https://doi.org/10.17221/433/2020-AGRICECON

The role of the leading exporters in the global soybean trade

Claudia V. Montanía, Teresa Fernández-Núñez, Miguel A. Márquez*

Department of Economics, Faculty of Economics and Business Administration, University of Extremadura, Badajoz, Spain

**Corresponding author: teresafn@unex.es*

Citation: Montanía C.V., Fernández-Núñez T., Márquez M.A. (2021): The role of the leading exporters in the global soybean trade. Agric. Econ. – Czech, 67: 277–285.

Abstract: This paper examines the global soybean market in a holistic way, analyses the land use and other historical determinants of soybean exports, such as labour and capital endowments, soybean productivity, international prices and demand conditions through an empirical model. In addition, it pays particular attention to the role of leading exporters in the export changes and the nature of the connections between them in an interrelated system. The results suggest that the productivity per hectare and the land used to harvest soybeans are the main factors explaining soybean exports in a global context. The analysis also reveals that Brazil, the current market leader, positively influences the other exporters. On the contrary, minor exporters such as Ukraine, Paraguay, or Canada present competitive relationships with the major exporters. The nature of the relationships between the exporters and the pressure on natural resources highlight the importance of government involvement in developing joint strategies that ensure the growth of this sector and the achievement of United Nations Sustainable Development Goals.

Keywords: interconnections between exporters; interrelated economic system; land use; world soybean exporters

The size of the international soybean trade, the geographical concentration of exporters and importers and its connection with socio-environmental problems have positioned this commodity on a progressively central spot in the discussion regarding sustainable agriculture (Jia et al. 2020). Soybean is one of the most important agricultural commodities for international trade. Although most soybeans are pressed or crushed to obtain derived products, soybeans are also widely traded in the form of grains as an intermediate input. Thus, this product, which has a high geographical concentration in its production, is not consumed where it is produced. Its trade generates linkages between distant places and between different actors of the global soybean system.

Since the second half of the 1990s, the production of soybeans has experienced the greater average growth among the other major crops in the world. Nevertheless, this product has been the only crop with a bigger advance in land use than in yields per hectare, generating important changes in land use patterns (Figure 1).

Over the last two decades, global soybean trade has also increased threefold. As a result, soybeans are currently the most traded agricultural commodity. This growth has been mainly driven by the positioning of China as the main importer worldwide.

However, meeting the global demand has relied on a small group of countries. The lack of new competitors in the global soybean market and the geographical concentration of exporters and importers suggest the existence of interconnections or relationships among these exporters. Nonetheless, this high concentration is committing the sustainable development in specific

Supported by Junta of Extremadura (Spain), European Regional Development Fund (Grant/Award No. GR18124) and Ministerio de Ciencia e Innovación (Grant/Award No. PID2019-109687GB-I00).

https://doi.org/10.17221/433/2020-AGRICECON

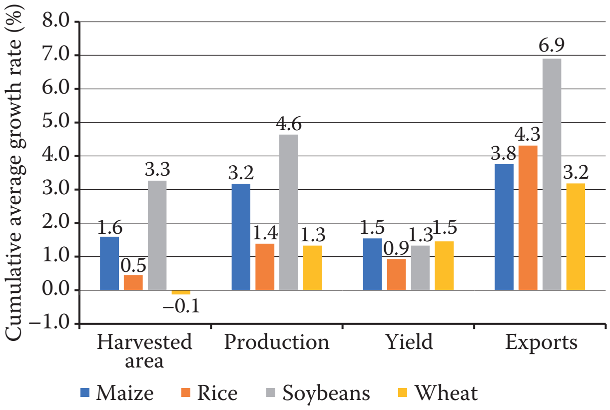

Figure 1. Cumulative average growth rate (%) of the harvested areas (ha), production (metric ton), yield (kg/ha), and exports (metric ton) of main crops at the world level, 1996–2017

Source: Own elabouration based on data from FAOSTAT (2019)

geographical areas due to the association of soybean production to environmental problems, such as deforestation and greenhouse gas emissions (Boerema et al. 2016; Herzberger et al. 2019).

The increasingly important role of soybean trade in the world economy and sustainability issues has attracted great interest. The dynamics of this commodity have been extensively studied within the literature. Most previous works have focused on the main determinants affecting demand growth (Tilman and Clark 2014). Another important part of the literature has studied productivity through the analysis of efficiency in yields and harvesting areas (Sanders et al. 2014). Other scholars have centred on the dynamics of the soybean trade of a particular exporter (Goldsmith and Hirsch 2006) or a group of them (Larson and Rask 1992). Recently, the focus has been on the environmental costs of the accelerated growth of soybean production and exports (Deininger 2013) and the governance and sustainability of the soybean supply chain (Jia et al. 2020).

