Innovation Scenarios for Ecuadorian Agrifood Network

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Abstract

The purpose of this study is to explore plausible scenarios and identify the desired scenario for the agrifood beef network in Santo Domingo, Ecuador until 2035. A methodological approach based on the processes of participation and collective reflection is proposed, which integrates methods from the French School of Prospective and The Futures Triangle V. 2.0. Four plausible scenarios were developed for the object of study: Innovate Against the Tide, National Pioneers, Obsolescent Gait, and Missed Opportunity. Of these, National Pioneers was deemed the desired scenario, because it integrates high innovation in the beef agrifood network with favorable environmental conditions. This study contributes to anticipating the evolution of Santo Domingo's innovation in the agrifood network, which can promote a favorable trajectory for the province's sustainable development.

Keywords: scenarios; futures studies; innovation; prospective; foresight; agrifood networks

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Introduction

Cattle ranching has transformed the socio-spatial dynamics of the province of Santo Domingo de Los Tsáchilas in Ecuador (Rivas et al., 2016). This territory has gone from being a land of sparse settlements in the 1970s to hosting the third most populated city in Ecuador (Gondard, Mazurek, 2001). The presence of land with high agricultural potential, the relevant expertise of the population, the growth of a local consumer market, and its location between the country's two main cities (Quito and Guayaquil) has boosted the province's development. However, the complexity of the agrifood system and the volatility of the behavior of its variables generate uncertain scenarios that call into question the system's capacity for innovation and development in the medium and long terms.

Futures studies rely on using tools that reduce the level of uncertainty for decisionmakers and allow for the construction of knowledge inputs to coordinate the actions of various actors to guide the development of the territories toward the desired scenarios. In this context, this study designs potential scenarios for the evolution of the agrifood beef network in the province of Santo Domingo de Los Tsáchilas (hereafter ABNSDT) up to 2030. In doing so, we hope to map the opportunity space, including different variables and pathways, that should be considered for the modernization of beef agrifood networks in Latin America using the ABNSDT case.

Conceptual Foundations: Future Studies and the Agrifood Sector

The field of Futures Studies articulates diverse perspectives and paradigms for exploring the potential residing in different futures. According to (Ortega, 2016), four schools are predominant, as shown at Table 1 – prospective, forecasting, foresight, and human and social welfare.

This research is based on the postulates of the Prospective school of thought, because this discipline favors participation and collective reflection, as well as the development of interdisciplinary studies. In addition, being premised on a voluntarist Futures Studies school of thought, the Prospective approach possesses a constructive focus and global vision, it employs quantitative and qualitative variables – both known and potential, it considers dynamic relationships, is based on mixed models, and contemplates the future as multiple and uncertain (Godet, Durance, 2011). This comprehension of the future surpasses a determinist perspective, which maintains a predictive vision and considers the future unitary and knowable.

The Prospective school of thought has been consolidated as a discipline through the contributions of three intellectuals: Berger (1957), from a philosophical approach, gave it the name Prospective; De Jouvenel (1967), as a political scientist, integrated the concept of futuribles – possible futures; Godet (1993), with his knowledge of economics, structured a model by applying various specialized methods and their mathematical bases. Gándara and Osorio (2017) recognize Prospective as an intellectual discipline because it has pre-established methodologies, although they are not unalterable paths. Most foresight exercises are based on collective reflection processes articulated in three phases: identification of key variables, an analysis of the actors' game, and scenario building (Van Dorsser, Taneja, 2020).

Throughout a Prospective process, systemic thinking is streamlined. This facilitates addressing complex problems characterized by the interaction of numerous variables, such as the future of the agrifood sector. Indeed, this issue has been addressed systemically. For Rastoin et al. (2010), agrifood systems are "*...an interdependent network of actors located in a given geographical space and participating directly or indirectly in the creation of flows of goods and services aimed at satisfying the food needs of one or more groups of local or external consumers in the area under consideration*." Thus, prospective exercises contribute to the understanding of the future of these systems.

The link between agrifood systems and the systemic approach makes it possible to study the diversity of interrelated links in the journey of agrifood goods from producers to consumers. As Sims et al. (2015) point out, network logic encompasses all stages of the production, transformation, marketing, distribution, and the consumption processes. The dynamics and efficiency of networks, from Drouillard's (2018) perspective, largely depend on their capacity for innovation within organizations, on the inclusion of technologies, and on human talent management. Thus, the development of agrifood systems depends both upon the quality of final products and on communicative, technological, commercial, and logistical aspects. Flaig et al. (2021) define innovation as the strategic generation of disruptions in productive, operational, management, and marketing issues to increase the value perceived by the actors participating on a specific market. In view of this, it is important to ask: to what extent has the beef agrifood sector been able to 0perationalize innovations to enhance its development in the long term?

The Beef Agrifood Sector in the Future

According to the Food and Agriculture Organization of the United Nations (FAO) (2020), world meat production is around 340 million tons per year. Of this amount, 63 million tons correspond

to beef. A noteworthy element is that, in addition to having an important share in the global protein supply, the global price index of beef exceeds that of other types of meat (sheep, poultry, pork). Increasing technology integration at all stages in the food system is central to boosting beef production. Schwab (2016) explains that agribusiness 4.0 has encouraged not only the acquisition of machinery and process automation through mechatronic designs, but also data and information management. Paliszkiewicz (2020) notes the importance of Big Data in agricultural production and its importance in decision making. By combining precision livestock farming with massive data analysis, it is possible to create historical records detailing the condition of each animal throughout its life.

