Strengthening the Maize Seed Sector in the Marginal Markets in Asia

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Background

The maize area, in South and South-East Asia, has been expanding by 2.2% annually, from 16.5 million hectares (2001) to 18.0 (2006) million hectares. Over 80 percent of this maize is grown under rainfed conditions and prone to drought. Drought has been identified as the most important abiotic stress in the region and climatic change and extraction patterns risk declining ground water tables. Addressing the problem of drought has been estimated to provide the highest technical returns to rainfed maize R&D investments in Asia. Substantial breeding progress has been made for drought tolerance in maize in other regions (Central America, and Eastern and Southern Africa) and the development of drought tolerant maize cultivars for Asia is thought to be both technically achievable and highly desirable.

However, for many small-holder farmers in the developing countries, access to, availability and affordability of seed of new crop varieties that are robust, drought-tolerant and high-yielding remains an urgent and lasting need. Both public and private sectors have the responsibility to develop sustainable solutions for agriculture, but delivery remains a challenge due to the remoteness and lack of infrastructure in stress-prone and outlying regions. It is a challenge for both public and private sectors to provide such solutions to farmers in these areas.

Developing and delivering technology to small-holder farmers on a large-scale often requires commercial solutions. Where government and market failures exist, these solutions may need to be nudged into existence by measures in the public interest that mitigate risk, and might include funding and other catalytic support. The Syngenta Foundation's Research and Seed Systems programs provide for this, as this brief paper shows.

Research partnership and project design

In recent years, significant progress has been made in the development of drought-tolerant maize (Bänziger and Araus, 2007) and highly-elite CIMMYT inbred lines available, whose resultant hybrids yield more than one t/ha than the existing commercial varieties under drought conditions. Much of this investment has been directed at Africa with insufficient spill-over to Asia or Latin America. Drought tolerance is a highly polygenic trait. Hence, effective introgression of drought tolerance into Asian germplasm requires transfer of several chromosomal regions into the target germplasm. This could be achieved through marker-assisted recurrent selection (MARS) with a pedigree (F1) or backcross population. Knowledge and careful selection of parental germplasm, accuracy of phenotype-by-environment interaction information for maximizing breeding progress is considered key to success (Ribaut and Ragot, 2007).

The Syngenta Foundation is a long-term supporter of breeding programs within the CGIAR and with NARS. The approach in recent years has been to develop public-private partnerships (PPPs) that bring the skills of the respective organizations closer together, realize the impact potential of CGIAR and NARS research, and build trust and longer-term links between public and private organizations involved in international agricultural research for development. All along, the goals motivating the collaborative relationship have included the delivery of research goods to farmers, and therefore, the creation of conditions enabling farmers to adopt the improved technologies that emerge from research.

Preliminary meetings between CIMMYT and Syngenta AG company scientists resulted in the development and conclusion of a PPP research agreement between the two parties, following the Syngenta Foundation PPP model. Key issues in forming such a partnership revolve around intellectual property issues and maintaining the business viability of the ideas without compromising the international public goods mandate of the CGIAR (or other IARC) center. CIMMYT brought its undoubted strengths in germplasm diversity, field trials and partnership approaches to reach small-holder farmers, and Syngenta AG brought strengths in plant genotyping, marker assisted breeding and product development expertise into the partnership. Both parties have germplasm resources that could be used to mutual benefit. A joint breeding consortium and initiative, involving through key Asian National

Agriculture Research Services (NARS), was subsequently developed and named "*Affordable, accessible, Asian drought tolerant maize*" or "AAA" project, for short.

The AAA project comprises three basic objectives: 1) To develop drought tolerant maize (inbred lines and hybrids) by breeding CIMMYT germplasm into locally-adapted Asian tropical backgrounds; 2) To develop drought screening facilities and protocols for public and private sectors; and 3) To identify novel sources and traits associated with drought tolerance. An early output of the initiative was the development of a number of fast-tracked, triple-cross hybrids using CIMMYT x Syngenta crosses. Results from testing of these fast-tracked hybrids, and strategies for their targeting and deployment, are briefly described below.

