Economia agro-alimentare /
Food Economy

An International Journal on Agricultural and Food Systems

Vol. 22, Iss. 1, Art. 5, pp. 1-24 - ISSN 1126-1668 - ISSNe 1972-4802
DOI: 10.3280/ecag1-2020oa10066

Protected-Denomination-of-Origin Cocoa Bean: Chain governance and Sustainability Performance

Carlos Moreno Miranda[*,a], **Raúl Moreno**[b], **Pablo Moreno**[c]

[a] Wageningen University & Research, The Netherlands
[b] Universitat de Barcelona, Spain
[c] Technical University of Ambato, Ecuador

Abstract

The Protected Denominations of Origin in agricultural goods through recognized chains, have a fundamental economic role. In Ecuador, the PDO cocoa bean certification becomes a protagonist since it presents an opportunity to boost the social performance of smallholders. A substantial amount of research focused only on examining the crop performance of PDO products. However, there is a shift in the agricultural chain perspective towards more sustainable models. In this respect, social, economic, and institutional aspects are consequential and tribute to the agricultural sector development. Also, the current rise of market opportunities at the local and international levels is a driver to support them. This study aimed to analyze socio-economic and governance components to understand the PDO Cocoa Arriba (*Theobroma cacao*) chain sustainability performance and bring forward potential strategies. Principal Components Analysis was introduced to contribute with relevant insights. The framework applied accounts with a revision of primary and support activities. The investigation clustered pre-production, production, and post-production tiers. Also, it executed the food chain mapping and identification of chain actors. Results stated several viable long-term strategies. Examples of those strategies are the enhancement of national regulation to assist chain

Article info

Type:
Article
Submitted:
18/09/2019
Accepted:
08/04/2020

JEL codes:
Q18, N56, L17

Key words:
Socio-economic
Agricultural regulation
Rural farming
Governance structure

* *Corresponding author*: Carlos Moreno Miranda - Department of Agricultural Economics and Rural Policy - Wageningen University & Research - WUR, The Netherlands - E-mail: carlos.morenomiranda@wur.nl.

actors and the stimulus of young producers and associations empowerment. The main research contribution is the application of governance mechanisms to assess the chain performance comprehensively. Based on the results, our recommendation is to incorporate new indicators to analyze the environmental and institutional components profoundly.

Introduction

Cocoa (*Theobroma cacao L.*) is cultivated mainly in Latin American countries and represents an important crop worldwide, for both industrialized and commodity markets (Rusconi & Conti, 2010). African countries have led world production in recent years (Abbey *et al.*, 2016; Ton *et al.*, 2008). According to the latest estimates of the United Nations Food and Agriculture Organization, world production of cocoa is more than 4,600,000 tons per year, resulting from around 1.200,000 ha of cultivated land (Food and Agriculture Organization – FAO, 2000). Nigeria, Indonesia, Ghana, and Cote D'Ivoire are the primary producers of cocoa, making up 67% of total world production (Alemagi *et al.*, 2015). Ecuador, with an output of 270,000 tons, placed ninth in the world ranking of cocoa-producing countries (Petithuguenin & Roche, 1995). In 2016, Ecuador was Latin America's largest producer, making up 35% of cocoa production (Ministry of Agriculture – MAG, 2018). However, in recent years, the Ecuadorian cocoa market faced troubles, and smallholders fell victim to price volatility and poor contingency strategies to manage risk. This risk resulted in a deceleration of 5%, as compared to the 3.8% growth it had experienced during the 2015 fiscal year (Kozicka *et al.*, 2018).

According to the Ministry of Agriculture – MAG census (Ministry of Agriculture – MAG, 2015), the Ecuadorian coastal region is the central location of cocoa production, contributing more than 70% of the Ecuadorian output. Los Ríos and Guayas provinces account for the most extended surface area, covering around 35% of the total cocoa crop area. Ecuador grows two varieties of cocoa, Arriba that owns a deep floral-fruity aroma, and it cultivated in Los Ríos province; and CCN-51 a cloned variety for high productivity, represent 30 and 70 percent of production, respectively (ANECACAO, 2017). Nevertheless, the reality of Cocoa Arriba production reveals a weak business model that brings short-term instability. For example, research showed a lack of appropriate remuneration to producers, and insufficient producer prices to compensate production costs (Sepúlveda *et al.*, 2018). The United Nations Development Program UNDP-Ecuador (Nicita *et al.*, 2013) reported the consequences of this, including rural migration, which is between 1.5% and 2.5% per year, as well as an increase in the

agricultural frontier, which causes a deforestation rate between 3.5% and 5% per year (Portalanza *et al.*, 2019). Therefore, specific instruments promoting sustainable chains are vital (Belletti *et al.*, 2017). The Protected-Designation-of-Origin (PDO) tool, a name of a particular area that recognizes official rules to produce certain foods with unique characteristics, aligns with the spirit of the regulation (Fournier *et al.*, 2018), which aims to increase small producers' welfare, and is coherent with sustainable governance mechanisms.

The Ecuadorian PDO cocoa is known as "Cacao Arriba", and it is the symbolic product of Ecuador. During 2002, the Ministry of Agriculture led a process of Cocoa Arriba revaluation, through the project "Recovery of Production and Improvement of the Quality of National Cocoa"(Macías *et al.*, 2019). In 2007, Ecuador submitted the designation of origin (DO) application for Cocoa Arriba, and it was approved in 2013 (Collinson & Leon, 2000). Today, Ecuador has the most significant world market share of Cocoa Arriba (63%). Its recognition by the international industry is due to its sensory characteristics (fruity and floral flavors); however, estimates indicate that less than 28% of cocoa exports correspond to Arriba cocoa (Pino *et al.*, 2018). Thus, Cocoa Arriba PDO production is an essential alternative crop, able to underpin sustainability and rural development in agricultural sectors. Various authors argue that studies have only addressed agronomic aspects, such as post-harvest practices and pest management, but lack an integrated perspective. This perspective would include PDO standards application, economic evaluation, and social implications, which underline existing shortcomings (Argüello *et al.*, 2019). Understanding gaps between standards and chain-level practices are paramount to assess the potential for sustainable governance and to drive the transformation in agri-food chains.

In such a context, the present article aims to contribute by addressing two research questions. The first RQ is *how is the Cocoa Arriba PDO chain different from the CCN-51 cocoa chain in terms of socio-economic performance?* The last RQ is *what kind of governance mechanism does the Cocoa Arriba PDO chain describe, and what sets it apart from the CCN-51 cocoa chain?* As such, the study hopes to further our understanding of the socio-economic sustainability assessment and the relevant insight it might provide regarding the cocoa PDO chain. It focused on Los Ríos province since it covers most of the Cocoa Arriba production in Ecuador.

