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Full Research Article

Small-holders perception of sustainability and chain coordination: evidence from Arriba PDO Cocoa in Western Ecuador

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Abstract. Protected Denominations of Origin (PDO) refer to the adoption of producers' voluntary standards to highlight the quality to consumers and improve the socio-economic sustainability of small-holders. Usually, in agricultural circuits, these focus on aspects of production systems and intrinsic features of agricultural raw materials. In agri-food clusters, PDO labels focus globally on market recognition of sensorial elements of farming and agroindustrial products. The study's objective was to analyze socio-economic and governance components to understand the PDO Cocoa Arriba (*Theobroma cacao*) chain and its sustainability to bring forward potential strategies in Ecuador. The information employed comes from the observation of two strings (Arriba PDO and CCN-51) by interviewing 450 respondents. Principal Components Analysis was introduced to contribute with relevant insights. The framework applied accounts with a revision of primary and support activities and coordination mechanisms identification. The study clustered pre-production, production, and post-production tiers. According to the results, Arriba PDO production systems represent a disadvantage for farmers because, from the production point of view, the premium price paid for product certification is debatable. Finally, the enhancement of national regulation to assist chain actors and the stimulus of young producers and associations empowerment is an urgent requirement.

Keywords. Socio-economic, agricultural regulation, family farming, governance structure.

JELCodes. Q18, N56, L17.

1. Introduction

Cocoa (*Theobroma cacao* L.) is a historically strategic agricultural sector in Latin America and constitutes an important crop worldwide for processed and raw material markets (Krauss, 2018)which fail to mention one of the actual key drivers: the need to shore up pro-

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duction in the long term in an embattled sector. Consequently, representations also downplay the need for systemic change, reproducing the power asymmetries they claim to change. The research seeks to establish to what degree public-facing communication differs from underlying priorities in terms of forefronting altruism over necessity, and whether this is problematic for the initiatives' overall outcome. Through semi-structured interviews, focus-group discussions, documentary analysis and participant observation in Latin America and Europe, it reviews relations in two cocoa sustainability initiatives with environmental foci. Crucially, the research establishes a link between representations, underlying priorities and the degree to which they (re. The FAO's latest estimates point out that the world's production of cocoa is more than 4,600,000 tons per year (1,200,000 ha) (Alemagi *et al.*, 2015; FAO, 2018). Ecuador, with an output of 270,000 tons/year, placed ninth in the world ranking producing countries (Saravia-Matus *et al.*, 2020; Williams, 2019). In recent years, the Ecuadorian cocoa chain faced problems such as price fluctuation and low production yield (on average 304 kg/ha) in contrast with direct competitors (e.g., Perú – 634 kg/ha, Colombia- 450 kg/ha) (Kozicka *et al.*, 2018). Besides, its PDO Cocoa is marketed without adequate mechanisms leading to low market performance (Pino *et al.*, 2018). The low coordination and commercialization strategies and biased public policies are unable to differentiate variety-based markets (Marette, 2016; UNDP, 2020). Therefore, specific instruments promoting sustainable chains are vital.