Regardless of the vast amount of research on this topic, a holistic assessment that includes all the players involved in the global soybean market and an explicit analysis of the drivers of export growth through cross-country comparisons have not yet been explored. Furthermore, little is known about the potential influences of the interconnections between exporting countries in the interrelated system that forms the world market. However, the exploration of the international market's countries behaviour and their relationships might be crucial for the effectiveness of actions aimed at promoting exports while reducing the socio-environment problems derived from soybean trade in a global context [protecting the planet and favouring the achievement of United Nations (UN) Sustainable Development Goals].

Hence, this paper extends the literature by using a framework that assesses the determinants of changes in soybean export shares, considering all the exporting countries and the interconnections that exist between them within the global system. From a methodological perspective, our model evaluates drivers related to land-use change and other historical determinants of soybean exports. It also allows objective cross-country comparisons, identifying whether an increase in the export share of one country will affect the export share of the rest of the countries that belong to the global soybean market system. From an empirical point of view, the novelty of our analysis is noteworthy since it contemplates all the export shares in the world during 22 years. Therefore, unlike previous works, our approach offers a complete picture of the drivers of soybean exports worldwide by taking into account all the exporters and the connections between them.

MATERIAL AND METHODS

The literature offers a wide variety of approaches to empirically assess the competitive performance of a country in the international market of a sector (Deodhar and Sheldon 1997; Carraressi and Banterle 2015). Among them, trade-based measures have been the most commonly used methods. One of these methods is the export market share (EMS) index (Larson and Rask 1992; Seccia et al. 2015). This index differs from other indicators since it evaluates the export performance of a country for a particular sector compared to the world exports, while the revealed comparative advantage assesses the country's export specialisation in a sector, and the net export index considers whether imports affect the competitive performance or not.

The EMS index used in this paper is calculated as follows:

$$EMS_{it} = \frac{X_{it}}{X_{wt}} \quad (1)$$

where: *EMS* – export market share of the country i in year t; X_{it} – soybean exports of country i in year t; X_{wt} – world soybean exports at time t; i – Argentina, Brazil, Canada, Paraguay, Ukraine, the United States, rest of the world (ROW).

The current study is based on data from 1996 to 2017. The UN Comtrade Database (2019) is used

https://doi.org/10.17221/433/2020-AGRICECON

as the data source for soybean exports. This database provides export data for each country/year in current US dollars (USD). To obtain the values of the soybean exports in constant prices, we used the value added deflator in agriculture (with the base year 2010). This deflator was obtained by dividing the current agriculture value added by the constant agriculture value added, with data that were taken from the World Development Indicators (World Bank 2019).

Table 1 exposes that although there have been changes in the six main soybean exporters, no other significant competitor appeared within the global system across these years. However, these countries did not have the same performance. The most important change corresponds to the cases of the United States and Brazil. While the former was the leading export in 1996, the latter was the leader in 2017, controlling almost 50% of the market.

To empirically examine the determinants of soybean market shares and the interconnections among all exporting countries in the global market, the specification proposed relies on theories and empirical evidence on competitiveness, productivity, and international trade (Jambor and Babu 2016; Narayan and Bhattacharya 2019). Following authors such as Márquez et al. (2003), Fernández-Núñez and Márquez (2014), the model also includes the relationships between the different export players worldwide to detect patterns of competition or complementarity between them, giving a new perspective to understand this market and providing a complementary approach to traditional gravity models. For some applications of the gravity model to specific agri-food product, see Dal Bianco et al. (2016), Gouveia et al. (2018), Nsabimana and Tirkaso (2020). The equation for our model is the following:

Table 1. Export shares in world soybean trade, 1996–2017

Countries	1996 (%)	2017 (%)	Cumulative average growth rate of exports 1996–2017 (%)
Argentina	8.23	3.83	–3.41
Brazil	14.05	49.73	5.91
Canada	1.65	2.34	1.60
Paraguay	4.03	3.67	–0.42
Ukraine	0.02	1.97	24.04
United States	67.59	34.06	–3.07
Rest of the world*	4.43	4.40	–0.03

