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Capacity Development for Agricultural Biotechnology and Biosafety Decision Making: Facilitating Implementation of Confined Field Trials in Uganda

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ABSTRACT

This paper draws upon experiences gained in Uganda, where a hands-on, integrated program for capacity development in agricultural biotechnology and biosafety regulations was implemented, spearheaded by national research and policy-making organizations and financially supported by the Government of Uganda, multilateral and bilateral donor agencies. Uganda is now regarded as a regional hub for agricultural biotechnology innovations, and connected with a range of international projects and programs aimed at developing relevant agricultural innovations. The paper analyzes key factors contributing to progress in biotechnology decision making in Uganda in the last 10 years, which are: (i) Building regulatory capacity and confidence; (ii) developing a biosafety regulatory framework: (iii) scientific and infrastructure capacity; (iv) working on a priority commodity and trait; (v) developing and implementing a communication plan; and, (vi) financial resources and partnerships for engagements in agricultural biotechnology and biosafety.

Keywords: *Agricultural innovations, Biosafety Regulatory Framework, Research*

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Introduction

A growing body of literature confirms the farm-level and societal economic benefits of growing genetically modified (GM) crops, as recently summarized and analyzed by Brookes and Barfoot (2009) and Smale et al. (2009). As the emerging "bioeconomy" expands to include second generation biofuels and biomaterial production, biotechnology and GM crops may play an even greater economic role. It is however, widely accepted that GM crops must be assessed for food, feed and environmental safety before they can be released for commercialisation (McLean et al., 2003). These principles are reflected in an internationally binding agreement, the Cartagena Protocol on Biosafety, which by now (March 2011) has been ratified by 160 countries (SCBD, 2000). Each State Party is obliged to domesticate the Protocol through enactment of relevant policies and regulatory frameworks. Farmers and economies, therefore, will only be able to take full advantage of the bioeconomy under a functional biosafety policy environment.

Despite significant effort and resources devoted to biosafety capacity development, and notwithstanding some good progress, many countries still do not have adequate capacity to design and implement biosafety regulations (SCBD, 2010). This remains a significant barrier to the testing and adoption of new transgenic crop varieties that would offer farmers a means to grow more food, enhance incomes and reduce environmental impacts of agriculture. Furthermore, an uncertain regulatory environment discourages private and public sector investment into the development of the crops and traits that poor farmers need the most.

Numerous programs have attempted to build global capacity for the regulation of biotech crops, with mixed success. Generally, countries with existing capacity for biotechnology research and development (R&D) and high-level political support to biotechnology and biosafety capacity building have made significant advances so far.

This paper draws upon experiences gained in Uganda, where a hands-on, integrated program for capacity development in agricultural biotechnology and biosafety regulations

was implemented, spearheaded by national research and policy-making organizations and financially supported by the Government of Uganda, multilateral and bilateral donor agencies. Uganda is now regarded as a regional hub for agricultural biotechnology innovations, and connected with a range of international projects and programs aimed at developing relevant agricultural innovations.

The lessons learned in Uganda can be applied to ongoing and future biotechnology and biosafety capacity building efforts to ensure that individuals and institutions involved are enabled to make decisions on biotechnology and biosafety in a timely, transparent and science-based manner, and to ensure that all countries can participate in the emerging bioeconomy.

The following sections analyze the key factors contributing to progress in biotech decision making in Uganda in the last 10 years, which are: (1) Building regulatory capacity and confidence; (2) Developing a biosafety regulatory framework; (3) Scientific and infrastructure capacity; (4) Working on a priority commodity and trait; (5) Developing and implementing a communication plan; (6) Financial resources and networking.

Building regulatory capacity and confidence

During the period 1998-1999, the UNCST undertook a scooping study with support from the UNEP-GEF to establish the status and potential for biotechnology applications in Uganda. The profile of biotechnology applications and services revealed that there would be need to develop a National Biosafety Framework for Uganda. The scoping study defined the parameters within which the various institutions involved in biotechnology and biosafety may operate in order to facilitate decision-making across institutions with varied but related mandates for biotechnology.

Uganda ratified the Cartagena Protocol on Biosafety (CPB) in November 2001. Under the CPB, member countries are expected to establish a national biosafety framework (NBF) that will ensure that biotechnology applications, particularly the transboundary movement of "living modified organisms" (LMOs), are regulated in a manner that will minimise any negative effects to human health and the environment.

