The Role of Multinational Corporations in the Supply of Agricultural Production Technology to China & India

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Abstract

Policy makers in Asia have long struggled with the challenge of how to access agricultural technology from multinational corporations (MNCs)while protecting their farmers and food and input industries from excess market power. This paper describes the pathways by which farmers can access technology and research capacity from foreign firms. Then it examines some of the policies that India and Chinese governments have used to encourage access. The recent history of research and technology transfer to these countries is reviewed to do a preliminary assessment of how these policies work. India has had a much more liberal policy on foreign investment in recent years which resulted in more access to MNC research and technology. So far, however, there are no studies that show this policy led to higher benefits to farmers or lower costs of transferring technology. Studies of benefits and costs of these policies could be very useful to Indian and Chinese policy makers.

Keywords: Foreign direct investment, agricultural technology, technology transfer, industrial policy, agricultural research.

El papel de las corporaciones multinacionales en el suministro de tecnología de producción agrícola China e India

Resumen

Los responsables de la formulación de políticas en Asia han luchado durante mucho tiempo con el desafío de cómo acceder a la tecnología agrícola de las corporaciones multinacionales (CMN) al tiempo que protegen a sus agricultores y las industrias de alimen-

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doi: 10.18278/wfp.4.2.3

tos e insumos del exceso de poder en el mercado. Este documento describe los caminos por los cuales los agricultores pueden acceder a la tecnología y la capacidad de investigación de las empresas extranjeras. Luego examina algunas de las políticas que India y los gobiernos chinos han utilizado para fomentar el acceso. La historia reciente de la investigación y la transferencia de tecnología a estos países se revisa para hacer una evaluación preliminar de cómo funcionan estas políticas. India ha tenido una política mucho más liberal con respecto a la inversión extranjera en los últimos años, lo que resultó en un mayor acceso a la investigación y la tecnología de las multinacionales. Hasta ahora, sin embargo, no hay estudios que demuestren que esta política haya generado mayores beneficios para los agricultores o menores costos de transferencia de tecnología. Los estudios sobre los beneficios y los costos de estas políticas podrían ser muy útiles para los responsables políticos indios y chinos.

Palabras clave: inversión extranjera directa, tecnología agrícola, transferencia de tecnología, política industrial, investigación agrícola.

多国公司在供应农业生产技术一事上产生的作用：印度和中国

摘要

亚洲的政策制定者长期以来一直挣扎于如何在保护农民、粮食和参与生产的企业不被过度的市场支配力影响的同时，评估多国公司（MNCs）提供的农业技术。本文描述了农民能从外资企业获取技术和研究能力的相关途径。本文随后检验了印度和中国政府在激励获取技术和研究能力一事上曾采用过的政策。本文检查了近期有关这两国在研究和技术转移上的历史，以作出关于政策是如何实行的初期评估。印度近几年在外国投资一事上的政策更为自由，这导致获取MNC研究和技术的机会更多。然而目前为止，尚无研究表明该政策为农民带来了更多利益，亦或是减少了技术转移的成本。研究这些政策的利益和成本能为印度和中国的政策制定者带来许多帮助。

关键词：外国直接投资，农业技术，技术转移，工业政策，农业研究

1. Introduction

One of the gurus of the study of agricultural technology was Robert Evenson of Yale University. He argued that countries should focus on how to work with the multinational corporations (MNCs) to meet the countries' agricultural development goals rather than obsessing about how they might be exploited by MNCs. Agribusiness MNCs spend billions of dollars on R&D. They have developed important technologies that are used in many developing countries. Most of those billions are used to develop technologies needed by American, European and Brazilian farmers. But a lot of technology they develop and a lot of research that they conduct is applicable in developing countries.

The agricultural sector is often the last sector in which trade and restrictions on FDI are liberalized. This is because of the political and strategic importance of food security. Restricting FDI on agricultural input firms, is not necessarily the best way to ensure that farmers get access to the innovative technology needed to achieve food security.

Countries may be able to reach their food security goals more rapidly with policies that induce MNC investments but assure local businesses and the public that these companies will not exploit monopoly power or sell products that are unsafe for human health and the environment. China and India have at times severely restricted the role of MNCs in food and agricultural inputs while at other times they have encourage them to invest. The objectives of this paper are to assess whether India or China have done a better job of accessing technologies from MNCs and identify the policies that have led to successful access to MNC technologies.

2. Pathways to Access Technology from MNCs

There are three pathways through which multinational agricultural technology has spread to India and China. *First*, companies can import technology—either "borrowing" the technology without payments or purchasing the technology or the companies that make the technology. *Second*, technology can come in through foreign direct investments (FDI) by MNCs and *third*, technology and ideas can spillovers from multinational investments in the country to local industries and eventually to the farmers.

