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Agro-Dealers and the Political Economy of Agricultural Biotechnology Policy in Kenya

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Acronyms

AATF	African Agricultural Technology Foundation
ABN	African Biodiversity Network
ABSF	African Biotechnology Stakeholders Forum
AGRA	Alliance for Green Revolution in Africa
ARDAP	Appropriate Rural Development Agriculture Programme
ASAL	Arid and Semi-arid Land
BTA	Biotechnology Trust Africa
CFT	Confined Field Trial
CIMMYT	International Maize and Wheat Improvement Centre
DAP	Diammonium Phosphate fertilizer
DTMA	Drought Tolerant Maize for Africa
DVS	Department of Veterinary Services
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FIST	Farmer Investment in Striga Technologies
GM	Genetically Modified
GMO	Genetically Modified Organism
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IARC	International Agricultural Research Centre
IFPRI	International Food Policy Research Institute
ImR-Maize	Imazapyr-Resistant Maize
IPR	Intellectual Property Right
IR-Maize	Insect-Resistant Maize
IRMA	Insect-Resistant Maize for Africa
ISAAA	International Service for the Acquisition of Agri-biotech Applications
KABP	Kenya Agricultural Biotechnology Platform
KARI	Kenya Agricultural Research Institute
KENFAP	Kenya National Federation of Agricultural Producers
KEPHIS	Kenya Plant Health Inspectorate Service
KNOTS	Knowledge, Technology and Society
NARS	National Agricultural Research System
NBC	National Biosafety Committee
NCST	National Council for Science and Technology
NEMA	National Environment Management Authority
NGO	Non-governmental Organization
PBS	Program for Biosafety Systems
PCPB	Pest Control Products Board
PPP	Public-Private Partnership
R&D	Research and Development
RPK	Resource Projects Kenya
S&T	Science & Technology
STEP	Striga Technology Extension Package
TSBF-CIAT	Tropical Soil Biology and Fertility Program of the International Centre for Tropical Agriculture
UNEP	United Nations Environment Programme
UNEP-GEF	United Nations Environment Programme – Global Environment Facility
USAID	United States Agency for International Development
WEMA	Water Efficient Maize for Africa
WeRATE	Western Regional Alliance for Technology Evaluation

Executive summary

Public and private actors and their networks are committing substantial resources to support agro-dealers to deliver novel technologies and information in line with the New Green Revolution for Africa. The main point of entry has been the cereal seed system, with a focus on maize seed in particular, which is seen as both a key staple and a politically important crop. In Kenya, the seed system landscape has been changing dramatically in recent years, with the entry of highly influential seed companies, biotechnology research and legislation of the biosafety regulations. Thus, the prospect of genetically modified (GM) crops being pushed through agribusiness networks is an emerging issue, raising the question of whether small-scale, independent stockists or 'agro-dealers' have the capacity to deliver these technologies and provide local regulatory control over the new seeds.

This study sought to investigate the policy and institutional environment within which agricultural biotechnology agro-dealers have evolved, as well as the agendas that are being pushed by particular interests in the new pro-GM policy and institutional environment in Kenya and their expected outcomes. In response to this evolving situation, an agro-dealer survey was conducted in high- and low-rainfall areas, in addition to an examination of two maize projects: STRIGAWAY® Technology and Water Efficient Maize for Africa (WEMA). STRIGAWAY® Technology is expected to provide a test case for delivering WEMA to smallholder farmers, with agro-dealership at the core of the initiative.

Research conducted by this study has found that the current commercial model of agro-dealership is faced with several challenges, raising issues concerning its sustainability in delivering novel technologies.

Agro-dealers lack adequate knowledge of the current commercial cereal seed varieties, and are also ill-equipped to address farmers' concerns on the utilization of existing technologies. The feedback mechanisms to address farmers' concerns are weak, and promises made to address these weaknesses remain unfulfilled.

Agro-dealers operate on a small capital base which limits their ability to procure meaningful stocks for new technological products. New technological products are rife with demand risks for agro-dealers. Many dealers seek assurance that their investments in new technologies can stimulate sufficient farmer demand to secure positive returns. Agro-dealers have called for demand stimulation through guaranteed markets for agricultural outputs and the stabilisation of output prices. It is seen that this would then lead to increased demand for the new technologies.

Regulatory enforcement has been a major constraint in the seed trade, leaving trading loopholes that have allowed 'fake' and poor quality seeds and unlicensed agro-dealers to infiltrate the system. Unless synergies are developed among agencies in charge of regulating agro-dealership, illegal agro-dealers and the proliferation of poor quality, adulterated and counterfeit inputs will continue to flourish, ruining the efforts of a New Green Revolution in Kenya delivered by agro-dealers.

Farmers and agro-dealers welcome the potential benefits of GM crops and seed, but they are wary of the perceived concurrent risks. A specific risk that has been identified is the erosion of genetic diversity in the smallholder farming, a result of gene flow, which is believed will lead to the disappearance of traditional varieties and the reliance of farmers on expensive external inputs.

The Kenyan agro-dealership in its present state is not capable of efficiently delivering GM seeds to farmers and providing a front-line regulatory service for their use. Extending trade in this new agricultural technology will require a much higher level of technical skills in agro-dealers than conventional technologies have demanded previously. Dealers will also be responding to new regulatory, economic and social challenges. Engaging Kenyan agro-dealers in GM technology delivery must take these governance issues into consideration if it is to be carried out successfully.

1.0 Introduction

1.1 Overview

Agricultural biotechnology is considered an important tool in addressing the problems of agricultural productivity and food security,[i] and is broadly categorized into traditional and modern biotechnology. Traditional biotechnology invo lves the use of traditional techniques such as fermentation, application, tissue culture, and in vitro techniques; whereas modern biotechnology uses genetic engineering techniques.

The transition from green revolution to gene revolution has been marked by changes in research and development work, along with the actors involved in these. For example, while the successful development and deployment of the Green Revolution varieties were largely carried out by public institutions, the gene revolution, with its focus on GM plants, uses a different approach.[ii] A majority of these research products are developed and deployed by the private sector or through public-private partnerships (PPPs) for commercial purposes (Bramel and Remington 2005). The private sector employs the agro-dealer model for the delivery of traditional (bio) technology products, especially seeds. Policy challenges arise, however, with respect to how modern biotechnologies would be dispersed, especially to poor smallholder farmers, in order to realize the envisaged productivity growth.

This study investigates the political and economic issues concerning the use of agro-dealers in delivering GM seeds in Kenya,[iii] among which include GM cereal seeds. These particular varieties are bred for resistance to harsh environmental conditions, such as drought and insect pests, along with enhanced nutritional quality. Public and private sector actors, together with their networks, are committing substantial efforts and resources to build and organize agro-dealer-based seed delivery systems.

The unique nature of some biotechnology applications and processes has led to the development of new regulatory regimes that focus either on the product or a combination of the process and the product (Konde 2006). The key regulations fall broadly into intellectual property rights (IPRs) and biosafety regulations. As cautioned in the report by the UN Food and Agriculture Organization (FAO), despite its potential, biotechnology is not a remedy to all agricultural productivity and food security issues (FAO 2004). The FAO report makes clear that biotechnology cannot overcome the gaps in infrastructure, markets, breeding capacity, input delivery systems and extension services that hinder all efforts to promote agricultural growth especially in poor, remote areas.

For the purposes of this study, an agro-dealer model was used as an entry point in assessing both the front-end concerns of agricultural biotechnology, such as investment, partnerships and IPR issues, and their back-end issues, including biosafety regulation in technology deployment and downstream impact of GMOs in Kenya's smallholder agriculture. In particular, the study sought to establish whether agro-dealers in Kenya have the capacity to deliver GM technologies and information services by analyzing the policy and regulatory environment and the attributes of agro-dealers and their perceptions of the potential benefits and risks of GM technologies. The study has also endeavoured to draw lessons from two case studies --to analyse biotechnology policy processes. The first case study is STRIGAWAY® Technology, which is non-transgenic but already commercialized, while the second case is WEMA project, which is transgenic and at the level of confined field trials.

1.2 Conceptual Framework

The Knowledge, Technology and Society (KNOTS) policy processes' conceptual framework was employed by this study due to its focus on three different but overlapping lenses, namely: actors and institutions and their roles; policy narratives and discourses; and politics and interests (IDS 2006). The first lens, actors and institutions, centres on the organisations and networks that are involved both formally and informally in biotechnology and seed systems policy processes. It assesses how organisations and networks interact and subsequently shape the processes of making biotechnology and seed system policies.

The narratives and discourses lens looks at how research and policy problem-solution storylines are constructed, perpetuated, communicated and associated with the policy process. These storylines provide justification for research and technology solutions that are given for particular agricultural production problems. On the other hand, the politics and interests lens focuses on the power dynamics that various actors and institutions wield in their relationship with policy. This lens also examines the causes behind policy agenda pursuit and acceptance by some actors and the rejection of others.

Understanding policy processes through an examination of knowledge/narratives, actors/networks and politics/interests can help with identifying policy spaces. For example, the emergence of alternative narratives (storylines) is possible where there is a weakness in the articulation of the dominant narrative. This in turn requires the identification of policy spaces within networks (spaces to join the network, or key actors who can be enrolled into an alternative network) (Keeley and Scoones 2003). A deeper examination of strategies for changing and influencing policy can be achieved by looking at these policy spaces.

This analytical framework aims to investigate the trends and drivers of policy processes surrounding biotechnology and GM seed delivery systems. This approach is guided by key analytical elements which include: investment and partnerships in biotechnology product development; intellectual property rights; regulatory issues, including biosafety; business models for biotechnology product delivery; and downstream impact of agricultural biotechnology research and development (R&D).

1.3 Study approach and methodology

This study attempts to answer the question: Do agro-dealers have the capacity to deliver GM technologies? GM crops/seeds are not yet commercially available in Kenya, therefore this study is anticipatory (ex ante). However, the STRIGAWAY® Technology project test case has been highlighted, which is widely believed to be a model through which GM seeds and other drought-tolerant hybrid seeds will be deployed (c.f. Odame and Muange 2011). The case studies involved confined field trials of a GM maize variety under WEMA and the promotion of Imazapyr-resistant maize (IR-Maize) technology. An extensive literature review was conducted of relevant published reports and websites of key organizations. The African Agricultural Technology Foundation (AATF) was considered a crucial organizational contact due to its leadership in Biotechnology brokerage.

To strengthen the literature review, interviews were conducted with key representatives across the seed supply chain, which included two seed companies, one NGO involved in deployment of IR-Maize, the Chairman of an agro-dealer network and two farmer representatives (Appendix 1). Two focus group discussions involving farmer groups were also held in Western Kenya, where IR-Maize technology has been deployed and a clear test case could be conducted. The purpose of key informant and focus group discussions was to identify general issues, assess the perceived benefits and risks associated with GM crops/seeds, and generate recommendations on preferred models of GM technology delivery. Additionally, an agro-dealer survey involving 140 agro-dealers was conducted in two counties: Machakos is located in a low rainfall region and Uasin Gishu is located in a high rainfall region, representing the country's main cereal-growing zone. The survey assessed the awareness and perceptions of agro-dealers concerning genetically modified organisms (GMOs), and their capacity to disseminate seeds of GM cereal crops. Further insights into these issues were exchanged through discussions held by policymakers and researchers from Kenya and the Philippines during the Biosafety Workshop in Nairobi in November 2010 (Odame and Okumu 2010).

1.4 Organization of the paper

The paper is organized into five chapters. Chapter One is the introduction, which covers the purpose of the study, the conceptual framework and the methodology. Chapter Two reviews biotechnology policy processes in Kenya. The results of a survey of agro-dealer GMO awareness, perceptions of potential benefits and risks of GM technologies and trading capacity is presented in Chapter Three. Chapter Four presents the two case studies of biotechnology delivery mechanisms: the cases of IR-maize technology and WEMA technology. Chapter Five provides a synthesis and conclusion of the study findings.

