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Towards better metrics and policymaking for seed system development: Insights from Asia's seed industry

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ABSTRACT

Since the 1980s, many developing countries have introduced policies to promote seed industry growth and improve the delivery of modern science to farmers, often with a long-term goal of increasing agricultural productivity in smallholder farming systems. Public, private, and civil society actors involved in shaping policy designs have, in turn, developed competing narratives around how best to build an innovative and sustainable seed system, each with varying goals, values, and levels of influence. Efforts to strike a balance between these narratives have often played out in passionate discourses surrounding seed rules and regulations. As a result, however, policymakers in many countries have expressed impatience with the slow progress on enhancing the contribution of a modern seed industry to the overarching goal of increasing agricultural productivity growth. One reason for this slow progress may be that policymakers are insufficiently cognizant of the trade-offs associated with rules and regulations required to effectively govern a modern seed industry. This suggests the need for new data and analysis to improve the understanding of how seed systems function. This paper explores these issues in the context of Asia's rapidly growing seed industry, with illustrations from seed markets for maize and several other crops, to highlight current gaps in the metrics used to analyze performance, competition, and innovation. The paper provides a finite set of indicators to inform policymaking on seed system design and monitoring, and explores how these indicators can be used to inform current policy debates in the region.

1. Introduction

Policymakers often face difficult challenges in promoting seed industry growth in developing countries where the intended beneficiaries are small-scale, resource-poor farmers operating in highly fragmented markets. Yet as a pathway to enhancing agricultural productivity and improving food security, there is strong historical evidence indicating that improved cultivars—and the seed systems required to deliver those cultivars to smallholders—are a highly effective means of doing so (Evenson and Gollin, 2003; Alston et al., 2000).

Despite the introduction of seed policy reforms beginning in the late 1980s, many developing-country policymakers still express concern or impatience with the slow progress on enhancing the contribution of a modern seed industry to the overarching goal of increasing agricultural productivity growth. One factor that has contributed to this situation is the enormous complexity in designing and implementing policies, rules and regulations that are appropriate to a given country's context, stage of development, needs, and priorities. Many of these early policy reforms during the 1980s tended to fall short because they equated market liberalization with seed system deregulation and privatization, leading to protracted struggles over the appropriate roles for the public and private sectors in cultivar improvement, and seed production and distribution to farmers (see, e.g., Tripp and Louwaars, 1997; Tripp, 1997; Byerlee and Echeverría, 2002).

One explanation for the persistence of this struggle may be that policies have been formulated and executed with insufficient cognizance of the trade-offs associated with rules and regulations designed to govern a modern seed industry. Where the aim is to supply affordable quantities of high-quality seed of improved cultivars to populations and markets made up of heterogeneous farmers and farming systems, there is no single set of rules or regulations that leads directly to the development of a system that is both productive and innovative across breeding, seed production, regulation, distribution, and marketing. Rather, decisions on how to build that system must balance a complex set of societal and economic trade-offs.

Static trade-offs exist, for example, in the distribution of the gains from innovation among plant breeders, entrepreneurs, seed companies, public research organizations, and farmers themselves (Kloppenburg, 1988; Jaffee and Srivastava, 1994; Morris et al., 1998). Intertemporal trade-offs exist where present efforts to introduce yield-enhancing

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cultivars threaten the in situ conservation of genetic diversity required to support future investments in cultivar improvement (Smale, 2006). Actors involved in these decisions necessarily develop competing narratives around how best to build an innovative and sustainable seed system, each with varying goals, values, and levels of influence. As a country's seed industry evolves and grows in size and value, balancing these narratives become increasingly difficult—but no less important (Tripp and Louwaars, 1997; Scoones and Thompson, 2011; Coomes et al., 2015).

In many developing countries, efforts to strike a balance between these narratives often plays out in the policy discourse surrounding national seed policies, rules and regulations. Often, however, the public policy discourse tends to overlook changing realities in the region's agricultural sector and seed systems. These changes include, inter alia, the rapid growth in private investment in cultivar improvement, biotechnology, and seed production and marketing (Pray and Fuglie, 2001; Langyintuo et al., 2010); stagnation in the capacity and contribution of public research to cultivar improvement (Beintema et al., 2012; Flaherty et al., 2013); and insufficient investment in the conservation of in situ and ex situ plant genetic resources (Koo et al., 2004; Smale, 2006). Instead, the policy discourse is often mired in legal and regulatory dimensions of seed systems management, with disproportional emphasis placed on the minutiae of rules, guidelines, procedures, protocols, and organizational mandates without commensurate analysis of their costs and benefits (see Tripp et al., 1997; Tripp and Louwaars, 1997). In some instances, the narrative revolves around the public regulator's emphasis on protecting the farmer from unfair business practices by seed providers, possibly resulting in a constrictive regulatory system. In other instances, the narrative may hinge on the social planner's desire for a more liberal economic system, which may come only with the withdrawal of regulations designed to protect farmers. In still others, the narrative may revolve around optimal ways of conserving scarce natural resources and biodiversity, resulting in an entirely different set of regulatory priorities and mechanisms.

