Chapter 1

Agricultural Biotechnology in Southern Africa: A Regional Synthesis

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The Convention on Biological Diversity defines biotechnology as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." Defined this way, it clearly emerges that biotechnology is an old science, with many established uses in areas such as agriculture, medicine, forestry, mining, industry, and environmental management. The old applications are generally referred to as traditional biotechnology, and in agriculture these have been in use since the advent of the first agricultural practices for improvement of plants, animals, and microorganisms (Persley and Siedow 1999).

The application of biotechnology to agriculturally important crop species, for example, has traditionally involved the use of selective breeding to bring about an exchange of genetic material between two parent plants to produce offspring with desired traits such as increased yields, disease resistance, and enhanced product quality. The exchange of genetic material through conventional breeding requires that the two plants being crossed be of the same or closely related species.

The Generations of Biotechnology

The progress and development of biotechnology is generally divided into three broad categories, also referred to as generations of biotechnology. This acknowledges that biotechnology is not a new technology, but rather is a continuum of techniques and approaches that have evolved over time.

The first generation. This refers to the phase of biotechnology that was based on empirical practice, with minimum scientific or technological inputs. This phase stretched all the way from 12,000 BC to the early 1900s.

The second generation. Developments in fermentation technology, especially during the period between the two world wars, constitute what is generally referred to as the second generation or phase of biotechnology. Major products from this generation were antibiotics such as penicillin and other products such as vitamins and enzymes. Another critical event of this generation, beginning in the 1930s, was the development and use of hybrid crop varieties in the U.S. Corn Belt, which resulted in dramatic yield increases.

The third generation (new biotechnology). The third generation or phase of biotechnology, also referred to as the new or modern biotechnology, is the present one. A turning point occurred in 1953 with the discovery at Cambridge University (U.K.) of the structure of deoxyribonucleic acid (DNA), which is the molecular carrier of stored information. DNA is a long and winding molecule that is made up of a combination of several chemicals. Four related chemicals in DNA, called "bases," are lined up in specific sequences, and these specific sequences represent the information that determines the traits, features, characteristics, abilities, and functioning of cells within an organism.

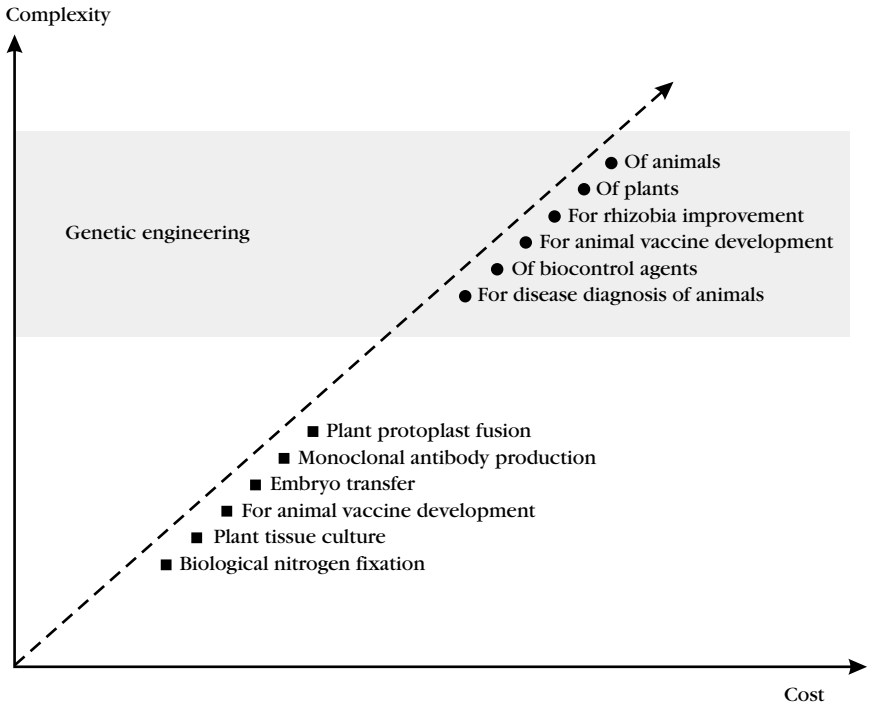
The particular segment of DNA that contains information for a particular characteristic or trait is called a gene. In other words, the genes represent information that is passed on from one generation to the next. It is also important to point out that not all segments of DNA represent information that can be or is passed on from one generation to the next. Because DNA is made up of chemicals that are present in cells where many life-maintaining processes are occurring, the DNA needs to "protect" itself, and hence some segments of the DNA serve the purpose of ensuring that the DNA remains intact.

The Current Status of Biotechnology Research and Use in the SADC Region

Countries in the Southern African Development Community (SADC) region are employing various forms of biotechnological techniques in their agricultural, environmental management, forestry, medicine, and industry efforts, and have been since time immemorial. However, without doubt Africa is the region where biotechnologies are the least developed. There are many different explanations for this situation, but several schools of thought associate it with the perennial economic problems affecting the continent (Sasson 1993).

Figure 1.1 shows the gradient of biotechnologies in terms of complexity and costs. An analysis of the status of biotechnology in the different SADC countries will be presented and discussed based on this gradient.

Figure 1.1 Gradient of biotechnologies in Southern African Development Community countries in terms of complexity and costs, 1993



Source: Sasson 1993.

