

GOVERNING AGRICULTURAL BIOTECHNOLOGY IN AFRICA

Building Public Confidence and
Capacity for Policy-Making

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Introduction

Persistent poor agricultural production and rising food insecurity in Sub-Saharan Africa have brought into sharp focus the role of modern agricultural biotechnology in human development. Growing food insecurity in Ethiopia, Kenya, Malawi, Mozambique, Swaziland, Zambia, Zimbabwe and several other countries of the region has stimulated political and public attention on genetic engineering in general and on the potential benefits and risks of genetically modified crops. In early 2003 more than 10 African countries were facing a major food crisis with more than 38 million threatened with hunger and starvation. This is a result of many interrelated factors, including rapid decline in food production caused by bad agricultural policies, severe droughts, deterioration of infrastructure and declining investment in agricultural research. The region's food demand has been expanding at an annual rate of 3.1 per cent since the mid-1980s. Overall agricultural production fell by 0.3 per cent, having increased by about 1.9 per cent in 1999. Eastern Africa saw agricultural output fall by 0.5 per cent in 2000. It declined by one per cent in Central Africa while in the Sahelian countries, cereal production fell by almost 13 per cent in that year. Western Africa experienced sluggish or slow growth of the agricultural sector. In southern Africa (excluding South Africa), agricultural production fell by 3.3 per cent in 2000 after increasing by 14.2 per cent in 1999. Crop and livestock production fell by 3 and 3.9 per cent, respectively.

According to recent estimates by the United Nations Food and Agriculture Organization (FAO), agricultural production is estimated to fall more drastically in Eastern and Southern Africa. "In several parts of southern Africa, the reduced 2001 maize harvest, caused by adverse weather, has led to food shortages. In Malawi, food shortages have emerged in southern parts, where floods affected more than 600,000 people. In Zambia, emergency food aid is required for almost 1.3 million people following the poor 2001 maize harvest. In Zimbabwe, the 2001 maize output declined by 28 per cent from the level of the previous year, resulting in food shortages in several areas. In Angola, emergency food aid is needed for over 1.3 million internally displaced people..."¹ The region has at least 25 per cent of the world's undernourished people. Millions of Africans, particularly children under the age of 6 years, die every year as a result of hunger. Many suffer from one or more forms of malnutrition, including protein-energy malnutrition (PEM) and a lack of micronutrients. The most vulnerable are pre-schoolchildren and pregnant women. Between 1980 and 2000, the prevalence of PEM among children rose by 2.3 per cent. PEM deficiency is manifested in stunting and causes poor cognitive development and low educational achievement.

Sub-Saharan Africa is now the largest recipient of food aid. Approximately 1.3 million people in Eritrea, 5.2 million in Ethiopia, 1.5 million in Kenya and 2 million in Sudan require emergency food aid in 2003. In Southern Africa emergency food assistance is required by at least 14 million people. Food security assessments conducted by the World Food Programme (WFP) in September 2002 showed that more than 70 per cent of households in Malawi and Zambia had no cereal seed while in Zimbabwe more than 94 per cent of farmers were without seeds. The causes of declining agricultural production and increasing food insecurity² in Sub-Saharan Africa are many, interrelated and complex. They have socio-political, economic, environmental and technological variables. Food insecurity is not simply caused by failure of agriculture to produce enough food, but also by many structural inadequacies that make it difficult for households to have access to food. Indeed, food security is much about

ensuring that individuals have access to sufficient food at the household level. Demand for and accessibility to food are influenced by a variety of factors, including income levels, population growth and movements, infrastructure, lifestyles and preferences, and human resource development. Increase in population is likely also to stimulate increased demand for food. In Sub-Saharan Africa, where most people have less than US\$1 per day to live on, many do not have access to basic food.

Related to the concerns of increasing food insecurity are the deepening poverty, increasing cases of tuberculosis, malaria and HIV/AIDS epidemics. There is also increased environmental degradation in the region. Sub-Saharan Africa is now the poorest region of the world at a time when other parts of the world are experiencing growing levels of food security, high rates of economic growth and better health standards. A growing portion of the wealth and better standards of living—high quality health, food security and low rates of mortality—are attributable to scientific and technological advances. For example, advances in modern biotechnology have made it possible to produce new, improved, safer, and less expensive drugs, food additives, industrial enzymes, and oil-eating and other pollution degrading microbes are just a few of the goods that can be developed using this technology. To meet increasing demand for food and enlarge the basis for food security in Sub-Saharan Africa, productivity increases will therefore be required. This will not be through expansion of cultivated area but mainly on the basis of improvements in crop yields. Greater attention must be put on measures that will improve the region's ability to harness and apply new scientific and technological advances to increase food production.

This book has been written to throw light on all these issues. It has involved a detailed empirical investigation of biotechnology and biosafety policy in three African countries. These are Kenya, South Africa and Uganda. Chapter 2 sets the analytical context by reviewing the nature of science policy research, especially as it applies to potential developmental impacts of biotechnology. Attention is paid to international experience, particularly with reference to the OECD countries, since many of these have been struggling to come to terms with issues of biotechnology development and related biosafety policy. In addition, the chapter pays close attention to the analysis of risk and how it may be managed. What has become abundantly clear over the past decade or so is the flawed nature of traditional approaches to biosafety management; by this we mean attempts to treat biosafety risks as reducible to probabilistic values. Not only is this invalid from a purely scientific standpoint, but it also fails to deal with attitudes of civil society more generally. It is largely for these reasons that the “*precautionary principle*” has begun to be taken seriously as an aid to biosafety management, even though there is still no consensus about its applicability.

1. Scientific and technological opportunities

Modern agricultural biotechnology has opened a wide range of possibilities of identifying, isolating, selecting and transferring genes from one organism into another. Essentially, “genetic information contained in a gene of a cell of one organism is isolated, taken out of that organism, and placed in the chromosome of a cell (or cells) of another organism. The resulting DNA in the recipient cell contains both its own original, naturally occurring genes and the new gene. ...the characteristic encoded in the foreign gene will be manifested, or “expressed”, in the recipient cell...”³ These developments have irreversibly changed agricultural research and production. They have enlarged capabilities of scientists to uncover a large body of information about the genetic makeup and functioning of plants, animals and microorganisms.

The 1990s witnessed a new wave of scientific advances in biotechnology. The mapping and sequencing of the human genome have given rise to a new scientific enterprise--genomics. Genomics is “the development and application of research tools that uncover and analyse thousands of different molecules at a time.”⁴ It has granted scientists an unprecedented access to the molecules of life. Through it massive amounts of biological information can be converted into electronic form, linking life sciences to information sciences. The science of genomics and associated techniques enable scientists to simultaneously analyse the identity and function of tens of thousands of different genes. It has considerably increased the speed and scale with which genomes of organisms are sequenced and functionally analysed. Agricultural genomics is making it relatively easy for scientists and companies to identify genes that are linked to particular agronomic traits and diseases. They are able to develop genetic sequences that are able to facilitate the expression of certain traits and prevention of certain diseases.

Agricultural genomics research is underway for a range of plants and crops and DNA sequencing for many is at an advanced stage. A majority of genes in rice genomes have been identified and sequenced. Governments and private industry are increasingly recognizing the potential of agricultural genomics. This is manifested in the large financial resources being invested in R&D. For example, in 1999 the US government allocated at least US\$ 40 million to fund genomics research on crops of national importance. Several major agricultural genomics initiatives have been established to determine the sequence and functionality of several cereal crop genomes. They include the International Rice Genome Initiative, the Japanese Government Rice Genome Project, the US National Corn Genome Initiative and the International Triticale Mapping Initiative.

In 1999 at least 70 genetically modified (transgenic) varieties of crops were registered for commercial cultivation worldwide. These include new varieties of cotton, potato, tobacco, tomato and clove. More than 15,000 field trials have been undertaken globally. New genetic modifications of more than 100 plant species are growing in laboratories, greenhouses, or in the field, providing farmers with new agronomic traits, particularly herbicide tolerance and pest resistance. In 2000 the global area under genetically improved crops was 44 million hectares mainly of maize, soya bean, cotton, canola (rappelled) and potatoes.⁵ By 2001 the total global area of genetically modified crops was 52.6 million hectares. More than 30 million

hectares were devoted to soybean, 10 million to maize, 7 million to cotton and 3 million to canola.⁶ Seventy four per cent of this area is in North America (USA and Canada) and the remaining twenty six per cent in developing countries notably Argentina, China, Mexico and South Africa.

The developments in agricultural biotechnology and particularly the commercialisation of genetically modified products are starting to influence international agricultural trade patterns. In 1996 Argentine soybean production was 11.2 million metric tons (t), of which 0.75 t were exported. The advent of transgenic soybeans helped boost production to 19.5 million tons and exports to 3.2 million in 1997, making Argentina the third largest exporter of soybeans in the world; exports increased further to 5.8 million t in 2000.⁷

Debate on benefits and risks of genetically modified crops

The debate on the benefits and risks of genetic engineering and its products is relatively old. It is traced back at least to the 1980s.⁸ Polarized into two extremes, the debate has intensified with revolutions in the technology as new products, particularly genetically modified foods, began to get into the marketplace. While extreme proponents of genetic engineering often fail to recognize that some of its products may have risks, those opposed to the technology either ignore or do not understand its potential to contribute to human development. As with many other technologies, some of the products of genetic engineering may cause risks to humans and the environment. There are concerns that introducing genetically modified crop varieties will negatively impact on the environment. One of the potential problems is that novel genes might be unintentionally transferred by pollination to other plants, including weeds and also wild relatives of the crop species. There are fears that such transfers could lead to the development of resistant 'super-weeds', loss of biodiversity within crop species, and possibly even the destabilization of entire ecosystems.

Concerns have also been expressed about the risks to human health of food products derived from genetically modified crops. This is particularly the case where novel genes have been transferred to crops from organisms that are not normally used in food or animal feed products. Those opposed to genetic engineering have suggested that this might lead to the introduction of previously unknown allergens into the food chain. Controversy was sparked when a gene from a Brazil nut was successfully transferred into a variety of soybean that was being developed for animal feed. It was confirmed that the allergenic properties of the Brazil nut were expressed in the soybean. However, the counter-argument was that this case demonstrated the effectiveness of scientific testing for safety. The allergen was specifically tested for during the development process, and as a result of the positive results the product was never developed for commercial use. Scientists further argue that the structure and characteristics of known allergens are well documented, and that testing for possible new allergens is therefore relatively easy.

On the other hand genetic engineering offers new avenues for increasing food production in Sub-Saharan Africa. It can develop drought resistant crop varieties, improve the nutritional quality of such crops as sorghum, cassava, millet and sweet-potato, reduce post-harvest crop losses, improve livestock's resistance to disease, and enable farmers to cultivate in saline conditions. For example, Quaim's (1999) ex ante analysis of the impact of pathogen-free banana shows for the larger farms that an average yield increase of 93 per cent can be anticipated, and this may increase to 150 per cent for smallholders. The technology in this

case has been developed through public/private partnership involving the Kenya Agricultural Research Institute (KARI), the South African Institute for Tropical and Sub-Tropical Crops (ITSC), and two tissue culture companies. ‘Golden’ rice is another example of how genetic engineering can be used wisely to contribute to the solution of food insecurity. In this case, genetic engineering has been deployed to develop a variety of rice with ability to produce beta-carotene that is metabolised into Vitamin A. This new variety has the potential to address the growing problem of Vitamin A that causes partial or total blindness in several million children each year on the African continent. The challenge now is to make this variety available to African rice farmers, and possibly to develop it further for African conditions.

