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SOCIAL STRUCTURE IN AN ARTISANAL COCOA PRODUCTION NETWORK: LA CHONTALPA, TABASCO

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ABSTRACT

The transformation of cocoa into a global commodity, with growing commercial value, resulted in a broad field of value extraction and modulation of local and regional agrifood systems, generating specific conditions of territorial planning and integration of local actors, but also creating structural, economic, legal and normative conditions in detriment of the artisanal peasant production of cocoa (*Theobroma cocoa L.*). However, rural communities are always trying to reformulate these parameters from their own organizational dynamics, rooted in the sociocultural processes that allowed cocoa to become an important food for ancient and current societies. The region of Chontalpa, Tabasco, concentrates more than 68% of the cocoa productive system in the country, and also focalizes an agrifood system and a field of conflict between conventional agroindustry and the artisanal way of cultivating cocoa, mainly because the latter tends to differ from the productivism of the former, but from an agroecological approach and the emergence of local relational structures. With the Social Network Analysis, semi-structured interviews were conducted with a group of key informants (artisanal cocoa producers), which allowed identifying relationships of input exchange (training, marketing and financing), as well as the degree of influence between cocoa producers. Networked social sub-structures were observed, through which information is handled in topics such as marketing, training, counseling, and financing of cocoa. These processes are characterized by being highly differentiated and hierarchical in access to this information, which generates growing conditions of vulnerability for cocoa producing communities.

Key words: agrifood hegemon, power distribution, structural vulnerability, traditional producers.

INTRODUCTION

During the last 40 years, agrifood systems have become integrated into a global, mercantile, technological and extractive *ethos*, which has broken the balance between the availability of natural resources, their exploitation, and the

amount of people to be fed (Meadows *et al.*, 1972), inhibiting agrobiodiversity and homogenizing food environments (Torres, 2018). Such is the case of the productive system of cocoa (*Theobroma cocoa L.*), native plant of the American continent (Barros, 2018); the Mayo Chinchipe culture, in Ecuador, was the first to use its fruits for food (Abad *et al*., 2020). Southeast Mexico is also considered as origin of cocoa, since its domestication/consumption was recorded in pre-Hispanic mythology, Olmeca and Maya, from the state of Tabasco (Santiago, 2018), and was integrated into the biocultural construction of Mayan peasant communities (Vargas, 2013), cultivated under the taller rainforest cover and serving as shade tree.

The zone of Chontalpa, Tabasco, was the one of highest production in Mesoamerica: the dominating indigenous castes controlled trade and production, as well as the most fertile lands. After the Conquest (18^{th}-19^{th} century), cocoa cultivation was reordered into orchard systems, substituting the natural rainforest shade, and introducing *Erythrina americana* ("mother of cocoa") and cocohite (*Gliricidia sepium*) as well as nurseries to expand the cocoa-producing zones (Tudela, 1992). The scarce Spanish interest on these lands caused for the dominion of cocoa cultivation to fall into the hands of the native indigenous peoples.

After the Mexican Revolution (1919-1934), a model of cooperativist organization was promoted in the region, introducing the diversification of crops, modernization and peasant training, and imports of improved inputs (Tudela, 1992, pp. 81-99). Between 1943 and 1961, the Rockefeller Foundation and the Ministry of Agriculture and Livestock Production (*Secretaría de Agricultura y Ganadería*, SAG), promoted the Green Revolution (Gutiérrez, 2020), a model of technological intensification that increased agricultural production. This model was implemented in 1963, in Tabasco, as the Plan Chontalpa, directed towards modernizing agriculture and driving the economic and social growth of the region, creating collective *ejido* units devoted to the production of commercial crops, taking advantage of the productive attributes of the Mexican humid tropics (Barraclough, 1981; Jiménez and Lara, 2023).

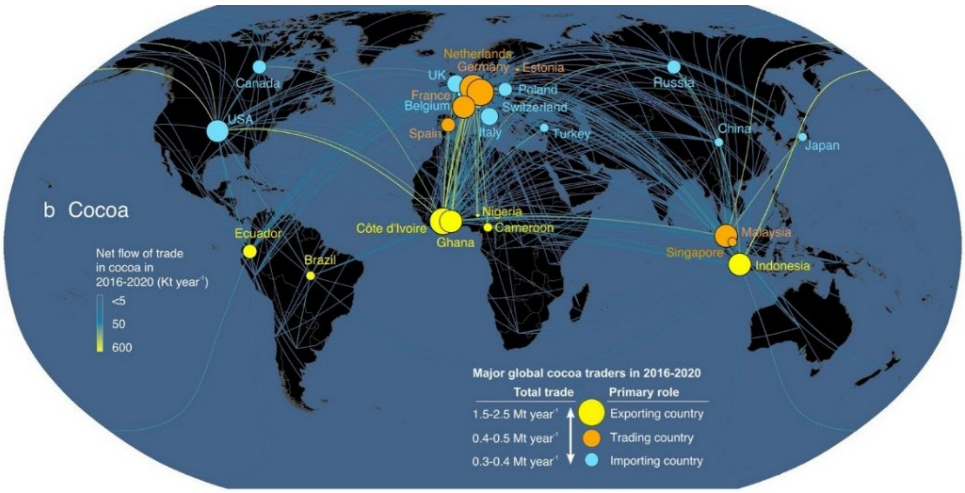
To achieve this, the production of short-cycle, perennial crops (e.g., cocoa and sugarcane) was encouraged, as well as cattle production, also promoting agroindustry. This all changed the local productive structures (Barraclough, 1981), devastating local agrifood systems, which were erroneously considered as peasant and primitive rural ways of life, and trying to replace them with the development of a local agribusiness agriculture (Bartra, 1976). The global economic crisis of 1972-1973 and the rise in oil prices, exposed the vulnerabilities of this development model, as well as its negative effects at the social, environmental and health levels of peasants and consumers (Gutiérrez, 2020; Chávez and Castelán, 2019).