Targeting and product profiles

An important approach in identifying suitable hybrids for further testing and selection, was to carefully analyze target "markets" and to develop product profiles following standard commercial practice. The consortium initially targeted the approx. 2 million ha (M ha) of remaining OPV drought-prone maize production areas in India and about 1.5 M ha in Indonesia. A typical product profile is shown in Table 1. Equivalent, future target areas could include Myanmar, Laos and the Philippines. A key point in the strategy was the expected, high-seed productivity of triple-cross hybrids which will enable the future production of low-cost seed, deemed necessary to promote the uptake of hybrids by predominantly OPV producing farmers. The adoption of triple-cross hybrids could then be seen as a "stepping-stone" towards more sustainable intensification of the land and water resources.

Results to-date

A set of 132 candidate triple-cross CIMMYT x Syngenta hybrids were evaluated in both wet and dry seasons, in natural and managed-stress environments, in both India and Indonesia. Results from India, from 2012 and 2013 campaigns, are given in Table 2. Five promising hybrids, selected primarily on the basis of yield stability across target environments (2012-2014) and consistency with the developed product profiles, have been selected for future PLC 6.1 trials, seed bulking and seed production research.

Conclusions

Promising results from trialing candidate triple-cross hybrids indicate that the public-private partnership can deliver varieties which appear to offer promise for smallholder maize sector in Asia, as originally conceived in the development of the "AAA" partnership. In addition to the current OPV areas, there is a strong possibility that the AAA material can also address markets in the low cost F1 markets. Promising hybrids will be developed and seed will be made available to small-holder farmers, thorough public and private channels, including the CIMMYT-led IMIC-Asia platform, as deemed appropriate.

Very few formalized public-private partnerships exist in the area of crop breeding, but experience with the "AAA" partnership to date appears to demonstrate that the model can deliver wins for both the public and private sector, while at the same time, achieve the goal of supporting small-scale maize farmers in the developing countries in Asia. That these partnerships are not appearing independently indicates the need for brokerage of such arrangements. However, it is expected that such models will set a healthy precedent that can be replicated more widely in the future.

Table 1. An example of a typical "AAA" initiative product profile.

Trait or detail	Target region
Total production area	1,100,000 ha
Focus area	Madhya Pradesh
Market segment	Tropical rain fed (drought prone); low price
Potential market area OPV	700k ha
Yield targets	3 t/ha (currently 1.5) and 80% of single-cross hybrids
Basic traits	Maturity 85-95 days
"value-added" traits	Bacterial stalk rot and drought tolerant
Competitor varieties	Commercial single-cross hybrids and OPVs

Table 2. Average yields (t/ha) of the top performing AAA project triple-cross hybrids, arranged in descending order, from results from multi-locational trials in India in 2012 and 2013. Check is a commercial single-cross hybrid and hybrids selected for further trials are shown in bold.

2012 dry season	2013 wet season	2013 dry season (irrigated)	2013 dry season (drought)	2012/13 combined results dry and drought sites
TA5144 (2.6)	TA5084 (6.5)	TA5164 (6.4)	TA5034 (1.6)	TA5124 (1.6)
TA5124 (2.4)	**TA5024** (6.4)	TA5044 (5.3)	TA5164 (1.6)	**TA5144 (1.6)**
TA5084 (2.2)	TA5184 (6.1)	TA5014 (4.6)	TA5074 (1.4)	**TA5084 (1.5)**
TA5104 (2.2)	**TA5014** (6.0)	TA5034 (4.6)	TA0264 (1.2)	**TA5114 (1.5)**
TA5054 (2.0)	TA5034 (5-9)	TA5084 (4.5)	**TA5114 (1.1)**	TA5104 (1.4)
TA5114 (2.0)	check (6.2)	Check (3.4)	Check (0.5)	Check (0.6)
check (0.7)				

References

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