1. Theoretical Framework

Value Chain Approach and Governance

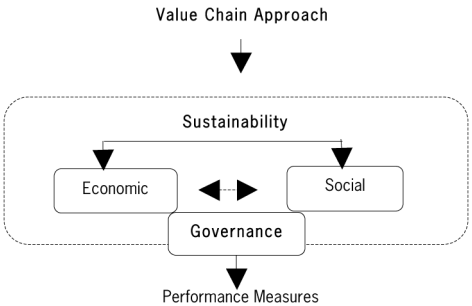
A value chain divides into two central elements. The chain component refers to the linkage and the relationship between the stages from pre-

production to the consumption stage (Council of Supply Chain Management Professionals – CSCMP, 2010). The value component refers to the process by which actors add utility to a potential value proposal (Ballou *et al.*, 2000; Lanka *et al.*, 2017). The scientific community uses the "chain approach" for a better understanding of sector dynamics. However, how chain actors add value depends on competencies (Koc & Bozdag, 2017). Those competencies can be retained if chain performance employs proper governance mechanisms. A governance mechanism describes how the practices and processes of chain actors are coordinated (Gereffi *et al.*, 2005b). Types of governance are market, modular, relational, captive, and hierarchy (Gereffi *et al.*, 2005b). The operability of these mechanisms depends on the coordination devices they own, and the degree of power asymmetry. For example, market governance depends on prices, and shows low power asymmetry, whereas hierarchy uses flows of information to coordinate activities. From a sustainability perspective, "value chain" has more appeal, since it encourages a full-lifecycle view. The geographical scope of this outlook allows the establishment of boundaries for a better examination (Lamine *et al.*, 2012). Political, economic, and environmental aspects of a chain engage scholars and practitioners because of the existing complexity (Dotoli *et al.*, 2005; Shleifer, 2005).

Sustainability and Agri-food Network

Sustainability aims to "meet the needs of the present without compromise the ability of future generations to meet their own needs" (WCED, 1987). When sustainability is applied to agri-food scenarios, it mainly focuses on biophysical approaches (Stoorvogel *et al.*, 2004b; Yakovleva, 2007a). Common findings from these studies suggest that environmental challenges are the central barrier preventing a sustainable development of agriculture (Carter & Liane Easton, 2011; Salmoral *et al.*, 2017). However, sustainability in the context of an agri-food chain depends on trade-offs between social welfare and economic growth (Ruiz *et al.*, 2014). The former concerns the life quality of actors and includes local purchases, local hiring, supporting local community events, the impact of products on society, and business dealings with ethical policies (Smetana *et al.*, 2016). The economic aspect explains the distribution of wealth across the stages (Tuesta *et al.*, 2017). Thus, a food system perspective is vital since it groups the elements as a whole and examines their dynamic in an open or closed scenario (Barbier, 2016). A closed setting does not interface with the environment, and knowledge flows within a closed circuit (Andres & Bhullar, 2016). An open scenario interacts with its environment by giving and receiving information (Chaparro, 2017). As such, we would expect a socio-economic performance to improve sustainability practices. Figure 1 shows the scientific basis of the framework used to assess the sustainability of Arriba and CCN-51 cocoa chains.

Figure 1 - Sustainability assessment framework



Protected Denomination of Origin "Cocoa Arriba"

The cocoa Arriba is produced widely in Ecuador and has unique genetic characteristics (Ecuadorian Association of Cocoa Exporters – ANECACAO, 2017). Researchers have tried to propagate it; even so, the plant has not developed either provided a product with the characteristic floral flavor (Pustjens *et al*., 2016). Research attributes its unique features to the Ecuadorian weather and soil conditions (Gateau-Rey *et al*., 2018). The production takes place in the equatorial zone at an altitude between cero and 1,200 meters above sea level (Estupiñán, 2018). This zone locates between latitudes 01° 27' 06 "N and 05° 00' 56" S and longitude 75° 11'49 "W to 81° 00'40" W. Also, it has a humid climate with rainfall of 2,000 to 4,000 mm, with slight variations, due to the small mountain ranges that modify the weather slightly. The word "*Arriba"* emerged in the colonial period, where Ecuador divided itself into four ecological zones (Arevalo, 2016). The Arriba zone comprised Guayas and Los Ríos provinces, which are the current leaders of Cocoa Arriba production (Pino *et al*., 2018). The following is a detailed map of the geographical area where cocoa Arriba is currently grown and produced (see Figure 2).

In the country, there are shortcomings in regulations of protected denominations of origin – PDO (National Institute of Intellectual Property – IEPI, 2019). In the precise control absence on the use of Ecuadorian PDO, the cocoa sector suffers permanent threats on economic, market, and sustainability terms (IICA, 2014; Ogus, 1992, 1994). The International Regulations Agreement on Trade-Related Aspects of Intellectual Property Rights – TRIPS –. R.O. No. 977, June 28/1996 and the Paris Convention for the Protection of Industrial Property. R.O. No. 244, July 29, 1999, supported the process of Cacao Arriba PDO legalization (IICA, 2014). Also, the Andean regulations Normative Decision 486 of the Cartagena Agreement of the

Figure 2 - Map of geographical area of Arriva cocoa cultivars in Ecuador

Table 1 - Standards of Cacao Arriba PDO and CCN-51

			Cocoa Arriba					CCN-51
	Requirement	Unit	ASSPS	ASSS	ASS	ASN	ASE	
Fermentation	One hundred of grains	g	135-140	130-135	120-125	110-115	105-110	135-140
	Good	%	75	65	60	44	26	65 ***
	Slight*	%	10	10	5	10	27	11
	Total	%	85	75	65	54	53	76
Biophysical	Violet	%	10	15	21	25	25	18
	Slaty	%	4	9	12	18	18	5
	Mould	%	1	1	2	3	4	1
Total number of defects (over 500 g)		%	0	0	1	3	4 **	1

Note: * brown colour, with pale violet zones, ** presence of rough rice only for the ASE type, and *** colour varying from brown to violet.
Source: Ecuadorian Institute of Intellectual Property – IEPI (2010).

Common Regime on Industrial Property R.O. No. 258, February 2, 2001, contributed to the process. Besides, the Ecuadorian Institute of Intellectual Property (IEPI) established the Cacao Arriba PDO standard (Table 1). "The standard technique allows an activity to take place without any ex-ante control, but the supplier who fails to meet the standards perpetrates an infringement" (Ogus, Geoforum, 1999: 225). The existing standards of Cocoa Arriba are INEN 176 and 177. However, the Inter-American Institute for Cooperation on Agriculture argued this Cocoa Arriba PDO standard requires a specific rule to guarantee the quality of the four types of the Ecuadorian Cacao Arriba (Aidoo & Fromm, 2015). These types are a) ASSPS – Arriba superior summer plantation selecta, b) ASSS – Arriba superior summer selecto, c) ASS – Arriba superior selecto, d) ASN – Arriba superior navidad and e) Arriba superior época.

