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# Applying Ecological Knowledge to Landuse Decisions

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## 9.

### **Environmental winners and losers in Argentina's soybean boom**

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In 1991, Argentina launched its “convertibility plan” with the aim of reducing rampant inflation and stabilizing its economy. The plan included a deregulation of the country's economy: tariffs were lowered and export taxes (temporarily) eliminated. These reforms had major structural effects on the agricultural sector, the price of inputs (goods and services) increased relative to the price of produced commodities. Development strategies based on cost reduction and economies of scale were favored, resulting in an expansion of no-till genetically modified soybean, and a considerable increase in the size of land-holdings. This modernization process was the dominant adaptation strategy by farmers and received considerable support from governmental extension services that provided technological packages for soybean cultivation for example.

Together with improved rainfall and high prices, these economic changes resulted in a “soybean boom” that has made Argentina the world's third soybean producer with more than 13 million ha under cultivation (Grau et al., 2005, Zak et al., 2008). Although it has undoubtedly brought benefits in terms of increased exports and regional wealth generation, the soybean boom and its agro-industrial development model has also come at a cost: not all farmers were able to follow the development model, thus contributing to land concentration; farm workers lost employment opportunities as labor-intensive crops and animal husbandry disappeared; small-holders and peasants were displaced, losing access to ecosystem services; and increasing pesticide use has brought health problems to rural communities. In spite of the overwhelming dominance of the agro-industrial model, alternative adaptation strategies were possible. In this paper we investigate these alternatives – their economic viability and environmental sustainability.

#### **Case study: Reconquista, Santa Fé province, Argentina**

The case-study area covers 7264 Km<sup>2</sup> with a population of 120,000 people around the city of Reconquista, in the North of Santa Fe province. The study area corresponds to the operational area of the *Asociación para el Desarrollo Regional de Reconquista* (ADR). ADR is a local non-governmental organization (NGO) with the aims to foster economic and cultural development in the region, and to provide extension services. By setting the stage for other local organizations and stakeholder groups involved in the region's development, the ADR is an important institutional innovation in the region. Nevertheless, it has not improved the political representation of the most marginalized sectors of society in the region.

Within Argentina, the region can be considered as marginal: it is dependant on markets and service centers located outside the region reached only by a poor road network. Most of the region's soils are not suitable for intensive agriculture and the

region is home to the majority of the province's rural poor. In the western plains, soils are poor and fragile. In the eastern flood-plain, frequent flooding prevents annual crop cultivation. Only the *Domo Oriental* (below) is extensively cultivated.

### *Ecosystems and their uses*

The Paraná River borders the region to the East and also sets the eastern limit of Argentina's *Chaco húmedo* ecosystem. The Paraná floodplain is a distinctive environment of regularly flooded plains, rivers and lakes and dispersed wooded islands. Low human impact by essentially semi-nomadic grazing are associated with high plant and animal diversity (Canevari et al., 1998, Malvarez, 2004). A number of ecosystem products such as game, honey, fuel-wood, or fish are used by local communities. The floodplain is considered a priority area for conservation at regional and even international level (Jaaukanigás RAMSAR Convention site).

To the West of the region lies the *Cuña boscosa* plain, covered by deciduous *chaco oriental* forests (Cabrera, 1976, Lewis & Pire, 1981) of around 360.000 ha with quebracho colorado (*Schinopsis balansae*), quebracho blanco (*Aspidosperma quebracho-blanco*) and algarrobos (*Prosopis* spp.) being the dominant tree species. Because of poor and fragile soils, the area has traditionally been used for raising livestock and extracting timber, fuel-wood and charcoal. Shrubs cover areas which have undergone selective logging and are heavily grazed. Some areas have saline soils.

The *Cuña boscosa* plains rise eastward towards the *Domo oriental*, before the lower-lying Paraná floodplain. The *Domo oriental* follows the main N-S road through the region and is home to most of its inhabitants. Having the best agricultural soils, it has been extensively cultivated since the beginning of the 20<sup>th</sup> century. Mixed livestock and crop systems (cotton, linen, sorghum, corn and sunflower) resulted in a diversified agricultural landscape with small parcels separated by hedgerows and small woodland patches (with typical oriental Chaco tree species). During the last quarter of a century, these systems have been replaced by monocultures: sunflower and more recently soybean. The increasing size of land-holdings is also associated with the loss of field margins and small woodland areas, reducing overall landscape diversity.