2.0 Biotechnology Policy Context

2.1 Overview

The role of modern biotechnology in the economic transformation and sustainable development of African agriculture is the subject of increasing debate and controversy. The subject has been at the forefront of international agricultural policy discussions and in the politics of international trade (Glover 2003). The polarity of US and European opinion on the societal impacts of biotechnology, specifically genetic modification, has equally shaped the biotechnology and biosafety debates in developing countries. The Kenyan biotechnology policy debate can be traced to the 1990s, however, in more recent years, it has acquired new dimensions as a result of a variety of factors including rapid scientific and technological advances in biotechnology, increasing commercialization of genetically modified foods, increasing food insecurity in Africa, and growth in the activities and influence of environmental activists. Despite ongoing debates and divergent opinions, the most important concern to both proponents and critics of biotechnology is the regulation (to minimize) the potential risks of GM technologies to the environment or health. With a focus on the downstream risks and effects of GMOs, biosafety regulation is just one piece in the multi-faceted issue of innovation governance.

This review of global-local biotechnology policy processes, from a historic perspective, is concerned with front-end issues such as investments, partnerships and IPRs in research as well as back-end issues including biosafety regulations in GM technology deployment. In so doing, the review employs the KNOTS framework of policy processes. As highlighted in the introduction section of this report, the framework comprises of three overlapping lenses: actors and institutions, their narratives, and their politics and interests. In this review, we contend that the interaction of these lenses create 'spaces' for influencing agricultural biotechnology policy agenda in Kenya.

2.2 Investments and partnerships in biotechnology

Global trends in modern biotechnology have seen increased investment in research and public policy development. The global context of agricultural biotechnology R&D policy is mainly influenced by interests of the private sector in both industrialized and developing countries. Whilst industrialized countries are ahead in biotechnology developments, developing countries are generally following, the existing gap is partly due to weak policy and regulatory frameworks to govern technology development and deployment, and limited national investment in biotechnology research. Public-private partnerships have also been significant in the development and deployment of modern agricultural biotechnology products in developing countries (James 2007), with multi-national corporations dominating funding for investment in biotechnology R&D. For instance, in the US venture financing reached an all-time high in 2007, with investment totaling about US $7.5 billion, fuelled by a record total of US $5.5 billion. Overall, the US is the global leader in biotechnology investment, R&D and the commercialization of biotechnology products (Ernst and Young 2007).

In contrast, through the National Agricultural Research Systems (NARS), governments in developing countries invest 5-10 percent of their total research expenditures on biotechnology. Donor funds accounted for a considerable share of the investment, amounting to roughly 60 percent in the case of Kenya and Zimbabwe (Jansen et al. 2000) .

Apart from private industry funds and NARS, financial support towards biotechnology also comes from International Agricultural Research Centers (IARCs). In particular, the Consultative Group on International Agricultural Research (CGIAR) invests an estimated US $25 million annually in biotechnology development. This figure represents 7.7 percent of the total CGIAR budget (Morris and Hoisington 2000).

At the global level, increased investment for biotechnology has been accompanied by a rapid expansion in the farmland areas covered by GM crops. Since the commercialisation of the first GM crop in 1996, the global area has increased from 4.2 million acres in 1996 to 282 million acres in 2007 - a 67-fold increase (James 2007). As of 2008, roughly 25 countries had started planting GM crops, cotton being the most common of these, and the land area being used to cultivate GM crops was estimated at 2 billion acres (or 800 million hectares). The number of global farmers cultivating GM crops had risen to 10.3 million by 2006. It was reported that approximately 12 million resource-poor farmers in developing countries (including South Africa, China and India) grew biotech crops in 2007, a significant increase since 2002 when the figure was closer to 5 million. In 2008 three new countries (including Egypt and Burkina Faso) and 1.3 million new farmers adopted biotech crops.

Trends in biotechnology investments and partnerships demonstrate that GM crops and traits (e.g. insect resistance, herbicide tolerance) that have been developed to date have been targeted at the needs of large-scale commercial farmers, particularly in North America. Agriculturalists such as the smallholder African subsistence farmers, on the other hand, have been largely excluded from consideration. The less well known crops grown by smallholder farmers in developing countries are not regarded as viable crops for biotech development. Similarly, crop traits of priority to subsistence farmers, such as declining soil fertility, drought, declining ground water levels and salinity, have only recently been considered by biotech developers. Many of the crop-growing challenges facing subsistence farmers in marginal areas require a variety of genes traits, whereas current GM crops provide only singular gene traits, such as Bacillus thrungiensis (Bt) or herbicide tolerance.

The limited response to the needs of small-scale subsistence farming by transgenics has led its critics to raise the need to look for alternatives, including such practices as ecological or organic agriculture, integrated pest and fertility management, participatory plant breeding, tissue culture, and marker-assisted breeding. These non-transgenic biotechnologies are considered cost-effective and do not involve the controversies related to GM development, such as IPRs and biosafety concerns.

Investment in agricultural biotechnology in Kenya is still limited to public-funded traditional technologies such as bio-fertilizers and tissue culture. However, there are declining trends in the public-sector funding of traditional (bio)technologies. In contrast, private funding is improving, though still confined to a few PPP research initiatives, focusing on the development of agricultural transgenic biotechnology such as a GM sweet potato, Bt. maize, Bt. cotton, and non-GM herbicide resistance in maize to combat the Striga weed. These research programmes are largely funded and supported by donor organizations, philanthropists and multinational companies, such as USAID and the Rockefeller Foundation, the Bill and Melinda Gates Foundation and the Howard G. Buffet Foundation, and Monsanto. Although many of these technologies are yet to be commercialised for adoption by farmers in Kenya, the partners behind them have stimulated activities in Kenya's science and technology (S&T) policy and influenced the development of legal and regulatory frameworks.

2.3 Intellectual property rights and access to biotechnology

Access to agricultural biotechnology products and processes by developing countries is becoming more difficult as biotech companies consolidate, merge and form strategic alliances. To access such goods, developing countries are required to form partnerships and make collaborative arrangements that can sometimes be to their disadvantage. Additionally, the inevitable commoditisation and privatisation of biotechnology often leads to products that are too highly priced for poor countries' access. In other cases, gaining access to transgenic biotech products that could address some of the cropping problems facing resource-poor farmers is severely limited by the extended ownership and complex arrangements of multinational companies. The related IPR implications include the imposition by multinational companies of limitless biological patents on particular GM crops, with serious repercussions for food safety, biological diversity, driving farmers towards dependency on costly seed, chemical purchases and foreign companies that produce them, and the compromise of both farmers' democratic choice and their food security (Berstein et al. 1990).

Whilst appreciating that the partnerships discussed in the preceding paragraph are fundamental for the growth and development of biotechnology, scientists and policy-makers in developing countries lack the necessary knowledge and skills for negotiating and collaborating with the private industry. Some efforts are being pursued under partnerships to increase the affordability of these technologies by negotiating for royalty-free technologies. However, closer analysis of these arrangements reveals that despite committing to providing royalty-free technologies, biotech companies are exploring Genetic Use Restriction Technology (GURT) to further their interests. GURT would ensure that farmers using this variety of seed would then be forced to purchase and apply additional chemicals that are needed in order for the new seeds to function (Millstone and Lang 2008). Whilst the GURT strategy will increase company sale revenues on one hand, it will simultaneously escalate the price of the seed/technology and further reduce the scope of affordability for resource-poor and smallholder farmers.

Issues of IPRs and regulations are crucial in the management of the modern agricultural biotechnology innovation process. In Kenya, seeds and planting materials developed through collaborative biotechnology research initiatives will be protected under Plant Breeder's Rights (PBRs). However, there still arise unresolved post-release IPR concerns, in particular, the extent to which Kenya Agricultural Research Institute (KARI) researchers may realize loyalty earnings, and the level of access and control by farmers' over the resulting technologies.

2.4 Biosafety Regulations

The creation of biosafety laws are a direct reaction to the development of modern transgenic biotechnology. The process of biosafety law-making in developing countries has been highly influenced by internationally-funded programs and projects that have often determined the direction of debates and actions (see box 1 below). The enacting of biotechnology policies and biosafety laws in Kenya has progressed slowly; stakeholders responsible for biosafety law-making have laboured over the process for an inordinately lengthy period of time, resulting in the development of a weak regulatory framework for biotechnology (Oikeh 2009) and the

Box 1: Biosafety regulations in Kenya-defining moments

1990 Government appointed "National Committee on Biotechnology Advances and their Applications" initiates an evaluation of biotechnology.

1993 DGIS Netherlands programme starts and Kenyan Agricultural Biotechnology Platform (KABP) is founded to initiate 'bottom up' biotechnology development projects.

1998 National Council for Science and Technology (NCST) publishes biosafety guidelines with KABP's support, which are then used to approve a series of subsequent GMO applications.

1999 Biosafety framework established via UNEP/GEF project2000; Government of Kenya signs Cartagena Protocol (UNEP-GEF, NCST).

2003 Government of Kenya ratifies Cartagena Protocol. GMO trial applications of sweet potato, Insect-Resistance Maize for Africa (IRMA) project, rinderpest vaccine and Bt cotton.

2004 Construction of Biosafety L-2 Green House Complex (BGHC) completed at KARI. Approval given for importation of Bt maize seed, and confined field trials.

2005 Relevant parliamentary committees advise ABSF and NCST to formulate biotechnology policies before the Biosafety Bill is passed. 2006 National Biotechnology Policy approved by cabinet, uncontested

2007 A private motion against the Biosafety Bill is debated in parliament. The bill becomes the focal point for debates 'for and against' GM crops.

2008 USAID-funded IFPRI Programme for Biosafety Systems begins. Lobbying for and against Biosafety Bill intensifies in and out of parliament. WEMA transgenic maize research project launched.

2008 Biosafety Bill passed by parliament.

2009 Biosafety Bill receives presidential assent and becomes law. Institutionalisation of National Biosafety Authority (NBA) to replace National Biosafety Committee (NBC). Regulations are drafted and implementation is begun.

2010 Launch of the NBA Board on May 13.

sluggish pace of biotech R&D (as illustrated by the WEMA case study in section 4.3 below).

Prior to the acceptance of the Biosafety Act in 2009, the Kenyan Government had relied on fragmented legislation to guide its biotechnology activities (Kingiri 2010). The purpose of the Biosafety Act was to 'regulate activities in GMOs, to establish the National Biosafety Authority (NBA), and for connected purposes' (Biosafety Act 2009: pg. 5). The National Biosafety Committee (NBC) was instrumental in the formulation of the National Biosafety Policy and the Biosafety Bill, and has since been replaced by the NBA. The role of the NBA includes implementation of the Cartagena Protocol on Biosafety to address issues of safety for the environment and human health, as well as carrying the responsibility of dealing with technical and policy issues involved in introducing GMOs into Kenya. The NBA Board is a broadly based multi-stakeholder entity composed of scientists, secretaries from key Kenyan ministries, directors of biosafety regulatory agencies, and representatives of farmers, consumers and the private sector.

In order to incorporate the views and opinions of the public whilst developing biosafety regulations, the NBA emphasized the need for farmer and consumer consultation. Sub-committees were formed in an effort to ensure that new biotechnologies are of relevance to Kenyan farmers, as well as providing a forum by which related concerns can be addressed. Another contentious issue is the current individual representation in NBA as opposed to institutional representation, which may compromise accountability and continuity –incase an appointed individual fails to attend meetings or communicate to the institution(s) s/he purports to represent.

