An analytical model to evaluate the performance of associative seed producer organizations in the framework of Plan Semilla - Agrosavia (Colombia)

Un modelo analítico para evaluar el desempeño de las empresas asociativas productoras de semilla en el marco del Plan Semilla - Agrosavia (Colombia)

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ABSTRACT

Low access and use of quality seeds limit agricultural competitiveness. Since 2013, the Corporacion Colombiana de Investigacion Agropecuaria -Agrosavia- initiated "Plan Semilla" with the aim of consolidating nuclei of quality seed producers under associative schemes that guarantee quality seed supply in the regions where the seeds will be used. Between 2013 and 2016, we undertook characterizations of the organizations participating within the framework of Plan Semilla using various qualitative tools for their diagnostics. However, it was not possible to specify the actions that needed to be taken in order to strengthen these organizations. The aim of this research was to generate an analytical model to evaluate the performance of participating organizations that would establish quality seed production nuclei and to validate the model's use in those organizations that produce cocoa seed in the Plan Semilla framework. An analytic hierarchy process (AHP) was used to construct the model, which is composed of 4 dimensions (technical capacities, environmental resources, organizational capacities, and management capacities) that are related to criteria that are considered decisive for the consolidation of nuclei of quality seed producers. The model was assessed by 11 experts who identified the importance weight of the elements. In the validation, we used indicators from 30 cocoa seed producer organizations participating in Plan Semilla. We calculated additive utility functions and used a cluster analysis to define the thresholds and to establish the level of performance of the organizations. The results have improved the procedural rationality for the classification of organizations that seek to consolidate quality seed production nuclei.

Key words: quality seed production nuclei, analytical hierarchy process (AHP), organizational performance, organizational typification, cocoa.

RESUMEN

El bajo acceso y uso de semillas de calidad limita la competitividad agrícola. Desde 2013, la Corporación Colombiana de Investigación Agropecuaria inició el Plan Semilla, buscando la consolidación de núcleos de productores de semillas de calidad bajo esquemas asociativos, a fin de garantizar la oferta de semilla de calidad en los territorios para ser empleada principalmente por productores de agricultura campesina y familiar. Entre 2013 y 2016 en el marco del plan se realizaron caracterizaciones usando diversas herramientas cualitativas para el diagnóstico de las organizaciones, sin lograr precisar las acciones a emprender para el fortalecimiento de las mismas. El objetivo de esta investigación fue generar un modelo analítico para evaluar el desempeño de las organizaciones asociativas que establecen núcleos de producción de semillas de calidad y validar su uso en aquellas que producen semillas de cacao en el marco de Plan Semilla. Se usó el proceso de análisis jerárquico (AHP) para construir el modelo, el cual está compuesto por cuatro dimensiones (capacidades técnicas, recursos ambientales, capacidades organizativas y capacidades de gestión) relacionadas con criterios que se consideran determinantes para la consolidación de los núcleos; para la estimación del modelo se sometió a consulta de 11 expertos logrando identificar el peso de la importancia que se atribuye a sus elementos. En su validación, se usaron indicadores de 30 organizaciones de productores de semilla de cacao participantes en el Plan Semilla; se calcularon funciones de utilidad aditiva y se realizó un análisis clúster para definir los umbrales, lo que permitió establecer el nivel de desempeño de las organizaciones. Los resultados obtenidos han permitido mejorar la racionalidad procedimental para la tipificación de organizaciones que aspiran a consolidar núcleos de producción de semilla de calidad.

Palabras clave: núcleos de producción de semilla de calidad, proceso de análisis jerárquico (AHP), desempeño organizacional, tipificación de organizaciones, cacao.

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Introduction

In Colombia, small agricultural producers face low-quality seed availability for the development of their productive activity (Arenas *et al.*, 2015). This, together with a reduction of agrobiodiversity, a dependence on improved genetic resources with spontaneous flows, the existence of informal seed markets as well as the low adoption of technologies, besides other factors, have created increased risk and uncertainty in national agricultural production (Martín, 2001).

Since 2013, the Corporacion Colombiana de Investigacion Agropecuaria (Agrosavia, formerly known as Corpoica) signed a proposal called "Plan Semilla" (Seed Plan) within the framework of a public policy. This proposal seeks the consolidation of seed producer nuclei under associative schemes in different regions of Colombia that will guarantee a supply of quality seed and the adequate and timely availability of seeds and plant materials with genetic, physiological and sanitary quality. The aforementioned will allow, in the short term, the strengthening and competitiveness of agricultural production systems in Colombia, with the aim of supplying seeds to farmer families and community agricultural producers who traditionally do not have easy access to these necessities (Corpoica, 2015).

In the implementation of the Plan, which seeks to establish formal systems that guarantee the production of certified or selected quality seed, provisions of the Resolution 3168 of 2015 of the Colombian Agricultural Institute (ICA, for its acronym in Spanish) have been followed. ICA regulates and controls the production, import and export of genetically improved seeds. ICA also supervises seed commercialization and planting and maintains a registry of agronomic evaluation and/or research units in plant breeding, for the country.

Since its inception, about 291 producer organizations in various regions of the country (which are related to the production of 22 species important in Colombian agriculture) have participated in some of the phases of the plan (Corpoica, 2015). Among the actions carried out within the framework of the plan between 2013 and 2016, has been the collection of information from participating organizations for carrying out an organizational diagnosis. To carry out this analysis technical-productive, social-business, commercial and organizational variables were used. The main approach used for the diagnosis was qualitative-descriptive and tools were designed incorporating various elements proposed in other methodologies. Among the elements that stand out are the Link methodology of inclusive business models for small farmers of the International Center for Tropical Agriculture (Lundy *et al.*, 2014), the Canvas business model (Osterwalder and Pigneu, 2010), the organizational capacities index (ICO, for its acronym in Spanish) (MADR, IICA, BM, 2003; Rivas, 2013) and the organizational state assessment (VEO, for its acronym in Spanish) (USAID, 2008). These methodologies are important as variables related to the business model, the value chain, the prototype cycle, and inclusive business (Lundy *et al.*, 2014). They are also related to services offered within the organization, participation, and democracy in the decision-making process, the economic and financial situation, the management and administrative capacities, and human development capabilities (MADR, IICA, BM, 2003; USAID, 2008; Rivas, 2013). These methodologies are also linked to productive, commercial, financial, administrative, and organizational capacities (MADR, 2011) and to the criteria related to the specific environment in which business deals are established (Báez, 2010). The above-mentioned elements were incorporated into the information collection instruments that were applied to the organizations participating in the seed plan. In addition, criteria related to technical variables that demand the production of quality seeds were included (Corpoica, 2013, 2014, 2015). These criteria were subsequently used in the methodology implemented for categorizing these organizations using qualitative scales designed for that purpose (Corpoica, 2015). However, during the progress made within the framework of Plan Semilla for the characterization of organizations, it has not been possible to find a robust and complete methodology that allows identifying the weaknesses of the organizations for achieving their classification according to their degree of performance.

