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Strengthening the Enabling Environment for Agricultural Technology Development in Sub-Saharan Africa

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Acronyms

AASCO	Association of American Seed Control Officials
ACAB	USDA Advisory Committee on Agricultural Biotechnology
APHIS	USDA Animal and Plant Health Inspection Service
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASEAN	Association of South East Asian Nations
ATRIP	Africa Trade and Investment Policy (Programme)
BINAS	The Biosafety Information Network and Advisory Service
BIOBIN	A co-operative resource on safety in biotechnology, developed between OECD's BioTrack Online and UNIDO's BINAS
BIO-EARN	East African Regional Programme and Research Network for Biotechnology, Biosafety and Biotechnology Policy Development
CAMBIA	Centre for the Application of Molecular Biology in International Agriculture
CILLS	Interstate Committee for Drought Control in the Sahel
CIPR	Commission on Intellectual Property Rights
DFID	Department for International Development
DGIS	Netherlands Ministry of Foreign Affairs
ECA	Eastern and Central Africa
ECAPAPA	Eastern and Central Africa Programme for Agricultural Policy Analysis
EPA	Environmental Protection Agency (US)
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration (US)
GM (O)	Genetically Modified (Organism)
IBAR	Inter-African Bureau for Animal Resources
ICGEB	International Centre for Genetic Engineering and Biotechnology
IFDC	International Fertilizer Development Center
IP(R)	Intellectual Property (Rights)
ISAAA	International Service for the Acquisition of Agri-biotech Applications
KARI	Kenya Agricultural Research Insitute
MNC	multinational corporation
NARI	National Agricultural Research Institutes
NGO	Non Governmental Organisation
NPV	Nucleopolyhedrovirus
OAU	Organization of African Unity
OECD	Organisation for Economic Cooperation and Development
PBR	Plant Breeders Rights
PIC	Prior Informed Consent
QDS	Quality Declared Seed
REDSO	Regional Economic Development Services Office
RUSSL	Recommended Uniform State Seed Law
SADC	Southern African Development Community
SPAAR	Special Program for African Agricultural Research
SSASI	Sub-Saharan Africa Seed Initiative
TRIP	Trade-Related Intellectual Property Rights
UNEP (GEF)	United Nations Environment Programme (Global Environment Facility)
UNIDO	United Nations Industrial Development Organization
UPOV	International Union for the Protection of New Varieties of Plants
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WTO	World Trade Organisation

Summary

Introduction

Agricultural technology must play a key role in Africa's economic development. In this paper agricultural technology development is seen as including innovation, diffusion and utilisation. It is particularly concerned with the enabling environment for technology development, specifically the policies and regulations that affect input availability, the interactions of the private sector with public agricultural research, and agricultural enterprise development. The paper examines the current status and future prospects for these aspects of the enabling environment. The analysis pays particular attention to current and potential donor roles for contributing to the evolution of a supportive enabling environment in sub-Saharan Africa.

The aspects of the enabling environment that form the basis of this analysis are all examples of market failure. These include: (a) the failure of private markets to produce optimum levels of public goods, such as agricultural research; (b) the externalities of technology use that call for regulatory frameworks, such as biosafety; (c) the role of intellectual property protection in providing incentives for biological innovation; and (d) the market weaknesses in developing countries that lead to high transaction costs in searching for information, and structuring and enforcing contracts.

These failures call for public investment in research, regulation and institutional development to foster enterprise development. Hence the focus of this analysis includes the roles of public agricultural research and regulation and the development of market mechanisms supporting agricultural enterprises. In many cases it is the interaction among these three areas that receives primary attention.

The analysis looks at two types of technology (plant breeding and other agricultural inputs) and two aspects of technology access and utilisation (intellectual property protection and biosafety).

Plant breeding technology

This section explores the aspects of seed regulation that currently limit the diffusion of new crop varieties. It examines links between public plant breeding and private seed enterprise, looking briefly at challenges for private participation in innovations in tissue culture and agroforestry research.

The regulation of variety release affects the availability of new technology to farmers. Variety release procedures in many African countries still leave much to be desired, although there has been progress in a few individual countries. More notably, there have been moves towards regional harmonisation of variety release. Most progress has been made in Eastern Africa; there have been some initial studies and meetings in Southern Africa and some discussions in West Africa. Much remains to be done in structuring variety release procedures that facilitate technology diffusion and promote regional seed trade.

Seed certification also deserves attention. Most countries in the region still insist on mandatory certification (or at least seed testing) for major staples, even though public regulatory capacity is rarely adequate to manage this. The regional harmonisation initiatives have made more progress on variety release than on certification, and there is little indication that national regulatory authorities are moving towards more flexible arrangements. On the other hand, there is a realisation that much of the certification responsibility will need to be passed to the commercial seed sector (e.g. through

licensing), but progress is slow. Of at least equal importance, there is a need to shift regulatory attention towards point-of-sale inspections, consumer education, and mechanisms to promote company reputations.

As systems of plant variety protection become established, National Agricultural Research Institutes (NARIs) have the opportunity to protect their germplasm, to earn royalties, and to use the private sector to promote publicly-developed varieties. NARIs need advice on how to take advantage of IPR legislation; how to negotiate royalties and licenses for their germplasm; how to recognise when protection is not a good idea; and perhaps most important, how to take better advantage of the emergence of the private seed industry in order to ensure a broader diffusion and uptake of public varieties.

There are other innovations related to plant breeding that have important implications for agricultural enterprise. Tissue culture is one example, where innovative commercial links between a central laboratory and farmer clients need to be established. A similar argument can be made for promoting innovations in agroforestry. The promotion of species that are useful for soil fertility maintenance and other on-farm and commercial applications is a challenge because their seed production is often difficult. The issue of identifying the most appropriate type of nursery arrangement for seed and seedling access is a key to promoting agroforestry.

Other inputs

This section explores issues concerning other types of agricultural inputs, including fertiliser, pesticides, and alternative pest control technologies. It looks at marketing and regulatory concerns for these inputs and addresses the organisation of input marketing, including the distribution of veterinary products.

Fertiliser is a key input for African agriculture. The liberalisation of fertiliser markets has met with mixed success and the development of private marketing capacity has been slower than expected. In addition, government interference in fertiliser markets has slowed the development of private sector interest. Several types of assistance would seem to be indicated. Better organisation and information for fertiliser dealers is required; public research needs increased links with dealers; and more attention is required for consumer education and protection.

Many African countries give relatively little attention to pesticide regulation. The vast majority of the products are imported, and although a government may decide to ban particularly dangerous products it will rarely have the resources to enforce such a decision. The regulatory situation at the national level is far from adequate. A study showed that 80% of developing countries did not have the capability to manage the distribution and use of pesticides to conform to the 1990 FAO International Code of Conduct. With increasing liberalisation there is a wider range of private sector participation in pesticide markets. This is not necessarily a good thing, as many of those selling pesticides, particularly in the informal market, have no capacity to provide information about safe usage. There is thus an urgent need for strengthening regulatory capacity.

The significant environmental and public health problems entailed by excessive use of chemical pesticides have led to a search for alternative products. We will refer to these as ‘biopesticides’. Some of these products offer opportunities for more environmentally-sound technology, often linked to local enterprise development. They also face regulatory and policy hurdles that deserve attention. Most governments have little experience in knowing how to regulate these products, and their environmental specificity means that per-unit registration costs may be high unless efficient regulatory mechanisms are established. In addition, significant quality control requirements mean

that care must be given to choosing the optimum level of local enterprise (i.e. beyond cottage industry).

In general, there are several weaknesses in the African agricultural input marketing sector that require attention. These include support for developing the skills and capacities of input dealers and fostering the emergence of dealer and producer associations.

An important area related to agricultural input distribution is the provision of veterinary services, particularly the issue of pharmaceutical sale. There are reasons for the public sector to maintain a role in the veterinary sector, but the examples of recent experiments in innovative service provision need to be expanded. There are important opportunities for developing more supportive regulations in the veterinary sector, promoting more responsive provision of veterinary pharmaceuticals, and developing the reputations and professional standing of service providers.

Intellectual property rights

All members of the WTO are required to provide a plant variety protection system that allows plant breeders to control the use of their varieties. Most countries in the region are developing legislation of this type, but a number of uncertainties remain. Despite these uncertainties, there are several useful contributions that might be made. Regional harmonisation will help stimulate trade. In addition, countries may need assistance in seeing that legislation is implemented and enforced in such a way that it stimulates seed system development. There will be need for advice to NARIs in helping them negotiate with seed companies, and to national seed companies in ensuring that their rights are protected.

Intellectual property considerations also affect access to biotechnology. The interface between public and private research deserves particular attention. Mechanisms need to be developed that allow public researchers to access protected technology through licenses, exchange or donation. National Intellectual Property (IP) management capacities need to be strengthened so that NARIs can take better advantage of their own resources in biotechnology and enter into productive agreements with commercial firms.

Biosafety

The introduction of transgenic crops requires the development of national biosafety capacity. This is a difficult challenge because biosafety protocols are evolving, even in industrialised countries, institutional responsibilities for biosafety need to be defined, and significant investment in human resources is required. Only a few countries in sub-Saharan Africa have made significant progress in biosafety, although there are a number of projects and facilities that offer assistance and training.

The Cartegena Protocol on Biosafety (under the Convention on Biological Diversity) allows a country to ban the import of a genetically modified organism (GMO) if it is uncertain of its effects. Uncertainties about trade in GMOs have important implications for biotechnology development in Africa. If strict limitations and segregation of GM produce become a permanent feature of world trade, this will be a disincentive to developing locally adapted GM technology.

Ways forward

There are significant opportunities for more donor input and co-ordination to support a strengthening of the enabling environment. But a number of weaknesses in current donor strategies must be corrected:

- project-based interventions are short-lived and are unable to provide the long-term follow-up required for institution building;
- project-based interventions do not allow institutional growth and evolution;
- a donor's projects are often poorly co-ordinated with other donors' activities;
- donor activities in a country may not always be internally consistent;
- donor activities at the country level have a very limited concept of institution building;
- there are few examples of an integrated approach that acknowledges the complimentary roles of regulation, enterprise development, and support to public research;
- projects rarely include an interface between regulatory reform at the country level and regional harmonisation activities;
- there are few examples where a donor invests in synthesising or applying experience in one region or country to work in another region.

The implications for structuring relevant interventions (that take account of a longer time frame, involve greater co-ordination, and feature broader scope) are more organisational than financial. The level of resources to be devoted to support for strengthening the enabling environment is not necessarily very high, but the organisation of that support is outside of normal donor project protocols. The requirements include a longer commitment; a greater willingness to survey and interact with other initiatives; and a significant level of technical expertise.

There are a number of activities that could be carried out by a donor or group of donors to strengthen the enabling environment. These ideas could be piloted in a few countries in order to gain experience and test the effectiveness of the approach.