2. Materials and methods

Research region

The study focused on the *Buena Fe* district in Los Ríos province, located in the coastal region. The zone has a total area of 6254 km^2 and a maximum altitude of 520 meters above sea level. Los Ríos presents a variety of climates from tropical humid to semi-humid. The average temperature is from 12 to 25 °C. The interest of Cocoa Arriba, and CCN-51 chains is because of their diversity in terms of market opportunities and peasant farming participation. Also, they are relevant due to their sustainability issues such as efficiency performance and farmers' welfare. This sector covers both conventional and emerging chains. The CCN-51 chain is traditional, with a secure positioning in local and district distribution markets. Cacao Arriba is an emerging chain because its demand consolidates slowly in the global chocolate industry. The methodology applied includes phases and tools detailed below:

1. Identification of value chain actors. This phase employed the information from the last census (2015) conducted by the Ministry of Agriculture – MAG. Also, it analyzed the post-production actors by examining the record of SMEs and large companies submitted by the Ministry of Industries and Productivity (MIPRO).
2. Sample size description. The experiment used the continuous variable "number of producers registered by MAG" to estimate the sample size of producers. Also, it applied the Sukhatme formula (Sukhatme, 1954) at the 95% confidence level. During the fieldwork, we surveyed 250 cocoa farmers of each cocoa chain (Arriba and CCN-51).
3. Chain Characterization. Beforehand, the experimental phase executed a workshop with stakeholders to select performance variables from a

predetermined list. The list considered productive and socio-economic factors. Also, it constructed surveys validated by Cronbach's alpha index to collect data from the selected locations. The analysis of data used descriptive statistical tools to present the findings and a chain mapping by employing Hawkes and Ruel scheme (Hawkes & Ruel, 2011).

4. Sustainability Analysis. In this phase, we applied Principal Component Analysis – PCA, which is a methodology developed by Karl Pearson (Jolliffe, 2002). The technique includes a correlation analysis and the standardization of variables. Besides, it built orthogonal variables (Z-scores) from the original ones to eliminate the effect of scales. The unification used the following expression:

$$Z_{ij} = \frac{x_{ij} - \mu_j}{\sigma_j}$$

With the orthogonal variables obtained from the PCA, we performed a multidimensional analysis to explain the performance of the chain under study.

3. Results

3.1. *Sectioning of value chain actors*

Table 2 shows the information provided by the Ministry of Agriculture about the production stage. The data accounted for 4.2% of cocoa-producing families. According to surveyed producers, the area stands out because its rivers and mountains promote a variety of climatic floors favoring the crops' development.

Table 2 - Number of producers and cocoa production area

Province	District	Number of producer families	Area of production (ha)
Los Rios	Buena Fe	1220	1884.5
	Ventanas	630	1025.2
	Vinces	470	821.4

Source: Ministry of Agriculture – MAG (2015).

3.2. *Sustainability characterization*

Socio-demographic characteristic of producing families

Table 3 states the socio-demographic characteristics of the respondents. Most of the participants at the CCN-51 chain were between 26 and 40 years old (54.6%). In the case of the Arriba chain, producers who were 41 to 55

Table 3 - Socio-economic characteristics of cocoa-producing families

		Proportion		
Variable	**Mean**	**CCN-51**	**Arriba**	**Difference (*p*)**
Gender (n = 250)				
Female		52.0	64.0	
Male		48.0	36.0	
Age (head of family) (n = 250)				
<18 años	17	2.5	1.9	0.057 *
19-25 años	23	14.6	4.7	0.048 **
26-40 años	34	54.6	8.2	0.028 **
41-55 años	46	17.6	64.2	0.039 **
56-65 años	59	8.2	13.7	0.025 **
>66 años	68	2.5	7.3	0.435
Education (head of family) (n = 250)				
Primary		12.4	22.5	
Secundary		48.1	51.3	
College		39.5	26.2	
Associativity (households) (n = 250)				
Members		44.9	57.4	
Non-members		55.1	42.6	
Montly household income (n = 250)				
< 700 USD	625	11.4	14.6	0.001 ***
701-1000 USD	830	19.6	34.5	0.021 **
1001-1300 USD	1220	25.2	29.7	0.027 **
1301-1700 USD	1580	38.3	17.8	0.032 **
>1700 USD	1950	5.5	3.4	0.001 ***

Note: Difference (*p*) represents the p-value significance of two population t-test with unequal sample sizes and unequal variances: *** for $p < 0.01$, ** for $p < 0.05$, and * for $p < 0.1$.

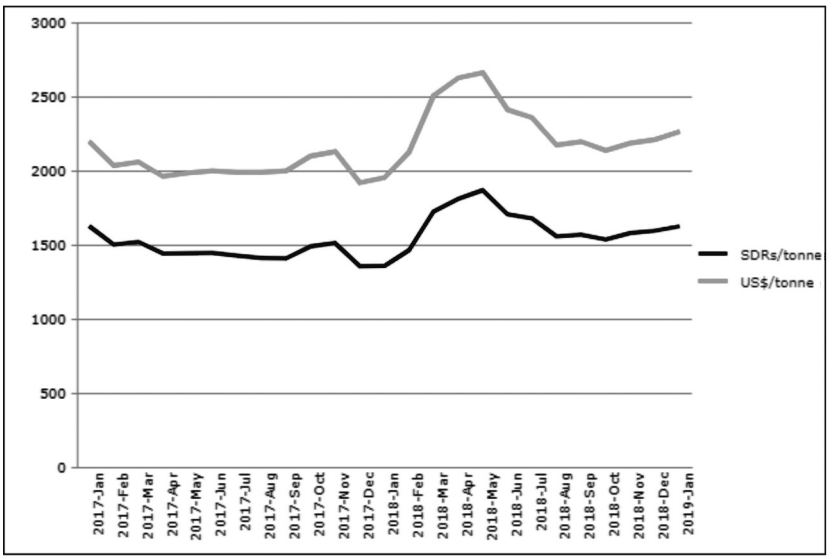
years old represented 64.2% of the respondents. Also, there was a difference in education level, since a high proportion of participants (39.5%), belonging to the CCN-51 chain reported a college education. However, more than 50% of Arriba producers only reported a high-school level of education. It is noteworthy that interviewees responded to crop management questions with a high level of knowledge. This aspect is because a large proportion (more than 50%) of producers of both chains followed agricultural science programs (Díaz-Montenegro *et al.*, 2018). Regarding monthly income, most Arriba producers reported a range between 701-1000 USD (34.5%), and CCN-51 producers presented a range between 1301-1700 USD (38.3%).

The average number of household members was 3.7 in both chains, and 63% of respondents reside in the Buena Fé district. According to the National Institute of Statistics and Census (INEC), the average number of members per household in Ecuador is 2.7, and the average monthly income was 450 USD in 2018 (Viteri *et al.*, 2018). Therefore, the sample demonstrated better representativeness in terms of the average salary of a household member.