Due to the fact that the models used by Corpoica incorporated generic criteria to promote business in organizations of agricultural producers, and because they were not designed specifically to establish the degree of capacities or performance of the associative organizations dedicated to specialized quality seed production, the scales and procedures used for their weighting and prioritization tend to be subjective and are based on the interpretation of the data obtained from the information collection stages. The obtained results have a limit for clearly determining the necessary actions to be carried out in order to strengthen areas with low performance in these organizations. Consequently, the models face the risk that the associative organizations might fail and that the quality seed production nuclei could have low sustainability, which could compromise the success of the plan.

The benefits attributed to associations in rural areas are numerous. Some of these benefits include the contribution associations make to improve product prices, achieve scale economies that allow the reduction of production costs, and to facilitate market entry and access to the support granted by sectoral public policies (training, technical assistance, value addition to the product), among other things (Machado, 2000; Moyano, 2006; Pérez et al., 2014).

In Colombia, agricultural producers, in their eagerness to access aid and support incentives granted by public policies, usually are organizations that, in many cases, do not turn out to be functional (Aristizabal, 2017; Gómez et al., 2017). Among these small-farmer organizations, the low empowerment of their members as well as the low developmental capabilities of collective actions stand out (Parrado et al., 2009). This situation means that the impact and contributions attributed to organizations for the improvement of living conditions of rural societies are low (Rondot and Collion, 2001), thus, perpetuating the dependence of rural producers on the institutional system (Mora and Sumpsi, 2004).

From specialized literature, some of the elements that explain the low success of producer organizations in the agricultural sector can be highlighted. These elements include, among others, the low capacity for collective action development (Machado, 2000). This situation does not contribute to the execution of plans or programs developed by groups (Olson, 1971) that prevent small-farmer organizations from reaching their outlined objectives. Ostrom and Ahn (2003) explain that the success of collective action depends on social capital, defining it as "the sum of real or potential resources that are linked to the possession of a lasting network of knowledge relations and mutual recognition - affiliation to a more or less institutionalized group that provides each of its members with the support of socially acquired capital". Bourdieu (1986) states that collective action is facilitated by "the existence of a set of shared norms and values", which delimit the social structure and determine the networks that exist by actors that cooperate and share their resources to pursue common interests (Coleman, 1990). In recent years, the production of cocoa in Colombia has gained considerable importance. It has been promoted by different institutions as a productive alternative for the national territories. Cocoa has a soil use vocation and there are adequate biophysical conditions for its development as a substitution of illicit crops. This could contribute to improve the quality of life and generate a decent income for the agricultural producers of these areas (Abbott et al., 2018).

A recent study of zoning for commercial cocoa cultivation performed by the Unit of planning of rural lands, land adaptation and agricultural uses (UPRA, 2016) identified 21.3 million ha with an aptitude for cocoa crops in the country. In addition, the national government and the cocoa producers' union -Fedecacao- have planned to increase the area planted with cocoa crops (Nuñez et al., 2017). In the last years, 57% of producers have renewed their crops through public policy actions executed principally in post-conflict territories (Abbott et al., 2018).

In 2017, cocoa production reached 60.535 t (Agronet - MADR, 2018). This production volume has been obtained because producers are implementing technological packages and materials that have been the outcome of research for several years that have resulted in more productive and healthy crops (tolerant to main pests and diseases) (Fedecacao, 2017).

It is important to be aware that quality seeds are required to achieve the goals set in the Plan Semilla. Ensuring an adequate seed supply (available and timely volumes of plant material) with physiological, genetic and phytosanitary quality will allow the strengthening of seed production systems by small-farmer organizations.

The aim of this research was to generate an analytical model to evaluate the performance of associative organizations that establish quality seed production nuclei and to validate its use in those organizations that produce cocoa seed within the Plan Semilla framework.

Materials and methods

In the first phase, we carried out a literature review in order to identify the theoretical approaches, methodologies, and tools used for the diagnostics of small-farmer associative organizations in the agrarian sector; through this review, we identified some elements that affect the success of the agrarian organizations. The collective action logic (Olson, 1971; Ostrom and Ahn, 2003; Gordon, 2005; Payne, 2016) and some tools used for organizational diagnoses such as IDEO, ICO, Canvas, and RUTA were highlighted. We analyzed the tools that Corpoica (2015) used for characterization of the organizations that participated in the previous phases of Plan Semilla and we reviewed the variables and indicators implemented by the producer organizations that have participated in the plan.

In the second phase, for an analytical model that evaluates the performance of small-farmer organizations, the

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Analytical Hierarchy Process -AHP- (Saaty, 1980) and the most commonly used multi-criteria decision making methods -MCDM- (Velasquez and Hester, 2013), related with the Multi-Attribute Utility Theory methods -MAUT- (Fishburn, 1967; Keeney and Fishburn, 1974; Keeney, 1977) are useable methods. These methods are widely used to analyze and resolve problems of multiple scenarios, characters, and criteria providing alternatives (Moreno-Jiménez, 2002). The AHP has been frequently used in recent years (Ho, 2008; Sipahi and Timor, 2010). Its main applications for agricultural issues include: various assessments of sustainability of agricultural systems (Parra-López *et al.*, 2008; Rezaei-Moghaddam and Karami, 2008; Veisi *et al.*, 2016), an analysis of extension systems (Allahyari, 2009), and decision-making related with agriculture in the developing countries (Alphonce, 1997) and producer organizations in the agricultural sector (Aranda-Camacho *et al.*, 2014).

The AHP allows modeling the problem by recognizing hierarchical relationships of a set of elements (dimensions, criteria, and subcriteria) of a qualitative and quantitative nature. These are logically arranged allowing different people or groups of interest to participate in analysis and assessment (Forman and Selly, 2001). To assess a model, the consulted participants comparatively judge each pair of elements belonging to the same node and level of the hierarchy using a common scale (Saaty, 1980). Through the aggregation of individual judgments (AIJ) (Forman and Peniwati, 1998) it is possible to estimate local weights attributed by the members of the evaluating group. This evaluation defines the relative importance of the elements belonging to the same node and level in the hierarchy of the model. Then, after the synthetic process, it is possible to estimate global weights that show the relevance of each element compared to all the others that comprise the model. Likewise, by using the AHP method, it is possible to verify the consistency of judgments and perform sensitivity analyses (Pacheco and Contreras, 2008). This improves the procedural rationality used for the analysis of the decisions of the studied problem (Velasquez and Hester, 2013).