However, the outlook for this industry is uncertain. According to data from the Organization for Economic Co-operation and Development (OECD, 2020), global beef demand decreased from about 63 to 60 million tons between 2018 and 2020. In developing countries, FAO estimates a 15% decrease in their beef exports, a quota that would be covered by developed countries (FAO, 2020).

Latin America has lost its share in world trade of beef products following the emergence of COVID-19 coronavirus. However, it remains the region with the highest production in the world. This apparent contradiction can be understood by the changes in global food consumption. In recent years, Europe and Asia have been trading with the most developed producers in terms of food security and sustainability, such as the United States, India, and Russia. As detailed by Brugarolas et al. (2020), European and Asian countries are entering greater trade agreements involving these producers because of their strong alignment with the Global Agenda for Sustainable Livestock raised by FAO (2020), as well as for their excellent traceability systems and the adoption of precision livestock farming.

For their part, the beef agrifood systems of several Latin American countries are beginning to stand out for their innovations. According to Aceituno (2020), Argentina and Chile have managed to realize their innovation policies in the beef agrifood sector through the construction of biotechnology laboratories and circular economy models. This has allowed them to harness what was previously considered "waste" and transform it into profitable by-products such as fertilizers and feed with high nutritional value for livestock, preserving the sense of being organic and sustainable (Tena et al., 2018). The case of Argentina is also striking because they import and manufacture technological devices and systems for the management of livestock agrifood systems (Aceituno, 2020; Arrieta et al., 2020). The main actors underpinning this initiative are private companies and public research centers. In recent years, innovation in these systems has been reflected in the installation of 4G antennas to connect various devices that enter information in real time via algorithms designed for each farm. Simultaneously, information is collected and systematized from collars, sensors, drones, artificial intelligence, and automated feeders, among other devices that provide data and answers instantly (Drouillard, 2018).

In the Ecuadorian case, state-of-the-art technology seems to have a less important role in the bovine agrifood sector. Nonetheless, according the Ministry of Agriculture and Livestock[1], the annual beef production is around 220,000 metric tons. This production allows the sector to be self-sufficient and even exceed domestic demand (200,000 tons per year), as is the case with other livestock derivatives, such as dairy products. Based on a diverse territorial configuration, the country has built several local and regional agrifood beef networks and established a competition for national leadership (Barragán-Ochoa, 2020).

The agrifood beef network of the province of Santo Domingo de Los Tsáchilas is one of the most dynamic at the national level. This province ranks fifth in number of animals with almost 160,000 head of cattle, according to ESPAE (2016).

Foresight exercises applied to the agricultural sector in Ecuador are rare. The Ecuador Agroalimentario initiative (2019) formulated long-term objectives for various agrifood networks.[2] This initiative comprises the sum of all agrifood networks in Ecuador and their actors in their different activity-domains: primary production, processing, marketing, exports, and related services (Hernández, Hurtado, 2020). However, the COVID-19 pandemic reduced the validity of the forecasting exercise with a 10-year time horizon. Therefore, carrying out new foresight work for the most important agrifood sector in the national economy means updating the foreseen challenges and strategic pathways.

Methodological Approach: from the Present to the Construction of Future Scenarios

The challenge of understanding future scenarios for the agrifood beef network of Santo Domingo must be approached by using complementary foresight methods. Adopting a mixed approach, we use methodological tools of foresight and Prospective. The

[1] https://www.agricultura.gob.ec/ecuador-esautosuficiente-para-cubrir-demanda-nacional-de-carne-bovina/, accessed 17.08.2022.

[2] https://ecuadoragroalimentario.com/wp-content/uploads/2019/06/EcuadorAgroalimentario-Junio-2019.pdf, accessed 14.06.2022.

Table 1. **Main schools of futures thought**

School	Country of origin	Brief Description
Prospective	France	Proposes mixed and highly flexible approaches that recognize the actors as the foundation of the construction of futures
Forecasting	United States	Relies on mathematical constructs to calculate forecasts
Foresight	United Kingdom	Based on qualitative methods based on the criteria of experts
Human and social welfare	Italy	Combines global responsibility, justice and solidarity to manage social change

Source: authors, based on (Ortega, 2016).

methodological approach is divided into six phases: expert selection, understanding the system, identifying key variables, structural analysis, analysis of actors, and the development of plausible scenarios.

Phase 1: Expert selection

Initially in the prospective process, the group of experts who contributed to this study's various participatory workshops was selected. Their expertise was confirmed by supplying a questionnaire to measure their expert competence coefficient K (Barroso et al., 2019; Cabero et al., 2020). This coefficient includes the knowledge coefficient Kc and the argumentation coefficient Ka. The first (Kc) measures how informed the expert is regarding the topic to be addressed through a self-applied scale, while the second (Ka) focuses on the sources of arguments that the experts will use in their contributions, covering work experience, previous studies, the reviewed literature, and, finally, the experts' intuition.

