Characterization of Cocoa (*Theobroma cacao* L.) Farming Systems in the Norte de Santander Department and Assessment of Their Sustainability

Caracterización de los Sistemas de Producción de Cacao (*Theobroma cacao* L.) en el Departamento de Norte de Santander y evaluación de su sostenibilidad

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Abstract. *The cocoa (**Theobroma cacao** L.) based economy has been considered a valid alternative to support sustainable development in northeastern Colombia. However, there is a lack of information about the cocoa production systems in the region which is needed for the implementation of effective plans to improve their performance and sustainability. Four of the main cocoa producing municipalities in the Norte de Santander department were considered for this study: Teorama, Bucarasica, Cúcuta and San Calixto. These entities were selected due to their adequate security conditions, availability of field assistants and departmental representativeness in cocoa production. The objective was to obtain basic information for local, specific and participatory actions for the sustainability of the cocoa production systems and to improve the living conditions of farmers. The methodology used was based on the farming system approach, considering the socioeconomic, technological and agro-ecological components, and their relationships, and evaluating them according to the principles of sustainable agriculture. The phases covered were: (1) analysis of secondary data, (2) formulation and evaluation of sustainability indicators, (3) design, implementation and analysis of survey data and (4) validation by the farmers of the obtained information and the prioritization of problems. The results indicate that there is only one cocoa production system of a family-mercantile type, with low technology. Most farmers have low incomes and basic needs such as health, education and public services are not met. They do not employ the agronomic and post-harvest practices recommended by specialists. The water and soil resources are being degraded. In general, the farming system leans towards unsustainability and it is vital that integrative actions be taken to change this situation.*

Key words: Cocoa, characterization, indicators, systemic approach, agricultural systems, sustainability.

Resumen. *Se considera que el desarrollo de una economía basada en el cacao (**Theobroma cacao** L.) constituye una alternativa válida para impulsar el desarrollo sostenible en el noreste colombiano. Sin embargo, se carece de la información básica necesaria sobre los sistemas de producción de cacao para la instrumentación de planes que permitan mejorar su desempeño y sostenibilidad. Para este estudio, se consideraron cuatro municipios del departamento de Norte de Santander: Teorama, Bucarasica, Cúcuta y San Calixto, los cuales fueron seleccionados debido a que poseen condiciones adecuadas de seguridad, asistentes de campo y son representativos del departamento en cuanto a producción de cacao. El objetivo fue obtener información básica para la toma de acciones locales, específicas y participativas hacia la sostenibilidad de los sistemas de producción de cacao, considerando los componentes socio-económicos, tecnológicos y agroecológicos, y sus relaciones, evaluándolos de acuerdo a los principios de la agricultura sostenible. Se realizaron cuatro etapas: (1) análisis de datos secundarios, (2) formulación y evaluación de indicadores de sostenibilidad, (3) diseño, instrumentación y análisis de los datos de la encuesta y (4) validación por los agricultores de la información obtenida y priorización de problemas. Los resultados indican que hay un solo sistema de producción de cacao del tipo familiar-mercantil de baja tecnología. La mayor parte de los productores reciben bajos ingresos y las necesidades básicas de salud, educación y servicios públicos no están satisfechas. Los recursos de suelo y agua se están degradando. En general, el sistema de producción tiende a la insostenibilidad y se requieren acciones integrales para cambiar esta situación.*

Palabras clave: Cacao, caracterización, indicadores, enfoque sistémico, sistemas agrícolas, sostenibilidad.

Sustainable development has been accepted as a major common goal around the world. This should involve social, economic and environmental issues, and their relationships, in order to satisfy human needs in the present and the future. Additionally, it has been recognized that rural communities play an essential role in economic development, especially in developing countries (Organización de Naciones Unidas, 2012). In northeastern Colombia, there are around 300,000 ha with potential for cocoa (*Theobroma cacao* L.) production and only 30% of this area is under cocoa cultivation. Crop yields are low, around 0.2 t^{-1} ha^{-1} year, with more than 94% of the production units being small farms, so the increments in area and productivity are a big challenge for sustainable development based on the cocoa