Currently, in Tabasco, there are 31,139 families that depend economically on cocoa production, harvesting 44.4 thousand hectares of cocoa; 46.5% of these producers use native seeds, 62.7% apply chemical fertilization, and 68.4% chemical herbicides, while 7% apply natural fertilizers (Vázquez and López, 2021; INEGI, 2019).

Production, processing and marketing of this crop are inserted in global trade, exporting around 2,250,000 annual tons of cocoa. Most of the production (74%) comes from the African continent: Ghana, Cameroon, Nigeria and Ivory Coast; the latter is the main producer (44.86%). The American continent represents 20% of the production; Ecuador is the main producer with 454,000 tons, while Mexico contributes about 0.54% of the global cocoa production (López, 2022; Servicio de Información Agroalimentaria y Pesquera -SIAP- 2023; International Cocoa Organization -ICCO-, 2024). The global market has increased the commercial demand by 1.5% annually and represents 27% of the global exports of this fruit, while chocolate, its main byproduct, 49% of the market; Europe is the maximum importer of grain cocoa, with 64% of global trade, and it is the global stockpiler of cocoa byproducts: it imports 69% of the butter, 47% cocoa powder and cake, 75% paste, and 62% chocolate (Arvelo *et al*., 2016).

The Americas import 19.3%, consuming more than 1,300,000 tons of cocoa per year, with average growth of 5% in annual demand; the United States (USA) is the largest consumer (62% of the offer); Mexico imports 5% of cocoa, with consumption close to 2.5 times more than it produces (Arvelo *et al*., 2016). The use of cocoa for the elaboration of a diversity of products in the food industry has positioned it as global economic interest crop, so its production has expanded to other tropical regions of the world (Compañía Nacional de Chocolate, 2021). In addition, its trade has generated a historical and global structure of cocoa extraction and exchange, as value (since the 19th century). This suggests territorial forms of production, policies, economies, decision making and hegemonic relationships, which has generated specific conditions of ordering and integration of actors (Schokoladenmuseum Köln, 2025) (Figure 1).

In 2022, the Mexican production of cocoa had a commercial value of 30.8 billion pesos, of which 39.8% of processed products were powder and paste chocolate, representing 27.9% of its commercial value; chocolate bars and figures contributed 30.1% of processed products, equivalent to 40.1% of the commercial value. Within the cocoa industry, 49.9% of the raw material is produced in the country and 50.1% is imported. At the same time, 48.2% of chocolate comes from the domestic market and 51.8% from outside. Chocolate production destined to the final demand was 73.5%, the remaining 26.5% was destined to trade with other industries (Instituto Nacional de Estadística, Geografía e Informática -INEGI-, 2023).



Source: Santika *et al*., 2024
Figure 1. Global cocoa commercial network.

The market dynamics of cocoa in Mexico suggest the agglomeration of various commercial, industrial and processing actors; the most prominent are Ferrero Rocher International S.A., Nestlé S.A., and Hershey Company, which supplied 65% of the domestic market (Pérez, 2022; Garduño and Torres, 2009). Other companies are Mars, Incorporated, Mondelez International Inc., Grupo Arcor, Chocoladefabriken Lindt & Sprungli AG, August Storck KG, Chocolatera Ibarra, S.A.P.I. de C.V., and Grupo NUTRESA (EMR CLAIGHT, 2023).

The cocoa industry in Mexico is sustained by a diversified social production system, focalized in the state of Tabasco, zone of Chontalpa, which concentrates around 68.6% of the national surface planted with cocoa, 64.43% of the harvest and most (80%) of the processing infrastructure, primarily in the municipality of Comalcalco (Tadeo-Sánchez and Tolentino-Martínez, 2021; Rosas and Ramírez, 2010). This agro-industrial preponderance of regional chocolate companies has been accompanied by the State itself. In the year 2010, the Ministry of Agriculture and Livestock Production, Forestry and Fishing Development (*Secretaría de Desarrollo Agropecuario, Forestal y Pesca*, SEDAFOP) in Tabasco and local agro-industrial businessmen, created the annual Chocolate Festival Fair, achieving in 2016 the General Declaration of Designation of Origin "Cacao Grijalva" (Camacho-Gómez, 2018; Reyes *et al*., 2018; Martínez, 2021). It should be mentioned that 97% of the cocoa production is carried out by small-scale producers, although it ends up being absorbed by international and national chocolate corporations that operate in the zone (Priego-Castillo *et al*., 2009).

Some of the dynamics implemented for the dominion of this market are economies of scale, industrialized production and processes, use of

agrochemicals, price regulation, product traceability, genetic research in plant improvement, support from the public sector in research, cocoa imports, control of the certification process, stockpiling of production and decision making, exclusion of primary producers, disloyal competition, among others (Skemperis, 2024; Aguilar, 2024; El Universal, 2023; Sántiz *et al*., 2023; Martínez, 2021; Azpeitia, 2020; Arvelo *et al*., 2017; Córdova–Avalos, 2008). All the above suggests the construction of a hegemonic agrifood system, which generates tensions and disturbances in the cocoa artisanal systems.

