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Collective efficiency of the soy cluster (*Glycine max* L.): Tamaulipas Case, Mexico

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ABSTRACT

Objective: To analyze the collective efficiency (CE) of the soy cluster (*Glycine max* L.) in the southern region of Tamaulipas, Mexico.

Design/methodology/approach: The Localization Coefficients and Gini indexes were calculated for the soy sector in the state, based on information obtained from SIAP (2018). The Collective Efficiency Index was obtained from the soy cluster, through the application of a questionnaire to producers in the region for the measurement of external economies and joint actions in the agglomeration.

Results: The indicators allowed identifying a high concentration of the soy sector in the southern region of Tamaulipas, in addition to the participation of a high proportion of the municipalities in production, production value, surface sown, and surface harvested. It was identified that the producers in the soy conglomerate have achieved a middle level of CE, with a higher presence of Joint Actions (JAs) than External Economies (EEs).

Study limitations/Implications: It is a transversal study, because the CE was only studied in the soy cluster during a specific period.

Findings/Conclusions: Although the soy cluster in the region evaluated offers its members various benefits, the maximum development of their CE has still not been attained, which is why there is still a need to continue strengthening the sector by the state government, through programs that promote individual and collective development of soy producers and organizations related with the sector located in the region.

Keywords: agriculture, collaboration, business agglomeration, collective efficiency.

INTRODUCTION

Presently, soy (*Glycine max* L.) is considered as the most important oleaginous plant worldwide, having as main producers the United States, Brazil, Argentina and China (CIMA, 2019). This crop is recognized for its high nutritional value and can be consumed directly or in presentations such as flour or vegetable oil, in addition to being used in the elaboration of cosmetics, soaps and biofuels (WWF, 2014). According to the Ministry of Agriculture and Rural Development (2019), although in Mexico 334,011 tons of this crop were produced in 2018, imports had to be carried out to satisfy the domestic demand of the crop by importing 5,230,000 tons, so it ranked as the third largest importer of soy in the world.

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At the national level, Tamaulipas has historically been leader in soy production, although, according to SIAP (2018), the state produced 78,915.62 tons of this crop and its production value reached $528,680,392.90, exceeded by Campeche which obtained $617,500,433.00 from the sale of 86,934.06 tons. At the state level, the municipalities with higher participation in the soy subsector are González, Altamira, Aldama and El Mante, located in the southern region of the state, which as a whole concentrate 86.96% of the total production of the crop (SIAP, 2018). Although the soy subsector in the state has been a study object in various studies (Maldonado, Ascencio and García, 2017; García *et al*., 2018), little has been analyzed about the collective efficiency with which the oleaginous-production businesses operate in the region and the advantages that have been achieved because of their location. The objective was to analyze the CE of the soy cluster in the southern region of Tamaulipas, given that this concept explains the benefits obtained by the members of a business agglomeration, whether they are sought or not (Di Tommaso, 1999; Giuliani, Pietrobelli, and Rabellotti, 2005). In this regard, according to Schmitz (1997), the CE encompasses two important dimensions, external economies (EEs) and joint actions (JAs). The EEs refer to the unsought advantages by the cluster members which anyhow exist in the region and which the companies can appropriate. In turn, the JAs are related to benefits derived from the interrelation between the different agents of business agglomeration, such as those carried out with other producers, with clients, with suppliers, and with organizations related to the sector (Di Tommaso, 1999).

MATERIALS AND METHODS

To identify the cluster and measure the collective efficiency in the southern region of the state of Tamaulipas, Mexico, three indicators were used: coefficient of localization (CL), Gini index (Ig) and Collective Efficiency Index (CEI).