Chain Actors: influencers/Enablers

Outcomes showed the intervention of chain influencers, such as public entities, advisors, and private agro-centers. These actors aimed to provide technical advice to producers during crop management. Peasant families were the first enabler cluster identified and were responsible for channeling the harvest to collection centers and distributors. The main difference identified was the crop volume of Arriba cocoa, which is 20% of the crop volume of CCN-51 cocoa. Also, exports of dried Cocoa CCN-51 are above 35% of Arriba cocoa exports. However, exports of liquor are the opposite; Arriba liquor exports are 21% greater than CCN-51 liquor. Processors, the second enabler cluster, transform the raw material (dried cocoa) into liquor or paste. Outcomes also identified dealers (third enabler cluster) strategically located in areas close to the plantations, which aimed to link processors and producers, thus dynamizing the trade. The primary goods sold by the CCN-51 chain are dried cocoa and nibs, while the Arriba chain sold mainly cocoa paste. The Central Bank (external influencer) established the reference prices for the commercialization of liquor and dried cocoa, based on the New York Stock Exchange and the International Cocoa Organization (ICCO) (see Figure 3).

Figure 3 - Monthly averages of daily prices



Source: International Cocoa Organization – ICO, (2019).

Functions of Chain levels

In the pre-production stage, outcomes showed the presence of private greenhouses, responsible for the supply of seedlings. In the production stage, actors paid great attention to climatic conditions for crop planning. Also, respondents pointed out December and May as the best cultivation time due to an increase in rainfall and temperature. It is noteworthy that crops require shade to achieve an optimum level of production. Another essential requirement is surface cleaning – the elimination of pests and weeds. Bush pruning is necessary after the first year of crop life. It is common to see producers plan the harvest stage in two phases, the first to collect Arriba cocoa in winter, and the second to harvest CCN-51 cocoa in summer. Producers performed the harvest at intervals of 10 to 15 days. Subsequent stages are fermentation, drying, and grain bagging. The sector's humidity and temperature helped the fermentation process, while the drying process took place at collection points. Producers dried the cocoa using solar energy, while collection points used gas dryers. The international market appreciates solar drying due to its sustainable orientation.

Roasting and shelling are the main steps in the transformation of cocoa beans. Roasting potentiates aroma and flavor, and husking separates the crust

from the almond. The final husked product is called the nib. Nibs are ground to obtain a thick paste, which is refined and later distributed as a semi-processed product. The primary demand of cocoa paste takes place in the confectionery sector, and its monetary value ranges between 10.00 and 15.00 USD/kg in the case of CCN-51 cocoa, and between 13.00 and 20.00 USD/kg in the case of Arriba cocoa. The pastry, baking, and catering sectors are the principal applicants for the refined paste. Cost ranges between 8.00 and 10.00 USD/kg in the case of CCN-51 cocoa, and between 15.00 and 25.00 USD/kg in the case of Arriba cocoa (see Figure 2). At the marketing stage, small intermediaries promote cocoa and supply the grain to small businesses and artisans.

Flows of resources

Outcomes identified two types of streams, classified as high and low importance. The cocoa trajectories used the high-relevance streams (HRSs) and took place at production, fermentation, and drying activities. In this sense, the quality standards of cocoa set up by the Ecuadorian Standardization Service (INEN) (see Table 4), play an essential role, due to local market requirements. The HRSs held during commercialization and transformation. The social, environmental, and political interests of cocoa derivatives are increasing; however, their quality standards, established by INEN through standards 175, 176, and 177, need revision, to boost their market growth (2.2 to 3.5 percent per year).

Table 4 - Biophysical standards of cocoa

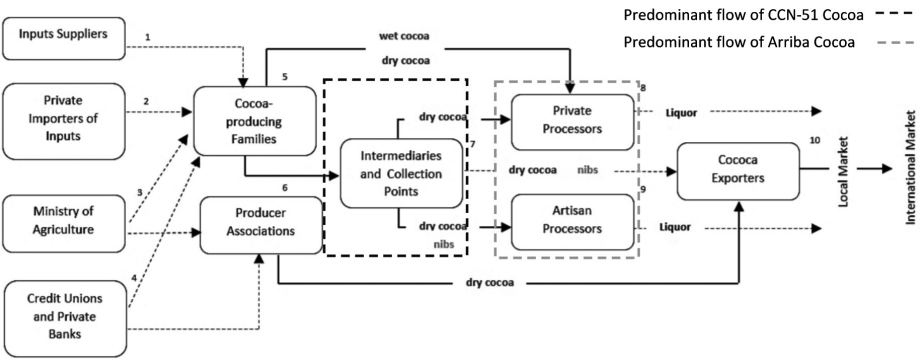
	Standard	
Type of grain	Degree I	Degree II
Moldy	Max. 3%	Max. 4%
Slaty	Max. 3%	Max. 8%
Flattened, blossomed or insects affection	Max. in total 3%	Max. in total 6%

Source: Ecuadorian Standardization Service – INEN (2006).

The low-relevance streams (LRSs) took place during supporting activities (Ding & Chen, 2008). The first flow was the financial one, and its supporters were public and private banking entities and credit unions. Outcomes showed financing programs, with facilities with access to microcredits. The flow of information was also essential. Technical and marketing information was in high demand from actors. Ministry of Agriculture and the Institute of Agricultural Research (**iniap**) were the leading providers. However, there were also private

organizations focused on disseminating aspects of prices and marketing opportunities. Figure 4 shows the mapping of all the components analyzed.

Figure 4 - Mapping of the Cocoa Chain at Los Ríos District



3.3. *Chain governance*

We examined governance, information-coding mechanisms, the complexity of the inter-firm information transfer, and the level of competence of actors. The study identified the following:

- market governance. The CCN-51 chain reported this scenario and characterized it, because governing bodies, such as farmers (suppliers) and dealers (intermediaries), performed repetitive transactions easily codified within exchange environments, such as district markets. The most common district markets close to Buena Fe are Quevedo, Ambato, and Guayaquil. Cash payments or contracts with short credit periods, no more than eight days, were the primary business coordination mechanisms. Also, transactional costs existed, which evidenced failures during logistics and commercialization (See Figure 5);
- modular governance. The Arriba chain demonstrated a setting whose transactions were codified by following a significant level of complexity. In this scenario, it is easy to observe a sort of power market imposed by governing bodies, such as processors and dealers. These actors set product specifications, credit periods, and buying prices for producers through contracts. Besides, liquor and nibs processors acquired generic machinery, to reduce the risk of investment. The most common acquisitions are refiners, molders, and peelers. The relationships between actors are relevant due to the high volume of local and global market information transferred, as well as technical procedures (See Figure 6).