However, community links between artisanal cocoa producers allow them to mutually establish strategic information exchange channels (about marketing, training, counseling and financing, among others), generating an organizational and structured process around this crop, which allows hypothesizing that access to various information inputs among rural cocoa producers will organize them hierarchically, defining part of their strengths or structural vulnerabilities. Identifying these relational dynamics is the central objective of this document.

THEORETICAL FRAMEWORK

Economic control and mechanisms of State domination by a group that holds the capital, justified through ideological consent of a dominant group over other less favored groups, allows us to think about Gramscian hegemony (Fusaro, 2022), as a group strategy made up of multiple relationships and domination canons (between a diversity of institutions, norms and social actors), which enable creating the structural, legal and normative conditions (social, economic, political and cultural) to seize productive forces and production relationships, thus managing to regulate and legalize the lifestyles (Foucault, 2016; Foucault, 2012) and the ways of thinking and organizing as networked social structures (Foucault, 2021; Latour, 2008).

Bourdieu (2000) considers this as *doxa*: daily structuring that organizes human thought in a social way, where individuals subject themselves to a stratification of functions, whether in productive or reproductive activity, taking for granted all forms of organization and structuring of the social world (Bourdieu, 2000, Bourdieu, 2007), and even regulating what, how and where food is consumed (Bourdieu, 2012). These hegemonic processes have been widened towards control of agrifood systems (subordinating legislative, economic aspects, division of labor, production relationships, marketing of goods, etc.) and the direct handling of natural resources (water, soil, forest species, etc.) (Gómez, 2014; Jiménez, 2018), thus consolidating the influence of the market economy, particularly subjugating the modes of production of agriculture, and even driving small-scale rural producers towards the intensive use of agro-industrial technologies and causing a growing dependence on these goods.

Thus, their capacity for investment and innovation has ended up depending on prices set by the agro-industrial market, under constant conditions of uncertainty and exploitation (Bourdieu, 2004). This enables the implementation of an agribusiness hegemonic model of control over soil, seeds, inputs and technology, excluding alternative peasant economies that do not respond precisely to these canons. The establishment of these unequal conditions in the distribution of power has caused a broad social mobilization around the rescue, recognition or reconstruction of artisanal agriculture and livestock systems, given the low energetic and environmental impact they have and the sociocultural agricultural diversity that leads them (FAO, 2007, Toledo, 2025).

The broader systemic derivation of this falls on the agroecological approach (Méndez *et al*., 2013; Altieri and Nicholls, 2012), which refers to the conformation of dynamics of transformation and management of agroecosystems around peasant and indigenous production, integrating knowledge from local communities with traditional or artisanal practices, incorporating technological and organizational innovations, such as short value chains, social and solidary economy, local markets, new cooperative relationships, and appreciation of the collective action to achieve a good life. This theoretical social framework is in contrast with the agrifood hegemon, since it proposes a redistribution of resources and power (González and Caporal, 2013).

This *contingency* can be seen in different peasant agricultural systems, for example, the artisanal cocoa productive system, which is product of an ancient epistemological matrix (Núñez-Espinoza and Navarro-Garza, 2021), expressed through the cocoa seed itself, as a food product (in ancient times as an input of value and barter -Berdan, 2013-).

However, paradoxically, it has become a commercial commodity as it has increased its commercial value, competing in the stock exchange (Becker, 2024; Boggiano, 2024). This has driven a clear differentiation between the agribusiness/industrial process of production (PAIDC) and the artisanal cocoa production process (PAC), especially due to the low degree of energy inputs used by the latter and the degree of independence it generates in peasant and indigenous communities (FAO, 2007).

For example, the PAIDC generates a more homogenous production (productive efficiency and viability, standard quantity/quality, scale economies), massive, concentrated in production units, with high incidence in the use of agrotechnological inputs in the various growth and cultivation phases (more leaf fertilization, thrips control -*Selenotrips rubrocinctus*-, systematic management of diseases, weed control twice per year, pruning and reduction of cocoa tree height, elimination of fruits in periods of low production, chemical processing of harvest residues, as well as for each reproductive flow), although with higher social and environmental impact (intensive production, deforestation,

unfair labor conditions, high carbon footprint, lower biodiversity), linked to extensive agro-industrial chains.

Additionally, processes of chocolate elaboration are automated (for example, fast cocoa roasting), with more training/technical assistance, incorporation of additives –vegetable fats, saturated fats, lecithin–, sugar and flavoring, and certification processes for greater competition and participation in national and international markets. In turn, cocoa production under PAC conditions is heterogeneous, distributed in small lots, with less hectares, and disperse in multiple communities; weed control is mechanical, there is chemical control of *Phytophthora capsici* with copper sulfate (2 kg/ha), and biweekly elimination of sick fruits, only during the harvesting period. Their agricultural processes are agroecological, they involve sustainable agricultural practices, short marketing circuits, and fair trade, more equivalent remuneration, although lower, minimal carbon footprint, use of agroforestry systems, greater biodiversity.