Some of the activities would involve co-ordination, such as the establishment of a forum to monitor and assess the status and opportunities of the enabling environment. The forum could be initiated on a very modest basis and would include donor representatives and senior policymakers.

Regional activities could include more attention to regulatory harmonisation, establishing regional regulatory authorities (in selected cases), and improving the links between agricultural research networks, on the one hand, and regulatory and enterprise development activities, on the other.

There is also a wide range of country-level activities that could be promoted, including the support of national regulatory reform, re-orientation of regulation towards consumer education and protection, and supporting local agricultural enterprise development.

Conclusion

The paper makes a case for institution building related to the enabling environment for agricultural enterprise in sub-Saharan Africa. The focus is on a long-term, co-ordinated effort to promote the evolution of local institutions. These include formal regulations and laws, but at least as important are the informal rules, operating procedures and mechanisms of trust that allow the development of agricultural enterprise. This is a particular challenge for conventional donor assistance because it depends on neither large injections of funds nor on the development of time-bound projects. Instead, it requires a commitment to long-term monitoring and support, the co-ordination of donor activities with national policy formation, and the ability to offer modest, targeted input at the appropriate time and place.

1 Introduction

This paper is concerned with the role of the enabling environment in agricultural technology development and diffusion in sub-Saharan Africa. Those aspects of the enabling environment that receive particular attention are the policies and regulations affecting input availability, the interactions of public agricultural research with the private sector, and the institutions of agricultural enterprise development. The paper's view of technology development includes the entire process from innovation to diffusion and utilisation.

Whilst acknowledging that economic development in sub-Saharan Africa is a complex process, the paper rests on the assumption that agricultural technology must be a key part of any solution. Approximately two-thirds of the region's population reside in rural areas and a high proportion of them engage in farming. Yet sub-Saharan Africa is the only region in the world where per capita agricultural production has fallen in the latter part of the 20th century. It is also the only region where both the number and proportion of malnourished children are expected to rise in the next two decades. Widespread and sustainable increases in agricultural productivity are essential to Africa's economic growth.

Much of the responsibility for structuring the enabling environment for agricultural technology development rests with national governments. They provide laws and procedures that set the course for enterprise development, establish regulatory frameworks, and provide support for public activities such as agricultural research and extension. The paper examines the current status and future prospects for these aspects of the enabling environment, paying particular attention to current and potential donor roles for contributing to the evolution of a supportive enabling environment.

The remainder of this section of the paper examines the concept of the enabling environment, reviews the instances of market failure that must be addressed by an enabling environment, and introduces the focal points (regulatory frameworks, public agricultural research, and enterprise development) and the technologies to be discussed. The next four sections provide reviews of current efforts and remaining deficiencies in the enabling environment related to technology development and access. Section 2 is devoted to technology focused on plant breeding and Section 3 looks at other inputs, particularly fertiliser, chemical pesticides and biopesticides. The following two sections on technology access review the status of intellectual property protection for agricultural technology (Section 4) and progress in establishing the biosafety standards required for the use of biotechnology (Section 5). The paper concludes by drawing implications for possible donor contributions to strengthening the enabling environment for agricultural technology generation and diffusion in sub-Saharan Africa (Section 6) and presents conclusions (Section 7).

1.1 The enabling environment

This paper is based on the premise that technological change contributes to development. In reviewing the history of the relationship between technology and economic growth, Mokyr (1990: 148) concludes that technological change 'accounted for *sustained* growth. It was not caused by economic growth, it caused it. It had no substitutes'. However, any technology development takes place within an enabling environment. In its broadest sense, the enabling environment is similar to what Davis and North (1971:6) describe as the institutional environment, a 'set of fundamental political, social and legal ground rules that establishes the basis for production, exchange and distribution'.

In the present case, we are particularly interested in the government contribution to the enabling environment. In his search for factors that encourage technology generation, Mokyr finds ambivalent evidence regarding government roles. On the one hand, he concludes that 'the weaker the government, the better it is for innovation' (1990:180). But on the other hand, he acknowledges that 'the free market system left on its own is unlikely to produce a desirable level of innovation…Governments enforce the rules by which the game of innovation is played, and they often set them as well' (ibid:181). The dilemma is summarised by North (1990:58): 'If we cannot do without the state, we cannot do with it either. How does one get the state to behave like an impartial third party'? Structuring an enabling environment to support technology generation is one of the greatest challenges for economic development.

It is not possible to address directly all of the potential elements that might be included in the enabling environment. But there are a number of factors, particularly related to policies and regulations, that impinge directly on agricultural technology generation and that are amenable to intervention. Moreover, it is possible to consider a relatively co-ordinated approach to these areas. Such an approach would not see the enabling environment as abstract policies and regulations, but rather as a set of institutions that evolve and develop. Just as support for technology development involves a collection of practical steps, many efforts to improve the enabling environment involve on-the-ground engagement with national and regional organisations (public and private) to strengthen local capacities. This paper attempts to identify some of the most important barriers to agricultural technology development in the enabling environment, concentrating on sub-Saharan Africa.[1] It suggests areas in which a more concerted donor strategy could support useful change.

1.2 Market failure

Markets stimulate and take advantage of new technology, but by themselves they are often inadequate to support the process of technology development. This analysis focuses on areas of market failure that affect the possibilities for the development of agricultural technology. Our definition of market failure includes areas that require public support or regulatory frameworks, as well as areas that require interventions to lower the transaction costs that cause private markets to perform poorly.

Market failure is often associated with the fact that private markets are not able to provide the optimum level of certain types of goods, thus justifying public or collective action. A good example is agricultural research, especially research that leads to information or techniques that are not excludable, or produces outputs that have higher social than private benefits.

A second example of market failure arises from externalities of technology use. There are several negative externalities occasioned by the improper use of agricultural technologies. For this reason, regulatory frameworks are needed in areas such as phytosanitary control in the use of plant varieties, control of dangerous pesticides, and biosafety protocols for transgenic crops.

A third example of market failure related to agricultural technology is the lack of incentives for developing biological innovations (such as crop varieties) that can be freely reproduced. For this reason, various types of plant variety protection and patenting (e.g. for biotechnology processes) are emerging, and it is important to identify appropriate levels and management for these regimes in developing countries.

1 The issues are similar for other developing regions. Based on an analysis of private investment in agricultural technology in Asia, Pray and Fuglie (2002) point to the importance of eliminating public monopolies, allowing private participation, fostering public-private complementarities, and paying attention to the regulatory environment.

These examples of market failure are found universally, not just in developing economies. They justify attention to the organisation and support of public agricultural research, the development of supportive regulatory frameworks, and the design of appropriate IP regimes.

In addition, there are many market weaknesses that limit private agricultural technology provision. Although also universal, their incidence and severity is particularly problematic in developing countries. There are various ways of characterising such weaknesses, but many can be related to the concept of transaction costs, which includes the following categories (Dahlman, 1979):

- Search and information costs. Examples related to agricultural technology include farmers' uncertainties about the performance of new technology that appears in the market, input dealers' lack of knowledge about the most appropriate products, and enterprises' uncertainties about the interpretation of regulations governing sale or export.
- Bargaining and decision costs. Examples include input dealers' uncertainties about the most efficient source of supply, enterprises' uncertainties about the size of local or regional markets, and research organisation's lack of experience in acquiring protected technology and marketing their own innovations.
- Policing and enforcement costs. These include farmers' uncertainties about their rights as input consumers, poor quality control by inexperienced enterprises, and the lack of regulatory presence at the point of input sale.

Some of these market weaknesses justify the establishment of regulatory systems that provide greater confidence in the market. But many are best addressed by strengthening the commercial institutions that provide information and enforce contracts through what can be described as self-regulation.

In summary, there are market failures that call for public investment in research and regulation, and market weaknesses characterised by high transaction costs that call for institutional development to foster the emergence of agricultural enterprises.

1.3 Focal areas

Our analysis will suggest that there are steps that can be taken to address these market failures and to ameliorate some of the more important market weaknesses. The appropriate focus for intervention may be a regulatory body, an enterprise or group of enterprises, or a public research organisation. In many instances the appropriate intervention will involve several of these entities simultaneously, emphasising that agricultural technology development depends to a considerable extent on effective links among regulation, private enterprise, and research.

Regulation is best seen as a response to inadequacies in information provision. If markets are unable to provide buyers and sellers with sufficient information on which to base judgements, regulation may be called for. Regulation is often based on legislation, but it usually entails a degree of monitoring and oversight that calls for special boards or other agencies. Although most regulation is done by government bodies, both public and private regulatory agencies are relevant. In addition, the development of private enterprise reputations (and consumer organisation) can foster self-regulation that obviates the need for third-party intervention (Klein and Leffler, 1981). It is thus important that any discussion of regulation includes the roles of producers and consumers, as well as regulatory agencies. It is also important that the concepts of 'deregulation' and 'privatisation' not be confused; a liberalised economy does not necessarily mean less regulation (Ayres and Braithwaite, 1992). This paper examines the performance of national regulatory agencies and considers the potential of regulatory reform, regional regulatory harmonisation and the responsibilities of technology producers and consumers in addressing the information deficiencies

associated with regulation. It also examines the related areas of intellectual property protection and biosafety.

Public agricultural research is often presented as an example of a public good. Although private agricultural technology development has been important for some time, and the emergence of fields such as biotechnology has emphasised its growing role, public research remains essential. A recent review of the challenges of agricultural sustainability and growing food demand underlines the roles of public and private research (Tilman et al, 2002). Despite the dominant position of the private sector in US biotechnology, a recent USDA review recommended a doubling in the level of support to domestic public plant breeding programmes (ACAB, 2002). The challenge for African agricultural research is particularly acute. National agricultural research institutes (NARIs) not only face a decline in government and donor support, they also must accommodate a diversification of the types of organisations involved in research, learn how to interact with the private sector, and accept new funding mechanisms that provide better incentives for performance (Byerlee, 1998). This review considers the roles of NARIs and the regional and international networks in which they participate. Although technology generation *per se* is not within the scope of this examination of the enabling environment, we examine how NARIs can take advantage of changes in regulatory frameworks and agricultural enterprise development.

The third focal area for our review is agricultural enterprise. The principal goal is to develop mechanisms that elicit increased private sector participation in the development and diffusion of pro-poor agricultural technology. In some cases the technology may be the property of MNCs, and an adequate enabling environment is essential for ensuring that such technology can be utilised by NARIs or delivered directly to farmers. In addition, there is a growing realisation that the delivery of both private and public agricultural technology depends to a large extent on the capacities of the local private sector. This includes private seed companies (that may do some of their own plant breeding); entrepreneurs that may work with the outputs of public research (such as biopesticides or tissue culture) to produce private products; and the various types of importers, input dealers, nurseries and other intermediaries who deliver technology to farmers.