Challenges and Issues for Sub-Saharan Africa.

How then should African countries respond to the opportunities and challenges posed by genetic engineering and international trade in genetically modified food? What is obvious is that many African countries lack coherent regulatory instruments and institutions for risk management in relation to genetic engineering. Many of the countries also lack capacity to design and implement science policies. Where instruments have been formulated and adopted by governments, there are weak institutional arrangements for enforcement of regulatory procedures. As a result, there is no consensus on how best to respond to global developments in genetic engineering and, particularly, whether to allow the importation and/or development of genetically modified crops. The current controversy over food aid to Zambia and Zimbabwe clearly demonstrates the importance of governments instituting and applying regulatory instruments as well as risk assessment and management procedures.

In addition science in general and genetic engineering in particular are not evolving in a socio-political vacuum. African public and politicians have (or should have) a direct interest in scientific advances and technological developments associated with genetic engineering, yet many are still not participating in the debate on the impacts of genetically modified organisms. In many countries of the region there appear to be obstacles to citizens’ participation in the debate on the impacts of genetically modified crops and the potential role of genetic engineering in solving food insecurity. Considerable institutional space in the debate is often taken by isolated groups of non-governmental organizations opposed to genetically modified crops and purporting to speak for the African rural poor, and (conversely) groups of scientists who espouse the benefits of the new technology for the poor. It is unlikely that the two groups—anti and pro genetically crops groups have the attention of millions of farmers in Africa. The general public and farmers in particular are not informed about the nature of the technology, its potential benefits and risks, and rarely do they participate in deciding on what crops or problems biotechnology research and development should focus on.

There are now many interest groups engaged in the debate on whether African countries should accept genetically modified food aid.⁹ These range of groups of scientists to activists. What is of concern is that they have focused no or very little attention on how best to use existing national, regional and international regulatory instruments to make informed decisions. In some cases interest groups may be exploiting political uncertainty, food insecurity and economic instability to promote narrow agendas to deny public choice and to undermine national learning from the application of risk assessment and management instruments.

2. Science and Public Policy

2.1 Evolution of Science Policy Studies

As the new millennium begins it has become clear that the one of the main determinants of its progress will depend upon the search for and the use of scientific knowledge. It is not for nothing that the phrase “knowledge economy” has become so standard not only in the management textbooks propagated by modern business schools but also in more general discourse on matters of public policy. In a very real sense sustainable economic development depends upon the use and abuse of knowledge in ways scarcely dreamed of by our forefathers of yesteryear. And yet “policy towards science” is still a relatively unexplored aspect of public policy despite a broad recognition of its importance over the closing decades of the last millennium. The social studies of science as public policy (or science policy) may be defined very broadly as how and why resources are committed to science and technology, what sorts of problems arise in so doing and what sorts of improvements might be made. Much of the reason for its development has depended upon demands on the part of the state for ‘expert assistance’ in the making and monitoring of policy, demands that have grown rapidly in recent years, as economies have become more knowledge dependent.

The subject goes back a long way, certainly as far as the famous C P Snow lecture in the 1950’s and probably also to the earlier writings of Bernal and Blackett in the period just before the 2nd World War¹⁰. However, the debates and discussions it has engendered have until recently tended to focus on industrialisation prospects for the richer countries and those “middle-income” parts of the world that are now beginning to play a significant part in global economic change. This is now beginning to change as a result of the growing recognition that there are large parts of the world’s population that are still living in dire poverty and under poor and worsening environmental conditions. It was mainly to address this issue that the achievement of the Millennium Development Goals (MDGs) by 2015 was adopted by the United Nations General Assembly in 2000. These have since been articulated by a number of Task Forces into steps that need to be taken if these goals are to be achieved over the coming 10 years and all will need science to help¹¹.

While resource allocation to science is often at bottom an economic question, the role of the scientific community and how it conducts itself is also of fundamental importance. In addition, science policy analysis is unusually complex. This is so because those who concern themselves with science policy issues come from widely different disciplinary backgrounds, with differing appreciations of what constitutes legitimate scholarship, how problems may be defined and tackled, what is the most appropriate technical language for communicating ideas, and so on and so forth. The area is, therefore, essentially “interdisciplinary” and from a policy point of view “interdisciplinarity” is hard to handle. The problem is a twofold one. Scientists are normally trained in a regime of disciplinary excellence and very often their interests (and capacities) do not go beyond this tight boundary. Policy makers on the other hand (and the problems they deal with routinely) require more subtle and rounded guidance. But they often do not know how to benefit from the knowledge that would simplify their task. Both “estates” would gain from interaction. The issue is, however, how best can this be brought about?

In practice the formulation and implementation of science policy has continued to be a difficult issue even in the industrialised countries, but as we shall see in the following section,

over the past 30 years or so governments have begun to experiment with new patterns of policy and advice. In the UK for example, the *Research Council* system has developed mechanisms to integrate pre-competitive research with industrial need such as the *Biotechnology Directorate*, which had much success in the 1980s and was responsible for the creation of *Celltech*, now a leading pharmaceuticals firm. At a more “macro” level the placing of the Advisory Council for Science and technology (ACOST) within the UK Government Cabinet Office in the early 1990s was a recognition that generic S&T could not be hidden away in sectoral ministries but had to be available equally to all users. From there it played a major role in launching the “foresight” exercises that have had much impact in many parts of the world. Very recently Kenya appears to be one of the first African countries to take similar action by placing a high-ranking advisory S&T council directly within the Office of the President.

But even when the generic importance of S&T has been fully recognised by governments, the actual creation of appropriate governance mechanisms is still an open issue. For example, within the more specific field of biotechnology and biosafety policy Wint (2005) has shown that there are big differences in country approaches. The US sees regulation as a purely “scientific” issue. It views biotechnological products, as being little different from their traditional counterparts and so do not require new regulatory legislation. Australia on the other hand attempts to “take account of science, ethics and community under one (regulatory) umbrella”¹² and so has built public acceptability directly into its legislation. The UK takes a similar view to Australia while other EU countries tend to place much more emphasis on public acceptability taking a more distanced attitude to traditional scientific criteria. As we will later illustrate, many African countries reveal similar ambiguity.

2.2 Risk Assessment Approaches and Instruments

As pointed out in the Introduction, while modern biotechnology has great welfare potential it is subject to significant concerns of ethics, morality and risk. This was recognised at a relatively early stage in Article 8 (g) of the Convention for Biological Diversity (CBD), which enjoins all signatories to:

Establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking into account the risks to human health.¹³

As Essegbey and Stokes (1998) have stressed, the risks are of two main types: “those associated with the contained use of biotechnological processes and intermediate products in laboratories; and potential risks and uncertainty of the impacts of biotechnological products when released into the wider environment”.¹⁴ However, while the former have been reasonably well catered for in most countries in terms of regulatory guidelines, the situation is not so clear-cut for the latter category. In the USA and Europe, risk assessment has been done on a step-by-step, case-by-case basis and has co-evolved with technology development, governance structures and management expertise¹⁵. However, in many parts of the Third World the “international diffusion of biotechnologies is progressing at far greater speed than their original development, leading to fears that developing countries are, or soon will be, exposed to biotechnology related risks which they do not yet have the capacity to manage.”¹⁶ The question then is how should they plan to cope with this dilemma in the best interests of development?

Risk Analysis

To understand the problems involved in risk analysis in relation to biotechnology it is necessary to take a step back in time. Science has always understood that technological and economic interventions are subject to risks. But such risks were seen as computable in the sense that values could be assigned to them. Decision-makers would then combine standard estimates of contributions to welfare with such risk values before making final policy recommendations. For example, the decision to introduce an innovation in crop production in a region would depend first of all on projected net benefits, which would be determined, say, through social cost-benefit analysis (SCBA). SCBA typically values expected outputs and inputs to projects and computes a resultant “rate of return” to the relevant capital investments. But these estimates would then be adjusted to allow for factors preventing the expected costs and benefits being realised. The techniques used would vary but ultimately would rest on probability theory—that is by computing the likelihood of sub-optimal performance based on past events of a similar nature.¹⁷ The adjusted projected net benefits would be computed and the decision to go ahead with the intervention would then proceed according to some wider set of decision criteria (for example whether or not the adjusted rate of return to the investment exceeded some numerical percentage like the current social discount rate used by the national planning agency¹⁸).

Of course it was always realised that such numerical forecasts would be imperfect. To take this into account a “safety” factor was often also added to allow for the possibility of “non-computable” risks. For example in the building of a new bridge, it would be accepted that despite over a century of bridge-building knowledge on the part of civil engineers, things could still go wrong. And therefore so-called “fail safe” factors would be included to allow for this. But (and this is the important point) ultimately the system in question was always seen to be computable in principle. It existed as an objective entity in reality, however hard it was to formulate it numerically in practice. As Thompson has put it, the view is based on an acceptance of 18th Century Natural Law and the utilitarian ethics that followed from the Enlightenment. It is useful at this stage in the argument to distinguish between two criticisms of this view.¹⁹ The first is a systems criticism. The second, is an ethical one.

On the first it is essential to realise that much of modern experimental science is based on the view that the system under investigation is relatively stable. This then allows it to be subject to experiment and characterisation in the sense that its parameters are computable. Once we know these, we can predict with some certainty how it will behave in future periods. If you like we can assign probability values to future behaviour based upon how the system has behaved in past periods. On the other hand if the system in question is evolving in terms of its underlying structure, then such a procedure is flawed simply because its parameters are no longer stable. Indeed its parametric instability increases in proportion to its rate of evolution. This need not be too much a problem in bridge building (bridges, and their immediate environments, are relatively stable systems) but is certain to be a serious problem in a field such as biotechnology subject to very rapid technical change. Here assigning probability values to, say, the impact of a GMO becomes impossible simply because the future “states of nature” are unknown. We live genuinely in a state of ignorance about the future system in question.²⁰

The second criticism is equally fundamental. For even if formal risk analysis could show that an intervention is likely to be relatively harmless there may still be important

issues associated with values and ethics. Thompson, for example, shows how in the context of the GM controversy consumers became “deeply resentful of a marketing approach that denied them the opportunity to give or withhold consent. Even consumers who thought of themselves as potentially benefiting from GM foods nevertheless insisted upon the right to decide for themselves whether to eat it or not.”²¹ Tait (2001) shows how throughout the 1990’s there arose increased resistance among many sections of European public opinion to the use of biotechnology to modify crop production. Some of this may have been “irrational” in the formal scientific sense but by no means all. The impact of “mad cow” disease in the UK did great damage to public trust of government regulation. It also called in question the relative inability of science to provide a coherent impartial judgement of such issues. The early attitude of industry did little to help. Tait and Chataway (2001) for example, show how “Monsanto’s response to European calls for a more precautionary approach to regulation was to mount a campaign of opposition”²² including a refusal to countenance “product labelling” as mechanism that might allay public concerns. And though much of the agro-biotechnology industry has now come to realise that a more inclusive strategy is probably necessary to deal with such issues, a great deal of damage has been done to their corporate interests.

