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DOCUMENTS

GREENHOUSE GASES (GHG) MITIGATION IN THE RURAL SECTOR OF ARGENTINA, BRAZIL, PARAGUAY AND URUGUAY AND ITS POTENTIAL IMPACT ON GLOBAL FOOD AND WATER SECURITY

JULY, 2015

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Presentation

GPS (Group of Producing Countries from the Southern Cone) is a project born in CARI (Argentine Council for International Relations) in 2011.

GPS is a network of private institutions from the agro industrial sector in Argentina, Brazil, Paraguay and Uruguay (ABPU), that work together to address world food security.(1)

ABPU is the largest food net exporting region in the world. It has a key role in Global Food Security through an efficient, productive and sustainable use of Natural Resources in order to fulfill its great exporting potential.

GPS works in the following spheres:

- *Gathering and consolidating ABPU's current and projected agro industrial data.*
- *Researching necessary measures to consolidate the ABPU region; addressing macro and micro issues both at economical and institutional levels.*
- *Participating in national, regional and international forums where governance, production standards, and trade regulation issues are discussed in order to state our position. This includes contacting regional and foreign government entities.*
- Identifying current and future exporting markets and develop a coordinated access strategy.
- *Proposing ideas on the relationship between large food exporters and large food importers.*

As part of its 2015 agenda, **GPS** has entrusted professional experts with the preparation of a series of documents that strengthen and support its goals.

This document entitled "Greenhouse gases (GHG) mitigation in the rural sector of Argentina, Brazil, Paraguay and Uruguay and its potential impact on global food and water security"

GPS would like to express its sincere gratitude to *Ernesto F. Viglizzo & M. Florencia Ricard* for this significant contribution.

GPS
GRUPO DE PAÍSES PRODUCTORES DEL SUR

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Greenhouse gases (GHG) mitigation in the rural sector of Argentina, Brazil, Paraguay and Uruguay and its potential impact on global food and water security

Ernesto F. Viglizzo & M. Florencia Ricard

Introduction

The IPCC 5th Report (2014) stated that "without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high/very high risk of severe, widespread, and irreversible global impacts"…"Mitigation options are available in every major sector. Mitigation can be more cost-effective if using an integrated approach that combines measures to reduce energy use and the GHG intensity of end-use sectors, decarbonized energy supply, reduce net emissions and enhance carbon sinks in land-based sectors". "… There are multiple mitigation pathways that are likely to limit warming to below 2°C relative to preindustrial levels… These pathways would require substantial emissions reductions over the next few decades and near zero emissions of CO_2 and other long-lived greenhouse gases by the end of the century… Implementing such reductions poses substantial technological, economic, social, and institutional challenges … on different timescales".

Within this framework, in a previous GPS work (Viglizzo, 2015) the issue of greenhouse gases (GHG) emission and global warming and its potential effect on human wellbeing, vulnerability and potential adaptation strategies in the ABPU (Argentina, Brazil, Paraguay and Uruguay) region was undertook.

In this new report we analyze current figures land trends of GHG emission in the ABPU region and, the same time, current figures and trends of food and virtual-water exports from this region to China and European Union. By linking those factors, we discuss the ABPU capacity to mitigate GHG emissions in the rural sector, and its relation to global food and water security.

On methods

Our work was based on the analysis of secondary data of sources such as those provided by FAO (2015), FAO Acquastat (2015), World Resources Institute (2015), SAyDS Argentina (2015) and World Bank (2014). Given that these global organizations have standardized and unified statistical estimates for all countries in the world, we considered that those data sources were more suitable to this assessment than those independently collected and published by each country in the region. Then, we reprocessed FAO and WB data to address the specific objectives of this work.

Background

It is widely accepted that agriculture is a major GHG emitter that directly affects both global warming and climate change. One inevitable and recurrent question is how much South American countries contribute to increase the current levels of GHG in the Earth atmosphere? In our above mentioned GPS report, we concluded that responsibilities, commitments and strategies of ABPU countries should previously be clarified and defined before addressing that question. It was recognized that more information was needed. The objective of that report was to get a clear idea about the share of ABPU region in the total GHG global emissions. To do that we worked on a comparison between ABPU GHG emissions and the emissions produced by other high-emitting countries.

Country groups	Country	GHG emissions (GT CO2 eq)	% of global total	% by country groups
World		42.67	100.00	100.00
High-emission countries	China	9.68	22.70	54.90
	USA	6.67	15.60	
	EU	4.66	10.90	
	India	2.43	5.70	
ABPU countries	Argentina	0.36	0.90	3.70
	Brazil	1.10	2.60	
	Paraguay	0.04	0.10	
	Uruguay	0.03	0.10	

Table 1. Average greenhouse gases (GHG) emissions by high-emission countries and ABPU countries in absolute and relative terms. *Source: Viglizzo (2015).*

We demonstrated that the absolute and relative gap between high- and low-emission countries (ABPU in particular) was extremely important. Table 1 shows that differences are huge when we compare the ABPU emissions with the major global emitters such as China, USA, EU and India. When the comparison is extended to country groups, the difference between the four ABPU countries and the four high-emission countries extends to 15 times. It is quite evident that global emissions will only show significant decreases if concrete mitigation actions are primarily implemented by those largest emitters. We concluded that the international pressure from high- to low-emission countries (like ABPU) to reduce their GHG emissions will not have in practice any measurable effect on global warming mitigation. We also demonstrated that less than 3% of global GHG emissions can be attributed to agricultural systems in the ABPU region, which certainly is a negligible figure.