2.5 Downstream impacts

The introduction of transgenic biotechnology in Kenya was justified on the basis of its potential to alleviate poverty, hunger and malnutrition (Wafula and Falconi 1998) by incorporating new traits such as herbicide tolerance, insect resistance and drought tolerance into crop varieties. Following the ratification of the Biosafety Act (2009) and the forthcoming Biosafety Regulations and Guidelines, efforts are underway to advance biotechnologies from research laboratories to farmers' fields. The contemporary challenge for Kenya is whether the country has the required structures, technical capacity and farmer empowerment programmes to support the generation and retention of appropriate and profitable innovations for smallholder farmers. Additional concerns include the nature of the acceptance of GM crops in Kenya, which are associated with the lack of local level capacity to manage the potential GM-related health and environmental risks and the representation of producer/user groups in research prioritisation and resource allocation. Although in recent times GM seeds and foods have been donated by global public and private sectors to alleviate poverty, hunger and malnutrition of smallholders in Kenya , it was only after the development of transgenic crops that the process began to pay attention to the issue of access to seeds for subsistence farmers. Unsurprisingly, therefore, opinions tend to be sharply divided on what are considered appropriate ways of identifying and managing the risks and uncertainties that surround the implementation of GM crops, and often centre on issues concerning transparency, participation and accountability in decision-making.

In summary, the global context of agricultural biotechnology R&D policy is influenced by interests of the private sector. In developing countries in particular, however, the biotechnology debate is largely dominated by the roles of public sector and the local, contextual interests of smallholder and subsistence farmers. Although private–public collaboration have become a popular institutional innovation in modern technology transfer to developing countries, the question of the appropriateness of transgenics to Kenya's smallholder farmers remains to be answered. In truth, multinational corporations tend to be the drive behind most PPPs, and in the process of promoting their own interests, lead smallholder farmers into relationships of dependency. In the following section, the pressing need for a biotechnology development strategy, which incorporates a strategy for balancing the private and public research interests of producers and users, and encourages the building of stronger and more stable bridges to institutional actors such as agro-dealers, is discussed.

3.0 Agro-dealer GMO Awareness, Perceptions and Trading Capacity

3.1 Overview

In Kenya, agro-dealers are the main conduit through which formal seeds are disseminated to farmers. Currently, there are no commercial GM cereal seeds in the country but development of this technology is at advanced stages and the seeds are expected to be released into the market in the near future. Naturally, once GM seeds become commercially available it is anticipated that agro-dealers will continue to play their role in the distribution of seeds. It is with this understanding that this study carried out an agro-dealer survey aimed at establishing the following: (i) agro-dealers' level of awareness about GMOs and the sources of their information; (ii) agro-dealers' perceptions of the potential benefits and risks of GMOs; (iii) the capacity of agro-dealers to deliver technology-specific information to farmers; and (iv) the ability of agro-dealers to communicate feedback on GMOs, including their associated liabilities and risks. The survey was conducted in two counties. Machakos was chosen for its location in eastern Kenya, representing low rainfall areas, whilst Uasin Gishu was selected for its location in western Kenya, representing high rainfall areas and the country's main cereal growing zone. A total of 140 agro-dealers were selected from main towns in the five districts (three in Machakos and two in Uasin Gishu), as shown in Table 1. The data was collected between October-November 2010, using a structured questionnaire administered by trained research assistants. Due to the ex-ante nature of

Table 1: Agro-dealer Survey Sample Distribution

County	District	Sample size
Machakos	Kathiani	23
	Machakos	24
	Matungulu	22
	Machakos Total	**69**
Uasin Gishu	Eldoret East	15
	Wareng	56
	Uasin Gishu Total	**71**
Total		**140**

Source: Agro-dealer Survey 2010

this study, there was limited agro-dealer experience with GM seed technology. Therefore, we sought to assess agro-dealer perceptions of GMOs, together with an exploration of their current trading practices in conventionally bred seeds, in an effort to predict agro-dealer capacity for trading in GM seeds.

3.2 Characteristics of Surveyed Agro-dealers

Most agro-dealer businesses are fairly young (Table 2), with the mean age averaging at about 5.7 years, but agro-dealers in Uasin Gishu had been in business longer (6.6 years) than their Machakos counterparts (4.8 years). About one third of the agro-dealers had been in operation for just two years or less, while only 15 percent had been in operation for more than ten years. In Machakos, nearly half (46 percent) of the agro-dealers were relatively new, having been in operation for two years at most.

A large proportion the agro-dealership owners were men (71 percent) and aged about 43 years. On average, Uasin Gishu agro-dealers were slightly older (46.5 years) than those in Machakos (39.4 years). Most agro-dealership owners were educated, with about 93 percent having attained a high school education and 65 percent having secured a college or university education (Table 3). However, only about 22 percent of agro-dealership owners with a post high school education had training in agriculture, whilst the rest had received training in animal health (31 percent), business (28 percent), or in the medical field (16 percent). About 46 percent of the total agro-dealership owners had been trained on some aspects of agro-dealership, however, a greater percentage had received this training in Machakos (62 percent) than in Uasin Gishu (33 percent). Although most business owners had a high level of training, only 50 percent of them managed their businesses on a full time basis, with a higher proportion of business owners in Machakos (59 percent) participating in the management of their businesses than their Uasin Gishu counterparts (41 percent).

Business size (stock value) and ownership of key assets differed among surveyed agro-dealers with regard to geographical location, gender of business owner and age of the business, as shown in Table 4. The average value of commodities stocked was 1.07 million. Howeveragro-dealers in Uasin Gishu, with an average stock value of Ksh 1.59 million, were generally larger than those in Machakos, with an average stock value of Ksh 0.56 million. Further, agro-dealerships owned by women were much smaller (average stock value of Ksh 0.37 million) than those owned by men (average stock value of Ksh 1.25 million). With regard to age, businesses aged below two years were almost ten times smaller (average stock value of Ksh 0.26 million) than those above five years (average stock value of Ksh 2.28 million). Only about 30 percent of agro-dealers owned the premises where they operated, with higher proportions of ownership found in Uasin Gishu (39 percent) and among the older agro-dealers, and lower proportions in Machakos (21 percent) and among younger agro-dealers. Agro-dealer ownership of vehicles (including motorbikes) was about 56 percent, but was higher on average in Uasin Gishu (65 percent) and among older agro-dealerships (72

Table 2: Agro-dealer Age Structure

County	Age category in years (% of sample)				
	2 and below	**2-5**	**6-10**	**Over 10**	**Mean Age**
Uasin Gishu	21	35	25	18	6.6
Machakos	46	21	22	12	4.8
Total	***33***	***28***	***24***	***15***	***5.7***

Source: Agro-dealer Survey 2010

Table 3: Education of Agro-dealership Owners and Participation in Business Management

Characteristic	Uasin Gishu	Machakos	Total
Male (% of sample)	71.3	71.4	71.3
Age (years)	46.5	39.4	42.9
Formal Education (% sample)			
None	3.8	0	1.9
Primary	8.8	1.3	5.1
Secondary	28.8	26.3	27.6
College	36.3	46.1	41.0
University	22.5	26.3	24.4
Post-secondary field of training (% respondents)			
Animal health	29.5	31.6	30.7
Business	36.4	21.1	27.7
Agricultural	22.7	21.1	21.8
Medical	2.3	26.3	15.8
Teaching	9.1	0.0	4.0
Some training in agro-dealership (% sample)	32.5	61.6	46.4
Main Occupation (% sample)			
Farming	15.0	12.0	13.5
Business	73.8	62.7	68.4
Employed government	7.5	12.0	9.7
Employed private	3.8	13.3	8.4
Participation in running business (% sample)			
Full time	41.3	59.0	50.0
Part time	58.7	37.2	48.1
Never	0.0	3.8	1.9

Source: Agro-dealer Survey 2010

percent for those older than five years), than in Machakos (46 percent) and among younger agro-dealers (39 percent for those below two years).

Agro-dealers are required to obtain a trade licence from local authorities (county/town/municipal councils), which then must be certified by the Pest Control Products Board (PCPB) and the Kenya Plant Health Inspectorate Services (KEPHIS). As shown in Table 5, almost all surveyed agro-dealers (98.6 percent) had been licensed by local authorities, whilst a smaller number had been registered with PCPB (78.3 percent) and KEPHIS (64.5 percent). While equal proportions of agro-dealers that were interviewed from both counties had trade licences, certification by PCPB and KEPHIS was much lower in Machakos than Uasin Gishu. Generally, the ability of an agro-dealer to obtain trade licences from relevant authorities seemed to increase with the number of years the business had been in operation. Almost all businesses that had operated for at least two years were likely to have been

Table 4: Agro-dealer Size (Stock Value) and Ownership of Key Assets

	Total	County		Business Age (Years)		
		Uasin Gishu	Machakos	Below 2	2-5	Above 5
Stock value (Ksh Million)	1.07	1.59	0.56	0.26	0.36	2.28
Own business premises	30.1	38.6	21.2	9.1	21.6	51.9
Own vehicle (% sample)						
Truck/van/saloon car	47.8	58.0	36.9	36.4	40.0	63.0
Motorbike	8.2	7.2	9.2	2.3	14.3	9.3
None	44.0	34.8	53.8	61.4	45.7	27.8

Source: Agro-dealer Survey 2010

Table 5: Proportion of Certified Agro-dealers by Region (County) and Age Category.

Certifying Agency	Total Sample	By County		By Age Category (Years)			
		Uasin Gishu	Machakos	Below 2	2-5	6-10	Above 5
Local Authorities	98.6	98.6	98.6	95.6	100	100	100
PCPB	78.3	85.7	70.6	67.4	84.6	90.6	70.0
KEPHIS	64.5	80.3	47.8	42.2	79.5	69.7	75.0

Source: Agro-dealer Survey 2010

licensed by local authorities. However, certification by PCPB was highest for the agro-dealers that were 6-10 years old, whilst registration with KEPHIS was highest for businesses that had been in operation for 2-5 years. Additionally, local authorities seemed to be relatively efficient in enforcing registration requirements, supporting the argument that certifying agencies should work closely with local authorities in an effort to enforce the legal requirements. Local authorities could, for example, be mandated to deny trade licences to seed dealers who have not been certified by KEPHIS and PCPB.

3.3 Agro-dealer Capacity

3.3.1 Receipt and Handling of Customer Information Needs

To get data on cereal seed customer information needs, agro-dealers were asked to rank selected types of information on a scale of 1-4 (where 1 was the most important) and a mean rank was calculated for each information type (Table 7). Overall, price was found to be the most important information need for customers at the seed shops, with a mean rank of 1.69. This was followed by information on variety yields (3.02), seed rate (3.28), and days to maturity (3.32). Seed price was the most important information need in both counties, however, the order of importance of other types of information was different thereafter. Uasin Gishu customer information needs were ranked as follows: yields (3.36), seed rate (3.39) and days to maturity (3.41). On the other hand, Machakos customer information needs were ranked in the following order: days to maturity (2.61), drought tolerance (2.69) and yields (3.67).

These regional differences in information needs may largely be explained by the fact that farmers in the low rainfall areas (Machakos) are more concerned about the ability of a seed/crop variety to withstand drought and reach maturity or to escape drought by maturing earlier, placing yield information needs after that of crop survival. On the other hand, farmers in high rainfall areas (Uasin Gishu) that typically have adequate rainfall to sustain crops to maturity, are most concerned about the yield potential of a variety. These results concur, in principle, with those of earlier studies conducted by Wekesa et al. (2003), who found early maturity and drought tolerance to be the most preferred maize characteristics by farmers in the coastal lowlands of Kenya (with lower rainfall); and Salasya et al. (2007), who reported high yield and early maturity (in that order) as the maize varietal characteristics most preferred by farmers in western Kenya, a higher with higher rainfall region.