To re-cap, the application of formal risk analysis to biotechnology issues is twofold. Firstly it runs foul of the speed at which biotechnology is moving. And so has difficulty in making judgements that stand up to strict scientific scrutiny. Even the application of fail-safe devices does not deal properly with the problem, not least because all too frequently scientists have been less than candid about the validity of their methods. Secondly, however, there are important ethical objections about the very nature of biotechnology interventions, and these concern the rights of the public to agree or not with them whatever may be the objective risks involved. Here many environmental groups have emerged in recent years to argue vigorously against the application of the biosciences to many aspects of economic production. And, as we shall see below, they are doing so to great effect not only in Europe but also in many African countries.

2.3 The Precautionary Principle

In order to deal meaningfully with the risks associated with modern biotechnology, therefore, a range of new approaches has been suggested and it is useful at this stage to summarise what these might be. Central to these is the notion of the Precautionary Principle, which began to emerge as an important conceptual organiser in the build up to the UNCED Earth Summit in the early 1990’s. Hence Common (1995) quotes Principle 15 of the Rio Declaration as follows:

In order to protect the environment the precautionary principle shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.²³

The Precautionary Principle is thus essentially a general injunction to decision-makers to postpone action where the environment is at risk but as Common points out “it does not offer much in the way of guidance as to how the problem should be dealt with. To say that a lack of certainty should not inhibit measures to protect the environment from serious and irreversible damage does not indicate what should be done and how it should be done. Nor does the

principle suggest how one might set about answering such questions.”²⁴ Common goes on to discuss some recent proposed mechanisms designed to operationalise the Precautionary Principle like the adoption of a Safe Minimum Standard or the posting of Environmental Performance Bonds²⁵ for project interventions. However, in both cases these are controversial and have been subject to criticisms even for well-defined projects. In the case of radical biotechnological change it is difficult to see how a specific decision tool of such types could play a useful role.

Nevertheless it is clear that in many countries the Precautionary Principle is having practical influence. Tait (2001) for example, shows how many European countries have now begun to take a much more cautious approach to biotechnology policy, especially with regard to the advent of GM crops. Her view is that the time has come to take the precautionary principle much more seriously than has been the case in the past. But this cannot be done through the simple application of the old risk-based formulae for the simple reason that we are now dealing with future events and our perceptions of such events and their implications. Here we are in a world of great uncertainty and ignorance, where views are influenced by economic, social, ethical and ideological interests, and therefore where decision-making has to be consensual if it is to be successful. Indeed one of the major problems faced by industry, science and government is that for many years each of these “estates” has refused to see the issue in this light and has therefore lost credibility in the eyes of ordinary people. Tait calls for a constructive dialogue among all interested parties so as to clarify the issues and reach a social consensus on all the underlying problems. This does not mean abandoning science. Rather it implies the need to recognise the limitations of science in a field that is developing very fast indeed.

But how should this be done? The first step is to recognise who the interest groups are and what factors influence their views. Tait identifies the following:

- Environmental pressure groups (ENGOS)
- Consumer organisations (CNGOS)
- Multinational companies (MNCS)
- Small scale industry (SMES)
- Farmers and farmer organisations (FOs)
- The public research system (and the scientists that work in it).
- Government ministries and secretariats.

Each of these interest groups generally view issues of biotechnology risk quite differently even where the presenting evidence appears to be very similar. But their views are neither static nor homogeneous. For example “unlike their American counterparts, several European companies would have been prepared at an early stage to accept labelling of food products arising from GM crops, avoiding one of the stimuli which has had an important impact on European public opinion.”²⁶ Again Paarlberg (2000) shows how agricultural and scientific ministries are usually much more promotional to biotechnology than are environmental ministries. And, as mentioned above, the views of European CNGOs have certainly changed from a neutral position to a much more hostile position over the 1990’s as trust in regulatory authority has dissipated (Tait 2001)

Paarlberg (2000) has analysed policies towards GM crops in four developing countries, Brazil, China, India and Kenya. Of these only China has been positive about granting permission for planting to go ahead. In each of the other countries he argues that international pressures from ENGO's, CNGO's and donors are working to discourage such developments despite the fact that government agencies in all three countries are much more positive towards GM crops. In China's case, however, NGO pressure groups are simply not allowed to function. Interestingly enough Paarlberg concludes that the existence of IPR regimes is not by any means the main determinant of MNC behaviour in any of the countries. Monsanto, for example, has been offering to share GM sweet potato technology with Kenyan scientists for nearly a decade but has been prohibited on biosafety grounds. In China, MNCs have been quite happy to enter into collaboration agreements despite widespread and blatant IPR piracy. Conversely, a relatively strong IPR regime in Brazil has not in itself been enough to get a GM revolution going in that country Paarlberg²⁷. Stokes (1998) has come to similar conclusions in her study of Zimbabwean biotechnology policy.

A related issue concerns international trade. Because trade in GM crops, for example, is subject also to the WTO agreement, in effect signing up to the WTO has constrained countries' abilities to prevent imports of GM crops on grounds of risk and safety. Because of the importance of this issue the WTO has set up a Committee on Trade and Environment to deal with associated disputes. As Tait and Bruce (2001) point out, however, the current WTO position is that such trade restrictions should be based on current internationally agreed food safety regulations and that if national standards are higher than these current *Codex* standards, "the additional safeguards must be based on scientific evidence and grounded in risk assessment."²⁸ In other words the WTO position does not recognise the wider view of risks associated with biotechnology development as outlined above.

We shall see later in the text that in the African countries investigated the issue of how to deal with biotechnology development and biosafety is still a very open one with no country having a well worked out set of policies. Indeed this is symptomatic of more general science policy approaches to agriculture, which are very much at an embryonic stage.

3. Agricultural Biotechnology in Sub-Saharan Africa

1.1 Biotechnology Research and Relate Policy-Making in Kenya

Kenya has been engaging with ‘low’²⁹ biotechnologies, such as bio-fertilisers and tissue culture for several decades (Odame *et. al.*, 2003a). Tissue culture continues to be an important technology in Kenya in the horticulture sector particularly in citrus and pyrethrum. More recently there has been immense focus on tissue culture in bananas (See ISAAA website). The first ‘modern’³⁰ biotechnology to be developed in Kenya was a genetically modified (GM), virus-resistant (VR) sweet potato. This project began in 1991 and was a public-private partnership (PPP) between the Unites States Agency for International Development (USAID), the Kenyan Agricultural Research Institute (KARI) and the Monsanto Company. The International Service for the Acquisition and Application of Agricultural Biotechnology (ISAAA) joined the project later in 1999 (ISAAA website).

Recently, the ARC-Roodeplaat Vegetable and Ornamental Plant Institute (VOPI) of South Africa, another public sector institute, joined the project along with the Danforth Plant Science Center in the USA (Horsch and Montgomery, 2004). Much has been written about this project in the academic literature and the international media, as it was the first attempt to develop and cultivate a GM crop in East Africa.³¹ Recent reporting in the national and international media has focused on results of contained field trials that showed the failure of the VR potato to protect against viruses (Gathura, 2004; New Scientist, 2004) (several internet sites). Despite the general failure of these trials, the project is still ongoing and new modifications of sweet potato are being researched and developed (ISAAA website) (Horsch and Montgomery, 2004). Several other GM crops have recently begun to be developed in Kenya via PPP mechanisms. KARI is a main public partner in all of these projects and most financial support comes from the international private sector and international donors. It should be made clear that none of these projects have led to the commercial cultivation of GM crops in Kenya. No GM crops have moved beyond contained trials. Table 1 details current modern biotechnology projects and partner organisations.

Table 1: Current agricultural modern biotechnology projects in Kenya

Product	Year of approval(s) ³²	Partners
Recombinant livestock vaccines (for diseases such as rinderpest and capripox)	1995 (ad-hoc ³³)	KARI, Pirbright (UK), University of California, Davis
Virus-resistant sweet potato	1998	KARI, Monsanto, USAID, ISAAA, ARC-VOPI, Danforth Center (USA)
Insect-resistant (Bt) maize	2001 leaves 2003 seeds	KARI, CIMMYT, Syngenta Foundation, Rockefeller Foundation
Insect-resistant (Bt) cotton	2003	KARI, Monsanto
Virus-resistant Cassava	2003	KARI, Danforth Center (USA) USAID (ABSP II) ³⁴

Adapted from IRMA (e2004)

Biosafety and regulatory developments in Kenya have been taking place concurrently with biotechnology development. Like the development of specific biotechnologies, the development of biosafety systems has mainly been sponsored by several major donor projects. The timeline (Table 2) gives an overview of the interaction between technology and regulatory developments and the donors that have sponsored each. The first large-scale biosafety project started in 1993 and was sponsored by the Netherlands Directorate-General for International Co-operation (DGIS). Kenya was one of four partner countries selected for this project. The DGIS project aimed to develop a biotechnology ‘platform’ for Kenya aimed at poverty alleviation. It involved elements of both developing specific technologies, as well as developing national regulatory and biosafety capacity. It set national priorities, stating that tissue culture and other low biotechnologies had great potential in Kenya, but that Kenya should start to focus on developing modern biotechnologies as well. (DGIS).

The DGIS programme laid the groundwork for the next major donor-sponsored project co-ordinated by United Nations Environment Program -- Global Environmental Facility (UNEP-GEF) in 1997. The Pilot Biosafety Enabling Activity Project of UNEP-GEF was aimed specifically at helping Kenya (and eleven other countries) develop biosafety frameworks. It also aimed to develop mechanisms for “cross boundary movement of living modified organisms” (UNEP-GEF website). Both the DGIS and UNEP-GEF programmes co-ordinated by the government of Kenya via the National Council of Science and Technology (NCST). The NCST was created within the Ministry of Education, Science and Technology by the Science and Technology Act (last amended in 1980). The NCST is charged with advising all government departments on issues of science and technology.

Largely because of the support of these two programmes, the NCST produced and published biosafety guidelines in 1998. Also via the UNEP-GEF programme, a National Biosafety Framework for biotechnology regulation was developed in 1999.³⁵ The biosafety guidelines set up the initial institutional structure to address issues of risk assessment and safe handling of GM products. These guidelines stipulated the formation of the National Biosafety Committee (NBC).³⁶ The NBC became the body charged with co-ordinating all biosafety efforts and regulation, including approval of all biosafety applications for biotechnologies to be developed in Kenya. The NBC falls under the NCST. The National Biosafety Framework established the structure for regulating biosafety, identifying the role of relevant ministries and government agencies. The biosafety guidelines were first written before the Cartagena Protocol³⁷ on biosafety was signed and ratified by Kenya (in 2000 and 2002 respectively). Also, the guidelines only address contained research and trials of GMOs, not commercial release. These are issues that the second phase of the UNEP-GEF project is addressing. This phase of the project (2002-2005) is charged with helping countries implement the biosafety schemes developed in the first phase.

There have also been many less direct but significant donor contributions to the development of biosafety regulation in Kenya. For instance, the Agricultural Biotechnology Support Program, (ABSP I) centred at Michigan State University and funded by USAID, trained scientists from Kenya via an internship programme. The focus was on teaching the scientists to help develop a regulatory scheme so that products could be tested and exchanged internationally {ABSP, 2002, #21401}. In addition to the ABSP scheme, Kenyan biosafety system is also currently obtaining support from the Programme for Biosafety Systems (PBS), co-ordinated by International Food Policy Research Institute (IFPRI) and sponsored by

USAID. The PBS programme seeks to further supplement implementation of biosafety systems in those countries that received UNEP-GEF funding (PBS website).