The following analysis encourages an approach that includes investment in selected actions at the national level in strengthening regulatory frameworks, agricultural enterprise and national research capacities, depending on donor priorities and individual country interests and receptivity. It also encourages investment in regional processes such as regulatory harmonisation, commercial associations and research networks. A possible unifying concept for the three focal areas is a broad conception of regulation that includes the responsibilities of technology providers and consumers in ensuring effective information flow. This view of regulation emphasises the primacy of institution building in order to develop local capacities to debate and structure regulatory frameworks, foster trustworthy and competent agricultural enterprises, and link public research to commercial agricultural development.

1.4 Technology

The following sections of the paper examine areas of the enabling environment that are of concern for agricultural technology development. Two of the sections address specific types of technology. The section on plant breeding looks at the challenges of establishing adequate seed regulatory frameworks, interactions between NARIs and local seed companies, and entrepreneurial opportunities for related technologies such as tissue culture and agroforestry. The following section reviews other agricultural inputs, including marketing and regulatory issues related to fertiliser, chemical pesticides, and alternative pest control products. The next two sections examine issues that limit access and utilisation for new technology; one discusses the current state of play in IP for agriculture and the other examines the emerging area of biosafety.

2 Plant Breeding Technology

New crop varieties are one of the most accessible types of agricultural technology for resource-poor farmers. It is to be expected that a major contribution of increased private sector investment in pro-poor agricultural technology will be through the seed industry, including both traditional plant breeding and biotechnology. This section examines the aspects of seed regulation that currently limit the diffusion of new crop varieties. It also examines links between public plant breeding and private seed enterprise; and looks briefly at challenges for private participation in innovations in tissue culture and agroforestry research.

2.1 An introduction to seed regulation

It is important to evaluate any regulatory barriers that might impede the development and diffusion of new plant varieties. Any crop variety (conventional or transgenic) must conform to national regulations regarding variety release and registration, whilst seed sale is governed by seed quality and certification regulations. In much of sub-Saharan Africa, until recently, seed regulatory frameworks have been structured in support of national public plant breeding institutes and national (often parastatal) seed companies. Under these frameworks, the introduction of foreign or private sector varieties was difficult. However, many countries have seen significant changes in their seed regulatory frameworks in recent years, in response to pressures of liberalisation that encouraged a diversification of the seed sector and made further cuts in chronically inadequate regulatory budgets. Although the situation is still in flux it is important to assess the implications and challenges for private technology development.

2.2 Variety release and registration

In some countries in the region there has been a move towards making variety release more efficient. In Zambia, for instance, there is a transparent approval process that involves two years of testing. Any organisation may enter its varieties, on payment of a fee. Variety release systems in Kenya and Uganda have recently been streamlined, and private sector entries are permitted. However, most countries still face questions regarding what type of variety approval process is required, how it should be funded, how it can keep clearly inadequate varieties off the market, and how at the same time to stimulate plant breeding to address the varied conditions of the region's farmers.

The process of variety release will be much more efficient if there is regional harmonisation of regulations. This will allow varieties approved in one country easy access to neighbouring countries and will stimulate seed trade, especially in instances where individual national markets are not large enough to generate sufficient demand. There are several instances of movement in this direction.

In Eastern and Central Africa (ECA), a major effort at seed regulatory reform was initiated through the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) and funded by USAID/REDSO in the project, 'Harmonisation of seed policies and regulations in Eastern Africa' (ASARECA 2000). The first phase concentrated on Kenya, Tanzania and Uganda. After initial country-level activities and workshops, a regional workshop was held in April 2000 and a number of changes were approved. The most important progress was achieved in the area of variety evaluation, including:

- public and private breeders may test their varieties anywhere in the region and then enter them in national variety performance trials;

- the mandatory variety performance trial sequence was reduced from three seasons to one season;
- the composition and procedures of national variety release committees were standardised;
- various institutions, including seed companies, can be accredited to carry out performance trials;
- a common variety catalogue will be produced for the region.

These changes imply an improvement in the efficiency of variety release and acceptance of a significant role for the private sector. In most cases the changes must still be instituted at the national level, but there is every expectation of further progress. There are plans to extend the harmonisation effort to other countries in ECA (Burundi, Eritrea, Ethiopia, Rwanda and Sudan) and USAID/REDSO has committed resources to this effort until 2006.

Efforts toward seed regulatory harmonisation in Southern Africa have been promoted as part of the Sub-Saharan Africa Seed Initiative (SSASI), co-ordinated by the World Bank. A sub-regional action plan for Southern Africa is part of SSASI and includes Malawi, Mozambique, Zambia and Zimbabwe. Status and Opportunity Reports were produced for the four countries, leading to a regional workshop in September 2001 (SSASI, 2001). The workshop endorsed a number of recommendations. Among those of most relevance for variety release are:

- guidelines should be developed at the national level defining the amount of data required for variety registration, and official variety testing can proceed whilst the new variety is marketed;
- a sub-regional group should be established to consider harmonised variety registration;
- NARIs should place more emphasis on links with the commercial seed sector;
- technical consultations should be held to consider the possibility of regional variety releases, based on agro-ecological zoning.

It should be noted that these are only recommendations with no binding follow-up, thus the move towards harmonisation is more tentative than in ECA. However, the recommendations include consideration of the interesting innovation of regional variety release. There is little current activity on SSASI, but a number of donors have contributed to initial activities of a Southern Africa Seed Security Network, under SADC, which would include regulatory reform and harmonisation in its mandate; long-term funding and modalities have not been established.

There appears to be less activity in this area in West Africa. There have been meetings regarding harmonisation of seed and fertiliser regulations through a project (ATRIP) organised by IFDC, African Seed Trade Association and USDA (K.Debrah, pers. comm.). More activity is planned in this area.

2.3 Seed certification

Seed certification involves the assurance of the genetic identity and purity of seed offered for sale, and also usually includes tests for physical quality. Seed certification may be mandatory or voluntary, and may be carried out by public or private agencies. In those countries where certification is voluntary, minimum standards for truthful labelling are usually defined and the major responsibility for quality control is left to the seed companies. In most sub-Saharan African countries, seed certification is mandatory for major food crops. Malawi recently removed most food crops (except hybrid maize) from mandatory certification, but still insists that all commercial food crop seed be tested for physical purity and germination. Zambia only maintains mandatory certification for hybrids (maize and sunflower) and potatoes.

Although most countries insist on mandatory certification (or at least seed testing) there is widespread realisation that public resources are inadequate for this task. This imbalance is not always obvious because of the low level of commercial seed production in most countries, but there are a number of moves towards allowing the licensing of seed companies to do their own certification. In Zambia, formal certification for most crops has been replaced by a Quality Declared Seed (QDS) scheme that puts increased responsibility on the seed producer and reduces external involvement to a system of spot checks.

The regional harmonisation initiatives (described in the preceding section) also consider changes in seed certification, but in general have made less progress than with variety registration. In the case of ECA, the workshop identified common definitions, classes, and standards for the certification of major crops; agreed that seed companies could be accredited to carry out certification; and promoted the idea of an interagency certification scheme to facilitate cross-border seed trade. Although these changes will help rationalise seed certification, most of them require further work and none move in the direction of voluntary certification. In the Southern Africa case, the workshop urged consideration of standardised certification protocols and endorsed the pursuit of cross-border seed trade, but gave no indication of interest in relinquishing mandatory certification.

A particularly important challenge which has yet to be tackled on the regional or national level is the fact that the majority of seed quality problems have their origin closer to the point of sale, rather than with the seed producer. This is related to improper storage, handling or transportation; or fraudulent practices by distributors or dealers. National regulatory management and enforcement is rarely adequate to deal with this, and hence farmers are in fact not adequately protected by the current regulatory framework. There is a need to shift regulatory inspection resources from upstream activities to point-of-sale presence (Tripp and Rohrbach, 2001).

2.4 Seed regulation: summary

More effort is needed at reforming seed regulatory frameworks to support the growth and diversification of the private seed market. Companies need the assurance that any new variety will receive a fair and efficient review and that seed sale will not be hampered by bureaucratic or under-funded quality control mechanisms. Part of the answer is to pursue the regional harmonisation initiatives that are in progress, by broadening their scope and participation.[2] But this must be accompanied by country-level activities and concomitant work with seed producers to strengthen their reputations and their capacities in quality control.

2.5 The interactions of NARIs with local seed companies

As systems of plant variety protection become established, NARIs have the opportunity to protect their germplasm, to earn royalties, and to use the private sector to promote publicly-developed varieties. NARIs need advice on how to take advantage of IPR legislation; how to negotiate royalties and licenses for their germplasm; how to recognise when protection is *not* a good idea; and perhaps most important, how to take better advantage of the emergence of the private seed industry in order to ensure a broader diffusion and uptake of public varieties. The SADC Regional Seed Sector Stakeholder Workshop (SSASI, 2001) recommended that each NARI appoint a 'seed manager' to be responsible for the marketing and promotion of germplasm to the private sector.

2 Seed regulatory harmonisation is not only an issue for Africa. A Recommended Uniform State Seed Law (RUSSL) is being promoted in the US by the Association of American Seed Control Officials (AASCO) in order to rationalise the array of individual state-level seed regulations currently in force.

There is also a need to strengthen the capacities of input dealers who are responsible for marketing seed (see section 3.4 below).

There is much to be learned on both sides. NARIs need to learn how to negotiate, whether to award exclusive access, what the limits of demand are, and how to preserve a pro-poor stance for technology diffusion. The private seed companies certainly have greater potential for delivering products than the parastatals or any other alternatives. But many of these private firms are not necessarily as skilled as some would believe when it comes to identifying potential markets or understanding farmers' needs.

Section 4.1(on plant breeders' rights) provides further discussion on the relationship between NARIs and seed companies.

2.6 New commercial enterprises for germplasm diffusion

There are other technological innovations related to plant breeding that also deserve attention in relation to agricultural entrepreneurship. Tissue culture is a good example. Although these techniques may be developed by public research, their application is best done by commercial firms, as is happening in Kenya for the production of tissue culture banana plantlets (Wambugu and Kiome, 2001).

Tissue culture is also a good example of an innovation that requires farmers to learn new management, and to recognise the appropriate inputs. What is the best way to deliver this information? Although the technology may be produced by a commercial, centralised laboratory, other kinds of intermediary are necessary to deliver these products to farmers at the local level. It is possible to imagine the development of small local commercial nurseries that develop reputations among farmers and serve a critical role in ensuring quality control. Donors often make the mistake of promoting village-level enterprise at too low a level (Tripp, 2001), but further exploration is required to understand what type of local intermediary is appropriate.[3]

A similar argument can be made for promoting innovations in agroforestry. The promotion of species that are useful for soil fertility maintenance and other on-farm and commercial applications is a challenge because their seed production is often difficult. The issue of identifying the most appropriate type of nursery arrangement for seed and seedling access is a key to promoting agroforestry (Franzel et al, 2002).

The fine balance between public and private domains characteristic of plant breeding is also evident in crop management technology. There is a necessity to take advantage of public research skills and motivations in technology development, on the one hand, while continuously searching for ways to transfer delivery, and ultimately research, to the private sector. Relevant examples include the opportunities for small-scale commercial development in biopesticides (discussed below) and agricultural machinery (Douthwaite, 2002).