However, an issue should call attention: data from global organisms (FAO, 2015; WB, 2015) showed that the weight of the rural sector in the domestic economy is certainly more important in the ABPU region than in the other four high-emitter countries. The consequence is that ABPU agriculture inevitably will be a prominent GHG emitter in the region. One criticism generally used to question agriculture in South America aims at the current deforestation rates and the conversion of natural into agricultural lands. That is a sound argument because it is well demonstrated and widely accepted that de-vegetation is a dominant cause of GHG emission in developing countries. Another argument is that ruminant rearing is a major source of GHG emissions, especially in arid and semiarid lands. It is also evident that the largest share of methane (CH_4) emission in ABPU agriculture comes from livestock production. The high incidence of ruminant species in relation to other non-ruminant species and crop activities is not under discussion. Then, it is argued that emission levels in South American countries could be drastically reduced if ruminants (more specifically, bovines) are removed from the production systems. Beyond those arguments, we think that this aspect admits additional insights and deserves special consideration in this new GPS report.

Given that GHG emissions from agriculture are an increasing cause of worldwide concern, current methods of food production in agricultural countries like Argentina, Brazil, Paraguay and Uruguay are inevitably exposed to cross-fire in global forums. In order to open new perspectives on the problem and enlarge the debate, in this new contribution we try to link the problem of GHG emissions to that of the global food and water security.

Agricultural production and GHG emissions in the ABPU region

Data from international organizations show a persistent linear increase of grain and beef production in the ABPU region (Figure 1). Certainly, such increase produces social and economic benefits as well as environmental and political pressures on the region. Novel strategies are needed to handle such conflict in the region. However, we must accept there are large differences between countries regarding production trends. Due to its large size, Brazil currently doubles the grain production of Argentina and exceeds more than ten times the grain production of Paraguay and Uruguay. Those differences are still greater in the case of beef production, showing that Brazil has applied a long-term strategy to increase livestock production (Figure 2).

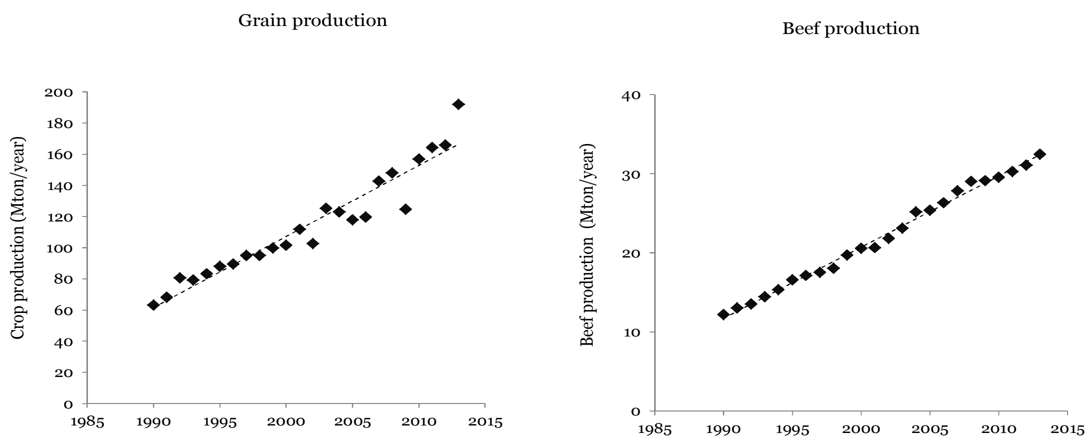


Figure 1. Annual grain and beef production in ABPU region during the period 1990-2012.
Data source: FAO (2015).

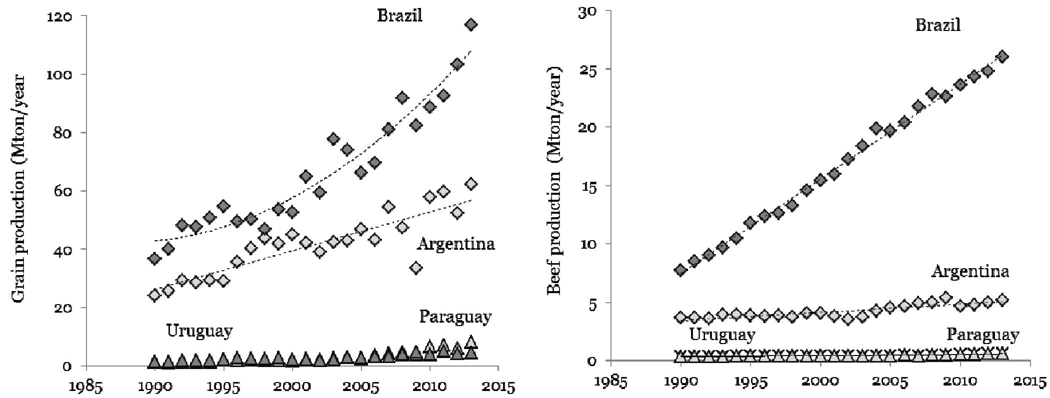


Figure 2. Annual grain and beef production in the four ABPU countries during the period 1990-2012. ***Data source: FAO (2015).***

Given that crops productivity in Argentina and Uruguay is higher than those of Brazil and Paraguay (Figure 3), the conclusion is that the high growth rate of grain production in Brazil is primarily explained by the rapid expansion of agricultural

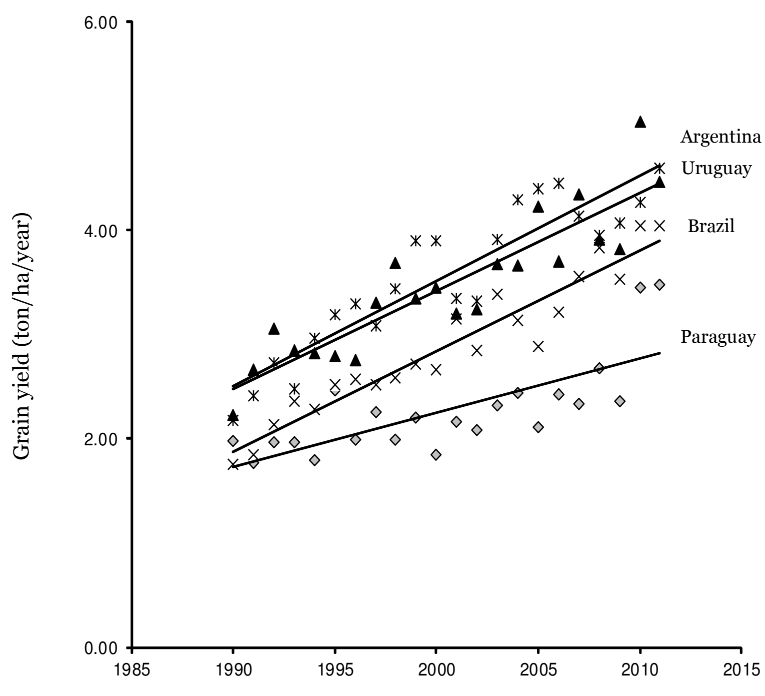


Figure 3. Average grains yield (ton/ha/year) in Argentina, Brazil, Paraguay and Uruguay between 1990 and 2011. *Source: World Bank (2013).*