The model incorporating determinant elements in the design of inclusive businesses and competencies of organizations of the agrarian sector (previously commented in the introduction) was designed following proposals of the AHP. This first model was submitted to seven experts (academics and researchers with experience in technical issues of seed production, agrarian economics, innovation and organizations of agricultural producers) to verify the pertinence of the model's elements. The recommendations of the experts were incorporated into the model for its adjustment. Elements were subsumed, debugged and organized, complying with the properties of completeness, operability, decomposability, non-redundancy and minimality that are required for modeling (Saaty, 1980; Aranda, 2015).

The goal at the first level of the analytical model was to establish the capacities and resources available for the organization in order to consolidate itself as a quality seed production nucleus. In the second level of the model's hierarchy, there are four dimensions (technical capacities, environmental resources, organizational capacities, and management capacities) that condition the consolidation of seed production nuclei of associative organizations, and these have 12 criteria and 39 sub-criteria relating to these four dimensions (Fig. 1).

Phase 3 consisted of the evaluation stage: we designed a questionnaire and a glossary with the definitions of the elements of the model and their respective graphic representation. For the estimations of the model, we consulted a group of 11 experts with specific knowledge of seed production, the agricultural and rural organizations, and agrarian technical assistance (managers, academics, researchers and professionals who provide technical and organizational assistance). These experts provided comparative value judgments between pairs of elements belonging to the same node and model level, using the Saaty (1980) scale. Before prioritization and synthesis, we used the AIJ technique (Forman and Penniwati, 1998) to build matrices of group judgments, from which we estimated the importance weights of each of the elements of the model. We first estimated the local importance weights, and after their synthesis, we obtained weights of global importance. Then, we verified the inconsistency index. We processed the data using the Expert Choice software version 11.

In the fourth phase, we used information from 30 cocoa seed producer organizations participating in Plan Semilla in order to validate the application of the model. These organizations are located in the provinces of Santander (8 organizations), Antioquia (4 organizations), Huila (6 organizations), Tolima (1 organization), Nariño (1 organization), Norte de Santander (3 organizations), Cesar (1 organization) and Boyaca (6 organizations). We obtained information of small-farmer organizations that implemented cocoa seed quality productive nuclei through the compilation of the instruments applied by Agrosavia between 2013 and 2015. Based on this information, we obtained indicators relating to the sub-criteria of the last model level.

To establish the degree of performance of organizations, we estimated the additive utility functions (Keeney and Raiffa, 1976; Fishburn, 1982) using the obtained information. First, we calculated a partial utility for each dimension, which was obtained as the product of the estimated global weight for each element of the last level (sub-criteria) and the value of the indicator related to these sub-criteria for each organization. Secondly, we calculated the total utility by adding the partial profits obtained previously. We repeated this procedure for each of the 30 organizations used as cases. These utility functions reflected the degree of performance of each of the evaluated organizations related to each one of the dimensions and the global performance.

To establish the ranges of the performance thresholds of the organizations as model decision alternatives, we performed a cluster analysis using the Ward method for the conglomeration. We used the Euclidean squared distance metric for both the partial utility of each dimension and also for the total utility. We used the value of the 5% cut-off average to obtain whisker plots with the respective upper and lower limits from which we established the ranges of the cut-off thresholds for three performance levels: high performance, average performance, and low performance. Once the performance levels with the utility values were established, we classified the organizations according to their performance. We analyzed the data with the software Statgraphics Centurion XVI and Excel.

Results and discussion

The AHP model for evaluating the performance of associative organizations that produce quality seeds

Based on the literature of various diagnostic methods of organizations and after a thorough analysis of the tools used within the framework of Plan Semilla (Corpoica, 2015), we identified the main criteria for characterizing and diagnosing seed producer organizations. Summarizing the above, it was possible to establish three dimensions constituted by 214 criteria and sub-criteria. Then, an exhaustive purification of these criteria was carried out, incorporating the comments and suggestions of the experts consulted in the first and second stages. Finally, we generated an analytical model including a main objective, four dimensions, 12 criteria and 39 sub-criteria (Fig. 1).

The first level of the model is the general objective to establish the level of capacities and resources available for the organization wishing to consolidate as a nucleus of quality seed production.

In the second level, four dimensions were found: (1) *Technical capacities* refering to the organizations linked to Plan Semilla that have the necessary knowledge and experience for the use, production, and management of good quality seed; (2) *Environmental resources,* the entire environmental conditions (soil, water, biophysical offer, etc.) that the territory in which the organizations are located have available for its use; (3) *Organizational capacities*, includes all the aspects that contribute to the personal and collective growth of the members of the association, highlighting characteristics that lead to the success of an organization. This also involves all the necessary actions for achieving a better position, including being more competitive, achieving its objectives, goals, fulfilling commitments, ensuring its continuity and projecting the organization into the future; (4) *Management capacities*, those abilities of the organizations relating to the administration of their financial, administrative, and commercial talents. This also includes all those relationships that occur with external entities, for the purpose of creating partnerships that are beneficial to the organization, and knowing the capacities that they have to obtain resources that can be used as capital, projects dealing with production, among others.

In the third level of the model are found the criteria relating to each of the dimensions. Regarding the technical capacities dimension, the criteria are as follow: a) *Production process,* which covers the main activities carried out by organizations at the technical and environmental levels to be able to produce and manage seeds that meet quality standards; and b) *Production resources*, refering to all the physical and human resources available in organizations to carry out seed production processes.

The criteria related to the environmental resources dimension are as follow: c) *Environmental offering*, which corresponds to all natural or biophysical resources that are part of the territory where the organization is located (such as soil, water, humidity, temperature, among others), that comprise seed production activity; d) *Threats due to natural phenomena* defining natural threats as those elements of the environment that are dangerous to humans and that are caused by external forces.