After applying these tools, a panel of 12 experts was formed. In this case, all the participants achieved a high score, according to the parameters of Cabero et al. (2020). Gándara and Osorio (2017) consider this number of experts to be adequate; they noted that a greater number of experts would complicate communication and could harm the quality of the results.

The profile of the expert panel reflects its diversity: eight experts have postgraduate training (five with master's degrees and three with doctorates); work experience is between seven and 30 years; ages range between 28 and 68 years; in terms of gender, 66% are men and 34% women. Due to their activities and relationship with the system, three subcategories are established: professors and researchers (average K = 0.91), beef producers (average K = 0.90) and public servants focused on the regulation and control of quality in the sector (average K = 0.95).

Phase 2: Understanding the system

Cruz and Medina (2015) suggest the use of business science and foresight tools to identify drivers of change. To understand the dynamics of ABNSDT, we conducted an *environmental scanning* exercise. We weighted the current systemic conditions by evaluating matrices of internal and external factors. To do this, we followed David's (2003) methodological guidelines, and defined expected changes for the future, according to Godet's stipulations (1993). Once the diagnostic phase was completed, we obtained the first list of variables, and subsequently refined it with the use of statistical tests.

To identify drivers of change, an expert consultation instrument was applied and analyzed in statistical software. One of the intermediate results is the definition of the system's constituent variables. A large number of variables were obtained, to which a Kendall's W coefficient of concordance was later applied. Through this process, 23 variables were discarded, because they could be subsumed into others or because they did not correspond to the system under study. The obtained level of agreement between the experts' judgments was 93.60%, a high value, since, as Ramírez and Polack (2020) indicate, the percentage value ranges from 0% (no concordance) to 100% (total concordance). Therefore, by obtaining p-value of less than 0.05, there is sufficient statistical evidence to affirm that there is consensus among the 12 experts in the selection and discarding of variables, going from 54 to a total of 31.

Phase 3: Identifying key variables

In this phase, variables that did not have a major impact upon the system or those that were duplicated were discarded by giving a survey to the experts. This instrument obtained a Cronbach's Alpha coefficient equal to 0.889; which allowed for validating the consistency of the following scale: 1 (totally agree), 2 (partially agree), 3 (neutral), 4 (partially disagree), and 5 (totally disagree). In addition, following Ramírez and Polack (2020), Kendall's W test was applied to identify the level of agreement between the experts' assessments. Moreover, to establish a definitive list of variables, only those with a mean and mode equal to or greater than 2 and 1, respectively, were accepted.

Phase 4: Structural analysis

In the fourth phase, the mixed method MICMAC (Matrix of Cross Impacts and Multiplication Applied to a Classification) was applied. Godet and Durance (2011) believe this method can successfully link the system's representative variables with environmental variables in an orderly manner to assess the levels of influence and dependence of each one. In this way, this method reveals which variables are critical for a system's future evolution. For Hernández and Cisneros (2020), the development of this phase begins by ordering the selected variables and assigning a code that will represent them when using the software.

Phase 5: Stakeholder analysis

In this phase, the mixed method MACTOR (Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations) was applied. For Godet and Durance (2011), this method aims to define the correlation of forces existing between the involved actors and pinpoint their positions in relation to the possibilities of the system's evolution. Similarly, Winkowska and Szpilko (2020) recognize that this method offers specific advantages over others by setting out the information in mathematical matrices that relate the actors to the strategic objectives arising from the key variables identified in the Map of Indirect Influences/Dependencies. On the other hand, in the Matrix of Valued Positions (2MAO), each stakeholder's position with respect to future challenges was individually captured.

Phase 6: Development of plausible scenarios

The construction of plausible scenarios was performed with the process laid out in Fergnani's Futures Triangle 2.0 (2020). This method, as in Inayatullah's (2008) first version, considers that three forces shape the long term: the weight of history, the push of the present, and the pull of the future. However, in the latest version, more visual resources are used. The main phases considered methodological recommendations from various authors and include the following: mapping the future (Inayatullah, 2008), generating a 2x2 matrix of scenarios (Schwartz, 1991), designing the Triangle of Futures 2.0 (Fergnani, 2020), and narrating the desired scenario.

Revealing Optional Futures for a Dynamic Agrifood Sector

The system under study (ABNSDT) is highly dynamic due to the involvment of a large number of variables that behave differently. To understand this system, we first analyzed the variables to identify which of them are strategic when studying the system's evolution. Next, the behavior of the actors and the identified future challenges were analyzed. Finally, the scenarios and their narrative were developed.

Strategic variables

Not all the variables at play in complex systems such as ABNSDT have the same weight or role, as seen in the Matrix of Indirect Influences/Dependencies. Each variable's location depends on the «dependence» and «influence» scores obtained. In this case, values of 350 on both axes delimit the conflict zone; that is, the box that contains the key variables, understanding that the possible values for the X and Y axes are in a range between 0 and 400, according to the Proportions Matrix produced by the MICMAC software (Table 2).

In order to interpret the importance and role that the variables have on the future of the system, they have been organized into eight categories as stated by Godet and Durance (2011). The results are displayed in Table 2. In the resulting graph (Figure 1), which is based on the diagonal strategic bisector and the centric circumference, eight groups of variables are categorized, as suggested by Hernández and Hurtado (2020). To interpret the above results and the importance of the variables upon the system's dynamics, the eight groups of variables are described in Table 3.