Coefficient of Localization. This indicator provides information regarding the degree of productive specialization that a territory has in the development of a sector or an industry (Kopczeska, Churski, Ochojski and Polko, 2017), and it is determined in the following way:

$$CL_{ij} = \frac{X_{ij} / X_j}{X_{in} / X_n}$$

Where: CL_{ij} = coefficient of localization of the activity *i* sector in the region *J*, X_{ij} = production of the sector of activity *i* in the region *j*, X_j = total production of the region *j* (state, region, municipality), X_{in} = production of the sector of activity *i* in all of the regions (national), and X_n = total production in all of the regions (national).

It is considered that if CL_{ij}>1 it means that there is privileged localization of the sector i in the geographic area *j*. With higher CL_{ij} there is higher concentration of the sector. If CL_{ij}<1 there is a lower localization of the sector *i* studied in the geographic area *j*. When CL_{ij} = 1 the regional participation of sector *i* is the same as the national participation (Kopczeska *et al*., 2017).

Gini index. The *Ig* measures the degree in which a distribution function is distanced from the uniform distribution function of such a variable, and for its determination the difference between two types of distributions *Pi* and *Qi* is divided by the total distributions of *Pi*, with the following formula:

$$Ig = \sum_{i=1}^{k}{}^{1}(Pi - Qi) / \sum_{i=1}^{K}{}^{1}Pi$$

$$Ig = \frac{\sum (Pi - Qi)}{\sum Pi}$$

Where *Ig* denotes the Gini index and *Pi* refers to the frequencies accumulated of the data of one distribution divided by the total observations times 100, which is expressed as:

$$Pi = \frac{Ni}{m} * 100$$

Where *m* corresponds to the total frequencies accumulated. *Qi* is equal to the frequencies accumulated of the distribution data divided by the total observations times 100, represented as:

$$Qi = \frac{Hi}{H} * 100$$

Where *H* is equal to the total frequencies accumulated from the data. Based on Asuad (2001), if *Ig* is close to zero, then the concentration is nearly non-existent and, on the other hand, if *Ig* is close to 1 there is high concentration.

Collective Efficiency Index. A questionnaire was elaborated to calculate the CE index, based on the model proposed by Giuliani *et al*. (2005). The instrument used included 56 items; the first 28 gathered the elements of the EEs, regarding the specialized market of the workforce, specialized market of inputs, access to information and access to markets. The next 28 items referred to the JAs, for example the relationship with suppliers, relationship with clients, relationship with producers and multilateral relationships (Table 3). For the calculation of CEI the sum of 0.5 of the results at the level of EEs plus 0.5 of the degree of JAs is considered. In this sense the CEI formula is represented as

$$CEI = (0.5 * IEE) + (0.5 * IJA)$$

For the interpretation of this indicator, three levels of CE are established based on Giuliani *et al*. (2005): ≥9.5 = High; 5.1>Medium<9.5; and ≤5 Low.

RESULTS AND DISCUSSION

Comparatives between coefficients of localization of the soy cluster

For this study, the CL was calculated by considering the production variables, production value, surface sown, and surface harvested from the soy sector in the southern region of Tamaulipas, made up of the municipalities of Aldama, Altamira, El Mante and González, based on statistical information obtained from SIAP (2018). Table 1 shows the CL for the production variable (tons) which obtained a value of 67.4005, the highest coefficient of the four variables. This result is derived from the fact that the in zone studied the soy production represented 3.73% of the total production, much higher proportion than what this same activity represented at the national level with 0.05%. The production value (thousands of pesos) variable had the second highest CL reaching 40.2489, due primarily to the volume of the crop produced in the region.

Table 1. Coefficients of Localization for the soy cluster in Tamaulipas, Mexico.

Variable	LC
Production	67.4005
Production value	40.2489
Sown area	32.7156
Harvested area	33.3070

Source: own elaboration with data from the Agri-Food and Fisheries Information Service (SIAP, 2018).

Table 2. Gini indexes for the soy cluster in Tamaulipas.

Variable	GI
Production	0.1888632
Production value	0.1888614
Sown area	0.1924682
Harvested area	0.1924695

Source: own elaboration with data from the Agri-Food and Fisheries Information Service (SIAP, 2018).

