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Tsukuba, Japan, 15-17 February 2010

BIOSAFETY EDUCATION RELEVANT TO GENETICALLY-ENGINEERED CROPS FOR ACADEMIC AND NON-ACADEMIC STAKEHOLDERS IN EAST AFRICA

Note by the Executive Secretary

1. The Executive Secretary is pleased to circulate herewith, for the information of participants attending the Third International Meeting of Academic Institutions and other Organizations involved in Biosafety Education and Training, an article entitled "Biosafety education relevant to genetically engineered crops for academic and non-academic stakeholders in East Africa", which presents the outcomes of the regional workshop on biosafety education in East Africa held from 17 to 19 April 2007 in Entebbe, Uganda. The article was published in the *Electronic Journal of Biotechnology*, vol.12, No.1, issue of 15 January 2009.

2. The workshop was organized by the Program for Biosafety Systems implemented by the International Food Policy Research Institute. Its objectives were to: (i) review the current status of biosafety educational programmes in East Africa; (ii) share biosafety educational resources among trainers in the East Africa region; (iii) discuss training strategies and approaches suitable for various stakeholders in East Africa; and (iv) build a regional network of biosafety/biotechnology trainers for continued interactions and information sharing to foster science-based decision-making.

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BIOTECHNOLOGY ISSUES FOR DEVELOPING COUNTRIES

Biosafety education relevant to genetically engineered crops for academic and non-academic stakeholders in East Africa

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Keywords: biotechnology, environmental safety, Kenya, Tanzania, Uganda.

Abbreviations: AATF:African Agricultural Technology Foundation
ABSF: African Biotechnology Stakeholders Forum
APEP: Agricultural Productivity Enhancement Program
BIOEARN: East African program and Research Network for biotechnology, biosafety and biotechnology policy development
Bt.- *Bacillus: thuringiensis*
CONSENT:Consumer Education Trust
COSTECH: Commission for Science and Technology
FAO: Food and Agriculture Organization
GATT: General Agreement on Tarrifs and Trade
GE: Genetic engineering
GEF: Global Environment Facility
ICGEB: International Centre for Genetic Engineering and Biotechnology
IEC: Information, Education, Communication
IFPRI: International Food Policy Research Institute
ISAAA: International Service for Acquisition of Agri-biotech Applications
MSU: Michigan State University
NARO: National Agricultural Research Organization
NCST: National Council for Science and Technology
OAS: Organization of American States
OECD: Organization for Economic Co-operation and Development
PBS: Program for Biosafety Systems, USAID
TBT: Technical Barriers to Trade

UNCST: Uganda National Council for Science and Technology
UNEP: United Nations Environment Program
USAID: United States Agency for International Development
WHO: World Health Organization

Development and deployment of genetically engineered crops requires effective environmental and food safety assessment capacity. In-country expertise is needed to make locally appropriate decisions. In April 2007, biosafety and biotechnology scientists, regulators, educators, and communicators from Kenya, Tanzania, and Uganda, met to examine the status and needs of biosafety training and educational programs in East Africa. Workshop participants emphasized the importance of developing biosafety capacity within their countries and regionally. Key recommendations included identification of key biosafety curricular components for university students; collaboration among institutions and countries; development of informational materials for non-academic stakeholders and media; and organization of study tours for decision makers. It was emphasized that biosafety knowledge is important for all aspects of environmental health, food safety, and human and animal hygiene. Thus, development of biosafety expertise, policies and procedures can be a stepping stone to facilitate improved biosafety for all aspects of society and the environment.

Production of genetically engineered (GE) crops has increased steadily since their introduction a decade ago (James, 2007). In 2007 more than 114 million hectares were grown worldwide, with 40% of those planted in developing countries (James, 2007). African countries, however, with the exception of South Africa, have not planted GE crops for commercial production, although research is in progress in a number of countries. Whether current or future GE crop technologies will be appropriate for African countries and farmers will depend on a combination of agricultural, health, environmental, social, and economic factors. Clearly, a primary concern must be safety of the products and their uses. Effective and safe use of these technologies requires the appropriate environmental and food biosafety assessment policies and processes to guide decision makers in choices for their countries, farms, and families.

