Global Food Security 10 (2016) 29–38

Contents lists available at ScienceDirect

Global Food Security

journal homepage: www.elsevier.com/locate/gfs

The growing role of the private sector in agricultural research and development world-wide

Keith Fuglie

Economic Research Service, U.S. Department of Agriculture, 355E Street SW, Room 6-178, Washington, DC 20024-3221, USA

ARTICLE INFO

Article history:
Received 7 March 2016
Received in revised form
11 July 2016
Accepted 16 July 2016

Keywords:
Agribusiness
Agricultural technology
Biotechnology
GM crops
Precision agriculture
Science policy
Venture capital

ABSTRACT

The private sector is playing an important role in developing technologies to raise productivity in agriculture. This paper presents new estimates of private agricultural and food R&D spending trends over the past 25 years. Global private spending on agricultural R&D (excluding R&D by food industries) rose from $5.1billion in 1990 to $15.6billion by 2014. Private R&D investment accelerated as agricultural commodity prices began to rise in 2003. Although the companies that account for most agricultural R&D spending are based in developed countries, their technologies have considerable and growing importance for developing countries. Some implications of these trends for public R&D policy are discussed.
Published by Elsevier B.V.

1. Introduction

Raising investment in agricultural research and development (R&D) to raise productivity of the world's farms, especially in developing countries, is thought to be essential for long-term global food security (Alston et al., 2009; Lobell et al., 2013). Although historically (due to market failures and the small size of agricultural firms) the public sector led investment in agricultural R&D, private agribusiness is playing an increasingly important role (Fuglie et al., 2012). Recent estimates of global spending on food and agriculture R&D found that private R&D has grown faster than public R&D, and in developed countries private spending now exceeds that by the public sector (Bientema et al., 2012; Pardey et al., 2015a).

How relevant is this trend for raising agricultural productivity in developing countries? One limitation of many global assessments is that estimates for the private sector combine R&D spending on food manufacturing and agricultural inputs. But detailed studies have shown that R&D by food companies is heavily oriented toward improving manufacturing processes and developing new food products. Except in some vertically integrated sectors like poultry, food R&D has limited relevance for production agriculture (Conner, 1981; Galizzi and Venturini, 1996; Fuglie et al., 2011). More relevant for agriculture is R&D spending by agricultural input manufacturers – seed, chemical, pharmaceutical, and machinery companies that invest in R&D to improve the quality of farm inputs. In an assessment of agriculturally-related R&D by agribusinesses, Fuglie et al. (2011) estimated that private agricultural R&D world-wide nearly doubled between 1994 and 2010, from $5.6 billion to $11.0 billion per year. Although more than 95% of this R&D was by companies based in developed countries, many of these companies operated global research networks to adapt and extend their technologies to serve global markets.

This paper extends Fuglie et al.'s (2011) results on global private agricultural R&D[1] spending to cover the years from 1990 to 2014. Having more up-to-date data provides insights into how international agribusiness responded to the rise in commodity prices since 2007. Generally, we would expect higher commodity prices to lead to greater farm demand for yield-increasing technologies, and thus greater R&D spending by agricultural input manufacturers to meet this demand. However, given the long lead times between new R&D spending and technology development and adoption, we would except a strong R&D response only if the price increases were expected to persist rather than be cyclical.

[1] Private agricultural R&D is defined as R&D by the business sector to develop new technologies for crop, livestock and aquaculture production. The business sector includes private and state-owned enterprises so long as they sell their products to the market. It excludes R&D by institutions financed by producer groups or industry associations as well as R&D by private universities.

E-mail address: kfuglie@ers.usda.gov

http://dx.doi.org/10.1016/j.gfs.2016.07.005
2211-9124/Published by Elsevier B.V.

The paper also revisits the question of how relevant private agricultural R&D might be for developing countries. Most private agricultural R&D is by companies located in high-income countries, although some of this is targeted to markets in developing countries. R&D spending by firms based in emerging economies is also growing. This paper uses two methods to allocate private agricultural R&D spending to markets in high income and developing countries. First, R&D spending is assumed to be targeted to the country or region in which each company is headquartered. Second, R&D is allocated to the country or region where each company sells its products. The second measure assigns a significantly larger share of private agricultural R&D to developing countries. The paper also examines how national policies in developing countries can incentivize private R&D, including by foreign multinational corporations, in their countries. Drawing on evidence from case studies presented in Pray and Fuglie (2015) and recent developments in agribusiness, the strategies pursued by the three largest emerging economies – China, India and Brazil - for acquiring agricultural technology services from the private sector are compared.

The paper concludes with a summary of key findings and discussion of their implications for science policy.

