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LINKING CLIMATE CHANGE, CARBON AND TRADE IN THE MERCOSUR FOOD SYSTEM: DO WE NEED A COMMON REGIONAL STRATEGY?

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Abstract

Matching the future demand of food can be possible with current knowledge and technical progress, but a greater impact in terms of greenhouse gases (GHG) and other environmental issues, is cause of increasing concern. So, the big question is how to produce more food in response to the increasing population demand improving, in parallel, the environmental performance of food production. Considering the increasing role of MERCOSUR countries in global food security, a common regional strategy seems to be quite necessary to face the challenge of harmonizing food production with environmental targets.

The main challenges for the MERCOSUR region are how to mitigate GHG emissions and adapt its food-production system to climate change and other environmental threats. A dilemma is opening in the regions: are national GHG inventories estimating carbon sequestration in a rigorous way? Some scientific evidence suggests that this issue has to be revisited. The application of methods different to those recommended by IPCC can drastically change de carbon balance of countries in the region, and this may request a revision of current international commitments and targets. Likewise, a revision of carbon footprint frameworks to assess the agri-food business is quite necessary, especially when this parameter can be used to raise commercial barriers.

What seems to be clear is that scientific knowledge and novel technologies can open new horizons on global warming mitigation and adaptation to climate change. Lower usage of fossil energy was achieved through reducing the use of machinery (e.g., by no-till operations), soil testing, site-specific use of fertilizers to avoid nutrient surpluses, precision-use of pesticides and smart application methods. Likewise, farmers in the region can adopt some measures to facilitate the future adaptation to climate change. GM crop varieties that are more resistant to the climatic stress and require a lower use of inputs such as nutrients and water is a way to face the climatic threat. Based on eco-physiology research, they also can adopt improved practices for conserving and managing water by altering the timing and location of cropping activities. Pest, disease and weed management can be improved by using climate and weather improved forecasting to predict risky events. All these knowledge-based innovations not only reduce carbon emissions but also increase the farm profitability.

The notion of sustainable intensification appears to be suitable to the region since it implies the double objective of increasing or maintaining gross productivity with less land and a lower environmental impact. By means of high-tech practices, the challenge is to keep or increase productivity using less fertilizers, pesticides, water and fossil energy in line with the principles of precision farming. Precision farming has introduced novel concepts such us “environmental driven cultivation”, “climate smart farming”, “variable-dose fertilizers use”, “site-specific pesticide application”, “permanent soil water and nutrient monitoring”, “permanent pest monitoring of crops”, “yield mapping of plots and fields” and so on. “Information and

Communication Technologies (ICT)" support the human control of those biophysical processes.

High-tech adoption by food-exporting countries will increasingly contribute to global food, climate and water security if free-trade conditions are enhanced worldwide. There are intangible services that can benefit food-demanding countries. The actual and potential transference of food, virtual water, carbon and nutrients can allow them to replenish their degraded aquifers and recover their exhausted carbon and nutrient stocks after many years of agricultural overexploitation. Free trade certainly will play a major role in the transference of environmental sustainability from some countries to others.

1. Introduction

Food demand is projected to increase quite rapidly during the next two decades as a consequence of population increase, the additional food demanded by a growing middle class and the need of closing the gap to one million people that still remain undernourished.

Matching future food demands can be possible under the current technological panorama, but a greater environmental impact in terms of greenhouse gases (GHG), land degradation, aquifers depletion in certain regions and the loss of ecosystem services is cause of increasing concern. The main challenge for the global community is how to produce more food in response to the increasing demand improving, in parallel, the environmental performance of food production. The international imperative arisen from COP21 and COP22 to reduce GHG emissions and increase C sequestration in a context of global food security imposes a growing pressure on food-producing and food-exporting countries. While four countries in the MERCOSUR area (Argentina, Brazil, Paraguay and Uruguay) contribute with 20%, 47% and 25% to the international trade of cereals, oilseeds and meats respectively -thus playing a relevant role in global food security (Regúnaga and Elverdín, 2017)-, it is not clear enough how they contribute to the global carbon balance and, indirectly, to the global climate change.

In order to face and resolve those dilemmas, a common regional strategy seems to be quite necessary in the MERCOSUR region. The aim of this contribution is to propose some alternative ways to face a smart strategy in the years to come.