The ability to perform and utilize biosafety assessments requires appropriate technical expertise, reliable sources of science-based information, and the mechanisms to deliver credible, verifiable information to a broad array of stakeholders with varying perspectives and concerns. The importance of capacity building for biosafety has been underscored by Meyer et al. (2007) noting that 'if the issue of capacity-building is not adequately addressed, the effort that went into negotiating the protocol will have been in vain'. A number of training programs have been carried out to help develop biosafety awareness and expertise, by both African and international agencies including those offered by the East African program and Research Network for biotechnology, biosafety and biotechnology policy development (BIOEARN); the African Union Biosafety Project; the United Nations Global Environment Facility (GEF); the International Centre for Genetic Engineering and Biotechnology (ICGEB); the FAO project for capacity building of regulation of genetically modified crops, products and processed foods; the Organization of American States (OAS) Capacity Building Program in Biosafety and Agro- Biotechnology in Latin America and the Caribbean Region and the USAID- Program for Biosafety Systems (PBS) in conjunction with the biosafety and ecological impact assessment capacity building programs at Michigan State University (MSU). These programs have been valuable in providing useful information and facilitating development of national biosafety frameworks in accordance with the Cartagena Protocol. However, the needs for expertise and information go well beyond what can be provided through such short term capacity building efforts. Local expertise and experience are needed to provide relevant biosafety education, perform biosafety assessments, and make locally appropriate decisions.

In April 2007, a workshop organized by PBS/MSU, was held in Entebbe, Uganda, to explore the current status of biosafety training and educational programs within the East African countries of Kenya, Tanzania and Uganda, and to address the question of how to best develop and deliver biosafety education in the East Africa region. East African biosafety experts, educators and communicators were brought together to identify needs, share resources and experiences, and facilitate development of future strategy for capacity building. The regional workshop participants included university faculty, research scientists, biosafety officers, and representatives of Ministries of Agriculture, Environmental Institutes, National Academy of Sciences, consumer organizations, farmer organizations, research and policy institutes, agricultural development programs as well as International and Regional networks (Table 1).

Specific objectives of the workshop were to: (1) Review current status of biosafety educational programs in East Africa; (2) Share biosafety educational resources among trainers in the East Africa region; (3) Discuss training strategies and approaches suitable for various stakeholders in East Africa; and (4) Build a regional network of biosafety/biotechnology trainers for continued interactions

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Table 1. **Participants in the workshop for biosafety education in East Africa.**

Names of trainers	Country	Institution
Margaret Karembu	Kenya	ISAAA International Service for Acquisition of Agri-biotech Applications
Eucharia Kenya	Kenya	Kenyatta University
Harrison Machari	Kenya	National Council of Science and Technology
Paul Odhiambo Mireji	Kenya	Kenyatta University
Felix Mmboyi	Kenya	African Biotechnology Stakeholders Forum
James Ochanda	Kenya	Nairobi University
Abdallah Kassuwi	Tanzania	University of Dar es Salaam
Lazaro Kitandu	Tanzania	Ministry of Agriculture
Kefas N Mugittu	Tanzania	Ifakara Health Research & Development Centre
Nicholas Nyange	Tanzania	Commission for Science and Technology
Mugassa S.T. Rubindamayugi	Tanzania	University of Dar es Salaam
Yona Baguma	Uganda	National Agricultural Research Organization
Henry Kimera	Uganda	Consumer Education Trust
Henry Kityo	Uganda	Farmer Representative, former PM
Arthur Makara	Uganda	Uganda National Council of Science and Technology
Vincent Muwanika	Uganda	Makerere University Environment Institute
Julie Namazzi	Uganda	International Food Policy Research Institute
Paul Nampala	Uganda	National Academy of Sciences, Makerere Univ.
George Nasinyama	Uganda	Makerere University
Theresa Sengooba	Uganda	Program for Biosafety System
Barbara Zawedde	Uganda	Program for Biosafety System
Telehun Zeweldu	Uganda	Agricultural Productivity Enhancement Project
Catarina Cronquist	USA	IFPRI - Washington
Rebecca Grumet	USA	Michigan State University
James Hancock	USA	Michigan State University
Kariim Maredia	USA	Michigan State University
Hector Quemada	USA	Calvin College
Cholani Weebadde	USA	Michigan State University

and information sharing to foster science based decision making.

The workshop began with an overview of crop biotechnology and food and environmental biosafety concerns; a discussion of issues raised by the general public and decision makers in the East Africa region with respect to GE crops; an outline of disciplinary aspects of biosafety as a scientific discipline; and presentation of factors influencing dissemination of accurate information. Following the presentation of background information, the workshop participants were divided into two groups to have focused discussions on the educational needs for academic (*e.g.* students of biotechnology, biosafety, plant breeding) and non-academic (*e.g.* legislators, regulators, extension agents, farmers) stakeholders. A summary of current status and issues relevant to biosafety education and communication in East Africa, results of deliberations of the workshop participants, and key recommendations resulting from the workshop are presented in this article.