From studies conducted by the Biotechnology Trust of Zimbabwe (BTZ) in 2001 and 2002, and studies by other organizations such as the Rockefeller Foundation and International Service for National Agricultural Research, it can be seen that the main area in which biotechnology techniques are being applied in southern African countries is agriculture, with the major thrust being crop improvement. Techniques such as tissue culture are being applied in almost all the countries, mainly because of the less intensive nature of this technique in terms of human and infrastructural resources.

Modern biotechnological techniques, which include genetic engineering, are being employed in few of the countries, namely Malawi, South Africa, and Zimbabwe, and to a small extent in Mauritius and Zambia. Of all these countries, only South Africa has reached the commercialization stage insofar as products of genetic engineering are concerned. The rest are still at the laboratory research stage.

Tied closely to the issue of research is the development and implementation of regulations to monitor the research and products thereof. Only three countries in the region, namely Malawi, South Africa, and Zimbabwe, have legal mechanisms for biosafety, that is, the safe development and application of biotechnology. The rest are still at varying stages in the development of their biosafety systems. All

Table 1.1 Status of development and use of biotechnology techniques in Southern African Development Community countries, 2002

	Areas of application		
Techniques/category	**Angola**	**Botswana**	**Democratic Republic of Congo**
Tissue culture (TC)	Little is known	Used on a limited basis for root and tuber crops	Little is known
Genetic modification (GM)	Little is known	Limited research is being done at the University of Botswana. No field trials have been approved.	Little is known
Fermentation technology	Little is known	Used in the brewing industry	Little is known
Marker-assisted selection	Little is known	None	Little is known
Artificial insemination and embryo transfer	Little is known	Used in livestock breeding	Little is known
Molecular diagnostics and molecular markers	Little is known	Used on a limited basis in plant and animal disease diagnosis	Little is known
Biological nitrogen fixation	Little is known	Used mainly through integration of legumes in cropping systems	Little is known
Manpower training	Little is known	Training is offered in other natural science modules at the University of Botswana	Little is known

countries of the SADC region are signatories to the Cartagena Biosafety Protocol, an addendum to the Convention on Biological Diversity, which governs safe transboundary movement of living modified organisms, among other provisions for ensuring safety in biotechnology.

Table 1.1 gives details on the status of development and use of various biotechnological techniques in the southern African countries.

Areas of application			
Lesotho	**Malawi**	**Mauritius**	**Mozambique**
Used in Irish potato production and micropropagation	Used in disease elimination and micropropagation for cassava, sweet potatoes, Irish potatoes, and horticultural crops	Used on a limited basis in sugar cane research	Used in cassava and Irish potato production, micropropagation, and disease elimination
None	At the research level for cassava improvement (virus resistance). *Bt* cotton trials have been conducted.	GM sugar cane is nearing field trials. Awaiting adoption of a biosafety framework.	None
None	Used for food and feed production	Widely used in the brewing industry	None
None	None	None	None
None	Used for cattle breeding	Used on a limited basis	None
None; serological techniques are still being used	At the research level for use in animal disease diagnosis and diversity studies	Serological techniques are still used for diagnosis	Serological techniques are still being used
Used for legumes only	Used for legumes only	Used for legumes	Used on a limited basis, for legumes
Undergraduate and graduate training is done in natural and agricultural science (National University of Lesotho)	Training is done in the natural and agricultural sciences (Bunda College of Agriculture). Most of the training is theoretical. No explicit biotech courses are offered.	No explicit biotechnology training is offered.	Limited training is done in the natural sciences and agriculture (Eduardo Mondlane University)

(*continued*)

Table 1.1 (continued)

	Areas of application		
Techniques/category	**Namibia**	**Seychelles**	**South Africa**
Tissue culture (TC)	Used in cassava and Irish potato production, micro-propagation, and disease elimination	Little is known	Active programs have been developed employing TC techniques for root and tuber crops, ornamental and horticultural crops, and animal vaccine production
Genetic modification (GM)	None	Little is known	Most major universities and research institutions (both government and private) have major projects employing GM techniques. Both crops and animals are covered in the research activities. Insect-resistant cotton and maize and herbicide-tolerant cotton and soybeans are already being grown commercially.
Fermentation technology	Used in food processing (small-grain crops)	Little is known	Used widely in food and beverages as well as in pharmaceutical industries
Marker-assisted selection	None	Little is known	Used in maize and small-grains breeding as well as livestock research and development
Artificial insemination and embryo transfer	Used in cattle breeding	Little is known	Used in livestock research, breeding, and conservation
Molecular diagnostics and molecular markers	Serological techniques are still being used	Little is known	Used for plant and animal disease diagnosis
Biological nitrogen fixation	Used for legumes only	Little is known	Used for soil fertility improvement through legumes and inoculants
Manpower training	Limited training is done, but University of Namibia is currently pursuing setting up an MSc program in biotechnology	Little is known	Specific degree-level training programs are available at most major universities, with access to state-of-the art resources

Source: Mnyulwa and Mugwagwa 2002.