The support of these multiple donors and over a decade of work has shaped the current biosafety regulatory system. The current system is a slightly updated adaptation of that set-up by the 1998 guidelines and the 1999 framework. It is an amalgamation of many government ministries, agencies and institutes based on various and complicated webs of existing legislation (See Figure 1). Despite the support of these multiple donors, Kenya still has not tabled a biosafety bill in parliament. At the time of writing, the draft bill is awaiting approval from the Cabinet. The legal and significance of this situation and events surrounding the draft bill will be discussed in more detail below. First the concepts of formal and informal governance are introduced and used to critique the governance of biotechnology in Kenya.

Informal and formal governance of biotechnology in Kenya

Formal governance of biotechnology in Kenya is the institutional and regulatory system that is being established. Some obvious criticisms of this decision-making framework are apparent. Firstly, the development of biotechnologies and the development of policies and laws to regulate them have been happening concurrently. (See the timeline in Table 2). This has forced the development of regulations to be largely *reactive*. For instance, the first modern biotechnology project in Kenya, the VR sweet potato project, began in 1991, long before the formation of the biosafety guidelines and the National Biosafety Committee in 1998. Furthermore, the approval to import the transgenic sweet potato came just a few months after the biosafety guidelines were issued, leaving critics to question how much the research agenda and research organisations were driving biosafety developments (Odame *et. al.*, 2003a).

This reactionary approach in formal governance is far from ideal, not least because it does not allow for adequate strategic co-ordination or planning to steer the development of technology. There is evidence that co-ordination and steering is still weak within the Kenyan biosafety system. Strategic linkages between the NBC and the three international research centres in Nairobi that deal with agriculture (ICRPE, ILRI and ICRAF³⁸) are generally weak.³⁹ ILRI is the only institute formally represented on the NBC. Furthermore, the NBC, does not generally approach these institutes to request specific research, or learn about relevant ongoing research that could be strategic for national development⁴⁰. This is disheartening because most other East African countries do not have the benefit of multiple international research institutes within their borders.

Adequate awareness of biosafety issues and the capacity to assess them are also weaknesses of current formal governance. It took over two years for the importation of the transgenic sweet potato due to lack of scientific capacity such as a shortage of molecular biologists and containment facilities (Traynor and Macharia, 2003). According to official representatives at the NCST, the situation is improving (HM interview). However, ministers and other government officials outside of the small biotechnology elite can still be largely ignorant about risks and benefits of biotechnology.⁴¹ Without scientific inputs and better training of decision-makers, formal governance will remain handicapped.

Most importantly, the current system of formal governance is operating under a 'legislative vacuum' (Wakhungu and Wafula, 2004:43). The biosafety guidelines, biosafety framework and the NBC itself were all created by the NCST under the legal authority of the Science

and Technology act of 1980. This act gives the NCST authority to advise the government on science and technology issues. However, it grants no regulatory authority to the NCST or NBC. Until a biosafety bill is passed in parliament, the NBC has no legal authority to enforce violations of the biosafety guidelines (Traynor and Macharia, 2003). Currently the only clear legal authority regularly exercised is that of the Kenya Health Plant Inspectorate Service. Moreover, this authority is only in terms of permits for importation and facility certification (Wakhungu and Wafula, 2004). Even if no serious violations of the biosafety guidelines occur, the lack of legal regulatory authority could cause unease among certain stakeholders and publics where it more widely known. Additionally, the lack of legislation also leaves a non-unified regulatory environment for biotechnology in Kenya. As it stands, the NBC does not have co-ordinating legal authority. The five ministries and multiple agencies involved in regulating biotechnology still hold precedence over their respective aspects of biosafety.⁴² This could lead to possible conflict of interests between ministries or agencies with no legal mechanism for resolution.

Overall, although the current formal governance of biotechnology in Kenya has the ability to approve technologies, it largely does not include mechanisms to enforce regulation or include mechanisms for strategic decision-making to guide technology development. If regulations cannot legally be enforced, then there is no accountability for decisions. The private sector, international donors or international research institutes cannot be legally held accountable to the public and farmers for their actions, should their actions violate biosafety guidelines. The general lack of authority and strategic decision-making in formal governance makes examining informal mechanisms for the governance of biotechnology critical.

The reality in Kenya is that governance of biotechnology is largely informal. For instance, because of a lack of a clear formal policy towards biotechnology and lack of awareness about biotechnology, many prominent ministers and officials often make ad-hoc media statements regarding biotechnology (Odame et al., 2003b). These statements are mostly in support of biotechnology, focusing on potential benefits over potential risks. Statements range from the more confusing and obscure to more formal speeches given at exclusive events. Almost always the national media will publish the statements in stories with strong headlines. For instance, in a story published with the headline “Yes we’ll take GM food aid, says minister” (*East African Standard*, 2004), Dr. Wilfred Machage, the Assistant Minister for Special Programmes in the Office of the President, stated that Kenya will accept GM food aid. This statement, however, was in direct conflict with an official press release sent to all newspapers by the Minister of Agriculture, which stated that all maize imports must be inspected and certified as GM free (Ministry of Agriculture, 2004). Non-official and ad-hoc statements by government officials can confuse and convolute publics. They create false awareness about official state policies and about who is responsible for them.

Even more important than creating confusion about the status of decisions amongst publics, is the role informal governance plays in the process which decisions are actually made. As mentioned above, all the biotechnologies currently being developed in Kenya are carried out via public-private partnerships (Table 1). All of these partnerships have originated from Kenya. They have been aimed at local problems but their original impetus was from multinational companies, international donors or international research organisations (Wakhungu and Wafula, 2004). This would be less problematic if formal governance was

strong with better mechanisms to accept, reject, modify and enforce these projects according to national priorities. However, interaction between the public-private partnerships that are developing technologies and formal governance is mostly limited to permit applications to import plant matter or build scientific facilities. The state is not an active partner in co-ordinating decisions about what technologies to develop and how to develop them. These decisions are largely left to non-governmental actors, namely the donor organisations, international research institutes and NGOs co-ordinating the partnership. As the distribution of informal and formal governance stands now in Kenya, participation of civil society and farmers in decision-making and accountability to them can largely only occur if it is facilitated via the informal governance of PPP projects.

The current biosafety bill presents an opportunity for Kenya to shift this topography of governance. The biosafety bill represents a chance to encourage co-ordination and cross talk amongst government ministries and departments. (CZ interview). This could provide formal governance with the ability to more strategically guide biotechnologies and make them more relevant to local needs. It could also provide formalised mechanisms for participation.⁴³ Through the biosafety bill, regulatory systems will acquire legal authority and actors could thus be held accountable. In general, the bill could give technology developments a national mandate in the face of criticism that current biotechnology developments are driven by the concerns of international partners.

The Draft Biosafety Bill

How is the government of Kenya taking advantage of the biosafety bill as a fulcrum for increased accountability and participation? In general, recent developments surrounding the current draft form of the biosafety bill have been controversial. In terms of accountability, there has been a general lack of transparency on the part of the Kenyan government, specifically the National Council of Science and Technology (NCST). Several civil society groups engaged in advocacy for small-scale farmers and the environment were refused copies of the draft bill upon making a request to the NCST (NGO interviews). The authors and other representatives from a Kenyan research institute, the African Centre for Technology Studies, were also refused copies of the draft bill. The NCST argues that it does not have the capacity to filter information and decide what to release to the public and what to keep confidential (HM interview). Regardless, given that the National Biosafety Committee also does not make their minutes available to the public (Traynor and Macharia, 2003), the denial of requests to acquire the draft bill closes off another avenue for accountability. One NGO respondent summed up the situation stating, “The biosafety process has been very secretive. They think it is the domain of scientists and a few in government” (TA interview).

Accountability and participation are clearly interrelated in the current biosafety process. In terms of participation, there is strong evidence that there is continuing under-representation of some interests in the policy process. On 20 August 2004, a coalition of civil society organisations⁴⁴ issued a declaration about biotechnology in Thika, North of Nairobi. In the declaration, the small-scale farmers represented by the Kenya Small Scale Farmers Forum (KESSFF) raised concerns about the development of GM crops in Kenya. Introducing GM crops, they argued, could cause environmental risks and threaten traditional farming methods that are key to their livelihoods, such as saving seeds from harvest to harvest. The declaration called for more participation of small-scale farmers in the policy process regarding

biotechnology in Kenya (Thika Declaration, 2004).

In general, organisations representing small-scale farmers and environmental advocacy have largely been absent the biosafety process thus far in Kenya (NGO interviews). This not to say that there have been no chances for stakeholders to voice their interests in the biosafety process. All of the large-scale donor funded initiatives discussed in the first section above have included stakeholder workshops (See for example UNEP (?)). In addition, groups such as the African Biotechnology Stakeholders Forum, ISAAA and BTA have conducted other workshops. Indeed, participants in these workshops have generally come to have representation on the National Biosafety Committee (See Table 3). However, a core group of civil society groups representing small-scale farmers and environmental advocacy have not been present at workshops and are not represented in the NBC or the biosafety process in general. The excluded civil society groups argue that the situation leaves issues of food security and environmental sustainability, particularly how they relate to small scale farmers, absent from the biosafety agenda (NGO interviews).

Table 3: Composition of the National Biosafety Committee in Kenya

Secretariat	
National Council for Science and Technology	
Ministries	
Ministry of Agriculture and Rural Development	Ministry of Trade and Industry
Ministry of Education Science and Technology	Ministry of Health
Regulatory agencies	
Kenya Bureau of Standards	Kenya Plant Health Inspection Service
National Environment Management Authority	Kenya Industrial Property Office
Research institutes	
International Livestock Research Institute	Kenya Medical Research Institute
Kenya Agricultural Research Institute	
Government departments	
Department of Research Development	Kenya Wildlife Service
Universities	
University of Nairobi	Kenyatta University
Non-governmental organisations	
Consumers Information Network	Seed Trade Association of Kenya
African Biotechnology Stakeholders Forum	Biotechnology Trust Africa
Kenya National Farmers Union	

Why these groups have not been represented at meetings and in the NBC is not clear. It is clear that none of the groups have ever been invited to any of the stakeholders meetings or to NBC meetings (NGO interviews). They claim that it is only through personal, ‘back-door’ inroads that they have had any chance to participate in the biosafety process at all. “It can be a total fluke if NGOs are involved” (NGO interview). It is generally the responsibility of the organisation co-ordinating a stakeholders meeting to invite stakeholders and publicise the meeting. (MK interview). Some of the civil society groups that have not attended meetings have had a relatively low public profile until recently, such as KESSFF. It might be understandable that these groups would not find out about workshops. However, some groups such as ActionAid have been working with small-scale farmers on food security issues since the 1970s. Certainly these groups should have heard about workshops.

Regardless of why these civil society groups have not been involved, the biosafety process in Kenya is surely losing out on a wealth of relevant expertise by not having them on board. Participants that have been part of the biosafety process seem to agree. The Director of the Consumer Information Network, a group that has been part of the biosafety process almost from its inception stated that “We have missed their voices inside the house” regarding the lack of food security and environmental advocacy civil society groups involved in the biosafety process (SO interview).

