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**What can biotechnology do for Africa? And how
can the associated risks and uncertainty be
managed?**

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(i) Introduction

This paper has been written as a contribution to the current policy debate about the status of biotechnology for African development. As we move into the 21st century it has become clear that biotechnology is certain to play a key role in economic and social development throughout the world. Already its impact on agriculture, health and the environment has been noted widely in the relevant literature but this is nothing compared to the widely held expectation that this generic technology will revolutionise these and other sectors in the coming decades. However, biotechnology is also a two-edged sword in that its capacity to modify and alter the course of nature raises many questions of ethics and risk. Unless these are resolved its economic potential is certain to be compromised. And for developing countries in particular, therefore, such issues of risk perception and management have great significance. 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.¹

As Essegbey and Stokes (1998) point out 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”.² 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 (Commandeur et al. 1996:3) and has co-evolved with technology development, governance structures and management expertise. 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.”³ The question then is how should they plan to cope with this dilemma in the best interests of development.

This paper addresses the issue in the following way. Section (ii) gives an account of what biotechnology can do for Africa providing a broad canvas of the potential benefits. Section (iii) explores risks associated with biotechnology, giving examples to illustrate the points made. Section (iv) goes on to ask the question “how do scientists account for risks?” Here a distinction is made between those risks that are measurable in some objective fashion on the one hand, and those that are not on the other. The conclusion here is that objective measurement of risk is much less straightforward than perhaps people imagine. Section (v) asks the same question about risks associated with biotechnology, using agriculture as the main focus since health applications are still some way off in Africa. Section (vi) considers implications for public policy while Section (vii) examines briefly the likely impact of sectional interests on policy outcomes. Section (viii) concludes with the simple message that only by building appropriate capacity in African citizens and institutions will its countries be in a reasonable position to harness biotechnology in a truly benefit-enhancing and risk-minimising fashion.

(ii) What can biotechnology do for Africa?

How then has biotechnology impinged on the developing world? Here both the threats and promises are considerable. In agriculture, for example, biotechnology promises the capacity to improve radically rates of growth of primary commodities such as cash crops for export. For example, tissue culture is now being used to promote the production of high value horticulture crops such as cut flowers and vegetables for European markets⁴. Other potential export products

¹ See Glowka et al (1994), p. 45.

² Op. cit. p 35.

³ Essegbey and Stokes, op. cit. p. 6.

⁴ See Clark (2002) for a series of examples of this.

are fine chemicals and cosmetics based on plant genetic resources that are native to many African countries. In the realm of food security also, the potential benefits for many subsistence farmers are likely to be considerable. For example, Wambugu et al. (2000) shows how tissue culture has been used to promote the production of disease-free bananas in East Africa, thus dealing with a major problem of the region. On a more industrial scale new genetically engineered seeds have the potential to substantially increase yields through for example, minimising the influence of poor soils or reducing the impact of harmful pests. One well-known example is that of Bt Maize. This is a form of maize that has been modified with a gene from a bacterium, *Bacillus thuringiensis* (*Bt*), which codes for a toxin against pests such as the Stemborer. This pathogen has had a devastating effect on maize yields in recent years. By incorporating the toxin into the seed itself the pathogen is destroyed as soon as it attempts to invade the young crop.

Sometimes such applications involve inputs from international companies, like for example the Monsanto-CINVESTAV agreement for the transfer of transgenic virus resistant potato technology. CINVESTAV is the acronym for the Centre of Research and Advanced Studies, a Mexican public R&D institute that has actively building plant biotechnology capacity for some years now. Under this arrangement Monsanto transferred a technology that can protect the potato from two major viruses plus relevant training for scientists and the legal rights to exploit that technology in Mexico. For CINVESTAV the advantages were that the arrangement would add to their long-term capacity in this general field rather than lead to immediate benefits for the poor farmer. There are a number of factors here but according to Bustamente (1995) they are mainly concerned with the economics of potato production. For the small farmer the risks associated with normally highly unstable market prices and the high investments typically necessary in this sector (for fertilisers, seed potatoes, insecticides, fungicides and nematocides) make the marginal benefits from this technology very small. And in fact the large production groups in the north of the country have shown the main interest because the technology will improve the profitability of the seed potato sub-sector. However, Commandeur (1996) points out that there are likely longer-term benefits from the technology in that there are now better possibilities to apply the resultant capabilities to areas with more direct applicability to problems of poor farmers.