As a follow up to the scoping study and ratification of the CPB, the UNEP-GEF in 2002 provided support through the biosafety global projects to Uganda to development a National Biosafety Framework. National Biosafety Frameworks may have different components but in the case of Uganda, the following components were pursued during the implementation of the UNEP-GEF project under the auspices of the National Council for Science and Technology (UNCST):

1. A policy on biosafety, which is often part of a broader national policy on biotechnology;
2. A regulatory regime for biosafety, which usually consists of a law or act in combination with implementing regulations;
3. A system to handle notifications or requests for authorisations for certain activities, such as field test releases of GMOs in the environment. The system typically provides for public participation and risk assessment and public participation;
4. A system for monitoring and enforcement; and
5. A system for public information, i.e. a system to inform stakeholders about the development and implementation of the national biosafety framework.

The above components were viewed to constitute a a minimum package for developing a framework that would enable Uganda to fully oblige to the provisions of the CPB and other related international conventions to which Uganda is signatory. Thus, the Government of Uganda has been a consistent and strong supporter to the judicious introduction and application of agricultural biotechnology research in the country.

A key component of the NBF, the proposed national policy on biotechnology and biosafety, aiming to build and strengthen national capacity in biotechnology through research and development; promote the utilization of biotechnology products and processes as tools for national development; and, provide a regulatory and institutional framework for safe and sustainable biotechnology development and application was finalized and presented by the UNCST for enactment in 2002. Following stakeholder consultations and multi-sectoral reviews, the Cabinet of Uganda approved the policy in April 2008. The policy reconfirmed government's balanced position on biotechnology and genetically modified organisms (GMOs), and that the best way to evaluate potential benefits and risks is to have the necessary research and risk/safety assessment capacity in place. This overall position is reflected in the country's regulatory framework.

Biosafety Focal Point and Biosafety Desk established

The Ministry of Water, Lands and Environment serves as the National Focal Point for Uganda and has represented the Country at various Conference of the Party (CoP) engagements. The UNCST is the designated Competent Authority for biosafety in Uganda and has a mandate to coordinate, regulate and make decisions regarding applications and use of biotech in the country.

Right from the time of signing the CPB, the functions of the Competent Authority were executed by UNCST using a project

[1] *UNEP = United Nations Environment Programme; GEF = Global Environment Facility. UNEP manages a range of GEF-funded biosafety capacity building projects worldwide.*

mode approach. During a consultancy exercise conducted in 2002 (Quemada and Traynor, 2002) under USAID support, there was general agreement among UNCST, the research community and government bodies that rising interest and activity in biotechnology and biosafety had created a need for administrative structures for coordination, management and information exchange. This recommendation was implemented in 2004 when a Biosafety Officer was appointed at UNCST to be in charge of the Biosafety Desk. This biosafety desk serves as a central facility to manage, support and effect environmental and health safety in the use of modern biotechnology, and to serve as a national information center. It provides the primary contact point at the Competent Authority Secretariat for national, regional and international activities related to biosafety. Functional linkages were established with other country biosafety coordinating bodies and international support programs in the area of biotechnology and biosafety.

The biosafety desk also serves as Secretariat to the National Biosafety Committee (NBC). It receives and processes applications for the experimental introduction of GM plants in the environment and forwards them to NBC members. It schedules and keeps records of meetings, acquires and delivers relevant publications and provides administrative support to the NBC. The biosafety desk at UNCST is also expected to maintain a roster of local and regional experts and recruit ad hoc expertise for technical assistance as needed. Acting as a bridge between the NBC, government officials and applicants, it facilitates biosafety reviews and decision making, regulatory inspections and monitoring, reporting and record keeping. The managers of this office have been supported by international biosafety initiatives such as the Program for Biosafety Systems (PBS) for training in the management of biosafety as well as in risk assessment, management and risk communication. Having designated biosafety officers at the UNCST to support NBC operations, has been instrumental in enabling review, approval and implementation (including monitoring for compliance) of confined field trials (CFTs), through their support to the application processes, participation in developing the necessary regulatory documents and in the training of regulators, trial managers and inspectors. Clearly, the Government of Uganda assigned high priority to putting a framework in place for developing and regulating modern biotechnology and this has been a key factor in building the necessary institutional and human capacity in biosafety.