A system modified by various actors

The group of experts, following the guidelines of Poli (2018), identified a total of 36 social actors with the capacity to modify the dynamics of the ABNSDT (Table 4). The behavior of these actors, in terms of their capacity to influence the system and their dependence upon the behavior of the system's variables, is observed at the level of influences and dependencies between actors (Figure 2). These behaviors, following Godet and Durance (2011), can be classified into four groups of actors, as described in Table 5.

To further identify agreements and discrepancies, the graphs of convergences (Figure 3) and divergences (Figure 4) between actors are presented. The greatest convergences are between: the Cattle Ranchers Association of Santo Domingo, Municipal Market Networks, the Ministry of Agriculture and Livestock, the National Secretariat of Higher Education, Science, Technology and Innovation, the academic sector, and the National Autonomous Institute of Agricultural Investment. The convergence here is established on the basis of a link between

local and national institutions and the academic sector, which shows the need and potential for the formulation of territorial public policies and their articulation with academia. In contrast, the greatest divergences are observed between: the Ecuadorian Business Committee, Other Producer Associations, Provincial GAD, Ecological Value Association, and Municipal GAD. It is noteworthy that the greatest divergences are observed between local and regional actors, which indicates a diversity of local views on the future of ABNSDT. This underscores the need for developing and applying local territorial planning tools with time horizons that go beyond short-termism and position the ABNSDT as an innovative development strategy that positions Santo Domingo in the national and international contexts.

The challenges of long-term territorial planning are established from multiple perspectives. One of the fundamental ones is the generation of agreements between different actors who have divergent views and unequal weights in the system's dynamics. In fact, the Cattle Ranchers Association of Santo Domingo (Qi = 1.7), the Municipal Market Networks (Qi = 1.6), Other Producers' Associations (Qi = 1.5), and the Ministry of Agriculture and Livestock (Qi = 1.5) accumulate great weight, which is expressed in the power ratio Qi.[3] These indicators were constructed considering the results of convergences and divergences of order 3, which expresses the direct and indirect modes of influence (passing through a third party) (Chung, 2009).

Convergences and divergences, when analyzed in greater detail, are expressed not between actors, but between challenges for the future. Each of them has a degree of mobilization that results from the relationship between agreements and disagreements. In other words, the social actors are not indifferent to the milestones expected for the system and share visions of change, as shown in Table 6.

Table 2. **Variables list**

№	Long title	X axis	Y axis	Code
1	Alternatives for financing innovation	334	327	AFI
2	Animal biotechnology	377	376	BA
3	Quality of final product	389	376	CPF
4	Climate change	342	285	CC
5	Demographic changes	331	312	CD
6	Legislation changes	326	286	CL
7	Changes in the target's preferences	360	373	CPT
8	Production capacity	320	344	CP
9	Quality certifications	324	330	CCA
10	Agroecological conditions	299	290	CA
11	Sanitary controls in foreign markets	316	316	CSE
12	Costs of logistics services	283	295	CSL
13	Innovation strategies	393	378	EI
14	Market structure	326	268	EM
15	Differentiating factors of the products	282	321	FDP
16	Human capital development	365	368	FCH
17	Administrative management	303	275	GA
18	Government incentives	381	372	IG
19	Internationalization of the Ecuadorian agrifood sector	266	311	ISA
20	Investment in Research, Development and Innovation	276	302	IDi
21	Mitigation of the pandemic's effects	303	316	MEP
22	Economic model	230	306	ME
23	Modernizing of infrastructure	288	279	MI
24	Local academic offerings	303	314	OAL
25	Rural development programs	365	364	PDR
26	Food security	312	307	SA
27	Traceability systems	259	315	ST
28	The country's macroeconomic conditions	359	255	SMP
29	Food sovereignty	236	332	SAL
30	Sustainability of the agrifood network	336	350	SRA
31	Transition towards the bioeconomy	375	356	TB

Note: translated from Spanish; the codes reflect the Spanish titles.
Source: authors, using LIPSOR Software, MICMAC Version 6.1.2.

