Understanding the Role of Intellectual Property Protection in Soybean Innovation (Primary Investigator: Jay Kesan)

The Kesan research team investigates patents on agricultural inputs in order to increase understanding of intellectual property rights and issues. Ag-biotechnology inventions are protected by two intellectual property regimes – the utility patent regime and the plant variety protection regime. It is not clear how these two regimes operate to promote investment and innovation in ag-biotechnology. Is there a double dividend for society from having both these regimes? Or is it merely a consequence of the technological path of progress and hence, as an initial matter, we should examine the propriety of having two such regimes? These questions are being investigated currently under an IMBA grant using analytical and empirical methodologies.

In this era of biotechnology-enhanced seeds, broad-spectrum herbicides and corporate R&D, farmers are consumers of licensed technologies; input suppliers are developers of new 'super seeds'; and governments are regulators of such technologies. At the nexus of the policies and strategies of these three groups lies the U.S. intellectual property [in this case, the patent and plant variety protection (PVP) regimes] system. Patented biotechnology-enhanced seeds, herbicides and process technologies command license fees. As proponents of the patent system have argued, such licensing revenues are rewards for undertaking costly and risky R&D and thus essential to maintaining a supply of new inventions to be exploited by producers.

The patent system, however, also imposes costs. The license fee for Roundup Ready soybeans, a variety of soybean employing patented technology, can be as high as 40%. These are direct costs for farmers which may not be entirely offset by corresponding reductions in other input costs or increases in yield, as a result of variations in commodity prices. In addition, patent enforcement imposes indirect social costs in the form of efficiency losses (referred to by economists as 'deadweight loss) if the new technology is not replaceable (*i.e.*, no non-infringing substitute products).

In spite of such costs, the patent system plays an important role in improving the efficiency of production agriculture by introducing new technologies. Patents stimulate private R&D investment required for such technologies by conferring to inventors exclusive limited rights for making, selling or using the patented invention. Over the past two decades, such exclusive rights have had a significant impact on the role of private R&D in agriculture. While public expenditures in agricultural R&D exceeded private expenditures prior to 1970 (when relatively few patented biotechnologies were being applied in agriculture), in 1980, private expenditures in agricultural R&D, which amounted to over $3.4 billion, exceeded public expenditures of $2.6 billion, with private R&D continuing to outstrip public R&D in later years. These R&D investments have resulted in patented technologies such as Yieldguard® and Roundup Ready® soybeans.

In short, the patent system provides new technologies which are ultimately adopted by producers and processors. These patents on agricultural inputs which impose costs and generate benefits for producers are a key determinant of producer welfare. There is an incomplete understanding of the process by which the patent system creates incentives for agricultural R&D. While the benefits of such new technology, which are distributed throughout the value chain, may be evident, it remains unclear how the patent system enables the inventor to appropriate the benefits of such technologies. In addition, scope of patent protection and rules of patent enforcement determine how rents in the agricultural value chain will be distributed among various players by virtue of the market power conferred to the seller.

Ag-biotech patents raise important issues for soybean producers: (1) What is the effect of patents in inducing technical change (*i.e.*, how does the patent system affect the speed of innovation and the type of inventions that are created?) (2) How does the patent system affect rent sharing in the agricultural value chain? (*i.e.*, does the market power conferred by patent protection allow inventors to reap downstream profits related to transformation, processing and distribution?)

The number of patented technologies used on the farm continues to increase. While patented inventions have for a long time been used by the agricultural sector (*e.g.*, the John Deere plow), unlike those inventions of the past, today's patents cover variable inputs such as seeds and herbicides. To access these technologies farmers often pay license fees (*e.g.*, Monsanto's 'technology fee'). A fee that is large enough can outweigh the pecuniary benefits of adopting the patented invention. The magnitude of the license fee determines how much of the farmer profits can be appropriated by the patent holder.

Patented biotechnology seeds enable valuable traits such as oil and fatty acid content to be regulated at the level of primary production. Many of the end user benefits (*e.g.*, leaner pork) can be obtained more efficiently by coordinating the technical systems of the value chain. It is well-known, for example, that leaner cuts of pork can be obtained by feeding specialized corn as opposed to later having to sort through different grades of pork based on differences in their intramuscular fat. The value of these efficiency gains can be captured in upstream patented technology through technology license fees. It remains unclear what proportion of the benefits due to increased efficiency can be internalized by the patentee who has invented the relevant technologies. Even when the license fee applies, the commodity price determines the net margin to several stake holders such as processors, feeders and farrowing operators. As a result, the patent system may function quite differently for the case of ag-biotech inventions, given that inventors may be 'squeezed' by downstream commodity prices.

In this study, we will develop an analytical model of rent sharing in corn and soybean supply chains. The supply chain in this case is defined as comprising all participants beginning with ag-biotech R&D to distributors for consumers/end users. We will determine how different rent-sharing regimes create differences in ownership and structure of R&D, e.g., Is increased patent protection conducive to more vertically or horizontally integrated supply chain? We will perform a case study analysis of supply chains involving patented inputs (*e.g.*, glyphosate resistant crops (*i.e.*, Round-up Ready® soybeans). We will apply models of organizational economics (*e.g.*, Teece, Williamson) to determine how patents on genetically engineered corn and soybeans allow the patentee to appropriate some downstream profits from corn and soybean processing. We anticipate that patents do not confer patentees with full monopoly power. The presence of substitutes limits the patentee's ability to charge the full monopoly price. Although the magnitude of benefits due to technical change may have been correctly estimated by simple measures of welfare change used in the past, the distribution of such benefits may be incorrectly represented by such simple measures. Patent enforcement which confers market power to inventors results in a larger proportion of the benefits from technical change being appropriated as producer, rather than consumer surplus.