There have been a number of high-profile examples of borrowing. One of the most famous examples in India is the seed company NavBharat's "discovery" of insect resistant cotton

varieties their fields. They multiplied the seed and sold it as an insect resistant non-GE cotton variety before the government found out it was Monsanto's genetically engineered (GE) insect resistant cotton. A similar case was the Chinese company, Dabeinong. Some of their employees were caught in cornfields in Iowa taking hybrid maize lines from Pioneer and Monsanto. The leader of Dabeinong's U.S. seed subsidiary is now serving a jail term of 5 years for theft on intellectual property.

Indian and Chinese firms have legally imported pesticides, tractors, fertilizers, veterinary medicines and some seeds and technology embodied in them for decades. The biggest imports of inputs by value are fertilizers —particularly for India—although little new technology is embodied in them. In addition, there have been important imports of the machinery and knowledge to produce fertilizer, pesticides and agricultural machinery.

The purchase of foreign technology and research by purchasing high-tech companies has become important in the last decade. ChemChina bought Makhteshim, the Israeli generic pesticide company for about $4 billion in 2011 and recently bought Syngenta for $43 billion. Chem-China is a state-owned enterprise and the money financing these purchases came from government banks in China. India's private companies such as Mahindra and Mahindra in the agricultural machinery business and UPL, the generic pesticide giant have also made a series of purchases although none as large as ChemChina's purchase of Syngenta. More modest sized sales include Monsanto's sale of its small BT cotton seed program in China and Bayer Crop Science's sale of its maize and vegetable seed business in India to a local company.

The second pathway is through multinational investments in research and technology transfer in India and China. These investments can take place in wholly owned subsidiaries or joint ventures with local firms. MNCs are making major investments in plant breeding and in agricultural biotech in India. In China in the late 1990s when it appeared that the Chinese government might approve GM rice and maize, there was a burst of investments in biotech by Pioneer, Monsanto, Syngenta and others. Syngenta and Dow are investing in developing active ingredients of pesticides in India. John Deere and Kubota conduct agricultural machinery research in China, while Deere has a major research program in India.

Finally, there are spillovers of knowledge and technology from MNC. Spillovers take place to Indian and Chinese company through patents which reveal proprietary technology and how they work. Spillovers also occur through examining MNC products that are in use by farmers and trying to improve on them or complement them. Some spillovers take place through the movement of people. Scientists and technician move to other firms or develop start-up companies. When Monsanto dropped their rice biotech program in Bangalore, several former Monsanto scientists started the seed and biotech

firm, Metahelix. In China, the biotech company Dabeinong was able to higher scientists who had been laid off by a big Syngenta biotech lab in Beijing.

3. Policies and the Impact of MNC activity on input industry structure, research and tech transfer

Both countries have tried to use policies on FDI and imports to support the upgrading of local industry (Table 1). In the 1960s these policies took the form of protecting local infant industries by restrictions on FDI and imports of agricultural technology. Policies gradually shifted their focus to policies and regulations to provide incentives for foreign firms to transfer technology and management techniques through joint ventures and selling technology to local firms. These two types of policies were combined into FDI policies that would not allow foreign firms to enter Indian or Chinese markets unless they agreed to transfer technology and research capacity to local firms. These "Technology transfer for market access" policies were eliminated in India after 1990 but continue in China (Holmes et al 2015). At present under Prime Minister Modi's "Make in India" program foreign investment is encouraged, and agribusiness is emphasized as a good area to invest in. China officially eliminated most restrictions on FDI after joining WTO in 2000. Interviews with executives from foreign agricultural machinery firms in China confirmed that they can operate under the same set of policies and regulations as local firms (Personal communication with John Deere in Beijing 2017). In other industries explicit restrictions remain. For example, foreign investment in the seed industry can only be done through joint ventures with a Chinese company that own at least 51% of the company.

A policy in both countries that provides incentives for both foreign and local companies to invest in research and innovation is government investments in public sector research and universities. According to Pardey et al 2011 Chinese government agencies spend more than the US on agricultural research and India is third after China and the US.

Restrictions on imports of agricultural inputs continue to be a constraint to technology transfer and innovation. Since both countries are large countries, most foreign companies would eventually want to produce their products in China or India, but many would prefer to test the market with imported technology before they make major investments in production technology. Some would also prefer to produce key components of their technologies in their home country to reduce the loss of control over key intellectual property.