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economy (Ministerio de Agricultura y Desarrollo Rural, 2007). The Norte de Santander department has ranked third in production in this region, but production levels have been decreasing for the last 15 years from 6,000 tn in 1995 to 1,600 t in 2010 (Espinal *et al*., 2005; Federación Nacional de Cacaoteros, 2012). In 2002, the Consejo Nacional Cacaotero proposed technological agroforestry guidelines to increase yields to 1.8 t^{-1} ha^{-1} year, but only 20% of the cocoa farmers have adopted the changes (Ministerio de Agricultura y Desarrollo Rural, 2007; Preciado *et al*., 2011). On the other hand, the Norte de Santander department contains a scenario with important social conflicts and illicit crops which form a more complex situation (Espinal *et al*., 2005).

The Farming System Research and Development (FSR/D) approach emerged in the seventies as an alternative holistic option to the failed attempts of modernizing peasant agriculture in developing countries through "top-down" vertical technology transfer from researches to farmers. The FSR/D methodology used began with the characterization of farming systems considering ecological, technological and social components and their relationships in the social-economical and ecological contexts (Butler *et al*., 1987; FONAIAP - Junta Acuerdo de Cartagena, 1988; Villota and Rodríguez, 1993; Jiménez, 1997; Lopera, 1997; Malagera and Prager, 2001; Gibbon, 2012). Afterwards, the agricultural systems research considered other levels of analysis, such as the production chain or region, to get a more complete vision of the farming systems context (Berdegué and Ramírez, 1995; Darnhofer *et al*., 2012). The Farming System approaches included the move from disciplinary to trans-disciplinary thinking and practices, rapid survey techniques, farmer participatory learning and actions, farmer experimentation and new linkages between research and extension (Gibbon, 2012). This would convey to agricultural innovation systems which combined technological, social, economic and institutional change. Therefore, production and exchange of knowledge should be combined with additional factors, such as policy, legislation, infrastructure, funding, market developments and alternative ways of organizing labor, land tenure and distribution of benefits (Klerkx *et al*., 2012).

In the nineties, the sustainability paradigm was incorporated into the FSR/D approach and since then considerable efforts have been made to develop theoretic and operational frameworks for the assessment of this multidimensional and dynamic property of farming systems (Astier *et al*., 2012, Marta-Costa and Silva, 2013). At present, to evaluate agricultural sustainability is considered an essential prerequisite for promoting sustainable agriculture and many methods and procedures have been proposed for this objective, including: Adaptive Methodology for Ecosystem Sustainability and Health (AMESH), Arbre de l'Exploitation Agricole Durable (ARBRE), Framework for the Evaluation of Sustainable Land Management (FESLM), Indicator-based Sustainability Assessment Framework (MESMIS, Spanish acronym for Marco para la Evaluación de Sistemas de Manejo de Recursos Naturales mediante Indicadores de Sustentabilidad), Indicateur de Durabilité des Exploitacions Agricoles (IDEA), Indicator of Sustainable Agricultural Practice (ISAP), Multiscale Methodological Framework (MMF), diagnostic de durabilité du Réseau de l'Agriculture Durable (RAD), Response-Inducing Sustainability Evaluation (RISE), Sustainability Assessment of the Farming and the Environment (SAFE), and the Sustainability Solution Space for Decision Making (SSP) method. All of which are indicator-based methods and include economic, environmental and/or social dimensions of sustainability (reviewed by Astier *et al*., 2008; Binder and Feola, 2010; Marta-Costa, 2010; Marta-Costa and Silva, 2013).

Sustainability assessment methods can be grouped in three categories, according to their structure and measurement methods: (1) sustainability indicators; (2) sustainability indexes; and (3) frameworks for sustainability assessment. The sustainability indicators are selected parameters that can be isolated or interconnected and reflect conditions of the analyzed systems. The sustainability indexes aggregate, or synthesize, in one numerical value the relevant information for system sustainability from various indicators. The sustainability assessment frameworks have a more complex and rigorous structure. They integrate elements from different evaluation strategies, because indicators and indexes are used to elaborate iterative and participative analysis of farming systems (Astier *et al*., 2008).