In health, breakthroughs in the new science of genomics show that resultant biotechnology applications have the potential (through improved diagnostic and therapeutic tools) to reduce considerably the impact of endemic disease. For example, Cuba has now developed a Meningitis B vaccine for which the US, no less, has broken its trade embargo and now permits imports. Similarly India has identified a candidate vaccine for Malaria⁵. A more generic example here is vaccine development which DNA technology is expected to revolutionise in the future. DNA vaccines have only recently started the testing process, but are expected to replace eventually other methods of vaccine production. To state it simply, conventional vaccines are made from either live, weakened pathogen (disease causing agent) or a killed pathogen. Vaccines produced using live pathogens confer greater and longer-lasting immunity than those using killed pathogens, but carry some risk of causing the full-blown disease to develop. DNA vaccines contain only those genes of the pathogen, which produce the antigen and not those used by the pathogen to reproduce itself in host cells. Therefore, DNA vaccines are expected to combine the effectiveness of live vaccines with the comparative safety of those based on killed pathogens. Several preventative and therapeutic vaccines for HIV are currently in early trials. DNA vaccines are likely to be more extensively available to developing countries than conventionally produced vaccines. First, the cost of DNA is low compared to producing weakened live organisms. Second, DNA vaccines are more stable at normal temperatures. Refrigeration costs can take up to 80% of a vaccination programme's budget where conventional vaccines are used in tropical countries

A second case is in disease diagnosis where two key broad areas of modern biotechnology are now used. The first is cell fusion, which involves the production of self-replicating antibodies – Monoclonal Antibodies - for a specific antigen, or disease agent. Monoclonal antibody diagnostic tests have been on the market for several years and are now one of the most profitable areas of commercial biotechnology. These diagnostic tests are actually quite inexpensive to produce, and this presents opportunities for some developing countries to enter the international biotechnology market, and also develop diagnostics for diseases of particular local relevance where these do not yet exist. The second area of biotechnology used for diagnostics is DNA technology. DNA probes, which use isolated segments of DNA to 'attract' complementary gene sequences from pathogens, are already on the market. They are relatively cheap to produce, and are usually

⁵ See Singer and Daar (2001)

more stable in transit and in tropical climates, than conventional diagnostics. DNA diagnostics are likely to grow into a major product area in the future, due to the developments taking place on DNA arrays, which are also known as DNA chips, and micro arrays. Micro arrays allow the detection and analysis of thousands of genes in a single small sample, giving the power of many DNA probes in one small array. Micro array technology is also expected to greatly increase the efficiency of drug discovery, though no drugs have as yet been developed using the technology.⁶

(iii) What are the risks and threats?

On the other hand biotechnology carries with many risks. For example, there are dangers that new synthetic substitutes derived from biotechnology can drive traditional export products out of the market. Already companies based in the North can produce products like pyrethrum and artificial sweeteners without any recourse at all to traditional products and the chances are that this capacity will grow considerably over the coming decades. In addition, concerns have been expressed in recent years regarding the way international seed corporations have begun to dominate agricultural production in many developing countries, for example through using genetically engineered seeds. One of the potential problems is that the novel gene might be unintentionally transferred by pollination to other plants, including weeds and also wild relatives of the crop species. Scientific research has shown that this is technically possible, but the potential long-term impacts this might have are still unclear. There are fears that such transfers could lead to the development of resistant 'super-weeds', loss of genetic diversity within crop species, and possibly even the destabilisation of entire ecosystems. This last concern also emerges from the specific application of *Bt*, where the genetic modification results in toxin being produced directly by the crop. Environmentalists argue that the toxin might unintentionally be taken up by non-targeted organisms, which might destroy populations of benign insect species. There are also issues associated with intellectual property rights and dangers that alternative "non-GMO" solutions to food security may become marginalised simply because the exercise of corporate power closes off such options. Finally there are worries that rapid growth of export-based horticulture may lead to environmental damage.⁷