Intellectual property rights policies are similar in these countries. The Indian system started in the colonial period. In 1972 agricultural inputs and medicines were excluded from product patent protection. In 2005 patent protection for agricultural inputs and medicines were restored. The Chinese pat-

Table 1: Policies influencing MNCs investments in China and India

Policies	China	India
Foreign ownership	Foreign ownership not allowed in "prohibited" industries MNCs must be minority shareholders in "restricted" industries, 100% permitted in "encouraged" industries	100% ownership allowed
Tariffs & non-tariff barriers	Seed and other input imports by government only Local production requirements	Imports of seeds, finished pesticides, and machinery restricted Local production requirements
Investment in public ag. research	Largest in World	Third largest after China and U.S.
Intellectual property rights	Patents in ag inputs since 1990s Plant variety protection law—enforcement weak but improving	No patents on ag inputs until 2005. Plant variety protection laws—enforcement weak but improving Royalty & price controls on GM cotton seed not in other seeds
Price controls and subsidies on inputs and crops.	Price controls on fertilizer Subsidies on all inputs—local content may be a condition for subsidies Price supports on major grains until 2016	Subsidies on machinery, fertilizer, irrigation equipment and seeds Price controls and supports for major grain crops
Regulations on safety, environment an efficacy	Pesticides/fertilizer registrations/regulations GMOs limited to cotton Seed variety mandatory until recently	Pesticides/fertilizer registrations/regulations GMOs limited to cotton Seed registration voluntary
Presence of State-Owned Enterprises	Large & growing in all input industries Mechanism for buying foreign technology Exports encouraged	Sold or privatized most SOEs except in fertilizer and seeds

Source: Compiled by authors from various sources.

ent system went into operation in 1983 and was strengthened in 2000 when China jointed WTO. Both countries have plant breeders' rights legislation to protect new plant varieties. Finally, the enforcement of IPRs in both countries has problem but are improving.

A set of policies that differentiate China from India is the support of state-owned enterprises (SOEs). SOEs are no longer important in any agricultural input industry except the fertilizer industry. in the late 1960s the Indian government and state governments in-

vested heavily in government and co-operatives to accelerative fertilizer and modern seed production in India. Indian central and state governments also invested in tractor and pesticide SOEs, but they were never important shares of those markets. SOEs in most of these industries were gradually sold to private firms in the 1990s and 2000s.

The input industry was entirely state owned and consisted of thousands of seed, pesticide, fertilizer and agricultural machinery firms before 1978. These companies were organized to produce and supply agricultural inputs and were owned by various levels of government from the county level up the national level. After 1978 the government gradually replaced central planning with markets in the input industries. In addition, the government gradually commercialized these industries by allowing private firms to grow and purchase some of the assets of the SOEs while encouraging the remaining SOEs to operate as private companies and to consolidate into larger SOEs. The remaining SOEs are owned by the government agencies and must meet certain government goals.

Today the Chinese government is promoting SOEs to become high tech industries that are competitive globally. China National Machinery Industry Corporation (also known as Sinomach) through its subsidiary has a 33% market share of the medium to large tractors in China (Deng 2018) Subsidiaries of state owned SinoChem sold about 7% of the pesticides (Agronews 2016). Subsidiaries of ChemChina, another chemical SOE, had a substantial market share even before in purchased the largest generic pesticide company in the world – Makhteshim in 2011 and Syngenta, one of the largest global pesticide companies, in 2017.

4. Which country did the best job of "exploiting" the MNCs? Impact on farmers and global competitiveness of Chinese and Indian industries

Private agricultural research foreign firms were much more important in India than China. MNCs paid for about 40 percent of Indian private research in 2009 and there are no obvious signs that the foreign firms are crowding out private Indian R&D (Pray & Nagarajan, 2014). In contrast in China only about six percent of Chinese private agricultural input research was conducted by foreign firms in 2010.

In India MNCs play a larger role in sales than in China. About 30% of seeds sales, 30% of pesticides and 40% of tractor sales are by MNCs (Pray and Nagarajan 2014). In China less than 5% of seeds sales, 6% of pesticides, 17% of agricultural machinery and 12 % of fertilizer sales were by foreign owned firms in 2010 (calculated from Howell's dataset). The growth in market share of MNCs in India has led less concentration rather than more concentration as some predicted. MNCs reduced concentration in the seed sector where MNCs are most active and did not increase concentration on pesticides and

tractors (Pray and Nagarajan 2014) Seed prices from MNCs were higher than from local firms due in part to higher quality seed.