Training NBC, IBC and scientists on evaluating applications

Before authorizing GM materials to enter the country, Ugandan scientists had to be trained in preparation of applications while at the same time regulators had to learn how to evaluate such applications. The National Biosafety Committee was established by UNCST in March 1996 when there was an urgent need to make a decision on a livestock product — bovine somatotropine (BST) hormone produced by genetically engineered bacteria. The hormone was intended to be tested for growth and boosting milk production in indigenous cattle. Currently, the main function of the NBC is to provide technical advice to UNCST on science and technology matters related to the safe development and application of biotechnology in Uganda. The NBC comprises members coming from different sectors of government as well as the private sector and general public and these members are selected on personal merit.

Given the rapidly changing and dynamic landscspe of biotechnology applications and services, many members of the NBC took it as their responsibility to learn more about biotechnology and attain competence to advise government from a well informed position. The NBC members attended several training programs to build their capacity for evaluation of applications. Research scientists and other relevant regulators also benefitted from these trainings. Some of the trainees later formed the Institutional Biosafety Committee (IBC) at NARO, when it was established in 2004 through PBS support.

The UNEP-GEF initiated training of biotechnology regulators during their two projects implemented from 1998 to 2005. Several workshops were conducted for various purposes including: improving general understanding of biotech applications and implications for Uganda; risk assessment and risk management principles; monitoring and enforcement mechanisms. Training courses were also conducted to improve knowledge on biosafety legislation, other countries' biosafety practices as well as legal and administrative aspects. Another capacity building initiative, the BIO-EARN[2] project was implemented in Uganda as one of the partners in the region and this project also contributed to capacity building for biosafety through workshops and short courses as well as formal university training leading to the award of postgraduate degrees. Several Ugandans were trained in aspects of risk assessment, monitoring and risk mitigation and management.

When the PBS started its work in Uganda it built on what the UNEP-GEF and the BIO-EARN projects had achieved and continued with capacity building for regulators but initially targeted enabling CFTs of GM crops likely to be planted in Uganda. Capacity for risk assessment and risk management of genetically modified crops was strengthened for biosafety regulators, including members of the National Biosafety Committee (NBC) and the NARO Institutional Biosafety Committee, who were trained through workshops and study visits. The trainings focused on authorization and safe conduct of CFTs, providing information on the characteristics and purpose of these field trials, and providing hands-on

[2] *BIO-EARN = Eastern Africa Regional Programme and Research Network for Biotechnology, Biosafety and Biotechnology Policy Development. BIO-EARN ran from 1999 – 2009 supported by the Swedish International Development Agency, SIDA.*

experience in evaluating applications for introducing GM plants for CFTs.

Training and supporting scientists to develop applications

The first successful application to establish a CFT came from NARO in collaboration with the Catholic University of Leuven, Belgium, where a Uganda scientist had participated in transforming "Gros Michel" banana plants for resistance to black Sigatoka disease (Mycosphaerella fijiensis). The PBS worked together with the Agricultural Biotechnology Support Project (ABSP-II) and NARO to put together a team to produce the field trial application dossier. The team comprised of two Uganda scientists who travelled to Leuven to gain first-hand experience as the banana application was worked on. These Ugandan scientists presented the application to the NBC and continued to participate in addressing queries that came from the NBC before approval. A similar process was followed when field trial applications for testing of insect-resistant (Bt) and herbicide-tolerant cotton were prepared. Again Ugandan scientists traveled to South Africa to participate in completing the application. In the case of GM cassava with resistance to mosaic virus, experts from the Donald Danforth Plant Science Center (DDPSC) collaborated with Ugandan scientists to prepare the CFT application. Currently the capacity to prepare application for CFTs of GM plants is well developed. For example the NARO banana team prepared an application for field trials of GM bananas with improved vitamin-A and iron content and one for bacterial wilt resistance. The NARO IBC is increasingly taking on the role of reviewing applications and helping scientists to complete their dossier before submission to the NBC.