The organizational capacities dimension includes criteria such as e) *Social and relational capital,* that refers in particular to the degree of trust between members including the unlimited exchange of information within the group; f) *Experience in the development of collective actions,* which starts from the recognition that as individuals, members do not have all the necessary information, resources, and
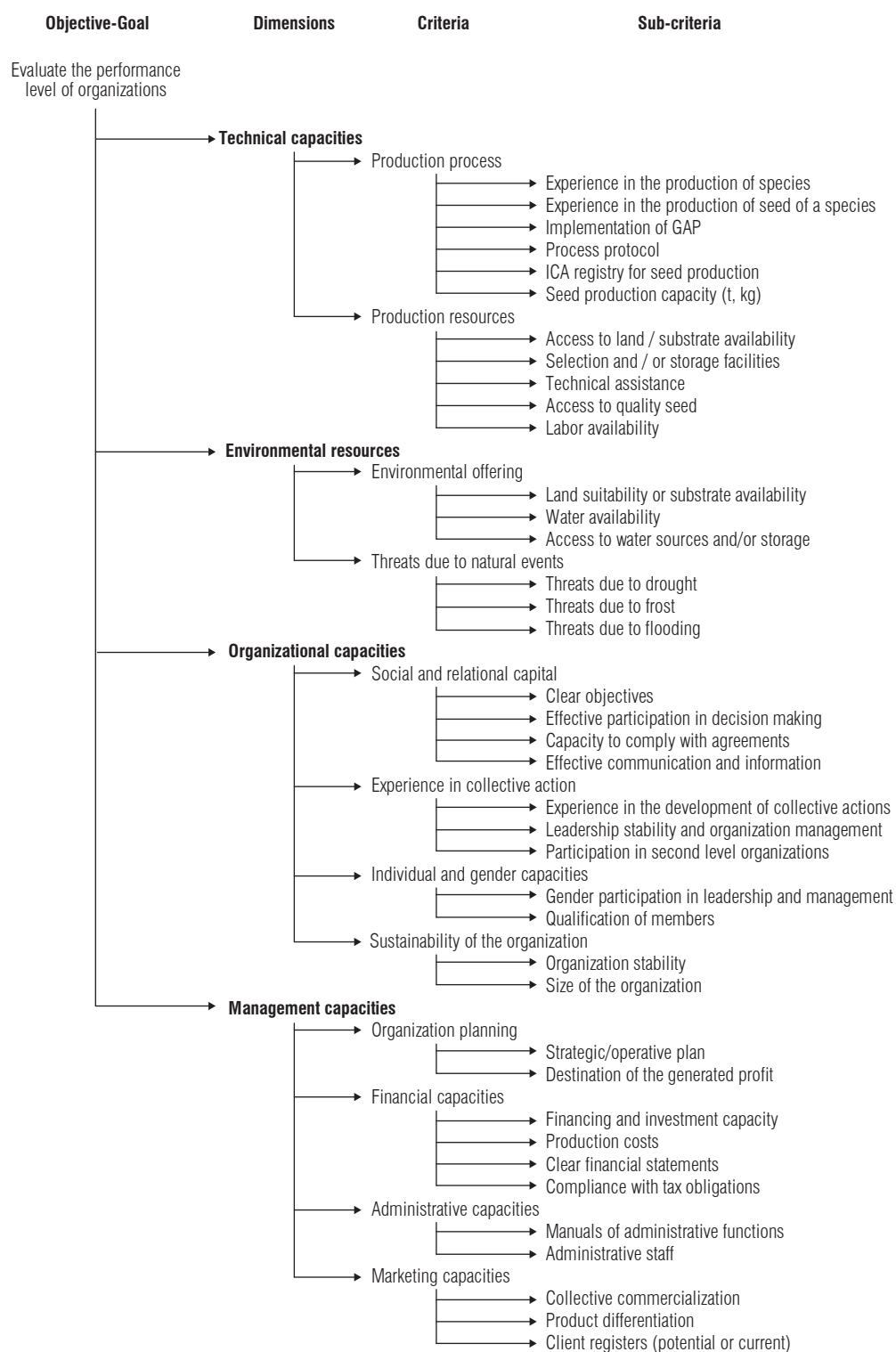
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Objective-Goal	Dimensions	Criteria	Sub-criteria

Evaluate the performance level of organizations

Technical capacities
- Production process
  - Experience in the production of species
  - Experience in the production of seed of a species
  - Implementation of GAP
  - Process protocol
  - ICA registry for seed production
  - Seed production capacity (t, kg)
- Production resources
  - Access to land / substrate availability
  - Selection and / or storage facilities
  - Technical assistance
  - Access to quality seed
  - Labor availability

Environmental resources
- Environmental offering
  - Land suitability or substrate availability
  - Water availability
  - Access to water sources and/or storage
- Threats due to natural events
  - Threats due to drought
  - Threats due to frost
  - Threats due to flooding

Organizational capacities
- Social and relational capital
  - Clear objectives
  - Effective participation in decision making
  - Capacity to comply with agreements
  - Effective communication and information
- Experience in collective action
  - Experience in the development of collective actions
  - Leadership stability and organization management
  - Participation in second level organizations
- Individual and gender capacities
  - Gender participation in leadership and management
  - Qualification of members
- Sustainability of the organization
  - Organization stability
  - Size of the organization

Management capacities
- Organization planning
  - Strategic/operative plan
  - Destination of the generated profit
- Financial capacities
  - Financing and investment capacity
  - Production costs
  - Clear financial statements
  - Compliance with tax obligations
- Administrative capacities
  - Manuals of administrative functions
  - Administrative staff
- Marketing capacities
  - Collective commercialization
  - Product differentiation
  - Client registers (potential or current)

FIGURE 1. AHP model for establishing the performance of an organization to consolidate quality seed production nuclei.

competencies required to meet a specific demand; g) *Individual capacities and gender,* which identifies if rural organizations apply the gender approach to recognize the capacities of the organization through the educational level of its members; h) *Sustainability of the organization,* the composition and functioning of the organization, in which the participation of the associates in decision-making processes and the way these processes will be conducted are identified.

Finally, management capacities criteria include: i) *Organization planning,* the organizations linked to Plan Semilla establish goals and stipulate the steps that must be followed to achieve these aims; j) *Financial capacities:* possibilities that organizations have to perform payments and investments (caused by good profit margins) in the short, medium and long terms, for their development and growth; k) *Administrative capacities,* related to the management staff that the organization has, as well as the way in which economic resources are managed and invested; l) *Marketing capacities:* strategies that will be used to sell a certain product, and in the end, the desired profitability that is achieved.

Nonetheless, sub-criteria are included in the fourth and final level (Fig. 1), and verifiable indicators are related to each of these sub-criteria, which allow the establishment of the performance of the organizations.

Estimation of priorities of the elements of the model based on the preferences of the consulted experts

Table 1 summarizes the local weights (W_L) and global weights (W_G) associated with the dimensions, criteria, and sub-criteria of the hierarchical model. In all cases, the consistency index was less than 10%, showing the logical consistency of the weights obtained in the estimation.

Likewise, the ranking of the weights of each element is presented in relation to the level to which it belongs.

At a second level, the group of experts expressed that the dimension that had greater importance was *Environmental Resources* (W_G 0.27); second, *Technical Capacities* (W_G 0.25); third, *Organizational Capacities* (W_G 0.24), and, finally, the *Management Capacities* dimension (W_G 0.23) (Tab. 1). The group of experts has assigned a degree of similar importance to the four dimensions of the model, and in most cases, the difference is only 2 percentage points.

It is important to emphasize that in the previous methodological proposals used by Agrosavia to characterize organizations in Plan Semilla there was no dimension relating to environmental issues. In this research, the *Environmental Dimension* was incorporated in a novel way following the recommendation of the experts who evaluated the relevance of the model. The environmental component is fundamental for the development of productive activities in rural areas, due to conflicts in the access and use of natural resources such as soil and water; rural populations face vulnerability to the development of productive activities due to phenomena such as climate change, natural disasters and the risks inherent to agriculture (Muñoz *et al.*, 2012).

TABLE 1. Weights of importance and ranking of priorities of the model elements based on the preferences declared by the consulted experts.