A few policy recommendations are clear. Firstly, the Kenyan government should make a purposeful and far-reaching effort to involve publics and farmers before the biosafety bill is sent to parliament. There was some indication from the NCST that this might happen (Anon interview), but the official stance of NCST is that the government will only follow normal procedures (HM interview). This only involves a low profile comment period before the bill is sent to lawmakers. Secondly, despite the support of the UNEP-GEF programme, the NCST and NBC continue to struggle with capacity issues. There are currently efforts via the Biosafety Clearing House programme⁴⁵ to help the NCST better disseminate information to the public (HM interview). More assistance, however, is needed from donors so that the NBC has capacity to more effectively interface with civil society.

The policy implications of this situation could indeed have long-term future ramifications. During the development of regulations for GM crops in Europe, lack of initial participation of environmental stakeholders and an overzealous push by firms for less restrictive regulations led to a powerful backlash against the technologies. Public and consumer groups shifted from a neutral stance towards GM crops to a stance of strong value-opposition to GM crops in the 1990s (Tait et al., 2004). Once a strong value-based oppositional stance is taken, it is unlikely that opinions will easily change (ibid.). The European situation could easily repeat itself in Kenya. Short-term efforts at increased participation now could bring long-term benefits to all sides of the debate.

3.2 Biotechnology Development and Policy-Making in South Africa

South Africa has a well-established (compared to other African countries) scientific infrastructure for agricultural biotechnology R&D, including genetic engineering. For example, the University of Cape Town has a number of internationally cutting edge research activities in biotechnology conducted within its Department of Biochemistry. The Department

qualifies as a centre of excellence in biotechnology R&D. With biotechnology R&D activities initiated in the early 1980s, the Department has extensive experience in such areas as thermodynamic and spectroscopic investigation of protein folding and protein DNA/RNA interactions, regulation of gene expression during the Sea Urchin embryogenesis, cloning of vertebrate gonadotropin-releasing hormone receptors, and isolation of genes responsible for certain nutritional characteristics of crop plants with a view of producing transgenic plants. Its teaching and training activities are at doctoral and M.Sc. levels. By 1995 the Department had generated two specialized doctoral degrees in biotechnology and at least 8 M.Sc. degrees. With a scientific staff 27, by 1999 the Department had published its biotechnology research in several international and local journals.

In collaboration with the Agricultural Research Council (ARC), the University of Cape Town's Department of Microbiology developed and released for field-testing the first transgenic potato in the country. The potato has been engineered with CP genes that confer resistance against potato virus Y and leafroll virus. In addition, the Department's research efforts have generated tobacco resistant to cucumber mosaic and tobacco necrosis viruses, via expression of both CP and CP gene antisense RNA. It also developed two years ago maize streak virus (MSV) as a high yield vector for maize cell culture systems and is now engaged in research to develop MSV-resistant maize.

The two departments (Department of Biochemistry and Department of Microbiology) receive funding from the Government of South Africa and additional research grants from private foundations and contract research for industry. The staff in these departments has published in international journals and some consult for such multinational biotechnology companies as Monsanto.

The first field trials for genetically modified crops were conducted in 1992, while conditional commercial release permits were granted in 1997. Applications for permission to use GMOs in field trial experiments have increased from one application in 1990 to 5 in 2004.⁴⁶ The country has now commercialized insect-resistant maize and insect-resistant Bt cotton. By end of 2000, 41 GM field trials had been conducted in the country.

Presently, nearly 20% of South Africa's cotton is genetically modified, and up to 5% of the maize grown. Most field trials and plantings have taken place in Gauteng, Northern Province, Mpumalanga and KwaZulu-Natal. Herbicide tolerant and pest resistant traits account for more than 93% of the types of GM crops grown worldwide. In South Africa a similar situation prevails: 91% of all field trials have been for herbicide (40%) and insect resistant (51%) crops. Seventy per cent of these applications were received from multinational companies including Monsanto, Pioneer Hi-Bred, AgrEvo, Delta and Pine, Novartis and du Pont.

Policy and institutional arrangements for biosafety

South Africa's main instruments for biosafety are the Genetically Modified Organisms Act (GMO Act) of 1997, and the Regulations for its implementation adopted in 1999. The legislation establishes norms and rules for importing to and exporting from the country genetically modified organisms. It requires that import and export of such organisms be done with permission of the national regulatory authority. Such permit is to be issued after a scientific assessment and risk analysis have been conducted and approved by the Executive Council. The Regulations require that the public be notified of any proposed release of GMOs prior to the application for a permit for such release.

The GMO Act is administered by the National Department of Agriculture (NDA). The NDA has a Registrar who receives all applications for permits to conduct GMO trials or to release commercial products derived from GMOs. After processing the applications, the Registrar takes them to the South African Committee for Genetic Experimentation (SAGENE) composed of scientists who conduct safety reviews and risk assessments. If the GMO product successfully passes this scientific review, the application is forwarded to an executive council composed of representatives from the ministries of Agriculture, Environmental Affairs and Tourism, Trade and Industry, and Health.

South Africa's regulatory system seems to be highly scientific approach and inclusive at least in so far as it involves various government departments, academia, and commercial producers as well as the concept of conditional approval, which obliges applicants to consider possibilities of technology transfer. Yet, it is also criticized for the lack of capacity to handle the numerous applications, the disregard of public participation in the decision-making process and the omission of the precautionary principle.

In addition to the GMO regulatory instruments, South Africa has an overall national biotechnology policy and strategy both adopted in 2001. The goals of the policy and strategy are to promote safe development and application of the technology to achieve national poverty reduction and economic growth. They are intended to stimulate industrial use of biotechnology.

The Department of Science and Technology (DST) has a mandate to implement the policy and strategy. It has established a Biotechnology Advisory Committee (BAC). The BAC assists the DST to ensure that national funds are targeted at specific activities, particularly the establishment of Biotechnology Regional Innovation Centres (BRICs). Although the BRICs are regionally focused, they do not operate independently. There is a process of facilitating collaboration across all BRICs to create a national cohesiveness amongst all the centres.

Three centres have been established. These are: (a) the **Biotechnology Partnerships and Development (BioPAD)** that focuses on the application of biotechnology to industrial growth through process and product development, mining competitiveness and environmental rehabilitation or prevention of adverse environmental effects is a key strategic focus for the BioPAD BRIC. BioPAD is active in the Gauteng region; (b) **Cape Biotechnology Initiative** that aims at promoting biotechnology sector in the Western Cape region of South Africa and represents the interests of all stakeholders in the region, including industry, academia, government and service providers to the sector; and **East Coast Biotechnology Consortium (EcoBio)** EcoBio has two primary programme areas, namely, human health and bioprocessing. A third program area, plant biotechnology, is a national initiative, and is a co-operative venture between the three BRICs. EcoBio is a team of interested and affected parties, primarily from the East coast region, and includes Durban, Pietermaritzburg, Nelspruit and Grahamstown. Further participation by other parties in this region will be actively promoted.

3.4 Governance of Biotechnology and Biopolicy in Uganda

Despite a broadening of its economic base in recent years Uganda's existing comparative advantage and economic potential is still heavily concentrated in agriculture. This is attributed to the favourable soil conditions and a climate that has contributed to the country's agricultural potential. Efforts aimed at promoting agriculture in Uganda have been characterized by both institutional and policy changes. Institutional changes include developments that have paved way for consolidation of all bodies dealing with agricultural R and D. Until the late 1980s, agricultural research was scattered under different government ministries and departments. In 1987, the process of consolidating all agricultural research activities under one organization was initiated. This process culminated to the establishment of the National Research Organization (NARO) in 1992 as the apex body with the mandate to undertake, promote and coordinate research in all aspects of crops, fisheries, forestry and livestock, and ensuring dissemination and application of research results. NARO is the largest sectoral body in Uganda with a total of nine research stations. This was followed by the Plan for Modernization of Agriculture (PMA), which was finalized in 2000. PMA reflects a major policy shift in the orientation of the agricultural sector in Uganda. It aims at achieving the broader objective of poverty eradication. The target of the plan is to transform subsistence agriculture to commercial or market oriented production.

With the increasing and growing potential of biotechnology, the Ugandan government is beginning to recognise and appreciate that biotechnology provides opportunities that must be fully explored and utilized to contribute to sustainable food production, improved health care and environmental protection. Agricultural biotechnology has been identified as a tool that can contribute towards realizing objectives of the PMA and one obvious intervention is how can agricultural biotechnology improve the productivity and product quality needed to strengthen international trade competitiveness (Nyiira, 2002). In addition, the government of Uganda has pronounced that, for the country to benefit maximally from this new technology, it will establish an adequate, workable and transparent national biosafety framework (see below), which will be implemented in consultation with relevant stakeholders so that all biotechnology applications are done in a scientific manner.

Biotechnology and Biosafety developments in Uganda are governed in the context of international instruments and regulations. The country signed and ratified the Cartagena Protocol on Biosafety on May 24, 2000 and November 30, 2001 respectively. The National Environment Management Authority (NEMA) represented the government in the negotiations leading to adoption of the Biosafety Protocol. The Ministry Of Environment continues to participate in the Conference of Parties (COP). The Ministry Of Environment is the designated focal point and reports to the secretariat of the Convention on Biological Diversity. On the other hand, the Uganda National Council for Science and Technology (UNCST) under the Ministry of Finance, Planning and Economic Development is the designated competent authority for the purpose of domesticating and implementing provisions of the Cartagena Protocol on Biosafety. The council advises the Ugandan government on matters of science and technology including biotechnology. The National Biosafety Committee (NBC) established in 1996 is the technical arm of the UNCST delegated with the responsibility of reviewing applications and implementing biosafety guidelines and regulations.

Uganda is currently free from GMOs. Applications to introduce Bt. cotton and Bt. maize were submitted to UNCST in the year 2000 but none was approved for research trials. There are divergent explanations as to why the two were not considered. According to the UNCST, approval was not granted because of procedural technicalities. The council as the competent authority felt that Uganda was unprepared to handle GM crops because of lack of a policy framework and biosafety regulations. In addition, Uganda lacks confinement and containment facilities where trials of GMOs can take place. Monitoring and enforcement mechanisms are yet to be put in place. Other reports reveal that there was lack of consensus between NARO and UNCST. NARO submitted an application for Bt. cotton after engaging Monsanto in consultations. Also possibilities for having the trials conducted at Serere Agricultural Research Institute in Soroti, eastern Uganda, had been explored.

It seems that NARO did not elicit the participation of UNCST right from the beginning. Subsequently, when questions of intellectual property ownership and liability arose, the UNCST requested the application to be submitted by Monsanto.⁴⁷ Further lack of consensus between the two bodies emerged later at a national stakeholders' workshop on biotechnology and biosafety in Kampala, where there were polarized exchanges between UNCST and NARO scientists. The UNCST scientists including the executive secretary (Dr. Z.M. Nyiira) were not satisfied with NARO's explanation about the risks that may be posed by cottonseeds. Other concerns regarding Bt. cotton were voiced by the Uganda Cotton Growers Association, which expressed fears that European buyers would refuse to buy cotton from Uganda if it is genetically engineered. The major issue was that Bt. cotton produces short-staple lint while conventional cotton grown in Uganda is long staple. On the basis of this information, it was believed that introduction of Bt. cotton would affect the quality of cotton produced. The long staple one commands a premium price in the European markets (New Agriculturalist, 2002).