2. The challenge of climate change mitigation and adaptation

A climate-smart agricultural strategy should aim to ensure that enough food is provided for a growing population while reducing the carbon intensity and enhancing adaptation throughout the food chain. It should be noted, however, that progress will be uneven, and the capacity to increase food production, reduce the impact on climate and increase adaptation will vary widely across countries and regions, and at different stages of production and consumption.

2.1. GHG mitigation

The available scientific evidence suggests that “business as usual” will lead to an uncertain future, putting the security of food supply at risk. So, a global strategy has to be built based on a strong scientific, evidence-based foundation in order to move agriculture and food production into a low-carbon intensity pathway. Both will have an important role to play in the process, as will do open markets that facilitate the sharing of technology and innovations to support a low-carbon food security. This means that all forms of protectionism should be avoided.

The advent of the digital age is exponentially enhancing the generation of new technologies that can be shared to improve the relationship between the food and the climate system. Digitization allows converting all types of information and media - texts, sounds, images, photos, data- into zeros and ones that represent the language that computers, cell phones, digital tablets, GPS and computer systems can understand. Digitalization will have two profound consequences: the acquisition of new knowledge (literally, to make more science), and the acceleration of innovation through the analysis of large databases, which comprise big-data analysis. Today it is possible to speak about "re-combinatorial technologies", which consists of combining different products of the digital age to produce new and unexpected technologies (Brynsjolfsson and McAfee, 2016). Many of these new developments are incorporating into the so-called "precision agriculture”, which promises to improve the relationship between the food and the climate system.

The irruption of high-tech into the agri-food sector is still confined to some countries that are adopting them at high rate. But it will also be incorporated by developing countries in the near future once some basic limitations (e.g., the “digital divide”) imposed by poverty and underdevelopment to benefit from those innovations worldwide is overcome.

High-tech resources aim at economizing the use of expensive inputs that depend on fossil fuels for manufacturing. Evidences from developed countries show that commercial farms (primary users of expensive inputs) reduce the use of “carbon-emitting” inputs in response to higher prices (Harris et al., 2008). Lower usage of fossil energy was achieved through reducing the use of machinery (e.g., by no-till operations), soil testing, site-specific use of fertilizers to avoid nutrient surpluses, precision-use of pesticides and smart application methods. All these knowledge-based innovations not only reduce carbon emissions but also increase the farm profitability (Wreford et al. 2010, OECD, 2010b). On the other hand, based on better scientific knowledge on plant physiology, agriculture and forestry will make a positive contribution to climate change mitigation by acting as carbon sinks.