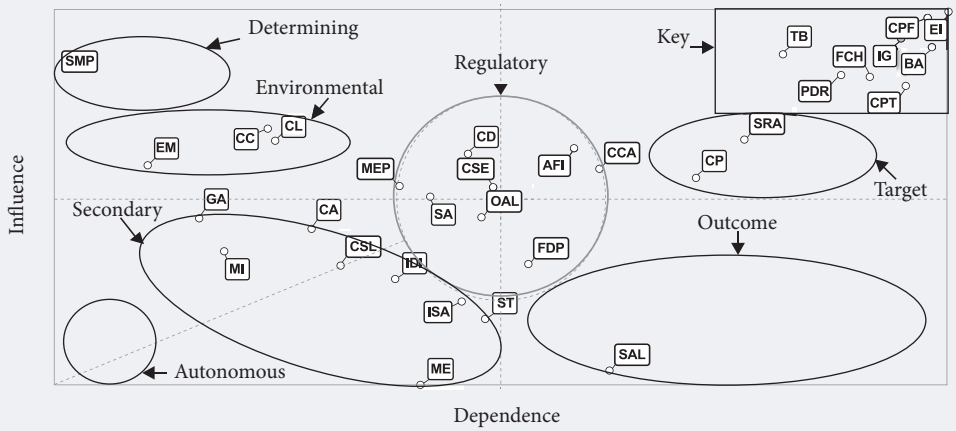
Development of Plausible Scenarios

Among the main results, four future alternatives were identified with the support of a participatory workshop in which all the learning obtained throughout the study was used to map the future. After this, two sets of variables were formed. The first, called «Innovation in the agrifood network», had the possible movements of «high» or «low». The variables included therein are: innovation strategies, product quality, animal biotechnology, and transition to a bioeconomy. In a complementary way, the second set, whose name is «Environmental conditions», had the possibilities of «favorable» and «unfavorable» movement. This set includes the variables: changes in the target's preferences, formation of local human capital, government incentives, and rural development programs. These associations were made by the expert group, depending on the capacity that the system itself or its environment would have to promote the evolutionary deployment of a certain variable.

Once the axes were formed in a 2x2 matrix, four titles were assigned to the plausible scenarios, considering the characteristics, trends, discontinuities, weak signals, wild cards, driving forces, and social actors that should be emphasized for each alternative. In this way, with the experts' collaboration, the dynamics that the system would have if each of the alternatives were to be materialized. The four future alternatives are summarized at Table 7.

[3] It is the strength ratio of the actor taking into account its maximum direct and indirect influences and dependencies and its feedback.

Figure 1. **Map of indirect influences/dependencies**



Source: authors, using LIPSOR Software, MICMAC Version 6.1.2.

Design of the Futures Triangle 2.0

The Futures Triangle 2.0 represents an important resource in refining the future narratives. In the first participatory round, it became evident that several edges corresponding to different scenarios coincided in their scores. Therefore, according to Fergnani's (2020) methodological guidelines, these should be redone so that the long-term visions reflect non-redundant possibilities. With the second participatory round, narratives were developed that further accentuate the characteristics that differentiate these plausible futures. The average values obtained for the four scenarios are displayed in Figure 6.

Narrating the desired scenario: "National Pioneers"

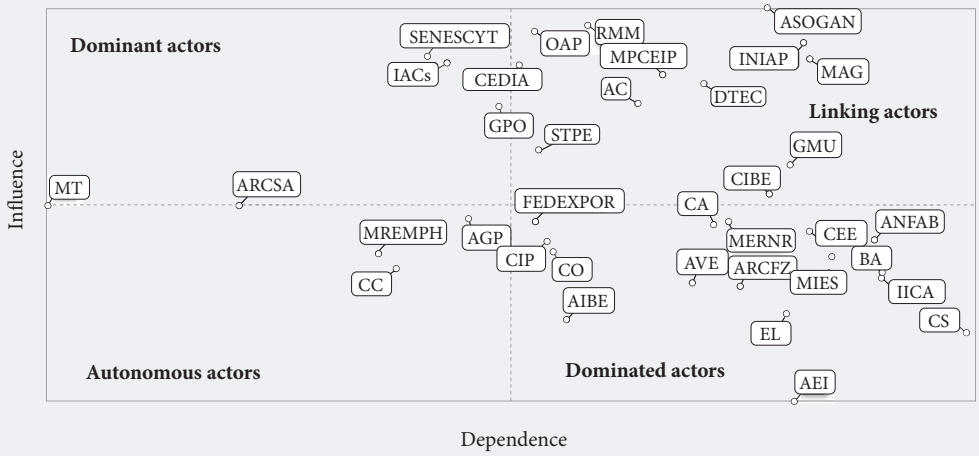
In the year 2035, the current conditions have favored the Santo Domingo beef agrifood network regarding the placement of beef products at the

Table 3. **Groups of analyzed variables**

Group	Description
Determining variables	Contextual systemic variables that do not depend on the system's behavior, but have an impact on it, such as the macroeconomic situation.
Environmental variables	Variables that influence the system, but are not very dependent on it, although they are more integrated than the determining variables. They may refer to various topics such as climate change or the legal framework.
Secondary variables	They show a similar level of dependence to the environmental variables, but their influence on the system is somewhat lower. Their effects upon the system are more specific and less generalized, i.e. the impact of their dynamics is more localized and specific to some of the phases of the ABNSDT.
Autonomous variables	No autonomous variables were identified, which can be explained in two ways. The first is methodological and expresses that all the identified variables considerably integrated into the system's dynamics, either by their influence or by their dependence. The second way in which this absence can be explained is that, according to Godet (1993), these variables correspond to past trends or inertias of the system. Their absence therefore shows the recent dynamics in the formation of the ABNSDT.
Regulatory variables	Fundamental variables in the functioning of the system. They are variables that have the possibility of generating important changes in the dynamics of the ABNSDT, both from the point of view of potentialities and limitations.
Outcome variables	Variables that, although they will have very little impact on the dynamics of the system, depend to a large extent on its behavior, and are therefore considered good indicators of the final results obtained, such as food sovereignty.
Target variables	Variables at which the dynamics of the system should be aimed; that is, the behavior of the variables previously analyzed should underpin the behavior of the target variables. In the context of ABNSDT these variables are related to production and its sustainability.
Key variables	These variables make it possible to operationalize the system's dynamics. These variables constitute strategic elements where efforts such as rural development and animal biotechnology programs can be strengthened. From the consumers' point of view, they include the target's preferences and the quality of the final product; whereas from a more transversal point of view, human capital development, government incentives and innovation strategies that mobilize a transition to the bioeconomy stand out. This view reveals the challenges in the ABNSDT that cannot be seen unilaterally or by sector, which is one of the key findings of the Prospective process.