Although much of this technology is not eligible for patenting or other protection, there are important opportunities for developing local enterprises. Careful management is required to develop productive public-private links (Byerlee and Alex, 1998:26). The incentives for doing the public research need to be sufficient to outweigh the fact that the commercial gain for the innovations will go mostly to the private sector. In some cases public researchers may decide to 'go private', or public researchers can earn consulting fees. In any case, relations need to be structured that elicit pro-poor research and good commercial follow-through and distribution.

3 Many US seed companies have relied on local 'farmer-dealers' to market their products, rather than larger commercial outlets (that sell, for instance, farm machinery).

3 Other Inputs

The previous section concentrated on issues relevant to seed-related technology. This section explores issues concerning other types of agricultural inputs, including fertiliser, pesticides, and alternative pest control technologies. It also looks briefly at the issue of commercial input distribution. There are relatively few opportunities for local technology development in chemical fertiliser and pesticide, but it is important to examine the policies and regulations that determine farmers' access to these products. Alternative pest control methods, on the other hand, may offer attractive opportunities for stimulating indigenous pro-poor commercial technology development. This section looks at marketing and regulatory concerns for fertiliser, chemical pesticides and biopesticides. It also addresses the organisation of input marketing, including the distribution of veterinary products.

3.1 Fertiliser

Chemical fertiliser is a relevant input for most African farmers. The major issues are not related to product development but rather involve affordable access and crop management research that helps farmers efficiently integrate the use of chemical fertiliser in a broader soil fertility management strategy.

Until the late 1980s, much of the fertiliser used in sub-Saharan Africa was subject to government procurement, distribution and subsidies. Liberalisation and structural adjustment have caused most governments to relinquish the major role in fertiliser provision, with mixed results. In most cases, the prices that farmers pay for fertiliser have risen, often leading to a decline in fertiliser use. On the other hand, private fertiliser distribution capacity has begun to develop, although a number of problems are evident.

More than a decade ago Shepherd (1989) warned that the liberalisation of fertiliser markets would not lead automatically to an effective private sector response. Fertiliser is a bulky input with seasonal demand, requiring considerable storage and transportation capacity, and with high financial requirements. It has not proven overwhelmingly attractive for entrepreneurs. In many countries there was an initial blossoming of activity and then a fairly drastic retrenchment and concentration, as many people found that the fertiliser business was more difficult than they expected. Debrah (2000) expresses concern about the emergence of a private sector oligopoly in fertiliser supply. Results of liberalisation have been mixed. Reports from Kenya are fairly positive (Omamo and Mose, 2001; Freeman and Omiti, 2002), with a significant growth in fertiliser retailers and evidence that fertiliser is reaching farmers in more marginal areas than previously. One of the innovations is the strategy to market fertiliser in smaller pack sizes. On the other hand, the removal of subsidies has often resulted in lower demand; fertiliser consumption in Cameroon dropped by 25% in the decade following the removal of subsidies (Debrah, 2000).

Fertiliser dealers in sub-Saharan Africa face several policy-related problems. First, although fertiliser is theoretically out of government hands, it remains an attractive temptation for intervention. Debrah (2000) gives details of recent policy vacillation in Nigeria and Togo that moved the government in and out of the fertiliser market, causing great uncertainty for the private sector. Pletcher (2000) shows how the Zambian government and its donors have never really left fertiliser provision to the private sector. Jayne et al (2002) discuss the problems of government control of fertiliser distribution in Ethiopia.

Second, although liberalisation has removed many of the restrictions on the type of fertiliser that may be imported, previous customs for specific formulations tend to be followed, which eliminate the possibility of bulk orders. Debrah gives the example of the minor differences in cotton fertiliser formulations across neighbouring West African states, leading to the necessity of small, individual import orders and consequent higher prices. There are some remaining restrictions on fertiliser type in certain countries, and donor aid may dictate the type of product available (Yanggen et al, 1998; Shepherd, 1989).

Another problem that needs attention in fertiliser provision is quality control. The move towards privatised distribution may have led to a decrease in fertiliser quality. A study in West Africa (Visker et al, 1996) found 43% of samples to be nutrient deficient (mostly because of poor process control), 58% with low bag weight, and a number of cases of inadequate labelling. The governments concerned had no quality control mechanisms in place. These problems are related mostly to deficiencies in manufacture or storage that require regulatory attention. There is only anecdotal evidence on the degree of adulteration and misrepresentation of fertiliser at the distributor level, but it is likely that more attention to point-of-sale regulation would be helpful.

These problems point to the need for several types of assistance:

- Better organisation of fertiliser dealers/importers and provision of information on availability of products (for more efficient bulking, importing) and on marketing (possibilities for small packs etc.) The ATRIP project in West Africa, implemented by USDA, the African Seed Trade Association and IFDC, aims to strengthen seed and fertiliser marketing in the region by promoting regulatory harmonisation and fostering trade associations. ASARECA (ECAPAPA) hopes to organise similar initiatives in ECA.
- Better connections between research and dealers to identify most appropriate products for farmers.
- Consumer education/protection and the establishment of an effective point-of-sale inspection scheme (Gisselquist and van der Meer, n.d.).

3.2 Pesticides

There is widespread use of chemical pesticides in Africa. These products are applied extensively on cash crops and increasingly on some subsistence crops. There have been a number of government programmes for pesticide provision (particularly related to key cash crops), although many of these are now being turned over to the private sector. In many countries there has always been at least some private participation in pesticide provision, and this role is increasing with liberalisation. The regulatory issues here are more important than for fertilisers, particularly because of the significant externalities associated with pesticide use. The rationalisation and organisation of private distribution also deserve attention.

Many African countries give relatively little attention to pesticide regulation. The vast majority of the products are imported, and although a government may decide to ban particularly dangerous products it will rarely have the resources to enforce such a decision. An important contribution to controlling trade in pesticides is the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. The text of the convention was adopted in September 1998 (under a secretariat of UNEP and FAO) and governments have agreed to continue with a voluntary PIC procedure until the Convention comes into force. It gives importing countries the power to decide which chemicals they are willing to receive and provides requirements for labelling and information on health and environmental

effects. The Convention provides for technical assistance in regulating chemicals. (Twenty sub-Saharan African countries are currently signatories and five of these have ratified the Convention.)

The regulatory situation at the national level is far from adequate. A study showed that 80% of developing countries did not have the capability to manage the distribution and use of pesticides to conform to the 1990 FAO International Code of Conduct on the Distribution and Use of Pesticides (Farah, 1994).[4] In most countries, regulatory authorities do not have adequate resources (Ak'habuhaya, 2002). The Kenya Pest Control Products Board regulates importation, manufacture and sale of pesticides, but has only seven inspectors to cover 3,000 retail outlets. Some countries do not even have a pesticide registry. There are relatively few efforts at regulatory harmonisation. One exception is the development of a common pesticide registration protocol for the nine CILLS (Interstate Committee for Drought Control in the Sahel) countries.[5]

With increasing liberalisation there is a wider range of private sector participation in pesticide markets. This is not necessarily a good thing, as many of those selling pesticides, particularly in the informal market, have no capacity to provide information about safe usage. There is increasing evidence of 'leakage' of pesticides from government programmes and unregulated cross-border movement of pesticides (Williamson, 2003). Studies in developing countries have shown a high incidence of fraudulent, outdated and misrepresented products (von Dueszeln et al, 1995). A study in Africa estimated that 30% of the pesticides for sale were inadequate (B. Dinham, pers. comm.).

The pesticide industry is taking some steps toward more responsible management of pesticide distribution, but it will take some time before the product stewardship principle or Safe Use campaigns reach the remoter areas of Africa. One step that has been taken to promote the responsible sale of legitimate products is a move toward smaller containers, with better labels, so that fewer pesticides are sold in unlabelled containers. Good labelling is necessary, but does not necessarily solve the problem.[6] A follow-up of Safe Use campaigns in Latin America showed some improvement in farmer knowledge, but little change in behaviour (Murray and Taylor, 2000).

3.3 Alternative pest control products

The significant environmental and public health problems entailed by excessive use of chemical pesticides have led to a search for alternative products. We will refer to these as 'biopesticides'.[7] The products include botanical pesticides, pheromones and other attractants, growth regulators, and microbial pesticides (including bacterial, viral and fungal products).

Many of these products offer opportunities for more environmentally-sound technology, often linked to local enterprise development. They also face certain regulatory and policy hurdles that deserve attention. These issues are discussed in this section, but first it is important to point out that the major impediment to the introduction of biopesticides at this time is neither local enterprise capacity nor regulatory failure but rather the challenge of identifying economically attractive technologies. Most of these products have somewhat different modes of action from conventional pesticides, and often require different application techniques. Farmers need to learn about their management and effects. Most biopesticides have limited shelf lives, and many require manufacture close to the point of use. This is an opportunity for local enterprise development in the medium

4 This code is currently undergoing revision.
5 The coastal West African countries have common registration procedures, but a product must be registered separately in each country (A. Cherry, pers. comm.). The problem is not confined to Africa. A study done by the US General Accounting Office (1993) found many differences between pesticide registration procedures in OECD countries.
6 In India, a move towards colour-coding pesticides according to human toxicity simply led farmers to choose the most toxic products. (J. Bentley, pers. comm.)
7 For a discussion of the definition of this and other related terms see Lomer et al, (n.d).

term, but can be a challenge for short-term promotion. There is a small (but growing) number of biopesticides that are of near-term relevance to African smallholder agriculture.

Many biopesticides are produced through biological processes (insect rearing, microbial production, etc.) that are best managed close to the environment where they are to be used. Relatively short shelf life is an added incentive for local production. There are already a few examples of commercially viable biopesticide production in developing countries (e.g. NPV production in India, Thailand, Brazil), but there are many challenges remaining (Marrone, 1999; Dent and Waage, 1999). A current DFID-funded project ('International Biopesticide Consortium for Development') is exploring issues related to the promotion of biopesticides.

It is not clear how many regulatory hurdles such products will have to clear in sub-Saharan Africa. Biocontrol manufacturers in the North complain of onerous registration procedures (Blum, 2002). Because few biopesticides have been proposed for registration in the region there is little experience. But there have been instances in other countries where regulatory approval has been severely delayed because the biopesticide has had to pass tests designed for conventional pesticides (Jones, 1994).[8] It will be preferable if separate biopesticide registration procedures are established, as long as these promote an efficient and specifically focused review process (D. Dent, pers. comm.; Langewald and Cherry, 2000)[9]. The most significant instance of biopesticide regulatory harmonisation in Africa is an initiative taken by CILSS, and there is interest in USAID in developing broader regulatory harmonisation (L. Vaughan, pers. comm.). A further challenge for biopesticides is that the enviromental specificity of most of these products means that per-unit registration costs are likely to be higher than for conventional pesticides.[10] In addition, to the extent that different microbial strains are used in different countries, there may be import restrictions (N. Maniania, pers. comm.).