ELEMENTS OR NODES OF THE AHP MODEL	Priorities by node		Ranking of priorities		
Level 1 (Objective) Level 2 (Dimensions)					
Level 3 (Criteria) *Level 4 (Sub-criteria)*	W_L	W_G	Dimension	Criteria	Sub-criteria
Technical capacities	**0.253**	**0.253**	**2**		
Production process	0.537	0.136		2	
Experience in the production of the species	0.192	0.026			13
Experience in the production of seed of the species	0.218	0.03			9
Implementation of good agricultural practices - GAP	0.037	0.019			22
Process protocol	0.159	0.022			18
ICA registry for seed production	0.156	0.021			19
Seed production capacity	0.138	0.019			23
Production resources	0.463	0.117		4	
Access to land	0.179	0.021			20
Selection and/or storage facilities	0.165	0.019			24
Technical assistance	0.204	0.024			16
Access to quality seed	0.222	0.026			14
Labor availability	0.231	0.027			12

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Table 1. *Continuation*

| ELEMENTS OR NODES OF THE AHP MODEL	Priorities by node		Ranking of priorities		
Level 1 (Objective)					
Level 2 (Dimensions)					
Level 3 (Criteria)					
Level 4 (Sub-criteria)	W_L	W_G	Dimension	Criteria	Sub-criteria
Environmental resources	**0.270**	**0.27**	**1**		
Environmental offering	0.488	0.132		3	
Land use suitability - TUT or substrate availability	0.311	0.041			7
Water availability	0.329	0.044			6
Access to water sources and/or storage	0.359	0.047			3
Threats due to natural events	0.512	0.138		1	
Threat due to drought	0.521	0.072			2
Threat due to frost	0.142	0.02			21
Threat due to flooding	0.337	0.047			4
Organizational capacities	**0.242**	**0.242**	**3**		
Social and relational capitals	0.232	0.056		10	
Clear objectives	0.412	0.023			17
Effective participation in decision making	0.156	0.009			38
Capacity to comply with agreements	0.274	0.015			30
Effective communication and information	0.158	0.009			39
Experience in collective action	0.239	0.058		9	
Experience in the development of collective actions	0.517	0.03			10
Leadership stability and organization management	0.298	0.017			27
Participation in second level organizations	0.185	0.011			37
Individual and gender capacities	0.170	0.041		12	
Gender participation in leadership and management positions	0.310	0.013			35
Qualification of members	0.690	0.028			11
Sustainability of the organization	0.359	0.087		5	
Organization stability	0.837	0.073			1
Size of the organization	0.163	0.014			33
Management capacities	**0.234**	**0.234**	**4**		
Organization planning	0.255	0.06		8	
Strategic/operative plan	0.749	0.045			5
Destination of the generated profit	0.251	0.015			31
Financial capacities	0.272	0.064		7	
Financing and investment capacity	0.270	0.017			28
Cost production registry	0.208	0.013			36
Clear financial statements	0.303	0.019			25
Compliance with tax obligations	0.219	0.014			34
Administrative capacities	0.187	0.044		11	
Manuals of administrative functions	0.425	0.019			26
Administrative staff	0.575	0.025			15
Marketing capacities	0.287	0.067		6	
Collective commercialization	0.526	0.035			8
Product differentiation	0.247	0.017			29
Client registers (potential or current)	0.227	0.015			32

Local weights (W_L) - Global weights (W_G).
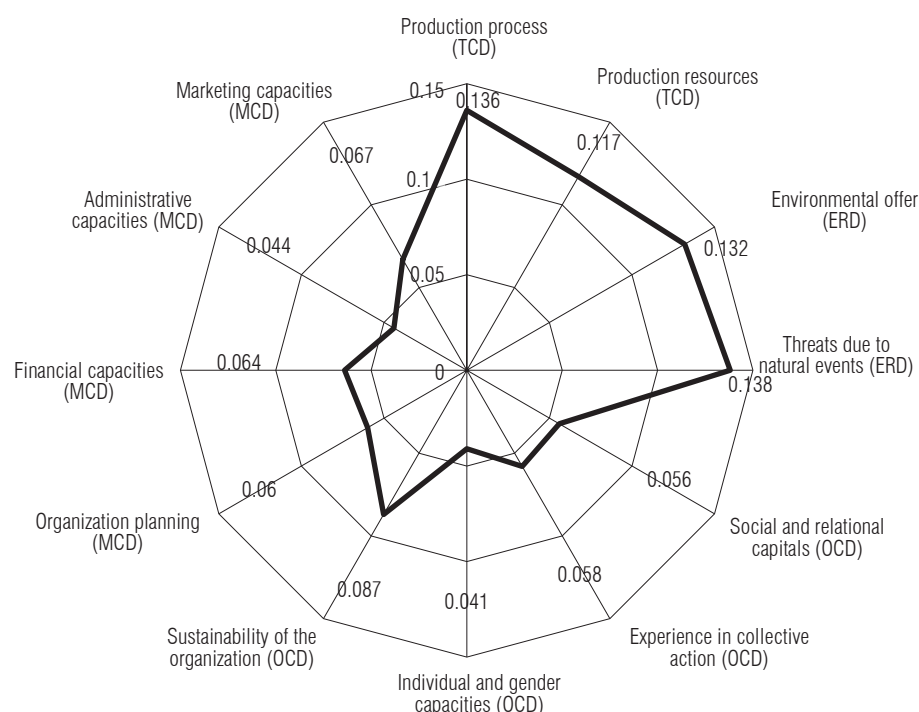
FIGURE 2. Results of Global priorities (W$_L$) at the level of criteria estimated in the AHP model. (TCD) - Technical capacities dimension; (ERD) - Environmental resources dimension; (OCD) - Organizational capacities dimension; (MCD) - Management capacities dimension.

With relation to the priorities obtained in the *Technical Capacities* dimension, the *production process* criterion (W$_L$ 0.537) is considered the most important, whereas *production resources* obtained a W$_L$ of 0.463. After the synthesis of the model at the level of the general objective, the *production process* ranked second taking into account all the model criteria (W$_G$ 0.136), whereas *production resources* ranked fourth among 12 criteria in the third level of the model. Therefore, the organizations that focus on the production of quality seed must have adequate knowledge and experience in the production of both the species and the seed in order to ensure product quality.