A further factor is that Uganda lacks containment and confinement facilities for evaluation of GMOs. This is a major limitation given that biosafety regulations require evaluation of genetically modified products to be done in a contained greenhouse facility prior to evaluation in the field. This is hindering importation of materials for testing. For instance, no application to test transgenic (Cavendish) bananas has been presented to the UNCST, despite the fact that this banana cultivar is functionally a self-contained system, due to its functional male sterility. Another constraint is the low understanding of IPR issues among researchers and scientists in Uganda. As a result, loss of biological resources, which are eventually patented, has grown to become a critical concern. To address this problem, a number of scientists from NARO institutes are currently benefiting from short courses on IPR management.

Risk Assessment And Regulatory Regimes

The UNCST is the competent authority with the mandate to approve GMOs. All the applications for introduction of GMOs are first forwarded to UNCST, which screens them for completeness and after sending acknowledgement to the notifier, the request is forward to NBC for risk assessment evaluation and review. Risk assessment is expected to be done by the applicant. The obligation of NBC is to review risk assessment dossiers and draft report advising the UNCST appropriately. The final verdict rests with UNCST after taking into consideration views from the public, line ministries and other stakeholders. The membership of NBC is broad based made up of representatives from over nineteen institutions including the scientific

community, relevant ministries, farmers' organizations and the private sector. Recently, the Ministry of Defence has been co-opted, given the transboundary nature of GMOs.

The procedural steps for handling applications and requests for introduction of GMOs are outlined below:

- Requests will be submitted by the notifier to the competent authority (UNCST)
- The competent authority will screen the application for completeness and after acknowledgement (to the notifier), the request will be forwarded to NBC for risk assessment evaluation
- NBC will evaluate the risk assessment carried out by the notifier, and send its findings to the Executive Secretary, UNCST
- Upon receiving the opinion of NBC, the UNCST will publish the request and opinion of the NBC
- The public may make comments to UNCST within 30 days
- After evaluating any comments received, the UNCST will consult relevant ministries and stakeholders, then make a decision

According to one interviewee, monitoring and risk management of GMOs if approved in future will be done by existing inspectorate bodies. For example, if UNCST makes approval for a GM crop, it will be the responsibility of the Ministry Of Agriculture to undertake the monitoring. A memo will be released from UNCST directing the ministry to monitor the trials. The inspectorate bodies that will be expected to play a role in monitoring and enforcement of biosafety regulations include:

- The Customs (URA) for commodity food imports and placing on the market of GMOs products.
- The Phytosanitary Department of the Ministry of Agriculture, Animal Industry and Fisheries for plant imports, and for contained use and environmental releases of GMOs.
- The NARO Committee for variety testing, field inspection and seed control,
- The Uganda National Bureau of Standards for commodity food imports
- The Agricultural Research and Development Centres (ARDCs)
- The Department of Forestry
- The Uganda Wildlife Authority
- The Ministry of Health

Most of the above inspectorate bodies have experience in handling inspections for conventional crops but have limited experience and capacity for handling GMOs. Given that this limitation has already been noted, training courses on transboundary movement of GMOs have been planned for to train members of NBC and inspectors for ministries of health, environment, agriculture and UBS. This will provide them with insights on the nature of the inspection capacity required for Uganda. At least two selected laboratories in Uganda will be equipped, certified and assigned for detection and identification of GMOs in the context of inspections.

There are no institutional biosafety committees in Uganda's biosafety system. If one wishes to introduce a GM crop, the application is submitted directly to UNCST, which in turn forwards it to NBC for expert review. While there are no institutional biosafety committees

working with NBC, some research institutions such as Makerere University and KARI have in-house measures and procedures to guide internal operations and ensure safety handling of materials and products that they work on. In the crop science department at Makerere University, risk assessment and biosafety is understood to be an internal way of safe handling of specific organisms, research activities and materials. The laboratory has facilities for destroying hazardous materials, e.g. incinerating facilities. It has drafted operating procedures to ensure safety. Refresher courses for technicians and scientists are conducted regularly. KARI has scientists trained in risk assessment. For instance, in early 2004, the co-ordinator of the tissue culture lab attended a three-week course on risk assessment in Sweden.

The UNCST has developed a National Biosafety Framework, which includes regulations and guidelines for recombinant DNA work in the laboratory, contained greenhouse, and contained field settings. The guidelines and regulations were first drafted in 1988. Development of the biosafety framework was described as a spontaneous process that was internally driven as opposed to being driven by external forces. The process was supported by the UNEP-GEF financial mechanism on biosafety frameworks. The Ministry of Finance, Planning and Economic Development was responsible for the development of the framework (Nyiira, 2000). The drafting of the framework was done by a task force from the council. The process is said to have been participatory and inclusive. Key ministries were involved and agencies such as NEMA were represented. Civil society organizations such as UCPA and consumer education advocacy groups were brought on board as well. The private sector was represented by Med-Biotech laboratories. These institutions were selected based on the cross-sectoral nature of GMOs and future roles that they are likely to play in biotechnology and biosafety related issues. For instance, NEMA was represented by the technical committee on biological resources and is expected to play a leading role in environmental impact assessment for GMOs.

After a draft was produced, workshops were held to reflect on the framework and revise it accordingly. While noting that the biosafety guidelines and regulations were first drafted in 1988, they are currently under revision with financial support from the UNEF-GEF project on the implementation of the biosafety frameworks. A working group formed by the National Co-ordinating Committee has been constituted to review the draft regulations. The draft regulations will be subjected to independent review by international experts from international organizations, governments, academia, NGOs, civil society and the private sector. The finalization of the regulations will be followed by a workshop that will be organized for stakeholders to create awareness on the regulations and the implementation process. Implementation is being done under the aegis of the UNEF-GEF project on the implementation of the National Biosafety Framework. This project started in September 2002 and will end in September 2005. A National Coordinating Committee (NCC) oversees the project. The NCC consists of 11 members, being representatives from various Ministries and departments including the private sector:

1. The Ministry of Water, Lands and Environment (1)
2. The Uganda National Council for Science and Technology (1)
3. The Ministry of Health (1)
4. The National Environment Management Authority (1)
5. The Ministry of Justice (1)
6. The NARO (1)

7. Makerere University (1)
8. Uganda National Farmers Federation (1)
9. Uganda Consumer Protection Association (1)
10. The Uganda National Bureau of Standards (1)

The objective of the draft regulations is to ensure the protection of the environment, including humans, in the use of GMOs. Approval for introduction of GMOs will be done under a permit system. That is, an applicant will be issued with a permit to introduce a GM crop or product by the UNCST after meeting the stipulated biosafety conditions and requirements. The future regulatory regime for biosafety in Uganda is embodied in the biosafety regulations. The regulations will be enacted under sections 3 and 32 of the Uganda National Council for Science and Technology Statute (1990). The statute empowers UNCST to formulate policies and strategies in all fields of science and technology including biotechnology and biosafety. It is not clear if the statute has specific provisions to address biotechnology research. One of the areas of controversy in designing a regulatory regime was whether or not Uganda should use the existing legislation (UNCST Statute) or enact a new piece of legislation to govern biosafety issues. While some members of parliament have been pushing for new legislation, UNCST is content that biosafety issues for the time being can be accommodated by the existing legislation.

Policy Formulation

A draft biotechnology and biosafety policy has recently been developed and handed over to the Ministry of Finance and Planning under which NCST falls. The task force that drafted the policy was constituted by UNCST under the leadership of the head of policy division at the council. Representatives from key institutions (Makerere University, Ministries of Agriculture, Health, Trade and Industry, NEMA, NGOs and consumer protection groups) were involved. While support for the development and implementation of the biosafety framework came from UNEF-GEF and donor agencies such as USAID, the policy process was entirely supported/sponsored by the government. In contributing to the policy process, Uganda was open in terms of borrowing key elements and tenets of a biotechnology policy from countries such as Kenya, Zimbabwe, South Africa, Namibia and European Union. Although experts from these countries were not consulted or involved, the task force relied on biotechnology policies and strategies of the aforementioned countries to write the policy. For example, some of the documents that the task force referred to include the European directive 90 on biotechnology and biosafety.

Upon completion of the draft policy, consultative workshops of stakeholders were held to discuss and review it. In total about four consultative workshops were held. USAID, ASARECA and BIO-EARN experts participated in the workshops. Participation from parliamentarians was also high. On aggregate, a total of about ninety MPs attended the workshops. The attendance was dominated by legislators sitting on the committees on agriculture and natural resources. The broader civil society was represented by consumer groups. NGOs such as ACODE have been instrumental in contributing indirectly/independently to specific dimensions of the policy such as the liability and redress regimes suitable for Uganda.

Uganda has developed a wide range of strategies for public information and public participation in the implementation of the national biosafety framework. Current and future channels for communicating the information to the public include the following:

- Convening of district workshops to raise public awareness for key stakeholders on the developments in biotechnology and biosafety.
- There are plans to develop a register that contains information about applications as well as non-confidential information about decisions on notifications and requests for permits for activities involving GMOs.
- An information database will be prepared to provide information for the general public in Uganda about modern biotechnology, the potential benefits and risks and the national biosafety framework of Uganda.
- A website will be developed to provide general information about the national biosafety framework of Uganda. It will include a link to the register and to the biosafety clearing house mechanism.
- Information on biotechnology and biosafety has been translated in 4 local languages including Luganda, Teso, Nyankole and Luo.
- Mass media approaches will include FM Radio and TV Programmes aired to disseminate information on various aspects of biotechnology and biosafety. In the past senior officers of UNCST have appeared on TV to disseminate information to the public. Articles on biosafety and biotechnology developments will be posted in the local newspaper dailies.
- Future plans will include development of a curriculum in biotechnology and biosafety for schools and colleges.

The Uganda Consumer Protection Association (UCPA) is the most active and vibrant civil society group in Uganda. UCPA is engaged in consumer protection and advocacy activities. The activities of the association seek to realize socio-economic justice, consumer safety, fair trade, sustainable and healthy environment plus good governance. Issues of food safety and security are a key focus for the association. The concern of the UCPA is to ensure that consumers in Uganda are amply represented in discussions on developments in the area of biotechnology. Towards this end, UCPA has been fully engaged in decision-making processes on biotechnology in Uganda. For instance, when the guidelines on biosafety were being drafted, UCPA and other civil society organizations firmly placed on the agenda the need for clear labelling of all imported products with GM content. It has also been instrumental in providing advice on best approaches in disseminating information and eliciting public participation in issues of biotechnology and biosafety. Although UCPA sits on the NBC, its mandate is constrained by lack of technical capacity in biosafety issues. Because of lack of scientific capacity and infrastructure, civil society organizations including UCPA have often been forced to seek guidance from public sector scientists. This raises questions about the objectivity and credibility of the advice given (BIO-EARN, 2002).