Figure 5 - Governance mechanism at CCN-51 cacao chain

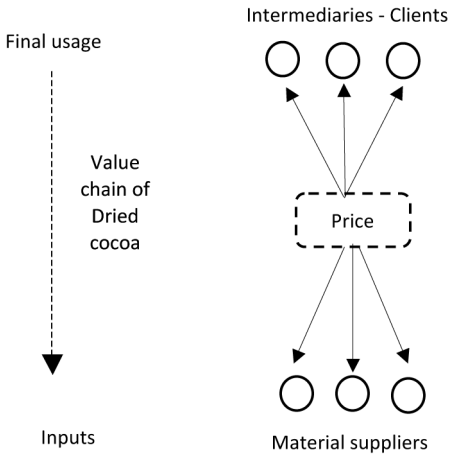
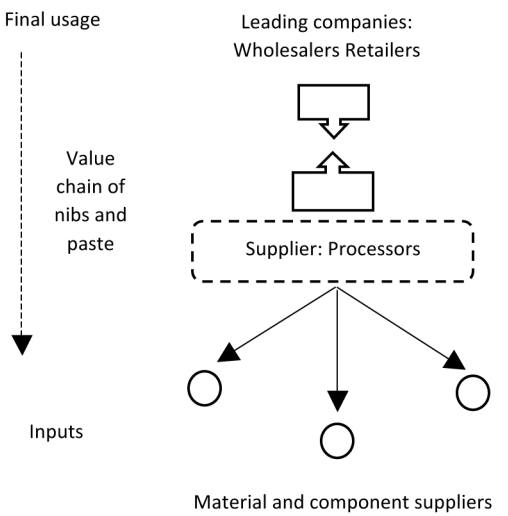


Figure 6 - Governance mechanism at Arriba chain



Producer perception and socio-economic variables

The experiment examined the cocoa producers' performance in both chains, to elucidate socio-economic and production aspects. We applied a Principal Components Analysis on the 12 primary variables. The details of the variables studied are in Table 5. The components (KMO = 0.818, Bartlett's

test χ^2 sig. 0.000) arose with values greater than 1, satisfactorily explaining 70.22% of the total variance.

Table 5 - Producer perception of the relative importance of productive performance aspects

	Relative frequency					Aggregate score	
Variable	**Fully not relevant**	**Not relevant**	**Neutral**	**Very relevant**	**Extremely relevant**	**Mean**	**S.D**
Acreage	2.2	1.5	14.3	38.1	43.9	4.31	0.85
Cocoa acreage	2.1	3.7	19.2	40.3	34.6	4.27	0.77
Production cost	2.5	4.5	28.2	38.9	25.9	3.69	0.89
Yields	3.1	4.9	33.7	36.2	22.1	3.55	0.92
Financing	2.5	5.9	38.1	32.5	21.0	3.69	0.91
Land tenure	2.9	5.7	40.2	34.9	16.3	3.67	0.88
Price	1.5	3.2	38.7	36.5	20.1	3.66	0.91
Cocoa variety	1.3	9.8	32.6	38.2	18.1	3.63	0.95
Cultivation technique	9.4	12.5	26.3	30.7	21.1	3.58	2.47
Additional crops	4.5	10.2	31.8	34.3	19.2	3.58	0.77
Post harvest practices	2.5	19.7	38.1	25.9	13.8	2.98	0.84
Associativity	18.2	22.2	30.2	18.1	11.3	2.74	1.35

Results in Table 5 reveal that the inherent aspects of crops were relevant for producers when performance analysis took place. Outcomes classified this component as agronomic. Variables in the element were cocoa variety, land tenure, cultivation technique, number of crops, and post-harvest practices. Cocoa variety is a factor that impacts producer performance; thus, we performed a PCA by producer group, i.e., Arriba and CCN-51, to investigate differences between both chains.

In the case of Cocoa Arriba producers, the first component is noteworthy on account of its impact. The variables included land tenure, cultivation technique, associativity, and post-harvest practices, i.e., factors inherent to crop development (see Table 6). Most of the variables represented strategic information for excellent production performance. However, it is essential to emphasize that the results presented the associative variable as a crucial

aspect for this group of producers. Besides, the price variable captured little interest, possibly because the cocoa market is expanding its quotas and business opportunities (Scherer & Ross, 1990).

Table 6 - Matrix of extracted components from PCA analysis of Arriba cocoa producers

		Component		
		1	**2**	**3**
Variable	Land tenure	0.961		
	Cultivation technique	0.855		
	Associativity	0.827		
	Postharvest practices	0.818		
	Acreage		0.875	
	Production cost		0.862	
	Cocoa acreage		0.795	
	Yields		0.761	
	Financing		0.733	
	Additional crops			0.725
	Price			0.772
Statistical factors	Eigenvalue	4.422	1.524	1.102
	Variance %	38.471	15.218	16.531
	Cumulative variance %	38.471	53.689	70.220
	Cronbach alpha	0.891	0.895	0.758
	Mean	3.11	2.53	2.89

In the case of Cocoa CCN-51 producers, the second component had the highest score. The variables included production cost, financing, yields, cocoa acreage, and acreage, i.e., factors inherent to economic and management planning (see Table 7). Most of the variables represented strategic information for excellent financial performance. However, the results showed the associative variable as having little impact on producers' perception. The price variable also had little effect, possibly because international markets have already established the price of CCN-51.

Table 7 - Matrix of extracted components from PCA analysis of CCN-51 cocoa producers

		Component matrix		
		1	**2**	**3**
Variable	Additional crops	0.824		
	Cultivation technique	0.811		
	Land tenure	0.752		
	Postharvest practices	0.623		
	Production cost		0.951	
	Financing		0.983	
	Yields		0.845	
	Cocoa acreage		0.839	
	Acreage		0.712	
	Price			0.753
	Associativity			0.694
Statistical factors	Eigenvalue	4.277	1.671	1.215
	Variance %	35.522	18.196	14.112
	Cumulative variance %	35.522	53.718	67.830
	Cronbach alpha	0.866	0.899	0.761
	Mean	3.05	2.73	2.71

Finally, Figure 7A distinguished two distinct segments – non-association members and associated members – by considering agronomic and financial components. We observed that most Cocoa Arriba producers opted to be part of associations. Respondents pointed out benefits, such as the reduction of economic risk, because representatives addressed production by following strategies formulated by consensus. In Figure 7B, the interpretation is different because CCN-51 producers did not tend to be part of associations; they opted to make decisions independently.

