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Environmentally sound resource valuation for a more sustainable international trade: Case of Argentine maize

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ABSTRACT

This study analyzed costs and benefits for Argentina when trading maize grain. Assigning an appropriate value to traded resources involves a comprehensive assessment of all kinds of sources driving the process, in order to avoid their misappropriation and non-profitable use, while at the same time enhancing the environmental performance of the region for the long term. Increasing amounts of slowly-renewable and non-renewable resources invested in producing intensive cash crops do not necessarily contribute to further development of local enterprises, nor does this strategy consider valuable contributions by local ecosystem services. The emergy method was applied to assess resource and environmental support used in production and trade of maize grain in the northern part of Argentina’s Pampas Region, in years 2009–10 and 2012–13. Exports were calculated for commercial periods 2010–11 and 2013–14. Results showed that intermediate organizations trading with importing countries through international grain traders (Emergy-to-Exchange Ratio, EER, for Argentina = 0.51) exported more environmental resources (emergy associated with exported grain) than emergy imports associated with monetary returns from traders to Argentina. This situation places the country in an unfair exchange. When trade was performed through national trade organizations, the EER = 0.91, resulting in a smaller disparity. Resource trade imbalance clearly appears when it is measured in emergy terms but not when it is accounted for in monetary units. This study provides data on which to open discussion and inform trade and production strategies that could help Argentina avoid jeopardizing its own natural resources in the long term.

1. Introduction

International trade is one of the key drivers of national economies. Agribusiness corporations usually influence the types of agricultural systems managed by farmers and the inputs used by controlling most steps in the industrialization process as well as by impacting strategic production decisions (Manuel-Navarrete et al., 2005; Barker, 2007; McMichels, 2009). Moreover, major companies have been integral to the transformation of food production into a globalized and purely financial business (Murphy et al., 2012). Consequently, highly intensified crop production methods and new varieties and hybrids that currently result from transgenic breeding techniques have created a technological treadmill for farmers; both have fueled the expansion of grain commodities production and their international trade (Manuel-Navarrete et al., 2005; Binimelis et al., 2009).

Agricultural systems stand at the interface between natural resource use from the environment and the economy, however ecosystem services are seldom recognized in resource and financial accounting (Campbell and Tilley, 2014). After the Brundland Report in 1987 and Rio Conference in 1992,\(^1\) these often ignored but essential components of the system became more recognized within the public domain and started to be explicitly identified and evaluated (Costanza et al., 1997; de Groot et al., 2002; Campbell and Tilley, 2014; Costanza et al., 2014). However, there is still a subordination of ecology, natural resource use, and long-term social stability to short-term economic returns in the current development paradigm and conventional accounting, both of which discount over-exploitation and also remove natural resources from democratic accountability and concern for sustainability.

\(^{1}\) As a result of “Our Common Future” or the Brundland Report (WCED, 1987), the United Nations General Assembly convened for the United Nations Conference on Environment and Development (UNCED), known as the Earth Summit. It was held in Rio de Janeiro in June 1992 and was a turning point for international negotiations on environmental and development issues.

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(McMichels, 2009). This all-too-frequent lack of acknowledging how natural resources allocation can promote social welfare during agricultural production and trading jeopardizes ecosystems and decreases the long-term sustainability of larger systems (Odum and Odum, 2000).

Even more, the economic concept of trade assumes that commodities or goods exported and imported have the same ‘value’ and that the only difference between them is their relative prices adjusted by the demand and supply dynamics (Brown, 2003). The usual values accounted for in commodities and goods traded are the costs of labor, land and purchased production inputs (Mitchel, 2008). These values do not account for the environmental contributions of providing natural resources to the production process, nor for their renewability and diversity. Also not accounted for are the environmental costs for the supporting human services (infrastructure, know-how, workers traveling time, non-working time in support of working activities), nor the impacts of the production activities on nature. Moreover, if trading of commodities is examined in a more rigorous manner, it becomes clear that the way to increase standard of living in a region is to make use of the work of nature within the region by adding value to those resources locally (Riveros and Heinrichs, 2014; Salvador, 2016), rather than exporting raw commodities to be refined and given added value elsewhere.

Specifically in Argentina, agricultural trading contributes an important currency-based share of the country’s economy, 56% (INDEC, 2015) or 50% (averaged 2005–2015, INDEC, 2016), and regulations on trade influence decision making about the types of technology used in agricultural production systems. Pampas Region, originally a prairie biome that occupies 19% of Argentina’s agricultural land (Ramankutty et al., 2008), is the most important area for grain commodities production and trade. It produces more than 80% of each of the major grain species (maize-Zea mays L., soybean-Glycine max L. Merr., and wheat-Triticum aestivum L., SIIA, 2016). In this region 100% of soybean varieties and 95% of maize hybrids sown today are based on transgenic (GMO) technologies (Trigo, 2016). Moreover, 94% of total agricultural seed production, GMO-based, is found in this region (Cluster de la Semilla, http://clusterdelasemilla.net/).