From the standpoint of technical advice there are very few science advisory bodies in Uganda. The Uganda National Academy of Sciences, which is expected to be a major scientific body, was formed recently and has not yet engaged in rendering scientific advisory services. UNCST mainly solicits for advice from independent advisory bodies such as ACODE, ASARECA and BIO-EARN. Scientific advice from the private industry largely comes from Med-Biotech laboratories. The National Biosafety Committee is chaired by the Director of Med-Biotech laboratories. This is a strong indication of the private industry's involvement in decision-making on biosafety issues in Uganda. The UNCST also makes use of *ad hoc* expert

bodies. A roster of scientific experts has been compiled and from time to time *ad hoc* expert bodies are convened to deliberate on specific issues.

Similarly the role of the university as a source of scientific advice is an idea that has not precipitated in Uganda. Owing to its size as one of the largest universities in Sub-Saharan Africa, Makerere University has a pool of experts in diverse fields of science. However, it has not yet received explicit recognition as a hub of scientific advice. There are no formal mechanisms to approach university departments for advice by bodies such as UNCST. University scientists are engaged in decision making as individuals and not as university delegates. To a large extent, this is determined by their experience, the level of recognition that they command and the prominent positions that they hold in national and regional bodies. For example a senior professor in the Crop Science Department is consulted quite frequently by UNCST and ASARECA. However, he is not involved in biotechnology and biosafety decision making processes as a representative of the university, but is his own personal capacity and by extension as the chairman of the ASARECA biotechnology group.

The Case of GM Food

In 2003, the president of Uganda approved the importation of processed GM products when opening a research laboratory at the Kawanda Research Institute. This decision was received with mixed reactions among lawmakers, scientists and civil society groups. However, according to two interviewees this decision was not a “science blind” policy. The presidential decree was informed by scientific advice. President Museveni constituted a small committee that advised him on the implications of allowing GM foods in Uganda. The advice was simply based on the positive history of GM foods in other parts of the world and lack of concrete evidence so far to demonstrate that they might pose risks to human health. However, given that the country has no capacity to monitor environmental consequences of GM crops, the approval strictly permits processed foods and not seeds or anything that can be planted or released to the environment.

The presidential committee was made up of

1. The late Attorney General
2. The Director of BIOEARN
3. Director general of medical services
4. A senior university professor
5. Senior officers from the ministries of agriculture and trade

Varied reactions to the presidential pronouncement suggest that the composition of the committee and decision-making process was not representative and consultative enough. Divergent reactions from legislators indicate that this issue lacked political support from some quarters. This could be explained by failure to engage MPs in discussions leading to the approval. For instance, MPs sitting on the agriculture committee argued that Uganda had no food insecurity problems and therefore there was no justification to allow importation of GM foods. Conversely, those supporting the idea argued that the President only allowed importation of GM foods from a country (the US) that exhibited some of the highest environment standards in the world (The Monitor, 2003).

In addition key institutions were excluded in the process. For instance, bodies such as the Uganda National Bureau of Standards whose mandate entails setting standards for both GM and non-GM food and screening were not consulted. The fact that GM foods can generate ethical and cultural issues cannot be overstated. However, there was no attempt to involve consumer groups and religious bodies that defend and articulate interests and concerns of the wider public. Reactions from the NARO secretariat scientists attests to the fact that the agricultural body was not part and parcel of the course of action. For instance, a report reacting to Museveni's decision from the NARO secretariat warned that Uganda lacked the capacity to distinguish between GM and non-GM products and therefore this will make the country vulnerable to influx of GM products. The NARO secretariat recommended that a law should be enacted in Uganda to guide the use of GM products before such products are granted entry. The existing pieces of legislation are deficient. In particular, the Food and Drug Act handles standards for food and drugs, but does not cover biosafety concerns regarding GMO foods and drugs, and the labelling of foodstuffs, feeds or pharmaceutical products for the consumer. FOSRI, a research body expected to look into issues of food safety and food biotechnology in the near future was not involved.

4. Towards public confidence and scientific capacity

How then should African countries respond to the opportunities and challenges posed by agricultural biotechnology and in particular genetic engineering? We suggest that these countries should establish broad-based platforms to mobilize the public and scientific communities to build confidence in the technological advances associated with genetic engineering. In addition, they will need to identify their specific national priorities in food production and harness the growing body of science and innovations in genetic engineering to address specific problems. Public R&D agencies and policies dedicated to genetic engineering as well as partnerships with private industry will be crucial, and lastly African countries will need develop and implement regulatory measures to manage any environmental, economic, health and social risks associated with genetic engineering.

4.1 Building Public Confidence and Support

Public confidence in modern agricultural biotechnology is one of the factors that will largely influence the extent to which countries of Sub-Saharan Africa invest in and benefit from genetic engineering to increase food production. Perceptions of the risks and benefits of the technology will influence the direction of innovation in, including commercialization of, the technology in the region. Values and psychological factors as well as confidence in scientific agencies responsible for risk assessment and management influence public perception of agricultural biotechnology. The public is also influenced by information from industry, governments, scientists, public interest groups, and media. Regulatory and scientific agencies are expected to conduct objective risk assessment and to provide the public with factual information on the nature of risks and benefits of a particular biotechnology product or process.

Science in general and genetic engineering in particular are not evolving in a socio-political vacuum. The African public and politicians have (or should have) a direct interest in scientific advances and technological developments associated with genetic engineering, yet they are not participating in the debate. In many countries of the region there are obstacles to citizens' participation in the debate on the impacts of GM crops and the potential role of genetic engineering in solving food insecurity. Considerable institutional space in the debate has been taken by isolated groups of non-governmental organizations opposed to GM crops and purporting to speak for the African rural poor, and groups of scientists who espouse the benefits of the new technology for the poor. It is unlikely that the two groups—anti and pro GM crops groups have the attention of millions of farmers in Africa. The general public and farmers in particular are not informed about the nature of the technology, its potential benefits and risks, and rarely do they participate in deciding on what crops or problems biotechnology research and development should focus on.

One of the great challenges facing society in the 21st century will be a renewal and broadening of scientific education at all age levels that keeps pace with the times. Nowhere is it more important for knowledge to confront fear born of ignorance than in the production of food, still the basic human activity. In particular, we need to close the biological science knowledge gap in the affluent societies now thoroughly urban and removed from any tangible relationship to land. The needless confrontation of

consumers against the use of transgenic crop technology in Europe and elsewhere might have been avoided had more people received a better education about genetic diversity and variation.⁴⁸

With the intensifying debate on GM crops, confusing counter claims from pro- and anti-GM activists, and often passive reactions by African governments, the public is likely to lose confidence in the scientific enterprise and overall decision-making authorities. What are required in the region today are processes that will legitimately bring the voices of the public to inform and change the focus and content of the current debate. Three actions that should be taken to build public participation and confidence are:

- (a) Well-structured and objective assessments of African public perceptions of and/or opinions on genetic engineering and GM products should be undertaken. Such assessments must be accompanied by organized activities to provide the public with reliable and adequate information on the nature of the technology and its products.
- (b) Have public stakeholders—the youth, women, farmers and other social groups—legitimately represented on bodies that are charged with regulating GM import, development and commercialization. Currently, it is difficult to determine the legitimate loci of GM decision-making in many countries of Sub-Saharan Africa. Even where biosafety frameworks have been developed and adopted (e.g. in Zimbabwe and Kenya), political institutions have either ignored these and have often made policy pronouncements that are not necessarily founded on science and informed by public opinion. What is required is the review and determination of appropriate decision-making mechanisms. Such mechanisms should have representation from all stakeholders including farmers, consumers, environmentalists and religious bodies.

If genetic engineering is to improve food production in Africa it should be guided to co-evolve with local social and economic production systems. Appropriate social and economic institutions will be required to articulate demand for the technology and to act as ‘watchdogs’ for its responsible application. It is in this regard that we are proposing the establishment of broad-based platforms that enlarge public confidence in genetic engineering through open participation in priority setting and decision-making.

4.2 Build and Efficiently Utilize Human Resources

Key elements of any national strategy to foster the development and safe application of agricultural biotechnology are the building and/or mobilization as well as efficient utilization of scientific expertise through training and establishment or acquisition of physical infrastructure (laboratories and related equipment) for R&D. A major challenge for most African countries relates to first and foremost mobilizing and efficiently utilizing existing national scientific expertise and infrastructure. Many of the countries have not been able to devise strategic ways to identify and mobilize available expertise to bear on the development of specific biotechnology products and processes. Barriers to entry into modern agricultural biotechnology can be broken through learning-by-doing and efficient use of such traditional techniques as tissue culture. Moreover, such precedents as the development of diagnostic kits for tropical diseases in Africa and work on developing vaccines for diseases such as hepatitis in Asia confirm that a small group of well-trained scientists can contribute significantly to the development and safe use of agricultural biotechnology.

Training in risk assessment and management procedures will be crucial to the building of national capacity for agricultural biotechnology R&D. Such training could be offered through international agencies such as the International Center for Genetic Engineering and Biotechnology (ICGEB) and from biotechnology industry. As we have stated above, the largest pool of scientific expertise in biotechnology, including in the assessment and management of related risks from LMOs is with private industry. Countries of Africa could build their competencies through strategic alliances between their public biotechnology R&D agencies and leading private companies. The alliances would be formed around joint biotechnology R&D projects, with the necessary emphasis on scientific and technical aspects of risk assessment and management.

Article 22 (Capacity-Building) of the Cartagena Protocol on Biosafety recognizes the role of private industry in the creation and/or strengthening of developing countries' capacities. In paragraph 1 it states that “[p]arties shall cooperate in the development and/or strengthening of human resources and institutional capacities in biosafety, including biotechnology to the extent that it is required for biosafety, for the purpose of the effective implementation of this Protocol, in developing country Parties, ... including through existing global, regional, sub-regional and national institutions and organizations and, as appropriate, *through facilitating private sector involvement,*” (emphasis added).

4.3 Strengthening Science Institutions

To harness and benefit from advances in genetic engineering as well as to manage any risks African countries need to build a diverse range of human and institutional capacities. They require expertise in such areas as molecular biology, biochemical engineering, plant breeding and bioinformatics. They also need national agencies or institutes dedicated to the conduct and management of genetic engineering. Currently many African countries do not have such agencies. Their limited investments in genetic engineering and biotechnology tend to be in the form of projects scattered across the institutional landscape. This is in sharp contrast to the organization of biotechnology and genetic engineering activities in such countries as Cuba, China, India and the USA where special centers devoted to genetic engineering have been established. It is probably only in Egypt, Nigeria and South Africa where agencies dedicated to biotechnology are found.

It is crucial that each African country identifies and implement measures to build dedicated biotechnology agencies. Such efforts may focus on identifying a few national institutes with potential, and providing political support and financial resources to such institutes to grow into national centers of excellence in biotechnology. National centers of excellence should focus on specific priority problems identified through public participation. They need significant and predictable funding and should have explicit links to private sector. In addition to research, they should devote their attention to training of scientists in such new science fields as genomics.