ISSUES RELEVANT TO BIOSAFETY EDUCATION AND COMMUNICATION IN EAST AFRICA

Issues raised by stakeholders on GE Crops in East Africa

There are varied perceptions about biotechnology and GE crops among policy makers and the general public in the East Africa region. These perceptions are influenced by reported benefits perceived risks, unfamiliarity with the technology, many prevailing uncertainties, and lack of confidence in available capacity to ensure safe use.

Most enlightened stakeholders are aware that biotechnology has benefits such as higher yields in crops like cotton and maize. These benefits result from control of pests that decrease yield. The value of effective weed management through use of herbicide tolerant crops is quite striking, but many policy makers are not convinced that this is applicable to the small-scale farm situation most common in the region. Benefits through reduction of pesticide application for a crop like cotton are attractive, but have to be validated under local conditions. Reduced exposure of farmers to chemicals, less toxic herbicide runoff to surface water and groundwater, control of biotic and abiotic stress factors, reduced pre- and post-harvest losses, longer shelf life, reduced exploitation of natural habitats for food crops, preservation of biodiversity, development of a broader range of crops suited for marginal areas (*e.g.* sorghum, cassava, pearl millet) are among the anticipated future benefits associated with biotechnology (Were and von Grebmer, 2003; Kohi, 2006). Other benefits attributed to biotechnology include improved crop quality, though the lack of real GE products in the region and distorted information often leads to imagining that any abnormally high yields or big fruits are the result of genetic engineering.

The potential risks associated with biotechnology are very pronounced in the perceptions of policy makers and the general public in the region. There is concern that genetic modification could affect the safety of food and animal feed and thus pose potential risks to human and animal health. It is feared that GE foods may cause allergic reactions, act as toxins or carcinogens, affect digestibility or cause drug resistance. The food safety concerns are not only based on what the food could cause, but also due to limited capacity in the region to perform testing. Labeling as a consumer choice issue is another concern. Environmental safety concerns are very much influenced by what appears in media which highlights the potential risks posed by GE to agriculture, ecology and environment. Issues that have been raised include: invasiveness, weediness, gene flow, impact on 'non-target' organisms, mixed virus infections, new pests and diseases and unexpected variability (Kohi, 2006).

While the above listed food, health and environmental safety related concerns are often presented as generic concerns when discussing biotechnology, the socio-economic issues engender greater interest and pose more challenge to decision making bodies. The issues raised include monopoly control by the trans-national companies; the need to buy GE seeds for every new planting which small farmers may not be able to afford; profit margins being squeezed between the seed cost and declining world prices; possible loss of existing robust crop varieties and technologies; challenging market dynamics, especially with the European Union; and the concern that GE crops may undermine biodiversity conservation. Other issues include benefit sharing, transferability of biosafety assessments across the region and beyond, and co-existence of organic and GE crops. From a religious perspective there is concern over the “Unnaturalness” of the technology- “Playing God” and questioning of the extent to which this technology is enabling mankind to interfere with nature and evolution.

Given these many concerns and the limited knowledge and awareness about biotechnology by policy makers, extension workers and the farmers, there is a great need for accurate, credible information. There has been much effort to communicate the value of biotechnology, train communicators and develop message maps. While notable progress is being made, inadequate knowledge and misinformation about GE technology still prevails in the region. Efforts to address concerns include developing national communication strategies, open discussions, training and supporting efficient communicators, developing and using effective messages and IEC (Information, Education, Communication) materials, targeting the proper time and audiences, and using study tours to allow key stakeholders direct observation of GE crops in the field. Ensuring presence of appropriate biosafety systems, policies, legal instruments, and decision-making processes are critical for safe deployment of GE crops.

Key principles of crop biotechnology and biosafety

Biosafety assessment of GE crops and their uses must be based on an understanding of the technologies used for development of GE crops, the relationship of GE crops to conventionally bred crops, and the relationship of GE crop production practices to current agricultural practices and their impacts. Food safety concerns with respect to GE crops include possible impacts on toxicity, allergenicity, and nutritional content (FAO/WHO, 2000; Lehrer, 2000; Kuiper et al. 2001; Ho and Vermeer, 2004). These concerns arise from the source of introduced genes, which can come from familiar food sources or from sources that are not related to the crop; or to the transformation and regeneration processes, which can cause unintended changes in the plant due to effects on gene expression or metabolism. While traditional breeding also can use genes from non-food sources (such as disease resistance genes from wild relatives) or can cause changes in gene expression or metabolism (Baudo et al. 2006; Thomson 2006; Harrigan et al. 2007), the use of novel genes and techniques in GE crop development has instigated careful analysis of GE products (Codex Alimentarius, 2004).

