Innovating in the Pampas

Zero-tillage soybean cultivation in Argentina

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The United States, Canada, the former Soviet Union, and many other countries have learned valuable lessons about the dire consequences of overexploiting land for intensive crop production. The emergence of dust bowls in the United States in the 1930s and in the Kazakhstan plains of the Soviet Union in the 1960s illustrated how unsustainable farming practices can cause long-lasting ecological and agricultural damages and losses.

Argentina faced similar risks as it began to intensify the cultivation of soybean in the 1970s in the Pampas region, an expansive area of fertile land stretching from the Andes Mountains in the east to the Atlantic Ocean in the west, an area more commonly associated with cattle ranching and the gauchos, Argentina's cowboys.

While soybean is a commercially lucrative crop, its cultivation negatively impacts soil fertility, particularly when farmed intensively following the cultivation of other crops such as wheat and maize. However, what could have been a disaster instead became an unmitigated success. The widespread adoption of zero-tillage cultivation practices, improved soybean varieties, and other technologies together enhanced yields, boosted production, and conserved soil fertility. Today, Argentina is a global leader in soybean production and exports, providing the international market with supplies of both food and feed that have helped keep global prices low.

The Essentials of Zero Tillage

Although soybean was introduced in Argentina in the early decades of the 20th century, commercial cultivation began in earnest in the 1950s. Protein-rich soybean is commonly used in livestock feed, and as global demand for livestock products—both dairy and meat—increased as incomes grew during the latter half of the 20th century in many countries, some Argentine farmers saw the financial benefits of shifting to soybean cultivation. The land area under soybean production in Argentina expanded rapidly during the 1970s, contributing significantly to an increase in Argentina's agricultural output.

But while this new crop meant higher economic benefits—derived from new demand and the possibility of growing two crops, soybean and wheat, instead of one—it required a much tighter and more careful management schedule resulting from, among other factors, increased climatic risks, higher demands for weed-control strategies, the need for more efficient use of machinery, and the need for greater technical assistance.[1] The fact that soybean was a new, relatively unknown crop, plus the greater complexity of the cropping system, required expert knowledge on how to bring all the pieces together in an effective way. Access to new and reliable information became a key issue for the success of soybean cultivation in Argentina.

Moreover, this new crop had a considerable impact on the land. On many farms where soybean cultivation followed wheat or maize farming, the conventional practice was to burn the remains of the crop cultivated in the period preceding soybean to minimize the time that the land was left uncultivated, thus extending the period available to till, seed, and grow the soybean.

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But this practice created problems such as soil erosion, water runoff, and loss of organic matter. The practice was so environmentally damaging that it actually started to undermine productivity, even in the best-endowed areas. By the early-1990s, soil degradation was estimated to have reached levels as high as 47 percent in the Arrecifes River basin and 60 percent in the farmland of the Carcaraña River basin, two of the most important areas in Argentina's Pampas region.[2]

As a result of these problems, both scientists and farmers were interested in exploring cultivation practices that were less aggressive with regard to the preparation of the soil, less conducive to soil erosion, and less detrimental to productivity. Their exploration was accompanied by debates about appropriate technologies, farm shows to demonstrate alternative cultivation practices, and foreign study tours to learn about practices in other countries. It was in this context that the development of zero-tillage cultivation practices began in Argentina.

Zero tillage (also called no-tillage farming) is a resource-conserving cultivation practice that depletes organic matter from the soil at a lower rate than conventional tilling and improves the soil's capacity to retain moisture. Under zero-tillage cultivation, crops are planted in untilled soil by making a narrow hole or trench of sufficient width and depth to cover seeds and apply fertilizer. The opening is typically prepared by a tractor-drawn driller, although in some countries such as India, draught animals are used instead of a tractor (see Chapter 9). The soil remains covered by plants from previous crops, and herbicides are used to break these plants down and return their nutrients to the soil. The seeds that emerge from the undisturbed soil draw on the nutrients from these plant residues for their growth.

The method was first popularized in the 1950s and 1960s in industrialized countries with the introduction of commercial herbicides. Farmers in the United States began experimenting with zero tillage in the 1970s, and scientists at the U.S. Department of Agriculture, the University of Illinois, and the University of Kentucky contributed greatly to the technology's further development. By the end of the decade, the pipeline of zero-tillage technology—cultivation techniques, drillers, herbicides, and so on—was substantial, with promising applications not only in the United States, but also in Canada, the United Kingdom, and Germany, among other countries. In Latin America, zero tillage was introduced by the Instituto de Pesquisas Agropecuarias Meridional (IPEAME) in Londrina, in the state of Paraná, Brazil, in cooperation with the German Agency for Technical Cooperation (GTZ).[3]

Zero tillage (and reduced tillage, which involves a minimal amount of tilling and land

Soybean production, Argentina

preparation) has several advantages. It can improve water retention, reduce soil erosion, lower the chances of drought-related crop failures, and lessen the need for labor that would be otherwise required for soil preparation and weeding. These advantages together help reduce or even neutralize decades-long erosion processes, improve soil fertility, maintain or increase crop yields, and lower production costs.