*Rest of the world groups together the exports of the rest of countries that are part of the global system but that are not analysed individually because their soybean exports represent less than 1% of total exports

Export values are expressed in constant 2010 million USD

Source: Own calculation based on UN Comtrade Database (2019) and World Bank (2019)

$$\ln H_{it} = \beta_0 + \beta_1 \ln LAND_{it} + \beta_2 \ln PK_{it} + \beta_3 \ln YIELD_{it} + \beta_4 \ln PRICES_{it} + \beta_5 GOV_{it} + \beta_6 TARIFF_{it} + \beta_7 \ln E_t + \beta_8 \ln GDPpc_{it} + \sum_{k=1}^{n-1} \beta_9 \ln H_{i,t-1} + \mu_{it} \quad (2)$$

where: H_{it} – export market share of each main exporter i (Argentina, Brazil, Canada, Paraguay, Ukraine, the United States) relative to the export share of the rest of the world (ROW), that is, $H_{it} = EMS_{it}/EMS_{ROWt}$; $LAND_{it}$ – land endowments; PK_{it} – physical capital per employment; $YIELD_{it}$ – land productivity; $PRICES_{it}$ – export prices; GOV_{it} – government support; $TARIFF_{it}$ – Chinese tariffs; E_t – world soybean exports; $GDPpc_{it}$ – gross domestic product per capita; k – all the countries of the system except ROW; μ_{it} – error term.

In Equation (2), the dependent variable reports whether a country gained or lost EMS and compares a country's performance with the ROW in the same market. The relative share of the ROW is considered as a reference due to its stability over time. In addition, since our system is defined as a zero-sum game, the complementarity or competitiveness among the countries can be detected through this approach.

The set of explanatory variables includes:

– Traditional factor endowments. In particular, land endowments ($LAND_{it}$) and physical capital per employment (PK_{it}). While the former is a very important factor for soybean production, the latter is a determinant for improving production efficiency (Huffman 2001). The data were collected from the Food Agriculture Organisation (FAOSTAT 2019) and the International Labor Organisation (ILOSTAT 2019).

– A variable to measure land productivity (yields). The volume of soybeans produced per hectare is included in the model ($YIELD_{it}$). Since in this sector, land productivity has been closely related to the use of genetically modified seeds (GMS) (Saha et al. 2014), the increases in the volume of production per hectare could also give some information on the adoption of this type of technology in soybean harvesting processes. The data were obtained from FAOSTAT (2019).

https://doi.org/10.17221/433/2020-AGRICECON

Table 2. Description of variables and sources

Variable	Description	Data source	Expected sign
$\ln LAND_{it}$	natural log of the share of soybean seed harvested area in the country area, relative to the world average (ha)	FAOSTAT (2019)	(+)
$\ln PK_{it}$	natural log of the net capital stock per agricultural employment in each country relative to the world average (million USD/person)	FAOSTAT (2019) ILOSTAT (2019)	(+)
$\ln YIELD_{it}$	natural log of the productivity of the land used to harvest soybean seeds in each country, relative to the world average (metric ton/ha)	FAOSTAT (2019)	(+)
$\ln PRICES_{it}$	real effective exchange rate (constant 2005 USD)	UNCTADstat (2019)	(–)
GOV_{it}	producer support estimates as a percentage of gross farm receipts (million USD); a positive (negative) sign of this variable indicates that tariffs and taxes to the export of agricultural products impacted positively (negatively) to the government support	OECD (2019)	(+)
$TARIFF_{it}$	dummy variable; it takes the value of 0 if China imposed a tariff on the soybean seed imports and 1 if there were no tariffs	WTO (2019)	(–)
$\ln H_{i,t-1}$	natural log of the soybean export share of each exporter, relative to the export share of rest of the world, at the time $t-1$ (constant 2010 million USD); a positive (negative) sign of this variable indicates that an increase of the relative share of one exporter in the year $t-1$ encourages the increment (decrease) of the relative share of the exporter considered as dependent variable at time t	UN Comtrade Database (2019) World Bank (2019)	(+)
$\ln E_t$	natural log of the global soybean seed exports (constant 2010 million USD)	UN Comtrade Database (2019) World Bank (2019)	(+)
$\ln GDPpc_{it}$	natural log of the gross domestic product per capita, relative to the world average (constant 2010 million USD)	World Bank (2019)	(–)

Source: Own calculation based on FAOSTAT (2019), ILOSTAT (2019), OECD (2019), WTO (2019), UNCTADstat (2019), UN Comtrade data (2019) and World Bank (2019)