As a result, India got access to more technology in the seed industry than China. Maize hybrids from MNCs account for 60 percent of the maize planted in India (Pray and Nagarajan 2014) compared to about 10 percent in China (Personal communication, DuPont officials, Beijing 2016). The major biotech traits that have been commercialized are the same in both countries —Bt for cotton—but an important difference is that China is still has Bt traits from the 1990s while India second general stacked Bt traits.

All the active ingredients of pesticides in both countries were developed in the US, EU or Japan. The basic method of accessing these technologies until the 1990s was reverse engineering of foreign active ingredients and the development of local production methods for their production by government laboratories in China (Shi and Pray 2012) and a combination of government and private labs in India (Pray and Nagarajan 2014). Since the late 1990s, stronger patents have induced more technology transfer of new pesticides through FDI in both countries. In addition, Indian private companies such as UPL have purchased lines of business from DuPont and ChemChina purchased Makhteshim and Syngenta.

Early tractor designs in both countries were built with foreign collaboration with government corporations or private companies contracting for designs and expertise from the Soviet Union, Europe, the US and Japan. Some of these collaborations evolved

Table 2: Value and Share of Global Imports and Exports of Fertilizers, Pesticides and Tractors in global trade, China and India

	Fertilizers (2015)		**Pesticides (2014)**		**Tractors (2015)**	
	China	**India**	**China**	**India**	**China**	**India**
Imports (US $s Millions)	3,929 (5.9%)	7,459 (11.1%)	771 (2.2%)	990 (2.8%)	303 (0.65%)	34 (0.04%)
Exports (US $s Millions)	10,878 (18.8%)	97 (0.17%)	4,147 (11.9%)	1,940 (5.6%)	1,582 (3.02%)	10,002 (19.1%)

Sources: Fertilizer and Ag Machinery UN-COMTRADE: Pesticides; FAOSTAT. Figures in parenthesis indicates % of imports and exports in global trade

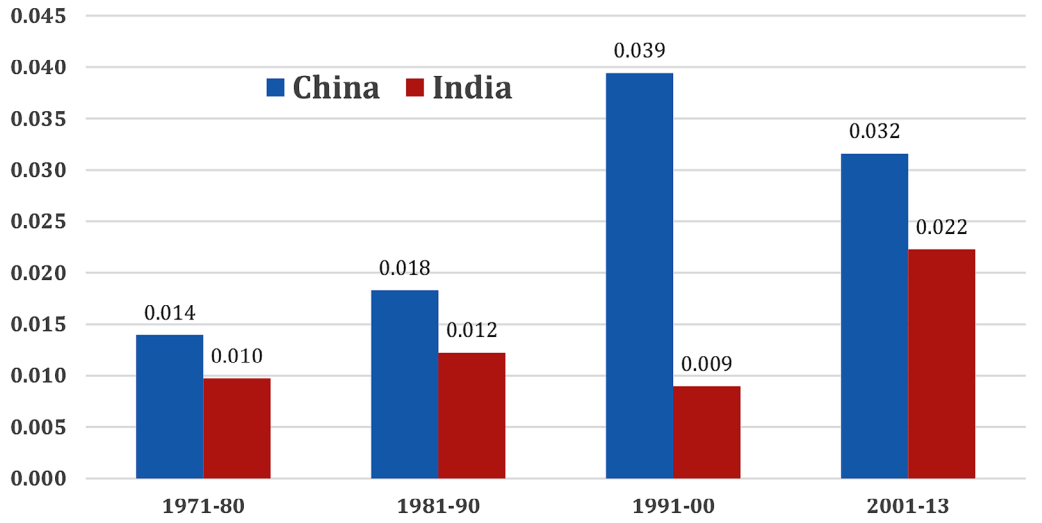

Figure 1. Total Factor Productivity (TFP) Growth—China and India (1971-80 to 2001-13)
Source: Keith Fuglie, ERS-USDA, Washington D.C., USA