Safety evaluation for GE foods as outlined in Codex Alimentarius (2003; 2004) involves extensive characterization of the gene and gene product, including testing for toxicity and allergenicity, and evaluation of gene expression and biochemical composition of the transgenic plants. GE foods are then compared to their conventional counterparts to determine whether they are ‘substantially equivalent’, or altered in a significant way that could influence food safety (Konig et al. 2004). The International Food Safety Assessment Guidelines provided by Codex Alimentarius affirm substantial equivalence as the basis of safety assessment. A conclusion of substantial equivalence is not by itself a safety assessment, but is a means of identifying the differences between the new food and its traditional counterpart, which then become the focus of the safety assessment through a framework of tests. While other attributes, such as colour, flavour, texture, or cooking qualities may influence ultimate suitability or acceptance of the GE crop, these are not food safety issues and are not generally part of a food safety assessment, unless the differences result from changes influencing factors such as toxicity or nutrition. There is international agreement on the principles of food safety assessment, and food safety assessments are done similarly in Europe, United States, Japan, and Canada though regulatory systems may differ in the way decisions are made (Kuiper et al. 2001; Konig, 2004).

Environmental safety concerns include potential effects on non-target species, gene flow to wild relatives, and potential effect on biodiversity or invasiveness (Conner et al. 2003). Potential effects on non-target species may occur if GE crops produce novel defensive compounds (*e.g.* Bt toxin to prevent insect attack). This concern is generally addressed through testing toxicity of active ingredient on indicator organisms and by monitoring for toxic effects (Andow and Hillbeck, 2004; Romeis et al. 2006). Potential effects of transgenes on invasiveness of a crop or native species depends on presence of compatible native relatives to which gene flow could occur and the resultant impact of the new gene (Conner et al. 2003; Snow et al. 2005). Information on the location and inter-fertility of compatible relatives, including those of most African crops, is generally available in the literature; information on invasiveness can be obtained from several sources including literature or indigenous knowledge. The most careful evaluation will be needed for crops that are already invasive or have invasive compatible wild relatives (Hancock, 2003).

Two other concerns that frequently arise are primarily agricultural, rather than environmental. Many have expressed concerns about losing land races through introduction of transgenes via hybridization with GE crops (Conner et al. 2003). It is important to note that potential impact of transgenic crops on land races is not different from that of conventionally produced cultivars unless the transgene incorporated into the crop provides a unique risk to the ecosystem (Hancock, 2003). Development of resistance by the target pest to the protective compound also has been raised as a concern with GE crops. In this case, the primary concern is loss of usefulness of the control strategy, as has been frequently observed with conventional breeding for resistance or application of chemical pesticides (Conner et al. 2003; Snow et al. 2005). Strategies to delay development of resistance for GE crops include use of very high toxin levels, stacking genes, and planting refugia to allow mating of resistant individuals with non-resistant individuals to reduce frequency of resistance genes (Bates et al. 2005).

In addition to potential negative effects of GE crops on the environment, it was indicated that there is also potential for positive effects. Numerous reports have documented reduced pesticide use in both developed and developing countries resulting from production of Bt crops engineered for resistance to specific insect pests (Brookes and Barfoot, 2006; Morse et al. 2005; Raney, 2006; Sankula, 2006). The use of herbicide resistant crops has led to the use of less toxic herbicides, reduced fuel use, and has facilitated the adoption of reduced-tillage or no-till production methods that help preserve soil quality and reduce soil erosion (Brookes and Barfoot, 2006; Cerdeira and Duke, 2006).

In the discussions following these presentations, participants expressed the need for African stakeholders to look at the research done for the different GE products themselves, and make their own decisions on a case-by-case basis. Based on the prior research, decisions could be made on whether additional information is needed for the intended new environments and uses. The high costs of safety assessments and regulatory process was seen as a potential obstacle for future public-sector development of

Table 2. Major universities in the East African region with biosafety-related course offerings.