Areas of application			
Swaziland	**Tanzania**	**Zambia**	**Zimbabwe**
Used in Irish potato production and micro-propagation	Techniques are employed relatively extensively for root and tuber as well as horticultural crops	Used in micropropagation and disease elimination for cassava, sweet potatoes, Irish potatoes, mushrooms, and planting materials	Used in micropropagation and disease elimination for sweet potatoes, mush-rooms, Irish potatoes, and horticultural crops
None	Limited research is being done, e.g., on virus resistance in bananas. There have been no commercial releases, but trials on GM tobacco were conducted in 2002.	Use limited; still at the research level for cassava improvement (virus resistance). Confined trials of *Bt* cotton were conducted in 1999/2000.	Still at the research level, mainly for use in crop improvement for cowpeas, tobacco, maize, and sorghum. Confined trials of *Bt* maize and cotton have been conducted.
None	Used in the brewing industry and vaccine production	Used for food and feed production	Used in food processing, feed and vaccine production
None	Used in genetic characteri-zation of coconuts, cashews, sweet potatoes, cassava, and coffee	None	At the research level for improvement of maize for drought resistance and for small-stock improvement
Used in cattle breeding	Used in livestock breeding and conservation	Used for cattle breeding	Used for cattle and small-stock breeding
Serological techniques are still being used	Used in plant and animal disease diagnosis	Used for plant and animal disease diagnosis and diversity studies	Used for plant and animal disease diagnosis and diversity studies
Used for legumes only	Used mainly for legumes; used on a limited basis for inoculants	Used for both legumes and inoculants	Used for soil fertility improvement for both legumes and inoculants
Training is done at the undergraduate level in natural sciences (University of Swaziland)	Training is done in agricultural and other life science courses. A BSc degree in biotech was recently introduced at Sokoine University. The country is also benefiting from the BIO-EARN (East African Regional Network on Biotechnology and Biosafety) program.	Training is done in the natural, veterinary, and agricultural sciences (University of Zambia). No explicit courses are offered in biotech.	Specific biotech training programs have been developed at both under-graduate and graduate levels (University of Zimbabwe, National University of Science and Technology, Africa University)

Biosafety Systems

An analysis of the SADC countries looking at the status of their development and use of policy systems to ensure the safe development and application of modern biotechnology shows that the countries are at different levels. They can be placed into three broad categories: those that have regulations, those that have draft regulations, and those that have yet to initiate or are still in the very initial stages of development of such regulations. Table 1.2 summarizes the countries' status.

Global and Regional Trends in the Production of GMOs

Worldwide it is estimated that more than 3 billion people have been consuming GM foods since their commercialization in 1996. The use of GM plant varieties

Table 1.2 Status of development and use of biosafety systems in Southern African Development Community countries, April 2003

Biosafety issue	Angola	Botswana	Lesotho
Status of development and implementation	There is no biosafety legislation at the moment. The Ministry of Agriculture has initiated discussions on biotechnology and biosafety issues.	There is no biosafety legislation in this country. A process to develop a national biosafety framework was initiated in 2002 with funding from the United Nations Environment Program (UNEP) and the Global Environment Facility (GEF). The National Coordinating Strategy Agency is the national focal point for biosafety.	A biosafety committee was set up in 2001 within the Environmental Protection Unit to initiate drafting of legislation. Very limited capacity for risk assessment
Use of biosafety system in regulation of work on or use of genetic engineering (GE)	It has been reported that GE grain imported by Namibia in 2001 was milled in Angola. Namibia's draft legislation guarded against contamination of the environment. Angola had and still has no regulations.	As indicated, there are no mechanisms in place to regulate GE and its products. The dependence of the country on agricultural produce from South Africa is a cause for concern.	There have not been any official reports of requests to conduct trials or import GM products. Absence of a biosafety system complicates the situation. However, some food products, especially from South Africa, are suspected to be GM.
Urgent requirements	Regulations, capacity building, public awareness	Development of a legal framework, capacity building, public awareness and participation.	Garnering support from policymakers, development of regulatory framework, capacity building, public awareness

represents the fastest adoption of a new technology according to reports of the International Service for the Acquisition of Agri-Biotech. The total land area devoted to cultivation of GM crops increased from 1.7 million hectares in 1996 to 52.5 million hectares in 2001 (James 2001). By 1998 some 40 new GM varieties were being cultivated worldwide, mainly in Argentina, Australia, Canada, China, France, Mexico, South Africa, Spain, and the United States.

The area of GM crops in the developing countries has increased over the years from 15 percent in 1998 to 25 percent in 2001, of which 22 percent was planted in Argentina and 3 percent in China. China is the only country where public researchers funded by the government produced and commercialized GMOs.

Malawi	Mauritius	Mozambique	Namibia
Has legally binding legislation on biosafety. A national biosafety committee was appointed, though the country has limited capacity for risk assessment.	Has a GMO bill that requires setting up a national biosafety committee (NBC)	Set up a committee within the Ministry of Environment to come up with interim legislation on biosafety. Legislation still being developed.	Has a national biosafety committee (the Namibian Biotechnology Alliance) and draft legislation. Also has very limited capacity for risk assessment.
An interim committee was consulted in the debate on whether Malawi should import GM food aid or not. Malawi accepted GM maize, with no conditions set.	Officially, no GE products have entered the country. The NBC is tasked with monitoring the registration and movement of GE products in the country. A locally developed GM sugar cane variety is awaiting release.	Has already officially received GM maize under the condition that it has to be milled before distribution to consumers. A framework is still needed to ensure effective monitoring of GM products.	Accepted milled GM maize in 2000. Rejected GM maize in 2002, and instead received food aid in the form of wheat, as per a recommendation by the national biosafety committee.
Raising awareness of new legislation among stakeholders, capacity building	Regulations, capacity building, public awareness	Development of regulatory framework, capacity building, public awareness	Finalizing processes for regulation development, capacity building, and public awareness