Capacity for environment risk assessment and risk management strengthened

Members of the NBC, IBC, crop inspectors as well as biotech scientists have been targeted specifically for evaluation of applications intending release of GM plants for confined trials and to a limited extent for advanced trials that may have to apply less stringent confinement measures due to their larger size and use of multiple locations. The regulators need to build competence to enable them assess risks that may be associated with products of modern biotechnology and how such risk may be managed. Both NBC and IBC members need to be aware of environmental and socioeconomic implications of adopting or rejecting particular products of modern biotechnology. These committee members and other decision makers need to be conversant with the overall advances in modern biotechnology and its implications to agricultural research advancement and the overall agricultural and industry development. The regulators need technical backstopping from scientists in their decision-making. The regulators and the scientists may access and use existing information for risk assessment but there are cases where locally generated information is critical due to ecological, social economic and other local factors. Hence knowledge and information on risk assessment and risk management is important for both regulators and scientists.

The PBS trained both regulators and scientists for risk assessment and risk management with a focus on plants or products that are likely to be introduced or developed in the country in the foreseeable future. In the same regard physical infrastructure that may be required for containing specific GM plants as they are studied for safety and other desirable traits was designed and later constructed by ABSP-II. Some risk assessment studies of local interest were pursued as part of graduate training programs.

Capacity for regulatory compliance and inspection

Hands-on, on-site trainings were conducted prior to implementing the CFTs to ensure that regulators and scientists clearly understood their role in conducting the trial according to established guidelines and detailed standard operating procedures (SOPs). These trainings were organized by PBS and partners with emphasis on: equipping participants with all SOP requirements in the management of specific crop CFTs; training biosafety inspectors on the procedures in CFT monitoring and evaluation; and, to educate CFT personnel on best practices for communication about the trials. These courses were designed to help participants understand what CFTs are and why there are needed, as well as the critical aspects of compliance and the biology of the test plant as it may relate to the confinement measures adopted. The trainings also covered the CFT reporting requirements in accordance to the SOPs as well as preparedness for incidents and contingency planning. The crop inspectors were particularly assisted to understand the inspection forms that would be used to assess for compliance during the GM crop growth and the post-harvest period. All trainings for compliance had a field visit component to help participants understand the expected layout of the trial and to assess compliance at that stage of implementing the trial.

Learning tours for key regulators and policy makers

Another form of capacity building for policy makers and regulators was achieved through study tours. Ugandan government officials have in different forums pronounced commitment and support to biotechnology application for over a decade. These consistent efforts have yielded desired results and in recent years, Uganda has made very encouraging progress in agricultural biotechnology research, human and infrastructural capacity building, development of regulatory frameworks and technology transfer activities. However, there was need to learn from countries that are intensively using biotechnology applications with regard to overall biotechnology policy design and implementation within the framework of national economic development strategies. In response, PBS in partnership with others players organized a 7-day study tour in 2007 to the Republic of South Africa for key agricultural biotechnology policy makers, regulators and capacity builders in Uganda. The objective was to acquire knowledge and share experience

about biotechnology capacity building, regulation and application from an African country that has made progress with both small and large-scale farmers. There were fifteen (15) participants for this tour including the Minister of State for Industry and Technology; Members of Parliament; senior policy makers from the Ministry of Agriculture; Office of the President; representatives from the Uganda National Council of Science and Technology; the Environment Authority and the National Farmers' Federation and consumer protection representatives. The team visited government research and development biotech programs, University and other training institutions, private sector supporting biotech applications as well as farmers growing GM crops. A similar visit to India was conducted in 2008 for another set of participants nominated from the same institution but with significant participation from Parliament of Uganda. These study visits helped participants to understand how GM crops are evaluated, grown and their benefit to the farmers.

In addition to international trips, policy makers and regulators have visited CFTs planted in the country including those of banana, cotton and cassava and they have been constantly impressed by the CFTs. As Charles Ngabirano, the Former Member of Parliament and Chairperson of the science and technology committee observed "Uganda has capable scientists who are doing a commendable job. The trial is showing positive results. We need to support them by ensuring that there are laws to enable them conduct research which in my view has great potential to address development concerns."

Developing the Biosafety Regulatory Framework

Having a biosafety regulatory framework is critical to enable proper implementation of CFTs. At the time of ratifying the Cartagena Protocol, Uganda was already in process of establishing the national biosafety framework. In 2000, the UNEP-GEF project working in close collaboration with the NBC and other stakeholders assisted the UNCST in developing a proposed National Biosafety Framework, referred to as NBF. Though not fully complete the Uganda NBF has advanced through the support of Uganda Government and other development partners. The NBF derives its authority from the UNCST Statute 1 (1990) which designates the Council as the competent authority in developing strategies for integrating S&T in the national development process. It is under this statute and specifically under the general guideline for biosafety that guidelines and manuals were developed by UNCST and partners through a participatory process to enable handling and implementation of CFTs. Specifically, guidance documents were developed, including the following[3]:

a. ***The Confined Field Trial Guidelines for Uganda:***
   These guidelines provide for a clear and concise summary of the regulatory requirements governing confined field trials of GM plants in Uganda, in accordance with the "Guidelines on Biosafety in Biotechnology for Uganda", which are administered by UNCST. The guidelines are meant for use by applicants and respective regulatory agencies.