Makerere University	Kampala, Uganda	http://www.mak.ac.ug/
Sokoine University of Agriculture	Morogoro, Tanzania	http://www.suanet.ac.tz/
University of Dar es Salaam	Dar es Salaam, Tanzania	http://www.udsm.ac.tz/
Egerton University	Egerton, Kenya	http://www.egerton.ac.ke/Regerton/index.php
Kenyatta University	Nairobi, Kenya	http://www.ku.ac.ke/
Jomo Kenyatta University of Agriculture and Technology (JKUAT)	Nairobi, Kenya	http://www.jkuat.ac.ke/
Moi University	Eldoret, Kenya	http://www.mu.ac.ke/
University of Nairobi	Nairobi, Kenya	http://www.uonbi.ac.ke/

GE crops and may make it difficult for products to reach the intended users. It was also noted that given competing demands for very limited public resources, agricultural research in Africa is under-funded. These constraints will make it difficult for introduction of GE biotechnology, like many other technologies, to realize its potential (Cohen, 2005). Finally, questions regarding the scope of assessments were also discussed - is it the responsibility of scientists to address socio-economic concerns; if not, who should? It was suggested that there is need to include socio-economists and communicators to address some of those issues.

Cross cutting issues in biosafety as a scientific discipline and educational capacity in the East African region

As a scientific discipline, biosafety entails identification of risks and development of practices to analyze, regulate, manage, and prevent or minimize exposure of humans and the environment to biological hazards. The evaluations may be directed toward known hazards such as pathogenic microbes or toxins of biological origin (Isaac and Kerr, 2003) or toward assessments of other potential biological hazards such as those which may be associated with modern gene-based biotechnology. In its broadest sense, biosafety also includes preparedness to deal with biological weapons, bioterrorism, biosecurity and biodefence issues. In addition to direct impacts on the health and safety of communities and environments, the implementation of biosafety practices can influence laws and regulations, product development, production methods, and international trade (Cohen and Paarlberg, 2004). Thus, the choice of appropriate biosafety standards and methods interfaces with society at many levels and raises numerous bioethical questions that go beyond laboratory assessments of risk. In some cases, the biosafety risk assessment process has been more broadly framed, and in addition to biosafety *per se*, has addressed potential effects of biotechnology products on matters of trade, livelihood of communities, access to products, and benefit sharing (Kameri-Mbote, 2002; Karlsson, 2003; Dhar and Anuradha, 2004)

As a multi-faceted discipline, biosafety training must span numerous disciplines. Scientific knowledge is required in the areas of genetics, plant breeding, molecular biology and biotechnology; agricultural production practices; food science, toxicology, and microbiology; ecology and environmental science; and environmental and food safety assessment methods. Understanding of the fundamental principles of risk assessment and risk communication, and public perception and concerns about the application and use of biotechnology is also critical. Knowledge of international conventions and agreements that influence development of national biotechnology regulatory instruments such as the Cartagena Protocol on Biosafety of the Convention on Biological Diversity, the Codex Alimentarius Commission of FAO/WHO, relevant World Trade Organization Agreements such as Sanitary and Phytosanitary (SPS) Agreement, Technical Barriers to Trade (TBT) and the general Agreement on Tarrifs and Trade (GATT) is also necessary (Isaac and Kerr, 2003). Students of biosafety should also know about the role of United Nations organizations including FAO, WTO, UNEP and GEF in biosafety regulations as well as that of regional organizations like the OECD and the African Union.

Proper governance and effective implementation of National Biosafety Frameworks, requires the ability to validate presence and concentration of genetically modified organisms in the environment or products, decision-making authority and capacity, mechanisms to enforce compliance, and effective procedures to communicate relevant information. Thus training is needed by biosafety officers, laboratory safety officers, directors of health and safety programs, biosafety committee chairs and members, technical staff, industrial hygienists, occupational health personnel working in environments with biohazards, research scientists, scientific journalists and architects and engineers designing facilities handling biological materials which are toxic, pathogenic or pests.

It was emphasized that training in biosafety should provide knowledge on crosscutting issues relevant to biosafety practices and regulations and should be accompanied by consideration of benefits and risks to the specific environment of application. Biosafety knowledge should not only be relevant to GE products but also to biological hazards such as toxins, pathogens, and invasive species, which frequently cause health or environmental impacts throughout the world (Sendashonga et al. 2005). Thus development of biosafety expertise, policies, and procedures can serve multiple important health and environmental goals.