In the case of the sown and harvested surface, their CLs were lower than the first two variables; this shows that the rest of the states in the country have greater participation in terms of the surface devoted to this crop. However, the southern region of Tamaulipas has achieved higher efficiency in the sector that is reflected in greater production and profits from its sale.

The CLs calculated for the soy sector in the southern region of Tamaulipas showed higher values than those obtained by other studies (Vidal and Pezoa, 2012) for outstanding sectors and industries at the national and international level. According to Kopczeska *et al*. (2017), when CLs higher than 1.25 were found in a region, it can be considered a potential exporter; however, this differs from the soy sector in Tamaulipas because according to the state's Ministry of Rural Development (2017), in recent years imports have been made to supply local consumption, importing up to three million tons of soy from the United States annually.

Comparative between Gini indexes of the soy cluster

The Gini indexes (*Ig*) were determined for the soy cluster in Tamaulipas, taking into consideration the production variables, production value, surface sown and surface harvested, based on data obtained from SIAP (2018). Table 2 shows that the highest *Ig* of the soy sector was the one that corresponded to the surface harvested with 0.1924695. This value was close to zero, which indicates that an important number of municipalities of the state in addition to devoting hectares to growing the crop also harvest it. In this regard, according to figures from SIAP, 19 municipalities presented a harvested soy surface in 2018; however, it stands out that González, Aldama, Altamira and El Mante covered 55,406 ha of the 62,910.32 ha harvested at the state level, which represented 87.56%.

The variable with the lowest *Ig* was the production value with an index of 0.1888614; however, a noticeable difference was not found with the highest *Ig*. In this sense, according to SIAP, in 2018 the value of soy production in Tamaulipas was distributed among 44.18% of the municipalities; however, it is highlighted that the study region concentrated $454,505,465.60 (85.97 %) of the $528,680,392.90 that this activity contributes to the state economy.

The variables of production and surface harvested attained *Ig* of 0.1888632 and 0.1924682, respectively, showing a similar behavior in their distributions. In both variables a high participation of the municipalities was found in the distributions, but this highlighted their concentration in a small group of municipalities, mainly those belonging to the southern region of the state. The *Ig* calculated for the soy sector in Tamaulipas showed weighting below those obtained by Sobrino (2016), for the important sectors in the country such as hide and leather (0.634) and the basic metallurgic (0.408). This is a result from the fact that although a high percentage of municipalities in the state are devoted to this economic activity, they do it at a small scale, and therefore its participation in it is relatively low.

Calculation of the Collective Efficiency Index of the cluster

For the analysis of the CEI of the soy subsector, the model proposed by Giulani *et al*. (2005) was used, and for this purpose a sample of ten companies from the oleaginous-production sector in the region were surveyed. In this regard, the CEI of the soy subsector cluster was 7.35 (Table 3), and a greater presence was identified of the JAs (7.53) than of the EEs (7.17).

In the dimension of the EEs, access to specialized workforce was the component with the highest index (2.05), with it being the one that offers the highest benefit to the cluster producers, such as the identification of qualified staff in the sector (2.22) and the ease to hire human resources in the region (2.16). In contrast, the access to markets was the component that presented the lowest weighting (1.48), because the cost reduction of equipment and raw materials (1.08) and the access to new local, regional and national markets (1.14) were identified as the least exploited elements by soy producers in the region.

The other two components: access to prime materials (1.66) and to technical knowledge (2.16), obtained intermediate scores. The results from the IEE reflect that the producers from the soy subsector have managed to appropriate the benefits that the business agglomeration offers, although they perceive that their localization has still not translated into great benefits referring to access to new markets, as well as acquisition of machinery and prime materials.

