The Adaptation of Soy-corn Double-cropping to the Brazilian Savanna

Gil DePaula
Iowa State University, gdepaula@iastate.edu

Ary Fortes

Follow this and additional works at: https://lib.dr.iastate.edu/agpolicyreview
Part of the Agricultural and Resource Economics Commons, Agricultural Economics Commons, and the Economics Commons

Recommended Citation
Available at: https://lib.dr.iastate.edu/agpolicyreview/vol2019/iss2/2

This Article is brought to you for free and open access by the Center for Agricultural and Rural Development at Iowa State University Digital Repository. It has been accepted for inclusion in Agricultural Policy Review by an authorized editor of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
The Adaptation of Soy-corn Double-cropping to the Brazilian Savanna

by Guilherme DePaula and Ary Fortes
gdepaula@iastate.edu; ary.fortes@embrapa.br

Two remarkable innovations have enabled Brazilian farmers to compete with the soy and corn exports of their US counterparts—breeding soybean varieties for low latitudes using biological nitrogen fixation (BNF) (Hungria, Campos, and Mendes 2001; Alves, Boddey, and Urquiaga 2002; Dobereiner 1997) and the adaptation of a double-cropping soy-corn system for production in the savanna.

The introduction of BNF soy alongside improved soil management practices in large-scale mechanized plantations led to rapid agricultural expansion in the Brazilian savanna. Figure 1A shows the rapid growth in Brazil’s soy exports. In the mid-1990s, Brazil was exporting only 3–5 million tons of soy per year, about 25% of annual US exports. Twenty years later, Brazil and the United States are competing to become the largest soy exporter with annual exports close to 50 million tons each (FAO 2019).

It is only natural to question whether such a unique large-scale technological transformation, also known as the “The Miracle of the Cerrado” (The Economist 2010), can be replicated. Can we systematically adapt crops for large-scale production in different soils and climates? Although we cannot yet answer this question, it is encouraging to find two innovations that broke through the biophysical barriers in a savanna region previously considered to be unsuitable for farming.

The second innovation, the focus of our research project, was the adaptation of a double-cropping soy-corn system for production in the savanna. In such a double-cropping system, farmers plant two crops in one season. Farmers first plant soybeans in October for harvest around February; and, immediately after the soybean harvest, farmers plant corn for harvest in May, June, and July. In 2018, 50% of soy plantations in the warm savanna were soy-corn double-cropping systems (CONAB 2019). Figure 1B shows the resulting increase in Brazilian corn exports. From 2000 to 2015, Brazilian corn exports increased fivefold to about 28 million tons per year.

Asian Soybean Rust and the Adaptation of Double-cropping to the Savanna

In contrast to the development of BNF soy, which started in the 1960s with a decades-long government-sponsored plant breeding program, the adaptation of the soy-corn double-cropping system was a response to a change in the soy growing season in the savanna. Starting in 2007, the soy growing season in the savanna was delayed and shortened to control the development of the fungi Phakopsora pachyrhizi that causes Asian Soybean Rust, a severe soybean disease that can spread by wind over large distances. Asian Soybean Rust was first observed in Brazil in 2001 and spread rapidly, affecting 60% and 90% of soybean plantations in the 2001/2002 and 2002/2003 seasons, respectively. As a result, Brazilian farmers lost approximately 8.5 million tons of soybeans from 2001 to 2003 (Godoy et al. 2016; Yorinori, Junior, and Lazzarotto 2004).

The incidence of Asian Soybean Rust in Brazil changed the growing season in two ways. First, the Brazilian...
government introduced new regulations to create a soybean-free period to stop the development of the fungi during the off-season, effectively changing the start of the soy growing season. This soybean-free period was first implemented in the savanna states of Mato Grosso, Goias, and Tocantins in 2006 and was later adopted in other producing states. Second, farmers had to anticipate the soybean harvest to reduce the risk of large losses as the Asian Soybean Rust fungi develops, strengthens, and spreads throughout the season. In particular, climate conditions suitable for soy development, such as high precipitation, favor the growth of the fungi.

The change in the soy growing season in the savanna induced a race for the experimentation, development, and diffusion of early-maturing soy varieties. The successful adoption of these new soy varieties then allowed farmers to introduce a second crop in the same season. In particular, Brazilian farmers found that the double-cropping system was productive in soils with better water retention capability, such as clay soils. Farmers started using hybrid corn varieties with an early maturation cycle for short-season production and intensified the management of the second crop with applications of nitrogen and phosphate fertilizers to improve soil fertility and the introduction of a third crop after corn, a grass (Braquiara) to conserve soil. As a result, the average yield for first- and second-crop corn has converged in the savanna in the past three decades, reaching an average yield of 3.8 tons per hectare. Specifically, second-crop corn yields have increased by 2.3% per year, while first-crop corn yields have improved by 1.9% per year (IBGE PAM 2019). Figure 2A shows the rapid expansion of the area harvested with second-crop corn in the savanna. From 2006 to 2019, the annual compounded growth rate for the second-crop corn harvested area was 12%. By contrast, the area harvested with corn planted as a first crop (summer crop in Brazil) decreased by 50% to 350,000 hectares.

**Policy Implications**

The expansion of large-scale multiple-cropping systems changes the calculation of important agricultural policy parameters, particularly the responsiveness of acreage and yield to price changes. The calculation of these price elasticities, which are central to the analysis of land-use change, biofuel expansion, and deforestation, has ignored large-scale multiple-cropping systems. The definition of agricultural productivity changes when considering a double-cropping system. Figure 2B shows the change in the agricultural productivity of single-cropping soy and double-cropping soy-corn systems in Brazil measured in terms of calories per hectare. In 2018, the average productivity of the double-cropping soy-corn system in the savanna, about 22 million calories per hectare, was twice that of single-cropping soy plantations. If global corn prices increase, Brazilian soybean farmers may thus choose to plant corn following their soy harvest without expanding into new land, benefiting from economies of scale from double-cropping systems (e.g., lower fertilizer costs due to soy nitrogen fixation). If soy prices increase, Brazilian soybean farmers may thus choose to plant corn following their soy harvest without expanding into new land, benefiting from economies of scale from double-cropping systems (e.g., lower fertilizer costs due to soy nitrogen fixation). The supply functions of these commodities will then tend to become more elastic.

**Figure 2. Soy-corn double-cropping expansion in the Brazilian Savanna**

*Data source: Brazilian National Supply Company (CONAB, 2019).*

*Note: Data is for three savanna states in Brazil: Mato Grosso, Mato Grosso do Sul, and Goias. The 2019 data represent projections from CONAB. The calorie content for corn and soybean are 1,690 and 1,590 calories per pound respectively (Williamson and Williamson 1942).*

---

continued on page 11