The growing gross production of the ABPU region has, as can be expected, implications on GHG emissions. A 23-year analysis of emission trends reveals that emissions increased in the four countries (Figure 4). However, a noticeable decrease can be appreciated since 2007 in Argentina and since 2010 in Brazil. Emission figures show a great disparity among ABPU countries, which directly correlates to the size of their respective agricultural economies.

Agricultural GHG emissions in the region can be explained by two main causes: (a) land-use change (e.g., deforestation, burning of logged vegetation), and (b) agricultural activities such as tilling, harvesting and plague treating. Intensification is always associated with the increasing consumption of fossil fuels and inputs like synthetic fertilizers and pesticides, which demand large amounts of fossil fuels for manufacturing and transportation.

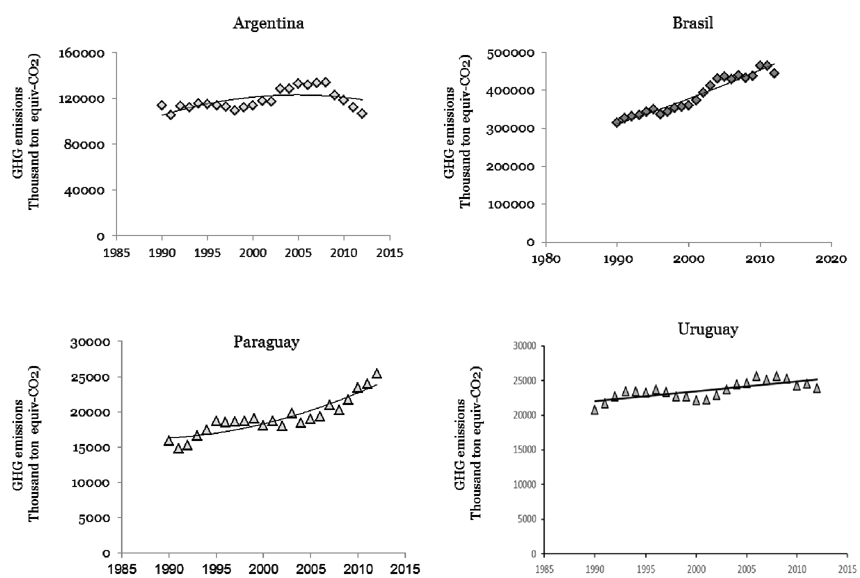
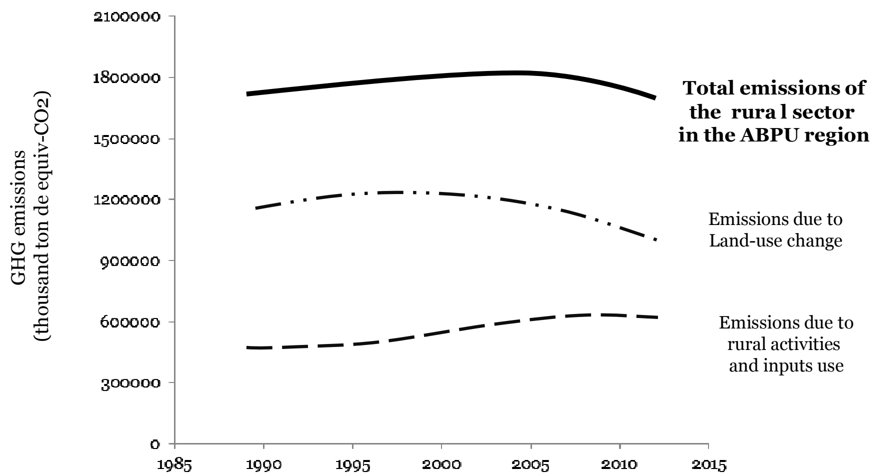


Figure 4 : Greenhouse gases emission (GHG) in the four countries of the ABPU region due to agricultural activities during the period 1990-2012. *Data source: FAO (2015).*

Figure 5 quantifies total emissions throughout the period 1990-2012, which is the result of adding the partial contribution of sources (a) and (b).



Emissions due to productive activities of tilling, animals fermentation , fertilizers and plaguicide use, etc.

Emissions due to land-use change: deforestation, burning, afforestation, plant residues degradation, etc.

Figure 5. Trajectory of greenhouse gases (GHG) emissions in the ABPU region during the period 1990-2012. *Data source: FAO (2015).*

No doubt those long-term trends in the region were strongly influenced by emission changes that have occurred in Brazil and Argentina. After a period of persistent GHG increase, emissions tended to decline during the last decade. This behavior can be explained by factors such as national policies and market events that have discouraged the deforestation of new natural lands, particularly in the case of Brazil and Argentina, or boosted afforestation through an extensive plantation program in the case of Uruguay. The effect of both strategies can be appreciated in Figure 6. Negative emissions in the case of Uruguay indicate that this country was gaining carbon across the period due to afforestation. On the other hand, while Argentina and Brazil reduced deforestation, Paraguay shows a relative delay in implementing a policy to decrease deforestation.