– Export prices. The prices in international trade ($PRICES_{it}$) are included through the real effective exchange rate (Jenkins 1996). The prices were taken from the UN Conference of Trade and Development (UNCTADstat 2019).
– Demand and capacity. The income per capita of each country ($GDPpc_{it}$) is used as a proxy for the domestic demand of the main soybean exporters, whereas world soybean exports (E_t) is considered to measure the size of the world market (Helpman 1981). On the other hand, given that government policies could influence the exports of agricultural products (Jambor and Babu 2016), a variable to measure the agricultural support is added to the model (GOV_{it}). Finally, we also include Chinese tariffs ($TARIFF_{it}$) to analyse the role of trade barriers in this market. The data were collected from the World Bank (2019), UN Comtrade database (2019), Organisation for Economic Co-operation and Development (OECD 2019) and World Trade Organisation (WTO 2019).
– Relationships between the exporters of soybeans. Following Fernández-Núñez and Márquez (2014), we use the lagged value of the relative share (relative to RWO) of each exporter to measure these interactions $\left(\sum_{k=1}^{n-1} \beta_9 \ln H_{i,t-1}\right)$.
A positive sign suggests a complementary relationship between the exporters. On the contrary, a negative sign indicates a competitive relationship.

Definitions and more details for these variables are presented in Table 2.

RESULTS AND DISCUSSION

The results of the estimation of Equation (2) for the exporting countries in the period 1996–2017 are shown in Table 3. We estimate the proposed system of equations using the seemingly unrelated regression (SUR) model. SUR estimates one equation for each country

https://doi.org/10.17221/433/2020-AGRICECON

Table 3. Seemingly unrelated regression estimations of Equation (2)

Variable	Mayor exporters			Minor exporters		
	Argentina	Brazil	United States	Canada	Paraguay	Ukraine
$\ln LAND_{it}$	1.157 (0.727)	1.300** (0.548)	3.718*** (0.391)	–0.081 (1.677)	0.516* (0.305)	1.892*** (0.302)
$\ln PK_{it}$	0.179 (0.112)	–0.434* (0.243)	1.134*** (0.347)	–1.438 (2.334)	–0.285 (0.387)	–1.128 (1.272)
$\ln YIELD_{it}$	3.234*** (0.301)	0.972 (0.598)	–0.231 (0.388)	2.518** (1.007)	1.522*** (0.160)	0.933 (0.724)
$\ln PRICES_{it}$	–0.004 (0.362)	–0.082 (0.439)	2.088*** (0.591)	4.141*** (1.594)	0.018 (0.531)	–1.285 (1.521)
GOV_{it}	–0.003 (0.008)	–0.014* (0.008)	–0.003 (0.019)	–0.152*** (0.058)	0.093 (0.065)	–0.365 (0.026)
$TARIFF_{it}$	–0.328 (0.215)	–0.370** (0.215)	0.388*** (0.132)	0.112 (0.459)	–0.405*** (0.085)	0.857* (0.476)
$\ln E_t$	0.018 (0.411)	0.250 (0.194)	–0.186 (0.236)	–0.218 (0.621)	–0.345*** (0.130)	–0.462 (0.767)
$\ln GDPpc_{it}$	2.560 (1.712)	–4.903*** (1.436)	–16.298*** (5.054)	1.341 (11.305)	0.308 (0.716)	–1.982 (1.695)
$\ln\left(\frac{EMS_{Argentina,t-1}}{EMS_{ROW,t-1}}\right)$	0.335** (0.144)	0.117 (0.920)	0.298*** (0.062)	0.295 (0.246)	–0.045 (0.070)	–0.218 (0.220)
$\ln\left(\frac{EMS_{Brazil,t-1}}{EMS_{ROW,t-1}}\right)$	0.526* (0.281)	–0.352 (0.215)	0.516*** (0.183)	2.266*** (0.585)	0.399*** (0.102)	0.211 (0.551)
$\ln\left(\frac{EMS_{United\ States,t-1}}{EMS_{ROW,t-1}}\right)$	–0.105 (0.210)	–0.095 (0.124)	–0.126 (0.147)	0.189 (0.406)	–0.059 (0.089)	0.245 (0.380)
$\ln\left(\frac{EMS_{Canada,t-1}}{EMS_{ROW,t-1}}\right)$	–0.233** (0.105)	–0.152 (0.093)	0.157 (0.047)	0.120 (0.182)	–0.046 (0.045)	0.593*** (0.155)
$\ln\left(\frac{EMS_{Paraguay,t-1}}{EMS_{ROW,t-1}}\right)$	–0.373 (0.312)	–0.092 (0.132)	–0.485*** (0.112)	–1.047** (0.505)	0.250** (0.107)	0.592 (0.428)
$\ln\left(\frac{EMS_{Ukraine,t-1}}{EMS_{ROW,t-1}}\right)$	–0.082*** (0.028)	0.025* (0.139)	–0.006 (0.011)	–0.130*** (0.492)	–0.012 (0.009)	–0.110* (0.058)
R^2	0.935	0.927	0.860	0.932	0.929	0.979
χ^2	453.720	350.950	155.680	339.430	357.890	1119.960
P-values	0.000	0.000	0.000	0.000	0.000	0.000