(*continued*)

Table 1.2 (continued)

Biosafety issue	Seychelles	South Africa	Swaziland
Status of development and implementation	Discussion of biotechnology and biosafety issues has only just started in this country to whose economy agriculture contributes only marginally. The main worry is that the country is a net food importer.	Has had a legally binding GMO Act since 1997; also has the institutional framework to administer the act. The country has a number of both public and private laboratories adequately equipped to do GE work. Has more than 110 plant biotech groups, more than 160 plant biotech projects, and more than 150 trials.	Set up a committee within the Environmental Protection Agency to come up with interim legislation on biosafety. Legislation still being developed.
Use of a biosafety system in the regulation of work on or use of GE	Importations of foodstuffs have been handled under the existing food and food standards regulations	Already has a number of GE research work projects and products on the ground, including commercial cultivation of GM horticultural crops, cotton, and maize by smallholder farmers	Has already officially received GM maize under the condition that it has to be milled before distribution to consumers. *Bt* cotton and maize are currently being grown by farmers in parts of South Africa bordering Swaziland, and thus there is fear for possible contamination.
Urgent requirements	Awareness raising, regulations, capacity building	Review of legislation, public awareness and participation	Obtaining stakeholder support, especially from policymakers, as well as regulation development

Source: Based on Mnyulwa and Mugwagwa 2002 but updated through continuous interaction with partners.

Trends in Southern Africa

Currently it is only South Africa that has commercialized GM crops. Both the commercial and small-scale farmers are cultivating these. Below are some figures on the trends of adoption of GM crops in the Makhathini Flats (Kwazulu-Natal Province), the first smallholder farming area to adopt the GM varieties of cotton.

Season	Percentage of farmers cultivating *Bacillus thuringiensis* (*Bt*) cotton
1998/1999	18
1999/2000	60
2000/2001	71

Tanzania	Zambia	Zimbabwe
A national biosafety coordinating committee was set up under the government's Division of the Environment in November 2002. This activity is taking place under the UNEP-GEF project.	Has draft legislation and a national biosafety committee. Limited capacity for risk assessment. Currently in the process of coming up with a national biotechnology strategy.	Has a legally binding biosafety system, which includes a biosafety board and its secretariat, as well as biosafety regulations and guidelines. Has some laboratories, which have the capacity to detect genetically modified organisms (GMOs).
Tanzania has been a port of entry for GM maize provided as food aid to some countries in the region. Consignments were handled under the existing phytosanitary regulations.	An interim committee recommended rejection of GM food aid (July 2002). A case of unapproved trial of GM maize was reported in 1999 (personal communication with Monsanto 2001).	Two field trials were approved in 2001, for *Bt* cotton and *Bt* maize. No commercialization has been approved as yet. Assessed applications for importation of GM maize; importation granted with conditions.
Regulations, resource mobilization, public awareness	Enactment of legislation, capacity building, public awareness	Review of current legislation, capacity building, public participation in decision-making processes

GM white maize has been commercialized (2002/03 season) in South Africa, and this will cause a number of smallholder farmers to adopt the cultivation of GM crops.

Overview of GM Use in the SADC Region

The use of biotechnology in the medical sciences is generally well accepted. Its use in agriculture is mixed; for example, South Africa is well into the use of GM crops, while the rest of the SADC nations are still behind. Importation policies are not clear, especially because producers from countries like the United States do not label GMO products.

Public Dialogue, Public Awareness, and Policy Responses

Background

Proponents of GM technologies cite several potential benefits that can accrue to society. These benefits include enhanced taste and quality of foods; nutritional enhancement of foods for chronically malnourished populations; reduced maturation times for crops, leading to labor savings; and enhanced tolerance of biotic and abiotic stresses for crops, leading to reduced dependence on herbicides and pesticides. But these perceived benefits are not uncontroversial.

As a result of the intense debate and controversy surrounding the development and use of GMOs it is important for countries to engage in wide stakeholder dialogues in order to ensure that people are equipped to make informed choices. The public ought to participate even in the development of frameworks for regulation of GM research and development work. The main reasons for public awareness of and participation in the development of national biosafety frameworks (NBFs) are to promote participatory decisionmaking and involve all sectors of the society, to bridge the differences between various parts of society concerning the safe use of living modified organisms (LMOs), to ensure the use of an inclusive process involving all stakeholders, to share a common vision and purpose, to promote improved decisionmaking based on information, and to promote transparency in the decisionmaking process. It is important to note that the development of NBFs goes beyond the creation of a document. It inevitably encompasses wider issues about the role of biotechnology and requires ongoing participation in biosafety processes after regulations have been developed. The process itself calls for commitment and the creation of an appropriate environment to access participatory mechanisms, capacity building, information dissemination, and strategies for involvement of all stakeholders.

Participation in biosafety is prescribed in Article 23 of the Cartagena Protocol on Biosafety (United Nations Environment Program 2002):

> Public awareness and participation:
> 1) Parties to the protocol shall:
> a) Promote and facilitate public awareness, education and participation concerning the safe transfer, handling and use of living modified organisms in relation to the conservation and sustainable use of biological diversity, taking also into account risks to human health. In so doing Parties shall cooperate, as appropriate, with other states and international bodies;

> b) Endeavour to ensure that public awareness and education encompass access to information on living modified organisms identified in accordance with this Protocol that may be imported.
>
> The Parties shall, in accordance with their respective laws and regulations, consult the public in the decision making process regarding the living modified organisms and shall make the results of such decisions available to the public, while respecting the confidential information in accordance with article 21.