Regarding the *Environmental Resources* dimension, the *threat due to natural phenomena* occupied the first place in the ranking of all criteria of the model (W$_L$ 0.512; W$_G$ 0.138). On the other hand, the *environmental offer* criterion was ranked, after the synthesis at the general objective level of the model, as the third criterion in order of importance (W$_L$ 0.488, W$_G$ 0.132). According to the consulted experts, the threat that agricultural producers face due to natural phenomena turns out to be an element of transcendental knowledge, in order to anticipate the occurrence of these phenomena and minimize the risk to which they are exposed through the implementation of measures for their mitigation. In this regard, FAO (2000) states that the

vulnerability of production systems increases when agricultural activities use unfit areas or lands, or places that are at risk, or when natural resources are mismanaged. This is especially due to marginality, poverty, the absence of social organization, and above all to the lack of policies for the management of the environment. Additionally, territorial planning and the lack of education of the population is unable to prevent and face the risks surely plays an important role. Therefore, besides having access to adequate information on agroclimatic variables, producer organizations that establish nuclei of quality seed production should strive to training their members on issues relating to water management and, in particular, they should comply with soil use zoning according to their suitability for the species that they are producing in the particular locality (FAO, 2000).

At the *Organizational Capacities* dimension, the *sustainability of the organization* criterion stands out in fifth place among all criteria (W$_G$ 0.087), whereas the *collective action experience* criterion ranked second in this group (W$_L$ 0.239) and it ranked ninth (W$_G$ 0.058) when performing the synthesis among all criteria. The foregoing indicates that one of the success factors of an organization is the strength it has to maintain itself through time under different circumstances (Lundy *et al.*, 2014). According to the preferences declared by the experts, it is strange that

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collective action, social and relational capital, and individual capacities and gender have been classified among the last elements at the criteria level. This may be due to the technical profile of some of the consulted experts who did not completely categorize the importance of these elements for establishing collective initiatives around the associated companies producing quality seeds. The social and relational capital criterion (W_L 0.232, W_G 0.056) was ranked tenth in the ranking of all criteria of the model. This result contrasts with what was stated by Serageldin (1998), who presents empirical evidence on the relevance that social capital acquires for the development of collective actions by small agricultural producers. However, the results of the estimation of this model by the consulted experts reached no agreement about the particular ways in which social capital contributes to development and how it can be operationalized. The individual capacities and gender criterion is located in the fourth place (W_L 0.17, W_G 0.041) of the criteria associated with the organizational capacities dimension. This is the last criterion among all models that indicates low recognition of the importance of female participation in managerial roles and also low recognition of the importance of the capacities of the associates in general.

Finally, in the criteria related to the Management Capacities dimension, the experts attributed a greater weight to marketing capacities (W_L 0.287, W_G 0.067) and this places it at sixth place in the general level of the ranking of the criteria. This position acknowledges the importance attributed by experts for organizations to strengthen their management capacities to implement value-added strategies that help to clearly identify current and potential clients, for whom the products will be oriented. Nonetheless, the financial capacities criterion (W_L 0.272, W_G 0.064) ranked seventh among all criteria. The Organization planning criteria (W_L 0.06, W_G 0.044) was ranked eighth among all the criteria of the model. In the dimension of management capacities, the group attributed the least importance to the administrative capacities criterion (W_L 0.187, W_G 0.044) and it was classified in tenth place among the twelve criteria of the model. Among the previous criteria, marketing capacities stands out; in this respect Knickel et al. (2008), Schermer et al. (2010) and Anderson et al. (2014) showed empirical evidence on the importance of skills, knowledge and market competencies for agrarian producer organizations that seek to articulate agri-food systems and how these skills are becoming tools that facilitate community development. Additionally, these skills also ensure that producers have access to markets and participate in them in a more democratic way at multiple scales.

In Colombia, Aranda-Camacho and Parrado (2016) showed the importance of these capacities so that agricultural producers achieve the development of markets that favor food and nutritional security. This could apply to the specific field of quality seed production. Aranda-Camacho et al. (2017) detail some specific actions developed to strengthen capabilities, both individual and collective. These actions were implemented in a scaling-up project of technical innovations (three new cultivars of more nutritive yellow potatoes). The project had the participation of small-farmer organizations that established nuclei of quality seed production and developed inclusive businesses in localities in the south and center of the Andean region of Colombia (Cuéllar et al., 2018).

The above-mentioned empirical evidence shows the importance of the fact that organizations must strengthen their management skills and knowledge of the market so that they can undertake the development of strategies that encourage added value to their products, directing specific promotion activities for current and potential customers. In order to guarantee the development of small-farmer organizations in the marketplace, it is important that seed producer organizations have adequate capabilities that allow the development of mutually beneficial collective actions (Cuéllar et al., 2018). In spite of this, in our national context, the producers and their organizations have few capacities to successfully develop their commercial functions. In general, this conditions the efficiency of the commercialization of their products (which are sometimes excluded) or presents limitations for small producers to achieve associative ventures.

The priorities assigned by the consulted experts indicate that, in any organization, it is important to strengthen marketing and commercialization capacities. In order to do so, knowledge of the dynamics and structure of the market is fundamental, so that organizations can participate effectively in it. However, in the context of this article, commercialization is the part of the commercial process in which producers and their organizations are less trained. This affects the efficiency with which products are linked to the market. Thus, products are excluded and limitations arise for small producers to achieve sustainable associative ventures (Rodríguez and Fernandez, 1996).

To summarize, after estimating the model based on the preferences declared by the expert consultants, the most important criteria for establishing nuclei of quality seed production are the threats due to natural phenomena, the previous experience in the production of the species,

an adequate environmental offering, the availability of production resources and the sustainability of the organization. Conversely, the least important criteria are those related to organizational and management capacities such as social and related capital, administrative capacities, and individual capacities and gender.

In the fourth level of the model, the following sub-criteria stand out due to their placement in the ranking: the *stability of the organization*, *threats due to drought*, *access to water sources and/or storage*, *threats due to flooding* and the *strategic/operational plan*, all of which are located in the first five places, respectively. It is worth mentioning that three of the five most important sub-criteria are related to the *Environmental Resources* dimension, which was the one

that obtained the highest degree of importance within the dimensions consulted by the experts.

Empirical validation of the model in associative organizations that establish nuclei of quality cocoa seed production