It should be highlighted that a large number of indicators have been developed but they do not cover all dimensions and levels. Therefore, indicators used for agricultural sustainability should be location-specific. They should be constructed within the context of the contemporary socioeconomic and ecological situation (Hayati *et al*., 2011). All this requires interdisciplinary efforts using multi-criteria and multi-scale frameworks considering qualitative and quantitative variables

(Astier *et al*., 2008). In this sense, the MESMIS framework is considered a very robust and flexible methodological guide based on the systemic approach and multidimensional assessment (environmental, social and economic dimensions), it permits *ex-ante* (previous to implementation of changes) and *ex-post* (after changes) evaluations, the indicators are generated in a "bottom-up" process through a previous characterization of farm systems. MESMIS integrates indicators and there is vast experience using it in the Latin American context (Astier *et al*., 2008, Marta-Costa y Silva, 2013). There is no other framework that integrates all these advantages. Priego-Castillo *et al*. (2009) applied the MESMIS framework to compare sustainability in two cocoa farms in Mexico and it was helpful to determine that organic production contributes to improved cocoa farming sustainability.

This paper shows the methods and results obtained in the characterization of cocoa farming systems in four municipalities, Teorama, Bucarasica, Cúcuta and San Calixto, of the Norte de Santander department, northeastern Colombia; and an assessment of the system sustainability as a contribution to building participatory sustainable development in the region. The specific objectives were to generate basic information about the cocoa farming systems and to assess their sustainability using relevant indicators.

METHODS

Cocoa farming systems characterization. The characterization of the cocoa farming systems was carried out through a survey. For which it was necessary to first compile secondary data and a preliminary recognition of the cocoa producer zones. This allowed to gather general data of the cocoa farmers and gatherers.

The survey issues were organized, according to the Jimenez (1997) methodology, in three subsystems: social-economical, ecological and crop system (technological). Afterwards, the questionnaire was designed including social-economical, ecological and technological related variables. This tool had a set of questions that varied in nature and was expressed in different formats for the purpose of getting truthful answers. The analysis of the data collected in the sources determined the framework to guide decision-primary information, giving input data about the structure, function and evolution of cocoa production systems (Ávila *et al*., 2000).

The data collection instrument was validated by applying the questionnaire to two agricultural technicians and two cocoa farmers from the municipality of Cúcuta. The sample was opinatic, and the sample size was adjusted according to the feasibility of access to the area, representativeness of selected farmers and public policy conditions. The final sample size was 182 respondents, which was distributed by town as follows: Teorama, with 80 respondents; Bucarasica, with 52 respondents; Cúcuta, with 32 respondents; and San Calixto, with 18 respondents. The survey was conducted during 2007 and 2008.

The analysis of the survey results was performed following the procedure of Dávila (2000) and Ramírez (2009), which consisted of adjusting the categories of each of the variables and putting the data in a table. Then mean values and frequency were calculated. Thereafter, the most significant variables in determining the farming systems were identified. This approach gave more weight to the socioeconomic variables which were considered as higher classification variables to define the farming systems of small farmers.

The results of the survey were validated by cocoa farmers from the Campo Alegre village in the municipality of Cúcuta, which is representative of cocoa production systems in Norte de Santander. This validation was performed in two workshops, as recommended by Cárdenas *et al*. (2007). The workshops followed this process: (1) presentation of the objectives and working techniques to farmers group; (2) study, analysis and discussion by subgroups of the collected data; (3) brainstorming; (4) building a map of characterization of cocoa farming systems in the village; (5) conducting a plenary in which conclusions were reached by consensus.

Formulation and categorization of the indicators of sustainability of cocoa farming systems. First, a literature review was carried out for sustainability indicators for small farmers, especially in Latin America. Considering the advantages and flexibility of the MESMIS framework (Astier *et al*., 2012), we used some of its indicators, according to the limitations of the zones. To develop sustainability indicators, the characteristics of the production units obtained from the survey of farmers and representatives of farmers associations were considered. Key informants of government agencies, nongovernmental organizations, and cooperation agencies in the Norte de Santander department were also considered. In the formulation of the sustainability indicators, variables of three subsystems were considered: (1) socioeconomic subsystem; (2) ecological subsystem; and (3) the cropping – postharvest subsystem (technological aspects). The indicators used are presented in Table1.