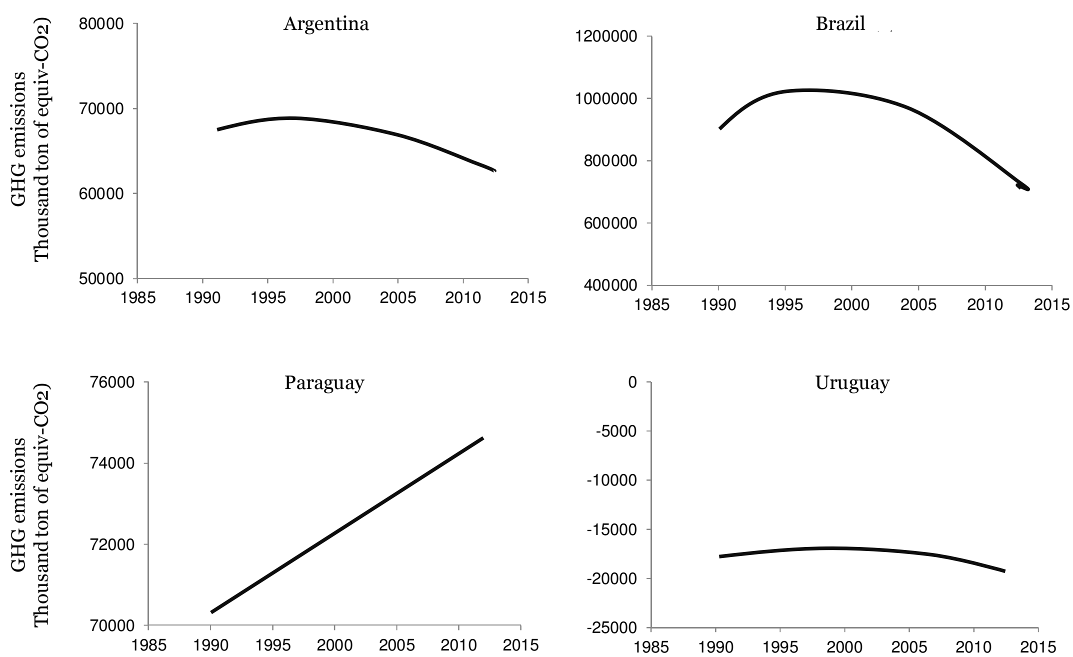


Figure 6. Trajectory of greenhouse gases (GHG) emissions in Argentina, Brazil, Paraguay and Uruguay during the period 1990-2012 due to land-use change. Positive values indicate emission. negative values: carbon sequestering. *Data source: FAO (2015).*

Given that modern farm-production methods unavoidably require inputs and activities that are associated with GHG emissions, the capacity to reduce GHG emission must rely primarily on programs to reduce deforestation of natural lands or expand afforestation into new lands. Results showing the effect of long-term deforestation and afforestation policies in the region can be appreciated in Figure 7. While Uruguay stands out due to the expansion of forest plantations, Argentina and Brazil show a considerable decrease in their rates of deforestation, probably tending to zero in the mid-term if current trends persist.

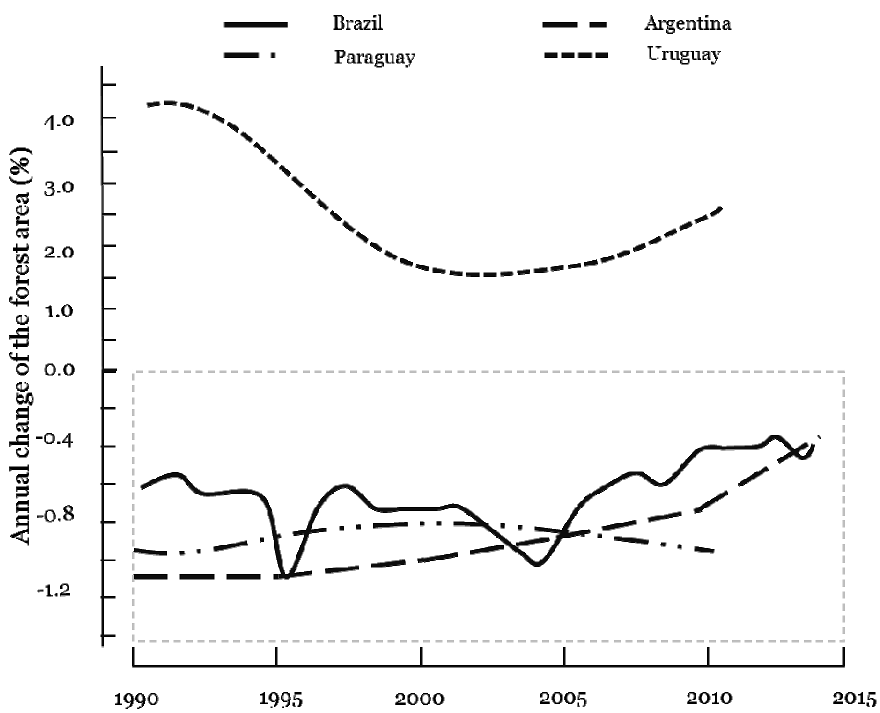


Figure 7. Annual deforestation rate in Argentina, Brazil, Paraguay y Uruguay during the period 1990 -2014. Negative numbers: deforestation. Positive numbers: afforestation.
Sources: data from Secretaría de Ambiente y Desarrollo Sustentable ofArgentina (2015), Global Forest Watch (2014), Mongabay (2015)

On the other hand, private and public organizations have made a considerable effort to boost the incorporation of minimum/zero-tilling practices that reduce fossil energy consumption and GHG emissions. Despite disparities among countries, the widespread adoption of reduced tillage was an outstanding achievement of agriculture in the ABPU region (Figure 8).