One way of shifting this discourse is to focus attention on the data and analysis that expand the understanding of how seed systems function. This paper explores these issues in the context of Asia's rapidly growing seed sector. Specifically, the paper explores current gaps in the metrics used to analyze performance, competition, and innovation in the seed industry, with a specific emphasis on maize in selected Asian developing countries. It then describes and characterizes a finite set of indicators to inform policymaking on seed system design, and explores how these indicators can be used to inform current policy debates in the region.

This paper proceeds as follows. Section 2 provides background on the performance and growth of the maize seed markets in selected Asian countries to illustrate the relationship between innovation and competition in developing-country seed systems, with several caveats on the paper's wider applicability. Section 3 critiques conventional indicators used to measure seed industry performance before proposing alternative indicators and examining the feasibility of collecting data on these indicators. Section 4 illustrates the utility of the proposed indicators for current policy debates surrounding Asia's seed systems. Section 5 provides policy recommendations and concluding remarks.

2. Innovation, competition, and maize

The present analysis relies partly on an industrial organization perspective on seed system development—a perspective that is slowly gaining currency in the study of agricultural development (Reardon and Timmer, 2012)—to illustrate the importance of measuring relationships between performance, innovation, and competition. For several reasons, maize provides an opportunity to demonstrate the utility of this perspective and the applicability of indicators that measure and monitor seed system development.

First, and unlike most other major field crops, maize has historically attracted significant levels of private investment in research, production, and marketing. Maize's appeal stems primarily from the breeder's ability to induce the expression of heterosis—an increase in yield or uniformity that results from genetic contributions derived from the crossing of distinct parental lines—in maize hybrids. This translates into economic value for breeders and seed companies because the yield gains conferred by heterosis decline dramatically after the first generation of hybrid seed (F1) is planted, thus compelling farmers to purchase new F1 seed each season to continually realize these gains. This is in contrast to the much lower economic value created by improving open-pollinated maize varieties (or by improving self-pollinated crops such as rice and wheat), from which harvested grain can be saved for use as seed in the subsequent season. In essence, the reproductive biology of hybrid maize confers a biological form of intellectual property rights protection to the breeder, creating an innovation incentive that has been central to fuelling a century of global knowledge accumulation in maize improvement in both industrialized and developing countries (Byerlee and Eicher, 1997; Morris, 1998; Fernandez-Cornejo, 2004). Estimates place the global market for maize seeds and traits at approximately $5 billion in 2006 and $10–12 billion in 2012, with the associated spending on R&D ranging from $1 to $4 billion (Fuglie et al., 2011; Bonny, 2014).[1] These figures are far greater than those for any other food staple crop.

Second, maize is an appealing crop to focus on given the rapid growth in demand for its use as feed for the livestock and poultry industries that supply Asia's rising population of consumers with incomes to spend on higher-value foods (Gulati and Dixon, 2008). The rapid growth in the derived demand for maize requires well-functioning markets for both maize seed and grain, a robust innovation system around maize improvement, and an effective regulatory system to sustain an innovative and competitive market. Yet in many developing countries, not all of these elements are in place, particularly the enabling policy environment needed to promote sustainable intensification of maize production among smallholders in Asia (Gerpacio and Pingali, 2007).

Third, earlier work on seed markets in Asia points to the maize seed industry's rapid growth as a "success story"[2] in which policy reforms introduced from the 1980s onwards succeeded in opening the market to private seed companies (Morris, 1998; Pray and Fuglie, 2001). Multinational seed companies with strong R&D programs and product lines played a central role in these markets, operating independently or in joint ventures with domestic seed companies in India (e.g., Joshi et al., 2005; Pray and Nagarajan, 2014), Pakistan (Rana, 2014), Thailand (Napasintuwong, 2014), and elsewhere. In India, for example, liberalization of seed market policy during the late 1980s encouraged the rapid growth of a private sector-led maize seed industry which, in turn, fuelled significant yield growth in maize (Morris et al., 1998; Pal et al., 1998; Pray et al., 2001; Ramaswami, 2002). The effects of this industry growth have been so substantial that the annual growth rates of yield, output, and area under maize cultivation during the period 2004–05 to 2013–14 were 2.9, 2.5, and 5.5%, respectively (KPMG/FICCI/NCDEX, 2014). Thailand experienced a similar growth pattern in which the combination of policy reforms and a strong public-sector maize development program in the 1970s transitioned the country into a hub for private R&D investment (see Fuglie, 2001; Napasintuwong, 2014).

[1] These figures are based on assumptions from Fuglie et al. (2011) that maize represents 25% of the global market value for private sector seed combined with more recent figures on the value of the global seed market from Bonny (2014). These figures are greater than R&D spending on other commercial crops such as soybean, cotton, or wheat, and greater than public R&D spending on maize. Among the "big six" multinational cropscience companies (Monsanto, DuPont/Pioneer, Syngenta, Bayer, Dow, and BASF), only two do not invest in maize R&D.

[2] For an analysis of how "success stories" come into being in the field of agricultural development, see Sumberg et al. (2012).