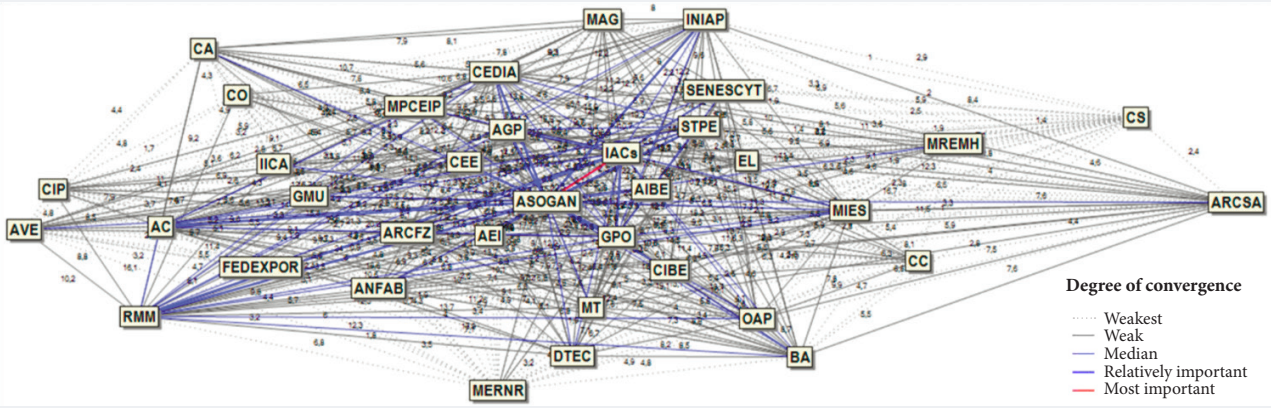
Source: authors.

Figure 2. **Map of influences and dependencies among actors**



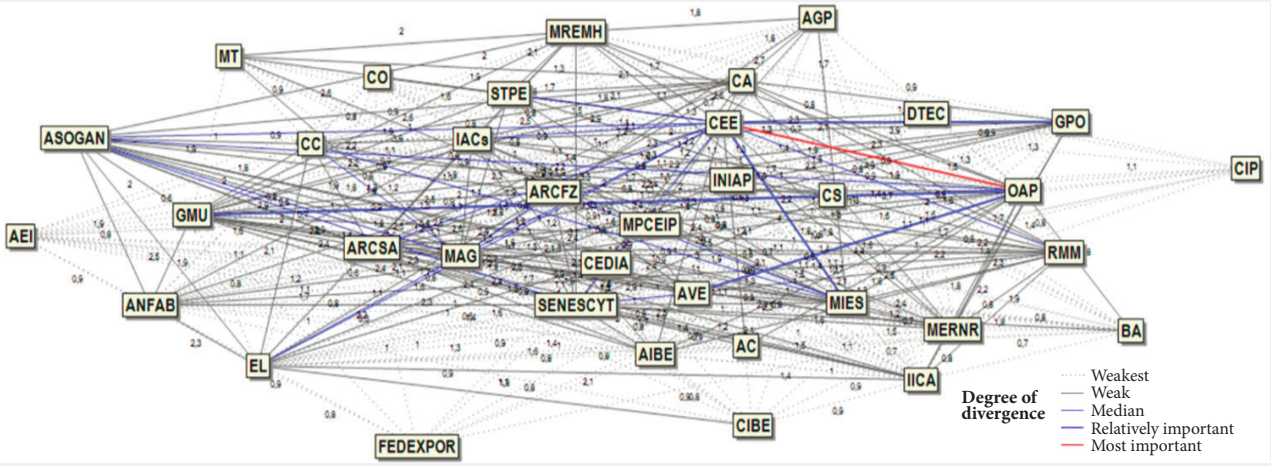
Source: authors, using LIPSOR software, MACTOR version 6.1.2.

Figure 3. **Convergences between actors**



Source: authors, using LIPSOR software, MACTOR version 6.1.2.

Figure 4. **Divergences between actors**



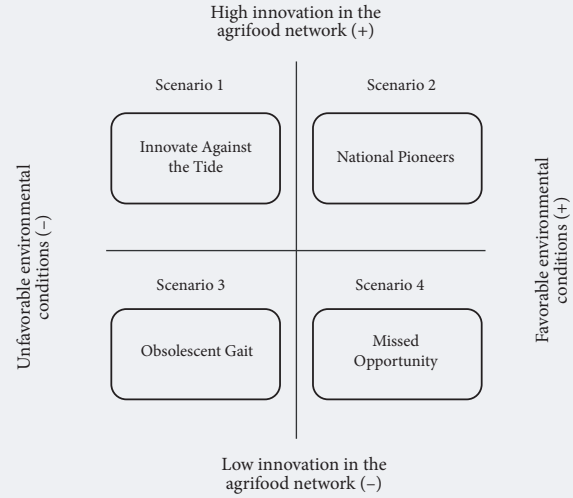
Source: authors, using LIPSOR software, MACTOR version 6.1.2.