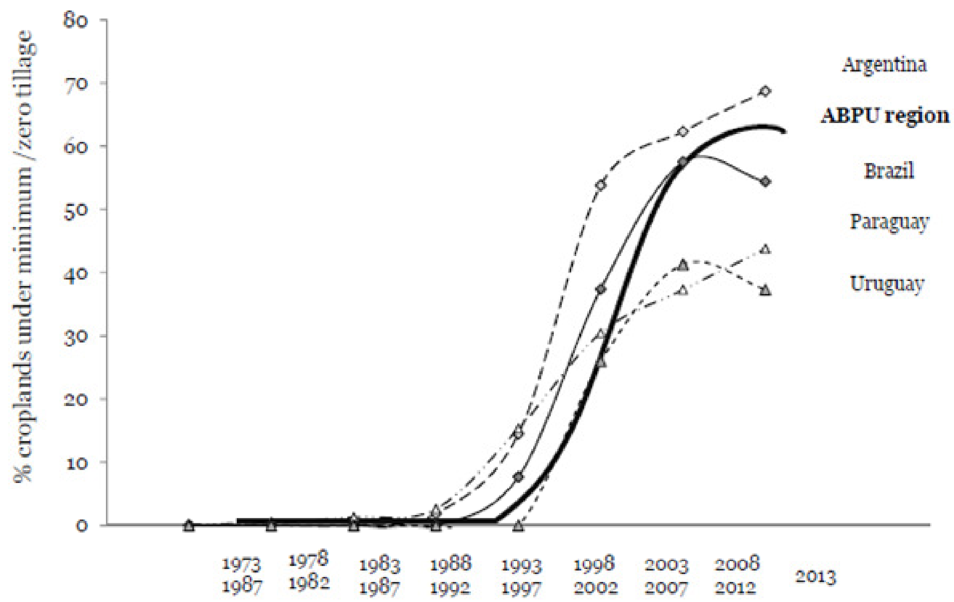


Figure 8. Adoption of minimum/zero tillage in Argentina, Brazil, Paraguay and Uruguay during the period 1973-2013. *Source: data from FAO (2015)*

The net effect of incorporating those practices has resulted in (a) a considerable reduction of soil erosion and (b) a decline of GHG emissions (Figure 9). The decreasing trend in GHG emission attributable to minimum/zero tillage adoption between the 1970's and the 2010's was meaningful: it declined from 12.7 % to 4.9 % of total agriculture emissions. Despite minimum/zero tillage is not a major determinant of agricultural emissions, it must be highlighted the effort of farm and public organizations to mitigate GHG emissions by means of technology incorporation.

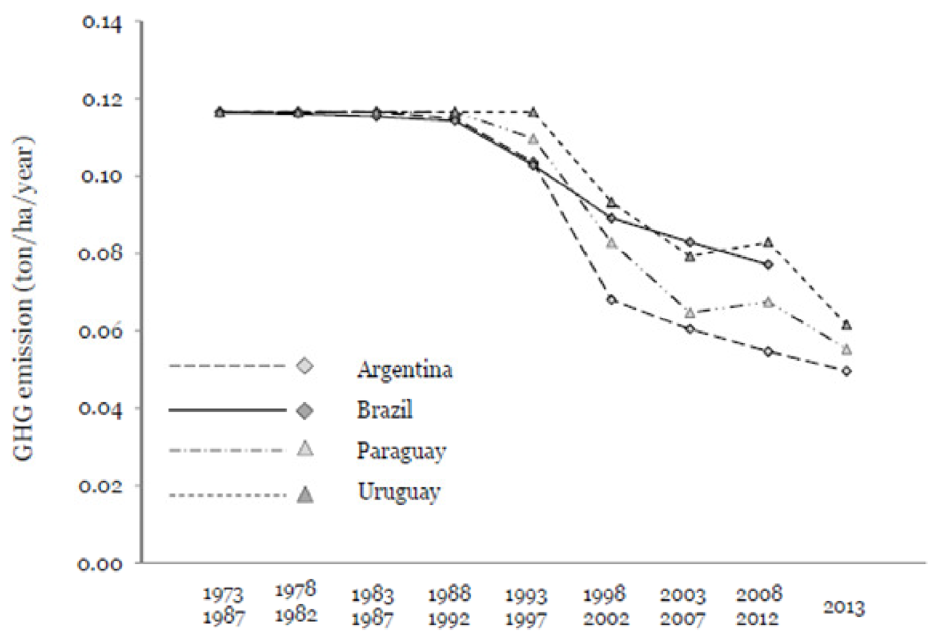


Figure 9. Estimation of greenhouse gases (GHG) emission due to minimum/zero tillage in Argentina, Brazil, Paraguay y Uruguay during the period 1973-2013. *Source: data from FAO (2015)*

The carbon footprint of the rural sector in ABPU countries

The carbon footprint is a measure of the potential of one country, region or production activity to inject carbon into the atmosphere and, in this way, enhance and worsen the global warming process. Various production and industrial systems are receiving increasing attention because of their carbon footprint. One way to estimate the carbon footprint of agriculture is to calculate the amount of equivalent-CO2 emitted per unit of product. In a preliminary GPS report (Viglizzo, 2014) made an estimation of the carbon footprint of grain production (expressed as ton eq-CO2/ton grain) for the four ABPU countries (Figure 10). There are significant differences among countries, particularly when the focus is put on the trend of carbon footprints during the period 1990-2011. Differences were highly influenced by deforestation, depending on the inclusion or exclusion of deforested areas.

