Research Policy 38 (2009) 793–801

Contents lists available at ScienceDirect

Research Policy

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

Reforming intellectual property rights and the Bt cotton seed industry in China: Who benefits from policy reform?☆

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ARTICLE INFO

Article history:
Received 9 June 2005
Received in revised form 10 December 2008
Accepted 18 December 2008
Available online 29 January 2009

Keywords:
Biotechnology
Intellectual property rights
Seed industry
China

ABSTRACT

China has been one of the leaders in agricultural biotechnology research and the adoption of transgenic plants. Despite this, critics argue that China's biotechnology policies could be improved to provide more benefits to farmers. The objective of the paper is to examine if policy changes could improve the welfare of farmers in the cotton industry. The paper first reviews recent changes in laws and policies that affect China's plant biotechnology sector—with a focus on IPR legislation and seed industry reform. Next, using a primary data set collected from 1661 plots from a sample of farmers in northern China in 1999, 2000 and 2001, we econometrically estimate the effect of changes to intellectual property rights (IPR) and seed industry reform on farmer pesticide use and yields. Our results are consistent with a conclusion that improvements to the IPR environment and greater commercialization of the seed industry can increase the benefits that farmers derive from new cotton technology.

1. Introduction

Until recently, China's government successfully raised the productivity of the agricultural sector with new plant varieties and other modern inputs (Zhang and Fan, 1999; Fan, 1999). Because of a number of perceived problems with the public-sector dominated system, since the mid-1990s reformers have tried to encourage new institutional approaches to develop and disseminate new varieties. Leaders have passed a number of new laws governing intellectual property rights (IPRs). Officials are experimenting with new biosafety management approaches. There are new initiatives pushing for the commercialization of the crop breeding system and seed industry (Louwaavs et al., 2005). In many of the efforts the private sector is being encouraged to play a larger role. In the case of the cotton industry the government has allowed joint ventures between international companies and domestic seed firms to commercialize genetically modified (GM) cotton. While it is clear that there are still weaknesses with China's IPR environment and seed industry reforms, a number of studies have documented the success of China's GM cotton technology in increasing the productivity of farmers (Pray et al., 2001, 2002; Huang et al., 2002a,b; Jia, 2004; Wu and Guo, 2005; Yang et al., 2005a,b).

Despite past successes, a number of questions remain about the sustainability of the way China is developing and extending agricultural technology. Will weaknesses in the IPR environment in China hurt the effectiveness of the technology that is in the field? Are the seed reforms working? Are new seed firms providing farmers with high quality seeds? Do seeds that come from foreign, joint venture firms (using foreign-produced genetic material) outperform those of domestic firms?

The overall goal of this paper is to help answer these questions. We seek to do so by quantifying some of the benefits of reforming China's IPRs and seed industry policies. We explore the benefits of two sets of policy reforms: (a) increasing the scope and improving the enforcement of IPRs; and (b) reforming the policies that govern the seed industry.

The main contribution of our paper is that it analyzes the effect of these policies using microeconomic models of household and firm behavior in China. Although the literature contains much discussion on the emergence of IPR and seed reforms, there are few studies that *empirically* link the policies with the production behavior of farmers.

Because the scope of our work is so broad, however, we necessarily must limit its scope. For example, the paper examines empirically the impact of biotechnology management policies on

☆ The authors would like to sincerely thank the editor of Research Policy and the anonymous referees for going above and beyond the call of duty in helping us revise this manuscript and make the findings clearer. We also acknowledge the financial support from the National Natural Science Foundation of China (70325003, 70333001 and 70021001), the International Food Policy Research Institute and IDRC. The final part of the research was supported by the EU project, CATSEI.

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doi:10.1016/j.respol.2008.12.008

the production of farmers (use of pesticides and yields). Unfortunately, while it is important to consider enforcement costs, we have little information on such costs. Likewise, although we analyze which types of seed allow farmers to use less pesticides and have higher yields, our data do not allow us to identify the precise reason (e.g., agronomic or pathology) why pesticide use is higher and yields are lower.

2. Reforms in China: IPR and the seed industry

2.1. Intellectual property rights (IPR)

Prior to the late 1990s it was legal for a seed company to reproduce a variety of another company for the purpose of marketing the new variety. There also were no restrictions on the use of another breeder's variety as a parent in the development of another variety. The new variety could be sold and marketed legally without paying any licensing fees or royalties to the original creators of the parent varieties. The use of varieties of other breeders as parents was a common practice in the 1980s and early 1990s for all crops (The State Council, 1997).

Despite the availability of Plant Varietal Protection (PVP) for most of China's crops since 1997, protection is still not very strong and the crop which is considered in this study, cotton, was excluded from protection until 2005. China's laws also do not restrict the use of protected varieties as parents in the production of other varieties. China's PVP legislation has a research exemption that explicitly allows research institutes and seed companies to use PVP varieties as parents to develop new varieties. PVP does not give proprietary protection to genes but new genes can be covered by patents in China.