In order for customers to receive accurate and sufficient information, agro-dealers must first be well-informed of GM crops, seed varieties, and their associated risks. This study therefore sought to establish the level of knowledge that agro-dealers commanded for conventional seed varieties stocked, especially concerning the information that has been identified as most valuable to seed customers. This data was then used to assess the capacity of agro-dealers to offer this knowledge to their customers. The study results (Table 8) show that an estimated 27 percent, 23 percent and 28 percent of agro-dealers were knowledgeable about yield potential, seed rate and days to maturity, respectively, of each maize variety they stocked. However, 8.5 percent, 12.3 percent and 11.5 percent of agro-dealers lacked knowledge concerning yield potential, seed rate and days to maturity, respectively, for each maize variety stocked. The remaining agro-dealers were knowledgeable regarding only selected varieties. The proportion of agro-dealers who maintained knowledge on yields and seed rate for all varieties stocked was slightly higher in Uasin Gishu, however, the opposite was true for information on days to maturity. Additionally, although information brochures are a vital reference point for basic varietal information,

Table 7: Key Information Sought by Cereal Seed Customers

Information Type	Rank (1=Most Important)		
	Uasin Gishu	Machakos	Overall
Price	1.27	2.13	1.69
Yields	3.36	3.67	3.02
Seed rate	3.39	3.89	3.28
Days to maturity	3.41	2.61	3.32
Drought tolerance	3.85	2.69	3.89

Source: Agro-dealer Survey 2010

Table 8: Proportion of Agro-dealers with/without Information for Stocked Varieties						
Information Type	**Had information for all varieties (% respondents)**			**Did not have information for any of the varieties (% respondents)**		
	Uasin Gishu	Machakos	Overall	Uasin Gishu	Machakos	Overall
Yields	48.5	35.4	26.9	9.2	7.7	8.5
Seed rate	30.8	15.4	23.1	16.9	7.7	12.3
Days to maturity	12.3	43.1	27.7	13.8	9.2	11.5
Information Brochure	12.3	18.8	18.6	44.6	40.6	42.6

Source: Agro-dealer Survey 2010

only 19 percent of agro-dealers had brochures for all varieties in stock, whilst a shocking 43 percent did not have any brochures whatsoever.

The study further assessed agro-dealers' capacity to address queries posed by cereal farmers by enquiring of the traders whether any seed customer had asked a question for which they did not have sufficient information to answer. According to the results, about 40 percent of agro-dealers had encountered questions which they found difficult to answer, with a higher proportion of the Uasin Gishu traders (46 percent) falling under this category compared to their counterparts in Machakos (33 percent). These results are consistent with assertions by Tripp (2006) and Langyintuo et al. (2008), that many agro-dealers are unfamiliar with the varieties they sell, a factor that constrains seed demand. The lack of knowledge on key varietal information among agro-dealers may be a clear indication of inadequate capacity among the traders to satisfy information needs of cereal farmers, potentially limiting the correct use and maximum benefits attributable to the adoption of improved farming technologies.

3.3.2 Incidences and Handling of Seed Customer Complaints

Through this study, we also sought to assess how agro-dealers handle farmers' complaints relating to cereal seed quality and whether affected farmers are eventually compensated for their losses. Results (see Table 9) show that during the last two years, 24 percent of surveyed agro-dealers had received complaints from customers. The main complaints were poor germination, susceptibility to diseases, malformed plant parts and abnormal height, reported by 55, 23, 13 and 7 percent of agro-dealers reporting complaints, respectively. Poor germination was the leading concern in both counties, susceptibility to diseases was a major concern in Uasin Gishu, and complaints of malformations and abnormal height were reported in Machakos. Reports of poor seed quality is not surprising given that more than one-third of agro-dealers (more than half in Machakos) were not certified by KEPHIS at the time of the survey (see Table 5). In addition, cases of extensive counterfeiting in the Kenyan maize seed market have been reported as a major

Table 9: Receipt, Handling and Fate of Cereal Seed Customer Complaints			
	Uasin Gishu	Machakos	Total
Received Complaint from Customer (% sample)	24.3	23.2	23.7
Nature of complaint (% respondents)			
Poor germination	68.8	40.0	54.8
Susceptibility to diseases	31.3	13.3	22.6
Malformed parts	0	26.7	12.9
Abnormal height	0	13.3	6.5
Other	0	6.7	3.2
Informed seed company or supplier (% respondents)	94.1	43.8	69.7
Whether the farmer was compensated (% respondents)			
Yes	12.5	14.3	13.0
No	50.0	57.1	52.2
Do not know	37.5	28.6	34.8
Such complaints can negatively affect business (% respondents)			
Yes	76.5	73.3	75.0
No	11.8	13.3	12.5
Do not know	11.8	13.3	12.5

Source: Agro-dealer Survey 2010

factor that not only negatively affects the country's seed industry, but also its maize production and food security in general (Owuor 2010; STAK 2008).

Most of the agro-dealers who received complaints from farmers informed the seed company or supplier responsible (about 70 percent on average), with a higher proportion of agro-dealers in Uasin Gishu taking such initiative (94 percent), than in Machakos (44 percent). Despite forwarding the complaints, 52 percent of the agro-dealers who took such initiative reported that the affected farmers were not compensated, whilst 35 percent did not know whether or not compensation was made. A meager 13 percent of the agro-dealers who forwarded customers' complaints reported that their farmers were compensated. About three quarters of the agro-dealers who received complaints from farmers believe that such complaints can negatively affect their businesses. These results support earlier claims of a weak feedback mechanism between seed companies and agro-dealers with regard to farmer complaints and preferences (Tripp 2006). Many farmers may be silently incurring losses as a result of the poor quality seed sold to them by unknowledgeable or naive agro-dealers, highlighting both the need for better trained traders and more effective channels for feedback and compensation.

3.3.4 Awareness, Sources of Information and Perceptions on GM Seeds and Crops

Agro-dealer awareness of existence of GM seeds and crops was determined by asking the survey respondents if they had heard of GM seeds or crops, to which they responded 'Yes' or 'No'. Results demonstrated a fairly significant level of awareness of existence of GM seeds among surveyed agro-dealers. However, this awareness varied across geographical regions, agro-dealer age and the level of education of the business owner (Table 10). Overall, close to half (49 percent) of the interviewed agro-dealers were found to be aware of existence of GM seeds, however, the level of awareness was higher in Uasin Gishu (58 percent) than Machakos (39 percent). This level of awareness is consistent those reported in earlier studies on consumer awareness of GM crops in Kenya (Gathaara et al. 2008; de Groote et al. 2004), which estimated that about half of surveyed consumers were acquainted with

Table 10: Agro-dealer Owner Awareness on GM Seeds by Region, Age and Education Level

County/Age Category	Level of GM Seed Awareness (% of Sample)
County	
Uasin Gishu	57.7
Machakos	39.1
Total	**48.6**
Agro-dealer Age	
0-5 years	41.2
Over 5 years	61.1
Owner's Education Level	
Primary	28.6
Secondary	31.6
College	50.9
University	64.7

Source: Agro-dealer Survey 2010

GM crops. Businesses that had been in operation for more than five years had a higher level of awareness of GM seeds (61 percent) than those that had been in operation for less than five years (41 percent). Further, level of GMO awareness was more than 50 percent where agro-dealer owners had a college or university education, but less than 32 percent where owners had not attained a college-level education. This result once again supports the findings of research conducted by Gathaara et al. (2008) and Kimenju and de Groote (2008) that respondents with a higher level of education also had a higher level of awareness of GM seeds and crops.

Agro-dealers who were aware of GM seeds and crops were provided with a list of information sources and asked to rank them on a scale of 1-4 (where 1 was the most important). Results (see Table 11) indicate that newspapers were the main source of information (75 percent of respondents), followed by television, radio, books, schools and NGOs (53 percent, 46 percent, 21 percent, 10 percent and 4 percent of respondents, respectively). Overall, the best ranked source of information was newspapers (with a rank of 2.37) followed

Table 11: Information Sources for GM Seeds/Crops for Agro-dealers

Information Source	Received Information (% respondents)			Rank of Importance (1=most important)		
	Uasin Gishu	Machakos	Overall	Uasin Gishu	Machakos	Overall
Newspaper	80.5	66.7	75.0	2.32	2.44	2.37
Television	65.9	33.3	52.9	2.76	3.15	2.91
Radio	68.3	11.1	45.6	2.24	3.67	2.81
Books	19.5	22.2	20.6	3.68	3.56	3.63
School	7.3	14.8	10.3	3.80	3.56	3.71
NGO	2.4	7.4	4.4	3.98	3.85	3.93

Source: Agro-dealer Survey 2010

Table 12: Agro-dealer Perceptions on Key Aspects of GM Seeds

Aspect of GM Seeds	Agree (% of respondents)			Don't Know (% of respondents)		
	Uasin Gishu	Machakos	**Total**	Uasin Gishu	Machakos	**Total**
Alleviate food shortage	78.0	81.5	**79.4**	12.2	11.1	**11.8**
More nutritious	12.2	38.5	**22.4**	34.1	34.6	**34.3**
More yield	63.4	77.8	**69.1**	19.5	18.5	**19.1**
Tolerate drought better	43.9	70.4	**54.4**	34.1	22.2	**29.4**
Resist pest better	42.5	63.0	**50.7**	27.5	29.6	**28.4**
Resist herbicide better	19.5	48.1	**30.9**	39.0	40.7	**39.7**
Contaminate local varieties	51.2	42.3	**47.8**	17.1	30.8	**22.4**
Dangerous to human health	50.0	40.7	**46.3**	30.0	29.6	**29.9**
Injurious to non-target organism	42.5	36.0	**40.0**	40.0	32.0	**36.9**
More expensive	53.7	75.0	**61.5**	17.1	20.8	**18.5**
Require more expertise to trade	63.2	58.3	**61.3**	21.1	12.5	**17.7**
Would trade in GM seeds	48.8	75.0	**57.4**	26.8	25.0	**26.2**

Source: Agro-dealer Survey 2010

by radio (2.81), television (2.91), books (3.63), schools (3.71) and NGOs (3.93). However, while newspaper ranked first among the information sources in both counties, ranking of the other sources differed. In Uasin Gishu, the three most important sources were newspapers, radio and television, in that order; whilst in Machakos, sources were ranked in the following order: newspapers, television, and books/schools. The findings confirm research conducted by Kimenju et al. (2005), which stated that the mass media was the main source of information on GM crops for Kenyan consumers. Interestingly, research findings also show that although civil society organizations advocating for farmer and consumer rights have been vocal in Kenya, and specifically in the study areas, they have not directly engaged agro-dealers on GMO debates.

Agro-dealer perceptions of GM seeds were assessed by asking respondents who were aware of GM technology what their position was regarding some key aspects of the technology (agree, disagree or do not know), as shown in Table 12. The results indicate that most agro-dealers were optimistic, allowing that compared to conventional seeds, GM technology would be more tolerant to drought (54 percent), resistant to pests (51 percent), give better yields (69 percent), and ultimately help in alleviating food shortage in the country (79 percent). This optimistic outlook among Kenyan consumers was also reported by Kimenju and de Groote (2008), who found that about 82 percent of surveyed consumers agreed with the view that GM crops would provide a solution to the global food problem. Only a minority of respondents agreed that GM cereal seeds could possess traits of improved nutritional quality (22 percent) and resistance to herbicides (31 percent), while 34 percent and 40 percent of the respondents were not aware that GM seeds could be superior in those aspects.

A significant proportion of respondents were also pessimistic that compared to conventional varieties, GM seeds would contaminate local varieties (48 percent), endanger human health (46 percent), injure non-target organisms (40 percent), be more expensive (62 percent) and require more expertise to trade (61 percent). These results were also comparable with those found by Kimenju and de Groote (2008), who had reported that a significant proportion of surveyed consumers raised the following concerns over GM crops: possible injury to non-target species (51 percent), loss of local varieties (51 percent), and risk to human health if consumed (up to 40 percent). However, consumers in the Kimenju and de Groote (2008) study were very optimistic that genetic modification would create nutritionally superior crops, contrary to the view of agro-dealers which was found during this study. Notwithstanding the pessimism expressed by surveyed GM-aware agro-dealers, more than half of them (57 percent) reported that they would trade in GM seeds if they were made available in the market, while 26 percent were unsure whether they would participate in the trade. Only 17 percent of the respondents were adamant that they would not trade in GM seeds. Again, these findings are comparable with those established by Kimenju and de Groote (2008), that most consumers in Kenya (68 percent) would buy GM maize meal at the prevailing (or even higher) prices of their preferred conventional maize meal brands.