*, **, ***Statistical significance at levels of 10%, 5%, and 1%, respectively; EMS – export market share; ROW – rest of the world

Standard errors (SE) are in brackets; Breusch-Pagan test of independence: Chi^2 (15) = 34.460 and *P*-value = 0.0029 indicate that the null hypothesis of independence is rejected, and these equations must be estimated as a system; 22 observations and 14 parameters

For the explanation of variables, see Table 2

Source: Own calculation based on the data source presented in Table 2

https://doi.org/10.17221/433/2020-AGRICECON

and lets to test some joint contrasts. The analysis is divided into two parts. First, to examine every country's behaviour, the estimations for each regression block are considered. Secondly, the global system is analysed.

Results by country. Overall, the results are well fitted in terms of significance. Regarding the major exporters, while the expansion of harvested areas is positive and significantly related to the export shares of Brazil and the United States, this variable is not significant for Argentina, whose relative export share is strongly linked to the productivity of the land. In addition, Brazil and the United States are also negatively influenced by domestic demand. Physical capital and the tariffs imposed by China have an opposite effect on their export shares: positive for the United States and negative for Brazil. Finally, government support also impacts negatively on the Brazilian exports, while prices have a positive result for the United States.

For the minor exporters, the land endowment is determinant for the export shares of Paraguay and Ukraine, but it is not significant for Canada. By contrast, the productivity of the land is positive and significant for Paraguay and Canada. Table 3 shows that minor exporters are not significantly influenced by the improvements on physical capital and domestic demand.

In summary, although each exporter has its own drivers, there are similarities between them: their increases in exports are mainly linked to land endowments and the productivity of these lands, bringing important environmental problems such as deforestation.

Relationships between all the exporters. According to Table 3, the relationships between the exporters are important drivers of changes in the global soybean market. Specifically, highly significant interactions of the relative share of Brazil (in the previous year) with the relative share of the rest of the exporters are detected. The positive and significant signs of this variable for all the countries, but Ukraine, indicates a complementary relationship between the current leader of the market and the rest of the countries. By contrast, significant and competitive relationships of minor exporters among them or with some of the major exporters are found. In particular, Canada has negative interconnections with Argentina and positive with Ukraine, while Paraguay's result suggests a competitive relationship with Canada and the United States. In the same way, we obtain evidence that Ukraine competes with Argentina and Canada. Then, these three countries have increased their participation within the market by capturing the relative export shares from the other countries that belong to the system.

The global system. Finally, Table 4 summarises the results of the conjoint significance analysis performed with all variables used in the SUR model, but this time from a global perspective.

Based on these outcomes, the productivity of the land is the most important driver of export shares in the global market, followed by land use. Furthermore, given that the technology commonly adopted to improve the productivity per hectare is associated with GMS (which can grow in any type of soil), this strategy also contributes to the expansion of soybean

Table 4. Ranking of statistical significance of the explanatory variables of the seemingly unrelated regression model (Wald statistic)