2. Methodology

For most countries, official estimates of private investment in agriculturally-related R&D are not comprehensive, if they exist at all. For countries that do report private agricultural R&D, it usually only covers R&D spending by firms in the farm sector (i.e., firms which primarily produce crop and livestock commodities). This misses most of the R&D by chemical, pharmaceutical, machinery, and biotechnology firms which develop and manufacture inputs for use by farms for agricultural production. This omission characterizes the private agricultural R&D data reported for European countries by the Eurostat and OECD databases. Only a few countries report private R&D spending by "socioeconomic objective," i.e., by the sector of intended use. The U.S. National Science Foundation (NSF), for example, occasionally reports R&D spending by firms in the manufacturing and service sectors that is intended for agriculture, but excludes agricultural firms from its surveys. Thus, it misses R&D spending by crop seed and animal breeding companies (which are classified as agricultural because they sell agricultural seedstock, though they are not "farms" in the usual sense). Fuglie et al. (2011) found R&D by seed companies to be the largest and most rapidly expanding component of private agricultural R&D spending in the United States.

To remedy this gap Fuglie et al. (2011) constructed a new and unique dataset on private agricultural R&D spending world-wide. First, they identified the major firms conducting research on agricultural inputs and then tracked each firm's spending on agricultural R&D over time. The sum of R&D spending among these firms, plus an allowance for R&D spending by small and mid-sized firms, provided an estimate of total private R&D for agriculture.

Firms were classified into seven input sectors: three for crop inputs (seeds/biotechnology, pesticides, and fertilizers), three for animal inputs (animal breeding, health, and nutrition for food animals and aquaculture), and the farm machinery sector. Industry associations and private consulting firms[2] specializing on agricultural input markets were contacted to identify leading firms in each input sector. For publically-traded firms, annual financial filings usually contain data on sales and R&D (unless R&D is an insignificant part of costs, in which case it is unlikely to be reported). Firms that manufacture products for both agricultural and non-agricultural sectors usually report sales by business segment but may not report agricultural R&D separately from other R&D. For firms that did not report agriculturally-related R&D separately from their total R&D spending, agricultural R&D was estimated either by contacting the firms directly for this information, prorating R&D across the firm's business segments in proportion to sales, or using an industry-average research intensity (R&D as a fixed percentage of sales). Similar approaches were used to obtain estimates of R&D spending by privately-held firms that did not published financial reports (although many such firms report sales and R&D information on their websites, at least for current years).

While Fuglie et al. (2011) were able to identify several hundred companies world-wide doing some formal agricultural R&D, they found that the largest 5–10 firms in each sector accounted for 80% or more of total R&D in that sector. Thus, trends in private agricultural R&D spending are driven by the investment decisions of a few large firms. Since most of the large firms publish audited financial reports annually, the aggregate R&D estimates should be reasonably accurate. Moreover, since R&D spending is often given a different tax treatment from other types of costs, firms are required to report R&D using standardized accounting criteria. Situations in which this approach does less well is when R&D in a sector is dominated by many small firms or when the dominant firms in a sector are privately-held and don't disclose financial information. In the 1990s, many biotechnology start-up companies invested in agricultural R&D, and it is difficult to get an accurate estimate of R&D spending by these firms (though they appear to make up a small part of the industry total). A similar situation may exist today regarding R&D for precision agriculture by IT firms, which is discussed later in this paper. The animal breeding sector is one in which there is a high degree of concentration (a few firms dominate poultry and pig breeding worldwide), but which are mostly privately held and don't make public their financial information.

The present study uses the same approach as Fuglie et al. (2011) and extends the estimates from 1990 to 2014. In the course of the current investigation several new firms were identified that have significant agricultural R&D programs. The present study also draws upon new evidence on private agricultural R&D spending in India (Pray and Nagarajan, 2014)[3] and China (Bryant, 2007; Hu et al., 2011; Zhi, 2013; CCM, 2014; Harkell, 2015).[4]

In total, the present study tracked the agricultural R&D spending of 324 companies world-wide (Table 1). This includes 182 companies that were operating in 2014 and 142 legacy firms

[2] Industry associations include Croplife International, the International Federation for Animal Health, the International Seed Federation, the Association of Equipment Manufactures, the International Fertilizer Association, the International Feed Industry Federation, and related regional and national associations. Consulting firms that specialize in global agricultural input markets include Agribusiness Intelligence (a division of Informa plc), Cropnosis for crop sectors, Vetnosis for the animal health sectors, and VDMA for farm machinery. Agricultural input firms may also publish special reports of their industries or include information of their markets and major competitors in their annual reports. In particular, Alltech publishes an annual survey of the global animal feed industry and Potashcorp publishes annual overviews of the global fertilizer industry.

[3] The author would like to extend a special thanks to Carl Pray and Latha Nagarajan for making available their firm-level data on agricultural R&D spending by private firms in India.

[4] Agricultural input industries in China have been highly fragmented, composed of many small manufacturers with little or no internal R&D (Pray and Fuglie, 2001; Bryant, 2007; Zhi, 2013). Companies with significant intramural R&D spending only appeared in the late 1990s. The estimates of private R&D by Chinese companies in the paper incorporate newly available estimates of R&D by leading Chinese seed companies from a survey conducted by the Ministry of Agriculture (reported in CCM, 2014) and by animal health companies from a survey by the China Veterinary Drugs Association (reported in Harkell, 2015).