Again with health applications, however, there are "risks" involved. These are of three types. The first refers to unforeseen dangers associated with technology use. For example in the vaccine case outlined above there are still some uncertainties about the potential for vaccine DNA to 'invade' the host's genome and possibly trigger genes relating to tumour development. There is therefore a great deal of caution surrounding the development of DNA vaccines at this time. The second type of risk relates to ethical issues associated with interference with the fundamental building blocks of life. Here there has been considerable discussion in Europe and North America though not so much in Africa. A good example is where an individual's genetic information may become available to organisations outside the medical profession, including insurance companies and employers. There are therefore concerns about loss of privacy, and genetic discrimination. The third is the bias of related R & D towards so-called "rich country diseases" such as Alzheimer's disease, Huntington's chorea and many types of cancer. Conversely diseases such as AIDS, malaria and tuberculosis that bedevil African populations receive comparatively little research support. Arguably this bias is driven primarily by considerations of profit on the part of the international pharmaceuticals industry.

(iv) How do scientists account for risks?

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

⁶ See Zweiger (2000) for a detailed discussion of many of these techniques.

⁷ For a detailed account of these and many related issues see papers in LEISA (2001)

the likelihood of sub-optimal performance based on past events of a similar nature.⁸ 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 agency).⁹

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 (2000) 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.¹⁰ The first is a systems criticism. The second one 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.¹¹

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.”¹² Tait (2000) 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. Nor did the early attitude of industry help. Tait and Chataway (2000), for example, show how “Monsanto’s response to European calls for a more precautionary approach to

⁸ 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 judgements with authority. This type of technique is sometimes called a Bayesian technique after the scientist who first suggested this statistical approach. See Clark and O’Donnell (1986) for a discussion of the use of Bayesian formulae in relation to Third World science policy decisions.

⁹ Alternatively where investment funds were limited only the high value projects would be sanctioned

¹⁰ See Thompson (2000) page 24, for a reference to John Stuart Mill in this context.

¹¹ 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. Clark and Juma (1992) explore these issues in respect of technology more generally. See Chapters 1 and 9.

¹² See op. cit. p. 25. Thompson also makes reference to Durant, Bauer and Gaskell (1998).

regulation was to mount a campaign of opposition"¹³, including a refusal to countenance "product labelling" as mechanism that might allay public concerns. And though much of the agrobiotechnology 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 they are doing so to great effect not only in Europe but also in many Third World countries.

(v) How can we account for risks in biotechnology?

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.¹⁴

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."¹⁵ 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 Bonds¹⁶ 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

¹³ See p. 6.

¹⁴ See Common (1995) p. 213

¹⁵ Ibid. p. 214.

¹⁶ See also Perrings (1989)

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 (ENGO's)
- Consumer organisations (CNGOs)
- Multinational companies (MNCs)
- Small scale industry (SME'S)
- 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."¹⁷ Again Paarlberg (2000) shows how agricultural and scientific ministries are usually much more promotional to biotechnology than are environmental ministries. And the views of European CNGO's 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).

In a recent IFPRI publication 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 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 MNC's 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 (Paarlberg 2000)¹⁸. 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."¹⁹ In other words the WTO position does not recognise the wider view of risks associated with biotechnology development as outlined above.

(vi) How can Africa manage risk and uncertainty?

How then should African governments proceed with respect to biosafety issues given the promises and threats of modern biotechnology? I suggest that an important necessary condition

¹⁷ See Tait, Op. cit. p. 184.

¹⁸ See Paarlberg (2000), Page 30.