Participation is crucial in the analysis of the issues, in decisionmaking and strategic planning, in implementation, and in monitoring and evaluation. Stakeholders can be defined as people from government agencies and the private sector, groups or individuals whose lives and interests could be directly or indirectly affected, and bodies, groups, or individuals with particular knowledge that could be called upon.

Public awareness was defined by the participants of a UNEP workshop on risk assessment and risk management held in Namibia in 2002 as a process of providing universal access to information (providing balanced information in terms of pros and cons), enlightening the public, and thereby providing for informed participation. *Public participation* was defined as involving stakeholders (at all levels of society) in decisionmaking processes (giving everyone a chance to express their views) and taking their suggestions into consideration in making a decision. Public awareness and participation are needed for

1. consensus building on issues that affect people directly or indirectly;
2. ensuring implementation of the decision;
3. building transparency and accountability;
4. facilitating informed participation;
5. achieving a better position from which to take action;
6. facilitating inclusiveness;
7. providing balanced information in terms of pros and cons;
8. harmonizing institutions that provide awareness activities;

9. removing bias;
10. building a sense of ownership and collective responsibility;
11. building stakeholder confidence;
12. bridging the knowledge gap;
13. ensuring sustainability;
14. minimizing conflicts;
15. creating a platform for action; and
16. attracting attention and interest.

Status of Public Awareness in the SADC Region

Different countries in the SADC region have sought to promote and facilitate public awareness and participation in the design and implementation of their NBFs. Different tools and approaches have been suggested by various efforts (see United Nations Environment Program 2003a). Participants at a UNEP-GEF Namibia workshop on risk assessment, risk management, public awareness, and public participation for sub-Saharan Africa held in Namibia in 2002 proposed an action plan for enhancing public awareness and participation in the southern African region (see United Nations Environment Program 2003a).

It is the responsibility of each party to determine the combination of the proposed tools suitable for their specific situation. In most countries in the region the lack of biosafety frameworks is partially attributed to these countries' lack of awareness at various levels of the importance of both the technology and the need for biosafety policy. Table 1.3 summarizes the levels of biotechnology awareness in the SADC countries, including the awareness-raising tools and approaches being employed in the different countries.

The Challenges of Public Participation

The public awareness levels shown in Table 1.3, together with the efforts to arrive at such levels, are confounded by many factors, some of which are discussed in this section.

Commercial confidentiality. One of the major challenges of public participation is defining the limits of confidentiality for the provision of information to the

Table 1.3 Levels of biotechnology awareness and public awareness strategies in Southern African Development Community countries, March 2003

Country	Levels of biotech awareness	Strategies used for information dissemination and awareness raising
Angola	Low (assumption)	Little is known about strategies
Botswana	Low overall	Uncoordinated and sporadic activities, mainly announced through newspaper articles and led by scientists and to some extent the consumer movement
Democratic Republic of Congo	Low (assumption)	Little is known about strategies
Lesotho	Low overall	A few sporadic activities, mainly driven by scientists
Malawi	Average among scientists, low among other stakeholders	Discussions in the form of workshops and meetings, mainly coordinated by Bunda College and the National Biosafety Committee. Other tools are mainly sporadic debates and responses via the local press.
Mauritius	Low overall	A few, largely sporadic, activities coordinated by the National Biosafety Committee
Mozambique	Low, even among scientists	Still largely uncoordinated and reactive efforts for coordination through the Africa-Bio and Southern African Regional Biosafety programs
Namibia	Average to low	Some activities coordinated by the National Biotechnology Alliance, the farmers' union, and the consumer movement
Seychelles	Low (assumption)	Little is known about strategies
South Africa	Average among the affluent groups but low among smallholder farmers and general consumers	Formal media and informal channels (including Web sites, leaflets, and public debates) sponsored by a number of nongovernmental organizations and companies such as Africa-Bio, Biowatch, SAFeAGE (South African Freeze Alliance on Genetic Engineering), A-Harvest, and Monsanto. Notices of application for trials or release of genetic engineering (GE) products are published in the government gazette to solicit public comments.
Swaziland	Low overall	A few sporadic activities, mainly driven by scientists
Tanzania	Average to low	A few activities, some coordinated by the National Biosafety Committee, some by scientists, and some by the Commission for Science and Technology
Zambia	Average to low among scientists, low among the rest	A few, largely uncoordinated and irregular, activities such as debates and discussions organized by the National Biosafety Committee, the National Farmers' Union, and the consumer movement
Zimbabwe	Average among the scientists, low among stakeholders	Advertisements in the government gazette soliciting public comments. A number of organizations engage in information dissemination (e.g., the Biotechnology Trust of Zimbabwe, the Biotech Association of Zimbabwe, the Consumer Council, the Pelum Association, COMMUTECH (the Community Technology Development Trust), the Intermediate Technology Development Group, and the biosafety board, among others. The main channels used include workshops, seminars, debates, information brochures, radio and television discussions, etc.

Source: Based on Mnyulwa and Mugwagwa 2002 but updated through continuous interaction with partners.

public. A statute on access to information might be needed, or the responsibility for deciding what represents confidential information might be given to the national governments in consultation with the companies concerned.