The attitude towards pesticides in the North has a significant influence on prospects for the biopesticide industry worldwide. The Netherlands, in anticipation of EC restrictions on pesticide residues, has recently initiated a programme in which it will use a tax on chemical pesticides to pay for the testing required to register a large number of 'products of natural origin' (H. van der Wulp, pers. comm.). Stricter rules on pesticide residues for exports have caused a number of developing countries to reconsider their stance and to promote alternative products. (Such rulings have a knock-on effect that can further stimulate demand for alternatives, as many pesticides used by African farmers are 'leakage' from cash-crop export programmes.) After an international ban on lindane residues in cocoa products, Ghana quickly pushed through the approval of two alternative (conventional) products (B. Dinham, pers. comm.) and has welcomed USAID efforts to explore the local production and use of neem products on cocoa.[11]

Biopesticides may be much safer than the conventional alternatives, but they present some serious quality control problems. The manufacture of many of these products requires exceptional care in order to prevent potentially serious contamination (Jenkins and Grzywacz, 2000; Dent and Waage, 1999). These requirements, plus the need for special formulations to improve shelf life and efficacy, indicate that local production of many biopesticides will be handled at a scale and level of sophistication beyond a cottage industry. In addition, there are instances of fraudulent biopesticide

8 In the case of 'Green Muscle', a fungal product for the control of grasshoppers and locusts, now produced in South Africa, a considerable time investment was necessary to push the product through the appropriate regulatory channels (D. Dent, pers. comm.).
9 The US EPA has a 'fast-track' procedure for registering biopesticides, although its procedures are sufficiently complex that it is probably not a good model for developing countries. A review of the situation in Africa recommended New Zealand's regulations as a model (Lomer et al, n.d.).
10 In addition, the results of toxicology and environmental impact tests done on behalf of private firms are often not publicly available, raising the possibility of added expense for repeat tests to meet the requirements of separate regulatory authorities (D. Dent, pers. comm.).
11 FAO is promoting the use of neem products on tomatoes in Ghana and there is local production of neem pesticide by a women's co-operative in Senegal for organic cotton production.

products reaching the market in developing countries (Tripp and Ali, 2001; Ahmed and Stoll, 1996). Point-of-sale regulation will require developing new tests and procedures. In the case of neem-based products, for instance, which are among the most accessible alternatives, their composition varies considerably and their efficacy depends on several components, making quality control and product testing particularly difficult.

3.4 Commercial input distribution

The discussion above has pointed to a number of weaknesses in the input marketing sector in Africa. These problems are relevant for seed marketing as well as for chemicals and other inputs. Support is needed to help develop the skills and capacities of input dealers. There are several NGO projects that have attempted to build input dealer networks, including Sasakawa Global 2000 in Uganda, Technoserve in Kenya and CARE in Zimbabwe.

National and regional commercial associations (seed producers, input dealers, etc.) are also a good focus for helping develop an industry. However, there are several patterns of donor support that need to be modified. First, donor projects often create such associations out of nothing, front-load them with immediate resources, and then are surprised that the association collapses at the end of the project. Donors need a more long-term, responsive approach. Associations should respond to the needs of their members, not to the goals of the donor. Second, associations are often seen as ways of lobbying for government support, rather than as ways of developing local capacity (Fairbanks and Lindsay, 1997). They can perform a useful role in the process of regulatory reform, but their mandate should be wider than this. Third, such associations should promote strategic thinking about the industry itself, how to make best use of local resources, and, where relevant, how to promote industrial clustering (Schmitz and Nadvi, 1999).

3.5 Veterinary services

An important area related to agricultural input distribution is the provision of veterinary services, particularly the issue of pharmaceutical sale.[12] This is an area that has typically been heavily controlled by the public sector but is now undergoing considerable re-orientation (Carney, 1998). A useful essay by Leonard (1993) makes clear the relationship between veterinary service reform and the issues of institutional development that are at the core of this paper.

The combination of positive externalities of some preventive veterinary service provision (as for zoonotic diseases) and the negative externalities of uncontrolled access to some veterinary pharmaceuticals make the role of the public sector in veterinary services difficult to ignore. But overzealous regulation and licensing have made veterinary services less accessible to African herdsman and farmers than they should be. There are a number of examples of innovative service provision through farmer co-operatives, paraprofessionals, or NGOs (Carney, 1998). Leonard (1993) discusses possible compromises between public and private provision, where private veterinarians may be contracted to provide services to a given area. These contracts would be subject to periodic review and performance would also be scrutinised by professional associations. A possible focus for regulatory harmonisation is the OAU Inter-African Bureau for Animal Resources (IBAR) (S. Holden, pers. communication).

There are thus important opportunities for developing more supportive regulations in the veterinary sector, promoting more responsive provision of veterinary pharmaceuticals, and developing the reputations and professional standing of service providers.

12 The commercial development of veterinary pharmaceuticals may involve public research, but usually at the international rather than national scale.

4 Intellectual Property Rights

Progress in world trading regimes and advances in technology are responsible for the increasing importance of intellectual property rights (IPR) as a precondition for technology development. Two areas receive attention here: new plant varieties and the protection of biotechnology.

4.1 Intellectual property protection of new plant varieties

One of the elements of the agreement on Trade-Related Intellectual Property Rights (TRIPs), instituted in 1994, requires all members of the World Trade Organisation (WTO) to provide some type of IP for new plant varieties. Such a system allows plant breeders to control the use of their varieties and, if they wish, to collect royalties or licensing fees from others. The system must also provide even-handed treatment to national and foreign varieties. The TRIPs agreement is not specific about implementation mechanisms, but three options are commonly discussed:

- plant patents, which are permitted and increasingly used under US patent law but are not recognised under the European Patent Convention and are unlikely to be feasible in most developing countries;
- accession to one of the versions of the UPOV convention, managed by the International Union for the Protection of New Varieties of Plants, to which most OECD countries belong;
- the establishment of *sui generis* ('of its own kind') national legislation, which may provide more flexibility (e.g. for farmer seed saving) than UPOV, but whose interpretation could be challenged before the WTO.

The establishment of IP legislation for plant varieties is a fairly high priority for developing countries. Many countries are receiving external advice, and there is sufficient understanding of the parameters and consequences of IP for plant varieties that local participation and interest tends to be quite strong. Recent sources of advice include a legal review for FAO of the options available to developing countries (Helfer, 2002). A number of African countries have already drafted legislation that is being debated. Only two sub-Saharan African countries (Kenya and South Africa) are currently members of UPOV, and Zimbabwe established a Plant Breeders Rights Act in 1973. In general, progress on enacting legislation is slower than expected, although least developed nations have been given until 2006 to implement the TRIPs agreement.

There are several other factors that complicate the situation. The Doha meeting of WTO in November 2001 indicated that a review will be conducted (at the behest of developing countries) to examine the TRIPs interpretation in light of other policy objectives. Particular concerns include the relation with the Convention on Biological Diversity, compensation for the use of farmer varieties, and the scope for seed saving. A recent review for the Center for International Environmental Law looks at these issues (Eugui, 2002). In addition, there is uncertainty regarding the relationship between IP for new plant varieties under TRIPs and the obligations of the recently signed International Treaty on Plant Genetic Resources.

The Commission on Intellectual Property Rights (CIPR, 2002) has concluded that developing countries should exercise caution in approaching IP for plant varieties (particularly with respect to patents and that legislation should be tailored to meet the needs of each country).

Thus it appears that the precise interpretation of IP for new plant varieties in developing countries will be a matter of uncertainty for at least several years. Nevertheless, it is possible to take a pragmatic approach with regard to incentives for agricultural technology development. Although it

seems likely that various details of national legislation will be debated and challenged in the coming years, it is important to examine the potential benefits of interim legislation or operating procedures for both public and private research.

One result of the establishment of some type of IP for new plant varieties, however imperfect, will be that public plant breeding institutes will be able to receive royalties for their varieties, which will be an incentive for interactions with the private seed industry and can provide additional revenue to public research. The level of extra revenue that might be earned is not clear, and there are probably excessive expectations in some quarters, but such arrangements are likely to stimulate more widespread diffusion of public varieties. In Kenya, KARI has already established several tentative agreements with private seed companies for exclusive rights to some of its new maize hybrids.[13]

The degree to which IP legislation will increase investment in private plant breeding in Africa is not clear. Most legislation will likely be an accession to the earlier (1978) UPOV act, which permits farmer seed saving, or will be a *sui generis* variant with the same allowance. There would thus be relatively little incentive for companies to invest in the development of non-hybrid varieties, as the repeat sale market would be very uncertain. The legislation would, however, protect the companies from competitors' unauthorised use or sale of their varieties, and this could be an important stimulus for market expansion.

Despite the continuing uncertainty about various aspects of IP for new plant varieties, there are several useful contributions that might be made. Regional harmonisation will help stimulate trade, and it will be helpful if national policy makers are well informed about progress and options in neighbouring countries. In addition, countries may need assistance in seeing that legislation is implemented and enforced in such a way that it stimulates seed system development. There will be need for advice to NARIs in helping them negotiate with seed companies, and to national seed companies in ensuring that their rights are protected.

4.2 The protection of biotechnology innovations

The use of biotechnology, and particularly the introduction of transgenic crop varieties, implies access to a range of genes, techniques and processes. Most of this technology is owned by firms or institutions in the North. Many biotechnology innovations will have complex ownership, and national IPR systems must be able to accommodate this. The most important issues for developing countries involve sanctioned access to the relevant technology and the fate of protected genes in released varieties.

Probably the most relevant aspect of biotechnology protection for this discussion is the interface between public and private research. Support needs to be provided to allow public agricultural research institutes to access protected biotechnology, through licenses, exchange or donations. Mechanisms need to be developed that allow researchers to lower the transaction costs currently in force for accessing protected biotechnology. One example is a biotechnology database assembled by the Australian institution CAMBIA (Centre for the Application of Molecular Biology in International Agriculture); the database facilitates preliminary freedom-to-operate audits. Discussions have been held about the possibility of establishing an IP clearinghouse facility that would help bundle relevant technologies and create patent pools (Graff and Zilberman, 2001).

There are instances where access to biotechnology may be possible without complex IP negotiation. For instance, in many cases the relevant IP may not be in force because patents are only national in

13 A potential drawback to pursuing royalties for the products of public breeding is the possibility that public research priorities will be directed exclusively to such opportunities and away from research for the problems of less commercially-oriented farmers.

scope. One argument holds that national research programmes in the South can use 'patented' technology to develop GM crops with impunity, as long as the resulting varieties do not enter international trade (Nottenburg et al., 2001).[14] Of greater relevance, companies may be willing to grant access to their IP for development objectives. ISAAA has brokered a number of donations of patented technology. The large biotechnology firms are open to the possibility of donating their technology (particularly in cases where the resulting products are not of commercial importance). On the other hand, they are very concerned about liability issues.

