Relational Contracts and the Diffusion of Agricultural Technologies in Brazil

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What is the role of the private sector in scaling agricultural technologies in developing countries? The Brazilian experience, with the soybean boom in the savanna and the expansion of the safrinha corn, suggests that the private sector can play a central role in technology diffusion, even in locations where credit and output markets do not function well.

The constraints of the agricultural technology adoption process in developing countries impose extra coordination costs for commercialization of new technologies. For example, many farmers lack access to credit, output markets, and technical assistance. Farmers could potentially partner with traders or processors who have the capabilities to commercialize new crops. However, writing a farmer-trader contract that accounts for several contingencies and that can be verified by a third party is challenging in this context. Moreover, contracts involving technology transfer are particularly difficult to enforce given the challenges of measuring the transfer and the use of knowledge. As a result, there is underinvestment in technologies that could promote economic development and environmental benefits. Despite the difficulties, the diffusion of savanna soybean and the recent expansion of safrinha corn in Brazil suggest that there are some combinations of technologies and farmer-trader contracts that enable the private sector to rapidly scale the adoption of agricultural technologies (DePaula 2017).

Relational Contracts and the Soy Boom in Brazil
In the case of the soy boom in the Brazilian savanna, traders and farmers cooperated using a special type of relational contract. A relational contract is an agreement that has features that are not verifiable or enforceable. Relational contracts are based on self-enforcing economic incentives and the self-enforcing nature of these types of agreements increases coordination costs (Levin 2003). For example, a farmer could renge on the contract after the technological transfer, and a trader could renge on performance payments to the farmer. In this case, contracting is only feasible if it generates repeated profits sufficiently large enough that each party commits to a long-term partnership. The adaptation of a crop to production in marginal land can generate an economic surplus sufficiently large for feasible contracting.

A key feature of the farmer-trader contract in Brazil was the bundling of output price guarantees, credit, technology, and technical assistance. Before planting, the farmer commits to supply a specific quantity of soy at harvest for a fixed price in exchange for inputs and financial resources to cover production costs. The agreement includes technical assistance and a "technological package" formed by seeds, fertilizers, and pesticides. In practice, the farmer commits a number of 60kg bags of soy to the trader and receives the resources and inputs to start planting. In 2005, for example, one ton of fertilizers for soy production was worth 19.6 bags of soy (Silva 2012). The technological package represents a "recipe" for soy production in the savanna with inputs provided, and in many cases produced, by the trader. The contract addressed the multiple coordination challenges for soy production in the savanna.

The Adaptation of Soy Production to the Savanna
The technological innovation that enabled soy production in the Brazilian Savanna (the savanna soy) was the development of soy seeds for low latitudes using biological nitrogen fixation (Hungria, Campos, and Mendes 2001). In the 60s, the Brazilian government sponsored a plant breeding program that combined enhanced seeds with nitrogen fixing bacteria strains. The seed-bacteria combination was developed specifically for poor nutrient soils, such as savanna soils, and led to new soybean varieties self-sufficient in nitrogen (Alves, Boddey, and Urquiaga 2002). However, clearing the land and chemically correcting the soil can be very expensive; large quantities of lime and fertilizers are necessary to prepare the soil, and depending on the previous use of land, the clearing process necessary for mechanized farming can be very costly. Rezende reports a conversion cost of $600 per hectare in 2003, three times the cost of the land at the time (Rezende 2003). The technology enables soy production in marginal land in large scale but also requires high upfront investment.

The Contracting Effect
The Brazilian government was initially heavily involved in the soy industry...
through the development of new technologies and the financing of production, but since the economic crises in the 80s, followed by the implementation of market reforms in the mid-90s, the industry transitioned to a market-oriented model with the expansion of the role of international trading corporations. The trading companies followed a consistent strategy of vertical integration of the soy supply chain, through investments in the production and commercialization of fertilizers, and direct financing of farmers through anticipated sales contracts. Traders offered farmers a package of services that included financing, price guarantees, technical assistance and inputs for production, to guarantee supply of soy at required quality levels (Junior 2011). Figure 1 shows the historical expansion of the savanna soy technology measured in millions of acres of planted area. The expansion of savanna soy progressed slowly for 40 years before the market reforms in the mid-90s. In contrast, in the 20-year period from 1996 to 2016, production of savanna soy boomed with an additional 37 million acres of plantations, an area of the size of Iowa.

The Brazilian soy boom presents a well-suited case for the examination of the benefits of a novel farmer-trader contract on technological diffusion, the contracting effect. I combine farm-level data from the 1996 and 2006 Brazilian agricultural census surveys to disentangle the contribution of contracting from the contribution of other drivers of technology adoption in Brazil. I find that the contracting effect varies significantly across farm types and locations in Brazil. Contracting explained over 80 percent of soy expansion in the Savanna frontier in locations where there was no soy production before the introduction of the contract. In contrast, in locations where soy was previously produced, contracting explained 37 percent of soy expansion. Contracting increased total value of agricultural output by 200 percent in the agricultural frontier and by 65 percent in traditional producing locations (DePaula 2017). The savanna soy technology diffused faster in locations where the total economic surplus from contracting was larger, either because of high yield improvement or because of high production costs without contracting.

**Policy Implications**

The scaling of agricultural technologies in developing countries depends on the feasibility of contracting. Cost-benefit studies of agricultural innovations should consider coordination costs between commercial partners, as ignoring these difficult-to-measure expenses could overstate the potential profitability and diffusion of new technologies. Public policy can influence the propensity for contracting. In particular, policies that improve protection of property rights and contract enforcement can not only increase the feasibility of contracting, increasing private sector investments, but can also affect the distribution of rents from contracting between farmers and traders.

The Brazilian experience does not end with the soy expansion in the savanna. In the last two decades, the diffusion of safrinha corn, a new production system for cultivation of corn as a second-season crop, is changing commercial agriculture in Brazil. In the 10-year period from 2006 to 2016, the area planted with safrinha corn increased by about 20 million acres, an area close to the size of South Carolina. The specific features of the commercial agreements that accelerated the diffusion of safrinha corn are the subject of ongoing research.

**References**


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**Figure 1. Agricultural land transfer to different types of entities**

*Notes:* Expansion is measured in terms of planted area. The planted area for the savanna soy includes the Midwest region of Brazil and the new agriculture frontier represented by the states of Maranhao, Tocantins, Piaui, e Bahia (MATOPIBA).