At the level of chocolate elaboration, the techniques are artisanal, derived from family transmission about their elaboration (for example, roasting is slow and "conchado" is long – mixing, milling and molding the chocolate dough continually for a prolonged period – nearly 72 hours, incorporating cocoa fat without additives), and there is limited technical training. There is no certification, because of its incidence in local markets. The benefits obtained under PAIDC, in terms of yield, are 1,082 kg/ha, obtaining net benefits of around 29,700 pesos (considering additional costs of 13,764.83 pesos). In turn, the benefits with PAC are yield of 228 kg/ha, with a net benefit of 8,744.60 pesos and additional costs of 1,980.66 pesos (Mendoza *et a*l., 2021; Ortíz-García *et al*., 2015; La casa del cocoa 2024).

Cocoa production is a wide extractive field for the market and control of local and regional agrifood systems, mainly due to its high connectivity with other agro-industrial systems: sugar, milk, vegetable fat, livestock feed, gastronomic use, agro-electrical sector, pharmaceutical and beauty industry, alcohol industry, decoration, container fabrication (Solano, 2023; UniAndes, 2021). And controlling this market means controlling what is consumed, and what is produced around it: how, when, where, with whom, with what inputs, and at what prices.

The construction of this agrifood system has caused tensions and disturbances in cocoa artisanal production systems. For example, the promotion of the Designation of Origin "Cacao Grijalva" benefited the private sector, excluding small-scale producers (Martínez, 2021). When standardization of productive processes was promoted in recent decades, such as cultivation techniques, varieties and inputs, the agro-industrial cocoa system was benefited, and technological transference in production was driven to homogenize the industrialization and production of the crop, and to increase its yields (Díaz-José *et al*., 2013).

However, this transference tends to mold the sociotechnical practices of traditional agriculture, reproducing agro-pedagogical models created for technological intensification and agricultural productivity, homogenizing the native germplasm and interrupting the pattern of family/inter-generational transmission of agricultural knowledge, and substituting it by a "teaching-learning" process that determines what to plant, how to plant, when to plant, and at what price to sell the cocoa harvests (and whom to sell it to) (Sosa, 2018; Azpeitia, 2020; Cárdenas *et al*., 2023).

This entails the existence of a structure of social relationships, where decisions about the productive process have been concentrating, weighing economic interests of the chocolate agroindustry, regulating the highly technological mode of cocoa production, in detriment of the traditional mode (Molina and Ramos, 2020), a formula derived from the Green Revolution.

Actors are always immersed and linked to an economic, social or legal system with scientific or technical advances that determine their formation and with which they deconstruct the homogeneous network context (Latour, 2008), generating and diversifying their own mechanisms of linking and transmission of knowledge and forms of production (Hernández *et al*., 2012). In traditional or artisanal agriculture of cocoa, this implies the configuration of networks for collaboration and agricultural production, from agroecological processes (Sevilla and Soler, 2009), meaning the emergence of small-scale cocoa groups, which have decided to continue reproducing these production processes from their ancestral worldview, through practices built along centuries of ecosystem understanding, improving biodiversity, and revaluing the cocoa agroecosystem in Chontalpa. Therefore, there are still traditional or artisanal cocoa production units, which resist adopting the conventional techniques of agroindustry (Programa de las Naciones Unidas para el Desarrollo -PNUD-, 2022; Fernández *et al*., 2023), seeking to recover a specific control around knowledge, foods, and financial benefits of the cocoa agricultural activity (Mateus, 2016).

Although peasant communities, in their organizational dynamics, do not escape the exercise of power and control, they always try to do it based on their own models of organization. An example of this is the emergence of base agroecological organizations, which developed their own historical processes (mobilization of actors, knowledge generation, collaboration, input procurement, generation of microbusinesses) and agroecology, through which a structural distribution of power between actors can be distinguished (Fernández, *et al*., 2023).

METHODOLOGY

This is a reality of the productive system of cocoa in the region of Chontalpa, Tabasco, which is integrated by the municipalities of Cárdenas, Comalcalco,

Cunduacán, Huimanguillo and Paraíso (Figure 2), located in the Mexican humid tropics, in the flatlands of Tabasco, with an altitude of no more than 25 masl, average temperature of 26.6 °C; the dominant climate is rainy tropical, with rainfall throughout the year (Af), in its septentrional area this climate is accentuated with Monsoon characteristics (Am); the average precipitation is 1,567.2 mm (INEGI, 2022). Although there are poor populations in this region, the level of regional marginalization is average (Consejo Nacional de Población-CONAPO, 2021).

To conduct this analysis, a mixed deductive method (Mendizábal, 2018) with structural approach was considered as basis. For this purpose, the following was used: a) specialized bibliographic review; b) non-probabilistic convenience method (Tamayo, 2000), applying a semi-structured interview in 2023 to a group of 8 artisanal cocoa producers (4 women and 4 men): small-scale cocoa producers with organic and agroecological methods, which have more than two generations in the cultivar production, generate their own marketing channels (short circuits), and participate the collective "Alternative cocoa and artisanal chocolate producers from Chontalpa"; the Tabasco census of cocoa producers was not used, since it lacks information about the number of alternative, organic or agroecological cocoa producers in the region. c) This

Source: prepared by the authors with data from the government of the state of Tabasco (2024).
Figure 2. Map, Municipalities of the region of Chontalpa, Tabasco, Mexico.

allowed obtaining much diverse relational information from the source, with relation to cocoa production. With the information obtained from the group of key informants, the exchange links of social inputs (financing, marketing, training, etc.) of 189 social actors involved in the artisanal cocoa production were identified, allowing the structural analysis of the following exchanges:

- Marketing of cocoa, chocolate and byproducts.
- Exchange of information about sales spaces, techniques, or local knowledge about cocoa.
- Training by technicians of the Sembrando Vida program: eradicating pests and diseases, natural fertilization, creation of nurseries, and post-harvesting transformation.
- Sale, loan or rental of land for cocoa cultivation.
- Labor relationships. Day laborers of the cocoa producing units.
- Associativity: group alliances between cocoa producers that are members of cooperative businesses or unregistered organizations.
- Family workforce participating in the production units.
- Consultancy about themes of economic financing and formalization of the brand registry, productive improvement and food safety, with the Ministry of Economic Development and Competitiveness (*Secretaría para el Desarrollo Económico y la Competitividad*, SEDEC) and Sembrando Vida.
- Connection with Colegio de Postgraduados (COLPOS): understanding agroecological techniques for cocoa.
- Spiritual. Participation in religious, ceremonial or healing activities with ecclesiastic and base groups in the Mayan region.
- Financing. Procurement of credit, loans or monetary support from the government and civil society (Ministry for Economic Development and Competitiveness –SEDEC-, Horizontes Creativos, and Sembrando Vida).
- Connection with strategic actors of the cocoa producing sector in the region, to obtain access to institutions or actors of the productive chain.
- Purchase, exchange and gifting of plants, seeds or cuttings with Nestlé, Hacienda La Joya and Sembrando Vida.
- Plagiarism. Stealing seeds or creations of their own: a chocolate company was an award-winner for cocoa from a woman producer, but she didn't receive the corresponding credit.

d) To analyze the relational values between actors of a community involved in a specific activity, with the case of cocoa producers from Chontalpa, the Social Network Analysis (SNA) was used. These values, also considered as attributes, allow distinguishing the structural behavior of the actors (Ávila, 2012; Kuz *et al*., 2016). Thus, this analysis made possible measuring patterns of social

organization through the conceptual apparatus of degree centrality (degree) and vector centrality (eigenvector) (Table 1). These measures allowed having a notion of the degree of influence or connection between cocoa producers. The elaboration of graphs was carried out with the UCINET-Netdraw software, version 6.581 (Borgatti *et al*., 2002).

RESULTS

Network of artisanal cocoa producers in Chontalpa, Tabasco

The organizational structure of a group of artisanal cocoa producers in Chontalpa, Tabasco, is characterized by the complex social composition of the inputs that are obtained from such a structure. In the case analyzed, these inputs were: marketing, collaboration, training, land acquisition, labor relationships, associativity, family relationships, technical counseling, academic accompaniment, and financial, public and spiritual relationships. This refers, at the same time, to a set of social actors (189 actors) linked through 257 relational arches, although only 9.52% were reciprocal relationships, indicating a low efficiency in the transfer of information and a limited clustering capacity, suggesting the presence of connection structures, differentiated

Table 1. Categories of centrality.

Indicator	Description
Nodal degree	Indicates the number of direct links of a specific actor, therefore, its degree of access to the information flow that is coming up in the social structure. The formula to determine it is: $d_i = \sum_{j \in V} A_{ij},\ \forall i \in V$ where D_i: Centrality (degree) of the actor in question and A_{ij}: Sum of the matrix that connects the nodes *i* and *j*
Eigenvector	Allows identifying actors connected to nodes with high degrees of centrality, therefore, determines the level of social influence that they have in the social structure. The values range from 0 (same level of centrality) to 1 (complete prominence). The formula is: $C_{vp}(j) = \sum_{i=1}^{n} A_{ij} C_{vp}(i)$ where $C_{vp}(j)$ is the centrality of the node and is defined as the weighted sum of centralities of all the nodes that are connected to it by an edge A_{ij}, therefore, C_{vp} is the eigenvector associated to set *A*.

Source: Wasserman and Faust, 2013; Hanneman, 2005; Ruhnau, 2000.

and hierarchical, around the exchange of information, understanding, and knowledge around cocoa.

Degree of communication in an artisanal cocoa production network

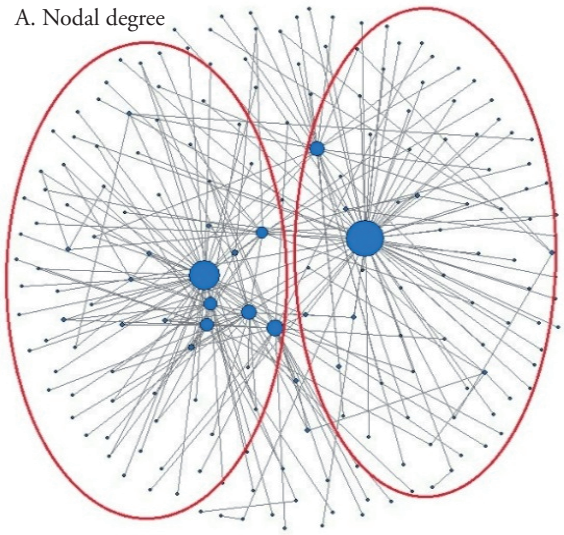
In the internal dynamics of these structures, the social prominence of the artisanal cocoa producers is also distributed in function of the degree of access to the information circulating in the network (Nodal Degree): considering the number of nodes in the social structure (189), the average of connections was 2.6 relationships per node, with a low average and indicating a circumstantial but centralized structure, with a much higher relational variability than the standard deviation. A consequence of this is the presence of 2 prominent actors and, in second place, a small group of actors separated into two sub-structures that manage the social prominence inside the general structure (Figure 3A).

