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# ANATOMY OF SUCCESS
## New genetic technologies in Argentina

## KEY THEMES

- Importance of innovation.
- Unique experience with crops.
- Economic, environmental and sustainability impacts of genetic modification.
- Keys to success.

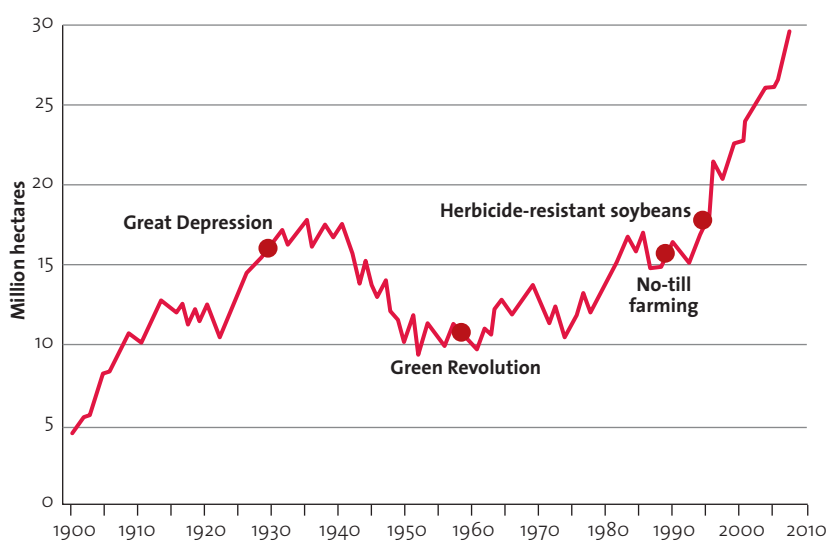
### Argentina's experience

In using genetically modified (GM) crops to reshape its agriculture, Argentina is a country that has made full use of its potential in both economic and non-economic terms. Crucial to achieving this is that it has benefited from a friendly and effective institutional environment. Applying science and technology in order to speed up agricultural development, improve food security, boost farmers' incomes and generally alleviate poverty goes hand-in-hand with a favourable climate for innovation.

### A century of agriculture

As Figure 8.1 shows, the history of agriculture in Argentina from 1900 to 2008 is broadly one of upward trends, as measured by area planted with grains and oilseeds. There are ups and downs, but in a hundred years or so the increase was more than fivefold, from 5 million to 28 million hectares.

**Figure 8.1 Evolution of the area planted with grains and oilseeds in Argentina, 1990–2008, and milestones along the way**

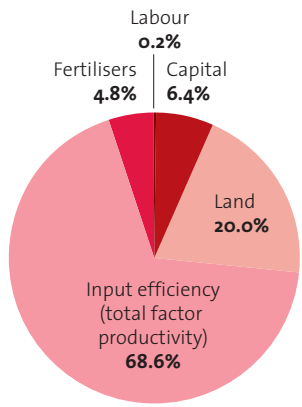



Source: Bennett and Jennings, 2013

Strikingly, the peaks and troughs closely reflect technological changes. The first decades, driven mostly by mechanisation, are followed by the Great Depression when planted areas were severely reduced. Yet, by the 1960s, the graph turns upwards following the Green Revolution, when improved dwarf wheat varieties and productive hybrid maize ushered in a new, innovation-based growth cycle that, with some fluctuations, has continued ever since.

Other landmarks include the widespread adoption of no-till farming (no ploughing or harrowing) in 1991, and the introduction of the first GM crop varieties – herbicide-tolerant soybeans – five years later. Together, these created a synergy that surpassed all expectations, outperforming even the USA where both technologies originated.

**Figure 8.2 Sources of growth in grains and oilseeds in Argentina, 1968–2008**




Source: Bennett and Jennings, 2013

### Genetic modification in Argentina: a unique narrative

The still-evolving story of GM crops in Argentina contains a number of elements that are unique. Analysts have been amazed by the sheer magnitude of the progress in the country's agricultural economy, which cannot be explained just by rising prices in grain and oilseeds. There are synergies at the heart of Argentina's success that can only be accounted for by technological change. How then has all this come about?