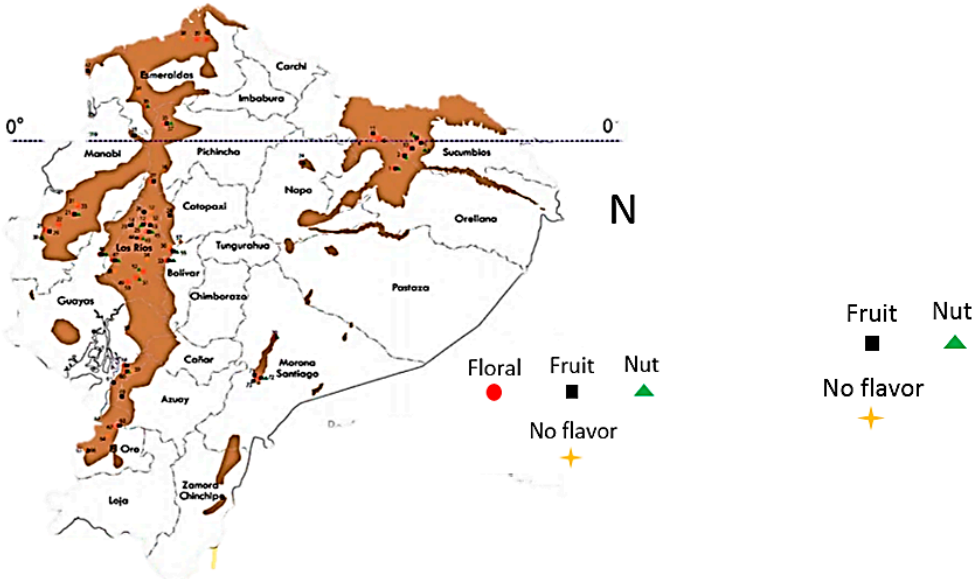
Nevertheless, the Ecuadorian Government, led a process of Cocoa revaluation, through the project "Production and Improvement of the Quality of National Cocoa" (MAG, 2015). The purpose was to improve yields of CCN-51 cloned variety and target national and international markets of PDO cocoa (MAG, 2018). The Ecuadorian PDO cocoa is known as "Cacao Arriba" and characterized by a deep floral-fruity aroma (Benitez, 2018). In 2007, Ecuador submitted the designation of origin (DO) application for Cocoa Arriba, and it was approved in 2013 (IEPI, 2019). Today, Ecuador has the most significant world market share of Cocoa Arriba (63%) (Pino *et al.*, 2018). PDO Arriba production is a clear alternative to promote sustainability and rural development. Various authors argue that studies have only addressed agronomic aspects (Tuesta *et al.*, 2017). An integrative perspective includes a series of variables such as standards application, economic evaluation, and social implications, which underline existing shortcomings (Corsi & Salvioni, 2017). For such reasons, it employs a Principal Components Analysis to reduce a large set by emphasizing variation and bring out strong patterns of social and economic sustainability between Arriba PDO and CCN-51 cocoa chains.

In such a context, the present article aims to contribute by addressing two research questions. The first RQ is *how the Cocoa Arriba PDO chain is 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 regarding the cocoa PDO chain. It focused on Los Ríos province since it covers most of the Cocoa Arriba production in Ecuador.

2. Background

Cocoa has been linked to Ecuador's economic performance and is one of the most priced agricultural products on the international market. The geographical structure and biodiver-

Figure 1. Map of geographical area of Arriva cocoa cultivars in Ecuador.



sity of Ecuador allow the cultivation of PDO Arriba cocoa (Figure 1). 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 (Villamar *et al.*, 2016). Also, it has a humid climate with rainfall of 2,000 to 4,000 mm and slight variations due to the small mountain ranges (ANECACAO, 2017). This native variety is the most appreciated in the international market by representing about 5% of total cocoa production worldwide (MAG, 2018). However, at the local markets, unsuitable mechanisms for the identification of cocoa varieties are largely affecting the chain development. Despite this challenge, Ecuador plays a crucial role because it is responsible for 63% of PDO Arriba cocoa exports at the world level. The responsible actors of PDO Arriba Cocoa production are associations and export enterprises. Besides the PDO Arriba Cocoa, Ecuador grows a cloned variety CCN-51 (Castro Naranjal Collection) for the industry. The agronomic performance of CCN-51 characterized by its resistance to disease and its relatively high productivity.

2.1 Transition of certifications and agricultural policies

The cocoa production certification in Ecuador has a direct connection with the quality of the variety and agriculture practices. In 2008, the Ecuadorian cocoa achieved UTZ (Rainforest Alliance) certification that focuses on attaining ecological agriculture and sustainability principles. In 2012, Organic certifications (USDA / BCS ÖKO) were obtained by cocoa producers, which requires constant revision of agronomic practices. The Fair Trade certification of the Ecuadorian cocoa started to be visible at the end of 2015. Besides, there are

national players such as the Ecuadorian Service of Standardization – INEN and the Agency of Phytosanitary Regulation and Control – AGROCALIDAD, focus on certifications related to Good Farming Practices. The lack of regulations of protected denominations of origin – PDO is evident in the subsector of Cocoa (IEPI, 2019; 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 Common Regime on Industrial Property R.O. No. 258, February 2, 2001, assisted in recognizing Arriba PDO Cocoa at the international level. Afterward, 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, 1994). 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).