Table 1. Sustainability indicators used in the cocoa (*Theobroma cacao* L.) farming systems of the Norte de Santander department, Colombia.

Sustainability indicator name	Criterion for measuring sustainability indicator	References of sustainability indicator
Social-economical subsystem:		
1. Land tenure	Percentage of farmers owning land	Proprietary Tenants Invaders Others
2. Financial resources for the financing of cocoa	Percentage of farmers with access to economic resources to finance crop	Access to credit Own resources Government support
3. Food production to consumption	Percentages of farmers who produce food for consumption	All foods Many foods Median Food production Few foods No food
4. Perception of Safety	Percentage of farmers with good perception of security	-
5. Social organization for the production	Percentage of farmers belonging to an organization of cocoa production	-
6. Business management of the crop	Percentage of farmers with crop business management	Records
7. Quality of public services.Percentage of farmers who have a perception that services they received are of high quality	Services: education and health. Home services for drinking water, electricity and domestic gas	
8. Access roads to the farm lands	Percentage of farmers with a good sense of conditions of access roads to farms.	
9. Bargaining power of farmers	Percentage of farmers with good perception of their bargaining power and scope of participation in the marketing of the product.	-
10. Diversity of income	Percentage of farmers with different incomes	Diverse Income : Cattle farm Farm crop Exploitation of minor species Employment Income Deal Other income
Ecological subsystem:		
11. Conservation of natural resources	Percentage of farmers who practice conservation of resources	Protection of springs. Using cocoa crop residues Using coverage species. Using live barriers Using green manure
12. Soil conservation	Percentage of farmers who practice conservation of soils	Adding organic matter Presence of native forest. Shade for cocoa farming Use of coverage

Continuation of Table 1....

Sustainability indicator name	Criterion for measuring sustainability indicator	References of sustainability indicator
Crop and postharvest subsystem:		
13. Availability of water for cocoa	Percentage of farmers with water availability for growing cocoa	River or stream Nascent Precipitation Well Irrigation system
14. Farming practices	Percentage of farmers who perform two or more agricultural practices	Preparing ground for planting Fertilization program Sowing Row Renew
15. Cultural practices	Percentage of farmers who perform two or more cultural practices a month	Pruning training Production pruning Weed control Disease management Pest Control
16. Postharvest practices	Percentage of farmers that consider FEDECACAO recommendations for post-harvest practices	Recommendations of FEDECACAO: Collect the cob with a frequency of less than 15 days Collect, brake the cob and ferment the grain during the first 15 days Fermented in a structure specially designed for that Ferment in a period of 5 days Dry in a structure specially designed for that Select the grain

Sustainability evaluated by biogram. The biogram is a graph that represents the degree of sustainable development of the unit of analysis, its apparent imbalances between different dimensions and, therefore, potential levels of conflict. Additionally, it generates a "state of the current situation" of the unit. The biogram is a very helpful tool to visualize an image of the sustainable development of rural areas, allowing a comparative analysis of the system at various times in its history, i.e. their evolution (Sepúlveda *et al*., 2005).

Identification and analysis of limiting factors for cocoa production in Norte de Santander. For the ranking of production system problems, a Vester matrix and problem tree were used as planning tools to identify and list the factors that affect the configuration of the problems. These tools allowed us to establish the hierarchical relationships of the causal factors and the degree of impact on the analyzed problem (Malagera and Prager, 2001).

RESULTS AND DISCUSSION

The characteristics and criteria of sustainable cocoa production system in the municipalities of Teorama, San Calisto, Bucarasica and Cúcuta, Norte de Santander, are summarized in Tables 3, 4 and 5.

Table 2. Categorization of sustainability indicators used in the cocoa (*Theobroma cacao* L.) farming systems of the Norte de Santander department, Colombia.

Categorization of results	From 81 to 100% Level 5	From 61 to 80% Level 4	From 41 to 60% Level 3	From 21 to 40% Level 2	From 0 to 20% Level 1
Criteria for sustainability	Very high	High	Medium	Low	Very Low

Table 3. Subsystem description of socioeconomic characteristics and criteria of sustainable cocoa production system in each municipality of the Norte de Santander department, Colombia.