Perceptions on GM seed attributes exhibited regional differences. Generally, agro-dealers in Machakos rated all the potential positive aspects of GM seeds more highly than their counterparts in Uasin Gishu. By contrast, the rating took an opposite trend for all perceived negative aspects of the technology, except the high cost of the seed. However, these differences were significant (10 percent level) with regards to aspects of nutrition (12 percent in Uasin Gishu and 39 percent in Machakos), drought tolerance (44 percent in Uasin Gishu and 70 percent in Machakos), pest resistance (43 in Uasin Gishu and 63 percent in Machakos), herbicide resistance (20 percent in Uasin Gishu and 48 percent in Machakos) and seed cost (54 percent in Uasin Gishu and 75 percent in Machakos). Attributable to the high level of optimism about GM seeds in Machakos, the proportion of agro-dealers who indicated that they would trade in GM seeds if they were available was significantly higher (75 percent) than in Uasin Gishu (49 percent).

Similar regional differences in public perceptions on GM crops in Kenya were also reported in a recent study by Anunda et al. (2010), in which members of public in arid areas (such as Machakos) were found to be more optimistic about GM crops and their perceived benefits, and more tolerant to perceived risks, than those in high rainfall areas (such as Uasin Gishu). While accounting for these differences, the authors argued that due to frequent crop failures and famines experienced in low rainfall areas, farmers in these regions perhaps perceive that such crops would be better adapted to their environment and therefore help mitigate the challenge of droughts. On the other hand, farmers in the high rainfall areas (such as Uasin Gishu) normally harvest enough food and may therefore not see the need for GM crops. It is not surprising then, that the proportion of agro-dealers who were willing to trade in GM seeds was higher in Machakos than in Uasin Gishu.

In conclusion, this survey has shown that agro-dealers in Kenya are differentiated with regard to geographical positioning, age, gender, level of training, formality/legal status, and business size and asset ownership. The level of knowledge that agro-dealers possess of current commercial cereal seed varieties, coupled their ability to address farmers' concerns over GM seeds and crops, differ with regard to the factors listed above. In general, agro-dealers' understanding of key information regarding seed varieties, and the capacity of agro-dealers to provide sufficient information to farmers, are currently inadequate. It has been shown that although farmers may raise seed quality issues, there is a breakdown in the complaints resolution mechanism, leaving farmers' concerns unaddressed.

Research findings demonstrate that agro-dealers have a mixed level of awareness concerning GM seeds and crops, and moreover demonstrate a varied response of optimism and pessimism about improved varieties. Most agro-dealers, however, are willing to trade in GM seeds. Nevertheless, this study has identified areas in which agro-dealers have demonstrated a lack of capacity to provide farmers with correct information about the conventional varieties. Additionally, the significant presence of illegal seed sellers and counterfeit seeds in the market are problematic. Further, agro-dealerships located in low rainfall areas, those owned by women and those that have been in operation for less than five years, may initially be in a disadvantaged position once GM seed varieties are made available in the market. These three groups have all been identified as commanding a lower capital base, which may limit their capacity to make the infrastructural adjustments that may be required to accommodate GM technology (e.g. finding separate stores for GM seeds). Bearing in mind that GM technology will require a much higher level of technical skills to trade than conventional technologies, these findings lead to the concern that Kenyan agro-dealership, in its present state, is not yet equipped to trade in GM seeds.

4.0 Biotechnology Delivery Mechanisms: Select Cases

4.1 Overview

The case studies under review, STRIGAWAY® Technology and WEMA, exhibit the roles of development partners, international and national research systems, the private sector (national and multinational corporations) and NGOs in shaping Kenya's agricultural biotechnology. STRIGAWAY® Technology is a technological package comprised of Imazapyr-resistant maize seed, fertilizer and a legume fodder seed (desmodium), which when applied on striga-infested maize fields are expected not only to suppress the weed, but also lead to increased maize yields. WEMA, on the other hand, is genetically engineered for drought-tolerance and developed to improve food security in Africa, especially for Arid and Semi-arid Lands (ASALs). Unlike STRIGAWAY® Technology, which has already been commercialised, WEMA is currently undergoing Confined Field Trials (CFTs) and mock-trials. STRIGAWAY® Technology is non-transgenic and is expected to provide a blueprint for the delivery of genetically engineered technologies such as WEMA. AATF has so far mobilized funding for the STRIGAWAY® Technology development and deployment, sometimes including subsidy packages to farmers. Both case studies have been advertised by AATF as royalty-free to small-holder farmers.

4.2 Testing the agro-dealer model: the IR-maize project case in western Kenya

4.2.1 Background

In 2006, AATF identified striga eradication as a priority problem that required immediate action. Striga is a parasitic weed that destroys cereal crops such as millet, sorghum, and upland rice, with greatest losses occurring in maize crops. The effects of striga infestation are diverse and long-lasting, causing food insecurity in thousands of households and limiting rural development. Striga is estimated to have invaded 2.3 million hectares of maize crop land in fifteen countries of eastern, southern and western Africa, accounting for 95 percent of the continent's striga-infested fields. In Kenya alone, striga infestation is most pronounced in western parts where it has invaded an estimated 210,000 hectares of maize farmland, resulting in total losses of about 300,000 tons of maize per year (AATF 2006).

AATF consulted with technology holders to identify an appropriate and effective technology that would reduce the threat of striga to maize production in Sub-Saharan Africa. A project dubbed the striga control project came into being in 2006, with financial support from the Rockefeller Foundation backing the testing a number of technologies for striga suppression, improvement in yields, net returns and its compatibility with other striga management technologies.

AATF was able to bring together public and private partners, guiding collaborative work by the employment of three key narratives: (i) ineffective traditional methods of striga control[Vii] demonstrated the need to devise an effective technology for its management; (ii) the need to develop a technological package that would not only suppress striga but also lead to maize yield increase; and (iii) the need to involve private sector participation due to the potential for profitable investments in the supply of seed and other farm inputs.

4.2.2 Partnership arrangements

From the project onset, a well-coordinated public-private partnership was considered vital for the success of the initiative, as quoted from a call to action by AATF in 2006: '...striga eradication requires that very different partners work together toward a difficult common goal' (pg 15). Thus, AATF's major role was to provide project stewardship in terms of technology brokerage and facilitating regulatory approval by KEPHIS. In this arrangement, several partners played different roles in the up-stream technology development.

BASF, a leading Germany multinational company in agrochemicals, provided the chemical Imazapyr, for which it holds intellectual property rights and the elite lines – IR-maize – a part of the Clearfield's Imazapyr resistance varieties. An initiative to develop a technology described as best-bet in striga suppression was undertaken by the International Maize and Wheat Improvement Centre (CIMMYT), the Tropical Soil Biology and Fertility Program of the International Centre for Tropical Agriculture (TSBF-CIAT), the International Institute of Tropical Agriculture (IITA), the Kenya Agricultural Research Institute (KARI) and the Weizmann Institute of Science of Israel. These partners settled on STRIGAWAY® technology, which is a technological package comprising IR-maize seed, fertilizer, and a legume fodder seed (desmodium), which, when applied on a striga-infested maize field, is expected not only to suppress striga but also lead to yield increase.

Once STRIGAWAY® Technology was identified as a technological break-through in striga eradication, AATF sought to partner with local seed companies in Kenya, namely the Kenya Seed Company (KSC), the Lagrotech Ltd and the Western Seed Company (WSC), for technology commercialization through mass seed production and marketing. However, on analysis of the level of investment required by the partners, together with the estimated returns on investment, only WSC stepped forward to enter into a partnership with AATF. Initial impediments to participation by seed companies in STRIGAWAY® Technology deployment is illustrated in Box 2.

AATF also brought new partners on board to participate in activities geared towards technology deployment, comprising both formal and informal grass-root organizations, such as the Western Regional Alliance for Technology Evaluation (WeRATE), a consortium of NGOs, community-based organizations and farmers' organizations. These NGOs have continued to act as intermediaries, despite the dissatisfaction that their role has caused amongst other partners during the AATF roll out of the Farmer Investment in Striga Technologies (FIST) package (the commercial model involving agro-dealers in STRIGAWAY® Technology, as their approach introduces procurement delays and even poor credit repayment.

Box 2: Impediments to participate by Kenya Seed Company in STRIGAWAY Technology deployment

Two main challenges discouraged the company from this business initiative. First, the IR-maize seed would only command a small market share compared to other maize hybrids which the company had already established strong distribution networks throughout the country. Secondly, one of the technological requirements involved setting up a separate seed processing line to minimize risks associated with Imazapyr herbicide. This additional investment did not seem commercially viable to the company given that the company would also be required to invest in agro-dealer training to ensure safety in handling as well as awareness creation among farmers. This would translate to high cost of the technology deployment which would eventually be passed to farmers. Thus, despite the good results of the technology in striga control, the company was skeptical as to whether the relatively high cost of the product would be acceptable and affordable to resource-poor smallholder farmers who were the most affected by the witch weed (Pers. Comm. Francis Ndambuki 2009).

Source: Source: Key informant interview

4.2.3 Technology delivery approach

Two strategies have been employed in delivering this technology: Striga Technology Extension Package (STEP) and the Farmer Investment in Striga Technologies (FIST). The STEP package takes a developmental approach with heavy input subsidies while the FIST approach is market-driven with credit services extended to agro-dealers and farmer groups. Both packages consist of different quantities of IR-maize seed and fertilizer, urea and DAP, each with user instructions in English and Kiswahili.

As a subsidized technological package, STEP was assembled by AATF in conjunction with NGOs, Resource Projects Kenya (RPK) and Appropriate Rural Development Agricultural Programme (ARDAP), to introduce IR-maize and related technologies to a large number of small-scale farmers through farmer groups. The package was comprised of 250g IR-maize seed (hybrid Ua Kayongo), 1.5kg fertilizer and user instructions, and was intended for application on 100m2 of severely striga-infested fields. With NGOs (FORMAT, ARDAP, RPK and CYEEP) mitigating costs by undertaking package deployment, it was made available to farmers at Ksh 90 per pack (approx. US $1.12).

AATF implemented the STRIGAWAY® Technology project commercial model of the FIST package, which comprises 2.5kg of IR-maize seed, fertilizer and desmodium seeds for application on 1000m2 (0.25 acres). FIST packages were deployed through farmer organizations on credit basis and were also made available through certified stockists in Western Kenya (Woomer and Savala 2008). Under this strategy, seed production and delivery are organized as follows: (i) AATF enters into a credit agreement with WSC for production of a given quantity of IR-maize seed, which WSC then produces; (ii) agro-dealers obtain the seed from AATF's lead partner, RPK, on credit; and (iii) agro-dealers pay RPK for the seed once they have sold it, and RPK, in turn, dispatches the money to WSC (AATF 2009). The FIST approach is still being conducted on a trial basis and is undergoing modifications to increase input access whilst building sustainability in approach. One such modification being considered is the setting up of a revolving fund which will ease seed procurement and ensure timely delivery of seeds to farmers, whilst simultaneously allowing agro-dealers to purchase additional stocks which will in turn reduce demand risks raised by WSC (Pers. Comm. Gospel Omanya 2010).

4.2.4 A critical analysis of STRIGAWAY® Technology deployment and use

The STRIGAWAY® Technology project exemplifies a few non-GM biotechnologies that are relatively successful in terms of deployment and use in Kenya. Farmers lauded the commercial model for improved maize yields, striga biomass and seed bank (seeds in the soil) reduction, as well as improved access to the technology. Farmer travel distance (walking) to NGO seed distribution points was reduced to less than two kilometers from over five kilometer trips previously necessary. Technology access to non-group farmers was also expected to improve, and in turn, boost sales for the seed company. However, these benefits and other envisioned project outcomes have not been fully realized due to the following challenges: inadequate and untimely seed supply, lack of capital, high price of seed, unstable seed demand and delayed or lack of payment for seed orders. Also, several fears have been raised regarding this STRIGAWAY® Technology that might affect its adoption . These include fear of contamination due to long-term residual effects in the soil, contamination of nearby crops and potential harm to livestock and human health by the chemical Imazapyr, especially when inhaled.