Figure 7A - Scatter plot of Arriba producers and associativity

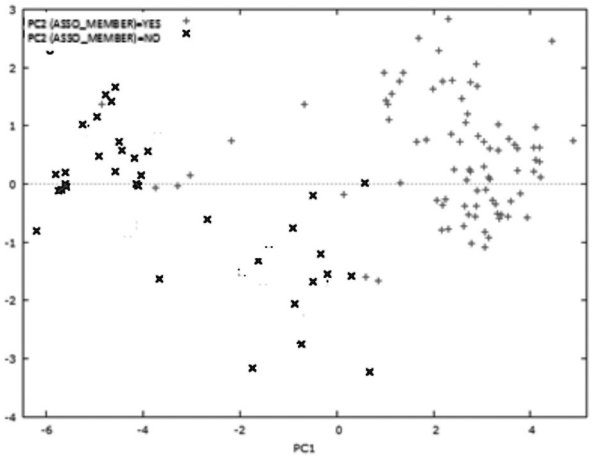
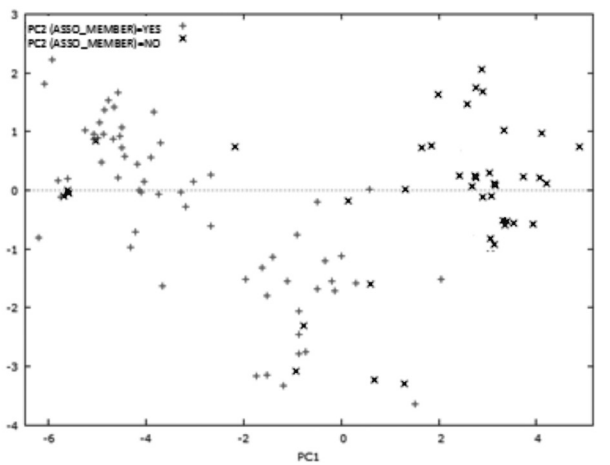


Figure 7B - Scatter plot of CCN-51 producers and associativity



4. Conclusions

Improving the social and economic sustainability performance of the agri-food networks would involve significant structural changes. As a sub-cluster of the agri-food sector, cocoa producers, traders, processors, and distributors have responded to rural development problems, associativity,

and cost-efficiency. Market opportunities, together with regulations through certification tools, such as Protected Designations of Origin, look for supporting viable and fair agricultural activities. Sustainable status for cocoa chains has received attention in the existing literature. Environmental aspects related to soil conditions of crops, pest-management plans, and deforestation practices were examined extensively.

Nevertheless, social conditions and economic performance have received little attention. This paper aimed to provide an initial comparison between two different chains, CCN-51, and Arriba PDO, by emphasizing PDO chain demographic, socio-economic situation, and the impact of these factors on economic performance outcomes. The paper aims to highlight their effect on the sustainability of a PDO widely recognized at the world market level. While two research questions tackled this aim, the results showed marked differences between both cocoa chains. We also faced a scarcity of indicators of a holistic sustainability assessment. Such findings highlight the complexity of evaluating sustainability conditions, encourage future discussion, and motivate frameworks for assessing the cocoa chain comprehensively at all levels.

The results of our study suggest that the Arriba PDO chain shows a disadvantage in the age profile of its population, which constitutes a possible threat. The education level of Arriba workers, as well as their associativity, are lower. Regarding academic formation, actors required an integrated perspective to make decisions effectively. Likewise, differences in monthly income pointed out a drawback for Arriba cocoa PDO producers. Together, this information allowed us to conclude that market differentiation principals are essential to recognize the implications of a good PDO, and help producers receive fair benefits. The public entities in charge of monitoring the production of Cacao Arriba, and those that manage local and international market intelligence systems, have not been able to establish such a differentiation. This issue is the main fault presented by the PDO chain. The strategies for the two circuits, CCN-51 and Arriba, are different. CCN-51 cocoa was designed for mass markets and the industrialization of comparable products (Porter *et al.*, 2002), such as nibs, cocoa powder, and degreased chocolate for toppings, among others. Cocoa Arriba is a good whose sensory potential must be exploited in consumer goods with a high degree of quality and differentiation, that is, in exclusive market segments.

Moreover, the study realized an urgent need for differentiated value-added procedures to address cost efficiency and improve margins for producers, SMEs, and entrepreneurs. Besides, governance played a crucial role in the performance of the PDO chain. Consequently, we confirm the inconsistency of equal establishment strategies for both chains, executed by public bodies. The modular governance of the PDO chain shows the need to design and strengthen precise information flows that aim at achieving high value-added

consumer goods. We believe that the market for processed Cocoa Arriba-based goods has full reception at the local level, and even more so in global markets (Banchuen *et al*., 2017). Europe, Asia, and North America are markets which demand this type of good.

Regarding perception, actors of both chains mentioned agronomic factors, such as cocoa variety, land tenure, cultivation technique, number of crops, and post-harvest practices, as the main drivers of economic sustainability. The PDO chain showed little interest in the price mechanism, since the world market is expanding, and actors are looking for a significant transition towards a sustainable chain. Apart from that, findings concluded that future research on integrated ecological and institutional practices within the multi-level approach is necessary (Martín-Gómez *et al*., 2019). Future studies must focus on different labor and agricultural practice regulations and policies to monitor their significant role in the adoption of sustainable models.

References

Abbey, P., Tomlinson, P.R. & Branston, J.R. (2016). Perceptions of governance and social capital in Ghana's cocoa industry. *Journal of Rural Studies*, *44*, 153-163, doi: 10.1016/j.jrurstud.2016.01.015.

Aidoo, R. & Fromm, I. (2015). Willingness to Adopt Certifications and Sustainable Production Methods among Small-Scale Cocoa Farmers in the Ashanti Region of Ghana. *Journal of Sustainable Development*, *8*(1), doi: 10.5539/jsd.v8n1p33.

Alemagi, D., Duguma, L., Minang, P.A., Nkeumoe, F., Feudjio, M. & Tchoundjeu, Z. (2015). Intensification of cocoa agroforestry systems as a REDD+ strategy in Cameroon: hurdles, motivations, and challenges. *International Journal of Agricultural Sustainability*, *13*(3), 187-203, doi: 10.1080/14735903.2014.940705.

Andres, C. & Bhullar, G.S. (2016). Sustainable intensification of tropical agro-ecosystems: Need and potentials. *Frontiers in Environmental Science*, *4*(FEB), doi: 10.3389/fenvs.2016.00005.

Arevalo, M. (2016). *Estado actual sobre el comercio de cacao en América*.

Argüello, D., Chavez, E., Lauryssen, F., Vanderschueren, R., Smolders, E. & Montalvo, D. (2019). Soil properties and agronomic factors affecting cadmium concentrations in cacao beans: A nationwide survey in Ecuador. *Science of The Total Environment*, *649*, 120-127, doi: 10.1016/j.scitotenv.2018.08.292.

Ballou, R. H., Gilbert, S. M. & Mukherjee, A. (2000). New Managerial Challenges from Supply Chain Opportunities. *Industrial Marketing Management*, *29*(1), 7-18. Doi: 10.1016/S0019-8501(99)00107-8.

Banchuen, P., Sadler, I. & Shee, H. (2017). *Supply chain collaboration aligns order-winning strategy with business outcomes*, doi: 10.1016/j.iimb.2017.05.001.

Barbier, E.B. (2016). Sustainability and Development. *Annual Review of Resource Economics*, *8*(1), 261-280, doi: 10.1146/annurev-resource-100815-095227.

Belletti, G., Marescotti, A. & Touzard, J.M. (2017). Geographical Indications, Public Goods, and Sustainable Development: The Roles of Actors' Strategies and Public Policies. *World Development*, *98*, 45-57, doi: 10.1016/j.worlddev.2015.05.004.