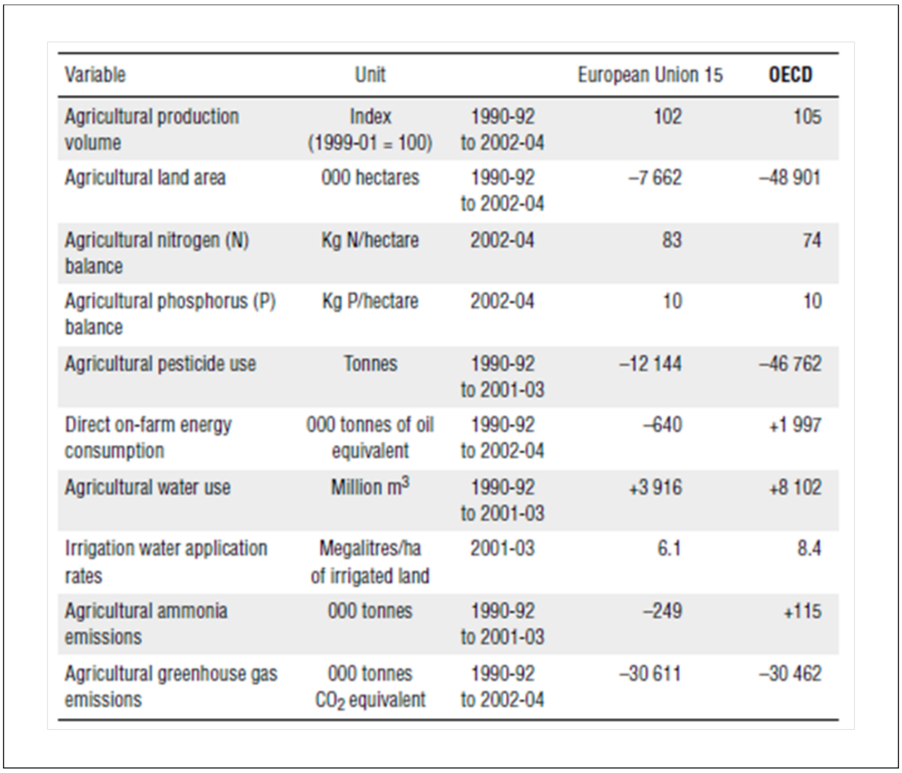
2.2. Adapting to climate change

High-tech can also improve the adaptation of farmers to climate change. There are management practices that can also generate other environmental and economic co-benefits. They can adopt GM crop varieties that are more resistant to the climatic stress and require a lower use of inputs such as nutrients and water. Based on eco-physiology research, they also can adopt improved practices for conserving and managing water by altering the timing and location of cropping activities. Pest, disease and weed management can be improved by using climate and weather improved forecasting to predict risky events. As a co-benefit, the IPCC estimates that the widespread adoption of these practices could produce a yield improvement of up to 10% compared to yields without such adaptation (Wreford et al., 2010).

2.3. Tracking progress

Environmental indicators are needed for tracking environmental progress, supporting policy evaluation and informing the public. Such indicators have gained in importance in many countries and international fora since the early 1990s. OECD countries increasingly use a reduced number of key indicators, selected from larger sets, to report on major environmental issues. Taking into account an indicator on GHG emissions in agriculture, in comparison to EU countries OECD countries have decoupled their CO2 and other GHG emissions from fossil-energy use due to technology application.

Table 1. Change of agricultural and environmental indexes of OECD in comparison to EU countries.



Variable	Unit		European Union 15	**OECD**
Agricultural production volume	Index (1999-01 = 100)	1990-92 to 2002-04	102	105
Agricultural land area	000 hectares	1990-92 to 2002-04	–7 662	–48 901
Agricultural nitrogen (N) balance	Kg N/hectare	2002-04	83	74
Agricultural phosphorus (P) balance	Kg P/hectare	2002-04	10	10
Agricultural pesticide use	Tonnes	1990-92 to 2001-03	–12 144	–46 762
Direct on-farm energy consumption	000 tonnes of oil equivalent	1990-92 to 2002-04	–640	+1 997
Agricultural water use	Million m^3	1990-92 to 2001-03	+3 916	+8 102
Irrigation water application rates	Megalitres/ha of irrigated land	2001-03	6.1	8.4
Agricultural ammonia emissions	000 tonnes	1990-92 to 2001-03	–249	+115
Agricultural greenhouse gas emissions	000 tonnes CO_2 equivalent	1990-92 to 2002-04	–30 611	–30 462

Source: OECD, 2008.

Despite GHG emissions from agriculture show similar figures in both country groups, it should be noted a noticeable decrease of land allocated to agricultural production in OECD countries, which in practice indicates that a much larger amount of land was spared and set aside from production in order to boost conservation objectives, mainly carbon sequestration (Table 1).

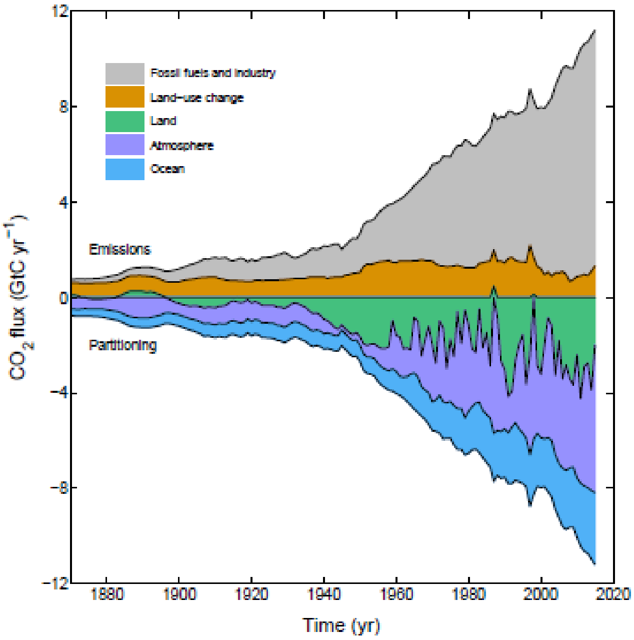
In synthesis, the worldwide dissemination of these technologies will require a very active process of media communication, capacity building and investment in high-tech resources (e.g., new machinery, information technology, GM seeds). The role of international organizations, like FAO the WB and many others, will be essential, as well as the participation of bilateral development support programs for promoting a coordinated effort.