Livestock still occupies the greater part of the area, especially in the *Cuña boscosa* and Paraná floodplain, and generates about half the income. Soybean has spread through a replacement of previous crops rather than through deforestation or conversion of natural ecosystems into cropland (as occurs in other areas of Argentina and South America, Grau et al., 2005).

### **Adaptation strategies**

In exploring the diverse adaptation strategies used by rural producers in adapting (or not) to the changing socio-economic context of agriculture in the 1990s, we consider two major production models: the dominant agro-industrial model largely based on GM soybean, and an agro-ecological model illustrated by self-sufficient "peasant" systems.

### *The dominant agro-industrial model*

Farmers that already had available capital at the onset of the 1990's reforms were the most involved in the spread of the dominant agro-industrial model. Small-holders who followed this pathway generally were unsuccessful. Within the agro-industrial model, successful farmers are those that adopted the whole technological package offered. They concentrated on increasing yields and specializing in their most profitable cropping system, following the example of farmers in more favorable regions of the humid Pampa. However, being located in more marginal environments for intensive agriculture, the production systems they developed tend to be less resilient and more sensitive to inter-annual variability.

Not all commercial farmers were successful in adopting the new technological packages. The economic context of the 1990s led a number of farmers into a process of decapitalization. Many such farmers invested heavily into modernizing their equipment but could not service their rising debt and were forced to sell their assets. Their land was generally rented or bought by more successful commercial farmers, contributing to land concentration in the area. The situation of these decapitalized farmers is dramatic as they are not economically viable (their equipment and/or land do not allow them to be competitive), yet they are not able to benefit from the government's social programs for the rural poor, nor do they have a cultural predisposition for it.

Some small-holders have also taken up the agro-industrial development pathway. Unable to invest in adequate machinery and without land to benefit from economies of scale, small holders base their production systems on family workforce. Many are specialized in fruit and vegetables, providing urban areas with a variety of fresh produce (from peri-urban locations) or specializing in a limited number of crops for the regional and national markets (e.g., strawberries in Coronda). The soy boom was associated with rising land prices, and many indebted small-holders took this opportunity to sell their land and leave farming. Others, under less financial pressure, now rent their land.

### *The agro-ecological model*

Small-holder production systems that are not integrated into the agro-industrial chain follow subsistence objectives, relying heavily on sustaining agricultural production with minimum external inputs. We chose to label this alternative model "agro-ecological" (Altieri, 1995a & 1995b). The majority of alternative small-holder systems in Santa Fe province are located in the more marginal areas of the *Cuña boscosa* and Paraná floodplain. They are usually not targeted by government or agri-business modernization efforts. Rather, they benefit from a diverse set of public and NGO assistance and rural development programs such as the "Programa Social Agropecuario" (PSA), a national government program that was in part designed to facilitate the adaptation of the rural poor to the 1990s reforms and support rural development through loans.

Rather than imposing a common development model, programs such as PSA develop bottom-up approaches through participatory work with farmer groups to identify locally suitable development opportunities. Most of these aim at diversification of

production (including crops, milk and meat), value-added activities (including jams, preserves, cheese, traditional medicines etc.) and marketing.

In the study area, the agro-ecological model has also inspired a group of capitalized farmers who have developed economically viable "biological" agricultural production systems (Altieri, 1995a & 1995b, Koepf et al., 1976). One example is the "*Naturaleza Viva*" farm started in 1991 and which today produces more than 150 types of agricultural products, on 220 ha (a small area for commercial agriculture by Argentinean standards). Some of these are processed on the farm using modern industrial processes (yogurts, cheese, vegetable oils, flours, jams and meats) and sold at markets. The farm's production system is centered on the idea of recreating a traditional agricultural system that incorporates recent scientific knowledge and know-how. It combines high plant and animal diversity in order to foster inter-species complementarities and biological pest-control (no agro-chemicals are used on the farm), with special attention to maintaining soil quality and fertility. Although initially a family-run business, the farm now employs personnel (a total 11 families currently live on the farm), and is rapidly expanding, both horizontally (coordinating production with other producers in the area) and vertically (a processing unit for organic products is being built).