The Plan for the Agro-industry Development of the Cocoa-Chocolate Chain (PMC Cacao) – 2019 is the most recent supporting policy launched by the Government. It seeks the Ecuadorian leadership as producer and exporter of cocoa and derivatives worldwide. This plan is a joint work between the public and private sectors. Its fundamental pillars are increasing quality and production, promoting national and foreign investment, and strengthening associativity. The plan also highlights the generation of new jobs with a growth rate of 15% per year and public investment - private with an amount of USD 600 million. The European Union – a strategic partner for the project – provides technical assistance in the socio-productive evaluation of the chain. Recent Government reports show an enhancement of productivity thanks to training and agronomic practices. It accounts for a traceability system to support certification efforts and improvement of marketing margins by adequate price incentives. However, the marketing and commercialization of Arriba PDO still present in-

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

	Requirement	Unit	Cocoa Arriba					CCN-51
			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

Source: Ecuadorian Institute of Intellectual Property - IEPI, (2010).

conveniences in price transparency and signaling in the local cocoa market. Therefore, there is a challenge to clarify its socio-economic sustainability and propose integrated strategies aimed to support the development objectives.

3. Methodology

3.1 Study Zone

The present empirical assessment is based on qualitative and quantitative data collected in 2017-2018 from beneficiaries engaged in the project "Production and Improvement of the Quality of National Cocoa." Babahoyo district, located in the coastal region, was selected for several motives. First, this zone is the leader in cocoa production, accounting for 15% of the national share, and with up to 8000 farmers. Second, its agricultural conditions, such as the location above sea level, a temperature between 12 to 25 °C, and climates from tropical humid to semi-humid make a proper ecosystem for cocoa production. Third, producers are ahead of other cocoa zones in adopting sustainability practices to protect the Arriba PDO. Fourth, the Babahoyo location is a dynamic point of Arriba and CCN-51 cocoa trade between producers, intermediaries, processors, and exporters. As such, this study arguably presents a more enriched view of socio-economic performance. The methodology applied includes phases and tools detailed below.

3.2 Questionnaire modeling and sampling

The study segmented producers by using the last Agricultural Census Data. Next, it interviewed professionals from the Ministry of Industries to section the post-production actors. Then, we executed a workshop with stakeholders to select variables from a predetermined list – the list considered social variables to determine the condition of people within the chain (Feschet *et al.*, 2013) we design a pathway for social LCA impact assessment. This pathway may be used to explain or predict the potential impact caused by the modification of one product sector upon the health of a population. The Preston relationship usually is calculated for a cross section of countries. We assess whether the Preston relationship is valid when a single country is considered alone. Drawing from scientific literature regarding development, we define the context where the use of the Preston relationship is justified. We describe the general design of the Preston pathway, using a recalculated (panel based. Production attributes showed aspects related to the agronomic models. Economic factors described sustainability in terms of costing, associativity, and margins (Barrera-Mosquera *et al.*, 2010). The experiment contemplated a one version survey, Cronbach's alpha index validated the questionnaire, and wording was changed to reflect the use of cocoa over other types of products. Each study was pilot-tested with at least three interviewees, who assisted with confusing and ambiguous items, as well as survey layout and flow. The final questionnaire consisted of three major sections, socio-productive and respondents' perceptions of how economic and agronomic issues impact their product performance.

The information obtained from the Ministry of Agriculture-MAG, and Ministry of Production-MIPRO resulted in a list of 450 chain actors. Then, it applied the Sukhatme formula (Sukhatme, 1954), at a 95% confidence level, and employed the variable "number of produc-

ers registered by MAG" to target 420 cocoa producers (farmers and cooperative representatives). We contacted post-production actors to participate in the study through interviews and know the information of local cocoa markets. Beforehand, we refined the respondent data set of post-production to eliminate irrelevant remarks. For instance, the study blocked fruit, vegetable, and cereal producers, since they focused on different issues. The final group of participants consisted of 70 post-production participants (cocoa traders and entrepreneurs). Overall, information gathered confirmed a reasonable basis for developing the governance analysis, using the Gereffi Framework (Gereffi *et al.*, 2005). Governance typologies in value chains showed the mechanism for coordinate actors, activities, and stages.

