C.-H., Chang, C.-P., and Yeh, S.-D. (2015).** Nucleotide sequence-homology-independent breakdown of transgenic resistance by more virulent virus strains and a potential solution, *Scientific Reports* 5: 9804.
6. **DeRosier, C., Sulemana, I., James, H., Valdivia, C., Folk, W. and Smith, R. (2015).** A comparative analysis of media reporting of perceived risks and benefits of genetically modified crops and foods in Kenyan and international newspapers. *Public Understanding of Science* 24(5): 563–581.
7. **Valdivia, C. and Gilles, J.L. (2001).** Gender and resource management: Households and groups, strategies and transitions, *Agriculture and Human Values* 18(1): 5–9.
8. **Quisumbing, A.R. and Pandolfelli, L. (2010).** Promising approaches to address the needs of poor female farmers: Resources, constraints, and interventions, *World Development* 38(4): 581–592.

9. **Meinzen-Dick, R., Adato, M., Haddad, L. and Hazell, P. (2003).** Impacts of agricultural research on poverty: Findings of an integrated economic and social analysis, *EPTD Discussion Paper* No. 111. Environment and Production Technology Division, International Food Policy Research Institute, Washington, DC, USA.
10. **Ostrom, E. (2007).** A diagnostic approach for going beyond panaceas, *Proceedings of the National Academy of Science* 104(39): 15181–15187.
11. **Valdivia, C., Seth, A., Gilles, J.L., García, M., Jiménez, E., Cusicanqui, J., Navia, F. and Yucra, E. (2010).** Adapting to climate change in Andean ecosystems: Landscapes, capitals, and perceptions shaping rural livelihood strategies and linking knowledge systems, *Annals of the Association of American Geographers* 100(4): 818–834.
12. **Hayward, C., Simpson, L. and Wood, L. (2004).** Still left out in the cold: Problematizing participatory research and development, *Sociologia Ruralis* 44(1): 95–108.
13. **Valdivia, C., Danda, K., Sheikh, D., James Jr., H.S., Gathaara, V., Mbure, G., Murithi, F. and Folk, W. (2014).** Using translational research to enhance farmers' voice: A case study of the potential introduction of GM cassava in Kenya's coast, *Agriculture and Human Values* 31(4): 673–681.

## Authors

***Dr Harvey James**, Associate Professor of Agribusiness Management, University of Missouri, Columbia, USA*
***Dr Corinne Valdivia**, Associate Professor in the Department of Agricultural Economics, University of Missouri, Columbia, USA*
***Dr William R. Folk**, Professor of Biochemistry, University of Missouri, Columbia, USA*
***Dr Dekha Sheikh**, Council Member, Multimedia University of Kenya, Nairobi, Kenya*
***Dr Festus Murithi, Violet Gathaara, Milton Kengo, Charles Bett and Grace Mbure**, Kenya Agricultural and Livestock Research Organization (KALRO), Nairobi, Kenya*