The first GM varieties introduced in Argentina were soybeans tolerant of the herbicide glyphosate, which kills a wide range of weeds. The first herbicide-tolerant soybean varieties were commercially available for the 1996/97 crop season, since when a further 20 more GM crop varieties have been approved for planting and consumption as food, feed or fibre. These include herbicide-tolerant and/or insect-resistant maize and cotton, and soybeans resistant to herbicides other than glyphosate.

By the 2010/11 crop season these technologies were being used over approximately 23 million hectares, with the improved soybeans occupying 100 per cent of the total area planted with soybeans, GM maize occupying 86 per cent of the designated maize area, and GM cotton 99 per cent of all cotton. These impressive totals place Argentina third in the world in GM crop area planted, behind only the USA and Brazil, and just in front of India and Canada.

Such progress is almost unprecedented in the history of world agriculture, comparable only to the adoption of hybrid maize in Iowa in the 1930s and certainly

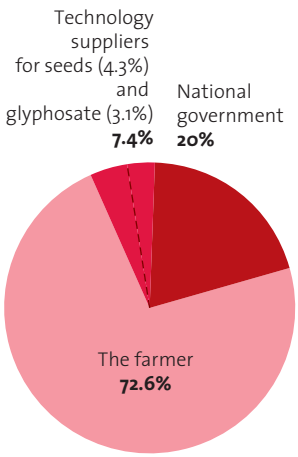
much faster than the spread of new technologies in America's corn belt states, or in other countries during the Green Revolution of the 1950s and 1960s.

Speed of adoption apart, another surprising feature of Argentina's deployment of the new GM technologies is that none of these evolved from the country's own research and development (R&D) programme. All of them were developed outside Argentina by multinational seed companies and introduced into the genetic pool of indigenous crops. Yet, despite the fact that no innovations have been locally developed, there is general agreement that both the strength of Argentina's internal breeding programmes and the existence of an efficient seed industry have been critical to the adoption of the new genetic technologies throughout its agriculture.

### Economic impact of the new biotechnologies

The new GM technologies, especially herbicide-tolerant soybeans, have had huge economic impacts, and not just because they reduce farmers' production costs. Farming practices have changed as well. By cutting the idle time between the wheat and maize harvest and the sowing of soybeans, short-cycle soybeans can be used as a double crop to take advantage of a newly created window of growing opportunity. Double cropping of two crops each year of wheat or maize and soybeans now takes place in areas where it was previously impossible. The net effect of this has been to enlarge the effective growing area by an estimated 3.5 million hectares.

**Figure 8.3 How the benefits of genetically modified crops have been shared in Argentina, 1996–2010**




Source: Bennett and Jennings, 2013

At the same time, the new technologies made soybeans very financially competitive compared to other crops – maize and sunflower – as well as in comparison with livestock production. This encouraged farmers to intensify their use of the new technologies, which resulted in marked gains in livestock productivity even with less land devoted to cattle and more to soya, much of which is fed to cattle. During 1996–2005, for example, pasture land was cut by more than 5 million hectares with no drop in beef production.

The cumulative gross benefits to Argentina derived from growing GM crops (soybeans, maize and cotton) between 1996 and 2010 amount to an estimated US$ 72.65 billion. Figure 8.3 shows how this was shared out, with farmers enjoying the largest portion of the increased income.

### Indirect effects on the economy

Alongside the direct economic benefits of GM crops are other, indirect gains. During the period 1996–2010, 1.8 million jobs were created, a substantial figure

given that Argentina's total workforce was no more than 17 million. Moreover, this was during a period when the country's economy as a whole was contracting by about 10 per cent while unemployment rose to more than 21 per cent.

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**A century of land conversion has taken its toll on the Argentinian Pampas, exposing the soils to erosion from wind and rain. Thanks to advances in biotechnology, things are looking up; however, the extent of monocropping of export crops like soybeans continues to cause concern.**

### Environmental benefits

Expanding the number of GM varieties under cultivation has led to a dramatic increase in areas under no-till farming. This has had two main environmental consequences:

- no-till helped to reverse the negative impacts on the physical structure of the soils caused by conventional tilling and ploughing practices, which had prevailed up to the beginning of the 1980s;
- greater energy efficiency was achieved through a reduction in fuel consumption and a concomitant fall in $CO_2$ and other polluting emissions.