Carter, C.R. & Liane Easton, P. (2011). Sustainable supply chain management: evolution and future directions. *International Journal of Physical Distribution & Logistics Management*, *41*(1), 46-62, doi: 10.1108/09600031111101420.

Chaparro Africano, A. & Calle Collado, Á. (2017). Peasant economy sustainability in peasant markets, Colombia. *Agroecology and Sustainable Food Systems*, *41*(2), 204-225, doi: 10.1080/21683565.2016.1266069.

Collinson, C. & Leon, M. (2000). Economic viability of ethical cocoa trading in Ecuador. In *Greenwich Academic Literature Archive*. -- Retrieved from http://gala.gre.ac.uk/12139.

Council of Supply Chain Management Professionals – CSCMP. (2010). Supply Chain Management Terms and Glossary. -- Retrieved July 25, 2019, from https://cscmp.org/404.aspx?aspxerrorpath=%2Fsites%2Fdefault%2Ffiles%2Fdownloads%2Fglossary.pdf.

Díaz-Montenegro, J., Varela, E. & Gil, J.M. (2018). Livelihood strategies of cacao producers in Ecuador: Effects of national policies to support cacao farmers and specialty cacao landraces. *Journal of Rural Studies*, *63*, 141-156, doi: 10.1016/j.jrurstud.2018.08.004.

Ding, D. & Chen, J. (2008). Coordinating a three level supply chain with flexible return policies. *Omega*, *36*(5), 865-876, doi: 10.1016/J.OMEGA.2006.04.004.

Dotoli, M., Fanti*, M.P., Meloni, C. & Zhou, M.C. (2005). A multi-level approach for network design of integrated supply chains. *International Journal of Production Research*, *43*(20), 4267-4287, doi: 10.1080/00207540500142316.

Ecuadorian Association of Cocoa Exporters – ANECACAO (2017). Agricultor ecuatoriano logró Denominación de Origen Cacao-Arriba | Anecacao Ecuador. Retrieved August 29, 2019, -- from www.anecacao.com/index.php/es/noticias/agricultor-ecuatoriano-logro-denominacion-de-origen-cacao-arriba.html.

Ecuadorian Institute of Intellectual Property – IEPI. (2010). Análisis de la primera propuesta normativa de un Consejo Regulador para la Denominación de Origen Cacao Arriba. Retrieved August 29, 2019, -- from http://iepi-iepi.blogspot.com/2010/05/reunion-tecnica-de-analisis-de-la.html.

Ecuadorian Standardization Service – INEN (2006). *NTE INEN 0176: Cacao en grano. Requisitos*. -- Retrieved from www.agrocalidad.gob.ec/wp-content/uploads/2016/03/NTE.-INEN-0176.2006.pdf.

Estupiñán, M. (2018). *Análisis de la situación actual de las asociaciones productoras del sector cacaotero en el cantón Rioverde con perspectivas de exportación* (Ecuador PUCESE – Escuela de Comercio Exterior). -- Retrieved from https://repositorio.pucese.edu.ec/handle/123456789/1537.

Food and Agriculture Organization – FAO. (2000). Cocoa. -- Retrieved August 28, 2019, from www.fao.org/3/y5143e/y5143e0w.htm#TopOfPage.

Fournier, S., Arvis, B. & Michaud, F. (2018). Localized AgriFood Systems dynamics and Geographical Indications as ways to reinforce food systems' sustainability? Case studies in Mongolia and Peru. -- Retrieved from https://hal.archives-ouvertes.fr/hal-01840957.

Gateau-Rey, L., Tanner, E.V.J., Rapidel, B., Marelli, J.-P. & Royaert, S. (2018). Climate change could threaten cocoa production: Effects of 2015-16 El Niño-related drought on cocoa agroforests in Bahia, Brazil. *PLOS ONE*, *13*(7), e0200454, doi: 10.1371/journal.pone.0200454.

Gereffi, G., Humphrey, J. & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, *12*(1), 78-104, doi: 10.1080/09692290500049805.

Hawkes, C. & Ruel, M. (2011). *Value chains for nutrition | IFPRI: International Food Policy Research Institute*. -- Retrieved from www.ifpri.org/publication/value-chains-nutrition-1.

Inter-American Institute for Cooperation on Agriculture – IICA. (2014). *IICA. 2014. "Estrategia IICA – Ecuador" 2014-2018*. -- Retrieved from http://repiica.iica.int/docs/b3676i/b3676i.pdf.

Jolliffe, I.T. (2002). *Principal Component Analysis* (Second). -- Retrieved from http://cda.psych.uiuc.edu/statistical_learning_course/Jolliffe I. Principal Component Analysis (2ed., Springer, 2002)(518s)_MVsa_.pdf.

Koc, T. & Bozdag, E. (2017). Measuring the degree of novelty of innovation based on Porter's value chain approach. *European Journal of Operational Research*, *257*(2), 559-567, doi: 10.1016/j.ejor.2016.07.049.

Kozicka, M., Tacconi, F. & Horna, D. (2018). *Forecasting Cocoa Yields for 2050*. -- Retrieved from www.bioversityinternational.org.

Lamine, C., Renting, H., Rossi, A., Wiskerke, J.S.C. & Brunori, G. (2012). Agri-Food systems and territorial development: innovations, new dynamics and changing governance mechanisms. In *Farming Systems Research into the 21st Century: The New Dynamic* (pp. 229-256), doi: 10.1007/978-94-007-4503-2_11.

Lanka, S.V., Khadaroo, I. & Böhm, S. (2017). Agroecology accounting: biodiversity and sustainable livelihoods from the margins. *Accounting, Auditing and Accountability Journal*, *30*(7), 1592-1613, doi: 10.1108/AAAJ-12-2015-2363.

Macías Barberán, J.R., Cuenca Nevárez, G.J., Intriago Flor, F.G., Caetano, C.M., Menjivar Flores, J.C. & Pacheco Gil, H.A. (2019). Vulnerability to climate change of smallholder cocoa producers in the province of Manabí, Ecuador. *Revista Facultad Nacional de Agronomía Medellín*, *72*(1), 8707-8716, doi: 10.15446/rfnam.v72n1.72564.

Martín-Gómez, A., Aguayo-González, F. & Luque, A. (2019). *A holonic framework for managing the sustainable supply chain in emerging economies with smart connected metabolism*. -- Retrieved from Elsevier website: https://pubag.nal.usda.gov/catalog/6255700.

Ministry of Agriculture – MAG. (2015). *Café – Cacao*. -- Retrieved from https://www.agricultura.gob.ec/cafe-cacao/.

Ministry of Agriculture – MAG. (2018). *Ecuador es el primer exportador de cacao en grano de América – Ministerio de Agricultura y Ganadería*. -- Retrieved from https://www.agricultura.gob.ec/ecuador-es-el-primer-exportador-de-cacao-en-grano-de-america/.