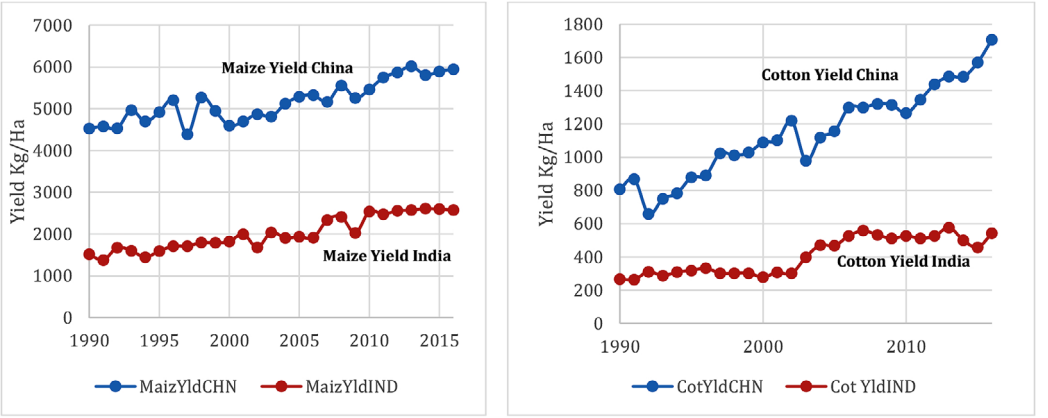

Figure 2. Maize and Cotton yields (Kg/Ha)—China and India (1990-2016)
Sources: Maize Yields (FAOSTAT, 2017); Cotton Yields (USDA-FAS, 2017)

into large foreign investments by MNCs in the 1990s. In recent years Chinese and India firms are buying foreign firms to access technology.

Imports of inputs that did not come through FDI or acquisitions of companies like Syngenta were virtually non-existent in seeds, limited in machinery and pesticides and large in fertilizer in both countries (Table 2). These numbers indicate that imports of modern technology imbedded in inputs was not very important since bulk fertilizer imports have little modern technology imbedded in them.

It is difficult to measure the impact of FDI and foreign technology on agricultural productivity. So far no one has measured its impact on total factor productivity.

Yields of corn and cotton are compared in Figure 1. The yields of cotton in both countries increased when GMO cotton was introduced from the U.S. There is no obvious difference in growth of corn yields despite more hybrid technology from MNCs in India. Data on total factor roductivity in the agricultural sector shows Indian productivity growing much more rapidly in after 2000 than in the decade before 2000. Chinese productivity growth is slower after 2000 than before(Figure 2), but FDI is likely to be very small factor in these changes.

Could allowing more FDI reduce the costs that governments, farmers and consumers pay for agricultural technology? The assumption of many policy makers is that farmers will have to pay higher prices for their inputs if they come from MNCs and consumers will end up paying higher prices for agricultural products. They cite high prices of hybrid seed or genetically engineered seed. Numerous studies of GM crops have shown that despite high seed prices and technology fees, these "expensive" technologies reduce farmer's total costs and increase their profits by lowering pesticide, labor and other costs (Klümper and Qaim 2014).

Both Chinese and Indian agricultural input industries have increased their competitiveness in global markets in recent years. In India the agricultural machinery industry has taken over 19 percent of the global market with considerable investments by MNCs (Table 2). Both Indian and MNCs are exporting machines to the Americas and the Europe. The Chinese agricultural machinery industry with much less MNC involvement, now makes up almost 12 percent of the world pesticide market mainly selling generic glyphosate with a big share going to Africa (Haggblade et al. 2017).

5. Policy options and future research

Do the experiences of India and China provide lessons for policy makers who want to increase research and technology transfer, reduce government expenditures, increase the competitiveness of Chinese and Indian firms, and improve farmers' access to technology? The following policy options seem to have some support from the literature.

1. Less restrictions on FDI and technology imports. This would mainly affect the seed and biotech industry in China but could also encourage the input industry in India. To be most effective FDI would need to be combined with stronger IPRs and less pressure for technology transfer.

2. Better IPR enforcement would increase investment in research and technology transfer by MNCs, Indian and Chinese firms without necessarily threat of monopoly power.

3. Strengthening SOEs is unlikely to increase farmers' access to technology except the purchases of large companies like Syngenta by SOEs with government financial support if it allows Syngenta to sell more of its technology in China.

4. Food safety and environmental regulations and enforcement need to be strengthened to ensure that farmers' have access to new technology but protects them and consumers from health and environmental issues. The need for science-based regulation is particularly acute with GMOs and gene editing which are now mired in politics in both countries. Ironically this allows farmers the Americas to reap the benefits of global (including Chinese and Indian) biological research that Chinese and Indian farmers are not allowed to use.

Two important areas of further research could be useful to policy makers. First, careful analysis of the impact of FDI on the agricultural input industries and food processing industries and then measurement of the impact of innovations from these industries on agricultural productivity, labor and the environment. This would allow governments to assess the benefits from FDI.

The second area for future research is assessing the costs to governments, local industry and farmers of FDI. Paying U.S. $43 billion of government money for a company like Syngenta and merging it into an $80 billion state owned chemical company may not be the most efficient way to access foreign biotech, seed and chemical technology. Constructing appropriate counterfactuals will be a challenge but such studies could provide policy makers with a better assessment of the costs of different strategies.

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