



Reference Module in Earth Systems and Environmental Sciences



The Argentine Pampas: A Novel Ecosystem at the Crossroad

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Synopsis

The historical expansion of agriculture on natural lands was driven by the incorporation of multiple anthropic elements in the Pampas, thus modifying basic structures and functions of the pristine ecosystem. The stocks and fluxes of carbon and water, closely related to habitat, biodiversity and ecosystem service provision, were profoundly affected with the result of remarkable trade-offs between provision and regulation ecosystem services. Technology incorporation successfully tended to smooth, and even reverse, the conflict in recent times.

Abstract

The [Pampas](#) plains were originally covered by grassland communities modulated through the millennia by a combination of rainfall, temperature and small topographic gradients. The anthropic intervention historically modified pristine structures and functions giving rise to a novel ecosystem that was reoriented to produce food, fiber and [bio-energy](#). From the beginning of the 20th century, the quick expansion of agriculture on natural lands and the [intensification](#) of agricultural practices triggered big ecological changes that altered the stocks and fluxes of carbon and the hydrological processes as well. Carbon and water were closely linked to the provision of habitat for biodiversity and the supply of regulation ecosystem service. Inevitably, ecological functions associated with carbon and water were profoundly modified the anthropic intervention, but conservation practices and technology incorporation in the last decades smoothed and even reversed the most outstanding negative trends. It is well known today that a return to the pristine condition will no longer be possible in the Argentine Pampas because of social and economic reasons, but an adaptive, science-based management helps maintaining the agricultural productivity preserving at the same time novel biodiversity assemblages and new configurations of ecosystem service provision.

Keywords

Agricultural intensification; Agro-ecosystems; Carbon, Croplands, Ecosystem functioning, Ecosystem services, Land use/cover change, Rangelands, Technology adoption, Water resources

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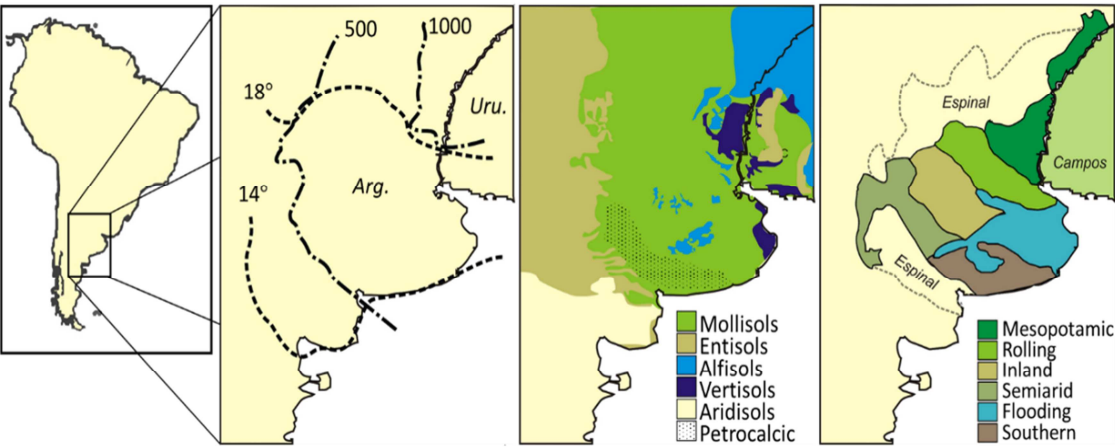


Figure 1. Climatic and edaphic characteristics and sub-regions of the Pampean biome. Sources: Own elaboration with data from LocClim (FAO, 2006), Moscatelli (1991), Berhongaray (2010) and Cabrera (1951).