b. ***Trial Manager's Handbook:***
   This provides detailed instructions for all aspects of biosafety for confined field trials in Uganda in form of Standard Operating Procedures (SOPs). The SOPs give procedures for shipping and storage, establishment, maintenance and confinement of CFTs; termination and post-harvest management of the trial site; and reporting of results to NBC. The procedures provided are for the use of all Trial Managers, Technical personnel, agents of the Authorized Party, and government officials engaged in planning, conducting or overseeing confined field trials of GM plants in Uganda.

   Procedures for the conduct of CFTs are intended to accomplish three important goals: 1) preventing the spread of novel genes in pollen, seed or other plant parts from the trial site; 2) preventing GM plant material from CFTs being consumed by humans and/or animals before a full food and feed safety assessment is conducted; and 3) preventing GM plants from escaping from confinement and establishing and persisting in the environment. With the achievement of these three goals, novel genes and their products may be confined to the field trial site, and their release into the general environment prevented. In addition to this manual crop specific manuals have been develop to guide research on those specific crops like bananas, cotton and cassava.

c. ***National Guidelines for Containment:***
   These guidelines seek to assist establishment and maintenance and use of containment facilities in order to ensure safety in biotechnology research and development as well as the development of national capacities to identify, assess and manage potential risks as well as establish codes of practice for containment of GM research. These guidelines have been useful in guiding laboratory and screenhouse research involving GM plants at the various NARO institutes.

d. ***Biosafety Inspection Manual:***
   These guidelines provide detailed procedures for inspecting CFTs of regulated genetically modified crops during the crop growth and post-harvest period.

e. ***Resource Book for Regulators:***
   This manual provides procedures and models for regulation of field trials for genetically engineered plants. The manual was also developed to assist NBC in the conduct of their work as they evaluate applications, authorise and oversee implementation of CFTs. Besides its use in field experiments of genetically modified plants, the booklet also provide a useful platform, or expanding and sustaining collective scientific efforts of promoting the safe application of genetic engineering techniques in agricultural production systems in Uganda.

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[3] *Approved guidelines are available online at URL: http://www.biovisioneastafrica.com/regulatory.html*

Scientific and infrastructure capacity

The Uganda agricultural research system embraced biotechnology towards the end of the 1990s when the then Director General of the National Agricultural Research Organization decided to join the international agricultural research consortium under the Consultative Group on International Agricultural Research (CGIAR). This decision was tied to a request for support to biotechnology capacity development, including plant transformation technology for Uganda. A multi-million dollar project on "Novel approaches to the improvement of banana production in Eastern Africa - the application of biotechnological methodologies" was developed and implemented between the banana network of Bioversity International, National Agricultural Research Organization – Kawanda Agricultural Research Institute (NARO-KARI), Uganda; Catholic University of Leuven (KU Leuven), Belgium; Forestry and Agricultural Biotechnology Institute, University of Pretoria (FABI), South Africa; and, the University of Leeds, UK. This project focused on highland bananas, which is an important staple food for the country. Several PhD scientists were trained in various universities with a focus on molecular biology and banana transformation technology.

Phase II of this project focused on developing transgenic East African highland bananas with resistance to banana weevil and nematodes in Uganda. In addition to efforts to develop human resource under this project, a well equipped biotechnology laboratory at NARO-KARI (now the National Agriculture Research Laboratories, NARL), was constructed, so that when the trained officers returned they had good facilities to continue conducting molecular biology research. This facility was officially launched and inducted to conduct research on biotechnology application by H.E. the President of the Republic of Uganda (Y.K. Museveni) August in 2003. Among the products from PhD training and research efforts were transformed plants, notably bananas transformed to resist black Sigatoka. These plants were developed at KU Leuven by a Ugandan PhD student and their being transferred to Uganda for evaluation needed both the scientific and regulatory and infrastructure capacity in place.