¹⁹ See Tait and Bruce (2001) 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/w9114e/

is the building up capacity to understand biotechnology in all its aspects so that whatever regulatory/promotional regime countries put in place are as fully informed as possible. And it is here that such countries are bound to confront a much more basic issue of S/T policy—the inability of traditional governance structures to fully understand the details of possible technology developments and hence to construct effective plans and policies to promote them safely. For while there are usually well-trained scientists within national laboratory systems who are well able to understand the detailed nature of biotechnology they are often not well connected into decision-making structures at government level. At the same time the degree of “connectivity” between relevant S/T organisations is often not very good either. What this means in practice is that since “innovation systems” are not well developed, mechanisms for relevant governance are hampered by lack of knowledge.²⁰

I would therefore recommend that countries take an approach similar to that recommended by Tait (2001). First of all national governments should recognise explicitly they are dealing with an extremely complex issue for which there are no simple solutions. Certainly they should not assume that they can issue directives from on high and wait for these issues to be obeyed uncritically. Secondly they should begin to encourage dialogue between and among all relevant stakeholders with the aim of clarifying the true nature of the issues and minimising degrees of misunderstanding and confusion. One good example of how this might be done is a recent attempt in Ghana to raise biotechnology awareness through the use of a “stakeholder conference”. In this case a donor-funded project brought together as many interest groups representatives as possible with a view to setting priorities for biotechnology development in Ghana over the medium term.²¹ Led by a policy research organ from a key ministry the project team then went on to conduct research into how well such stated priorities are being met in practice, through an analysis of secondary literature and interviews with individual stakeholder groups. Finally a smaller feedback workshop was arranged at which results were discussed and disseminated. At the same time a newsletter was produced and disseminated as widely as possible so that all groups could feel they were part of this dialogue and could benefit from the resultant exchange of views. It is not difficult to see how the appropriate use of the Internet could enhance and promote such initiatives.

Thirdly, countries need to do more to build up relevant S/T capacities amongst civil servants. As Paarlberg (2000) points out biosafety administrators are prone to err on the side of undue caution if they know that they will be subject to NGO and media criticism. This has certainly been the case in Kenya where the drafting of policies has proceeded much faster than the capacity to administer the resulting decisions. Indeed donors have an important role to play here since they are apparently much readier to fund the drafting of biosafety policies than the building up of necessary implementation capacity. Indeed it is interesting to note that of all countries in the Paarlberg study, it is arguably the one that has done most to build up an independent (of donors) biotechnology capacity (China) that has done most to promote the sensible use of GM crops for development. Fourthly, developing countries need to do more at Higher Education level to provide their scientists with an understanding of the social and economic contexts within which biotechnology is likely to develop. So fundamental is this technology to practically every avenue in modern life, that training the current generation of students solely in narrow areas of relevant disciplines (like molecular genetics, for example), is certain to produce graduates that have great difficulty in providing the necessary advice to policy makers.

All this is not say that progress is not being made. The intense dialogue surrounding the drafting of the Biosafety Protocol to the Biodiversity Convention (signed finally in Cartagena in January 2000) shows that countries can certainly get their act together when it comes to international policy. In this case the big debate took place between two major blocs; the so-called Miami group of countries (Argentina, Australia, Canada, Chile, Uruguay and the USA) and the Like-minded group of developing countries (including Africa) and NGOs. The former group felt they had most to lose in terms of trade and were much less willing to agree to a restrictive protocol than the latter group. It was able to “water down labelling requirements and succeed in that the protocol applies only to LMOs so that no segregation is required for non-living GM organisms”²². However, the very fact that the Like-minded group were unsuccessful here may well reflect their weaker capacity to argue what must have been a complex case at that event. In other words while

²⁰ See for example Clark (2002)

²¹ See Essegbey et al. (2000). The donor in this case was the UK bilateral agency DFID.

²² Tait and Bruce Op. cit. p. 107.

countries such as those in Sub-Saharan Africa, have clearly begun to engage with these issues their capacity to do this in an informed way is still some way short of what is desirable.

(vii) Whose interests are the interest groups serving?