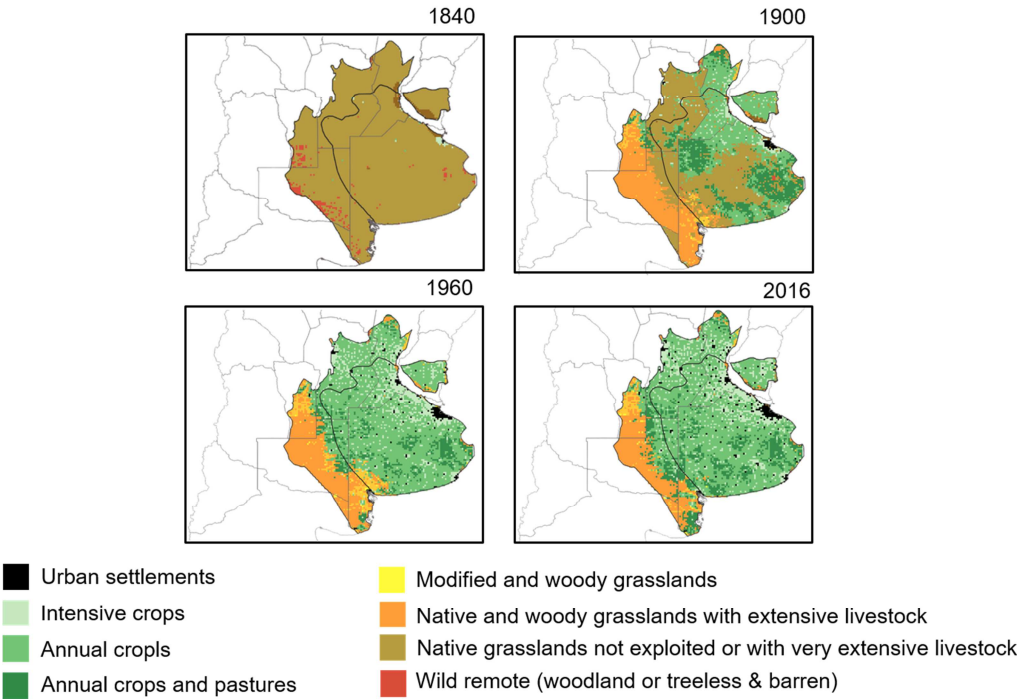


Figure 2. Pampas anthromes evolution since the mid-nineteenth century. Source: Own elaboration from Goldewijk et al. (2017).