Variable	χ^2	*P*-value	Ranking
$\ln YIELD_{it}$	205.610	0.000***	1
$\ln LAND_{it}$	104.910	0.000***	2
$TARIFF_{it}$	55.720	0.000***	3
$\ln\left(\frac{EMS_{Paraguay,\,t-1}}{EMS_{ROW,\,t-1}}\right)$	47.510	0.000***	4
$\ln\left(\frac{EMS_{Brazil,\,t-1}}{EMS_{ROW,\,t-1}}\right)$	41.660	0.000***	5
$\ln\left(\frac{EMS_{Argentina,\,t-1}}{EMS_{ROW,\,t-1}}\right)$	34.730	0.000***	6
$\ln GDPpc_{it}$	26.400	0.000***	7
$\ln\left(\frac{EMS_{Canada,\,t-1}}{EMS_{ROW,\,t-1}}\right)$	23.430	0.001***	8
$\ln\left(\frac{EMS_{Ukraine,\,t-1}}{EMS_{ROW,\,t-1}}\right)$	22.580	0.001***	9
$\ln PRICES_{it}$	18.920	0.004***	10
$\ln PK_{it}$	16.540	0.011**	11
GOV_{it}	14.870	0.021**	12
$\ln E_t$	11.380	0.077*	13
$\ln\left(\frac{EMS_{United\ States,\,t-1}}{EMS_{ROW,\,t-1}}\right)$	1.900	0.928	14

*, **, ***Statistical significance at levels of 10%, 5%, and 1%, respectively; EMS – export market share; ROW – rest of the world

For the explanation of variables, see Table 2

Source: Own calculation based on the data source presented in Table 2

https://doi.org/10.17221/433/2020-AGRICECON

cultivation to forest areas. Therefore, the accelerated growth of the international trade of this product worldwide has been based on land-use changes.

To a lesser extent, the interactions of the relative export shares of Paraguay and Brazil are also relevant to explain the changes in the export shares of the other exporters: when their relative export shares improve in a given year, the other countries gain market share in the following year.

Discussion. Although there have been changes in the leadership of the international soybean market, the exporting countries remain the same over the years. This occurs despite the modernisation of the soybean complex that has been carried out mainly in Argentina and the United States and has positioned them as the major exporters of soybean oil and meal above soybean seeds.

Our empirical results suggest that soybean exporters did not follow the same pattern to increase or maintain their participation within the market. However, in a global sense, the main variables that stand out as key drivers of the soybean export changes are related to the use of land for soybean production and the interconnections between the different exporters.

This finding is in line with several studies that also report land use increases due to the role of international soybean trade (Secchi et al. 2011; Hausman 2012; Boerema et al. 2016; Santeramo et al. 2021). The rapid surge of global soybean production, caused by the growing demand for biofuels, soybean meal for animal feed and cattle ranching, has produced changes in land use patterns. The expansion of cropland is occurring through grassland conversion, deforestation, and recently by the expansion of soybeans to non-cultivated ecosystems, generating great concern for preserving natural resources. Hence, the environmental effects of soybean expansion derive mainly from the impact of agrochemicals on biodiversity and the effects of deforestation, such as carbon loss and the decrease in the level of water flow that contribute to the acceleration of climate change (Jia et al. 2020). However, it is important to clarify that the harmful impacts of the expansion of soybean cultivation have not similarly affected all exporting countries. In this sense, the strongest environmental impacts occur in regions like the Brazilian Cerrado and Matopida and in the Argentine and Paraguayan region of Gran Chaco (Boerema et al. 2016; Capaz et al. 2020).

Additionally, all of these exporting countries, but Ukraine, have adopted the GMS technology, improving their productivity but also expanding their harvested areas, as modified seeds can be grown in any type of soil (Hausmann and Klinger 2007; Saha et al. 2014). However, the adoption of GMS also generates changes in the production costs and international prices of some exporters. Similarly, the modernisation of the soybean complex affects government support and the expansion of infrastructure dedicated only to soybeans. This situation is reflected in Table 3, although the values are not significant for all the countries.

On the other hand, it is important to highlight the positive and significant influence of Brazil on the export shares of Argentina, the United States, Canada and Paraguay, indicating a complementary relationship between the current leader of the market (Brazil) and these countries: as the market leader's export share grows, the shares of these exporters also benefit.

The interconnections between the analysed countries, particularly the complementarity between major exporters, suggest that the high geographic concentration of exports will continue in the coming years, which could compromise the global supply chain of this product and deepen the threat that land-use changes represent for sustainable development. Therefore, there is an urgent need of developing strategies to mitigate the socio-environmental problems within a collaborative framework between the governments of the main exporters of soybean worldwide. In this way, it would be possible to shape joint guidelines that provide institutional instruments to promote soybean production and international trade without compromising sustainable development.

CONCLUSION

This paper analyses the soybean export worldwide with a holistic scope and explores its drivers through cross-country comparisons. Furthermore, it investigates the existence of competition or complementarity between the exporters.