The trained molecular biologists could easily understand the language involved in completing a CFT application and so participated in the preparation of the banana application from a well informed position. The regulators including both the IBC and the NBC had also been trained on evaluating CFT applications hence they could consider the application with confidence.

At the time of establishing the molecular biology laboratory, NARO-KARI already had a modern tissue culture facility. On that foundation, a biosafety containment facility level II was constructed with financial support from USAID, and technical guidance by PBS and ABSP-II. This biosafety facility was a great incentive for regulatory agencies to have confidence in the scientific capacity available at NARO to handle GM plant materials. In addition to the biosafety facility, a biotech centre was supported to establish a confinement facility to enable field testing of GM plants under appropriate confinement conditions.

Working on a priority commodity and trait

Highland bananas provided excellent entry point to start CFTs in Uganda not only because a Ugandan scientist was involved in developing the product but also because banana is a key staple crop in Uganda. More than 12 million people depend on banana for food and income. The crop is grown on about 1.5 million hectares of land, which represents about 38% of total arable land in the country. Farmers in various parts of the country rank banana as their most important staple for various reasons including availability of harvest through the year and the relatively low production costs (Kalyebara *et al*, 2003).

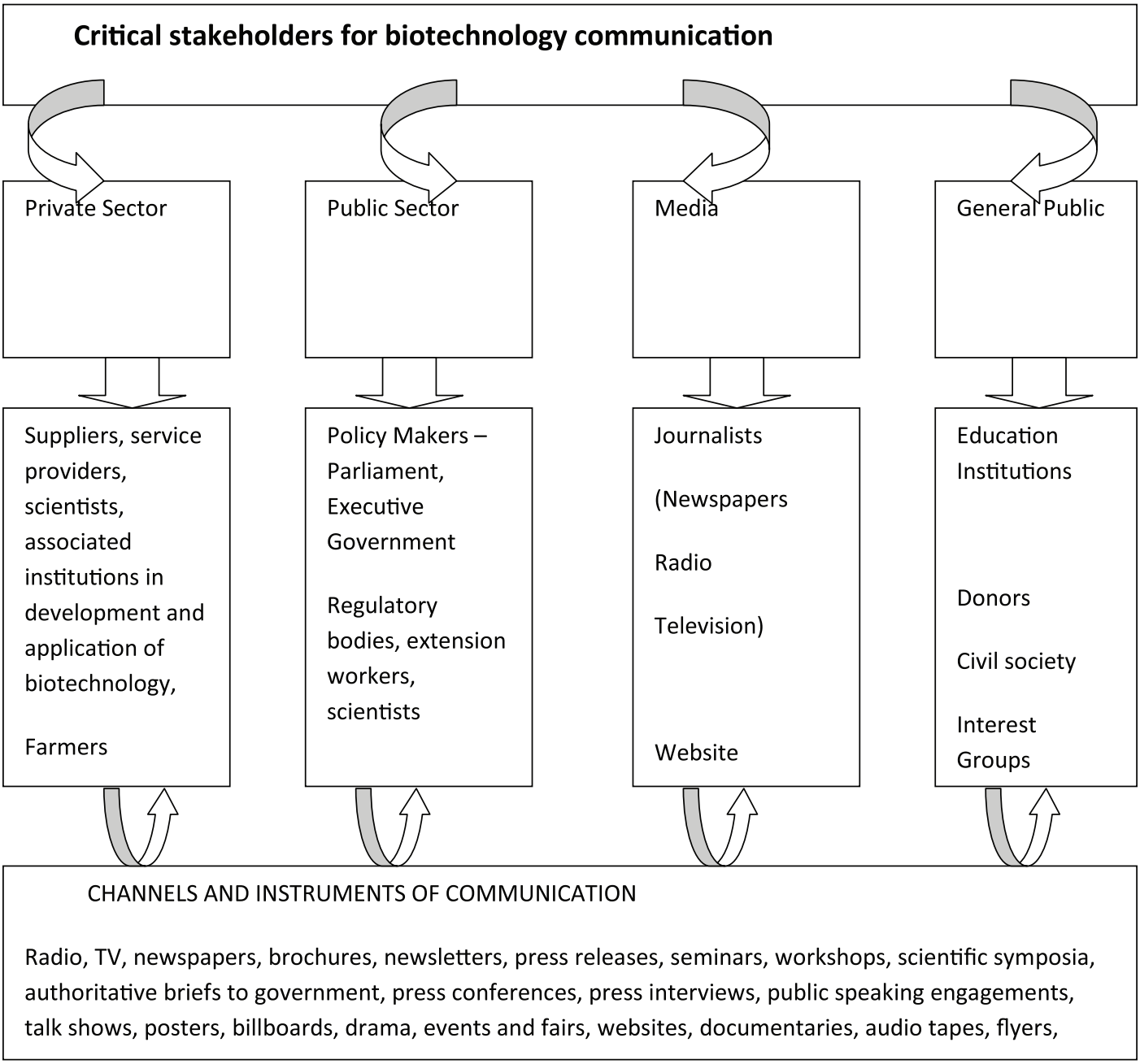
Despite its importance, banana productivity has been in continuous decline in the last 30 years (Insert reference). In the past, banana was a highly sustainable crop in Uganda, with long plantation life and stable yields. Indeed in some areas, one would find women of over 80 years saying that "I found this plantation here when I got married" (insert reference). More recently plantations are short lived requiring replanting every 3-5 years particularly in central Uganda. The most devastating production constraints that have become increasingly serious over the years are black Sigatoka, weevils and nematodes and more recently also the bacterial wilt. These four biotic constraints are very difficult to overcome through conventional approaches hence transformation technology is a welcome option to explore in fighting them. Under these circumstances the CFT application for GM banana was embraced by regulators and scientists considering that it could be a solution to a serious farmers' problem. Having been developed in Belgium, it was also appreciated that the materials needed to be evaluated under field conditions in Uganda where the product was expected to be grown. Government of Uganda has in the past 5 years earmarked and provided funds for research in banana biotechnology.