However, it is not reasonable to expect that all of biotechnology's techniques and products will be donated, or that they will be utilised in the context of subsistence agriculture. Most of the protected technology that firms are willing to donate has been in widespread use for some time, and private companies and NARIs working on pro-poor technology also require access to more cutting-edge biotechnology (Byerlee and Fischer, 2002). In addition, biotechnology will be needed to develop market-oriented products, including those for export. Even for produce confined to domestic boundaries, there are limitations on the degree to which segmentation agreements can be structured and enforced to the satisfaction of potential technology donors. The conclusion is that national IP management capacities need to be strengthened, so that the local private sector can develop and so that NARIs can take better advantage of their own resources in biotechnology and enter into productive agreements with commercial firms.

14 This is what Byerlee and Fischer (2002) call 'unilateral access'.

5 Biosafety

The advent of biotechnology has entailed the development of new sets of regulatory protocols for the development, testing and release of genetically modified crop varieties. In addition, consumer concerns about GMOs have brought forth a growing amount of legislation and regulation regarding trade in these products. Both these aspects of biosafety have implications for agricultural technology in developing countries.

5.1 The regulation of biotechnology research

The introduction of transgenic crops (locally developed or imported) requires the presence of biosafety capacity. It is not prudent to grow, or even test, a transgenic crop variety unless there is adequate biosafety capacity in place. The basis of biosafety is the ability to assess and contain risks related to the introduction of genetically modified organisms. It includes understanding the characteristics of donor, vector, and recipient organisms; assessing the way in which a GMO is to be used; and understanding the potential interactions with the environment. It also involves testing or assessing, where necessary, for food safety concerns. These involve, for the most part, skills and resources not currently found in developing countries and hence imply significant investment in training (and, to some extent, infrastructure). Beyond these technical requirements, the establishment of biosafety protocols also requires the existence of adequate polices and the capacity to implement and maintain the regulatory framework (McLean et al, 2002).

There are several characteristics that make biosafety regulation a particularly difficult challenge:

- Biosafety practices and protocols are best thought of as evolving systems (J. Komen pers. comm.) and there is no uniform agreement on requirements and practices. In some cases countries may start with voluntary guidelines (as in South Africa) and then move to instituting relevant regulations and laws.[15]
- It is often not clear which institution(s) in a country should have authority for biosafety, or whether new institutions are required. For instance, there is considerable inter-ministry hostility in Zimbabwe regarding who should have biosafety authority (Mohamed-Katerere, 2001). Several different institutions in Ghana might be candidates for biosafety authority (Essegbey and Stokes, 1998). One of the arguments against using existing institutions is the resulting fragmentation of authority, as in the US, where agricultural biosafety is led by USDA (APHIS), with inputs from EPA and FDA. [16]
- Biosafety implementation implies a significant investment in human resources. This is costly, and decisions must be made regarding who pays for these services.[17] Byerlee and Fischer (2002) point out that donor assistance for biotechnology often focuses on technology development, at the expense of assistance for regulation and testing.
- Harmonisation could improve efficiency, but there is still the necessity to develop national authorities. In addition, the subject of biosafety is sufficiently new and controversial that national authorities are unlikely to cede jurisdiction until more experience is developed (J.

15 Even countries with well-established biosafety practices may find that these are subject to reconsideration. A recent review of US practices for assessing environmental impact has called for additional assessments (NRC, 2002), and the government's Office of Science and Technology Policy has suggested earlier reviews for food safety of transgenic crops entering preliminary field trials.

16 For example, the approval of Monsanto's Bt 'New Leaf' potatoes: EPA regulates pesticides such as Bt, but because it has determined that Bt is safe as a pesticide, does no extra tests on Bt potatoes. Because it is a pesticide, the Bt in the potatoes is exempt from FDA regulation; new proteins regarded as additives are brought to FDA's attention by companies on a voluntary basis.

17 A review of US regulatory procedures concluded that there were deficiencies in staffing and training in some areas of APHIS's Biotechnology, Biologics and Environmental Protection unit (NRC, 2002).

Komen, pers. comm.).[18] Despite the limited possibilities for short-term harmonisation, more South-South interchange and sharing of expertise is worth pursuing.

Development of biosafety regulation mirrors a country's technological situation, and only a few countries in sub-Saharan Africa have significant biotechnology capacity at the present time. The most advanced include Kenya, South Africa, Nigeria and Zimbabwe, and it is these countries that have made the most progress on biosafety. Most of these countries have National Biosafety Committees. Transgenic crops are in commercial production in South Africa and are undergoing field tests in Kenya.

There are a number of sources for biosafety training and advice. Perhaps the most important initiative is the UNEP-GEF Global Project on the Development of National Biosafety Frameworks. At the end of 2002 there were 42 African countries eligible to participate in this initiative, and 26 were actively involved at some stage of the process of developing national project documents. The project sponsors its own workshops and other activities and maintains contacts with bilateral donors to assist the process.

Various donors and other institutions offer technical assistance in biosafety. BIO-EARN is a Swedish-funded initiative providing support in biosafety to Kenya, Ethiopia, Uganda and Tanzania. ISAAA has offered courses and currently provides a CD-Rom on 'Essential Biosafety'. The International Centre for Genetic Engineering and Biotechnology (ICGEB) offers courses and support in biosafety. The Stockholm Environment Institute has a Biotechnology Advisory Centre. Several US universities, through USAID, have offered biosafety support to developing countries.

Several databases are available, including one from UNIDO (BINAS) and one from the OECD (BIOBIN). BINAS is in the process of developing a 'Pilot Decision Support System for Safety Assessment of Genetically Modified Crop Plants'. A biosafety clearinghouse is to be developed under the Cartagena Protocol on Biosafety.

5.2 Trade in GMOs

The techniques of genetic engineering have raised a number of public concerns. In some countries these have led to rulings on the use or cultivation of GM crops and the identification or restriction of GM foods. These activities have important implications for trade in GMOs and hence to decisions about the use of GM technology.

The Cartegena Protocol on Biosafety (under the Convention on Biological Diversity) allows a country to ban the import of a GMO if it is uncertain of its effects. Shipments will have to be identified as possibly containing GMOs. There is concern that this could be used as a non-tariff barrier to trade, so any decision to deny import must be based on sufficient scientific evidence. The exporter can appeal to the WTO, but there is no supremacy of either the WTO or the Protocol in these matters. A biosafety clearinghouse is supposed to level the playing field for developing countries that do not have access to scientific capacity or data. The clearinghouse will function on a website, but this is still being developed.

The adverse effects that could halt the importation of a GMO may be related to public health or environmental protection concerns. With respect to public health, any imports would have to be identified in a way to conform to a country's labelling laws. In July 2002 the European Parliament

18 One example of a move towards some regional harmonisation in Asia is a set of non-binding guidelines on risk assessment for GMOs for ASEAN countries agreed in 1999. A meeting to discuss regional co-operation on biosafety in Eastern and Southern Africa was held in Zimbabwe in July 2001, sponsored by the Biotechnology Special Programme of DGIS (The Netherlands).

voted for labelling if food contains a minimum of 0.5% GM, mandatory labelling for GM-derived animal feed, and the creation of a label for products from animals raised on GM feed, but these measures still have to be approved. In the UK (since March 1999) all foods of above 1% GM content require a label. The issue of labelling is a difficult one; the Codex Alimentarius Commission is currently trying to develop voluntary guidelines that would promote international harmonisation on labelling of GM products, but the results of the most recent Codex Committee on Food Labelling (May 2002) indicate slow progress.

With respect to environmental protection, Article 26 of the Cartagena Protocol allows 'socio-economic considerations arising from the impact of living modified organisms on the conservation and sustainable use of biological diversity'. This has obvious implications for GMO seed, but can also be extended to food imports if there is the possibility of seed use.[19]

There are several implications of these GMO trade issues for developing countries that are considering the applications of biotechnology. First, there is a growing precedent for GMO labelling. If developing countries decide to follow suit, this would seriously affect the potential for the introduction of GM crops. The costs of segregation and labelling in developing countries would be much higher than in industrialised ones and would effectively prohibit the use of many such crops. Second, interest groups could lobby to prohibit the import of GM crops in order to protect local production, thereby thwarting any efforts at local development of transgenic crops.[20] Finally, if international trade requires the segregation and labelling of GM foods, developing countries will think carefully about the implications for those foods, or derived animal products, that require such treatment for export, and this may be a disincentive to the development of locally adapted GM technology.

19 Mexico prohibits the import or use of any GM maize seed, but imports millions of tons of maize grain every year from the US. It is hardly surprising that analyses of 'native' maize grown in even isolated parts of the country have found traces of transgenes, leading to a controversial series of communications in the journal *Nature* (see *New Scientist*, 19 June 2002). Several countries in Southern Africa have recently expressed the same type of concern in rejecting or limiting US maize as food aid.

20 Conflicting interests will emerge; China, which has the most comprehensive biotechnology programme in the developing world, is currently attempting to block the import of GM soybeans.

6 Ways Forward

This paper has discussed the enabling environment for agricultural technology development as it relates to the areas of regulatory reform, public agricultural research management, and agricultural enterprise development. This section concentrates on actions that donors might take, in collaboration with national governments and regional organisations, to further strengthen the enabling environment. Donors already provide some assistance in establishing regulatory capacities and encouraging regulatory harmonisation. They also provide considerable support to public agricultural research, and there are occasional examples of assistance to agricultural enterprise development. But donor support rarely looks at the enabling environment with the institutional focus described in this paper. More support is needed not only for the actions of particular public or private organisations, but to support the interactions among these entities. Part of the problem is related to the project-orientation of much donor activity. There is also growing realisation that the incentives within development agencies must be restructured if they are to give attention to areas such as institutional development (e.g. Martens et al, 2002)

This section begins with an assessment of the deficiencies in donor support in this area. This is followed by the presentation of some principles for more concerted action and some examples of specific activities. The final section of the paper concludes with some remarks about the risks and strengths of an effort to improve the enabling environment.

6.1 Limitations to current donor strategies

The current prospects for effective donor intervention to strengthen the enabling environment for private participation in agricultural technology generation are limited by a series of factors. These include the limited time commitments of most donor projects, a lack of co-ordination, and inadequate scope of intervention.

6.1.1 Time commitments

Project-based interventions are short-lived and are unable to provide the long-term follow-up required for institution building
An example is the Sub-Saharan Africa Seed Initiative (SSASI), initiated by the World Bank in late 1997 under the auspices of the Special Program for African Agricultural Research (SPAAR). SSASI had the objective of improving the enabling environment for seed provision, and began a set of activities focused on Southern Africa. Country studies were carried out and a workshop in late 2001 discussed the implications of the studies and the steps for a regional seed strategy, including moves toward regulatory harmonisation. However, that programme is now in an undefined status and much of the momentum generated by the initial activities has been lost.