In response to these loopholes in the PVP laws and their enforcement, research institutes and seed companies have taken actions to prevent their proprietary varieties and novel genes from being used by other scientists without permission or at least begin to receive royalties. Above all, the seed industry is beginning to use the patent system. For example, Dr. Guo Sandui of the Chinese Academy of Agricultural Sciences (CAAS) received a patent on the Bt gene that he developed. This gene (henceforth, the *CAAS gene*) is being used in all of the China-produced varieties that are being sold by a CAAS (fully domestic) joint venture enterprise (henceforth, Biocentury—Fang et al., 2001). Monsanto also has patents on several genes that are important in the production of transgenic plant varieties, although it did not patent its initial Cry1Ac Bt gene in China (henceforth, the *Monsanto gene*). Monsanto genes are legitimately found in the seeds sold by two joint venture seed enterprises set up originally by two foreign-owned life science firms, Monsanto and Delta and Pine Land (DP). In the past decade these foreign-owned firms partnered with two different provincial seed companies (Jidai in Hebei and Andai in Anhui—henceforth, both JVs are called *Jidai* for convenience). The CAAS and Monsanto Bt genes are inserted into plants to make them resistant to certain classes of insects. In particular, the patents cover processes that create transgenic cotton varieties.

Research institutes and seed firms also can try to use trademarks – another form of IPR – to protect their technology (Louwaavs et al., 2005). Biocentury has trademark protection on its name and on the names of some components of their technology (Fang et al., 2001). Jidai uses Monsanto's Bollgard trademark on its Bt cotton varieties to try to prevent other firms from using the name on their varieties.

While some seed companies in the cotton industry have taken steps to protect their seed varieties, their actions do not appear to have helped keep other companies from appropriating their technology. Interviews with CAAS, Biocentury, Monsanto and Jidai managers and research administrators reveal that few people believe that the current system of IPRs – and the way that the regulations are being enforced – provide effective protection for the plant technologies that are patented, have plant variety certificates or have trademarks. Cotton seed firms have had little success in keeping other firms from copying their genetic technologies or trademarks. Seed companies in the Bt cotton seed market still regularly reproduce, backcross and market the varieties developed by both Biocentury and Jidai.

2.2. Reforms to the seed industry

In recent years changes also have been occurring in the seed industry. As late as the mid-1990s local and regional state-owned enterprise (SOE) seed monopolies dominated China's seed industry (Qian, 1999; Keeley, 2003; Li and Yan, 2005; Huang et al., 1999). In total, 2700 SOEs operated in their local counties, prefectures and provinces. In many counties only the local SOE was allowed to sell seeds of the major crops. Regulations banned the participation of non-SOE seed firms in the production, distribution and sale of hybrid maize and rice. In the typical case the county-based SOEs sold their seed through township agricultural extension agents (which in the rest of the paper we will call a traditional, non-commercial seed sales channel). Indeed, during the 1990s agricultural extension agents earned a large share of their income from selling agricultural inputs, including seed. In addition, seed also flowed to farmers through other traditional, non-commercial channels, such as the cotton office (originally – through the late 1990s – the cotton office was the state-designated cotton monopoly procurement agency; it was turned into a cotton technology extension and cotton policy administrative agency after 1998) and seed production bases (which are villages or groups of villages that have contracts with the former SOEs for the reproduction of their seed).

The evolution of the seed industry continued after the late 1990s. In 2000 the government passed a new seed law that for the first time legally defined a role for the private sector. All firms – private, quasi-commercialized SOEs and traditional SOEs – were allowed to apply for permits to sell seed in any jurisdiction. Measures also were put into place that allowed firms to have their seeds certified at the provincial level which would entitle them to sell seed in any county in the province. By late 2001 nine companies had permits to sell seed anywhere in the country. For the first time it became feasible for national companies to establish their own distribution and retail networks. At the other end of the spectrum hundreds of small seed companies opened up to supply local needs.

Since the mid 1990s the laws and policies that govern the seed industry have changed in such a way that a commercial and competitive seed industry has begun to evolve (Keeley, 2003; Li and Yan, 2005). Among other parts of the legislation, the law makes it clear that any entrepreneur that has access to the required minimum amount capital and facilities can sell seed. Private companies are allowed to sell seed (including any variety of GM or non-GM cotton) that was bred by public breeding institutes. With the passage of this legislation, the legal protection of the monopoly positions of county, prefectural and provincial seed companies was formally removed.

As the reforms began to be implemented, commercial seed distribution channels for seeds opened along side the networks through which agricultural extension agents (and personnel in cotton offices and seed production bases) had traditionally sold seed to farmers. New sources of investment in the industry have emerged. For example, domestic entrepreneurs invested in private seed firms. Some of the traditional SOEs have transformed themselves into commercial firms. Although they are still few in number and are required to sell through a joint venture with a Chinese firm, foreign firms have begun to invest in China's seed industry.

In the cotton seed industry – especially in the part of the industry that is involved in the creation and marketing of GM cotton – the government's recent policy efforts appear to have been