Communication plan for education, information and creating an enabling environment

While building regulatory capacity for CFT review was in process, program partners were mindful of the needs of policy makers and the public in general to get information on biotech and biosafety, and supporting an enabling environment for its research and development processes. A biotechnology communication strategy (UNCST 2009) was developed to guide the procedure and process for the transfer of relevant knowledge and information to diverse audiences, and to promote public awareness and participation in discussions around the CFT and the development of the biosafety framework in general. The critical audiences within the Ugandan context were defined as: (i) the media (print, broadcast, electronic, multi-media); (ii) policy makers (legislators and regulatory bodies); (iii) scientists; (iv) agricultural extension workers; (v) the private sector (seed companies, processors, exporters); and, (vi) general public (consumers, farmers).

Each of these audiences requires specific communication approaches and activities tailored to suit their information needs with regard to achieving the CFT implementation and overall biotech advancement in Uganda. The communication strategy identified gaps in the transfer of biotechnology information and knowledge to these audiences and on this basis, facilitated audience segmentation and setting objectives for communicating to the different groups (Fig. 1).

Figure 1: Identified audiences for communication strategy



The unique role of the media was recognized. The media, generally, are both a beneficiary and an effective channel for delivering messages to key audiences including policymakers and other decisionmakers (e.g., farmers) Therefore, the communication plan identified the needs of the media and how they could be addressed in order to transform the Uganda media into a communication partner for advancement of the biotechnology. Apart from the media, policy makers, scientists and extension workers were identified as critical audiences in the communication process for biotechnology development and adoption. It was recognized that each of these audiences play a critical role with regard to biotechnology development and use in the Ugandan context, and consequently formed the focus of the communication activities in the strategy. The core objectives for communicating with each of the identified audiences were defined (Table 1).

Table 1 Core objectives for communication across stakeholders

The Media	Policy makers	Scientists	Extension workers	General public	Private sector
Create awareness and promote understanding of Biotechnology	Educate about status of global and regional legislation in biotechnology	Provide opportunities for sharing research and feedback	Educate and inform on global and national biotech advancements and relevant case studies	Enhance awareness and promote understanding	Increase understanding of biotechnology policy and regulatory system
Enhance the image of biotechnology	Stimulate discussion and debate of biotechnology	Stimulate discussion and debate of biotechnology	Demonstrate benefits of bio-tech	Provide avenues for information acquisition	Provide knowledge on investment opportunities in biotechnology
Educate and inform on biotechnology advancements	Change attitudes about biotechnology	Change attitudes about biotechnology	Create dependable information links with farmers	Participate in regular dialogues	Provide avenues for information acquisition
Increase interest in, and coverage of bio-tech issues	Increase/Expand attendance of dialogue sessions	Develop pressure group pro-biotech		Provide information on benefits	
Provide consumers with access to relevant and accurate information	Galvanize strategic action like speedy decision making on biotechnology issues such as the policy	Develop skills and resources to provide accurate information to other audiences			