Indicator	Characteristics of farming system and sustainability criteria			
	Teorama	San Calixto	Bucarasica	Cúcuta
1. Land tenure. Percentage of owners.	95% Very high	89% Very high	61% High	84% Very high
2. Financial resources for the financing of cocoa. Percentage of accessibility	0% Very low	0% Very low	11% Very low	5% Very low
3. Food production to consumption.	35% many foods Low	25% many foods Low	20% many foods Very low	29% many foods Low
4. Perception of security. Percentage of good perception.	30% Low	29% Low	35% Low	46% Medium
5. Social organization for the production. Percentage of associated producers.	25% Low	28% Low	22% Low	15% Very low
6. Business management of the crop. Percentage of producers who make a business management	10% Very low	12% Very low	9% Very low	5% Very low
7. Quality of public services. Percentage of farmers who have a perception that services they received are of high quality.	20 % Low	30% Low	60% Medium	60% Medium
8. Access roads to the farm land Percentage of producers perceived with good roads	10% Very low	15% Very low	16% Very low	8% Very low
9. Bargaining power of farmers Percentage of producers perceived with bargaining power.	5% Very low	17% Very low	8% Very low	9% Very low
10. Diversity of income Percentages of producers with other incomes.	45% Medium	39% Low	53% Medium	63% High

Table 4. Ecological subsystem description and criteria of sustainable cocoa production system in each municipality of the Norte de Santander department, Colombia.

Name of the indicator	Characteristics of the production system and sustainability criteria			
	Teorama	San Calixto	Bucarasica	Cúcuta
1. Conservation of natural resources. Percentage of producers practicing 2 or more methods.	23% Low	25% Low	36% Low	22% Low
2. Soil conservation. Percentage of producers practicing 2 or more methods.	33% Low	18% Very low	29% Low	36% Low

Table 5. Cultivation-postharvest subsystem features and sustainability criteria of cocoa production system in each municipality of Norte de Santander department, Colombia.

Indicator	Municipalities			
	Teorama	**San Calixto**	**Bucarasica**	**Cúcuta**
1. Availability of water for cocoa. Percentage of producers practicing 2 or more methods.	27% Low	32% Low	33% Low	40% Low
2. Farming practices. Percentage of producers practicing 2 or more methods.	33% Low	56% Medium	49% Medium	32% Low
3. Cultural practices. Percentage of producers practicing 2 or more methods	39% Low	42% Medium	32% Low	36% Low
4. Postharvest practices. Percentage of producers practicing 2 or more methods	25% Low	29% Low	32% Low	38% Low

In general, the indicators point to a similar situation of low or very low sustainable cocoa farming in the four municipalities. The trend continued in the three subsystems evaluated: socioeconomic, ecological and crop-postharvest. This situation emphasizes the need to attend very diverse aspects to achieve sustainable cocoa farming in this region and calls to an integrative efforts from public and private sectors. This should involve the main actors: farmers, including youth and woman, extension agencies, universities and research organizations, finance services and agroindustries. Successful colaborative programs around cocoa production have been developed in Santander department in Colombia (Sierra, 2012), Zulia State in Venezuela (Portillo and Portillo, 2012) and other Latin American countries (World Cocoa Foundation, 2013). Farmers associations have demonstrated to be a powerful platform to a improve the yields and quality of cocoa, get environmental and other certifications and to improve quality of life of communities (Sierra, 2012). Given the industrial market of cocoa, national and international associations of agroindustries should be involved in the cocoa sustainability goal too (Page, 2013).