### *Winners and losers*

Effective adaptation strategies to 1990s reforms were developed both within the dominant model and the alternative agro-ecological model (e.g., *Naturaleza Viva*). The agro-industrial model is largely dominant in terms of area and production, and its success is well documented, particularly in the context of Argentina's recovery from the 2001 financial crisis. However, successful agro-ecological producers are also rapidly developing as the markets for organic and 'natural' products develop, both nationally and internationally. Both types of producers, but especially those that followed the dominant model, are often considered the winners of the 1990s reforms, and for many, the post-2001 situation has brought immense benefits through lower domestic costs and high export prices.

Stakeholder interviews in the Reconquista area showed that ineffective production systems can be found within both models explored here. Some operations are not economically viable (e.g., farmer decapitalization and small labor-intensive strategies) or remain dependant on outside intervention (e.g., peasant farmers in PSA programs). These are the losers of the 1990s reforms. Other losers include temporary rural workers who lost many employment opportunities as cotton and sugar-cane were replaced by annual crops with heavily mechanized harvesting (e.g., wheat and soybean) and also lost protective social laws to labor market reforms. Former rural workers and people of indigenous descent now form the most vulnerable components of society, seeking out a living on the periphery of the region's towns and cities. As in many areas of Argentina and South America, structural reforms in the 1990s and the expansion of the agro-industrial model the intensification of annual crop production in ever bigger land-holdings has also had major impacts on the region's environment.

## Environmental impacts

Environmental impacts of agricultural intensification and homogenization in the *Domo oriental* have also been felt in the adjacent *Cuña boscosa* plains (to the West) and Paraná floodplain (to the East) through the displacement of pastoral activities and agro-chemical transfers.

### *Ecosystem services*

Changing land use patterns and practices can affect the delivery of ecosystem services (Daily, 1997) by modifying both the structure and functioning of ecosystems (Chapin et al., 2000) and agro-ecosystems (Foley et al., 2005). The Millennium Assessment defines four main categories of services provided by ecosystems (Millennium Ecosystem Assessment 2005):

*Provisioning services* are the material benefits people gain from ecosystems, such as food and fiber, fuel and timber, genetic resources for crop improvement and medicine, natural chemicals and water.

*Regulating services* are the benefits people gain from ecosystem processes that sustain different components of Human well-being. Examples include crop pollination, ecosystem resistance to invasion by exotic species, climate and atmospheric chemistry regulation, pest control, water purification and erosion control.

*Cultural services* are the intangible benefits people obtain from ecosystem through their contribution to such things as education and science, spiritual fulfillment, aesthetic beauty and “sense of place”.

*Supporting services* are necessary for the sustained provision of all the previously described services. These include primary productivity, soil development, nutrient cycling and mineralization of organic matter (source of soil fertility for plant growth), water cycling and the production of the oxygen.

Not all ecosystem services are provided at the same geographical scale (Díaz & Cáceres, 2002): “sense of place” is a local service that benefits people in or around the ecosystem in question. Carbon sequestration has global benefits through reducing the concentration of CO<sub>2</sub> in the atmosphere. Not everyone benefits from the services provided by a given ecosystem. Harvesting trees in a forest for timber certainly represents a provisioning service for foresters and urban dwellers in need of houses or furniture. However, it does not benefit those who use the forest for other benefits such as medicinal plants and game (also provisioning services) or attach a particular importance to its trees (a cultural service). Because different people benefit from different sets of ecosystem services at different geographical scales, it is important to assess land-use change impacts on ecosystem services through a multi-stakeholder perspective. This will enable us to identify those sectors of society that have been more (or less) impacted by the modifications the soy boom has induced in ecosystem structure and function in the Reconquista area.

### *Land-use change impacts on ecosystem services in Reconquista*

In the *Cuña boscosa* plains and Paraná floodplain, reduced access to forest products (timber, fuel wood, medicines and honey) is the main environmental impact of recent land-use change in the Reconquista area. However these ecosystems still provide numerous ecosystem services to both local inhabitants and society in general. In the *Domo Oriental* however, the environmental impacts of agricultural intensification and homogenization are more varied. They include decreased food security for the rural poor (security being understood as both objective food availability and subjective assessment of one's ability to obtain it); health issues related to pesticide use (air spraying around houses and water pollution); soil degradation and loss; biodiversity loss (in-field through specialization and out-field through pesticide use) and landscape homogenization.