When the gender attribute (masculine -blue- and feminine -pink) is distinguished (Figure 3B), it can be seen that: a) the masculine node has a higher number of links, suggesting a greater prominence by having a nodal network in various sectors; however, b) the feminine node has a more horizontal distribution of information in its structure, by having six nodes that are better connected, as a group of communication, with a more solid network. This node corresponds to a woman producer recognized due to the training she has received or shared with the rest of the cocoa producers. The social prominence is distributed in different levels of integration (Figure 3C): the most significant values are in the extreme right of the graph. When the gender variable is added, a rather equal participation in the structure is observed, accentuating the fact that women have power and relevance to shape this structure. In addition, it is clear that differences between the first-level nodes are very marked with the subsequent lower levels.

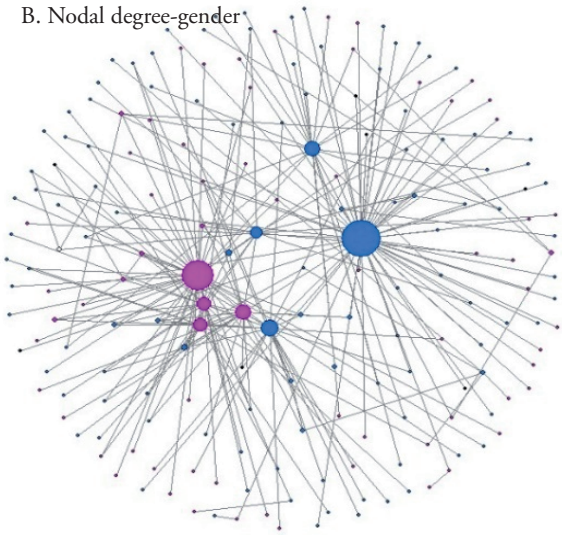
Popularity and cohesion in an artisanal cocoa production network

In the network of cocoa producers, these values were minimal, indicating hierarchical management of that capacity, although less centralized, so other actors are seen with a similar possibility of gaining access to similar levels of popularity to transmit the information (Figure 4). The person with highest eigenvector value, being a trainer, is considered as an agent of improvement and protector of knowledge, linking him to a level of productive practices and transformation of cocoa. In the second level, there are two nodes (pink and blue) with certain pertinence for information dissemination; in a third level, there are two feminine nodes close to the principal node and a third masculine node, which, together, also allow disseminating information to certain sectors of the network.

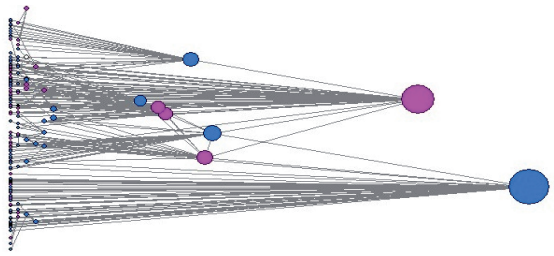
A. Nodal degree



B. Nodal degree-gender



C. Horizontal nodal degree



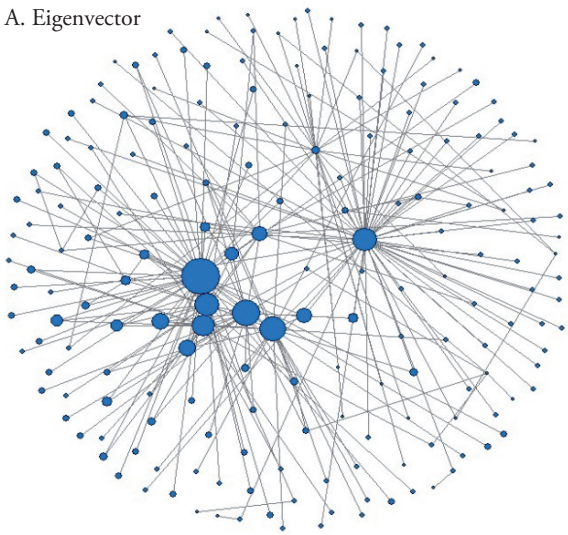
Descriptive statistics

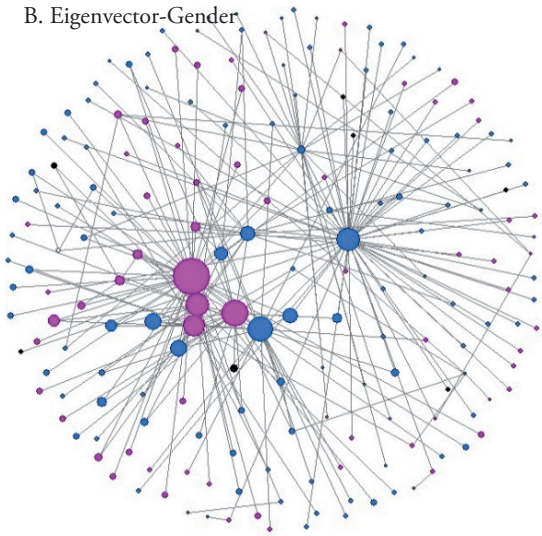
Opc	Nodal degree
Mean	2.6
Std Dev	6.6
Variance	43.5
Minimum	1
Maximum	61
N of Obs	189