Using the estimated weights defined by the expert consultants of each sub-criteria related to the analyzed dimensions, we proceeded to calculate utility functions for each of the 30 associative organizations that implemented nuclei of quality cocoa seeds. We selected verifiable indicators related to the elements of the last level (sub-criteria), which we used to estimate utility functions as the Multi-Attribute Utility Theory (MAUT) (Fishburn, 1967; Keeney and Fishburn, 1974; Keeney and Raiffa, 1976; Keeney, 1977).
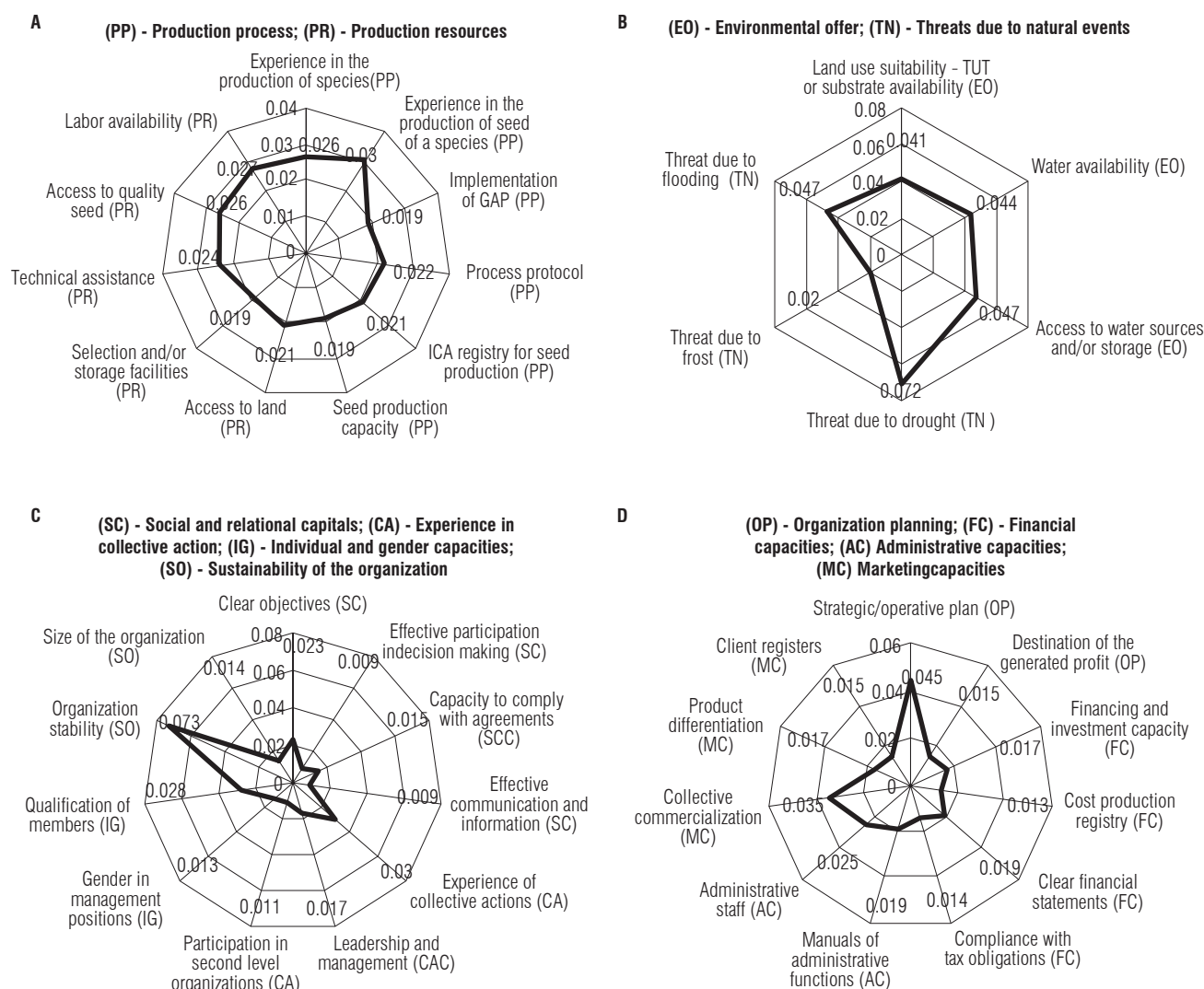

FIGURE 3. Results of Global priorities (W_G) at the sub-criteria level estimated for the AHP model. a) W_G of sub-criteria of the Technical Capacities Dimension; b) W_G of sub-criteria of the Environmental Resources Dimension; c) W_G of sub-criteria of the Organizational Capacities Dimension; d) W_G of sub-criteria of the Management Capacities Dimension.

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The scale used to qualify each indicator in the 30 cases of cocoa seed producer organizations that had information was 0, 1 and 2 (i.e. low level (0) to a high level (2)).

Once the functions of partial and global utility were obtained for each organization, we performed a cluster analysis, and with these results, we proposed three performance levels: high performance, average performance, and low performance. We determined the cut-off thresholds using whisker plots with a value of 5% for constructing the respective upper and lower limits (Tab. 2).

Table 3 shows the performance of the 30 associative organizations that participated in the Plan Semilla framework and that were analyzed in this research. The results presented allow distinguishing the level of performance achieved by each organization based on the partial utility for each analyzed dimension, and also the level of global performance of each of the organizations.

The results show that four organizations stand out for their global performance: Coopercacao (Santander), Aprocafrum (Santander), Aprocampa (Boyaca) and Asocati

TABLE 2. Total profit thresholds defined to establish the levels of performance of cocoa seed producer organizations.

Dimensions	W_G of the dimension	Maximum dimension utility	Cutting thresholds* Low performance		Cutting thresholds* Medium performance		Cutting thresholds* High performance	
			Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
Technical dimension	0.254	0.598	0	0.315	0.316	0.400	0.401	0.598
Environmental dimension	0.270	0.542	0	0.105	0.106	0.19	0.191	0.542
Organizational dimension	0.242	0.640	0	0.308	0.309	0.454	0.455	0.64
Management dimension	0.234	0.594	0	0.235	0.236	0.351	0.352	0.594
Total utility	1.000	2.374	0	0.997	0.998	1.306	1.307	2.374

*Thresholds cluster dimension obtained with truncated mean of 5%.

TABLE 3. Levels of performance of cocoa producer organizations - Plan Semilla.

Case	Organization	Partial Utility Performance Technical dimension		Partial Utility Performance Environmental dimension		Partial Utility Performance Organizational dimension		Partial Utility Performance Management dimension		Total Utility Global performance	
1	APROCAMPO 27	0.168	L.P.	0	L.P.	0.151	L.P.	0.117	L.P.	0.436	L.P.
2	ASOPECA	0.168	L.P.	0.144	M.P.	0.164	L.P.	0.187	L.P.	0.663	L.P.
3	APROCAPAL	0.288	L.P.	0.144	M.P.	0.138	L.P.	0.152	L.P.	0.722	L.P.
4	MUZCACAO	0.329	M.P.	0.094	L.P.	0.194	L.P.	0.168	L.P.	0.785	L.P.
5	ASOPAICOL -ASOCACAO	0.28	L.P.	0.144	M.P.	0.232	L.P.	0.152	L.P.	0.808	L.P.
6	ASOHUPAR	0.288	L.P.	0.144	M.P.	0.178	L.P.	0.221	L.P.	0.831	L.P.
7	ASAPA	0.28	L.P.	0.144	M.P.	0.229	L.P.	0.202	L.P.	0.855	L.P.
8	ASOPROCAL	0.31	L.P.	0.144	M.P.	0.215	L.P.	0.187	L.P.	0.856	L.P.
9	ASOCAT	0.384	M.P.	0.094	L.P.	0.249	L.P.	0.149	L.P.	0.876	L.P.
10	ASOPROCAMU	0.282	L.P.	0.144	M.P.	0.274	L.P.	0.206	L.P.	0.906	L.P.
11	ASOPROLAN	0.456	H.P.	0.094	L.P.	0.193	L.P.	0.168	L.P.	0.911	L.P.
12	ASOCAVAL	0.378	M.P.	0.072	L.P.	0.218	L.P.	0.269	M.P.	0.937	L.P.
13	APRASEF	0.336	M.P.	0	L.P.	0.418	M.P.	0.186	L.P.	0.94	L.P.
14	ASOPROCAR	0.331	M.P.	0.144	M.P.	0.283	L.P.	0.197	L.P.	0.955	L.P.
15	ASOCASAR	0.274	L.P.	0.144	M.P.	0.33	M.P.	0.221	L.P.	0.969	L.P.
16	ASOCATIGRA	0.349	M.P.	0.144	M.P.	0.356	M.P.	0.212	L.P.	1.061	M.P.
17	Consejo Comunitario Tablon Dulce	0.345	M.P.	0.166	M.P.	0.436	M.P.	0.173	L.P.	1.12	M.P.