In terms of the dimension of JA, the greatest advantage perceived by oleaginous-production businesses in the cluster was associated with the component of relationship with the clients (1.94), highlighting that consumers have a high valuation of the entirety of regional products that the oleaginous subsector offers in the region (2.16). The least weighted segment of the JA was that of relationship with other producers (1.82), which can be derived from the mistrust to collaborate with other companies considered rivals in the market. The components of relationship with suppliers and bilateral and multilateral actions obtained scores of 1.88 and 1.89, respectively. The IJA value (7.53) denotes that the participants of the soy cluster have managed for promotion of work with the rest of the agents of the agglomeration to be articulated as an important source of advantages in the sector.

The mean value of CEI for the cluster of the soy sector in Tamaulipas reflects that the EEs and JAs have not been consolidated; however, the index is above the one obtained for other agglomerations (Pietrobelli and Rabelloti, 2005), which indicates that the oleaginous-production businesses in the region have effectively achieved benefits because of their localization, which they probably would not have reached in an isolated way.

CONCLUSIONS

The existence of the soy cluster was identified in the southern region of Tamaulipas, and its CE level was defined. The existence of a high concentration of the soy sector could be observed in the zone comprised by González, Altamira, Aldama and El Mante, which indicates that this activity has greater participation in the region's economy compared to other states. It was identified that a high percentage of the municipalities have participation in the production, production value, surface sown and surface harvested. However, all the variables are concentrated mainly in the municipalities of the study region. Although it was identified that the soy cluster offers benefits to its participants, highlighting the predominance of the JAs over the EEs, the maximum development of its potential EEs and JAs has still not been achieved.

REFERENCES

Asuad, S. (2001). Economía regional y urbana. Introducción a las teorías, técnicas y metodologías básicas. Puebla, Puebla, México. Benemérita Universidad Autónoma de Pueda y Colegio de Puebla. http://www.economia.unam.mx/cedrus/descargas/LIbro%20completo.pdf

Table 3. Collective Efficiency Index of the soy cluster in Tamaulipas.

Component	Concept	Average	Index
External economies			
Access to skilled labor	Skilled labor	2.22	2.05
	High experience	1.86	
	Hiring local staff|	2.16	
	Local education	1.98	
	Attendance at training courses in institutions in the region	2.1	
	Training by regional suppliers	1.68	
	Shared work experiences	1.92	
	Learning through formal and informal networks	2.16	
	Learning collaborations	2.22	
	Learning through coexistence	2.16	
Access to raw materials	Outsourcing of activities	1.56	1.66
	Second hand machinery and equipment	1.92	
	Market of inputs and intermediate inputs	1.92	
	Market of inputs and specialized inputs	1.86	
	Reduction of input costs	1.38	
	Outsourcing of complementary activities	1.32	
Access to technical knowledge	New companies from former workers	1.56	1.99
	Transmission of information and knowledge	2.1	
	Technical information	2.04	
	Generation of innovation for competitiveness	2.16	
	Formal and informal channels	1.92	
	Collaboration between companies	1.98	
	Conversion of ideas	2.16	
Access to new markets	Access to new clients	2.1	1.48
	Ease of access to markets	1.14	
	Low transportation costs	1.08	
	Adequate regional infrastructure	1.38	
	Support and auxiliary companies	1.68	
EXTERNAL ECONOMIES INDEX			7.17
JOINT ACTIONS			
Vertical actions with suppliers	Bargaining power of suppliers	1.32	1.88
	Competition for the acquisition of inputs and resources	1.62	
	Formal relationship with suppliers	2.28	
	Inventory management	2.16	
	Reciprocity with suppliers	2.04	
Vertical actions with clients	Bargaining power of customers	1.86	1.94
	Bargaining power company-client	2.1	
	Contracts with clients	2.04	
	High reputation for regional products	2.22	
	Company reputation	1.5	
Horizontal actions with producers	Collaboration agreements and stable alliances	1.8	1.82
	"Enemy" companies	1.14	
	Marketing and sales relationships	1.98	
	Relationships in high demand markets	2.04	
	Share production costs	1.68	
	Share management and administration costs	1.68	
	Dispute and conflict resolution	2.16	
	Mutual understanding between companies	1.86	
	Joint participation in fairs and exhibitions	2.04	
Bilateral and multilateral actions	Programs to promote and help SMEs	1.2	1.89
	Institutions that provide information on resources	2.1	
	Institutions that provide information on customers and markets	2.04	
	Importance of regional institutions	2.28	
	Research links	2.1	
	Assistance and training by institutions	1.62	
	Promotion of regional institutions	1.38	
	Participation in business and professional associations	2.16	
	Collaboration between institutions	2.1	
Joint action index			7.53
Collective efficiency index			7.35