Our study highlights the extreme concentration of soybean exports in a reduced number of countries during 1996–2017. Furthermore, the analysis shows that this market has experienced a redistribution rather than shifts in its composition, as no other country entered the market in a significant way. This redistribution is mainly associated with the consolidation of Brazil as the most important exporter of soybean in recent years, to the detriment of the United States and Argentina. Paraguay has lost participation within the market regarding the minor exporters, while Canada and Ukraine have increased their importance in this sector.

To provide a deeper understanding of the changes detected in the EMS of the analysed countries, an em-

https://doi.org/10.17221/433/2020-AGRICECON

pirical model based on productivity and international trade theories is proposed. The results indicate that the international soybean trade is highly dependent on land use. In addition, the assessment of the relationships between exporters reveals that the growth of Brazil's export share encourages the presence of the rest of the exporters in the global market. Besides, minor exporters show competitive relationships between them and with Argentina and the United States.

These findings are in line with the existing debate on the environmental cost generated by the expansion of soybean production and exports to satisfy the global demand for meat, animal feed and biofuels (Secchi et al. 2011; Hausman 2012; Boerema et al. 2016; Santeramo et al. 2021). But our analysis also sheds light on another dimension of this trade-environment issue: there is a high degree of complementarity among the leading exporters of soybeans who have adopted land use expansion as their main strategy to maintain or gain participation in the global market. Thus, the detection of the interconnections among countries at the world level opens the door to think about possible collective actions between the main exporters to alleviate the pressure that soybean international trade is exerting on natural resources.

Consequently, there is an urgent need for the exporters to develop public policies that promote the adoption of technologies and mechanisms to satisfy the demand without compromising natural resources, such as regulations based on the improvement of productivity (Paleari 2017) or forest conservation programs (Rochedo et al. 2018) with a particular focus on the regulation of soybean cultivation in forest areas. It is important to highlight that collective and global measures are necessary since the consequences of the mismanagement of soybean international trade affect producers and exporters but could compromise global welfare and the fulfilment of the Sustainable Development Goals within the soybean production and trade system. However, the interrelation between the exporters found in this paper suggests that these strategies and policies should be framed within a collaborative strategy between the governments of the countries involved in soybean production and exports, especially between those countries with the higher level of land-use changes: Argentina, Brazil, and Paraguay.

Finally, as future research, the paper makes explicit the significance of the interconnections among the leading exporters of soybeans at the world level, providing further encouragement to explore empirical and theoretical foundations of the determinants of these interconnections.

Acknowledgement: We thank Geoffrey J.D. Hewings for his valuable help and comments on a previous draft of the paper.

REFERENCES

Boerema A., Peeters A., Swolfs S., Vandevenne F., Jacobs S., Staes J., Meire P. (2016): Soybean trade: Balancing environmental and socio-economic impacts of an intercontinental market. PloS one, 11: 1–13.

Capaz R.S., de Medeiros E.M., Falco D.G., Seabra J.E., Osseweijer P., Posada J.A. (2020): Environmental trade-offs of renewable jet fuels in Brazil: Beyond the carbon footprint. Science of the Total Environment, 714: 1–14.

Carraressi A., Banterle L. (2015): Agri-food competitive performance in EU countries: A fifteen-year retrospective. International Food and Agribusiness Management Review, 18: 27–62.

Dal Bianco A., Boatto V.L., Caracciolo F., Santeramo F.G. (2016): Tariffs and non-tariff frictions in the world wine trade. European Review of Agricultural Economics, 43: 31–57.

Deininger K. (2013): Global land investments in the bio-economy: Evidence and policy implications. Agricultural Economics, 44: 115–127.

Deodhar S.Y., Sheldon I.M. (1997): Market power in the world market for soymeal exports. Journal of Agricultural and Resource Economics, 22: 78–86.

FAOSTAT (2019). Data. [Dataset]. The Food and Agriculture Organisation of the United Nations. Available at http://www.fao.org/faostat/en/#data (accessed Nov, 2019).

Fernández-Núñez M.T., Márquez M. (2014): The dynamics of trade composition: Do trade-type interdependencies matter? The Journal of International Trade & Economic Development, 23: 710–734.

Goldsmith P., Hirsch R. (2006): The Brazilian soybean complex. Choices, 21: 97–103.

Gouveia S., Rebelo J., Lourenço-Gomes L. (2018): Port wine exports: A gravity model approach. International Journal of Wine Business Research, 30: 218–242.