A final point to stress is that policy makers should be made fully aware of the "interests" of different lobbies. To the extent they are not, this then allows different interest groups to exploit a confused situation to try to achieve advantage for this or that position, regardless of the objective situation. Paarlberg, for example, shows how the NGO sector in India has been able to stir up popular feeling against GM technology by playing on fears about the activities of international corporations. And this is despite the fact that in some cases the adoption of GM technology could have beneficial consequences. For example, India's cotton factors are "plagued by bollworms that have become resistant to chemical sprays. Insecticidal Bt cotton presents an alternative method to control bollworms, yet efforts by Monsanto/Mahyco since 1997 to gain biosafety approval----- have repeatedly been slowed by NGO protests. By filing law suits---and by sponsoring physical attacks against field trials, anti-GM activist groups in India have transformed the biosafety approval process into a highly politicised—and at times paralysed--- policy struggle".²³ Thus an activity with clear development and environmental benefits has been stopped by pressure groups that ostensibly are working in the best interests of the environment and development. The issue here is usually about a perceived conflict between commercial and environmental interests though often the conflict may in reality be much less than perceptions would indicate. Policy makers should be aware of these issues and be able to come to sensible judgments on cognate decisions.

Nor are the battles confined to the NGO sector since there are often similar conflicts at government level. For example, environmental ministries often tend to take a fairly negative view about biotechnology whereas ministries of science are usually more sanguine. A good example of this is in Brazil where disagreements between environmental and science ministries have clearly played an important role in slowing down biotechnology development. Another source of conflict may occasionally be the donor community whose ideological biases may be in a negative direction and who may therefore try to prevent or hold up, biotechnology applications. There is some evidence that Kenyan biosafety legislation has been thus influenced by donors whose views may have been so slanted.²⁴ The important point again is that those making national policies in such areas should be aware of these factors and take them into account in policy formulation. And where they feel the lack necessary technical competence to take fully informed decisions, they should know how to commission advice from disinterested expertise.

(viii) Concluding comments

This paper has been written as a contribution to current debates about biotechnology policy in and for Africa. Inevitably it has set out the issue in relatively simple terms and readers are encouraged to consult the cited texts and other sources for more detailed discussion of the issues. However, not only is biotechnology now evolving very rapidly, it is almost certainly going to play a fundamental role in future development policies in both developed and developing countries. It promises immense gains in food security, environmental protection, agriculture, health and industrial production. But it also interferes with living processes in ways, and to degrees that have never occurred before in human history. We simply do not know what the impacts will be, how widely spread and with what effects. Moreover the advent of third generation biotechnology has raised ethical issues that are deeply felt by people and organisations at all levels. All the more reason, therefore, to approach associated public policy analysis with as much dispassion and objectivity as possible. My suggestion is that decision-making in this sphere should not rest solely upon narrow instruments of decision-making as conventionally understood. Instead governments must establish new initiatives, capabilities and institutions that can have a profound effect on legitimacy at a much more fundamental level. Unfortunately there are no standard models here. Each country must establish its own procedures in the light of its own unique circumstances.

But in order to do this sensibly there must be radically increased investment in the associated science base and supportive institutions such as schools, regulatory bodies and government

²³ Op. cit. p. 19

²⁴ Ibid. pp. 15 and 12.

departments. At one level the argument is straightforward. So strategic is biotechnology nowadays that no country can afford to neglect it. However, at a deeper level the issue is by no means clear-cut since it begs the question "what is biotechnology capacity?" Essegbey and Stokes (1998) show that capacity goes well beyond "laboratories plus scientists". Indeed in most African countries shortages of suitably trained scientific manpower in the life sciences may not be the basic issue (though there are of course constraints here, as well as lack of equipment and related laboratory apparatus). What seems to be mainly missing, however, in many cases are the entrepreneurial capabilities, supportive institutions and associated networks needed to translate raw scientific knowledge into economic production.²⁵ It is this systemic competence that determines "biotechnology capacity" and that appears in very short supply.²⁶ Nevertheless the agenda is clear. While African countries should certainly continue to monitor their use of this powerful new technology, their success in so doing will depend on building up the appropriate capacity. The time to start this process is now.

References

Bustamente R R (1995) "An Example of the Transfer of proprietary Technology from the Private Sector to a Developing Country" in D W Altman and K N Watanabe *Plant Biotechnology Transfers to Developing Countries* (Landes; Austin, Texas)

Clark N G (1995) "The Interactive Nature of Knowledge Systems", *Science and Public Policy*, **22** (4) August, pp 249-258.

