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**Staple Crops, Smallholder Farmers and Multinationals:
The 'Water-Efficient Maize for Africa' Project**

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Staple Crops, Smallholder Farmers and Multinationals: The 'Water Efficient Maize for Africa' Project

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Doubling food production by 2050 under conditions of climate change and depleted natural resources requires increased investment and creative approaches. The Water-Efficient Maize for Africa (WEMA) project, a five-year public-private partnership begun in 2008 and led by the African Agricultural Technology Foundation (AATF), is an excellent example. Under WEMA, Monsanto, the International Maize and Wheat Improvement Center (CIMMYT), and national agricultural research systems in Kenya, Mozambique, South Africa, Tanzania and Uganda are developing, testing and disseminating drought-tolerant maize. Efforts involve both advanced, conventional breeding techniques and biotechnology tools. Transgenic drought tolerance from Monsanto and BASF is being added to elite, drought-tolerant maize lines from CIMMYT and Monsanto so that the new varieties will better withstand the increasing impacts of climate change in Africa. WEMA varieties under development have been licensed to AATF for eventual use by local, qualified seed producers and made available to them royalty-free.

The project reflects both Monsanto and CIMMYT's goals of putting advanced technology within reach of smallholder farmers in developing countries. In this pioneering effort, important challenges have arisen around project governance, contrasts in institutional culture, managing risk, intellectual property and external communications. More difficulties loom in the areas of regulatory approval, contracting, delivery and stewardship. Addressing these issues demands determination, creativity and good faith of all parties. WEMA is proving a valuable learning experience for participants and, hopefully, a model for multi-sectoral alliances that focus on crucial development aims.

Introduction

Doubling food production by 2050 under conditions of climate change and depleted natural resources requires increased investment and creative approaches. The public and private sectors have an increasing responsibility to work together to help smallholder farmers adapt to climate change. Agriculture has served as an engine of economic growth and as a major force for poverty reduction in many countries. But in sub-Saharan Africa (SSA), yields and poverty have changed little in recent decades (World Bank 2007). In most countries of this region, low agricultural growth, rapid population growth, weak foreign exchange earnings and high transaction costs in linking domestic and international markets all combine to threaten household food security. Chemical fertiliser use has expanded in most of the developing world, but not in SSA.

The risks of agriculture without choice: human and national deprivation

Sub-Saharan Africa is the only region in the world where both the number and the proportion of malnourished children is expected to increase over the next decade (Rosegrant *et al.* 2001). Over 60% of all people in SSA depend on agriculture for food and income. Most are members of very poor families with smallholder mixed farming systems in drought-prone areas with little access to inputs, service providers and produce markets, education and infrastructure, and an average annual per capita income of only US\$165 (FAO 2006; World Bank 2006). The average yield for maize region-wide is 1.2 tons per hectare, but in drought-affected years or on widespread, infertile areas, farmers obtain less. Poor harvests mean that households often run short of last year's maize before the next crop is ready for harvest, that school fees and health costs cannot be paid, and that no monies are available to purchase inputs for next year's crop.

Recurring droughts provide a continuous challenge to farming in Africa. A close relationship between maize yields and rainfall can be observed for eastern and southern Africa (Heisey and Edmeades *et al.* 1999). A terrible drought in 2002–2003 resulted in a food deficit of 3.3 million tons, with an estimated 14 million people at risk of starvation. A severe drought in the Horn of Africa as recently as 2008–2009 led the World Food Program to appeal for more than US\$230 million to provide emergency food assistance to

3.8 million Kenyans (WFP 2009). To make matters worse, the predictions of climate change suggest that increased variability of rainfall and temperatures will significantly affect maize grain outputs (Jones and Thornton 2009). Even under current circumstances, many farmers living in drought-prone areas are highly vulnerable and would benefit from crop varieties that are higher-yielding in good and bad years, and produce sufficient food in a much greater number of drought years. Stabilising and increasing productivity in the face of recurring droughts also has significant importance for crop diversification, soil fertility and income generation, as farmers typically respond to the recurring threat of drought by planting more maize than needed in an average year. Drought-tolerant maize varieties would provide them with food security on a smaller land area, freeing up land and labor for soil fertility-enhancing legumes, vitamin-rich vegetables and cash crops.