The subsequent discussion of biosafety educational needs emphasized that biosafety issues are not new or limited to GE products, so when talking about biosafety we need to include broader issues of food safety and hygiene. It was suggested that infusing elements of biosafety and biotech in the existing science curriculum at the secondary level could avoid the challenge of overloaded curricula. While on-line courses could be very helpful in reaching a broader audience and could assist in serving regional needs, most universities in the region are not conducting e-learning in biotechnology and biosafety, except Kenyatta University in Nairobi.

The workshop participants noted that there are many training programs and resources available for biosafety and food safety education inside and outside of the East African Region (Table 2; Table 3). Organizations that routinely carry out training on biosafety include The International Centre for Genetic Engineering and Biotechnology (ICGEB), which also provides a bibliographic database and a range of publications; Michigan State University, which offers both short courses and longer-term internships for biosafety and food safety; and UNEP-GEF which organizes training internationally. There are also numerous regional and international sources of information on biosafety and food safety, many of which are web-based.

Educating and communicating effectively about the benefits and potential risks of biotechnology products

Communicating information about biotechnology and biosafety faces a range of challenges due to different information needs and backgrounds of various stakeholders, perceived interests vs. actual interests, and existing views of the technology that may influence receptiveness to information. Therefore, effective communication requires matching the proper speaker to the target group in order to enhance comprehension of audiences with diverse perspectives, levels of knowledge, and sophistication. Scientists and regulators should be involved in communication to help assure that facts are not distorted, over-simplified, or sensationalized.

Effective risk communication must deliver accurate and well presented information and ensure transparency and openness at all levels. An interactive exchange of information and opinions throughout the risk analysis process is important to clarify misconceptions and promote understanding. Constraints to risk communication in agricultural biotechnology include uncertainty, complexity and incompleteness of biosafety data, e.g., not all non-target organisms can be studied, testing cannot be done indefinitely, and standards for testing are not universally accepted. Thus the outcomes of risk assessments are estimates, and conclusions reflect value judgments. There is also distrust and scepticism stemming from disagreement among experts, lack of co-ordination among risk management organizations, inadequate risk communication skills, and a history of arrogance, distortion and exaggeration from groups on both sides of the issue. Thus the problem of risk communication is not so much to regain trust as to function without it. Psycho-social factors that determine how people process information about risk also have to be taken into consideration for effective communication.

Other constraints in biotechnology communication include limited resources and selective reporting by news media. In most cases, communicating about biotechnology is not a high priority for limited public funds, and the media tend to select stories about unusual situations such as verbal confrontations rather than agreements, or sensational situations such as disasters that may be imagined or real. Reporters tend to exaggerate “outrage factors”, heightening perception of risk (Chartier and Gabler, 2001). Truth in journalism is different from truth in science; journalists will try to obtain information from accessible sources and present both sides of an issue as if they are equally important (Chartier and Gabler, 2001).

The ensuing discussion raised several points relative to the presentation of biosafety information. There is need to develop different approaches and messages for communicating biotechnology to different target groups. The content and packaging of the messages is very important, especially with respect to presentation of potential risks. Presenting risks as real instead of potential may cause misquotation and misinterpretation. The lack of biotechnology products in current use in Africa was viewed as a further challenge to communication and reducing misconceptions.

Several points referred to the role of scientists and the media including the need to be more proactive in training scientists to become media reporters, or to provide journalists with skills in communicating about science. It was also emphasized that scientists need to be ready to provide media with information immediately when contacted to avoid misinformation, and that they should also communicate with others in their institutions to minimize misunderstanding and misinformation.

WORKSHOP DISCUSSIONS AND RECOMMENDATIONS

Biosafety education needs for non-academic stakeholders in East Africa

The group addressing education of non-academic

Table 3. Key regional and international resources for biotechnology information in Africa.