AATF's key narrative in its promotion of STRIGAWAY® Technology is that it gives preference to technologies that are simple, cost effective, and provide sustainable value to the farmer. However, the relatively higher price of IR-maize seed (at Ksh 170 per kg) and the accompanying inputs required by the seed, drive farmer preference towards other hybrid maize varieties (estimated cost at Ksh 120 per kg). This preference was also echoed by a group of farmers in two focus group discussions, together with other key informants, who specified several other challenges that make this technology more costly than alluded to by AATF (Box 3).

Further, these challenges limit the impact of the technology, as narrated by one farmer representative:

> 'ARDAP supplies only 1kg of IR-maize seed, which is not enough to create a big impact on our fields, thus, it takes a long time for the striga to be eradicated since the technology works best during the long rains only. Seed acquisition has been a problem since ARDAP stopped supplying seed directly (during field trials) and the main challenge now is the price of the seed, which has gone up tremendously from the initial ARDAP price of Ksh 90 per kg to Ksh 170 per kg in the agro-dealers. Also, farmers are still required to buy by order, passing so many channels before reaching the agro dealers.'

The problem of inadequate seed supply has persisted since the technology was first launched. As noted in Manyong et al. (2008), some early adopters were quitting the technology altogether due to its limited access and because they did not find it an appropriate means to providing sufficient food for their families on their small, intensively cultivated holdings. This study established that on average, it takes not less than two weeks for ordered seed to be delivered and if a farmer gets the information about the availability of seed in the agro-vets late, then she might not achieve timely planting, which can lead to low yields. Interruption in information flow regarding quality and volume of IR-maize seed, prevailing high prices and unreliable delivery timing all affect decision-making at farm level, and in effect, the commercialisation agenda of AATF and WSC.

Although AATF envisioned agro-dealers as playing a key role in IR-maize seed advocacy, technology delivery, and acting as extensionists, the farmers interviewed revealed that most of the technical knowledge they have on IR-maize seed was acquired from NGO extension staff, field days and farmer trainings as opposed to agro-dealers. According to farmers, attempts to solve emerging issues take the following approach: *Farmer → Training of Trainer → Field Officer → Project Coordinator → NGO Consortium in the region*. This means that farmers are yet to see agro-dealers as a source of technical knowledge on IR-maize seed.

The STRIGAWAY® Technology is royalty-free, but concerns have been raised over the likelihood of tying smallholder farmers into a dependency relationship with multinational corporations who supply the associated inputs. WSC argues that because of the low buying

Box 3: Benefits and challenges of adopting STRIGAWAY Technology

Deployment of the STRIGAWAY® Technology in western Kenya presents both benefits and challenges. Farmers lauded the commercial model for improved maize yields, reduced striga infestation and improved access to the technology. But these benefits have not been fully realized due to several challenges. For instance, the high cost of the technology throughout the production process has contributed to low adoption rates, and in some cases has even led to abandonment of the technology in preference to the conventional hybrids.

Benefits:

Farmers in the FDGs reported benefits in terms of yield gains while reducing striga biomass and improved access to the technology through local NGOs and agro-dealers in nearby local markets. In the past, farmers used to walk long distances of 10 km to buy maize seed. Some benefits of the STRIGAWAY® Technology were well articulated by the following farmer:

John* *reports: I pulled and buried striga on my two-acre farm for the past 17 years and the problem only grew worse. During a farmer field day in 2005, we learned about herbicide-treated maize seeds and I was one of the first farmers in the community to receive the new IR-maize seed. Ua Kayongo (the first IR-maize hybrid seed released in the region) has provided the best crop of maize that I have ever grown. I used to get 40kg from one-half acre but when I started planting IR-maize seed, I now harvest 200kg of grain from the same piece of land.*

Farmer Focus Group Discussion (FGD) in Bukhalalire village, western Kenya (Jan 2011)

Challenges:

The STRIGAWAY® Technology faces many challenges in western Kenya as most farmers traditionally use retained grain as seed and the formal seed systems in the region are not well developed for the supply of improved seed to farmers. First, the main challenge has been the high price of the seed which increased from the initial ARDAP price of Ksh 90 (US $1.12) per kg to Ksh 170 (US $2.05) per kg in the agro-vet shops. Second, lack of information on the availability of the seed also remains a challenge since seed passes many channels before reaching agro-dealers and farmers. Third, some agro-dealers fear trading in the IR-maize seed as they cannot sustain their businesses due to low demand by farmers and also the time the seed takes to reach the agro-dealers. This makes agro-dealers unreliable as source of the seed. For instance, farmers have often been disappointed by not getting the seed to buy from the agro-dealers on time and in enough quantities. Due to these challenges, on average farmers buy 6kg of IR-maize seed and plant less than 0.75 an acre per season while 10kg of other hybrid maize seed varieties is bought, planting one acre per season.

Source: Agro-dealer Survey 2010

capacity of agro-dealers and their inability to pay upfront, seed companies are not willing to give agro-dealers inputs on credit, unless that credit is guaranteed. The company also notes that although the AATF credit model provides some form of guarantee, its design introduces delays in seed procurement and there have been cases of uncollected ordered seeds, affecting revenue flow. To mitigate this risk, the Company has put more emphasis on confirmation of orders and receipt of down payment before it produces the quantity ordered by AATF.

According to agro-dealers in the region, the proportion of IR-maize seed demanded in 2010 was estimated at 14 percent, as compared to other varieties whose demand stood at 86 percent . The market share of IR-maize seed is minimal due to agro-dealers dealing with a majority of smallholder farmers whose incomes are very low, making input affordability equally low. This means that the level of IR-maize seed purchases will remain low unless there are external interventions to stimulate and sustain demand. Further, RPK, the NGO administering input credit on behalf of AATF, has had to deal with incomplete repayments and loan defaults which affect seed procurement for the next season, making the agro-dealer input credit model unsustainable.

AATF's principle of '...advancing market-led paradigms for greater returns on investments on additional input use, new production technologies and farm practices for increased household incomes and related agribusiness' is therefore faced with a myriad of challenges. It has been observed that there is a tendency to move back to developmental approaches, characterized by heavy donor support, instead of pursuing market-driven approaches.

Apart from promoting royalty-free striga-control technology, AATF took up a stewardship role which, according to the project brief,[xi] involves the 'development and implementation of a technology stewardship plan focused on seed stockists and maize farmers'. Under the project stewardship plan, AATF has so far achieved the following:

i. Creation of technology awareness through demonstrations, field days, printed and electronic media, translation of user guidelines into local languages in order to reach out to more farmers, participation in trade fairs and exhibitions.
ii. Facilitation of seed production and distribution.
iii. Monitoring and evaluation (M&E) conducted on a regular basis, however, more personnel are required to collect and collate data, synthesize information, recommend actions and disseminate findings to relevant stakeholders.

Box 4: Challenges for the optimal perfomance of WSC

It is the view of WSC that administrative delays at AATF contribute to less than optimal outcomes. For instance, after approval by KEPHIS, a process which took one year, it took another 12 months to be allowed to start producing and marketing the IR-maize seed. This was due to the conditions of multiple associated agreements, which have now been signed officially this year (2010) (long after WSC started producing and marketing IR-maize seed). Secondly, the funding pledged by BASF in 2006 towards acquisition of machinery and equipment had not yet been received in 2010. The company has been forced to borrow money from other internal sources to deploy the technology, train its staff, agro-dealers and farmers. Third and finally, the current input-credit strategy being administered by AATF through RPK is also proving to be a major risk where the orders are sometimes not honored and paid for as agreed. This makes the company incur huge losses (Pers. Comm. Osman, WSC 2010).

The prime movers of STRIGAWAY® Technology namely CIMMYT and WSC, have reservations over the research and extension capacity of AATF as it undertakes stewardship roles. In particular, AATF has amassed an increasing repertoire of roles and new partners, leading to delays in the technology deployment process and inefficiencies in M&E (see Box 4).

Upon seeking to know the position of AATF regarding administrative delays and capacity, Dr. Gospel Omanya was forthright in stating that '…the department is understaffed, we have collected a lot of data which has not been analyzed wholly to give appropriate guidance in redesigning delivery models and other aspects of the technology' (Pers. Comm., AATF 2010).

AATF has had to intervene on several occasions in terms of mobilizing resources for technology deployment and thus, is obligated to ensure appropriate use of the funds in order to be accountable to the financier(s), explaining its extended roles (see Box 5).

AATF supports RPK in its credit scheme administration task, a strategy which, farmers and WSC argue, introduces delays in seed acquisition. It would be expected that if indeed the FIST package is a commercial model, there should be no need of NGO involvement, which blurs the commercial nature of the model and instead makes it appear to be a developmental approach.

Box 5: Why the additional roles for AATF?

Once the technology was developed and ready for large-scale testing and awareness-creation, there was no institution (among the prime movers of the technology) prepared to invest in such an undertaking. AATF stepped in and mobilized funds for the multiplication of Ua Kayongo by WSC, which would be subsidized and deployed through local level NGOs and farmer organizations. On a second occasion, upon launching the commercial STRIGAWAY® Technology model, AATF realized that capital constraints impeded agro-dealers from acquiring substantial stocks of IR-maize and again stepped in to set-up an input-credit scheme, through an agro-dealer network which would build their capacity to stock more of the IR-maize packages (Pers. Comm. Gospel Omanya, AATF 2010).

In summary, the case study of STRIGAWAY® Technology exemplifies the process of evolving partnerships in technology development and deployment by bringing on board new partners to deal with challenges experienced in technology delivery. For instance, in its pursuit of striga eradication, the project expanded from an original network of four formal institutions to that of a diversity of formal and informal actors at different levels of the ImR-maize seed supply chain.

In as much as evolving partnerships are discernible in technology deployment, the case of STRIGAWAY® Technology introduces high transaction costs in the procurement process and also raises political economic concerns over whether this technology can be sustained as a purely commercial model for the target users. If sustainability is possible, which elements of sustainability should be put in place for a self-propelling commercial model with few actors? Who should these actors be and which linkages are vital in strengthening actor networks?

Although this project was designed with a commercial motive of promoting agribusiness PPPs, seed companies have to date borne substantial additional risk compared to participating public sector (i.e. government), farmers, farmer organizations and agro-dealers or stockists. This is because a seed company's return on investment is hinged on seed variety adoption, strong market networks, farmer repayment for input credit, own production risks, and those risks associated with delays in release of funds for additional investment.

The goals of the STRIGAWAY® Technology project would be more effectively achieved by paying greater attention to the needs of seed producers, grassroots collaborators and maize farmers. Financing innovations, especially for seed companies and their network of agro-dealers, would be additional tool in enhancing capital access. For instance, facilitating linkages between agro-dealer networks and financing institutions is recognized as a welcome move in increasing access to capital and seed business volumes. An alternative model is to set up a revolving fund, which is considered by AATF as a measure to build sustainability elements in the IR-maize seed technology deployment and use processes. Aside from the high price of seed, farmers' concerns also relate to human, livestock and environmental risks which have not been adequately addressed, despite being raised more than five years ago. Neither agro-dealers nor NGO extension workers have the capacity to educate farmers on these risks, as they have little or no information about the associated risks nor are they aware of possible mitigation measures. Therefore, the commercial/agro-dealer model adopted by AATF in the deployment of STRIGAWAY® Technology has been faced with several challenges which need to be addressed in order to achieve effective delivery to smallholder farmers in parts of western Kenya, as well as attaining possible replication in the WEMA project in the low rainfall regions of eastern Kenya.

4.3 Agro-dealer challenges of deploying GM seeds in Kenya: an anticipatory case study of WEMA

4.3.1 Background[xii]

Water Efficient Maize for Africa is a public-private partnership, led by the AATF with the aim of addressing the devastating effects of drought through the development of drought-tolerant maize and its extension to small-scale farmers in Sub-Saharan Africa. Seed development is being achieved through conventional breeding, marker-assisted breeding and biotechnology. Launched in March 2008, the project is implemented in five African countries (Kenya, Tanzania, South Africa, Mozambique and Uganda) by a consortium of actors including AATF (the lead partner), CIMMYT, national agricultural research systems in project countries, and the private multinational seed corporation, Monsanto. The project is funded by the Bill & Melinda Gates Foundation (BMGF) and Howard G. Buffett Foundation, to the tune of US $47 million over the first five years.