3.3 Fieldwork Database Analysis

The study examined socio-demographic data obtained from surveys by applying statistical descriptions. The descriptive information includes averages for Arriba and CCN-51 respondents, as well as two-population t-tests to examine means' differences. This procedure allowed the characterization of Arriba and CCN-51 chains. The analysis provided a chain mapping by employing the Hawke scheme (Hawkes & Ruel, 2011) and the Dotoli approach (Dotoli *et al.*, 2005). The mapping showed a graphical description of stages, linkages, and connections. Also, it displays vital chain elements, such as value-trajectories, information, and financial flows. Analysis of producer perception used a scale similar to that of Melnyk (Melnyk *et al.*, 2003). Here, the study asked respondents about the relevance of economic and agronomic factors to their crops. The variables were measured on the relative frequency of a five-point scale: 1, extremely irrelevant; 2, irrelevant; 3, neutral; 4, very relevant; and 5, extremely relevant. Then, we employed Principal Component Analysis (PCA) (Jolliffe, 1982) to assess crop constructs (e.g., land tenure, cultivation technique), economic constructs (e.g., costs and yields), and associative measures. The method includes a correlation analysis and standardization of variables. Once orthogonal variables (Z-scores) were obtained from PC analysis, we unified them by using the following expression:

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

where:
x_{ij} z-score of i observation, j variable
μ_j mean of j variable
σ_j standard deviation of j variable
Z_{ij} z-score ij ajusted

4. Results

4.1 Actors' segmentation and value-chain characterization

Table 2 shows the data provided by the Ministry of Agriculture about the production stage. The data accounted for 10.5 % of cocoa-producing families.

Table 2. Number of producers and cocoa production area.

Province	District	Number of producer families	Area of production (ha)
Los Rios	Babahoyo	1250	1955.5
	Ventanas	750	1040.2
	Vinces	520	840.7

Source: Ministry of Agriculture - MAG, (2015).

4.1.1 Socio-economic Profiles

Table 3 states the socio-demographic profiles of respondents. Most of the CCN-51 chain actors were between 26 and 40 years old (55.3%). The Arriba chain actors were between 41 to 55 years old and represented 65.8% of the respondents. There was a difference concerning the education level, since a high proportion of participants (38.5%), belonging to the CCN-51 chain reported a college education. However, more than 50.3% 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

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

Variable	Proportion			
	Mean	CCN-51	Arriba	p-Value
Gender (n = 250)				
Female		54.0	62.0	
Male		46.0	38.0	
Age (head of family) (n = 250)				
< 18 años	17	2.5	1.4	0.058*
19-25 años	23	14.2	4.2	0.045**
26-40 años	34	55.3	8.2	0.028**
41-55 años	46	17.3	65.8	0.039**
56-65 años	59	9.2	12.2	0.025**
>66 años	68	1.5	8.4	0.437
Education (head of family) (n = 250)				
Primary		13.4	22.5	
Secondary		48.1	50.3	
College		38.5	27.2	
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	36.2	0.021**
1001-1300 USD	1220	25.2	29.7	0.027**
1301-1700 USD	1580	37.5	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 < 0.001, *** for < 0.01, ** for < 0.05, and * for < 0.1.

chains followed agricultural science programs (Díaz-Montenegro *et al.*, 2018). Regarding monthly income, most of Arriba producers reported a range between 701-1000 USD (36.2%) and CCN-51 producers presented a range between 1301-1700 USD (37.5%).

The average number of household members was 3.6 in both chains, and 63% of respondents reside in Babahoyo district. According to the National Institute of Statistics and Census (INEC, 2010), the average number of members per household is 2.9. (in the coast region). Besides, during 2018, the monthly income was USD 450, on average (Viteri-Salazar *et al.*, 2018). Therefore, the sample showed better representativeness in terms of the average salary of a household member.