The costs of various levels of participation. These costs need to be planned for and addressed during the planning period. They have to be dealt with in the context of the limited human, infrastructural, and financial resources of most of the countries.

The diversity of the various developing countries' farming systems and other cultural and social factors. This diversity makes it difficult to come up with a common framework for the involvement of stakeholders in the decisionmaking processes.

High science. How does one simplify highly scientific information to facilitate and increase the comprehension of the concepts by the general public, the majority of whom are illiterate? Challenges exist regarding how to effectively communicate science to a public of such a dynamic background as obtains in most of the developing SADC countries, where stakeholders have different priorities to address and have to deal with a language barrier (explaining science in local languages is impossible in most cases). It is noted that dialogue requires honesty, openness, transparency, and inclusiveness, along with mutual respect and an absence of mistrust. The starting point for dialogue should be the premise that the public has valid views that need to be to be voiced and understood, taking into account room for variance. Public participation has to be based on access to information, and it is necessary for national governments to facilitate the packaging of information in a way that meets the stakeholders' needs.

External influences. Many such influences affect decisions taken by developing countries on the commercial use, risk assessment, and risk management issues related to LMOs. Trade in GM crops and products will be subjected to the international agreements signed by the member states. The majority of the developing countries, SADC countries included, are parties to the World Trade Organization (WTO), and thus the protocol is supposed to allow free and equitable trade. Yet the following issues need to be taken into account:

- GMOs require special clearance mechanisms to allow developing countries to make a choice—to accept or reject GMO goods and not be bound by the WTO provisions alone.

- An exporting country is not liable for damage and environmental pollution due to GMOs.

National laws are needed on labeling both the grain and seed and any blended products. Experience so far has shown that the use of GMOs in developing countries is dictated by trading partners such as the European Union.

The murky interface (food aid, politics, science, and regulations). A number of public concerns resulting from the use of modern biotechnology relate to their impact on trade, the environment, and health. Says David Dickson of SciDev.Net: "On closer inspection, the decision by Zimbabwe and Zambia begins to lose some of its apparent naivety. The real fear officials of these countries are said to have explained to the officers of the World Food Program, is not the health danger that these foods are said to cause. Rather it is that if GM maize seed is planted rather than eaten, there could be 'contamination' of local varieties, and this will mean that the agricultural produce of these two countries, including beef fed on the crops, could no longer meet the 'GM free' criteria demanded by European Markets" (http://www.scidev.net/archives/editorial/comment28.html). A study by Environment and Development Activities in Zimbabwe after the 1991/92 drought revealed that about 20 percent of the smallholder farmers from some selected districts of Zimbabwe had retained the yellow maize grain provided as drought relief to use as seed. So the danger that GM maize grain will find its way into the seed system is real.

Most of the developing countries' positions are compromised by those of their trade partners, whether Europe or America. The conflicting positions of the two major trading partners of most southern African countries has greatly influenced the current positions adopted by the various nations.

The United States, one of the major suppliers of food relief, has been commercially growing GM crops for the past 5 or 10 years, and they do not segregate or label these products. The political dimension of the debate over southern African hunger and GM maize is that the United States appears to be using the current famine as a cover to promote acceptance of a technology "enthusiastically embraced by its own corporations, while remaining widely distrusted in Africa" (Dickson 2002). The United States has shown frustration with African critics of its food offer, and has also shown reluctance to provide funds for processing the maize, conditions that have further fueled the political dimension. A statement in early 2002 by one U.S. official that "beggars cannot be choosers" has further haunted the humanitarian effort.

The absence of regulations for monitoring the movement of GM material in most of the affected countries is another problem. Personal communications with some authorities in Zambia have shown that although the trade, food safety, and environmental dimensions have been mentioned, one salient but important dimension has not: that of regulations. The affected parties have feared that lack of a legal framework would frustrate any efforts to ensure monitored and controlled movement of the GM maize once it was released to the population. The situation in Zimbabwe has been different because regulations were in place already, and Malawi (then) was at an advanced stage in the development of its regulatory framework; hence it has been possible for decisions to accept the GM maize to be made.

The situation that has been faced in southern Africa points to the reality that countries have to accept regarding the impact of modern science on society—that it involves a complex of scientific, economic, and political factors that cannot easily be reduced to any single dimension (Dickson 2002).

The Public Awareness Effort in Southern Africa—A SWOT Analysis

Below is a strengths, weaknesses, opportunities, and threats (SWOT) analysis (Table 1.4) of the public biotechnology awareness effort in southern African countries. This analysis is adapted from results of the UNEP-GEF workshop held in Windhoek, Namibia, in November 2002.

Recommendations

Mindful of the situation prevailing in the SADC region with respect to biotechnology, and cognizant of the role that the technology can play in agriculture and food security issues, we recommend that the following needs be addressed.