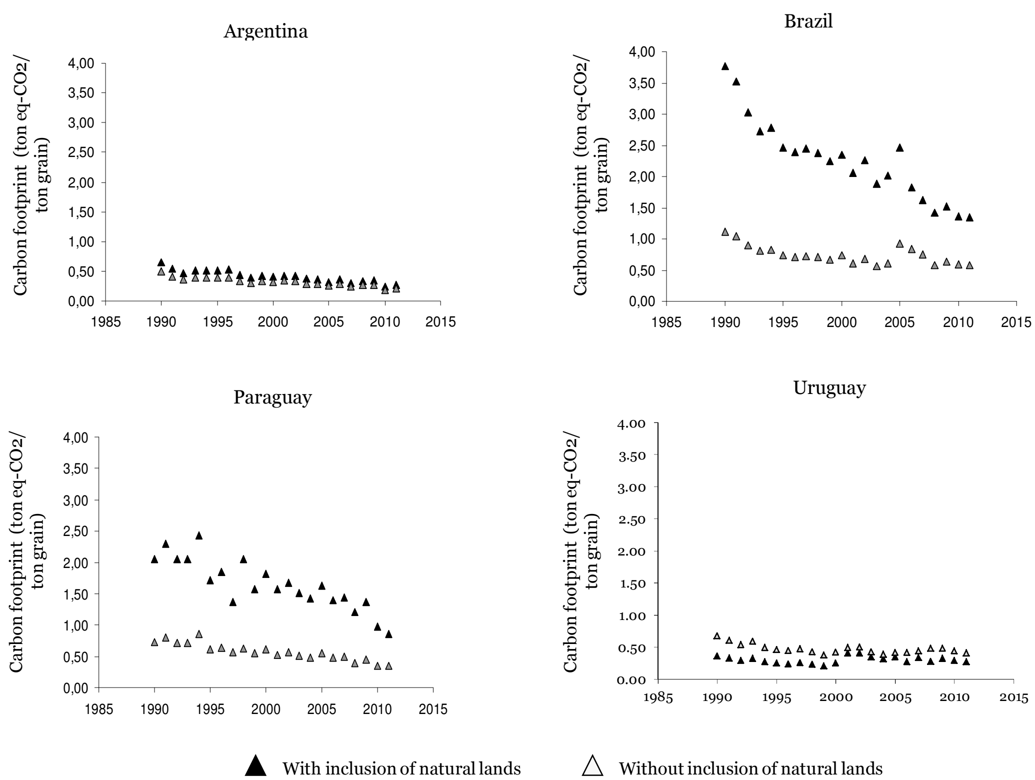


Figure 10. Carbon footprint (ton eqCO2/ton grain) of Argentina, Brazil, Paraguay and Uruguay with and without imputation of land-use change in natural areas. *Source: Viglizzo (2014) based on data from World Bank (2014).*

Deforestation dramatically increased the estimations of carbon footprint. But on the other hand, the calculations were also affected by the average grain production yield of each country. Beyond differences, Figure 10 shows a noticeable decreasing trend in the carbon footprint of Brazil and Paraguay. How can this phenomenon be explained? A persistent decline of deforestation in Brazil and a parallel and persistent increase in agricultural yields in Brazil and Paraguay, explain the decline of carbon footprint in both countries.

A question is triggering a debate: Are the decreasing deforestation rate and the increasing crop yield related? In other terms, does agricultural intensification produce a large-scale "saving" of forest land? Certainly, we cannot be conclusive, but what is clear is that a parallel, two-way process has been triggered; an increasing grain yield on the one hand, and a decreasing deforestation rate on the other hand. No doubt that the four countries have made a non-concerted decision of increasing crop productivity on already cultivated lands through technology incorporation. This type of processes can be qualified as "sustainable intensification"; two good first examples of "agricultural intensification" can be found in the case of Argentina and Brazil, where deforestation agree with an increasing yield in croplands. On the other hand, while Paraguay has taken only one way of the process (crop yield increase), Uruguay offers the most outstanding example of "agricultural intensification". This country is getting a clear advantage over the other three countries because crop yields have increased while, in parallel, a long-term afforestation program of new lands is developing. It should not surprise that the best single example of low carbon strategy in the region can be found in this country.

The role of ABPU in global food and water security

Setting aside for a moment the problem of agricultural emissions, it is meaningful to ask ourselves about the role that ABPU agriculture plays in global food and water security.

One way of doing it is to evaluate the size of our commercial exchange with two important country/regions (e.g., China and European Union) that are major demanders of agricultural products from ABPU. The analyzed data (FAO, 2015) show that in average 45.5 % of grains and 51.9 % of beef purchased by

		Total traded products (thousand ton/year)		% traded products	
	Region/ country	Grains	Beef	Grains	Beef
Demand	EU-China	113.89	11.29	**100**	**100**
Supply	Argentina	26.90	1.69	**45.50**	**51.92**
	Brazil	19.92	3.24		
	Paraguay	3.40	0.11		
	Uruguay	1.55	0.82		

Table 2. Absolute and relative participation of ABPU in the total volume of food sold to China and EU during the period 1990-2012. *Data source: FAO, 2015.*

China and EU between 1990 and 2012 came from the four study countries (Table 2), where Argentina has tended to dominate the trade of grains and Brazil the trade of beef. These results are indicative of the relevant role that ABPU has in contributing to the food security of two important countries/regions in the world.

Another aspect to be considered is the role of ABPU in water security of both country/regions. Over the past decade a growing consideration was paid to the concept of "virtual water". In practical terms, "virtual water" is the number of liters of water used to produce 1 kilogram of marketable food, and is expressed as liters of water/kg of product. This view assumes that when a kilogram of food was sold, an amount of "virtual water" equivalent to the total water used to produce that kg of food is transferred from the seller to the buyer. In other words, the buyer purchases food but, at the same time, is acquiring considerable amounts of water that can be saved or re-oriented to another use or purpose (urban, industry, etc.). Under this view, an increasing traffic of "virtual water" is occurring nowadays in the world (Hoekstra, 2003).