The Emergence of Zero Tillage in Argentina

The successful introduction of zero-tillage cultivation practices in Argentina—not only for soybean, but also for wheat, maize, sunflower, and sorghum, although on a much smaller scale—is a unique story in many ways. Zero-tillage cultivation was advanced by the emergence of a farmer-driven network that brought together researchers, extension agents, private input suppliers, agricultural machinery producers, and others to adapt zero-tillage techniques and equipment to the needs of farmers in the Argentine Pampas.[4]

The story begins as early as 1968, when the National Institute of Agricultural Technology (INTA), Argentina's largest agricultural research institution, started to notice the soil erosion problems that affected crop yields and output. This issue led to the establishment of a soil conservation program at INTA (later known as INTA's Conservationist Agriculture Project), which played a significant role in developing both scientific capacity to address soil-fertility issues, and specialized machinery needed to practice zero-tillage cultivation.

But INTA was not the only one to notice the effects of inadequate soil-management practices. In fact, zero tillage was being explored by a number of individuals representing various interests—farmers, technical-assistance providers, agricultural-input companies, and researchers—as early as 1975. Through informal exchanges of information and experience, the idea that zero-tillage cultivation could be adapted to the needs of Argentine farmers gained substantial footing.

In working together to identify problems, try alternatives, and share information, these informal exchanges between and among private and public actors laid the groundwork for a formal network that spearheaded the widespread promotion and use of zero-tillage cultivation practices. A shared perception of the nature of the problem and a convergence of interests among these various actors was the initial glue that led to the creation of the Argentine Association of No-Till Farmers, known by its Spanish acronym, AAPRESID.

AAPRESID was formed in 1989 as a nongovernmental organization composed of farmers with an interest in conservation. Its main goal was to bring together researchers, extension agents, and private input-supply companies to get zero tillage off the ground, but it also acted as a lobbying group to help its members acquire necessary farm equipment, and to secure loans and tax exemptions for farmers adopting zero-tillage practices on their farms.

AAPRESID's 20 or so founding members were mainly medium-and small-scale farmers and technical-assistance providers, all of whom were already involved in the movement to promote zero-tillage agriculture in Argentina. AAPRESID grew rapidly in tandem with the speedy increase in the adoption of zero-tillage farming throughout the country. Soon, the majority of key players in the agribusiness sector became members, and by 1996, AAPRESID was firmly established as the main force driving the development and expansion of zero-tillage cultivation.

Accelerating the Cultivation of Soybean

Three events contributed to a boost in zero-tillage cultivation of soybean and other crops in Argentina in the 1990s. First, new soybean varieties were introduced in 1996 that were genetically modified to be resistant to the herbicide glyphosate (sold commercially in many countries under the brand name of Roundup Ready®). Glyphosate, commonly used as a weed killer, is particularly useful in zero-tillage cultivation because it breaks down plant residues and returns their nutrients to the soil. Using glyophsate in combination with the herbicide-tolerant soybean meant that farmers could apply the chemical, break down plant residue and weeds, and plant soybean quickly. This technique was aided by the use of drillers that seeded rather than plowed the soil in a way that encourages erosion.

Second, there was a significant decline in the global price of glyphosate during roughly the same time. The herbicide's price began falling when its patent, held by Monsanto, a U.S.-based crop science

and agricultural inputs company, expired. The patent expiration allowed for new competition and lower prices in the local market for the herbicide.

Third, there was a change in Argentina's economic policy regime with respect to agriculture. The government eliminated agricultural export taxes and reduced import duties on inputs and capital goods during the early-1990s. This change, together with the deregulation of a number of key markets for both agricultural goods and services, created favorable conditions that eventually led to the increase of both grain and oilseed production, the latter of which includes soybean.

As a result of these convergent events, overall grain and oilseed production in Argentina grew from 26 million tons in 1988–89 to more than 67 million tons in 2000–01. Cultivation of grain and oilseed crops using zero tillage expanded from about 300,000 hectares of land in 1990–91 to more than 22 million hectares in 2007–08 (see Figure 8.1).