Source: Modified from UNCST (2009)

Various channels and instruments were used to communicate about the CFT, advances in the regulatory system and biotech in general. Radio was often used to report about specific events, research activities, to host panel discussion and talk shows with an intention of keeping listeners abreast of progress with the technology. The talk shows were particularly useful to capture feedback from the public and provide a two-way communication channel. Besides the Government radio station, Uganda has over 80 private FM radio channels in operation and these have been used to report on biotech and biosafety, particularly by reporters who have attended biotech communication training courses. Television stations have been used with a similar approach but also to air documentaries on the status and advances in biotechnology research and the regulatory system in the country. Other tools of communication that have been used include newspaper articles, brochures and newsletters, policy briefs and posters. A PBS-supported newsletter, BioVision, is published quarterly. This newsletter particularly targets members of parliament and other policy makers to keep them abreast of developments in biotechnology in Uganda and beyond.

The communication process was guided by developing messages that would facilitate acceptance and informed discussion about biotech in the country particularly regarding the safe use of GM crops. The messages were developed according to the audience based on six thematic areas: 1) Definition of biotechnology; 2) Use and footprint of biotechnology; 3) Regulation of biotechnology / biosafety issues; 4) Benefits of biotechnology; 5) Impact of biotechnology on human health and environment; and 6) Product development process (e.g., why CFTs are needed).

The communication strategy was implemented by partners each taking a lead role where they had comparative advantage or core responsibility. The NARO commodity programs took a lead role in communicating about their CFTs while PBS played key role in capacity building for biotech and biosafety communication and for communication to facilitate progress on the legislation process. Two participating civil society organizations, SCIFODE and Consent were the main players for communication to create public awareness. UNCST was responsible for monitoring implementation of the overall communication strategy.

Financial resources and partnerships

Obviously, as noted in the sections above, Uganda has benefited from strong external support in developing its national capacity for agricultural biotechnology and biosafety. However it would be mistaken to regard the process as externally driven, as the leadership and coordination roles are clearly performed by national agencies and organizations, ensuring that international support contributes to a national agenda and does not lead to duplication of efforts.

Building biotechnology and biosafety capacity requires significant levels of funding. By providing an enabling environment for modern agricultural research, Uganda is very well connected in a range of agricultural biotechnology programs (e.g., BIO-EARN, ABSP-II, AATF/WEMA) which have all contributed to establishing R&D infrastructure for safe research and experimentation with GM crops. All international programs active in Uganda have organized hands-on training programs and, in some cases, longer term degree training abroad in relevant disciplines.

In addition, and connected with the above, several international programs support biosafety regulatory capacity development in Uganda. Notable examples include the UNEP-GEF biosafety implementation projects and USAID-supported programs such as PBS and ABSP-II. Other projects supporting biosafety development and training include BIO-EARN and the Danish-supported BioSafeTrain. These programs have operated at the regional level and have contributed significantly to capacity building efforts in the different countries of Eastern Africa.

It should be stressed that those programs would have had limited impact without the strong support from, and active involvement by Ugandan individuals and institutions – UNCST, NARO, Universities (especially Makerere University) and regulatory agencies involved in the overall NBF that have worked in a coordinated fashion to ensure that international investments in agricultural biotechnology and biosafety have paid off over the last 10 – 15 years.

Concluding remarks

The preceding sections exemplified Uganda's progress in developing and implementing biosafety capacity, tailored to the overall needs and development objectives of the country. It has taken a long-term and product-orientated approach, in order to ensure that regulatory development and training were put in practice.

In addition to the activities and developments described above, primarily governing confined field trials, the biosafety regulatory framework's authority and scope would be strengthened when a comprehensive biosafety law is in place. Drafting a biosafety law started in 2002 under the UNEP-GEF project and has advanced since then, through various rounds of review and stakeholder consultations. The Draft Biosafety Bill is currently being finalized for submission and adoption by Parliament as the National Biosafety Act. The Act (biosafety law) will be an essential next step in bolstering Uganda's capacity in the judicious use of agricultural biotechnology.

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