Project-based interventions do not allow institutional growth and evolution
For instance, the short-term nature of projects creates a danger of ‘front-loading’ processes that should involve iterative change. A good example is the funding of seed producer associations. In Ghana, Sasakawa Global 2000 was responsible for supporting the emergence of small-scale commercial seed producers and initiating seed producer associations. On paper, the producer associations were to assume several important roles in lowering transaction costs, but they were nothing but empty shells. Meanwhile, significant steps were taken by indigenous institutions to lower these transaction costs in completely unexpected fashion (Tripp, 2001). A second example is the rapid formation of a seed producers association in Malawi under an EC project. The association emerged not as a result of producer initiative but rather as a part of project strategy. The necessity

of propping up an artificial entity led to mismanagement and a significant setback to hopes for small-scale seed production in Malawi.

6.1.2 Lack of co-ordination

A donor's projects are often poorly co-ordinated with other donors' activities
Project-based interventions may duplicate or compete with each other if there is no mechanism for seeking donor co-ordination. In the example of seed policy in Southern Africa, whilst the SSASI faces an uncertain future, a number of donors are examining support for a Seed Security Unit under the auspices of SADC and various donors are funding other related activities in the region.

Donor activities in a country may not always be internally consistent
A donor operating within one country may send contradictory signals to policymakers. In the late 1990s, DFID in Malawi was funding three seed initiatives with quite different implications. An NGO-based community seed enterprise project was based on the presumption that local communities could profitably produce and distribute their own seed. Support to national bean research included the production and delivery (at cost recovery) of seed that could have expanded into a small-scale commercial operation. Finally, the Starter Pack Scheme was introduced, which was based on several objectives that were not internally consistent (including both strengthening the perception of government as the provider of free seed and stimulating demand for commercial seed). Today only the descendant of Starter Pack remains, and its contradictory messages have not been resolved.

Donor activities at the country level have a very limited concept of institution building
Institution building tends to be interpreted as support and training for local organisations or vague requirements for 'working with partners'. If we accept the interpretation of institutions as 'the rules of the game', institution building should address the current deficiencies in information flow, trust and networks that impede the synergies between regulation, enterprise development and public research upon which agricultural technology development increasingly depends. At both the country and regional level donors should work towards rough maps that define what institutions are required and encourage the idiosyncratic evolution of indigenous institutions, in part through external assistance that features carefully considered and sequenced donor support.

6.1.3 Breadth of intervention

There are few examples of an integrated approach that acknowledges the complimentary roles of regulation, enterprise development, and support to public research
Projects tend to have a single thematic focus, ignoring the importance of the interactions among regulation, enterprise development and public research. For instance, Byerlee and Fischer (2002) describe the fragmentation of donor efforts at support to biotechnology, with an overemphasis on technology development at the expense of regulatory and policy development and a lack of attention to developing relations between public research and private enterprise. The overemphasis on technology is typical in other areas. DFID (and other donors) have supported biopesticide research in India, but have not given equal attention to building capacity of the local private sector to manage the technology, nor to initiating policy debate regarding appropriate regulation (Tripp and Ali, 2001); this imbalance can be found in African initiatives in this field as well (Cherry et al, 2000).

Projects rarely include an interface between regulatory reform at the country level and regional harmonisation activities
Even successful regional harmonisation efforts are rarely supported by strategies that address the needs of the participating countries. Thus although East Africa has made progress in defining regional seed regulatory mechanisms, the individual countries must work through the implications, which includes changing local procedures and at times drafting new legislation. There is no clear mechanism through which donors with interests in a particular country will be alerted to the need for assistance. In addition, most discussion of regulatory reform is limited to participation by the regulators themselves, rather than including higher level policy makers who may have a more adequate vision of how regulatory reform can serve national development goals.

There are few examples where a donor invests in synthesising or applying experience in one region or country to work in another region
There is rarely any communication among donor projects to share lessons regarding strategies for the enabling environment. The donors that support the CILLS countries in West Africa have made great progress in harmonising pesticide registration procedures, but such a move is hardly contemplated in other regions. Conversely, first steps are now being taken to discuss seed regulatory harmonisation in West Africa, apparently without reference to the significant progress in East Africa. The same problems occur for country-level projects. Several projects have attempted to strengthen the capacities of input dealers, but there is little evidence that there is much sharing of information, especially among NGOs that are competitors for donor funds.

6.2 Implications for donor strategies

6.2.1 Principles

The implications for structuring relevant interventions (that take account of a longer time frame, involve greater co-ordination, and feature broader scope) are more organisational than financial. The level of resources to be devoted to support for strengthening the enabling environment is not necessarily very high, but the organisation of that support is outside of normal donor project protocols. The requirements include a longer commitment; a greater willingness to survey and interact with other initiatives; and a significant level of technical expertise.

The emphasis is less on specific technical assistance and more on ensuring that national policies, complemented by coherent donor support, promote the evolution of local institutions for the development of a robust commercial agricultural sector. These institutions will promote the flow of information among researchers, entrepreneurs, and farmers; build the competence of all participants; and engender the growth of trust and confidence in agricultural enterprise.

This paper has suggested several types of technology that can be the basis for initial activities. Precise priorities will depend on individual country situations, but it is likely that those activities related to biotechnology (much of IP management and biosafety) will receive less initial attention. This is because of the relatively slow growth in national technical capacity in this field, as well as the necessity of dealing with more basic input regulatory and policy issues before addressing their application to biotechnology.

6.2.2 Activities

The following is a partial list of the type of activities that could be carried out under an approach led by a donor or donors. Although many of these activities would normally be candidates for

conventional, isolated projects, a more useful approach would be distinguished by a longer time frame, more attention to institution building, better co-ordination, and a comprehensive approach to the enabling environment. These ideas could be piloted by a small number of donors (or even a single donor) in a few countries in order to gain experience and test the effectiveness of the approach.

Co-ordination activities

- The establishment of a permanent donor forum to monitor and assess the status and opportunities of the enabling environment for agricultural technology development in selected sub-Saharan African countries. The forum could be initiated on a very modest basis by designating one contact person from each interested donor agency, agreeing upon modes and frequency of contact, and arranging to meet once a year. Each contact person would be responsible for keeping abreast of the relevant activities within his or her agency.
- The forum would identify senior policy makers within each of the participating countries who are willing to participate in assessments at the national (and, where relevant, regional) level. In each country the forum would fund a periodic assessment of the status of the enabling environment. This would be done perhaps every two years and would result in a brief report (8–10 pages) based on secondary data and, more important, on a growing range of contacts within the country (academics, industry representatives, researchers, farmer representatives) who would be able to provide observations and insights.

Regional activities

- Support to convening authorities to manage meetings, workshops, and studies that promote regulatory harmonisation (related to seed, other inputs, IP or biosafety). Support for including the private sector and public research in these deliberations. There are several examples of such regional efforts currently in progress, but support in most cases is short-term and insecure. The support would include efforts to involve senior policy makers (above the level of the regulatory officials who normally participate in these discussions) to ensure that the broadest support possible was enlisted for regulatory reform and implementation.
- Providing opportunities for exchange of experience between regions on regulatory reform or implementation. The current efforts in regional harmonisation would profit from learning about progress in other regions and also from broadening the scope of effort (e.g. extending modalities established for one type of regulatory reform to other areas).
- In a limited number of cases, initial support for the establishment of a regional regulatory authority. Such regional authorities may be more efficient, particularly for areas where individual countries have little experience or technical capacity (e.g. biopesticide registration).
- Developing links between regional public agricultural research networks, on the one hand, and regulatory and enterprise development activities, on the other. Although regional research networks receive considerable funding for technology generation, they receive little support for ancillary activities that can increase the probability of technology adoption. Examples might include enabling public plant breeders to take advantage of regional seed regulatory harmonisation or linking public plant breeders to regional seed trade associations.

Country-level activities

- Providing advice and support to carry through on the implementation of regulatory harmonisation, or instituting national regulatory reform. The momentum of regional deliberations is often lost at the national level.
- Support and development of best practice for re-orienting national regulatory activities for

inputs toward point-of-sale enforcement and consumer education. There is little current activity that might help redirect national regulatory resources to more relevant consumer protection activities and promote farmer participation in regulatory performance.

- Providing advice to seed companies and other agro-enterprises on how to promote their products and reputations. Although technical advice may be available to start-up enterprises through donor projects, there are few opportunities to link the diffusion of product information with the local regulatory and research systems.
- Providing advice on relations between NARIs and seed companies. NARIs are only beginning to learn how to deal with an environment in which the delivery of their varieties will be almost entirely in private hands and will be at least partially determined by PBR legislation.
- Providing advice for the development of new intermediary commercial services, such as nurseries for tissue culture or agroforestry products.
- Assistance to national or regional input dealer or seed producer associations.
- Providing guidance on intellectual property management in support of public biotechnology research.
- Providing guidance on sources of support for the development of national biosafety frameworks. Although the technical aspects of biosafety are beyond the scope of this discussion, national governments require support for working through the national institutional responsibilities for biosafety.

7 Conclusions

This paper has made a case for institution building related to the enabling environment for agricultural enterprise in sub-Saharan Africa. 'Institution building' is a term with an ill-defined trajectory in development assistance. It is sometimes associated with 'bricks and mortar' projects, and more frequently with various types of training. However, the kinds of donor activities suggested by the present analysis do not involve investment in infrastructure and only partially concern specific training opportunities. The focus is more on a long-term, co-ordinated effort to promote the evolution of local institutions. These include formal regulations and laws, but at least as important are the informal rules, operating procedures and mechanisms of trust that allow the development of agricultural enterprise. This is a particular challenge for conventional donor assistance because it depends on neither large injections of funds nor on the development of time-bound projects. Instead, it requires a commitment to long-term monitoring and support, the co-ordination of donor activities with national policy formation, and the ability to offer modest, targeted input at the appropriate time and place.

The analysis is based on the premise that agricultural technology development, and its links with the emergence of sustainable local enterprises, is essential to economic progress in sub-Saharan Africa. But there are risks and limitations associated with this approach.

One of the major impediments to improving the enabling environment for agricultural input enterprise in sub-Saharan Africa is the very limited activity on which to build. It is *not* the case that there are many small seed companies hoping to be released from onerous regulations, or dozens of environmentally-friendly technologies awaiting approval, or hundreds of dedicated input dealers waiting to serve an eager farmer clientele. The raw material on which a commercial agricultural technology sector can be built is in very short supply, implying the need for a carefully targeted and iterative approach. The call for a long-term approach to the problem does not imply projects with ten-year goals and outputs already defined, but rather the commitment to spend ten years adjusting and readjusting assistance with the goal of promoting indigenous institutional development.