As of 2007, Argentina's soybean production accounted for more than 20 percent of global production, up from less than 5 percent as late as 1982. Argentina is now the third-largest exporter of soybean, after the United States and Brazil (see Figure 8.2).

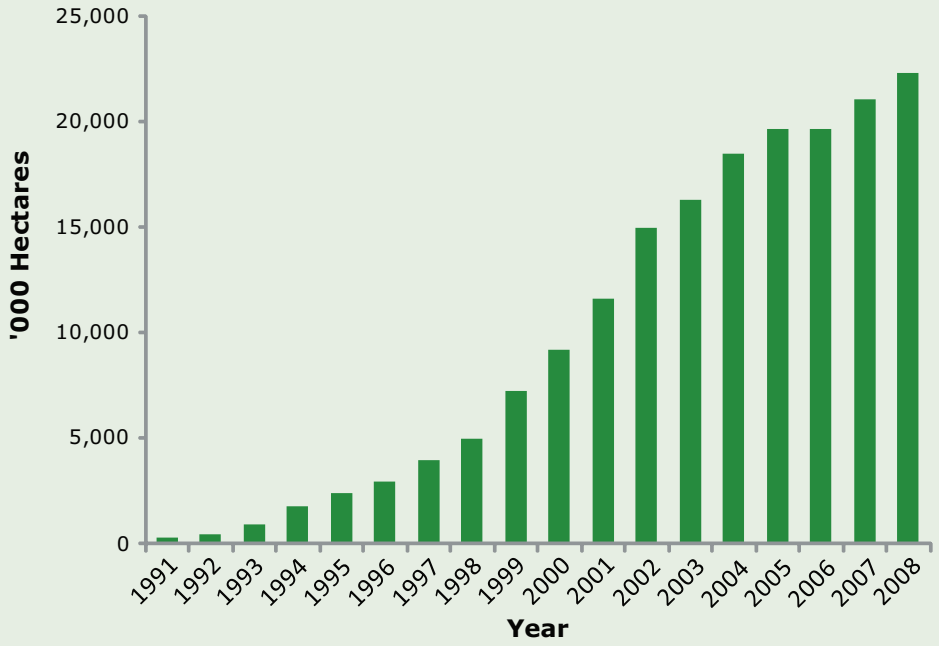
Controversy and Opportunity

There is much global debate about the use of chemical herbicides and genetically modified, herbicide-tolerant soybean in Argentina. These two inputs are central to making zero-tillage cultivation possible, and studies show that their environmental impacts are, at worst, no more significant than alternative inputs, and at best, when combined with zero-tillage practices, beneficial for soil fertility.[5]

There is also some debate in Argentina over the influence of zero-tillage soybean cultivation on farming systems beyond the Pampas. Additional research is needed to better understand the potential impacts of a shift in farming systems—from mostly extensive livestock production to relatively intensive agricultural production—in the more marginal areas outside the Pampean region.

Irrespective of these issues, more than 22

Figure 8.1—Area under grain and oilseed cultivation using zero-tillage cultivation, 1991–2008



Adapted from AAPRESID (Asociación Argentina de Productores en Siembra Directa). 2007. *Base estadística*. www.aapresid.org.ar. Rosario, Argentina; SAGPyA (Secretaría de Agricultura, Ganadería, Pesca y Alimentos). 2009. *Estimaciones agrícolas*. www.sagpya.mecon.gov.ar. Buenos Aires, Argentina.

million hectares of land were brought under zero-tillage cultivation in Argentina between 1991 and 2008, with valuable benefits for soil fertility, farmer incomes, export earnings, and global stocks of both food and feed. The use of zero tillage, along with the introduction of herbicide-resistant soybean varieties and other factors, improved soil fertility by reversing decades of erosion and the long-term threat of unsustainable land exploitation.

In economic terms, about 8.3 percent of the total value of production of soybean and maize in Argentina—around US$12 billion—could be attributed to zero tillage, complementary technological innovations, and economic factors described earlier. For farmers alone, the cumulative savings associated with the use of zero tillage since 1991 comes to about $4.7 billion. Moreover, the industry that emerged from the introduction of zero tillage—farm equipment production, extension services, input supplies, farming, and other related activities—is estimated to have generated some 200,000 new jobs in Argentina's agricultural sector between 1993 and 1999.[6]