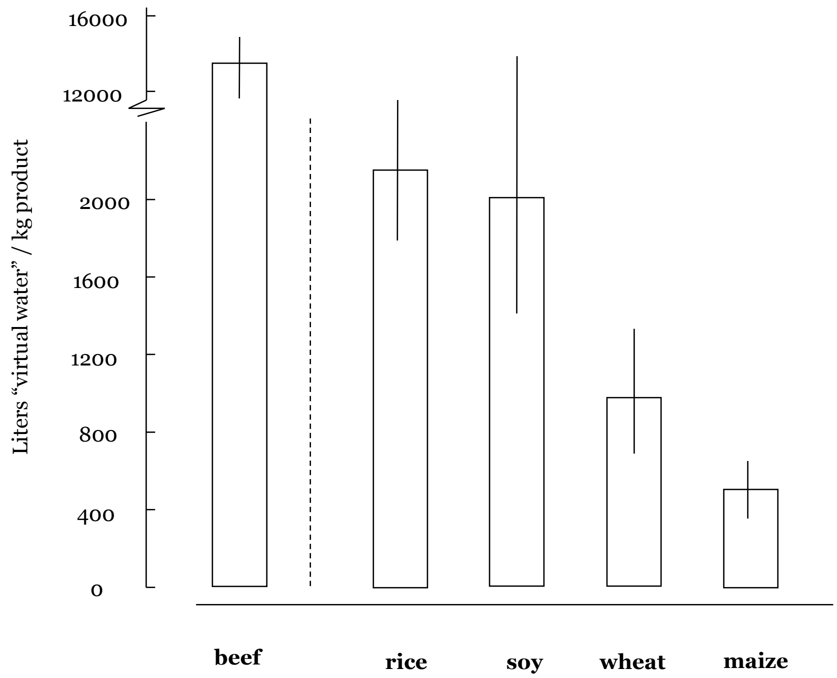


Figure 11. Average "virtual water" content of beef and some grains.
Sources: Aldaya (2010), Hoekstra & Chapagain (2007); Frank (2012)

The amount of "virtual water" that an exporter sells and transfers to the importer is highly influenced by the composition of the bulk product. Different foods have different water footprint, that is, the content of "virtual water" may vary greatly from one product to another. The average "virtual water" content of different exportable products (Hoekstra & Hung, 2003; Hoekstra & Chapagain, 2007; Aldaya, 2010; Frank, 2012) generally traded by the ABPU countries is showed in Figure 11. In this example, rice and soybean have a "virtual water" content that doubles that of wheat and maize. Because of its high grain yield, maize tends to show low "virtual water" figures. On the contrary, beef shows the largest "virtual water" index. Figures vary, but the water required for producing one kg of beef ranges between 12000 and 15000 liters. The low water-use efficiency of ruminants in general, and of bovines in particular, can be explained by their low biological productivity. Low productivity is the result of a highly wasteful energy metabolism, which is an unchangeable biological characteristic of ruminants. The high rate of methane release (a potent GHG), plus the high water demand of ruminants, are generally two powerful arguments that environmentalists use to question and disqualify beef production processes.

Beyond the soundness of this argumentation, it should be noted that ruminants still play a decisive role in the agricultural economy of many regions of the world, especially in arid and semi-arid regions where poor populations live and grain cropping is not viable. There are several reasons that justify the rearing of bovines and other ruminant species in those environments: first, by their digestive characteristics, ruminants are the only on species that have the capacity of digesting fibrous grasses that otherwise would be lost. Second, this attribute confers biological and economic stability to producers, which are unable to crop or to use other non-ruminant species.

		Trade of "virtual water" (km^3/year)		Trade of "virtual water" (%)
	Region/ country	Grains + beef		Grains + beef
Demand	EU-China	383.95	383.95	**100**
Supply	Argentina	38.77	116.78	**30.42**
	Brazil	65.03		
	Paraguay	7.12		
	Uruguay	5.86		

Table 3. Absolute and relative participation of ABPU region in the amount of "virtual water" exchanged with EU and China during the period 1990-2012. *Sources: FAO (2015), Hoekstra and Hung (2003), Chapagain and Hoekstra (2003).*

Third, bovines and other ruminants provide milk and meat of high biological value because their proteins are rich in various essential aminoacids that are not present in most grain proteins. Fourth, countries importing bovine proteins are buying large amounts of "virtual water" that allows them to release and decide about alternative uses to their own water resources.

Following the example of food security, in Table 3 we show results that illustrate about the importance of ABPU region for providing water security to China and UE. Through the trade of grains and meats, ABPU countries provide in average 30.4% of the "virtual water" that China and EU purchased in the world. Most of the "virtual water" is provided by Brazil, which exceeds by more than 100% the contribution of the other three countries in the region. The most significant portion of the "virtual water" provided by Brazil comes from traded beef.

What does it mean in practical terms? If the ABPU region provides China and EU more or less 117 km^3 of "virtual water", this hydrological transference serves to cover the annual water needs of 120 million people. Under this view, ABPU significantly contributes to the water security of European countries and China.

Carbon mitigation, food and water security: the coming trilemma

It is likely that pressures on food-producing countries to reduce their GHG emissions can increase in the coming years. However, the practical possibility of

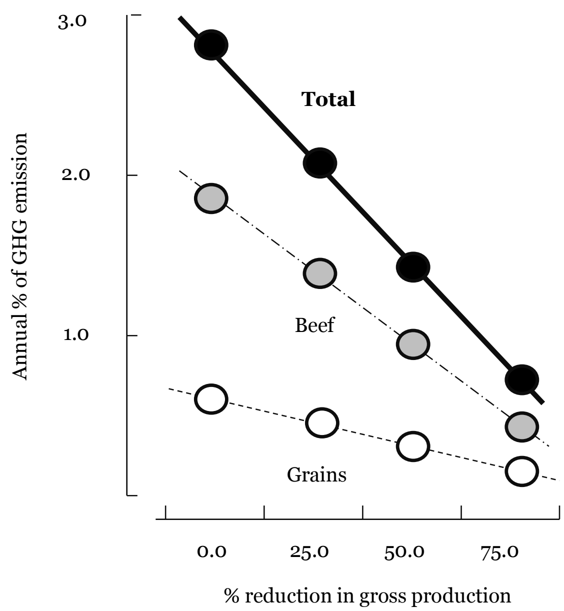


Figure 12. Estimating the potential impact of reducing gross agricultural production (beef and grain) on the mitigation of GHG emissions in the ABPU region.

these countries to reduce their GHG emissions without affecting their gross production shrinks once deforestation rate approaches to zero and technology does not allow additional mitigation effects. In absence of other alternatives, the most simplistic pathway for these countries is to reduce GHG emissions is to reduce the current levels of agricultural production. But would this decision be sensible?