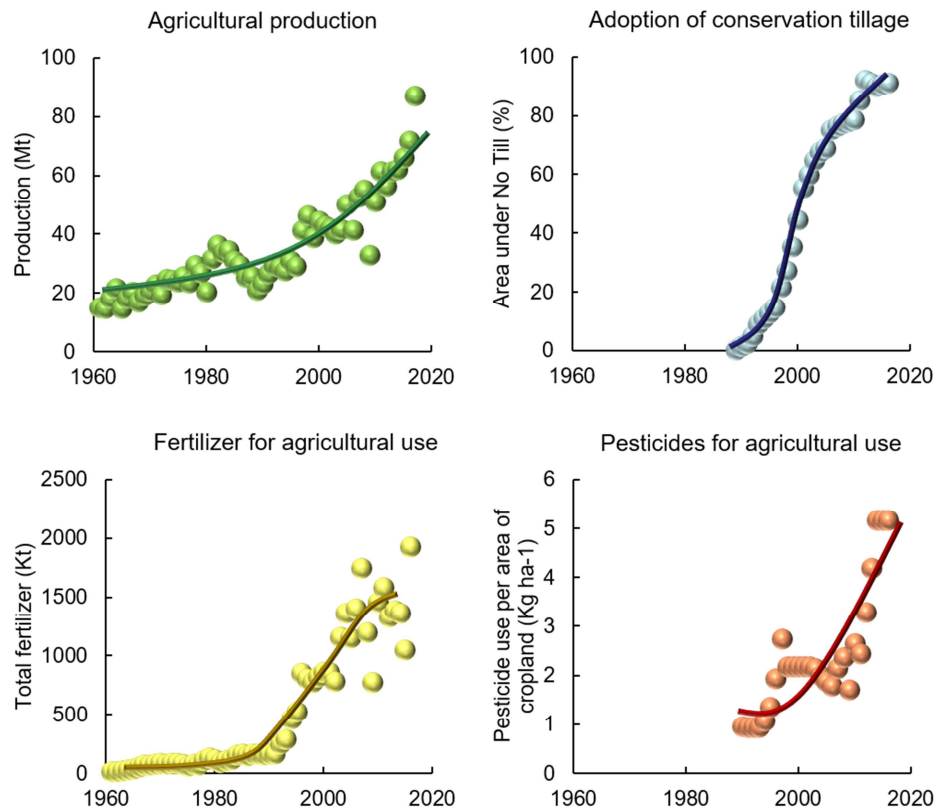


Figure 3. Technological drivers of landscape change in the Pampas for half a century. Agricultural production represents values for the principal commodities produced in the Pampas region (maize, sunflower, soybean and wheat). Cultivation techniques represent the change from conventional tillage to no-till system. Fertilizer (all Nitrogen (N) and phosphate (P_2O_5) nutrients) and pesticides inputs are referred to national agricultural use. Sources: Own elaboration from Secretaría de Agroindustria (2019); Nocelli (2018); FAOSTAT (2019).

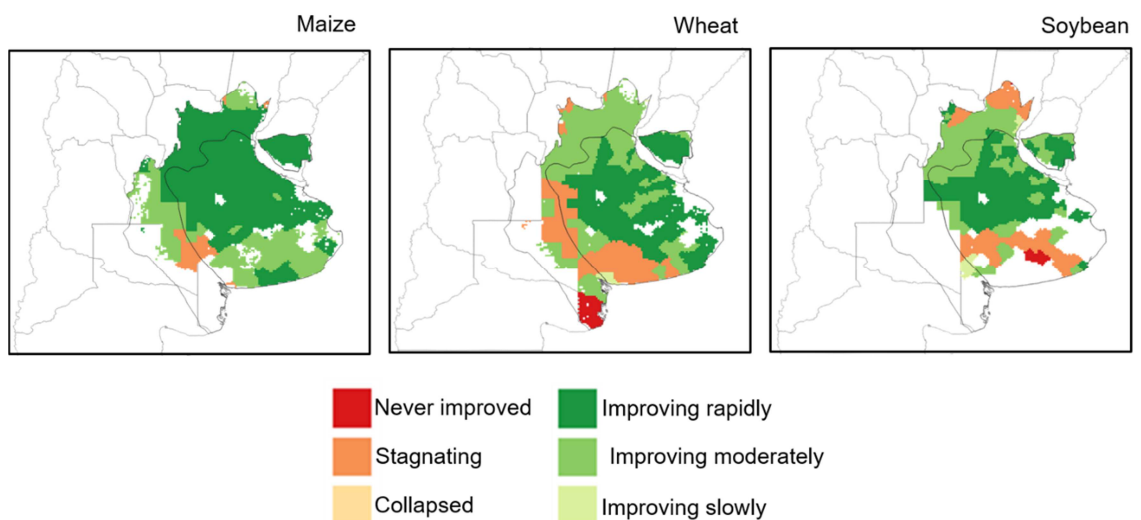


Figure 4. Crop yield trends over the period 1961–2008. The trends were divided into the six categories and colour coded. Maps show only those areas in the political unit where the crop was harvested. Source: Own elaboration from Ray *et al.* (2012).