4.2 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 a technical assessment to crop management. Peasant families were the first enabler cluster identified and were responsible for channeling the harvest to collection points and wholesalers. The main difference detected was the crop volume of Arriba cocoa, which is 20% of the CCN-51 cocoa volume. Also, exports of dried CCN-51 Cocoa 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 detected dealers (third enabler cluster) strategically located in areas close to the plantations. Dealers aimed to link processors and producers, thus dynamizing the trade by transferring the raw material ata the national level. 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 of liquor and dried-fermented cocoa, based on the International Cocoa Organization–ICCO and the New York Stock Exchange (see Figure 2).

4.3 Chain Roles and resources' streams

Outcomes of the pre-production stage showed the presence of private greenhouses as the main responsible for the supply of seedlings. Due to an increase in rainfall and temperature, respondents pointed out December and May as the best cultivation time. It is noteworthy that crops require a daily shade-period to achieve an optimum level of production. Another essential requirement is surface cleaning – the elimination of pests and weeds, while bush pruning is necessary after the first year of crop life. 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 and grain bagging, thanks to the sector's humidity and temperature. Then, producers dried cocoa beans by using solar energy and collection points employed gas dryers.

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 product is called the nib, which is ground to obtain a thick paste. The paste is refined and later distributed as a semi-processed product. The confectionery sector highly demands the

Figure 2. Monthly averages prices (USD/TM).

Source: New York Stock Exchange, (2019).

cocoa paste, and its price 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. Production cost ranges between 8.00 and 10.00 USD/kg in the case of CCN-51 cocoa, and between 11.00 and 15.00 USD/kg in the case of Arriba cocoa. At the marketing stage, small intermediaries promote cocoa trading and supply the grain to SMEs and artisans.

Concerning the key streams of resources, outcomes identified two types classified as high and low importance. The cocoa trajectories used the high-relevance streams (HRSs) and connected production, fermentation, and drying activities. The Ecuadorian Standardization Service (INEN) set up a high-quality cocoa standard (see Table 4), which plays an essential role due to local market requirements. The commercialization and transformation are the last HRSs within the chain. Besides, 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).

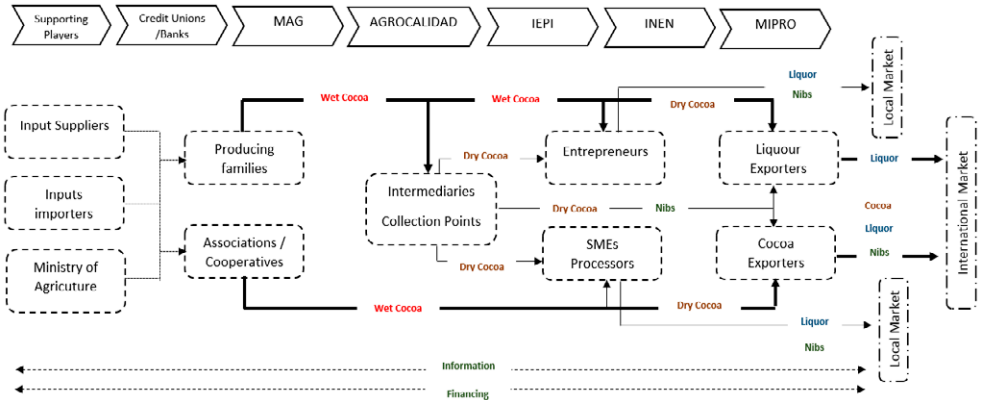
The low-relevance streams (LRSs) connected supporting activities. The first stream was the financial one. Public and private banking entities and credit unions perform financial support. Observations showed financing programs with access to microcredits. Besides, the flow of information was also an essential supporting stream.

Table 4. Biophysical standards of cocoa.

Type of grain	Standard	
	Degree I	Degree II
Moldy	Max. 3%	Max. 4%
Slaty	Max. 3%	Max. 8%
Affection by insects	Máx. in total 3%	Máx. in total 6%

Source: Ecuadorian Standardization Service - INEN, (2006).

Figure 3. Mapping of the Cocoa Chain at Babahoyo District.