The ports located in this region are the export gate for grains leaving the country (SIIA, 2016). Economic infrastructure and people’s wealth are well developed in this region and enhanced by the richness of the natural environment and commercial activity of society, although distribution of benefits remains a challenge. Consequently the region is characterized by the diversity and functions of ecosystem services provided by a modified prairie as well as those provided by society through the development of local industries and large export of commodities. Assigning an appropriate value to traded resources requires a comprehensive assessment of all kinds of sources driving the process, in order to avoid their misallocation and inefficient use, while at the same time enhancing the environmental performance of the region.

In order to avoid the continued exportation of virtual natural resources, national institutions and the academy are currently carrying on projects to assess the potential of locally added value to agricultural production (PRECOP, 2011; Salvador, 2016).

In addition, globally, alternative trade and demand mechanisms have also appeared, such as Fair Trade International, (http://www.fairtrade.net/), and the Slow Food movement (www.slowfood.com). Moreover, efforts to study the dynamic interactions between the environment and the economy embodied in products and services have provided valuable insight on production and trade. Riveros and Heinrichs (2014) referred to the need for including the natural resources operation within national accounts as a novel development for valuing the locally added value. Chapagain and Hoekstra (2008) evaluated virtual water flows between countries resulting from agricultural and industrial products trade by adopting a direct and indirect mass accounting approach; WAVES (Wealth Accounting and the Valuation of Ecosystem Services, https://www.wavespartnership.org) is one method to measure the economic costs of natural resources over-exploitation and degradation; and WAVES and SEEA (System of Environmental Economic Accounting, http://unstats.un.org/unsd/envaccounting/default.asp) can be used together to create a methodological tool that includes the environmental components within the economic accounting and where the concept of GDP is being reconsidered and enlarged. However, these last two approaches generally adopt a receiver point of view.

There are few studies that address the trade of products from current agricultural systems from a donor point of view and by using suitable accounting tools for inclusive analysis of both the costs incurred and the benefits that can be achieved. A comprehensive and reliable method that quantifies ecological and economic processes on a common basis is needed. The emergy method (Odum, 1996; Brown and Ulgatia, 2004b, 2011; Ulgatia et al., 2011) has proven to be the most convenient for this type of analysis. This approach is capable of accounting for all material, energy, information and money inflows to a system, from a biosphere supply-side point of view, expressing them by means of one unique unit, the solar enjoule, which is a measure of the biosphere contributions and human work for resource generation and processing. With this type of analysis, a comprehensive comparison of production systems, processing alternatives, resource qualities, and even future scenarios for the entire grain sector can be performed and checked against business-as-usual, contemporary accounting methods. This assessment procedure seems to be more robust than any other based on current economic measures alone, since the latter are constantly affected by changing exchange and interest rates, stock market performance in multiple national markets, political decisions, and changing levels of financial stability and speculation around the world (Odum, 2007). The emergy method represents a stable and objective biophysical measure of a system’s performance in the long term and takes into account both the environmental and economic dimensions of the system itself. This method has been used for the evaluation of agricultural systems (Lan et al., 1998; Odum, 1996; Lagerberg, 2000; Ortega et al., 2000; Lefroy and Rydberg, 2003; Castellini et al., 2006; Cavalett et al., 2006; Martin et al., 2006; Rótilo et al., 2007; Fonseca et al., 2015; Rótilo et al., 2014, 2015a, 2015b), natural capital and its associated ecosystem services (Campbell and Tilley, 2014; Coscieme et al., 2014) and the impacts on ecological system when studying the urban-industrial symbiosis in a city of China (Sun et al., 2017). The emergy method was also applied to analyze international trade both by individual provinces of China in order to put into evidence the difference in benefits when trading primary and domestic manufactured resources (Tian et al., 2017), and among countries (Brown, 2003; Cuadra and Rydberg, 2006; Cavalett and Ortega, 2007; Xu et al., 2017).

Our research is designed to answer the following questions: a) what proportion of the value of agricultural products is returned to farmers and industries within the country and what proportion is accrued outside the country by international grain traders, and b) how much wealth based on natural capital is returned to the country/region by current trade and agricultural management strategies and how much is exported? Therefore the main objective of this study was to analyze benefits and their distribution, in terms of environmental wealth and development potential, associated with trading of agricultural products, using maize grain produced in Argentina as an example.

2. Materials and method

2.1. Maize system in Argentina

Maize trade complex represents nearly 6% (averaged 2005–2015, INDEC, 2016) of Argentina’s economy. Data on maize production for the annual cycles of 2009–10 and 2012–13 and trade for the...
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