African Sources
African Agricultural Technology Foundation (AATF): http://www.aatf-africa.org
AfricaBio: http://www.africabio.com
African Biotechnology Stakeholders Forum (ABSF): http://www.absfafrica.org
AfriCenter-The International Service for the Acquisition of Agri- Biotech Applications: http://www.isaaa.org/
Biosciences Africa: http://www.biosciencesafrica.org
Eastern and Central Africa Biotechnology and Biosafety (ECABIO) program of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA): http://www.asareca.org
International Institute of Tropical Agriculture (IITA): http://www.iita.org
Program for Biosafety Systems (PBS): http://www.biovivioeastafrica.com
Public Understanding of Biotechnology: http://www.pub.ac.za
International Sources
Agriculture and Agri-Food Canada: http://www.agr.gc.ca
Biosafety Clearing House (BCH) of the Convention on Biological Diversity: http://bch.biodiv.org
Biosafety Information Network and Advisory Services (BINAS): http://binas.unido.org
Codex Alimentarius: http://www.codexalimentarius.net
Consumer International: http://www.consumersinternational.org
Food and Agriculture Organization (FAO) and the Biosafety Protocol to the Convention on Biological Diversity (CBD): http://www.fao.org/sd/RTdirect/RTre0034.htm
Food Biotechnology Communication Network: http://www.foodbiotech.org
International Centre for Genetic Engineering and Biotechnology ICGEB: http://www.icgeb.trieste.it/biosafety/
International Register on Biosafety (IRB): http://www.unep.org/unep/program/natres/biodiv/irb/
Joint Research Centre (JRC) of the European Union: http://www.jrc.cec.eu.int/
The European Consumer Organizations: http://www.beuc.org
The National Food Safety Database: http://foodsafety.ifas.ufl.edu/indexNFSDB.htm
U.S. Department of Agriculture (USDA): http://www.usda.gov
U.S. Environmental Protection Agency (EPA): http://www.epa.gov
U.S. Food and Drug Administration (FDA): http://fda.gov
World Heath Organization (WHO): http://www.who.int

stakeholders were asked to identify key needs to facilitate availability and dissemination of reliable and relevant information regarding biotechnology and biosafety within the region. The specific questions addressed by the group were: who are the target non-academic stakeholders to be reached; what kind of information should be prepared; who will disseminate the information and in what form; what are the bottlenecks to providing information to the target groups; and what strategies could be used to alleviate such barriers or challenges? Finally, the group proposed possible methods and mechanisms to reach the target groups and recommended priority actions for the future.

The non-academic stakeholders encompass a wide range of interests and backgrounds. An initial challenge was to identify the possible target groups and to prioritize among them. The groups for whom it was thought that biotechnology and biosafety information would be important, and who play an important role in the community included, farmer and farmer organizations, agricultural and food industries, extension workers, environmentalists, regulators, politicians and opinion leaders, policy and decision makers, mass media professionals, consumers of biotechnology products, and faith and culture leaders. The groups identified to be of highest priority to receive information were policy makers, politicians, mass media and farmers. Regulators and consumers also were thought to be important target groups.

The group discussed at length the kind of information to be disseminated to the various stakeholders and the varying needs for the different groups. It was agreed that all of the groups would be helped by basic information on biotechnology and biosafety, potential benefits of the products, and the possible cons and pros of their use. Other sorts of information needs that may vary with the target group include comprehensive information with reference to safety, compliance on international trade, environmental considerations, and bio-politics. It would also be important for farmers and extension workers to acquire knowledge and skills on good agricultural practices and proper management of the products, while market information was seen as important for politicians/opinion leaders, farmers and extension providers.

With respect to who could, or should, disseminate such information to the target group, it was suggested that scientists, non-governmental agricultural organizations, and agro-industries could play role across all target group categories. For farmers and politicians, farmer organizations and ‘champion politicians’ can be the most effective. Although the media was identified as one of the stakeholders to receive information, they also play a key role in delivery of information needed by other groups. It is important to provide the media with relevant information, and for knowledgeable groups and individuals to ensure regular and timely availability to the media.

An important part of the discussion was identification of barriers that could hinder the information transfer to non-academic stakeholders, and possible solutions that could be used to avert some of these problems and challenges. These are outlined in Table 4. Depending on the target group, challenges can include limited literacy, inadequate extension services, current misconceptions or fears, lack of trust, and lack of time and funds.

Numerous suggestions were proposed to reach the target groups and overcome obstacles. The consensus was that workshops, media, publications, audio/radio programs, on-line resources, and exhibitions could have significant impact on outreach. Radio was seen as a primary medium to reach farmers to counter limitations of distance and literacy. Other suggestions included study tours, short courses, demonstrations, and visits to biotech information centres where stakeholders could access and hear primary and secondary information from informed educators. Leading institutions from each of the riparian countries could take the lead as source of information. Local or regional institutions currently providing information and resources include African Agricultural Technology Foundation (AATF), African Biotechnology Stakeholders’ Forum (ABSF), International Service for the Acquisition of Agri-biotech Applications (ISAAA) and the National Councils of Science and Technology. Other reliable resources are South African-based AfricaBio and Public Understanding of Biotechnology

Lastly the group discussed and agreed on three main priority actions to start with: organizing study tours (country, regional or international) for policy-makers, politicians, and farmers; development of information materials for media; and production of IEC material (video clips, radio clips and posters) for farmers. The group emphasized the importance of reaching the media with accurate information. Study tours were reported to be especially effective by providing a first-hand look at GE crops in the field and a chance to interact with farmers currently using the technology

Development of curriculum for environmental biosafety and food safety in EA universities

The objective of the group focusing on university curricula for biosafety education was to determine key topics to be addressed in biosafety courses, identify relevant courses currently taught within the region and additional curricular needs, and identify ways to share materials and expertise within the region.