The importance of maize

Maize is the primary grain crop grown for human consumption in sub-Saharan Africa, forming a significant part of the diet (Bänziger and Diallo 2000). Over 650 million people consume on average 43 kg of maize per year (a 35% increase since 1960), reaching 85–140 kg in Kenya, Lesotho, Malawi, South Africa, Zambia and Zimbabwe (FAO 2006). Among different income groups, maize is a relatively more important source of both calories and protein for the poorer proportion of consumers (Byerlee and Eicher 1997), including HIV/AIDS-affected families who cannot afford more expensive foods such as bread, milk or meat. For a smallholder farm family, harvesting sufficient maize despite drought is core to family food and income security: it determines whether children eat twice or more a day and whether fees can be paid for them to attend school; it enables families to take care of their basic needs and to acquire assets as a reserve for harsher times. More than 50% of all SSA countries assign over 50% of their cereal area to maize. Maize production has strategic importance for food security and the socioeconomic stability of countries and sub-regions.

Many constraints adversely affect maize yields, including poor soils, weed and insect pressure and drought. In addition to its destructive effects on the food security and household economies of smallholders, drought is particularly damaging because it discourages farmers from investing in best management practices, including quality

hybrid seed and fertiliser, for fear of losing their investment. Because over 90% of SSA cropland is rainfed and likely to remain so, identifying ways to mitigate drought risk, stabilise yields and encourage investment in best management practices is fundamental to enable a 'Green Revolution' in Africa.

Drought-tolerant varieties: a reality

In collaboration with a wide range of public and private partners, CIMMYT has achieved significant successes in the development of drought-tolerant maize varieties (Bolaños and Edmeades 1996; Edmeades *et al.* 1999; Bänziger *et al.* 2006). The first suite of drought-tolerant open-pollinated and hybrid varieties adapted to SSA agro-ecologies were released in 1999, and through collaboration with a wide range of public and private partners seed production has been scaled up to plant over one million hectares every year with certified seed from the formal sector (Van Eckert *et al.* 2006). Through collaboration with the International Institute of Tropical Agriculture (IITA), under the Drought-Tolerant Maize for Africa (DTMA) project¹⁴, equivalent drought breeding methods have been applied to maize germplasm adapted to WCA countries, and West African national agricultural research systems are now annually providing 300 tons of breeder seed to community-based seed production schemes for diffusion to farmers.

Research by Monsanto on drought-tolerant maize

Drought-tolerant varieties developed to date by CIMMYT are benefiting farmers, but there is more that can be done. Monsanto is also working on drought tolerance in maize for commercialisation in the United States using a combination of

conventional breeding, molecular breeding and biotechnology techniques. Their research targets parameters associated with yield stability under drought conditions such as improved harvest index and kernel number. Monsanto evaluates hundreds of genes each year in its biotechnology pipeline. Its current lead drought tolerance event¹⁵ has been tested extensively and reached the pre-commercialisation stage. Data demonstrating the food and feed safety of this event have been submitted to numerous regulatory agencies around the world and are currently under review.

Monsanto invests about one billion USD in R&D each year. CIMMYT invests about USD 40 million in R&D each year. It thus seems clear that CIMMYT and other public research organisations should partner with the private sector to bring products of private investment to developing world farmers who cannot be reached through commercial market channels.