3. The unresolved question of C sequestration in rural lands

3.1. Sequestration capacity of terrestrial lands

There is a growing concern among climate scientists regarding the IPCC recommended methods to estimate carbon (C) budgets that are reported by national GHG inventories. In general, they agree that while IPCC guidelines are very exhaustive and thorough in its methods to estimate C emissions, methods to calculate C sequestration by terrestrial lands still remain rudimentary. Inevitably uncertainty arises in countries that have large areas of land covered with vegetation. Using an indirect method to calculate the terrestrial C sink, Le Quéré et al. (2016) provided a valuable historical estimation of the Earth C budget during the period 1880-2015. They show that the amount of C sequestered by terrestrial lands would be growing since 1940 (Figure 1).

Figure 1. Carbon sequestration capacity of terrestrial lands (area in green) since the mid-20th century until 2015.

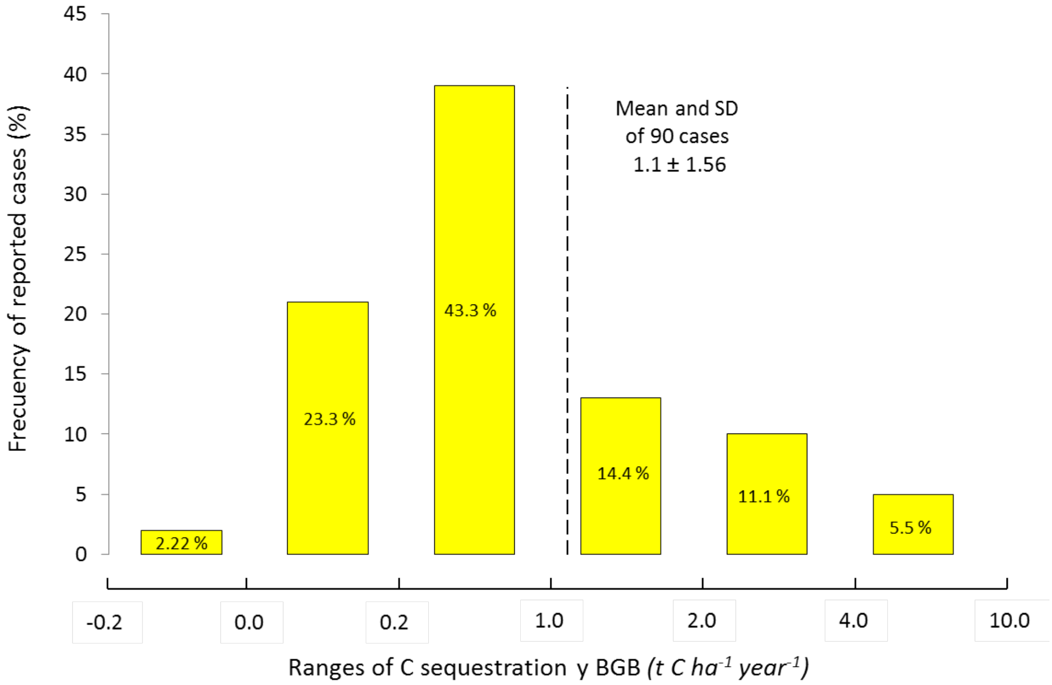


Source: Quéré et al., 2016.

3.2. How much carbon can grasslands capture and store?

Grasslands represent a special biome that deserves reconsideration. National GHG inventories generally show that grazing lands behave as great net emitters, minimizing the ability of grasslands to capture and store carbon (C) in soil. Most national reports on GHG inventories have followed the IPCC Guidelines (1996, 2006), which in its Tier 1 method have recommended using a unified default factor of 1 (no change in soil C stock) for grasslands ("…after a finite transition period, one can assume a steady state for this stock…"). Such a long-term stability can only be reached under zero-grazing conditions (Keel et al., 2017, Garnett et al., 2017, Schipper & Smith, 2018)), but in the real world grasslands have been and are still subjected to permanent grazing conditions. Therefore, a default factor of 1 is misleading and represents an oversimplification of reality that inevitably underestimates the C sequestration capacity of grasslands. Considering the large amount of grasslands (mostly grazed) that covers about 25% of planetary ice-free lands (Asner et al., 2004), a C sequestration different from zero can dramatically change the C budget of some countries (which even could show a C neutral condition) and the entire Earth.