National Institute of Intellectual Property – IEPI (2019). Denominación de Origen – Ecuador. Retrieved August 29, 2019, -- from www.derechosintelectuales.gob.ec/.

Nicita, A., Ognivtsev, V. & Miho, S. (2013). *Global Supply Chains: Trade and Economic Policies for Developing Countries Policy Issues in International Trade*. Geneve.

Ogus, A. (1992). Regulatory law: Some lessons from the past. *Legal Studies*, *12*, 1-19.

Ogus, A. (1994). Regulation: Legal form and economic theory. In *Oxford: Clarendon*.

Petithuguenin, P. & Roche, G. (1995). Ecuador: the cocoa sector, results and prospects. *Plantations, Recherche, Developpement*, *2*(4), 15-26. -- Retrieved from www.scopus.com/record/display.uri.

Pino, S., Aguilar, H. & Sisalema, L. (2018). The Denomination of origin for cocoa arriba. In search of the Holy Grail. *Espacios*, *39*(16), 1-15. -- Retrieved from www.revistaespacios.com/a18v39n16/a18v39n16p13.pdf.

Portalanza, D., Barral, M.P., Villa-Cox, G., Ferreira-Estafanous, S., Herrera, P., Durigon, A. & Ferraz, S. (2019). Mapping ecosystem services in a rural landscape dominated by cacao crop: A case study for Los Rios province, Ecuador. *Ecological Indicators*, *107*, 105593, doi: 10.1016/j.ecolind.2019.105593.

Porter, M., Sachs, J. & McArthur, J. (2002). *Competitiveness and stages of economic development*.

Pustjens, A.M., Muilwijk, M., Weesepoel, Y. & van Ruth, S.M. (2016). Advances in Authenticity Testing of Geographical Origin of Food Products. *Advances in Food Authenticity Testing*, 339-367, doi: 10.1016/B978-0-08-100220-9.00013-8.

Ruiz, K., Biondi, S., Oses, R., Acuña-Rodríguez, I., Antognoni, F., Martinez-Mosqueira, E., … Jacobsen, S.E. (2014). Quinoa biodiversity and sustainability for food security under climate change. A review. *Agron. Sustain. Dev*, *34*(2), 349-359, doi: 10.1007/s13593-013-0195-0ï.

Rusconi, M. & Conti, A. (2010). Theobroma cacao L., the Food of the Gods: A scientific approach beyond myths and claims. *Pharmacological Research*, *61*(1), 5-13, doi: 10.1016/j.phrs.2009.08.008.

Salmoral, G., Willaarts, B.A., Garrido, A. & Guse, B. (2017). Fostering integrated land and water management approaches: Evaluating the water footprint of a Mediterranean basin under different agricultural land use scenarios. *Land Use Policy*, *61*, 24-39, doi: 10.1016/j.landusepol.2016.09.027.

Scherer, F. & Ross, D. (1990). *Industrial Market Structure and Economic Performance*. University of Illinois at Urbana-Champaign's.

Sepúlveda, W.S., Ureta, I., Mendoza, C. & Chekmam, L. (2018). Ecuadorian Farmers Facing Coffee and Cocoa Production Quality Labels. *Journal of International Food & Agribusiness Marketing*, *30*(3), 276-290, doi: 10.1080/08974438.2017.1413612.

Shleifer, A. (2005). Understanding Regulation. *European Financial Management*, *11*(4), 439-451.

Smetana, S., Mathys, A., Palanisamy, M. & Heinz, V. (2016). Journal of cleaner production. *Journal of cleaner production*. -- Retrieved from Elsevier Science Ltd website: http://agris.fao.org/agris-search/search.do?recordID=US201700127812.

Stoorvogel, J.J., Antle, J.M., Crissman, C.C. & Bowen, W. (2004). The tradeoff analysis model: Integrated bio-physical and economic modeling of agricultural production systems. *Agricultural Systems*, *80*(1), 43-66, doi: 10.1016/j.agsy.2003.06.002.

Sukhatme, P. (1954). *Sampling Theory of Surveys, with Applications*. New Dheli: Indian Society of Agricultural Statistics.

Ton, G., Hagelaars, G., Laven, A. & Vellema, S. (2008). Chain Governance, Sector Policies and Economic Sustainability in Cocoa: A Comparative Analysis of Ghana, Côte D'Ivoire, and Ecuador. *SSRN Electronic Journal*, doi: 10.2139/ssrn.1609686.

Tuesta, O., Santistevan, M., Borjas, R., Castro, V. & Julca, A. (2017). Sustainability of cacao farms in the district of Huicungo (San Martín, Perú) with the "rapid agroecological method". *Peruvian Journal of Agronomy*, *1*(1), 8, doi: 10.21704/pja.v1i1.1062.

Viteri Salazar, O., Ramos-Martín, J. & Lomas, P.L. (2018). Livelihood sustainability assessment of coffee and cocoa producers in the Amazon region of Ecuador using household types. *Journal of Rural Studies*, *62*, 1-9, doi: 10.1016/j.jrurstud.2018.06.004.

World Commission on Environment and Development – WCED (1987). *Our Common Future*. -- Retrieved from https://sswm.info/sites/default/files/reference_attachments/UN WCED 1987 Brundtland Report.pdf.

Yakovleva, N. (2007). Measuring the sustainability of the food supply chain: A case study of the UK. *Journal of Environmental Policy and Planning*, *9*(1), 75-100, doi: 10.1080/15239080701255005.

Carlos Moreno-Miranda
Department of Agricultural Economics and Rural Policy, Wageningen University & Research – WUR
Department of Food Science and Engineering, Universidad Técnica de Ambato – UTA
Wageningen 6708-PB, The Netherlands
Tel: +31 317 480 100, E-mail: carlos.morenomiranda@wur.nl
PhD Candidate at WUR, Full Professor at UTA. Current research interests include the issues of economic sciences in the area of institutional economics, the economics of agri-food supply chains in Ecuador and in the world, agricultural sustainability, emerging supply chains, strategies for cooperation on agriculture, and agribusiness on global markets.

Raúl Moreno
Department of Food Science and Biotechnology, Universitat de Barcelona, Gran Vía de las Cortes Catalanas 585 Barcelona, Cataluña, España
Tel: +44 1792 205678, E-mail: romm01@alumnes.ub.edu
MSc, Company Advisor. Current research interests include the development of the food industry and biorefineries both on the domestic and global markets, in particular research related to biotechnology and the impact on the rural area.

Pablo Moreno
Department of Business Administration, Technical University of Ambato
Río Payamino, Av. Chasquis, 10860, Ambato, Ecuador
Tel: +593 997179340, E-mail: pi.moreno@uta.edu.ec
MSc, Post-graduate Professor at UTA, Company Advisor. Current research interests include the development of the food industry both on the domestic and global market, in particular research related to cluster arrangements and the impact on developing countries, and company and business management.