Hausman C. (2012): Biofuels and land use change: Sugarcane and soybean acreage response in Brazil. Environmental and Resource Economics, 51: 163–187.

Hausmann R., Klinger B. (2007): Growth Diagnostic: Paraguay. Centre for International Development, Harvard University: 1–44.

Helpman E. (1981): International trade in the presence of product differentiation, economies of scale and monopolistic competition: A Chamberlinian-Heckscher-Ohlin approach. Journal of International Economics, 11: 139–152.

https://doi.org/10.17221/433/2020-AGRICECON

Herzberger A., Chung M.G., Kapsar K., Frank K.A., Liu J. (2019): Telecoupled food trade affects pericoupled trade and intracoupled production. Sustainability, 11: 1–15.

Huffman W.E. (2001): Human capital: Education and agriculture. Handbook of Agricultural Economics, 1A: 333–381.

ILOSTAT (2019): Data. [Dataset]. International Labor Organisation. Available at https://ilostat.ilo.org/data/ (accessed Nov, 2019).

Jambor A., Babu S. (2016): Understanding the Factors Behind Agricultural Competitiveness in Competitiveness of Global Agriculture. Cham, Switzerland, Springer International Publishing: 131–149.

Jenkins R. (1996): Trade liberalisation and export performance in Bolivia. Development and Change, 27: 693–716.

Jia F., Peng S., Green J., Koh L., Chen X. (2020): Soybean supply chain management and sustainability: A systematic literature review. Journal of Cleaner Production, 255: 1–20.

Larson D.W., Rask N. (1992): Changing competitiveness in world soybean markets. Agribusiness, 8: 79–91.

Márquez M.A., Ramajo J., Hewings G.J.D. (2003): Regional interconnections and growth dynamics: The Spanish case. Australasian Journal of Regional Studies, 9: 39–64.

Narayan S., Bhattacharya P. (2019): Relative export competitiveness of agricultural commodities and its determinants: Some evidence from India. World Development, 117: 29–47.

Nsabimana A., Tirkaso W.T. (2020): Examining coffee export performance in Eastern and Southern African countries: Do bilateral trade relations matter? Agrekon, 59: 46–64.

OECD (2019): Data. [Dataset]. Organisation for Economic Co-operation and Development. Available at https://stats.oecd.org/ (accessed Nov, 2019).

Paleari S. (2017): Is the European Union protecting soil? A critical analysis of Community environmental policy and law. Land Use Policy, 64: 163–173.

Rochedo P.R., Soares-Filho B., Schaeffer R., Viola E., Szklo A., Lucena A.F., Rathmann R. (2018): The threat of political bargaining to climate mitigation in Brazil. Nature Climate Change, 8: 695–698.

Saha B., Sarker R., Mitura V. (2014): Impact of genetically engineered varieties on the cost structure of corn and soybean production in Canada. Canadian Journal of Agricultural Economics/Revue Canadienne D'Agroeconomie, 62: 263–282.

Sanders D.R., Altman I.J., Ferraro N. (2014): Technological advances in soybean yields: A disaggregated approach. Agribusiness, 30: 207–221.

Santeramo F.G., Di Gioia L., Lamonaca E. (2021): Price responsiveness of supply and acreage in the EU vegetable oil markets: Policy implications. Land Use Policy, 101: 1–16.

Secchi S., Kurkalova L., Gassman P.W., Hart C. (2011): Land use change in a biofuels hotspot: The case of Iowa, USA. Biomass and Bioenergy, 35: 2391–2400.

Seccia A., Santeramo F.G., Nardone G. (2015): Trade competitiveness in table grapes: A global view. Outlook on Agriculture, 44: 127–134.

Tilman D., Clark M. (2014): Global diets link environmental sustainability and human health. Nature, 515: 518–522.

UNCTADstat (2019): Datasets. [Dataset]. United Nations Conference of Trade and Development. Available at https://unctadstat.unctad.org/EN/ (accessed Nov, 2019).

UN Comtrade Database (2019): International Trade in Goods Based on UN Comtrade Data. [Dataset]. United Nations. Available at https://comtrade.un.org/data (accessed Nov, 2019).

World Bank (2019): World Development Indicators (WDI). [Dataset]. The World Bank. Available at https://data.worldbank.org/data-catalog/world-development-indicators (accessed Nov, 2019).

WTO (2019): Data. [Dataset]. World Trade Organisation. Available at https://data.wto.org/ (accessed Nov, 2019).

Accepted: April 30, 2021
Received: October 28, 2020