The project is anchored on a philosophy that links Africa's food insecurity and poverty to drought, and identifies biotechnology as a powerful tool that can be used to improve drought tolerance in Africa's staple crop, maize. This is also seen as a key strategy for spurring a new Green Revolution in Africa. According to the project brief available at AATF's website:

> "Africa is a drought-prone continent, making farming risky for millions of small-scale farmers who rely on rainfall to water their crops. Maize is the most widely grown staple crop in Africa – more than 300 million Africans depend on it as their main food source – and it is severely affected by frequent drought. Drought leads to crop failure, hunger, and poverty. Climate change will only worsen the problem. Drought tolerance has been recognised as one of the most important targets of crop improvement programs, and biotechnology has been identified as a powerful tool to achieve significant drought tolerance by the United Nation's Food and Agriculture Organization. Identifying ways to mitigate drought risk, stabilise yields, and encourage small-scale farmers to adopt best management practices is fundamental to realising food security and improved livelihoods for the continent. AATF is leading a public-private partnership called Water Efficient Maize for Africa (WEMA) to develop drought-tolerant African maize using conventional breeding, marker-assisted breeding, and biotechnology…"[xiii]

Based on this narrative, WEMA builds on an earlier project known as Drought Tolerant Maize for Africa (DTMA), a programme that uses conventional breeding techniques, by introducing biotechnological components, such as marker assisted breeding (MAB) and genetic engineering. DTMA is implemented by CIMMYT with funding from the BMGF. The justification for use of MAB and genetic modification tools in WEMA is that drought tolerance is a complex phenomenon that can only be achieved through a combination of networked factors, the realization of which cannot come through conventional breeding tools alone. In this context, MAB is a useful tool for assessing the breeding value of individual genomic regions of maize germplasm under moisture stressed conditions. Genetic engineering enables a breeder to combine genes from various geographical regions and organisms and, with high precision, introduce a single gene that directly affects the complex physiological pathways resulting in increased yields under drought conditions. It is argued that the realisation of drought tolerance traits in seeds would take decades, or even be impossible to achieve using traditional breeding tools, yet, there is urgent need to avail drought tolerant maize varieties to farmers in SSA.

4.3.2 Project approach and anticipated outputs[XIV]

A four-component approach is used in this project. First is the technical component, which aims to improve drought tolerance of African maize varieties. Second is the regulatory component, the objective of which is to develop the capacity of national and international product development teams to conduct risk assessments and prepare safety data dossiers for submission to regulatory authorities, for approval of confined field testing of the drought-tolerance trait. Third is the communication component, which aims to promote public awareness and consumer acceptance of developed maize varieties, test this maize in project countries, and develop incentives for its rapid deployment to needy smallholder farmers. Fourth is the governance component, the objective of which is to conduct and manage regulation of the project's research, product development, and innovations.

To achieve its objectives, the project draws on the expertise and capacity of each of the key consortium partners. The non-profit making organization, AATF, is the partner through which the project is funded and managed. They provide expertise in leadership, PPP management, technology stewardship and project management. CIMMYT, an international agricultural research organization, provides high-yielding maize varieties that are adapted to African conditions and expertise in conventional breeding and testing for drought tolerance. The private commercial multinational seed corporation, Monsanto, provides germplasm, advanced breeding tools and expertise, and drought-tolerance transgenics. The public national agricultural research system contributes expertise in field testing and seed multiplication and distribution.

The project is divided into two phases. During the first phase (research and development), new African drought-tolerant maize varieties with the potential to increase yields by 20-35 percent under moderate drought, will be developed. Under the second phase, market and reliability trials for the varieties will be undertaken, during which farmers will be able to assess their value. The two phases attempt to balance the uncertain dynamics of technology investment, risk and uncertainty in farmers' decision making, which, according to some studies, has tended to limit the adoption of drought-tolerant varieties (Brooks et al. 2009). In an effort to boost adoption, varieties to be developed under WEMA are expected to be distributed royalty-free, through AATF, to African seed companies, who in turn will supply them on a commercial basis (and at the going rate of maize seed) to smallholder farmers. The royalty-free transgenic material and the PPP institutional arrangement (with AATF as the technology broker) differentiate WEMA from its predecessor DTMA. It is expected that WEMA-developed transgenic drought-tolerant varieties will be accessible to farmers between 2015 and 2017.

4.3.3 Project Achievements and Challenges

According to the reports of various forums, by September 2010 the project had made considerable progress (see Oikeh 2010a; Oikeh 2010b; AATF 2009). For example, the development of CFT sites and conducting of mock trials, using conventional drought-tolerant varieties, had begun in all but one of the project countries. In addition, the partner countries, with the exception of Mozambique are at advanced stages of implementing CFTs: South Africa leads the pack, having harvested the first transgenic hybrids in May 2010. Kenya and Uganda had secured approval for CFTs for transgenics, which had been scheduled for October/November 2010, while Tanzania's application to carry out similar trials was awaiting final decision from authorities. Mozambique was planning to conduct mock trials in September 2010, and apply for CFTs in October 2010. WEMA had further trained more than 35 journalists from project countries in science and biotechnology reporting and made deliberate efforts to popularize the project locally and internationally.

These achievements have not come without challenges. The main challenge encountered so far has been bottlenecks in regulatory frameworks. In most of the project countries, the regulatory framework for biotechnology has been weak, with slow progress in regulatory framework development as a result of 'stops and starts' (Oikeh 2009). In Kenya, for instance, the regulatory framework for biotechnology was not in place until February 2009 when the Biosafety Act (2008) was approved. This Act sets out a strategy for the 'regulat[ion of] activities in genetically modified organisms... establish[ment of] the National Biosafety Authority, and... connected purposes', as explained in Page 5. This delay meant that WEMA activities in Kenya could not progress as fast as in South Africa, where the biotechnology regulatory framework had been in place much earlier (as already stated above, South Africa had completed the first CFT with WEMA transgenics by May 2010, while Kenya was still grappling with the regulatory challenges). Other challenges have included managing the large and dispersed project team; losing (highly-trained) key staff; handling communication issues around biotechnology and risk; and managing issues around confidentiality and intellectual property (Oikeh2010a; Oikeh 2010b).

4.3.4 Future challenges and their implications for agro-dealers

In the context of the intertwined food crises, poverty and general development challenges facing SSA, it is imperative that modern farming technologies are sought and applied in the region, in order that meaningful economic development is achieved. The goal of WEMA, in principle rhetoric if not in practice, resonates well with this agenda. However, a number of criticisms can be made of their approach, particularly the genetic modification element, which presents the project with key future challenges that can potentially constrain its impact in Kenya. These challenges are examined from a political economy perspective, which considers the technical, communication, regulatory and governance components of the project.

Climate change and variability present technical challenges for policy makers, who must necessarily employ a range of response strategies, rather than focusing on one option such as development of a single maize variety.[xv] For example, it is known that environmental changes create new burdens for poor smallholder farmers, who are already faced with a number of challenges such as crop failure, food and income insecurity, malnutrition and ill-health. Thus, droughts and other challenges for smallholders are interconnected and mutually reinforcing . Under these circumstances, drought-tolerant crop varieties, are limited in terms of how they address (or not) patterns of differential vulnerability and climatic variability between, and within, regions and social groups.

This challenge is particularly acute in low-rainfall areas (such as Machakos), where there are locally specific variations in the timing and intensity of rainfall. The AATF and other WEMA project collaborators consider genetic modification to be the main technological solution to droughts in such areas. This solution has been challenged by its critics on the basis that AATF has ignored other technologies and management strategies.

> '…the strategy substitutes 'drought tolerance' with 'helping plants to cope with the stress of drought' - a more rubbery, unquantified and undefined concept open to interpretation,' said Bob Phelps of Gene Ethics[xvii] .

The second technical challenge of WEMA is loss of diversity in farming systems. The Inter-cropping and planting of diverse varieties (inter-and intra-species diversity) helps maintain agro-biodiversity which acts as a protection against climate change, unpredictable weather, pests, weeds, diseases and even market variability[xviii] . It is feared that this would not be the case when WEMA becomes the dominant variety in any region.

The third technical and policy challenge relates to the politics of formal and informal seed systems. Biotechnology antagonists argue that 'biotechnology crops lack the latitude that evolution and seed saving provide and the genetic diversity to function across numerous conditions.[xix] Of particular concern is the impact that expanding an extension of the coverage of formal seed system will have on the informal seed system, and how a reduced informal market will impact livelihoods. As noted by Brooks et al. (2009), attempts of eroding the informal seed system, especially in drought prone areas, would leave smallholder farmers more vulnerable to seed and food insecurity because many smallholder farmers plant local maize seed, saved from the previous year, or from farmer exchange within the community, rather than purchase commercial seed from their local agro-dealers and stockists. These farmers are reluctant to invest their scarce resources in farm inputs given the unpredictable climate and frequent occurrence of drought, and their high confidence in the quality and reliability of local seeds within local agro-ecological conditions.[xx] It is also feared that GM WEMA varieties may have gene flow effects on local maize varieties, and will not allow saving and replanting of seeds.

The application of biotechnology in agriculture and particularly genetic engineering is a relatively new technology not only in Kenya but also in Africa at large. Hence, there is little awareness about both the process and its products. In Kenya for example, studies estimate awareness of GMOs among the general public at around 50 percent (Gathaara et al. 2008; de Groote et al. 2004). According to the Chairman of the Parliamentary Committee on Science and Technology in Kenya that attended a WEMA regional meeting of stakeholders in Johannesburg in April 2010 , there is a general lack of acceptance of these foods. This further implies that if agro-dealers are to effectively participate in deploying WEMA products and awareness campaigns, safety assurance to humans not only among the agro-dealers but also among their immediate customers (farmers) and the general public, will be required.

Even among those who are aware of GMOs, opinions differ with respect to the characteristics and/or impacts (real or perceived) on humans and the environment. Oikeh (2010b) argues that although there have been efforts to inform the public about GM technology, such initiatives are 'hijacked by anti-GM lobby groups, who… demonise GMOs' (Page 38). This is a hurdle that WEMA must overcome if the products of its investment are to be widely distributed and adopted and cause any meaningful impact. For example, in the agro-dealer survey section, we reported that 46 percent of the GM-aware entrepreneurs were of the view that GMOs are harmful to human health. If agro-dealers are to be effectively involved in deploying WEMA seeds, then they will need to be assured that the products are safe to humans, so that they can in turn assure farmers of the same and boost their chance of making sales.

Lack of capacity among the relevant regulatory authorities to enforce agro-dealership laws, as evidenced by the presence of unlicensed agro-dealers, is particularly problematic in low rainfall areas where WEMA products are targeted (Odame and Muange 2011). In addition, the agro-dealer survey section reported the presence of fake seeds in the market as well as customer complaints regarding seed quality.

An experience with GM maize in South Africa shows that the presence of poor quality seed in the market, even though it may be from genuine suppliers, results in significant losses that necessitate compensation. This case is contained in an article by Travis English on August 27, 2010, which reports that:

'... in South Africa in 2009, Monsanto's genetically modified maize failed to produce kernels and hundreds of farmers were devastated. According to Mariam Mayet, environmental attorney and director of the Africa Centre for Biosafety in Johannesburg, some farmers suffered up to an 80 percent crop failure. While Monsanto compensated the large-scale farmers to whom it directly sold the faulty product, it gave nothing to the small-scale farmers to whom it had handed out free sachets of seeds[xxii].'

The possibility of a similar occurrence in Kenya is high due to poor enforcement of seed trade laws.