Using the ecosystem service framework, we made a qualitative assessment of the impacts of the dominant agro-industrial model and the alternative agro-ecological model on both the most and least vulnerable social groups in the case-study region. Peasants and decapitalized farmers as well as rural workers and urban poor are the most vulnerable sectors of society (losers in both the agro-industrial and agro-ecological models, but more so in the former). Successful commercial farmers, following either the agro-industrial or the agro-ecological model, as well as the more well off urban population are the least vulnerable. Although it provides important financial benefits to some segments of society, the agro-industrial model generates many negative impacts, not only in the *Domo oriental* where it expanded, but also on in the adjacent Paraná floodplain and the *Cuña boscosa* plains (Table 9.1). These negative impacts affect all segments of society through the loss of important ecosystem services. The agro-ecological model, on the contrary, brings many environmental benefits, especially to the more vulnerable segments of society (Table 9.1).

### **Conclusions and policy implications**

Land-use change policies should strive to generate win-win configurations, where economic viability for some does not come at an environmental cost for others. In spite of being associated with poor peasants, recent developments (e.g., *Naturaleza Viva*) in the Reconquista area have shown that the alternative agro-ecological model can be economically viable, generating income and employment as well as environmental benefits.

Options for win-win land-use configurations are perhaps more feasible in the Paraná floodplain and the *Cuña boscosa* plains which have been less impacted by agricultural intensification and landscape homogenization. However, it is also possible to envisage win-win configurations in the *Domo Oriental* by increasing the share of the alternative agro-ecological model in that area. Many people in the Reconquista area have maintained an intimate knowledge of its ecosystems. This makes the development of win-win configurations based on this alternative model still possible, given adequate institutional support.

Institutional support is what is most lacking for the expansion of the alternative model in the region and in Argentina in general. Fostering the development of new,

locally embedded institutions (such as the ADR) could help, but only if they can operate in a broader institutional context that can accept an integrated vision of land-based resources (environmental, productive and social) and that shares equity goals. Developing such a context requires an active participation from national, provincial and local levels of government.

**Table 9.1:** Qualitative evaluation of the effects of existing land-use model on ecosystem service provision to more and less vulnerable stakeholders. The signs “-”, “+”, and “0” indicate negative, positive and neutral (respectively) impact of the dominant and alternative agricultural models on ecosystem services (lines) for a given stakeholder type (columns). G and L indicate the global and local (respectively) scale at which ecosystem services are provided. A question mark indicates insufficient knowledge while a blank indicates that the ecosystem service is not relevant for a particular stakeholder type.

Ecosystem Service	Scale	Dominant model			Alternative model		
		Local stakeholders		Society in general	Local stakeholders		Society in general
		More vulnerable	Less vulnerable		More vulnerable	Less vulnerable	
<b>Provisioning services</b>							
Food	G	-	+	+	+	-	-
Genetic resources	G	-	-	-	+	+	+
Non-Timber Forest Products	L	-	-	-	+	+	-
Fiber	G	0	+	+	0	-	-
Timber	G	-	0	0	+	0	0
Fuel	G	-	0	0	+	0	0
Drinking water	G	-	-	-	+	+	+
<b>Regulation services</b>							
Polinization	G	-	-	-	+	+	+
Resistance to invasive & exotic species	L	?	?	-	?	?	-
Micro- & meso-climate regulation	L	-	-	-	+	+	-
Carbon sequestration	G	-	-	-	-	-	+
Pest control	L	-	-	-	-	-	-
Water purification	L	-	-	-	+	+	-
Erosion control	L	-	-	-	+	+	-
Natural hazard mitigation	L	-	-	-	+	+	-
<b>Cultural services</b>							
Food & health security	L	-	0	-	+	0	-
“Sense of place”	L	-	-	-	+	+	-
Recreation (including aesthetic beauty)	G	-	-	-	+	+	+
Knowledge & inspiration	G	-	-	-	+	+	+
<b>Supporting services</b>							
Primary productivity	G	-	-	-	-	-	-
Habitat provision for wildlife & game	G	-	-	-	+	+	+
Nutrient cycling	G	-	-	-	+	+	+
Soil development and conservation	G	-	-	-	+	+	+
Oxygen production	G	-	-	-	-	-	+
Water cycle regulation and maintenance	G	-	-	-	+	+	+
<b>General Trend</b>		-	-	-	+	+	+

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