Continue...

Table 3. *Continuation*

Case	Organization	Partial Utility Performance Technical dimension		Partial Utility Performance Environmental dimension		Partial Utility Performance Organizational dimension		Partial Utility Performance Management dimension		Total Utility Global performance	
18	ASOMUCARI	0.271	L.P.	0.144	M.P.	0.504		0.202	L.P.	1.121	M.P.
19	APROCASUR	0.376	M.P.	0.072	L.P.	0.435	M.P.	0.238	M.P.	1.121	M.P.
20	APROCESU	0.427	H.P.	0.072	L.P.	0.356	M.P.	0.272	M.P.	1.127	M.P.
21	EL MANANTIAL	0.3	L.P.	0.144	M.P.	0.402	M.P.	0.282	M.P.	1.128	M.P.
22	ASOCAM	0.308	L.P.	0.144	M.P.	0.434	M.P.	0.247	M.P.	1.133	M.P.
23	CIPAOTANCHE	0.279	L.P.	0.144	M.P.	0.457		0.264	M.P.	1.144	M.P.
24	ASOCACABO	0.324	M.P.	0.144	M.P.	0.434	M.P.	0,316	M.P.	1.218	M.P.
25	CORTIPAZ	0.442	H.P.	0.072	L.P.	0.499	H.P.	0.218	L.P.	1.231	M.P.
26	ASOCAP	0.305	L.P.	0.238	H.P.	0.513	H.P.	0.197	L.P.	1.253	M.P.
27	COOPERCACAO	0.343	M.P.	0.144	M.P.	0.49	H.P.	0.434	H.P.	1.411	H.P.
28	APROCAFRUM	0.379	M.P.	0.238	H.P.	0.522	H.P.	0.283	M.P.	1.422	H.P.
29	APROCAMPA	0.464	H.P.	0.238	H.P.	0.495	H.P.	0.278	M.P.	1.475	H.P.
30	ASOCATI	0.397	M.P.	0.238	H.P.	0.5	H.P.	0.417	H.P.	1.552	H.P.

H.P. High performance; M.P. Medium performance; L.P. Low performance.

(Norte de Santander); these showed a high level of performance (13%). Eleven organizations corresponding to 37% showed an average level of performance, whereas 15 organizations (50%) showed a low level of performance.

The analytical model developed in this research has allowed the characterization of the organizations based on the level of performance of the analyzed dimensions, improving the procedural rationality used until now within the framework of Plan Semilla. The obtained results have allowed identifying with greater clarity and certainty the areas in which organizations are considered to have a low degree of performance. Given the attributes of the hierarchical composition of the designed model, the model can be used to propose specific actions to improve those criteria that are considered strategic in order to contribute to correcting and improving the capacities for the consolidation of quality seed production nuclei.

Some of the actions that could be implemented to design plans to strengthen the capacities of organizations may be the following: organizations with low performance in the environmental resources dimension should prioritize training actions to develop capacities to identify the agroclimatological risks they might face and that could affect the procurement of quality seed. They must also acquire skills and knowledge to take appropriate measures for both the prevention and mitigation. In organizations with low performance in the organizational dimension, actions

that lead to the strengthening of individual and collective capacities to comply with agreements and norms should be implemented. Leadership issues should be considered so as to improve the participation of the associates and their capacities so that they assume management positions. This could improve the probability of success of the undertakings carried out by rural organizations. In order to strengthen management capabilities in those organizations that show low performance, specific actions could be taken to lead organizations and their members to acquire skills and abilities for strategic planning, monitoring, and analysis of production costs. In addition, these organizations should implement the use of records to determine the unit cost and, in turn, the profitability of the business.

Conclusions

The identification of the variables relating to technical, economic, social, organizational, managerial and regulatory components, among others, should influence the adequate consolidation of nuclei of quality seed production by collective organizations of small agricultural producers. It has been an expensive and complex process that has required a great capacity of synthesis to select those elements that could be more representative for the purpose of this research.

The environmental resources dimension, considered the most important after estimating the model in this research,

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has been incorporated in a novel way compared to other methodologies used to characterize organizations in the agricultural sector. This dimension had not been taken into account in the characterizations made by Plan Semilla, due to the specificity of the resources and dimensions required for the production of quality seed.

The AHP has been used in a novel way as a discrete method of multicriteria decisions, which allows improving the procedural rationality required to analyze complex scenarios influenced by multiple variables like agricultural producer organizations. Nonetheless, the developed methodology and the results obtained have allowed a reduction in the level of subjectivity with which agricultural sector organizations are traditionally defined.

Using the Multi-Attribute Utility Theory (MAUT), it was possible to calculate additional utility functions that incorporate both the weight of importance associated with the elements of the model in each of its levels as well as the performance of organizations based on verifiable indicators.

Based on calculated utility values and cluster analysis, it has been possible to establish cut-off thresholds that have allowed the construction of relative performance ranges (low, medium and high) that allow rating and ranking performances (partial and total) of producer organizations currently seeking to consolidate nuclei of quality seed production. This allows the identification and selection of those elements that are considered as weaknesses in an organization and that requires the development of specific actions to strengthen them to achieve sustainability as associative enterprises that produce cocoa seeds.

We consider that the selected elements are universal for organizations that produce seeds; nevertheless, it is necessary to establish new thresholds to define the levels of performance if the model is used for other species.

It is important that institutions that work with organizations of agricultural producers develop research projects with prior implementation of appropriate intervention actions in the processes of characterization. It is necessary to have, from the beginning, conceptual and methodological clarity about the scope of the project, and for the use of the appropriate tools for the exercises of organizational typification. This should be done in order to propose pertinent actions according to the needs that the organizations face as well as to strengthen their capacities of collective action and social capital at technical and social-business levels, which are key for the development of any joint initiative.

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