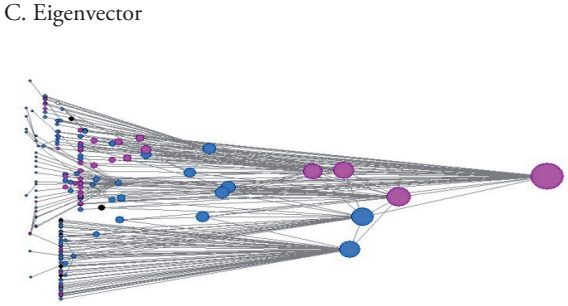
Source: prepared by the authors.
Figure 3. Hierarchization, gender, and nodal degree in an artisanal cocoa production network, Chontalpa region 2023.

Proposing a diversity of social values of the actors of this community of cocoa producers, a composition of areas and sectors that are influenced irregularly between one another is suggested, generating a complex organizational and "endemic" game of the community analyzed (Table 2).

This allowed opting for a structural distribution of the nodes based on a similar social length between all the components, making it possible to observe the different functions of the various institutional actors. For example, the links given through counseling (purple), were conducted by research institutions (circle), grouping (downward triangle), private companies (shape), chocolate shops (circle in a box), and producers (square); in turn, the theme of public relationships (red color), happened through connections with Civil Organization (diamond) and public institutions (upward triangle). This combination of visualizations allowed







Estadísticos descriptivo

Opc	Eigenvector
Mean	0.042
Std Dev	0.059
Variance	0.004
Minimum	0.001
Maximum	0.498
N of Obs	189

Source: prepared by the authors.
Figure 4. Degree of popularity and cohesion in an artisanal cocoa production network, Chontalpa region 2023.

observing the prominence of grouping (downward triangle) and research institutions (circle), as nodes of social connection, therefore, inputs for counseling or training as elements of integration inside the network of cocoa producers (Figure 5).

Regarding this, it is important to understand the integration of various actors, because of social cohesion processes inside the social structures. These are elements that strengthen communities, although they can also be infringed upon. For example, when the possible scenario of the absence of the nodes with greater centrality is suggested (Figure 6), this caused the fall in the information flow between nodes and the capacity for diffusion: the average of the nodal value was displaced from 2.6 to 1.5; the capacity for dissemination of information went from 0.042 to 0.032 and the connection capacity from 48.7 to 6.6.

Table 2. Social and institutional complexity in a social network of the artisanal cocoa productive system, Chontalpa region 2023.

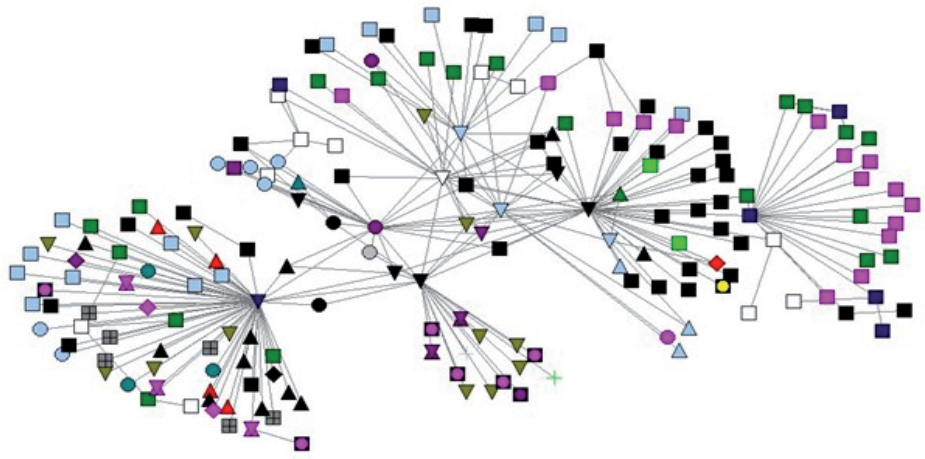
Values of the institution/actor		Type of /link	Chromatic value
Academic-research	Circle	Marketing	
Producers	Square	Collaboration	
Public institutions	Upward triangle	Training	
Spiritual	Box	Land acquisition	
Grouping	Downward triangle	Labor	
Chocolate shop	Circle in the box	Associativity	
Civil org.	Diamond	Family	
Farmers	Cross	Counseling	
Private company	Shape	Academic-researcher	
Health system	Rounded square	Spiritual	
		Financing	
		Public relationships	
		Plant acquisition	
		Plagiarism	

Source: prepared by the authors.