Development of the Capacity to Make Decisions

One critical issue that emerged from the 2002 debate on food security vis-à-vis the use of GM maize as a food aid was that the majority of countries in the SADC region lacked the regulatory and scientific structures necessary to take decisive steps. During the BTZ's regional consultation on the status of development of biosafety systems in eastern and southern African countries, it emerged as a major sticking point that most countries did not prioritize development of regulatory structures for biosafety, mainly because of the low level of biotechnology research and development activities in their countries. If the lessons drawn from the 2002 GM food aid debate are anything to go by, countries in the region are best advised to put regulatory and scientific monitoring mechanisms in place, because the GM products in the region are not the products of research efforts in the region, but

Table 1.4 Strengths, weaknesses, opportunities, and threats analysis of public awareness and public participation in southern Africa, November 2002

Strengths	High literacy level
	Political will (many countries in the region have signed the Biosafety Protocol)
	Common official language, facilitating information dissemination
	Existing administrative structures
	Information-sharing structures
	Existing human resources (biotech specialists, etc.)
	Relevant legislation and policies
Weaknesses	Limited programs on and capacity for modern biotechnology
	Lack of policies on biotechnology and biosafety
	Ignorance of biotechnology, which impedes the dissemination of information
	Lack of sustainable funding
	"Science" illiteracy
Opportunities	Existing public awareness and participation programs that can be used to disseminate information, e.g., HIV/AIDS awareness programs
	Decentralized system of governance
	Availability of UNEP-GEF funding
	Existing subregional programs (SADC)
	Innovative financial instruments that could be used to generate additional funds for programs in the form of taxes, levies, and other fees
Threats	Lack of networking among scientists and with other political and civic leaders
	Lack of communication between scientists and other interest groups such as sociologists, politicians, and civil society

Source: United Nations Environment Program 2003b.

rather are products introduced from elsewhere. The scenario is the same as that for products of most other technologies, but the need for regulations remains critical. The GM debate underlined the fact that in a globalized economy the development of regulations is a necessity, not a luxury.

The development of scientific and infrastructural capacity is not an overnight activity. Given the varying levels of capacity and resource endowment in the countries of the region, mechanisms for collaboration and the development of synergistic relationships need to be put in place for countries to be able to pool their resources. Through the SADC and regional as well as national governmental and nongovernmental organizations with activities in the areas of agriculture, the environment, and biotechnology and biosafety, activities can be implemented for the development and strengthening of national and regional capacities that will enable informed decisionmaking on GM products. Arrangements for the transfer of technology and expertise should also be entered into with institutions within the region and beyond that can provide such expertise. Individual countries and the

region should place an emphasis on developing their own capacity to do the work so they can become self-sufficient in the long run.

The SADC countries should also be cognizant that genetic engineering is building on the achievements of other accepted and established techniques such as tissue culture, molecular biology, fermentation technology, and so on. Countries need to develop a capacity for these techniques, not necessarily to use them as a foundation for genetic engineering, but to exploit them and assess whether some of the agricultural production constraints can be solved using such technologies. Examples abound from Colombia, India, Kenya, and Zimbabwe, where tissue culture programs have been successfully implemented to provide sufficient quantities of high–health status planting materials for crops such as bananas, yams, cassava, and sweet potatoes.

Identification of Regional Needs and Priorities

For the region and individual countries to realize some of the benefits to be derived from the employment of modern biotechnology techniques, they need not only to develop regulatory and scientific capacity, but also to identify needs and priorities for intervention at national and regional levels. Priorities would include targeting crops or animals for the research efforts, along with traits to be researched (drought tolerance would be an obvious choice) and the human and infrastructural capacity needs of the countries and the region. Genetic engineering technologies invariably need substantial financial investment, and the SADC countries would best be advised to invest in areas in which they have sustainable competitive advantages or in areas that address their priority food security needs.

Creation of an Enabling Environment for Research about or Use of Biotechnology Products

The development and implementation of regulations is one avenue for creating an enabling environment for biotechnology research and development as well as for the use of products of genetic engineering. The SADC countries need to develop appropriate biosafety systems for monitoring and controlling biotechnology activities in them. Given that the region already has three countries with legal biosafety systems, experience-sharing mechanisms can be put in place and employed so countries can learn from each other about the development and use of such systems. Discussion among policymakers needs to be stepped up so as to garner the necessary political will. For example, in Zambia efforts to put policies in place are thwarted not only by lack of funding and scientific expertise, but also by lack of political will. This certainly is the case in most of the countries of the region.

Stakeholders need to develop strategies for ensuring that national governments prioritize policy development and investment in infrastructural and human capacity for biotechnology activities, and at least some measurable capacity for risk assessment and risk management. In a 2001/02 eastern and southern African study on the status of development and implementation of biosafety systems conducted by the BTZ, one of the major findings to emerge was that the source of information most trusted by the lay public was one to which local researchers would have made a contribution. One way to achieve this end is to raise the general level of discourse about biotechnology issues both in the individual countries and at the regional level. With an increased awareness of the potential dangers and benefits of genetic engineering technology, policymakers will be in a better position to see the need to develop the necessary legislative frameworks. Awareness also needs to be raised in the general population of the SADC region because people have a right to know whether they should consume certain products. In addition, transparency and trust need to be developed among the private sector, local researchers, national governments, and all stakeholders in the region with respect to the real hazards or benefits presented by genetic engineering technology.

Harmonization of National and Regional Policies

One major lesson from the food aid debacle is that the countries of the SADC region need to harmonize their legislation in order to facilitate smooth movement and transit of food materials. This harmonization should encompass issues such as standards, risk assessment and risk management procedures, prior informed consent requirements, information and documentation requirements, and other issues. In essence the harmonized policies should facilitate the development of procedures for approval of the use and movement of products in the region.