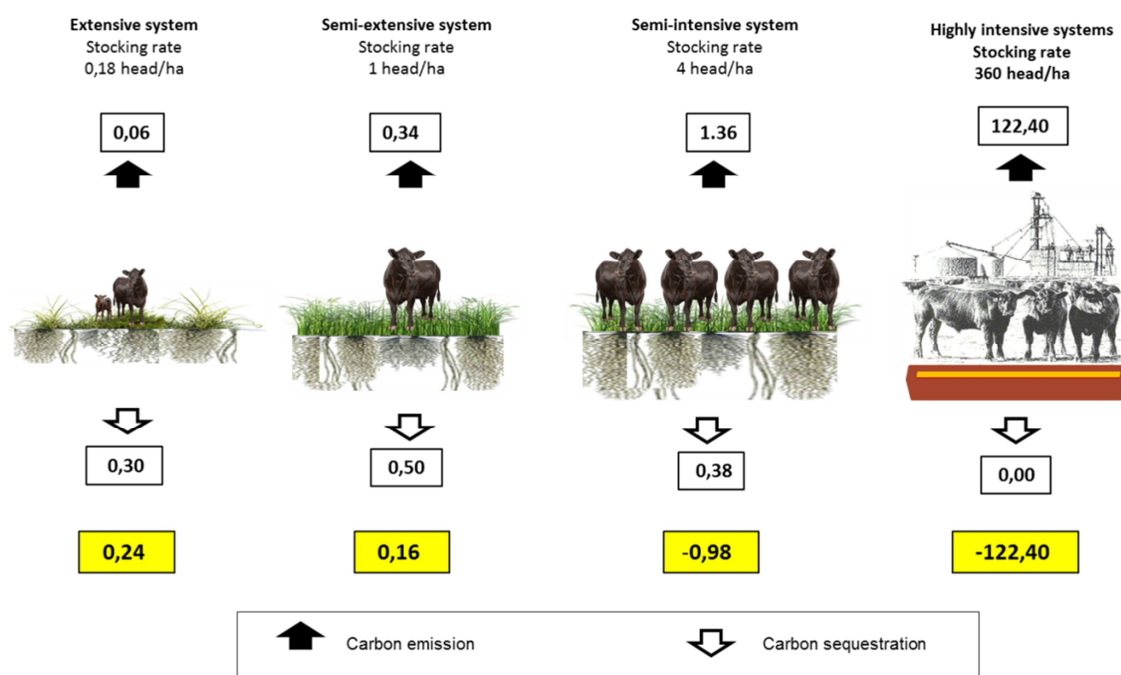


Figure 5. Estimated figures show the difference of carbon emissions, soil carbon sequestration and carbon balance (ton ha⁻¹ year⁻¹) between four beef production systems that differ in their intensification level. Negative figures indicate that carbon emission is greater than carbon sequestration.

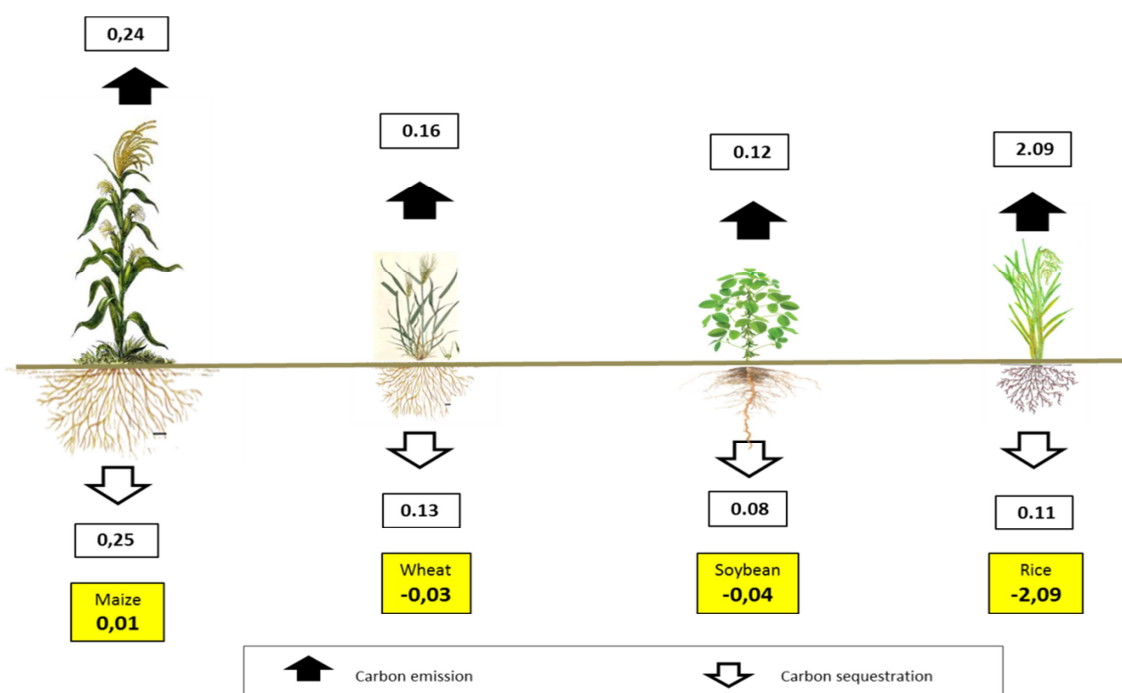


Figure 6. Estimated figures show the difference in carbon emissions, soil carbon sequestration and carbon balance (ton ha⁻¹ year⁻¹) between four crop production systems that are spread in South America. Negative figures indicate that carbon emission is greater than carbon sequestration.