Clark N G and A T O' Donnell (1986) "Project Analysis and Science Policy Making in Underdeveloped Countries", *Project Appraisal* **1** (1), March, pp. 43-50.

Clark, N., and C. Juma (1991) *Biotechnology for Sustainable Development: Policy Options for Developing Countries* Nairobi: Acts Press.

Clark N G and C Juma (1992), *Long Run Economics*. (London: Pinter), revised edition.

Clark N G (2002) "Innovation Systems, Institutional Change and the New Knowledge Market: Implications for Third World Agricultural Development" *Journal of the Economics of Innovation and New Technologies* **3 & 4** July (forthcoming)

Commandeur, P (1996) "Private-Public Co-operation in Transgenic Virus-Resistant Potatoes", *Biotechnology and Development Monitor*, **No. 28**, September, pp 14-19.

Common M S (1995) *Sustainability and Policy* (Cambridge; Cambridge U P)

Essegbey G & K Stokes (1998) "Building Capacity for Biosafety Policy in Ghana: Issues and Options for Policy-Makers", *Science, Technology and Development*, **16** (2), August.

Essegbey G, G Frempong, K Stokes and C Gbedemah (2000) "National Stakeholders Conference: Priority-Setting for Biotechnology in Agriculture and Health" *Biotech. Ghana* **1** (1), January, pp. 3-4.

Glowka L et al (1994) *A Guide to the Convention on Biological Diversity* Environmental Policy and Law Paper No. 30, IUCN Gland and Cambridge.

²⁵ Mugabe (2002) explores this issue in terms of environmental policy more generally.

²⁶ Clark and Juma (1991) explore this point in some detail arguing that strategic links with carefully chosen types of production is probably a necessary ingredient in building such capacity. And there is an important role for government in helping to create and nurture such links. And as noted above Essegbey and Stokes (1998) come to similar conclusions in their assessment of biotechnology in Ghana. On a scale of technological sophistication they examine the different stages involved, concluding in this case that Ghana has probably reached the stage at which the application of tissue culture techniques is feasible. But it is an open question as to whether real biotechnology "capacity" is yet present.

LEISA (2001) *Magazine on Low External Input and Sustainable Agriculture* Vol 17, No 4, Netherlands, December

Mugabe J (2002) *Scientific and Technological Capacity for Managing the Global Environment*, mimeo, ACTS, Nairobi, March.

Paarlberg R L (2000) *Governing the GM Crop Revolution: Policy Choices for Developing Countries*, IFPRI, Washington DC December.

Perrings C (1989) "Environmental Bonds and Environmental Research in Innovative Activities", *Ecological Economics*, 1: 95-115.

Singer P A and A S Daar (2001) "Harnessing Genomics and Biotechnology to Improve Global Health Equity" *Science*, Vol. 294, October.

Stokes K (1998) "Intellectual Property Rights and the Transfer of Biotechnology to Zimbabwe" *Biopolicy International*, ACTS, Nairobi.

Tait J (2001) "More Faust Than Frankenstein: The European Debate about Risk Regulation for Genetically Modified Crops", *Journal of Risk Research* 4 (2), April, pp 175-189.

Tait J and A Bruce (2001) "Globalisation and Transboundary Risk Regulation: Pesticides and Genetically Modified Crops" *Health, Risk and Society*, Vol. 3, No. 1, pp 99-112.

Tait J and J Chataway (2000) "Technological Foresight and Environmental Protection: Genetically Modified Crops" in Cottam M P, D W Harvey, R P Pape, and J Tait (Eds.) *Foresight and Precaution*, Proceedings of ESREL 2000, SARS and SRA-Europe Annual Conference, Edinburgh, Scotland, 15-17 May, Vol. 2, pp829-838 (Rotterdam, Balkema).

Thompson P (2000) " Food and Agricultural Biotechnology: Ethical Issues behind Research Policy Choices" *IPTS Report No. 50*, JRC Seville, December.

Zweiger G (2001) *Transducing the Genome* (New York, McGraw Hill)