Figure 2. Frequency distribution of C sequestration ranges in BGB in a sample size based on peer-reviewed 90 cases from scientific literature

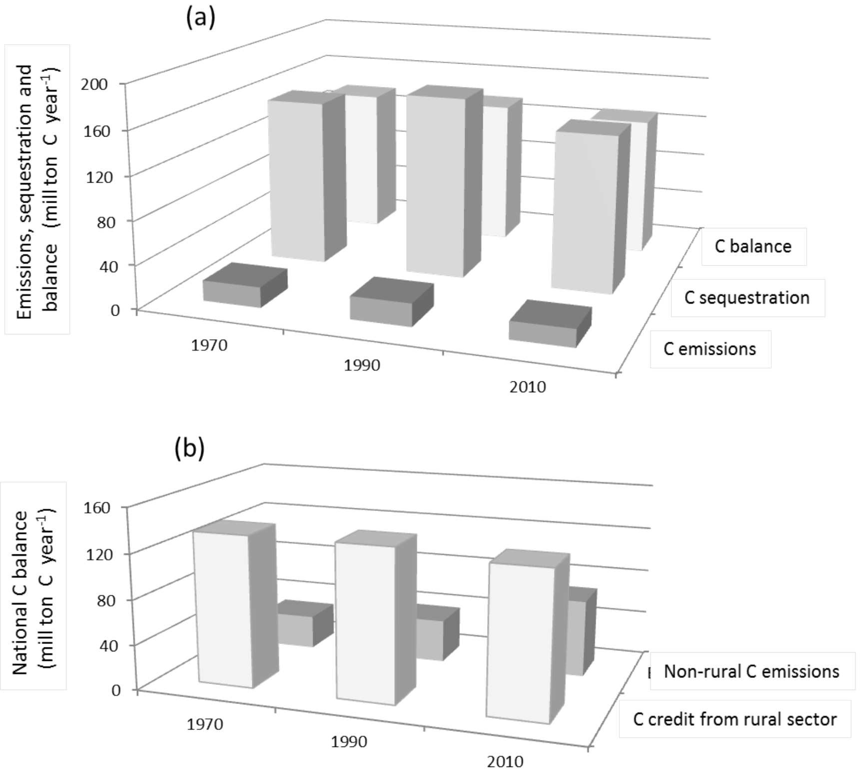


Source: Authors.

By ordering 90 cases of peer-reviewed scientific publications on soil C sequestration in grasslands, we depicted data on a frequency distribution graph that is showed in Figure 2. Only in two cases out of 90 grasslands show a negative capacity for carbon sequestration. The remaining 88 cases show a positive sequestration capacity that varies from one climatic region to another and from one technological level to another.

It is of major importance that countries in the MERCOSUR region agree to promote a significant effort to produce more precise and regionally relevant parameters for estimating C sequestration by grasslands and other agricultural biomes. Revisiting current methods and exploring alternative methods to estimate C sequestration by rural lands would modify our view on food production systems and the pressure on production methods applied in food-exporting developing countries. As an example, Figure 3 shows the case of considering the C balance of Argentina in 1970, 1990 and 2010 (Figure 3a) if C sequestration by grasslands would be incorporated in calculations in a way different of those recommended by IPCC (1996/2006) guidelines to elaborate national GHG inventories. Estimations showed that the C credit produced by grasslands C sequestration is of such magnitude that it could neutralize the emissions of the rural sector, plus the emissions of other non-rural sectors (Figure 3b). If these estimations would be verified, Argentina would be rose to a C neutral position due to the impact of grasslands on the national C budget.

Figure 3. Carbon budget (a) and the national carbon balance (b) of Argentina in 1970, 1990 and 2010 if carbon sequestration by grasslands would be incorporated into national inventory calculations.