In the socieconomic subsystem notable values include very low (0-11%) access to finance and the high values, above 61%, of land tenure as owner. The latter can be considered as an important strength; however, it is necessary to improve all other indicators in order to transform this condition into a real opportunity to progress towards sustainability. It is also noteworthy that there is a perception from 60% of the respondents in the municipalities of Bucarasica and Cúcuta of having a good quality of services. This, in turn, corresponds to the highest values of 53 to 63% of respondents with diversified revenue in those municipalities, which confirms the advantages of economic diversification and non-exclusive dependence on cocoa. Diversification has been proposed as an essential feature of sustainable farms (Kremen *et al*., 2012). The socioeconomic subsystem is a key factor to change the small-scale cocoa farms, being the appropriate public policies in education, health, finance, infrastructure, markets and public services, necessary to promote the conditions for that change (Bacon *et al*., 2012; Bowman and Zilberman, 2013; Forero, 2013). Cocoa processing by rural women enterprises, to obtain chocolate and other products, has been an alternative option that has improved incomes and sustainability of cocoa systems in Dominican Republic and other countries (World Cocoa Foundation, 2013).

Regarding the ecological indicators, the four municipalities have a low or very low value, which implies the need to increase conservation practices to move towards a more sustainable condition. Considering the crop-postharvest subsystem, the San Calixto municipality had the highest percentage of farmers who perform two or more farming practices (56%) and two or more cultural practices (42%). However, in the post-harvest stage, the four municipalities had low percentages of respondents,

<38%, performing FEDECACAO recommended practices, resulting in the production of poor quality cocoa for processing, low price of dry grain and low bargaining power of farmers. The agroecological management have been proposed as a desirable model for cocoa farming in Colombia since 2002 (Ministerio de Agricultura y Desarrollo Rural, 2007) but its adoption have been very low. Increasing biodiversity over and under the soil, increasing the biomass in the soil, reducing of pesticides residues and nutrient and water losses, promoting the interactions between components of the agroecosystem and efficient crop and animal schemes are all important process in this kind of management (Kremen, 2012; Nicholls and Altieri, 2012; Sierra, 2012).

According to FONAIAP-Junta del Acuerdo de Cartagena (1988), Jiménez (1997) and Forero (2013), the profile of cocoa production units determined through data analysis, allows to define them as a single Family-mercantile system, given the prevailing social relations of production with extensive use of family labor, low hired labor, low level of capital accumulation and low technology. These results are similar to other cocoa farming system studies in Colombia (Mantilla *et al*., 2000; Espinal *et al*., 2005; Preciado *et al*., 2011) and they should be the basis of any program to improve or expand cocoa production in the northeastern Colombia region.

Smallholder cocoa farmers represent 94% of Colombian cocoa production (Ministerio de Agricultura y Desarrollo Rural, 2010) and, to involve them in the achievement of a more sustainable cocoa economy, it will be essential to determine if they can make the desired changes and how they will make them, given their situation and their vision of growing cocoa. Cocoa farming on a small scale and in the current social-economical context does not seem to be a sustainable development option in this region. However these family systems have important strengths that could be taken in advantage to promote sustainable scenarios (Maletta, 2011; FAO, 2012, Forero, 2013). The negative trend in cocoa production in the last 15 years in Colombia is an unequivocal signal that very important changes should be made to building a real viable economy based on cocoa.

Biogram of the cocoa farming system of the municipality of Cúcuta. Figure 1 shows the biogram of the cocoa farming systems of the municipalities Teorama, Bucarasica, Cúcuta and San Calixto, representative of the Norte de Santander department. Most variables are under 3 in the range of 5, which indicate a very low sustainability of the systems. The situation is similar in the four municipalities, which suggest a similar management to make the changes. This biogram illustrates the current status of farming systems, shows the strengths and weaknesses and facilitate the monitoring of the evolution of sustainability, as changes are made (Priego-Castillo *et al*., 2009; Merma and Julca, 2012).