The cumulative effects on the Pampas region of water and soil erosion caused by traditional farming methods had severely affected yields – and therefore the economic viability of agriculture. By the end of the 1980s it was becoming clear that, in order to recover this lost productivity, changes were necessary, among them the introduction of no-till farming.

Breakthrough came in the late 1990s when the new strains of herbicide-tolerant soybean came on stream, enabling no-till farming to pick up speed and rapidly establish itself as the predominant strategy. The practice increased coverage from just 300,000 hectares in 1990/91 to 25 million hectares today.

This combination of no-till and herbicide-tolerant crops integrates two technological concepts: new mechanical means of modifying the soil-crop interaction; and the use of a total broad-spectrum herbicide – glyphosate. Although capable of controlling most kinds of weeds, glyphosate has no residual effects, so has less of an impact on the environment.

The effects of this synergy between two technologies are hard to quantify, but there is no doubting the positive pay-offs in terms of soil fertility and land productivity. There is also a contribution to mitigating the greenhouse effect thanks to a reduction in the amount of organic content lost from the soil.

These technologies have even more pronounced effects on the farming industry's contribution to climate change. So great are the reductions in fuel consumption

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**Phosphorus fertiliser can be organic, as is the case with guano, but very little of that is available. So the vast majority has to be mined from finite deposits of phosphate rock – 50 per cent of which are in the Arab regions – and transported over huge distances.**

associated with no-till farming that the atmosphere has been spared an estimated 5.19 million tonnes of $CO_2$ that would have been generated by conventional practices. Annually, Argentinian farmers consume 13.5 million litres of fuel less than under the old agricultural regimes.

Similar improvements have been seen in carbon sequestration – the soil's ability to capture and store carbon from the atmosphere. The new reduced or no-till cultivation of soybean crops alone may be sparing the atmosphere more than 50 million tonnes of unwanted $CO_2$.

### Sustainability and the soybean

The dramatic transformation of Argentina's agriculture brought about by introducing GM crops in the mid-1990s is not without its downside. A predominance of monocultures and low levels of fertiliser use, especially in those regions where ecosystems are relatively fragile, have created significant soil-nutrient losses. The long-term effects of the continual export of nutrients from the soil, particularly phosphorus – essential to all life – are serious and throw a question mark over the issue of sustainable production. Many millions of tonnes of phosphorus are lost over time – an estimated 14 million between 1996 and 2010 – which can only be replaced at huge cost to the farmer and the environment.

### Argentina on the world stage

As the world's third-biggest soybean producer, exporting nearly all its output to Europe, China and Southeast Asia, Argentina is an international player of huge importance to consumers. Soybeans are a major component both of a large number of processed foods for humans and of much farm animal feed. By adopting novel technologies, the country has been able to reduce the price of the commodity compared to what could have been achieved using conventional practices. In monetary terms, this means a saving in consumer expenditure of US$ 89 billion for 1996–2010, such is the power of the new genetics.

### Conditions for success

The story of GM crops in Argentina highlights a number of conditions that are necessary for a country to benefit from the new technologies. These include:

- early adoption of novel crops made possible by having in place institutions able to deal with technology transfer and diffusion;
- biosafety regulations and the infrastructure available for assessing new technologies;

- an active and efficient seed industry to enable the rapid introduction of new genes into commercial varieties of crops.

Together, these advantages have been more important than a local R&D capability for generating innovation. GM technologies seem to travel well. This is seen not just in Argentina but in many other parts of the world too.

What really matters is to have the right tools in place to extract maximum benefit from innovation when it becomes available. Smooth technology transfer at farm level, for example, depends on having in place proper biosafety and intellectual property frameworks. Policy makers, too, need to be alert to ensure that land use, input prices, market regulation and so on are all taken into account to avoid any negative effects of these paradigm-shifting innovations.

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**Phosphorus deficiency results in stunted growth and a dark reddish-purple hue to the plant's leaves.**