Furthermore, the agro-dealer survey reported a very weak feedback mechanism between farmers and seed companies with regard to the former's complaints and priorities. This is evidenced by the small proportion of agro-dealers who forwarded customer's complaints to seed suppliers (especially in the low rainfall areas targeted by WEMA) and the even smaller proportion of reported compensations. This finding points to the possibility of smallholder farmers incurring losses that cannot be compensated because they purchased GM seeds from illegal agro-dealers or because the (fake) GM seeds they purchased cannot be traced to the company purported to have produced or distributed them. If agro-dealers in Kenya are to be effective in disseminating WEMA products, then there is need to strengthen the capacity of seed industry regulatory authorities to ensure compliance, as well as the capacity of agro-dealers to negotiate feedback and compensation between farmers and seed companies.

In light of the above arguments, WEMA has to overcome the challenge posed by the overall feeling of critics that GM technology is being pushed down the throat of the Kenyan government and the public by powerful external forces. The critics seem to be of the opinion that the apparently philanthropic biotechnology activities being carried out in the country favor private companies and foreign interests and do not seem to adequately regard farmers' concerns.

These concerns were also recently confirmed by Cooke and Downie (2010 of the Centre for Strategic and International Studies in their global report on food security that focused on African perspectives on GM crops. The authors reported that (Page 13):

'Non-governmental observers express a concern that because many of the research partnerships are externally funded, either by Western donor governments or private interests, research priorities may be skewed toward external or commercial interests and not coordinated in a way that meets Kenyan national needs or the needs of the smallholder farmer.'

An example of these commercial interests was revealed in The BioenergySite in December 19, 2008, in which the US Grain Council Director in the Mediterranean and Africa was quoted as saying that:

'The passage of this (Kenya's Biosafety) bill is a direct result of past Council efforts in the region. It also shows that pro-biotech forces in Africa have won a significant battle in the biotechnology debate.'

In addition, the Council's Director of Biotechnology was also quoted as saying:

'Our activities in Africa are a good example of how Council programmes on biotechnology can pay off in the long run... I'm very pleased to see that things worked out so well (Passing of the Biosafety Bill) in Kenya, a country that has emerged as a leader in biotechnology in east Africa.'

If the sentiments expressed in this section are anything to go by, there seems to be plausible concern that while genetic modification is a potential tool for fighting drought in SSA, it is not a silver bullet in that regard. In a press release dated August 25th, 2010, by Community Alliance for Global Justice's AGRA Watch Program, Travis English asserts that one conclusion by the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) report of 2008, was that 'small-scale agro-ecological farming is more suitable for the third world than the industrial agricultural model' – which includes the use of GM technology, advocated for by powerful philanthropic organizations and private multinational farm input companies..' Locally, a senior representative of the Kenya National Federation of Agricultural Producers (KENFAP) was recently quoted by Cooke and Downie (2010) as saying that there are numerous technologies (other than genetic engineering) in the country that haven't been fully explored.

Widespread distribution of WEMA products in Kenya is also likely to face the same limitations encountered in trading commercially available dryland maize technologies. Langyintuo et al. (2008) argue that conventionally-bred drought-tolerant maize varieties that increase maize yields by over 20 percent are available, but constraints relating to release and accessibility of seed hinder their widespread use by farmers. The authors further argue that farm-level constraints, such as lack of awareness of available varieties, the high price of seed relative to grain, farmers' reluctance to change from their old practices, inadequate access to credit to buy seed and complementary inputs and inadequate extension services, constrain demand by farmers for current varieties. This problem is compounded by agro-dealer constraints, the most critical being lack of credit to purchase and deliver adequate quantities of seed (Odame and Muange 2010). These constraints cast doubts over the capacity of agro-dealers to deploy WEMA products once they are released. To alleviate these constraints, activities will be required that raise farmer demand for improved maize varieties (WEMA products), and increase agro-dealer capacity to procure and distribute adequate stocks of the varieties to farmers.

5.0 Conclusion

The place of the small-scale agro-dealer in the New Green Revolution for Africa has been central in many programmes and projects initiated by governments, the private sector and public-private sector initiatives across Africa. The role of agro-dealers is to not only supply agro-inputs but also to act as a link between private seed companies, technology developers and farmers. Thus, they have a responsibility for offering technical advice (i.e. varietal information, input options, yields, agronomic practices, etc.) to farmers and providing feedback between actors in the input supply chains. In Kenya, public and private actors are committing substantial effort and resources to organise and facilitate agro-dealers in delivering novel technologies and allied information, in line with the Africa-wide initiatives of the New Green Revolution. Among the key technologies to be delivered are GM cereal seeds that have been developed for resistance to harsh environmental conditions, such as drought and insect pests, and enhanced nutritional quality.

From a political economy perspective, this study sought to investigate the policy and institutional environment shaping agricultural biotechnology development and deployment in Kenya, within which agro-dealers act as vehicles for the delivery of novel technologies such as agricultural biotechnology and allied information. The study drew on the insights gained from two case studies. The first test case is IR-maize, which is non-transgenic but already commercialized, and the other is WEMA, which is transgenic and undergoing confined field trials in Kenya. IR-maize technology is expected to inform the delivery of WEMA technology to Kenyan smallholder farmers, with the agro-dealer at the centre.

The established case of IR-maize has demonstrated that the current commercial model of agro-dealership has faced several challenges and, as a result, is not efficient in delivering novel technologies. First, agro-dealers lack adequate knowledge of the current commercial cereal seed varieties and are ill-equipped to address farmers' concerns about the existing technologies. Partly to blame are the ineffective complaints resolution mechanism and the poor linkages between technology developers and agro-dealers. The weak regulatory system has led to a mushrooming of *illegal* agro-dealers operating within the formal seed system that are inadequate at linking technology users and developers/organizations involved in deployment.

Second, agro-dealers in Kenya operate on a small capital base, which limits their ability to procure meaningful stocks for new technological products. In addition, they are forced to diversify into stocking not only inputs but also general merchandise to buffer against times of low sales resulting from the seasonal nature of demand. Although most agro-dealers are optimistic about new technological products like GM seeds, their main concern is whether the price of the technology (as a whole) can stimulate sufficient demand to warrant positive returns on the agro-dealers' investment. Such concerns are evident among stockists of IR-maize, who claim that the high price of the IR-maize seed reduces its demand relative to other conventional maize varieties. Thus, agro-dealers have called for stimulation of demand, achieved through assured markets for output and stability in output prices..

Third, regulatory enforcement has been a major constraint in the seed trade, leaving loopholes for trading in fake and poor quality seeds by unlicensed agro-dealers. Despite lacking adequate capacity to enforce regulations, the three agencies in charge of regulating agro-dealership (local authorities, PCPB and KEPHIS) often work in isolation, which further limits their overall impact. Unless synergies are developed between these agencies, illegal agro-dealers and poor quality, adulterated and counterfeit inputs will continue to flourish, ruining the efforts geared towards agro-dealers delivering a Green Revolution in Kenya.

So, with the introduction of GM technologies in Kenya and the likelihood that the agro-dealer model will be used in its deployment, to what extent are the needs and priorities of farmers considered? Based on the survey, farmers and agro-dealers welcome the potential benefits of GM crops and seeds: food security, yield improvement, drought tolerance and disease resistance. However, they are wary of perceived risks such as gene flow (causing marginalisation or disappearance of local/traditional varieties,) health and environmental risks, reliance on expensive external inputs, and seed quality issues. These fears are caused by information asymmetries among actors resulting from weak linkages and poor communication between the front-end and back-end stakeholders. In addition, much of this information is held by the technology developers but not by regulators, which further limits the effectiveness of regulation, participants in the Biosafety Workshop, 2010, pointed out:'. . . you cannot regulate a technology unless you know or understand it.'

Seed security is a centre-piece of policy and regulatory development. The issue of access to seed has been given a policy platform through the National Seed Industry Policy (2009) and the Biosafety Act (2009). A general concern, however, is that these policy developments were driven by stakeholders in the formal seed sector, despite the fact that this sector provides less than 20 percent of seed demand in the country, with the rest being supplied by the informal seed system. Development of regulations to guide enforcement of the Biosafety Act 2009 has not only ignored this reality but also excluded the participation of key stakeholders such as civil society organizations. The likely outcome will be heightened practical challenges of regulating the informal seed system in the face of new technologies such as GM seeds, which call for strict adherence to new aspects of seed laws such as plant breeders rights or patenting. In conclusion, agro-dealers may not have the capacity to provide effective linkages for deployment and local level regulatory control of new seeds.

End Notes

i http://www.answers.com/topic/biotechnology

ii The reason for public sector involvement was the dependency on the international public goods and national agricultural research capacity to develop new varieties adapted to local conditions.

iii The emphasis is on cereal seeds because they are the main crops important for food security. For example, maize is an important staple crop, averaging over 80 percent of total cereals (rice, wheat, millet and sorghum) (Mbote 2010). Poor maize yields result in food shortage and famine in Kenya (see http://www.steps-centre.org/PDFs/Steps%204%20Maize%20Security%20does%20not%20equal%20Food%20security.pdf).

iv This was revealed by a study carried out on investment in biotechnology in Kenya, Mexico, Indonesia and Zimbabwe during 1985-1997 (Jansen et al. 2000).

v Awareness here refers only to having at least some information that GM crops exist. Cereal GM seeds are not yet commercially available in the country therefore few agro-dealers would have significant knowledge about their attributes.

vi For more information on other striga management practices, see AATF, 2006.

vii Only AGMARK certified agro-dealers have been allowed to trade in ImR-maize seed.

viii See also: Fred K. Kanampiu, Joel K. Ransom, Dennis Friesena, Jonathan Gressel, 2002: Imazapyr and pyrithiobac movement in soil and from maize seed coats to control Striga in legume intercropping.

ix Interviews with agro dealers in Sega, Siaya County.

x www.aatf-africa.org/striga/. STRIGA Project Brief.

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xii Source: WEMA Project Brief, Available at http://www.aatf-africa.org/userfiles/WEMA-brief.pdf, Accessed January 2011

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xiv http://www.steps-centre.org/PDFs/Steps%204%20Maize%20Security%20does%20not%20equal%20Food%20security.pdf

xv http://www.steps-centre.org/PDFs/Steps%201%20Environmental%20Change.pdf

xvi http://ipsnews.net/news.asp?idnews=53247

xvii The use of Agrobiodiversity by Indigenous and Traditional Agricultural Communities in Adapting to Climate Change-Synthesis Paper-http://agrobiodiversityplatform.org/blog/wp-content/uploads/2010/05/PAR-Synthesis_low_FINAL.pdf

xviii www.stwr.org/.../market-led-development-aid-for-africa-good-for-business-bad-for-farmers.html

xix http://www.steps-centre.org/PDFs/Steps%206%20Living%20in%20parallel.pdf

xx www.aatf-africa.org/userfiles/PartnershipsNewsletter_5-6_Feb-July10.pdf. Accessed 17 January, 2011

xxi Source: www.foodfreedom.wordpress.com/2010/08/27/gates-foundation-invests-in-monsanto. Accessed 18 January, 2011

xxii www.thebioenergysite.com/news/2615/kenya-passes-biosafety-bill-aided-by-usgc-efforts. Accessed 18 January, 2011

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Appendix 1: Contact details of Key informants

Organization	Name of Key informant	Position
Western Seed Company	Syed Osman Bokhari	Commercial Director
Kenya Seed Company	Francis Ndambuki	Head of operations
OTIT Farm Care – Sega	Charles Odiero	Chairman, Agro Dealers, Western Kenya
ARDAP- an NGO	Boniface Omondi	Striga Project Coordinator -ARDAP
Ebachamani S.H.G	Salome Wesonga	Chairperson, Ebachamai S.H.G
Bulala Self Help Group	Philip Opicho	Chairperson, Bulala S.H.G
Maseno University	George Odhiambo	Lecture, Maseno University

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Western Seed Company	Syed Osman Bokhari	Commercial Director
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OTIT Farm Care – Sega	Charles Odiero	
ARDAP- an NGO	Boniface Omondi	Striga Project Coordinator
Bulala Self Help Group		Farmer group
2FGDs		Farmer group

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