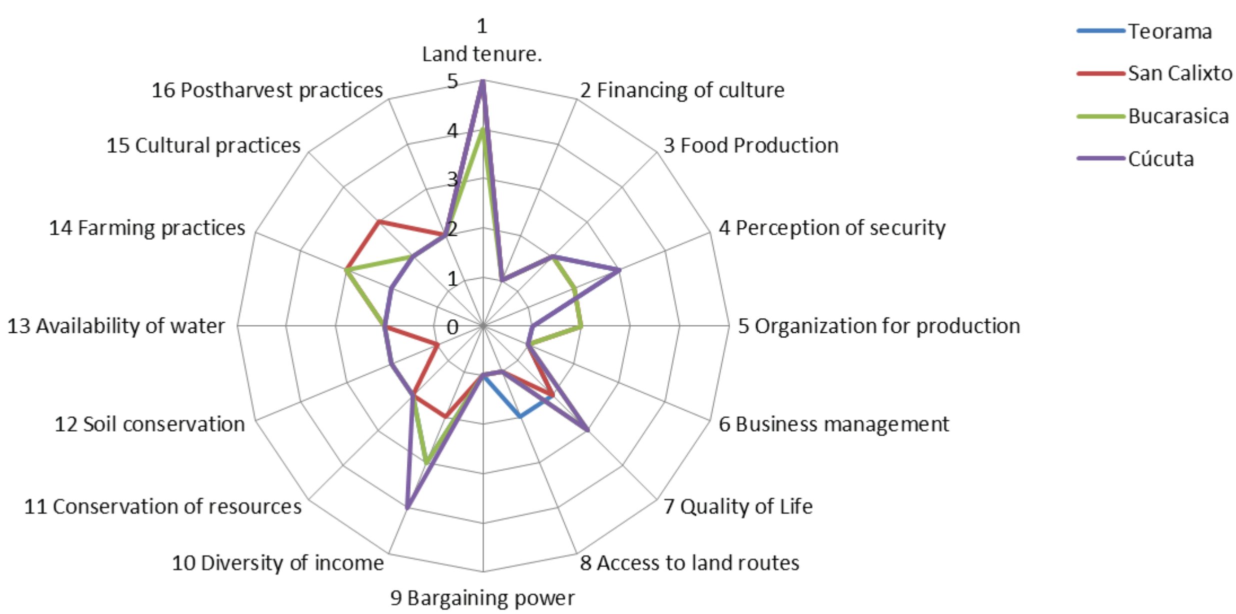

Figure 1. Biogram: most important indicators of the cocoa production system in the studied municipalities of the Norte de Santander department.

Identification and analysis of limiting factors in the crop-postharvest sub-system. As a result of the workshops held with the farmers, using the tools mentioned in the methodological section, the nesting trouble of the Crop– Post-harvest subsystem was performed in the Campo Alegre village, municipality of Cúcuta. The following major asset problems were determined: low frequency of agricultural and cultural practices, low frequency of postharvest practices, and little technical assistance. Problem liabilities are low cost, high incidence of diseases, and poor grain quality. The low frequency of cultural practices, farming and postharvest asset is the biggest problem, to which should be given special attention to improve crop productivity and strengthen the socio-economic component of these production systems. The low profitability is considered the biggest liability problem. This problem requires special consideration due to the significant impact it has on the stability of the system, being both a problem that influences and that is influenced by others. As it was pointed out, the socioeconomic subsystem is the key for the changes in the system toward sustainability and this involve to take internal and external actions (Bacon *et al.*, 2012; Bowman, 2013).

CONCLUSIONS

The cocoa farming system of Norte de Santander is at high risk of unsustainability and comprehensive measures must be implemented to change this scenario. It is necessary to address a range of socio-economic, ecological and technical issues, detailed in this paper, in order to ensure the sustainability of these systems. Particularly, the crop–postharvest subsystem requires the implementation of good agricultural practices and the improvement of postharvest processing to obtain a dry grain that is competitive, nationally and internationally, increasing the price of the product and increasing the bargaining power of farmers.

The system approach allowed for the characterization of cocoa production units of the family-mercantile type in the Norte de Santander department and the sustainability indicators yielded important data, which were validated by farmers in the municipality of Cúcuta, that provided useful information for farmers and for the generation of planning policies aimed at sustainable development of the region.

The methodology proposed in this paper can be applied to other cocoa farming systems and other production systems of small farmers because this method takes into account the particularities of each production system, the complexity of agricultural production processes and emphasizes the socioeconomic component, which allow for a better analysis of the reality of production systems, in order to design appropriate instruments and alternative economic policies and techniques. Farmers and government agencies should jointly search for strategies that contribute to a trend of sustainability in cocoa farming systems.

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