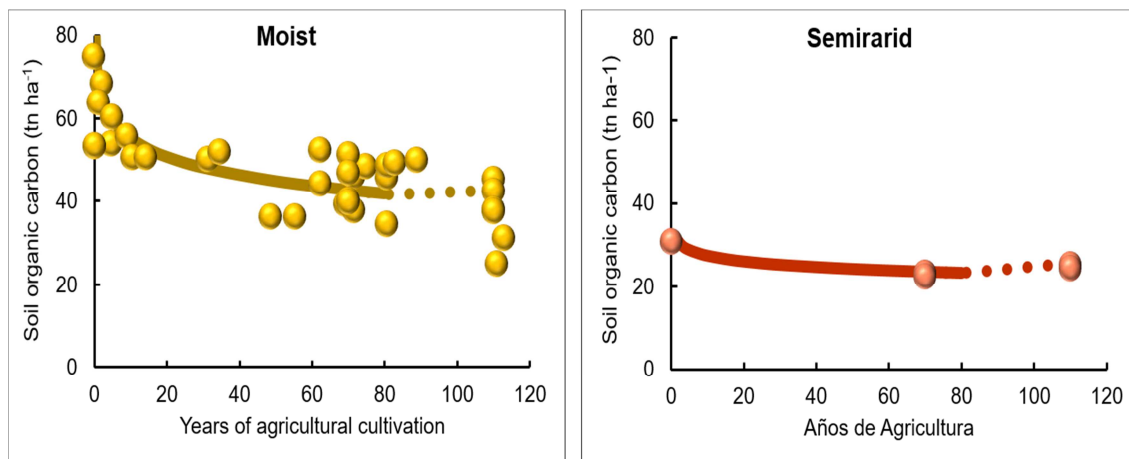


Figure 7. Soil organic carbon loss in the Pampas during 120 years of agricultural crops. References: Full line represents the changes occurred in systems under conventional tillage. Dotted line represents the changes due to agriculture into no-till system. Source: Own elaboration from Andriulo and Cordone (1998), Berhongaray *et al.* (2013), Alvarez *et al.* (2015).