Source: Authors.

4. Land sparing and sustainable intensification

Global food security requires increasing yields with a minimum impact on the environment to match the needs of an expanding population and the environmental requirements of human societies. These contrasting targets have led scientists, scholars, development agents and political decision-makers to create and handle the concept of "sustainable intensification".

The basic idea behind sustainable intensification is intensifying the production of food in the better endowed lands, releasing at the same time others lands (land sparing) to environmental and ecological conservation with minimum human intervention. Thus, less suitable lands can be allocated to the provision of essential ecosystem services like carbon capture and storage (Stevenson et al., 2013). Sustainable intensification implies the double objective of increasing or maintaining gross productivity with less land and a lower environmental impact. By means of high-tech practices, the challenge is to keep or increase productivity using less fertilizers, pesticides, water and fossil energy. The key point is to maximize the use efficiency of expensive inputs in line with the principles of precision farming. Precision farming has introduced novel concepts such us “environmental driven cultivation”, “climate smart farming”, “variable-dose fertilizers use”, “site-specific pesticide application”, “permanent soil water and nutrient monitoring”, “permanent pest monitoring of crops”, “yield mapping of plots and fields" and so on. "Information and Communication Technologies (ICT)" support the human control of those biophysical processes throughout time and space.

There are many empirical evidences that precision farming is not a simple fashion, but a useful and feasible idea. An above mentioned report by the Organization for Economic Cooperation and Development (OECD, 2008) entitled "Environmental behavior of agriculture in OECD countries since 1990" provided, in comparison to other countries, concrete examples of "sustainable intensification" in 30 country members. Despite the high level of intensification, a significant decrease of negative environmental impacts was verified in most evaluated categories: production increased by 8% per hectare, but the area of cultivated land was reduced by 7%, which was released to conservation. Regarding non-OCDE countries, the rate of water and wind erosion of soils dropped significantly, as well as GHG emissions (-3%), nitrogen fertilizers use (-17%), pesticides (-7%) and irrigation water (-10%). On the other hand, fossil-energy consumption and ammonium emissions increased slightly. Based on crop diversification and rotation, diversity indicators were improved. So, there is much room to explore in an age of technological optimism.

5. Free trade and the carbon dilemma

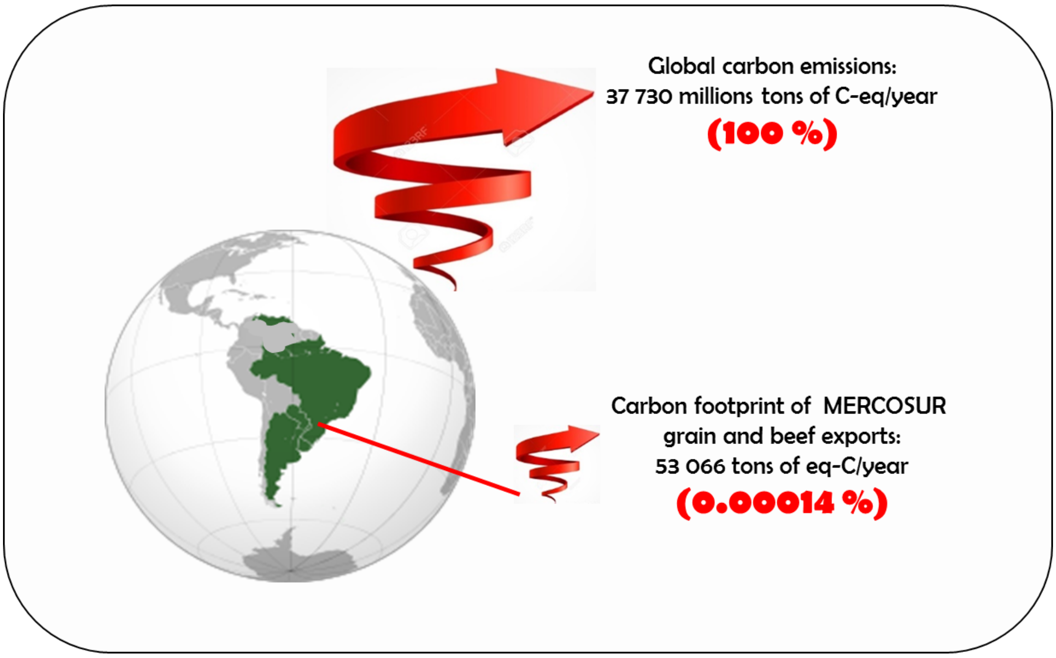
5.1. The elusive issue of carbon footprint

The complex relation of carbon footprint (CF) with food security is at the core of GPPS objectives (Viglizzo & Ricard, 2017). Humans left their footprint on the planet during their evolution, being global warming and climate change two important impacted fields that indirectly affect the sustainability of the global food system. The critical role of food security in a context of climate change deserves special attention.