Table 4. **List of actors**

№	Name of the actors	Code
1	Academic Sector	AC
2	Phytosanitary and Zoosanitary Regulation and Control Agency	ARCFZ
3	National Agency for Health Regulation, Control and Surveillance	ARCSA
4	Agropesa	AGP
5	Alliance for Entrepreneurship and Innovation	AEI
6	Cattle Ranchers Association of Santo Domingo	ASOGAN
7	Association of Non-Alcoholic Beverage Industries of Ecuador	AIBE
8	Association of Ecological Value	AVE
9	National Association of Food and Beverage Manufacturers	ANFAB
10	Banks	BA
11	Supermarket chains	CS
12	Meatpacking plants and municipal slaughtehouses	CC
13	Chamber of Agriculture	CA
14	Chamber of Industries and Production	CIP
15	Biotechnological Research Center of Ecuador	CIBE
16	Ecuadorian Business Committee	CEE
17	Consumers	CO
18	Ecuadorian Corporation for the Development of Research and Academia	CEDIA
19	Technology developers	DTEC
20	Logistics businesses	EL
21	Ecuadorian Federation of Exporters	FEDEXPOR
22	Municipal GAD	GMU
23	Provincial GAD	GPO
24	Sustainable Trade Support Institutions	IACs
25	Inter-American Institute for Cooperation on Agriculture	IICA
26	National Autonomous Institute of Agricultural Investments	INIAP
27	Ministry of Agriculture and Livestock	MAG
28	Ministry of Energy and Non-Renewable Natural Resources	MERNR
29	Ministry of Economic and Social Inclusion	MIES
30	Ministry of Production, Foreign Trade, Investments and Fisheries	MPCEIP
31	Ministry of Foreign Affairs and Human Mobility	MREMH
32	Ministry of Telecommunications	MT
33	Other producer's associations	OAP
34	Municipal market networks	RMM
35	National Secretariat of Higher Education, Science, Technology and Innovation	SENESCYT
36	Technical Secretariat Planifica Ecuador	STPE

Note: translated from Spanish; the codes reflect the Spanish titles.
Source: authors, using LIPSOR software, MACTOR version 6.1.2.

Figure 5. **2x2 Matrix for scenario construction**



Source: authors.

national and foreign levels. This has been possible with the application of proactive and opportunistic innovation strategies that originated in the year 2022, which have given anticipatory responses to variations in preferences caused by new members of the network. As a result of the above, the Cattle Ranchers Association of Santo Domingo, the Technical Secretariat Planifica Ecuador, and the institutions supporting sustainable trade have invested heavily in research in order to become as the most important network in the country in terms of technical and market dominance.

Therefore, the quality of the final product in the regular and premium supply exceeds national standards and competes with excellent results on European markets. In addition, livestock production in Santo Domingo is considered to have the highest genetic value due to the appropriate integration of biotechnology, which has enhanced animal breeding and reproduction. Similarly, the automation of production processes has been achieved with the use of technological packages from government incentives.

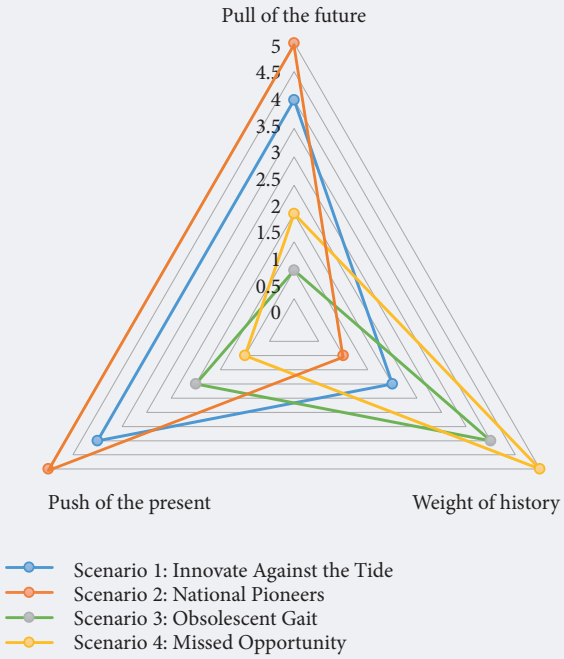
Moreover, a system of organic beef production has been consolidated in response to new sustainability demands and the national desire to establish circular economy models with eco-friendly production. Similarly, the agrifood beef network has been supplied with technical devices and computer products designed by local human capital that has been specialized with the support of SENESCYT. Also, with the help of rural development programs promoted by the Provincial Government and the Ministry of