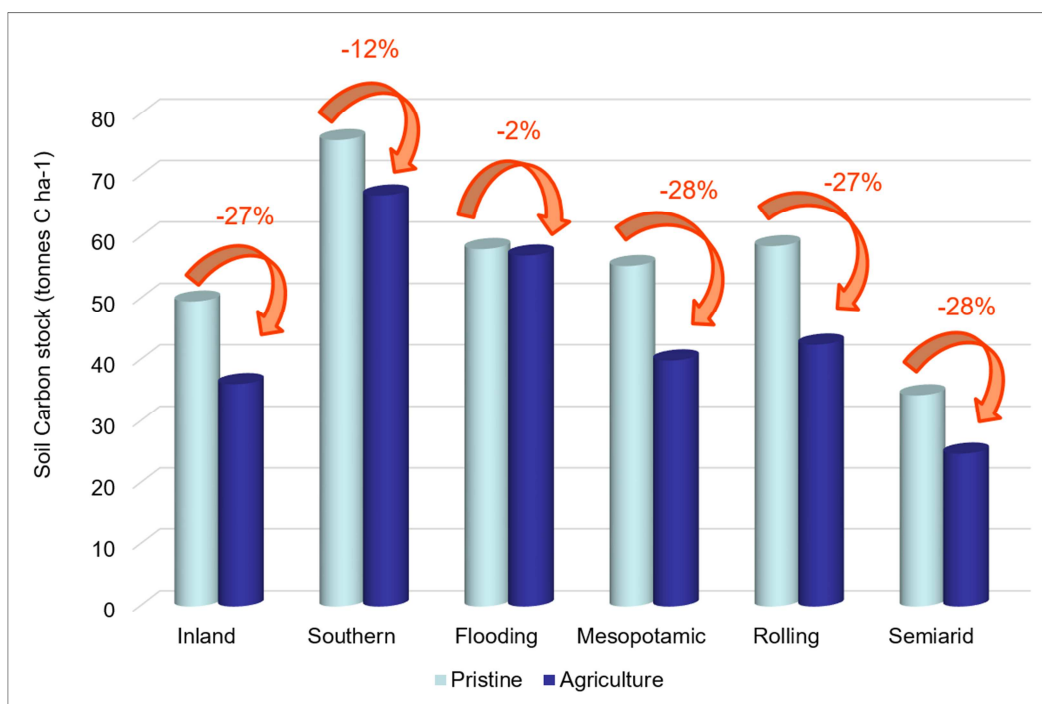


Figure 8. Soil carbon stock in natural remnants and croplands (equivalent soil mass of 3000 t ha⁻¹) of different sub-regions of the Pampa biome. Source: Own elaboration from Berhongaray *et al.* (2010).

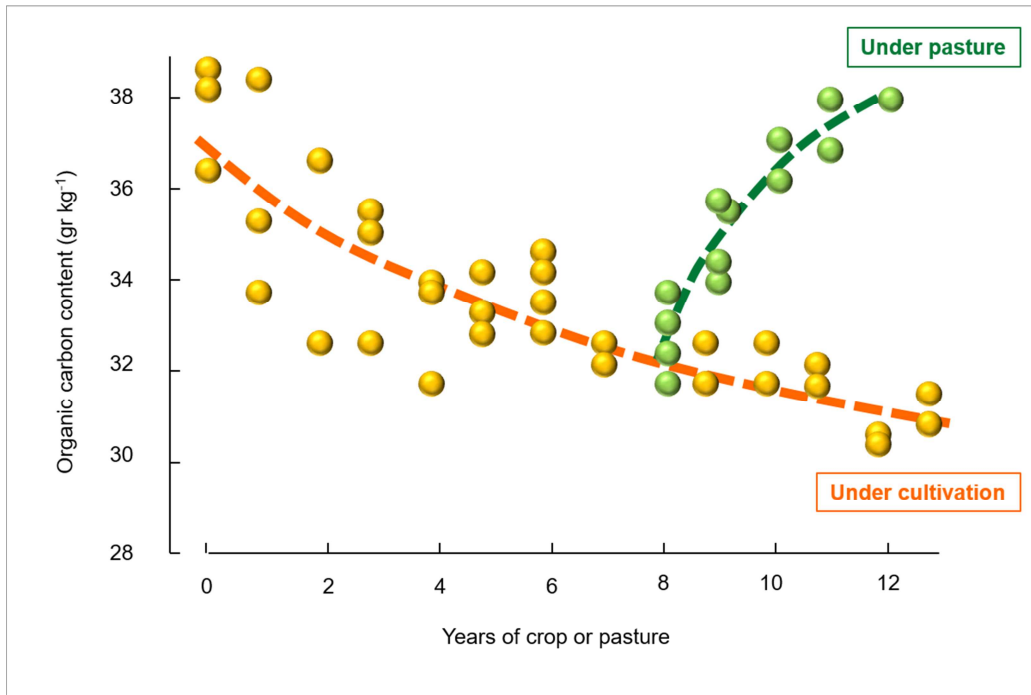


Figure 9. Evolution of organic carbon content in soil under agriculture and in response to the inclusion of a grass-based perennial pasture. Source: Own elaboration from Studdert *et al.* (1997).