To put the question in context, it should be noted that GHG emissions from the rural sector in MERCOSUR countries represent less than 3% of the world GHG emissions that today include all sectors of the global economy. This means that the contribution of the four countries to global warming is not significant. Accepting that food security involves not only food availability but also the economic and logistic access to food, it is necessary to highlight the issue of food and CF in the region in order to propose strategic ways to face the issue. When people focus their attention on footprints only, part of the story is missed. Two tales deserve to be told to understand the problem: a small and a big one.

On the one hand, the small tale strictly refers to CF. Animal products (e.g., meat, milk) and processed products (e.g., bread, oilseeds, biofuels) show higher footprint than primary and not processed products like grains, vegetables, fruits and so on. Several questions arise when we look ahead. Is the CF of exported food from the MERCOSUR region a threat to the global environment? Are those exports destabilizing the global carbon balance? Would the imposition of trade sanctions on the region because of this issue be justified? Or are regional footprint of food exports a false dilemma and potential sanctions a demonstration of commercial myopia?

Figure 3. Influence of MERCOSUR exports of grains and beef on global carbon emissions



Sources: Authors based on Quéré et al., 2016 and National Footprint accounts, 2014.

The big tale, on the other hand, shows that the carbon released throughout the food chain by MERCOSUR exporting countries is fully irrelevant in practical terms and has no measurable impact on the global carbon balance (Figure 3). The figure below shows the incidence of ABPU food exports on the balance of carbon assessed in terms of its global implications. The CF of its exported food represents only 0.00014 % of the total carbon emitted by global agriculture. Then, putting too much attention on the CF of food exports by MERCOSUR region sounds irrelevant in terms of the global food trade.

5.2. Can sustainability be transferable by free trade?

Because of its large availability of land, biomes diversity and renewable water, the MERCOSUR region plays today, and will play in future, an increasing strategic role in global food-, climate- and water-security. This role is simply accomplished by exporting food to food-scarce countries. So, beyond the short-sighted view focused on CF penalizations, it should be recognized that MERCOSUR exports can alleviate future food and water scarcity in a global context of climate change and population growth. So, the carbon emitted and the water used to produce and export food to food- and water-scarce countries goes beyond the local scale and reaches great significance at the global one. Some figures that illustrate the importance of virtual water (VW) transference from the MERCOSUR region to some food-demanding countries are shown in Table 2.

Table 2. Absolute (Gm^3 year^{-1}) and relative (%) participation of MERCOSUR countries in the total amount of virtual water (VW) demanded by the principal food-importing countries (average figures of period 1996–2005).

		Trade of agricultural VW (Gm^3/yr)		Trade of agricultural VW (%)
		Country/Region	Total	
Demand	European Union	615.6	957.4	100
	USA	183.8		
	China	107.6		
	Russian Federation	50.3		
Supply	Argentina	97.6	228.2	24
	Brazil	110.3		
	Paraguay	12.7		
	Uruguay	7.6		

Source: Ricard & Viglizzo (2016).

If the transference of food and water through is globally feasible, it will require an improvement of trade conditions, which must be accompanied by local logistical improvements and infrastructure investments. It should be noted that high-tech adoption in food-exporting countries will increasingly contribute to global food, climate and water security if free-trade conditions are enhanced in the world. The co-benefits of increasing the environmental sustainability within food-supplying countries will be the rebuilding of sustainability indicators in food-importing countries. Intangible services –not still assessed by conventional economic analysis- can benefit food-demanding countries.

The transference of food, virtual water, carbon and nutrients can allow them, in the mid- and long-term, a replenishment of their depleted above- and below-ground aquifers and a gradual rehabilitation of their exhausted carbon and nutrient stocks in abandoned and degraded lands.

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