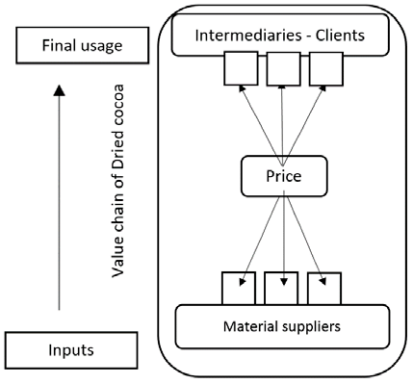
Technical and marketing information streams were in high demand from actors. Ministry of Agriculture and the Institute of Agricultural Research (INIAP) were the leading providers. However, there were also private organizations focused on disseminating aspects of prices and marketing opportunities. Figure 3 shows the mapping of all the components contained herein.

4.4 Chain Coordination

The study examined the coordination mechanism, information coding, the complexity of the inter-firm information transfer, and the level of competence of actors. Therefore outcomes are as follows:

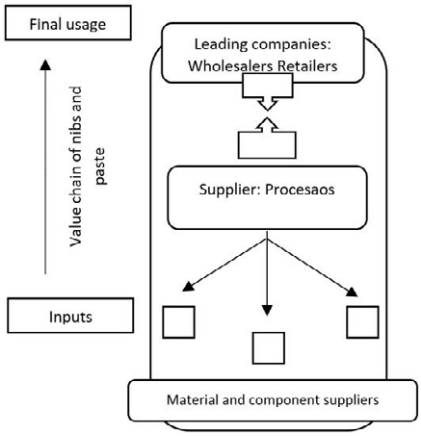
1. Market coordination. The CCN-51 chain characterized by governing bodies, such as farmers (suppliers) and dealers (intermediaries). Repetitive transactions easily codified within exchange environments, such as local markets, are the main feature. The most common district markets close to Babahoyo are Quevedo, Ambato, and Guayaquil. Cash payments or contracts with short credit periods, no more than eight days, were the primary business coordination mechanisms (See Figure 4).
2. Modular coordination. The Arriba chain showed a setting whose transactions codified a relatively high level of complexity. The study observed a sort of power market imposed by governing bodies, such as processors and dealers. These actors set product specifications, credit periods, and buying prices through contracts. Besides,

Figure 4. Coordination mechanism at CCN-51 cacao chain.



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 is based on local and global market information and technical procedures (See Figure 5).

Figure 5. Governance mechanism at Arriba chain.



4.5 Producer Perception and Comparative Analysis

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 $\chi 2$ sig. 0.000) arose with values greater than 1, satisfactorily explaining 70.22% of the variance.

Results in Table 5 reveal that for producers' performance evaluation, plant production factors are the most relevant. Outcomes classified this component as agronomic. Variables in the agronomic part were cocoa variety, land tenure, cultivation technique, number of crops, and post-harvest practices. Cocoa variety is a factor that had the most impact on 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).

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 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.

Finally, Figure 6A 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 reducing economic risk, because representatives addressed production by following strategies formulated by consensus. In Figure 6B, the interpretation is differ-

Table 5. Producers' perception of the relative importance of productive performance aspects.

Variable	Relative frecuency					Aggregate score	
	Fully no relevant	No 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	3.62	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

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

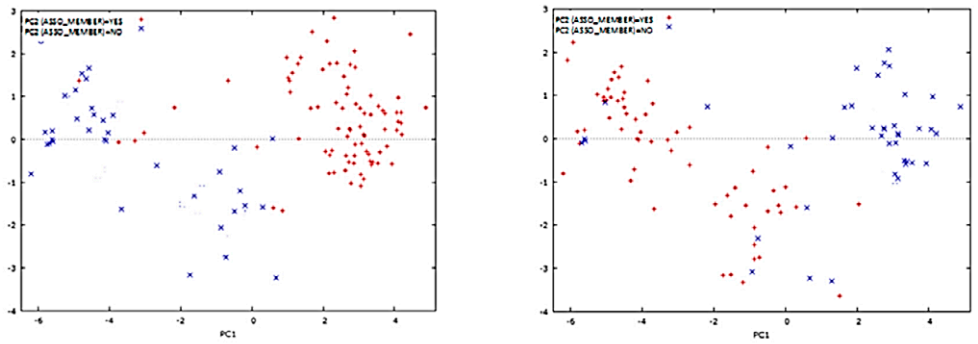
		Component		
		1	2	3
Variable	Land tenure	.961		
	Cultivation technique	.855		
	Associativity	.827		
	Postharvest practices	.818		
	Acreage		.875	
	Production cost		.862	
	Cocoa acreage		.795	
	Yields		.761	
	Financing		.733	
	Additional crops			.725
	Price			.772
	Eigenvalue	4.422	1.524	1.102
Statistical factors	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

ent because CCN-51 producers did not tend to be part of associations; they opted to make independent decisions.