A numerical exercise that simulates the effect of different levels of production decrease in the region on total GHG emissions is shown in Figure 12. It can easily be seen that a drastic voluntary reduction of food production (up to 25%, 50% and 75% of current levels) would cause a very significant fall in GHG emissions. It can also be seen that, at similar levels of production decrease, the removal of beef production would be more effective to mitigate emissions than the elimination of crop production systems. The steeper slope of beef- regarding crop-production shows this. What does it mean? It means that the most effective first strategy to mitigate global warming is to reduce livestock activities, and the second one would be to reduce the size of the cropping area.

Assuming that this would be feasible in practice, what would be the consequence in terms of global food and water security? Proceeding on our simulation results, in Figure 13 we can get a rough panorama of possible consequences.

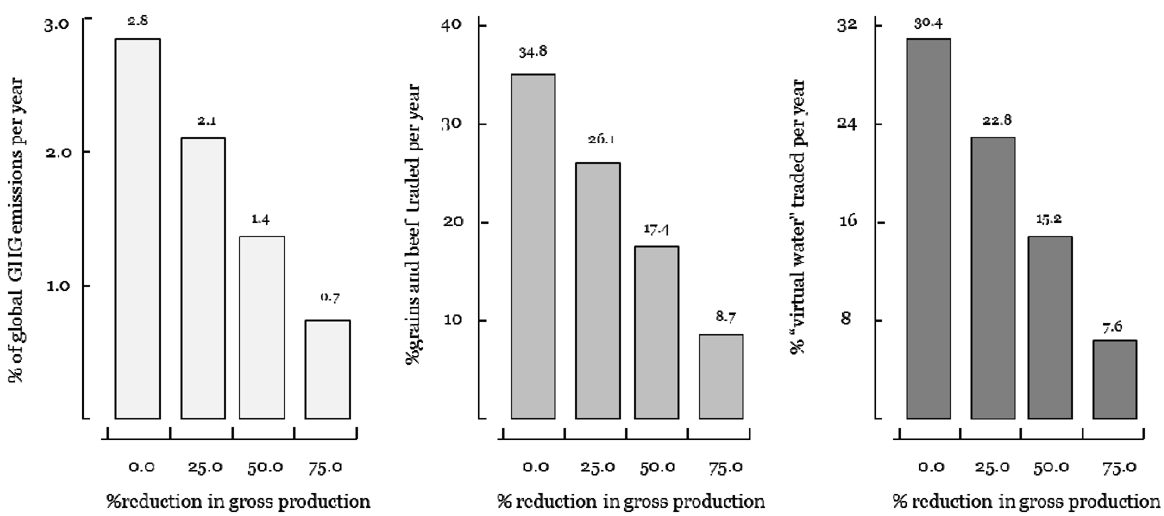


Figure 13. Estimating the potential impact of reducing agricultural gross production in the ABPU region on the decrease of global GHG emissions from ABPU and the global retraction of food and "virtual water" trade

The model is sensitive enough to provide a broad picture about the outcomes of such decision. If we locate on the extreme case of 75% reduction in current levels of agricultural production, it is possible to quantify some global effects. While the four ABPU countries would mitigate GHG emissions by no more than 2% of global emissions, the transference of food would globally decline more than 25% and the provision of "virtual water" more than 22%.

Certainly, this would mean that a disproportionate price should be paid in terms of global food and water security to achieve a negligible reduction of global GHG emissions. The most basic reasoning indicates that such a strategy would be unsuitable as well as impracticable both in regional and global terms. Common sense indicates that mitigation strategies should not be focused on food production, but on those economic sectors that today have the higher technological and operative possibility of reducing GHG emissions. Certainly, an eye should first be put on emissions in country-energy systems, residential and public buildings, luxury wastes and transport means.

References

Aldaya, M.M., Allan J.A., Hoekstra, A.Y. (2010). Strategic importance of green water in international crop trade. Ecological Economics 69: 887–894.

FAO (2015). FAOSTAT database http://faostat3.fao.org

FAO Aquastat (2015). AQUASTAT database http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

Frank, F.C., Viglizzo, E.F. (2012). Water use in rain-fed farming at different scales in the Pampas of Argentina. Agricultural Systems 109: 35–42.

Hoekstra, A.Y., Editor (2003). Virtual water trade: proceedings of the international expert meeting on virtual water trade. In: Hoekstra, A.Y. (Ed.), Value of Water Research Report Series No.12. UNESCO-IHE, Delft, The Netherlands. www.waterfootprint.org/Reports/Report12.pdf

Hoekstra, A.Y., Chapagain, A.K. (2007). Water footprints of nations: water use by people as a function of their consumption pattern. Water Resources Management 21: 35–48.

Hoekstra, A.Y., Hung, P.Q. (2002). Virtual water trade: a quantification of virtual water flows between nations in relation to international crop trade. Value of Water Research Report Series No.11, IHE, the Netherlands.

IPCC 5th Report (2014). Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

Rhett A. Butler, R.A. (2015). Rainforests: Ten things to watch in 2015. Mongabay Report, http://news.mongabay.com/2015/0102-what-to-expect-for-rainforests-in-2015.html

SAyDS Argentina (2015). Monitoreo de la Superficie de Bosque Nativo de la República Argentina Período 2013-2014. Edición SAyDS, Buenos Aires, 85 pp.

Viglizzo, E.F. (2014). Carbon footprint and sustainable intensification in Argentina, Brazil, Paraguay and Uruguay. GPS (Group of Producing Countries from the Southern Cone) documents. Buenos Aires, 20 pp. www.grupogpps.org.

Viglizzo EF (2015). Climate Change in the ABPU region (Argentina, Brazil, Paraguay and Uruguay): Threats and opportunities. GPPS Report, March 2015, 15 pp. www.grupogpps.org

World Bank (2014). World Bank Data Base (http://data.worldbank.org/indicator)

World Resources Institute (2014). Global Forest Watch. www.wri.org/our-work/project/global-forest-watch