Source: prepared by authors with field information.

Centro de Información de Mercados Agroalimentarios (CIMA) (2019). Reporte del mercado de soya. https://www.cima.aserca.gob.mx/work/models/cima/pdf/cadena/2019/Reporte_mercado_soya_070819.pdf

Di Tommaso M. R. (1999). Eficiencia colectiva y clúster de empresas: los nodos de la política. Encuentro. 30 (50), pp. 34-50. https://doi.org/10.5377/encuentro.v0i50.3814.

García, F., Domínguez, A. L., Galván, A. y Sánchez, N. (2018). La gobernanza de la cadena de valor de la soya en el sur de Tamaulipas (México): mapeando procesos. Agroalimentaria, 24 (47), pp. 113-131. https://www.redalyc.org/jatsRepo/1992/199260579007/html/index.html

Giuliani, E., Pietrobelli, C. y Rabellotti, R. (2005). Upgrading in Global Value Chains: Lessons from Latin American Clusters. World Development, 33 (4), pp. 549-573. https://doi.org/10.1016/j.worlddev.2005.01.002

Kopczewska, K., Churski, P., Ochojski, A., y Polko, A., (2017). Measuring Regional Specialisation, a nex approach. Palgrave Macmillan Doi 10.1007/978-3-319-51-505-2

Maldonado N., Ascencio, G. y García, J. C. (2017). Huasteca 600: variedad de soya para el sur de Tamaulipas. Revista Mexicana de Ciencias Agrícolas, 8 (8), pp. 1897-1904. https://doi.org/10.29312/remexca.v8i8.713

Pietrobelli, C., y Rabellotti, R. (2005). Upgrading in clústeres and value chains in Latin 628 America: The role of policies. In Sustainable Development Department Best 629 Practices Series. Washington, DC: Inter-American Development Bank. 630

Secretaría de Agricultura y Desarrollo Rural (SADER) (2019). Atlas Agroalimentario –Panorama Agroalimentario 2019. https://nube.siap.gob.mx/gobmx_publicaciones_siap/pag/2019/Atlas-Agroalimentario-2019

Secretaría de Desarrollo Rural (2017). El cultivo de soya en Tamaulipas. https://www.tamaulipas.gob.mx/desarrollorural/2017/03/el-cultivo-de-soya-en-tamaulipas/

Sistema de Información Agroalimentaria y Pesquera (SIAP, 2018). Datos abiertos estadística de producción agrícola. Disponible en http://infosiap.siap.gob.mx/gobmx/datosAbiertos.php

Sobrino, J. (2016). Localización industrial y concentración geográfica en México. 656 Estudios Demográficos y Urbanos, 31 (1), pp. 9-56. 657 http://dx.doi.org/10.24201/edu.v31i1.1502

Vidal-Suñé, S. y Pezoa-Fuentes, F. (2012). Identificación de clústeres productivos: aplicación a la economía chilena. Revista de Ciencias Sociales, 18 (3), pp. 482-497. https://produccioncientificaluz.org/index.php/rcs/article/view/24992/25605

World Wildlife Fund (WWF, 2014). El crecimiento de la soja impacto y soluciones. https://d2qv5f444n933g.cloudfront.net/downloads/documento_fvs_espanol