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

		Component matrix		
		1	2	3
Variable	Additional crops	.824		
	Cultivation technique	.811		
	Land tenure	.752		
	Postharvest practices	.623		
	Production cost		.951	
	Financing		.983	
	Yields		.845	
	Cocoa acreage		.839	
	Acreage		.712	
	Price			.753
	Associativity			.694
	Eigenvalue	4.277	1.671	1.215
Statistical factors	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

Figure 6. (A) Scatter plot of Arriba producers and associativity; (B) Scatter plot of CCN-51 producers and associativity.



(A) (B)

5. Discussion and Conclusions

Improving the sustainability performance of agri-food circuits from the socio-economic point of view implicates structural changes. Cocoa producers, traders, processors, and distributors are agri-food sub-clusters and have responded to rural development problems, associativity, and cost-efficiency. Market opportunities, together with certification, such as

PDOs and supporting policies such as the Plan for the Agro-industry Development of the Cocoa-Chocolate Chain, look for synergy to supporting agricultural activities. Environmental aspects related to soil conditions of crops, pest-management plans, and deforestation practices have been examined extensively. However, social and economic factors have received little attention. This paper aimed to provide an initial comparison between two different chains, CCN-51, and Arriba PDO. The emphasis was on highlighting the socio-economic conditions and their effect on the sustainability of the PDO chain, which is widely recognized worldwide. 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.

Results 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, have fundamental weaknesses. 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. Thus, our findings conclude with the need for public intervention aimed to promote training programs on topics such as sustainable farm management and incentives to linkage young producers. Most public bodies' response has focused on production and market price monitoring. Instead, private institutions, such as ANECACAO has led various projects aimed to coach producers on cultivation techniques and the use of technology in crops (ANECACAO, 2017).

Furthermore, public entities engaged in manage local and international market intelligence systems have focused on on-demand detection. For instance, PRO ECUADOR is a public institution aimed to connect buyers and sellers of high-value products (PROECUADOR, 2018). Also, it provides webinars on specific topics such as market strategy and market niches information. However, the effectiveness of market participation requires a profound accompaniment aimed to differentiate, recognize, and re-evaluate Arriba PDO at the local and international levels to address cost efficiency and improve margins for producers, SMEs, and entrepreneurs. In 2016, FEDECADE, a private association of cocoa producers, performed a national study investigating the Arriba PDO cocoa market (IICA, 2010). It concluded that small-holders do not possess sufficient resources to invest in promoting the Arriba PDO cocoa and derivatives.

Based on these events, the government launched the public policy Plan for the Agro-industry Development of the Cocoa-Chocolate Chain (PMC Cacao) – 2019. With the aim for underpinning both circuits, CCN-51, and Arriba (MAG, 2019). CCN-51 cocoa was assessed for mass markets and the industrialization of comparable products, such as nibs, cocoa powder, and degreased chocolate for toppings, among others. Cocoa Arriba is a good whose sensory potential is exploited in products with high quality and differentiation, that is, in exclusive market segments.

Consequently, we confirm that the execution by public bodies of equal strategies for both chains in terms of market orientation is a severe error. Thus, coordination mechanisms play a crucial role in correcting the affection at the market level and improving the PDO chain performance. 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. The modular governability of the PDO chain shows the need for design and strength-

ening precise information flows that aim to achieve 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 (IICA, 2014). Europe, Asia, and North America are markets which demand this type of good. Further, findings concluded that future research on integrated ecological and institutional practices within the multi-level approach is necessary. Future studies must focus on different labor and agricultural practice regulations and policies to monitor their significant role in the adoption of sustainable models.

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