A second major problem with the approach is the assumption that it is necessarily congruent with the current interests of the participants. Although everyone would hope to promote a more productive commercial agricultural sector, the various actors have their own interests to defend, and these must be understood and addressed. Regulation is a highly political territory, and significant battles are fought for its control; in addition, regulators can be expected to defend their positions. Local enterprise seeks opportunities that a more supportive enabling environment can offer, but it also seeks advantage and monopoly; in addition, the paucity of experience and capital combined with political privilege provides many opportunities for crony capitalism. Public agricultural research is anxious to see that its products are utilised by farmers, but it also faces severe budgetary problems and is told that it must increase its own income generation; in addition, public research often sees the private sector as a competitor for its staff and for donor support. Any effort to develop the enabling environment must be sensitive to these complex and conflicting interests.

Finally an additional challenge to developing the enabling environment for agricultural technology presents both a risk and an opportunity. One of the principal reasons that technology development is restricted in sub-Saharan Africa is a lack of demand caused by inadequate agricultural output markets. Farmers face considerable uncertainty and often receive unacceptably low prices when they market their products, making them conservative about commercial production and reluctant to invest in technology. The reasons for poor market performance include inadequate produce buying, storage and transport capacity; a lack of market information; and uncertain government roles and policies. In short, the enabling environment for agricultural produce markets is also deficient. It

would be straightforward to make a case similar to the one presented in this paper for attention to supporting the institutions required to develop an adequate agricultural produce marketing system. A co-ordinated approach to both of these enabling environments would move agriculture in sub-Saharan Africa many steps forward.

References

ACAB (2002) *The Future of Public Plant Breeding Programs: Principles and Roles for the 21st Century*. Washington: USDA Advisory Committee on Agricultural Biotechnology.

ASARECA (2000) 'First Regional Workshop on Harmonization of Seed Policies and Regulations in Eastern Africa'. Entebbe: ASARECA (ECAPAPA).

Ahmed, S. and Stoll, G. (1996) 'Indigenous Biotechnology: Biopesticides' in J. Bunders, B. Haverkort and W. Hiemstra (eds) *Biotechnology: Building on Farmers' Knowledge*. London: Macmillan and ILEIA.

Ak'habuhaya, A. (2002) 'African Regulators Starved for Resources', *Pesticides News* 58:15.

Ayres, I. and Braitwaite, J. (1992) *Responsive Regulation: Transcending the Deregulation Debate*. New York: Oxford University Press.

Blum, B. (2002) 'Blocked Opportunities for Bio-control', *Pesticides News* 57:18.

Byerlee, D. (1998) 'The Search for a New Paradigm for the Development of National Agricultural Research Systems', *World Development* 26: 1049–56.

Byerlee, D. and Fischer, K. (2002) 'Accessing Modern Science: Policy and Institutional Options for Agricultural Biotechnology in Developing Countries', *World Development* 30: 931–48.

Byerlee, D. and Alex, G. (1998) *Strengthening National Agricultural Research Systems: Policy Issues and Good Practice*. Washington, DC: World Bank.

Carney, D. (1998) *Changing Public and Private Roles in Agricultural Service Provision*. London: ODI.

Cherry, A., Maniania, N. and Odour, G. (2000) 'Microbial Insecticides in Africa, Current Use and Future Prospects', Paper presented at the SIP annual meeting, Mexico.

CIPR (2002) *Integrating Intellectual Property Rights and Development Policy*. London: Commission on Intellectual Property Rights.

Dahlman, C. (1979) 'The Problem of Externality', *Journal of Law and Economics* 2:141–62.

Davis, L. and North, D. (1971) *Institutional Change and American Economic Growth*. Cambridge: Cambridge University Press.

Debrah, S.K. (2000) *From State Monopoly to Private Sector Oligopoly: African Agricultural Input Markets in Crisis*. Lome: IFDC.

Dent, D. and Waage, J. (1999) 'Wanted: Investors in Biological Control', *Pesticides News* 45:10–11.

Douthwaite, B. (2002) *Enabling Innovation*. London: Zed Books.

Essegbey, G. and Stokes, K. (1998) 'Developing a Biosafety Regime in Ghana: Issues and Options for Policy Makers', *Science, Technology and Development* 16 (2): 32–54.

Eugui, D. (2002) *Issues Linked to Convention on Biological Diversity in the WTO Negotiations: Implementing Doha Mandates*. Geneva: Center for International Environmental Law.

Fairbanks, M. and Lindsay, S. (1997) *Plowing the Sea*. Boston: Harvard Business School Press.

Farah, J. (1994) 'Pesticide Policies in Developing Countries: Do They Encourage Excessive Use?' *World Bank Discussion Paper* 238. Washington, DC: World Bank.

Franzel, S., Phiri, D. and Kwesiga, F. (2002) 'Assessing the Adoption Potential of Improved Fallows in Eastern Zambia' in S. Franzel and S. Scherr (eds.) *Trees on Farm: Assesing the Adoption Potential of Agroforestry Practices in Africa*. Wallingford, UK: CABI.

Freeman, H.A. and Omiti, J. (2002) 'Fertilizer Use in Semi-arid Areas of Kenya: Analysis of Smallholders Adoption Behavior Under Liberalized Markets', *Nutrient Cycling in Agroecosystems* (in press).

Gisselquist, D. and Van Der Meer, C. (n.d.) 'Regulations for Seed and Fertilizer Markets. A Good Practice Guide for Policymakers', *World Bank Rural Development Working Paper*. Washington, DC: World Bank.

Graff, G. and Zilberman, D. (2001) 'Towards an Intellectual Property Clearinghouse for Ag-biotechnology', *IP Strategy Today*, March 2001 (www.biodevelopments.org/ip/)

Helfer, L. (2002) 'Intellectual Property Rights in Plant Varieties: An Overview with Options for National Governments'. *FAO Legal Papers Online* #31 (www.fao.org/legal/prs-OL/lpo31.pdf)

Jayne, T., Govereh, J., Mwanaumo, A., Nyoro, J. and Chapoto, A. (2002) 'False Premise or False Promise? The Experience of Food and Input Market Reform in Eastern and Southern Africa', *World Development* 30:1967–85.

Jenkins, N. and Grzywacz, D. (2000) 'Quality Control of Fungal and Viral Biocontrol Agents – Assurance of Product Performance', *Biocontrol Science and Technology* 10:753–77.

Jones, K. (1994) 'Registration and Use of Microbial Insecticides in Developing Countries' in *Proceedings of the 6th International Colloquium of Invertebrate Pathology and Microbial Control*, Volume 1:82–8. Montpellier, France: Society for Invertebrate Pathology.

Klein, B. and Leffler, K. (1981) 'The Role of Market Forces in Assuring Contractual Performance', *Journal of Political Economy* 89:615–41.

Langewald, J. and Cherry, A. (2000) 'Prospects for Microbial Pest Control in West Africa', *Biocontrol News and Information* 21:51N–56N.

Leonard, D. (1993) 'Structural Reform of the Veterinary Profession in Africa and the New Institutional Economics', *Development and Change* 24:227–67.

Lomer, C., Cherry, A. and Langewald, J. (n.d.) 'Report on Joint IITA/CGIAR-SPIPM/IAPSC/IBCD Survey on Biological Pesticide Regulations in Africa'. Draft report.

Marrone, P. (1999) 'Microbial Pesticides and Natural Products as Alternatives', *Outlook on Agriculture* 28(3)149–54.

Martens, B., Mummert, U., Murrell, P. and Seabright, P. (2002) *The Institutional Economics of Foreign Aid*. Cambridge: Cambridge University Press.

McLean, M., Frederick, R., Traynor, P., Cohen, J. and Komen, J. (2002) 'A Conceptual Framework for Implementing Biosafety: Linking Policy, Capacity and Regulation', *ISNAR Briefing Paper* 47. The Hague: ISNAR.

Mohamed-Katerere, J. (2001) 'Biotechnology and the Policy Process: Zimbabwe', Draft Paper, Brighton: IDS.

Mokyr, J. (1990) *The Lever of Riches*. Oxford: Oxford University Press.

Murray, D. and Taylor, P. (2000) 'Claim No Easy Victories: Evaluating the Pesticide Industry's Global Safe Use Campaign', *World Development* 28: 1735–49.

North, D. (1990) *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

Nottenburg, C., Pardey, P. and Wright, B. (2001) 'Accessing Other People's Technology: Do Non-profit Agencies Need it? How to Obtain it', *EPTD Discussion Paper* 79. Washington, DC: IFPRI.

NRC (2002) *Environmental Effects of Transgenic Plants: The Scope and Adequacy of Regulation*. Washington, DC: National Research Council.

Omamo, S. and Mose, L. (2001) 'Fertilizer Trade Under Market Liberalization: Preliminary Evidence from Kenya', *Food Policy* 26:1–10.

Pletcher, J. (2000) 'The Politics of Liberalizing Zambia's Maize Markets', *World Development* 28:129–42.

Pray, C. and Fuglie, K. (2002) *Private Investment in Agricultural Research and International Technology Transfer in Asia*. Bogor: International Potato Centre, Rutgers University and USDA Economic Research Service.

Schmitz, H. and Nadvi, K. (1999) 'Custering and Industrialization: Introduction', *World Development* 27:1503–14.

Shepherd, A. (1989) 'Approaches to the Privatization of Fertilizer Marketing in Africa', *Food Policy* 14:143–54.

SSASI (2001) SADC Regional Strategy Document, Regional Seed Sector Stakeholder Workshop. Harare: SSASI.

Tilman, D., Cassman, K., Matson, P., Naylor, R. and Polasky, S. (2002) 'Agricultural Sustainability and Intensive Production Practices', *Nature* 418:671–7.

Tripp, R. (2001) *Seed Provision and Agricultural Development*. Oxford: James Currey.

Tripp, R. and Ali, A. (2001) 'Farmers' Access to Natural Pest Control Products: Experience from an IPM Project in India', *AgREN Network Paper* 113. London: ODI.

Tripp, R. and Rohrbach, D. (2001) 'Policies for African Seed Enterprise Development', *Food Policy* 26:147–61.

US General Accounting Ofice (1993) *Pesticides: A Comparative Study of Industrialized Nations'*, *Regulatory Systems*. Washington, DC: US General Accounting Office.

Visker,C., Rutland, D. and Dahoui, K. (1996) *The Quality of Fertilizers in West Africa* (1995). Lome: IFDC.

Von Dueszeln, J., Vereno, I. and Wieland, T. (1995) 'Pesticide Quality Control: Experiences from GTZ Plant Protection Projects', *Agriculture and Rural Development* 1995 (2):37–41.

Wambugu, F. and Kiome, R. (2001) 'The Benefits of Biotechnology for Small-Scale Banana Producers in Kenya', *ISAAA Briefs* 22. Ithaca, NY: ISAAA.

Williamson, S. (2003) 'Pesticide Provision in Liberalised Africa: Out of Control?' A*gREN Network Paper* 126. London: ODI.

Yanggen,D., Kelly, V., Reardon, T. Naseem, A. (1998) 'Incentives for Fertilizer Use in Sub-Saharan Africa: a Review of Empirical Evidence on Fertilizer Response and Profitability', *MSU International Development Working Paper* 70. E. Lansing, MI: Michigan State University.