The establishment of national centers of excellence in biotechnology needs to go hand in hand with the creation of appropriate mechanisms to finance R&D. Current funding of biotechnology R&D is still relatively low to enable African countries to effectively engage in genetic engineering. For example, an assessment by Falconi in 1999 showed that Indonesia's total expenditure for the 1985-96 was US\$ 18.7 million while Kenya spent just about \$3.0 million. Nigeria and South Africa are increasing their financial investment in

biotechnology and genetic engineering. Nigeria's Federal Government now provides the National Biotechnology Development Agency with an average of US\$ 263 million per year for the next three years as a start-up grant. South Africa's new biotechnology strategy commits more than US\$ 300 million per year from government to finance a variety of biotechnology initiatives. Other countries of the region need to invest more in genetic engineering. Some of the may wish to create special funding mechanisms (possibly National Biotechnology Funds (NBFs) for R&D. Such mechanisms would mobilize domestic and international public and private finance to support specific priority research and innovation activities that target the improvement of food production.

4.4 Build Capacity for Policy Development and Implementation

While governments of Africa are expected to confront the above and other sets of complex issues, their capacity to engage in policy analysis and making on the issues is fairly limited. Thus the enhancement of capacities of these countries to engage in the analysis and making of policies on biotechnology should be treated as a priority by national and international programmes. The nature of policies that would stimulate and enlarge biotechnology R&D in Africa is going to be a subject of study for several years to come. Technology policy groups and institutions in Africa have not really established coherent policy analysis programmes on these issues. Demand for policy analysis is growing as many countries show interest in the technology and some start grappling with ways of maximizing benefits while reducing risks from the technology.

Many African countries lack coherent regulatory instruments and institutions for risk management in relation to genetic engineering. Where instruments have been formulated and adopted by governments, there are weak institutional arrangements for enforcement of regulatory procedures. As a result, there is no consensus on how best to respond to global developments in genetic engineering and, particularly, whether to allow the importation and/or development of GM crops. The current controversy over GM food aid to Zambia clearly demonstrates the importance of governments instituting and applying regulatory instruments as well as risk assessment and management procedures.

Risk management and making decisions on the development, importation and use of GM crops are knowledge intensive responsibilities that the participation of scientists and consumers. Appropriate regulatory instruments should guide these processes. Such instruments should enable countries to invoke the precautionary principle without denying them with opportunities to address short-term and urgent needs, particularly in terms of access to and provision of food to the hungry. They should create institutional arrangements that mobilize domestic and international science to make informed decisions.

There is need to build national capacity to formulate regulatory measures—biosafety guidelines and laws. Such initiatives as the capacity building programme of the International Center for Genetic Engineering and Biotechnology (ICGEB) will play a major role in building the capacity of African countries to develop and implement technology promoting regulatory measures. The ICGEB is engaged in the building of national capacity in biosafety.

4.5 Towards Public-Private R&D Partnerships

Private-public sector cooperation or partnerships in R&D has over the past two decades become a prominent form of organising and managing technological innovation mainly in developed countries. The pressure of international competition, increased diffusion of information and communication, declining public financing of R&D and the opening up of national economies, including liberal foreign direct investment and trade regimes have facilitated the enlarging of private industry engagement in R&D. In the area of biotechnology, industry is perhaps the holder of the largest volume of technological information and knowledge. It is thus crucial that Africa countries tap into this pool in order to build their technological competence in biotechnology.

A large and growing portion of the scientific information and investments in genetic engineering are held by private sector mainly in the industrialized world. For public research institutions in Africa to access this information they will need to create strategic links with or to the private companies in the industrialized countries. The second reason has to do with the fact that commercialization of biotechnology is effectively achieved with the participation of private sector. The economic history of public R&D in many parts of the world demonstrates that public agencies have limited capacity to engage in the commercialization of new innovations. They often require private entrepreneurs to take their innovations into the economic domain.

Another good reason is that private biotechnology companies are potential new sources of financial resources for biotechnology R&D in Africa. The historical evolution of biotechnology in such countries as the United States, Germany and Japan vividly demonstrates the role of companies as sources of finance for biotechnology R&D. In Japan biotechnology companies have financed biotechnology R&D through such arrangements as venture capital. In the USA they have provided finances to university departments and scientists to undertake specific research on contract basis. Countries of Africa may wish to explore and exploit financial opportunities associated with partnering with private companies.

Conclusion

The role that modern biotechnology plays in improving food production and agriculture in Africa will continue to be a matter of public debate and academic discourse, at least until countries of the region institute policies that will reduce uncertainty and misunderstanding of benefits and risks of GM products. The debate is likely to intensify as more new GM products are released and commercialised around the world while in Africa food insecurity persists. This paper has argued that for Africa to benefit from the rapid advances scientific and technological advances associated with modern agricultural biotechnology its countries need to build public confidence in the role of the technology and its implications for human development. They required knowledge-based platforms for participatory decision-making and increased investment in scientific development. It is through their own investment in biotechnology R&D that they are able to acquire confidence in the technology and to make informed decisions to manage any risks of GM products.

The paper has suggested a number of actions to build public confidence and scientific capacity in African countries. It has put emphasis on those actions that will improve public

confidence in and understanding of biotechnology, strengthen national science institutions, mobilize and build expertise in new scientific fields of biotechnology, and encourage and strengthen partnerships between public R&D institutions and private biotechnology companies.

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Footnotes

- 1 FAO, 2002.
- 2 We define food insecurity as the lack of access to adequate food to maintain an active healthy life.
- 3 Abramovic (1996) See p. 9.
- 4 Zweiger, G., 2001. *Transducing the Genome: Information, Anarchy, and the Revolution in Biomedical Sciences*, p. xii. McGraw-Hill, New York.
- 5 UNDP, 2001. *Making New Technologies Work for Human Development*, p. 35. United Nations Development Programme, New York.
- 6 James, C. 2001. *Global Review of Commercialized Transgenic Crops: 2001*. International Service for the Acquisition of Agri-Biotech Applications (ISAAA).
- 7 Oehmke, J., Maredia, M. and Weatherspoon, D. 2001. 'The Effects of Biotechnology Policy on Trade and Growth'. *The Estey Centre Journal of International Law and Trade Policy*, Volume 2 Number 2, 2002/p. 284.
- 8 See for example OECD, 1986. *Recombinant DNA Safety Considerations*. Organization for Economic Cooperation and Development, Paris, France, and Rifkin, J. 1983. *Algeny*. Viking Press, New York, USA.
- 9 See for example Paarlberg (2001) and Clark, Stokes and Mugabe (2002)
- 10 See Snow (1963) and Bernal (1969)
- 11 Reference in particular should be made to Task Force 10 on Science, Technology and Innovation, which has now been published (See reference to the Millennium Development Goals Project Task Force 10 Report in the bibliography).
- 12 Wint (2005), p 16 This source provides an impressive and scholarly account of much of the modern governance issues associated with biotechnology and biosafety
- 13 See Glowka et al [11] p. 45.
- 14 Op. cit. p 35.
- 15 See Wint (1995) for a detailed analysis, especially on the UK framework
- 16 Ibid. p. 6.
- 17 Thus formally a distinction is made between "risk" and "uncertainty". In the latter whereas future states of nature are known there is not enough prior knowledge available to determine an exact set of probabilities. In such cases these would be estimated with aid of by "experts", those who were trusted to know the state-of-the-art and could make judgments with authority. This type of technique is sometimes called a Bayesian technique after the scientist who first suggested this statistical approach. See Clark & O'Donnell (1986) for a discussion of the use of Bayesian formulae in relation to Third World science policy decisions.
- 18 Alternatively where investment funds were limited only the high value projects would be sanctioned
- 19 See Thompson (2000) page 24, for a reference to John Stuart Mill in this context.
- 20 Again more rigorously, a distinction should be made between "uncertainty" and "ignorance". In the former future states of nature are known. In the latter they are not, in which case the assigning of objective probabilities becomes impossible. In the case of biotechnology change the level of ignorance is certain to be considerable. We are grateful to Mick Common for pointing out this distinction to us. Clark and Juma (1992) explore these issues in respect of technology more generally.
- 21 See op. cit. p. 25. Thompson also makes reference to Durant, Bauer and Gaskell (1998).
- 22 See p. 6.
- 23 See p. 213
- 24 Ibid. p. 214.
- 25 See also Perrings
- 26 See Tait [10], p. 184.
- 27 See page 30.
- 28 See p. 105. These standards refer to the Codex Alimentarius established in the 1960s by the FAO and WHO Tait and Bruce show that the Codex contains more than 200 standards for foodstuffs and in 1998 membership of the Codex Commission comprised 163 countries representing 97% of the world

- population. They also refer to the Codex web site—www.fao.org/docrep/w911e/
- 29 The term ‘low’ here is used to denote biotechnologies which do not involve any genetic modification or recombination.
- 30 The term ‘modern’ is used to denote biotechnologies which do involve genetic modification.
- 31 See for example Quaim, 1999; Wambugu and Kiome, 2001; Odame et al., 2003a; New Scientist, 2004).
- 32 Approval here refers to the year that the products were approved for importation by the Kenyan regulatory system discussed below.
- 33 There have been several recombinant animal vaccines that have been developed by Kenya and international partners. The first of which (a rinderpest vaccine) received ad-hoc approval for importation by the Department of Veterinary Services in 1995. This approval came before the formation of the national biosafety guidelines and the National Biosafety Committee in 1998 (Traynor and Macharia, 2003). The biosafety guidelines are discussed more below.
- 34 The Agricultural Biotechnology Support Program Part II is a 5-year, \$34 million USAID program to “complement regional and country efforts to develop and commercialize genetically modified (GM) crops” (ABSP II). ABSP is discussed more below.
- 35 HM interview.
- 36 The biosafety regulations also established two Institutional Biosafety Committees (IBCs). These committees are located within the Kenyan Agricultural research Institute (KARI) and within the International Centre for Insect Physiology and Ecology (ICIPE). Biosafety applications must be approved by the relevant IBC before moving on to the NBC.
- 37 The Cartagena Protocol on biodiversity is a protocol that was drafted as a supplementary agreement to the Convention on Biological Diversity of UNEP. It came into force once in 2003 after 50 countries had ratified it.
- 38 The International Centre for Insect Physiology and Ecology (ICIPE), the International Livestock Research Institute (ILRI) and the World Agro-forestry Centre (ICRAF) are all located in Nairobi.
- 39 Interview data.
- 40 Interview data
- 41 It is important to note here that several organisations like ISAAA and ABSF have committed much time and energy to educating decision-makers about biotechnology, including running several workshops for MPs. Turnover in Ministers after the new government was elected in 2002, however, has been an obstacle to raised awareness about biotechnology (MK interview).
- 42 Interview data
- 43 Increasing public awareness is a stated focus of the current revisions of the draft biosafety bill (NCST website) and is stipulated by Article 23 of the Cartagena Protocol.
- 44 The organisations include the Intermediate Technology Development Group, Participatory Ecological Land Use Management, Action Aid and the Kenya Small Scale Farmers Forum.
- 45 The Biosafety Clearing House programme is an “information exchange mechanism established by the Cartagena Protocol on Biosafety” (BCH website).
- 46 Mayet, M. 2000. Scrutinising the Legalities of Genetic Modification in South Africa: Food Safety, Public Participation and the Conservation and Sustainable Use of Biodiversity. Briefing document produced for Biowatch South Africa.
- 47 Visit <http://allafrica.com/stories/200308280241.html>
- 48 Borlaug, N. 2000. ‘Ending World Hunger: The Promise of Biotechnology and the Threat of Antiscience Zealotry’ in *Plant Physiology*, October 2000., Volume 124, p. 490. www.plantphysiol.org