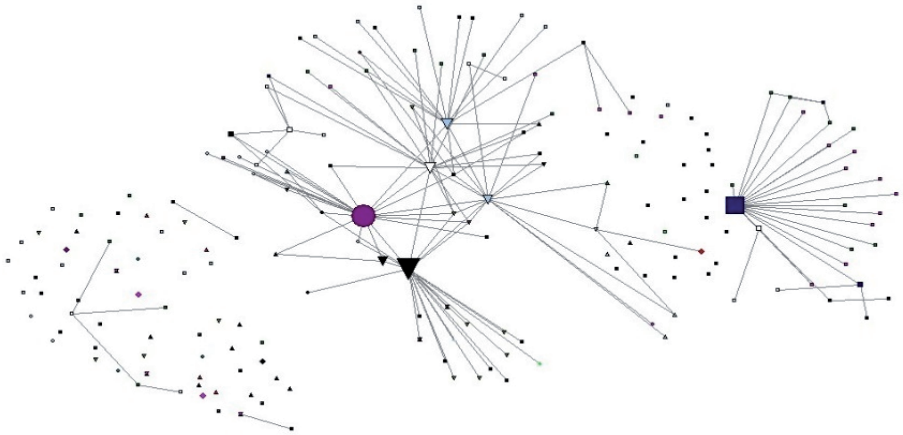
DISCUSSION

Structural vulnerability in an artisanal cocoa production network

According to Foucault (2016; 2012) and Bourdieu (2012), hegemonic processes of the agrifood system, by managing to regulate and legalize both production, market and consumption of foods, end up affecting natural resources, redirecting, again and again, peasant communities towards a growing



Source: prepared by the authors.
Figure 5. Distribution of the socio-institutional complexity in a social network of the artisanal cocoa production system, Chontalpa region 2023.



Source: prepared by the authors.
Figure 6. Structural hypothesis of the artisanal cocoa production system, Chontalpa region 2023.

dependence on the market of technological inputs, generating a model of control of the soil, water, seeds, inputs, machinery, and technology.

However, this agrifood system has a counterpart in traditional and artisanal production processes, since rural communities, by generating their own network formulas (Latour, 2008), break with this doxa imposed from the agrifood system. And this is achieved with the development of agroecological processes: of lower energetic cost, with the conformation of broad social networks of exchange of understanding, knowledge, and technologies (FAO, 2007), as well as the recovery of traditional or artisanal processes, incorporating new organizational models (short circuits, short value chains, social and solidary economy, local markets, etc.). This allows thinking, from rural communities, about the possibility of a redistribution in the appropriation of natural and agro-biocultural resources, according to what was suggested by Méndez *et al.* (2013) and González and Caporal (2013).

Therefore, the artisanal cocoa production process (PAC) is circumscribed within a broad social and political mobilization, around the processes of recovery and conservation of understanding, technologies and knowledge of traditional peasant agriculture, with the aim of recovering a more realistic role in the control of traditional and artisanal agricultural systems, as well as their byproducts and benefits (Mateus, 2016).

In this direction, artisanal cocoa producing communities reveal themselves as social structures, where the producers themselves generate mutually differentiated and hierarchical processes in access to information, allowing them to be identified as a network of knowledge exchange around cocoa. With regards to the nodal degree (dissemination), a group of social actors was

observed, which are the ones that motivate the configuration and connection of this network, in topics of marketing, training, counseling, and financing, giving them a significant social prominence, by recognizing which type of information is flowing in the network around cocoa, giving them the possibility of managing that information flow: a) the first actor is a woman producer recognized for training that she has received or shared with the rest of the cocoa producers, who has higher popularity and ability to disseminate information horizontally. This node, as community trainer, is considered as agent for improvement and protector of knowledge, connecting her at the level of practices for production and transformation of cocoa; b) the second actor centralizes an entire social structure, has a large capacity for disseminating knowledge about cocoa in that area, is a community and business leader around the artisanal production of cocoa.

In community structural systems of rural producers, the inputs of trust and communication are complex and fragile, being generated on a recurrent basis of social reciprocity, so their strength depends on their transitive capacity to manage and distribute strategic inputs (training, counseling, financing, equipment, infrastructure, markets, etc.) (Núñez-Espinoza *et al.*, 2021). In the case of the network of cocoa producers, this capacity is managed in a differentiated way, generating nodes with greater potential to manage the social inputs.

In this sense, since it is a node with many connections, it helps to be up to date in the topics of importance in the network, although in the cocoa producers' community, the social weight of this quality is so concentrated and distributed in a hierarchical way that the separation between the main node and the other values express structural inequality and vulnerability, evidencing a degree of inconsistency in the network: its organizational dynamics also entail a centralization in decision-making, increasing its degree of instability, and by doing without the values with highest degree of centrality, social intertwining, it is weakened and a clear vulnerability in the rural communities is exposed. The removal of the two main nodes caused the collapse of the network structure: access to information, dissemination of information and connection between nodes, moved towards minimal values, generating a grave loss of information and integration of channels for training or cocoa marketing.

CONCLUSIONS

In the region of Chontalpa, Tabasco, small-scale artisanal cocoa producers generate community social structures, which serve as mechanisms for communication and management of diverse forms of organization, producing dynamics of connection (between actors, companies and local institutions), decision making, local influence, and exchange and transmission of information,

knowledge and traditional agroecological knowledge. However, these actors also generate highly centralized and vulnerable structures, so when socially prominent actors of the network are exempt, it becomes disconnected, causing the loss of information, disarticulating channels for training or cocoa marketing, and directly affecting producers with lower capacity for connection.

Given this, the suggestion is to develop support policies to strengthen the social capital of artisanal cocoa producers, as well as their autonomous strategic alliances. Their importance is because: a) they are depositaries of artisanal and sustainable processes in cocoa production, and b) they generate particular social formulas that allow them to mitigate social inequalities in local and artisanal productive chains under specific circumstances.

It is not obvious that the complexity of each history on the artisanal production of cocoa exceeds the huge limitations of this document. Therefore, the objective set out was partially covered. However, this analysis is proposed as a fragmentary approach to the underlying structural complexity of cocoa producing communities in Chontalpa, Tabasco.

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