Water-efficient maize for Africa

The Water-Efficient Maize for Africa (WEMA) project, a five-year public-private partnership initiated in 2008 and led by the African Agricultural Technology Foundation (AATF), is an excellent example of a unique approach to help African farmers respond to climate change. Under the project, Monsanto, CIMMYT and national agricultural research systems in Kenya, Mozambique, South Africa, Tanzania and Uganda are developing, testing and disseminating drought-tolerant white maize. In the WEMA partnership, AATF is contributing its leadership, unique experience in public-private partnerships, and technology stewardship. CIMMYT is providing high-yielding maize varieties that are adapted to African conditions, expertise in conventional breeding and testing for drought tolerance, and its good name and the trust of partners in the region, including national research programs and local seed companies. Monsanto is providing proprietary germplasm from its global germplasm pools to introduce novel sources of drought tolerance to African germplasm, its conventional and molecular breeding platforms, drought-tolerance transgenes developed in collaboration with BASF, and its expertise in these tools. These contributions are being provided without royalty to the WEMA project. The national agricultural research

¹⁴ Formally launched in 2007, the DTMA (<http://dtma.cimmyt.org/>) is jointly implemented by CIMMYT and IITA and funded by the Bill and Melinda Gates Foundation and the Howard G. Buffett Foundation. Its activities build on nearly two decades of collaborative research beginning in Mexico to develop drought-tolerant maize and a history of generous support from donors including the United Nations Development Programme (UNDP), the Swiss Agency for Development and Cooperation (SDC), the German Federal Ministry for Economic Cooperation and Development (BMZ), the International Fund for Agricultural Development (IFAD) and the Eisele Foundation. Maize varieties from the DTMA provided yields as much as 30% higher than those of other widely-sown varieties in the severe drought that hit eastern Africa during 2009.

¹⁵ An 'event' refers to a specific instance of a specific transgene that was successfully introduced into the plant genome at a specific location and that is 'expressed' in an experimental maize plant.

systems participating in the project are contributing their expertise in field testing and play a key role in the development of the WEMA varieties, in seed multiplication and in distribution.

The partners estimate that the maize products developed over the next ten years could increase yields by 20–35% under moderate drought compared to current varieties. This increase would translate into about two million additional tons of food during drought years in the participating countries, meaning 14–21 million people would have more to eat and sell. In addition, the WEMA partnership provides a unique form of capacity building, especially through the extensive scientific training underway in participating countries.

Each partner has its own reasons for joining the partnership. CIMMYT joined to capitalise on the research and development investments of Monsanto for the benefit of African farmers. The centre has developed drought tolerance to a certain level in SSA germplasm and hopes that this work will be further amplified in the WEMA partnership, with help from Monsanto's marker-assisted breeding platform and the drought-tolerance transgenes.

Monsanto joined this partnership because it believes African farmers deserve the chance to choose the same kinds of technologies and tools as farmers elsewhere. Monsanto recognises the importance of providing drought-tolerance tools to smallholder farmers in Africa as quickly as possible and believes it has a responsibility to make that technology available to African farmers who choose to use it.

Lessons learned and issues to address

The deployment of improved maize varieties in Africa will require public and private partners working to develop a functional regulatory framework and improved seed systems. Regulatory systems in Africa must be developed that allow for timely field trials, collection of data and the deployment of transgenic products. They must give confidence to the public on the safety of the products. Success will also require seed companies that have excellent quality control measures and the infrastructure and production capacity for producing hybrid seed, while managing intellectual property at the delivery end. This partnership is designed to foster the growth and viability of small and medium-scale African seed companies, promoting healthy competition in the market place and, ultimately, an affordable supply of quality

seed and other inputs and services to farmers in the region.

The WEMA partnership is two years old and working towards developing and delivering drought-tolerant maize for African farmers. Over the last two years, we have learned many new things. Most importantly, we have learned that working in partnerships has its challenges and requires effective communication, both internally within the partnership and with external stakeholders. Monsanto and CIMMYT have very distinct institutional histories, cultures and expectations. Both have gained considerable experience already in working together and understanding what motivates the other.

More generally, the WEMA partners are diverse and represent the public and private sectors and several countries. All are learning to recognise and respect their differences and work towards a common goal of helping improve the lives of Africa's farmers.

Helping farmers face the future

The extensive challenges facing African farmers are expected to increase as a result of climate change. Helping farmers respond to them will require the leveraging of both public and private expertise. WEMA is an example of a partnership that does just that.

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