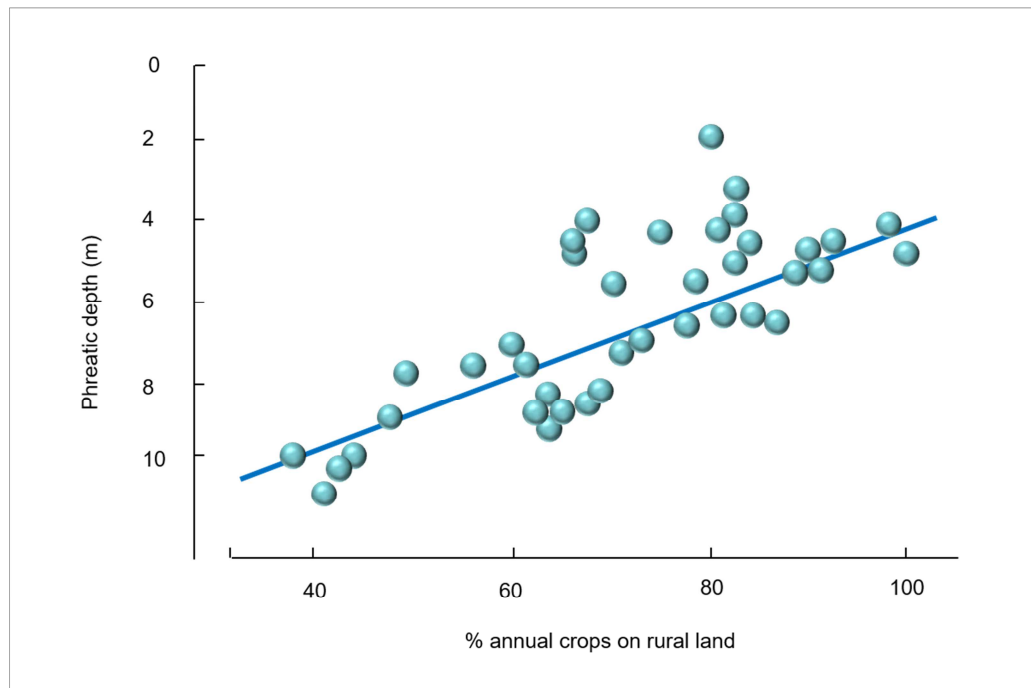


Figure 10. Relationships between the percentage of annual crops and the water table depth in a soybean-cropping area of Central Argentina. Source: Own elaboration from Bertram and Chiacchiera (2017).

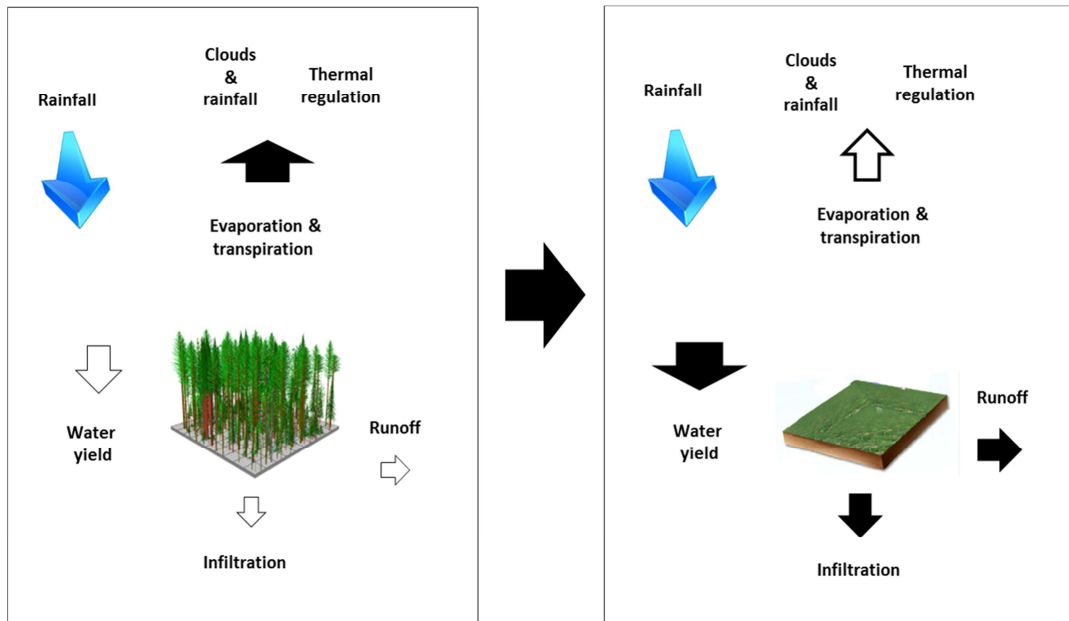


Figure 11. The modification of carbon- and water-related processes by land-use/land-cover change can drastically modify both basic ecological functions and the provision of essential ecosystem services. Source: Own elaboration from Viglizzo *et al.* (2016).