Depending on the institution, there may be comprehensive biosafety courses dedicated specifically to biosafety, and/or allied courses which cover some aspects of biosafety. In Kenya biosafety courses are offered at the BSc and MSc level at Kenyata University, University of Nairobi (MSc) and Moi University (BSc). In Tanzania BSc biosafety courses are offered at Dar es Salaam and Sokoine

Universities, and in Uganda a biosafety course is offered at MSc level at Makerere University. The above universities also offer comprehensive food safety courses which include safety of GM derived foods and feed.

In determining needs for biosafety education, it was observed that several occupational programmes should include biosafety training. These include training for environmental scientists, medical researchers and practitioners, veterinary workers, agricultural researchers, food scientists, food safety regulators, biosafety officers and occupational health workers, scientists working with biotechnology tools, and laboratory employees working with pathogenic or hazardous biological materials.

The group identified a set of key topical issues to be addressed under biosafety curriculum:

Introduction to concepts and application of biotechnology and potential benefits, risks and concerns

- Basic biosafety concepts, principles and practices/techniques

- Principles and concepts of biosafety risk analysis including concepts of biosafety risk assessment, biosafety risk management and biosafety risk communication

- Relevant policies on development of biotechnology and its safety

- Bioethics, legal, and social implication of application of biotechnology

- International conventions linked to biosafety development and institutionalization.

The need to improve the overall education in biosafety was noted. It was suggested that the biosafety educators work together to develop a model biosafety curriculum for East Africa, possibly by assembling a small panel of experts from each country to review existing curriculum and make recommendations to university representatives. Where full University courses could not be accommodated, it was recommended to include biosafety aspects in other relevant existing courses. It was also suggested that some biotechnology and biosafety aspects should be integrated into secondary school curriculum. The group agreed to form a biosafety trainer's network to facilitate optimum use of the available capacity and sharing of training materials.

CONCLUDING REMARKS

The regional biosafety education workshop developed several prioritized recommendations to improve biosafety

Table 4. Barriers to biotechnology information transfer to non-academic stakeholders and possible solutions.

Target group	Barrier to reach them	Means to overcome barrier
Farmers and extension workers	Inadequate simple, translatable materials, logistics; level of farmer literacy; inadequate farmer's organizations; lack of GE products; inadequate extension services	Use of local radio programs; training programs for farmers and extension workers; development of simple translatable IEC materials; study tours
Politicians and opinion leaders	Differing opinions on priorities for national development; lack of availability; inadequate awareness; inadequate lobbying	Workshops; champions within parliament; regular information supply from competent authorities; development and implementation of relevant legislation
Policy and decision makers	Bureaucracy; unavailability; confidentiality principles in the services; not convinced about the technology	Institutional networking; sensitization discussion fora; study tours; breakfast/luncheon meetings
Media	Too few well-informed science journalists; misconceptions; lack of interest; inadequate information supply from scientists; editorial policies influencing coverage and balance	Workshops; training modules for science writers; media discourse; contact with editors and feature writers
Regulators and environmentalists	Bureaucracy; insufficient legislation; insufficient knowledge; misconceptions	Training modules for regulators; study tours; regular supply of simple IEC materials
Consumers and faith and culture leaders	Inadequate information supply to media; misconceptions;faith and cultural concerns	Radio/TV talk shows; information supply for the media; respected champions; simple IEC materials

education and communication in East Africa. Specific actions to reach non-academic stakeholders included organization of study tours for policy makers, politicians, and farmers; development of information materials for the media; and development of IEC materials for farmers and extension workers. The primary recommendations for university instruction were to define key curricular needs and components, and establish mechanisms to allow for exchange of information and materials among institutions and countries. Finally, a recurring theme was that biosafety expertise serves important health, food, agriculture, and environmental safety concerns that extend beyond biotechnology applications. Academic and non-academic education programs should be structured to facilitate improved biosafety in all aspects of society and the environment.

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