Conclusion

The SADC countries are at different levels in the development and application of biotechnology as well as systems to govern the use of this technology. This scenario should be exploited to ensure that all countries attain a certain minimum level of technical and regulatory capacity, especially for monitoring the development and use of GM technologies and the products thereof. It is crucial for all the countries in the region to realize that they need each other, especially given the increasingly globalized economy and the fluid nature of national boundaries, as well as the limited capacity to monitor cross-border movement of materials. Adequately equipping the general public, especially farmers, will go a long way toward building self-

monitoring and -policing mechanisms that will complement efforts by regulatory authorities to limit the unintended spread of GM products in the environment. An informed society will also influence the national research agenda, thereby ensuring that the constrained research and development resources of countries in the region are used to address priority issues. Little is known about the existing institutional framework within which GMO legislation and regulation are likely to be implemented, especially in rural areas. Several questions therefore remain unanswered. For instance, what roles are played by the national, provincial, and local governments in the various countries? What scientific testing infrastructure exists to implement regulations? What are the existing leadership structures, especially in rural areas? To what extent will uninformed smallholders rely on opinions, information, and advice from village-level leaders in making their choices? What problems and opportunities will result from using the rural governance already in place as a coordinating mechanism for spreading information? What is the degree of transparency and accountability in implementing agencies?

Appendix: Tools for Participation, Consultation, Information, and Education

The following tools have been adapted from United Nations Environment Program (2003b) and from the author's workshop notes.

Tools for Participation and Consultation

There are a number of strategies or approaches that can be used to engender public participation in discussion on biotechnology issues. Some of these are as follows.

Enabling legal frameworks. Laws on public participation or on rights to information facilitate meaningful public involvement in biosafety decisionmaking.

Routine opportunities for public comment. In many countries, applications for regulatory approval are published in a register with opportunities for public comment as a matter of routine. Although this methodology is commonly used in developed countries (for instance, in Canada, the Netherlands, and the United Kingdom), it may be especially useful in developing countries, where there are usually limited resources to facilitate participation.

Multilevel consultations. In some countries, public consultations on different aspects of the biosafety framework have taken place at the national level. For exam-

ple, consultations were held in Zimbabwe to decide whether to accept GM food aid and, once the decision was made to accept it, how to handle the products.

Independent public inquiries. Independent bodies can be designed to facilitate assessment of the risks and benefits of a technology considering broad public interests. These bodies, if well constituted, can target the particular needs of indigenous groups.

Independent advisory committees. The authority and credibility of such bodies depend heavily on their independence of the government and the way they are constituted, that is, the extent to which they include the views of nonscientists and represent a broad spectrum of stakeholders. These are the tools used by most of the SADC countries, such as Malawi, South Africa, and Zimbabwe. In some cases these are complemented by advertisements in either the government gazettes or the local press soliciting comments from the public.

Ongoing oversight and evaluation. Stakeholder bodies, such as the African Biotechnology Stakeholders' Forum, can be set up to review biosafety procedures on an ongoing basis.

A bottom-up participatory process. Participatory processes facilitated by credible and experienced nongovernmental organizations can help stakeholders at risk of being left out by the government-led consultation processes. Examples include the Citizens Jury facilitated by the Intermediate Technology Development Group in Brazil, India, and Zimbabwe.

These tools can be used in combination to facilitate the all-inclusive participation of stakeholders in the decisionmaking process. The challenges presented earlier in this chapter hinder such effective participation in most developing countries.

Tools for Information and Education

The identification of information gaps through surveys is a good starting point for any awareness and education initiatives. Information collected through these means would help a country's government in the development of a public information campaign using the following tools.

Informal means of disseminating information. Web sites, leaflets, advertisements, and telephone help lines can be used to explain biosafety processes and how

stakeholders can be involved in information dissemination. These can even be translated into local languages. The BTZ has been using some of these methodologies in disseminating information to the rural poor.

The established media. Newspapers, radio, and television provide useful routes for informing the public about biotechnology and biosafety regulations. These can be used to educate or inform the public about GMOs. Advertisements can also be used to get feedback on proposed releases of GM products.

References

Dickson, D. 2002. African hunger and GM maize. http://www.scidev.net/archives/editorial.

James, C. 2001. *Preview: Global review of commercialized transgenic crops, 2001.* ISAAA Briefs no. 25. Ithaca, NY: International Service for the Acquisition of Agribiotechnology Applications (ISAAA).

Mnyulwa, D., and J. T. Mugwagwa. 2002. *Agricultural research needs for southern African countries: Towards a regional initiative on need-driven agricultural biotechnology.* Harare, Zimbabwe: Biotechnology Trust of Zimbabwe.

Persley, G. J., and J. N. Siedow. 1999. *Applications of biotechnology to crops: Benefits and risks.* CAST Issue Paper 12. Ames, IA, USA: Council for Agricultural Science and Technology.

Sasson, A. 1993. *Biotechnologies in developing countries: Present and future.* Vol. 1, *Regional and national survey.* Paris: United Nations Educational, Scientific, and Cultural Organization Publishing.

United Nations Environment Program (UNEP). 2002. Cartagena protocol on biosafety. UNEP Web site (http://www.unep.org).

———. 2003a. DFID/UNEP [Department for International Development / United Nations Environment Program] study on public awareness and participation. UNEP Web site (http://www.unep.org).

———. 2003b. Report of the Regional Workshop on Risk Assessment, Risk Management and Public Participation, Windhoek, Namibia, November. UNEP Web site (http://www.unep.org).