Lessons Learned

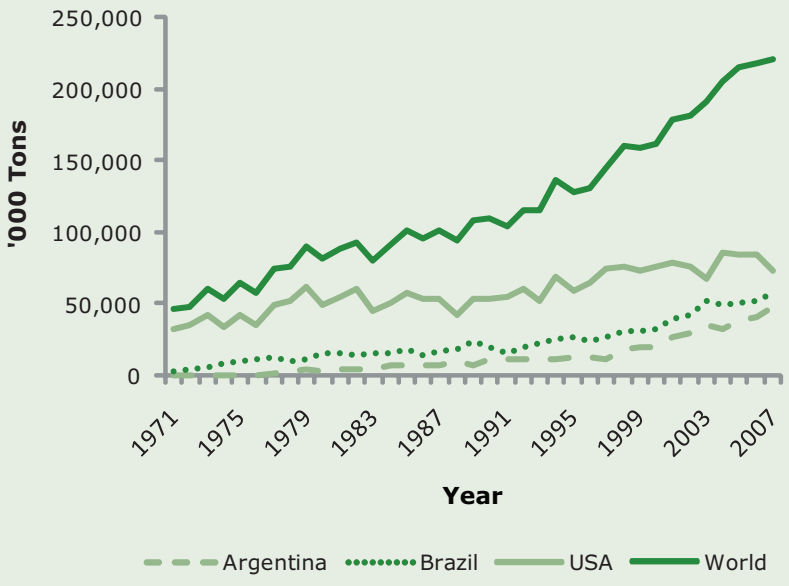
The success of zero tillage in Argentina can be attributed to a combination of appropriate research and technology and the will to make it work. Beyond the quantitative impacts that have benefited Argentine farmers and global consumers, the social and economic processes that brought about the boom in zero tillage are themselves a success story.

Argentina's switch from conventional planting to zero-till cultivation demonstrates that change is often more than the introduction and adoption of a new technology. Rather, change can involve the entire reorganization of the agricultural sector. The diffusion of zero-tillage cultivation practices in Argentina has had long-lasting effects on the ways in which key economic players—farmers, businesses, and government—interact to improve agricultural production. It has had a durable impact on the structure and composition of Argentina's agricultural sector. And it has had a long-term impact on the soil—on the sustainability of intensive agriculture—in the country.

In particular, this story is anchored by a partnership among very diverse stakeholders—farmers, scientists, extension agents, input suppliers, and farm-equipment producers—who identified a problem and, in the process of sharing information and developing solutions, coalesced around an innovative network that allowed for the tremendous growth in zero-tillage cultivation.

And with the rise of Argentina as a major soybean exporter, this combination of technologies, practices, and ideas has provided the country with valuable export earnings while also supplying the international market with a food and feed crop that has contributed to keeping global food prices low. ■

Figure 8.2—Argentina's contribution to global soybean production, 1971–2007



Source: FAO (Food and Agriculture Organization of the United Nations). 2009. FAOSTAT statistical database. Rome.

Cultivating the Cerrado in Brazil

The world's savannahs have long been written off as wastelands due to their highly weathered, acidic, nutrient-poor soils that inhibit agricultural production. The Cerrado region of Brazil—an area covering approximately 204 million hectares of land (or 24 percent of Brazil's entire land area) and representing 15 percent of world's savannah area—was one such region, until the 1970s.[a]

From a scientific perspective, the Cerrado region's potential was unleashed when scientists at the Brazilian Agricultural Research Corporation (Embrapa) formulated a mixture of phosphorus, lime, and other inputs that could dramatically improve soil fertility and thus the agricultural potential of the region. But removing this technical impediment is only part of the story. Complementary investments by the Government of Brazil and hard work by farmers who took a chance by investing their livelihoods in the Cerrado also played key roles in the region's development. For example, a critical contribution came from Embrapa's investments in the development of crop varieties and cultivation practices that were appropriate to the savannah's climate and soil and, therefore, encouraged the expansion of agricultural production in the region. Similarly valuable contributions came from direct government support in the form of road and irrigation development in the region, and indirect support in the form of low-interest loans to purchase fertilizers and machinery and to access veterinary services.

By the late-1970s, large-scale farming and cattle ranching began to expand dramatically in the Cerrado. Today, with an estimated 40 to 50 percent of the Cerrado under productive use, the region accounts for 59 percent of Brazil's coffee production, 55 percent of its beef, 54 percent of its soybean, 28 percent of its maize, and 18 percent of its rice.[b] By bringing the Cerrado into production, Brazil has been transformed into a global powerhouse for food and agriculture, and has been able to contribute to keeping both domestic and global food and feed prices relatively low.

Importantly, the development of the Brazilian Cerrado offers valuable insights for other developing countries aiming to increase food and agricultural production as a means of reducing food insecurity, increasing incomes, and improving livelihoods—particularly in Sub-Saharan Africa, where the largest concentrations of savannah areas still exist.

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