Table 5. **Types of actors**

Type	Description
Dominant actors	Actors who have a high capacity to influence and, in turn, are little influenced by the other actors in the system. These are mainly institutional external actors who represent mainly the central or decentralized State (provincial autonomous governments).
Linking actors	Fundamental actors in the system since they largely depend on the behavior of the other actors. In turn, they have a high impact on the dynamics of the ABNSDT. The profile of these actors is diverse and includes national and local government institutions, private actors that go through all phases of the ABNSDT and the Academic sector. This diversity shows that the major challenges in the ABNSDT are multiple and cannot be addressed by a single actor, but rather through participatory processes of joint interaction that enhance agreements and resolve disagreements. In this sense, it is important to identify convergent and divergent positions from the perspective of this diversity of actors.
Autonomous actors	Actors with low capacity to influence and low dependence on other actors in the system. In this case, their actions have a minor, but not absent, relevance in relation to the system's dynamics. These are actors with little room to maneuver in the formulation of their strategies.
Dominated actors	These are actors with low capacity to influence, but very dependent on the other actors in the system. These are, in general, businesses, trade unions and civil society actors that will be greatly impacted by the dynamics of the ABNSDT. In the case of national public institutions in this category, these are actors that deal with the central theme of the system in a complementary manner, without the ABNSDT being an essential part of their competences.

Source: authors.

Figure 6. **Futures 2.0 triangle of the 4 plausible scenarios constructed**



Source: authors.

Agriculture and Livestock, the national beef agrifood network has been established with greater integration between all players. As a result, the creation of a bioeconomy system based on the production, utilization, and conservation of biological resources for resupply has been consolidated, integrating producers outside ASOGAN and municipal market networks that have been strengthened with the support of crowdfunding.

Conclusions

In this study, four plausible scenarios were established for innovation in the Santo Domingo beef agrifood network by 2035. The relevance of these visions of the future lies in their anticipatory and strategic usefulness, which can guide decision makers. Therefore, they should be considered an input for the next plan generated by the Autonomous Decentralized Government of the province, since the development of the rural and livestock sectors appears as one of its main institutional competencies.

As an essential part of this research, the eight key variables of the system under study were determined. This showed that, from the perspective of innovation, the axes that shape the future of the agrifood network are related to its capacity for

Table 6. **Challenges for the system to the year 2035**

Future challenges	Number of agreements	Number of disagreements	Degree of mobilization
1. To lead in the placement of beef products at the national level through the adoption of offensive and opportunistic innovation strategies.	48.2	–0.7	48.2
2. Increase the quality of the final product in the regular and premium offerings to the level of foreign competition.	39	–3.4	35.6
3. To convert Santo Domingo's livestock production into the one with the highest national genetic value through the integration of animal biotechnology.	39.7	–2.8	36.9
4. Automate production processes with partial support from government resources.	46.2	–2.6	43.6
5. Consolidate an organic beef production system in response to changes in target preferences.	51.9	–0.6	51.3
6. To supply the agrifood beef network with technical devices and IT products designed by specialized local human capital.	42	–3.8	38.2
7. Establish the national beef agrifood network with greater integration with the help of rural development programs.	37.2	–3.1	34.1
8. Create a bioeconomy system based on the production, utilization and conservation of biological resources for replenishment.	37.5	0	37.5

Source: authors.

Table 7. **Description of scenarios**

Scenario	Description
Innovate against the Tide	The high level of innovation in ABNSDT is achieved through the private initiative, since the government's capacity for action is limited by budget issues and political interests.
National Pioneers	The level of innovation in the ABNSDT is exceptional and places it as the most important beef agrifood network in Ecuador. This is achieved with the link between the private companies, the public sector, the Academic Sector and other relevant social actors. This scenario meets all the future challenges for the ABNSDT.
Obsolescent gait	The level of innovation is low in the ABNSDT, due to the poor management of the public and private sectors. The main problems are the disarticulation of social actors and the scarce investment in the agrifood sector.
Missed opportunity	The low innovation in the ABNSDT is the result of the waste of government funds by the ranchers. Organizational and leadership problems in the agrifood network prevent the receipt and use of state allocations.

Source: authors.

technical advancement and modernization in each link and to the surrounding conditions. In addition, due to the correct selection of experts and the use of specialized software, this phase could be carried out without major calculation problems, but will require repeated consultations to collect the necessary data.

Similarly, the strength and position of the 36 social actors that affect the system were identified. This was instrumental in mapping futures as it provides clarity by revealing the number of agreements and disagreements, as well as the degree of mobility for future challenges stemming from the key variables. In addition, the mathematical power of the selected method provided the Qi force relationships, which clarified the importance of convergences and divergences, since it demonstrated that alliances are established between actors with a high incidence and that conflicts occur with those that have moderate incidence.

On the other hand, an appropriate course of action was defined to achieve the desired scenario: National Pioneers. This will help local planners and decision makers recognize the priority changes to be made through the formation and implementation of programs and projects that will develop the conditions for all established innovative pathways to be fulfilled and ultimately achieve the desired vision in an estimated term of 15 years. As in previous phases, the work with experts was essential for organizing future challenges. At this point, however, three elements - the collective learning achieved, the common language created, and the solid knowledge of the system - helped to quickly group the challenges and identify tentative deadlines for their fulfillment.

Finally, it is recommended that policymakers continue with the prospective process and delve into the strategies to follow. In this way, the policies generated by the public sector and the programs and projects formulated by the private sector will be able to converge in planning documents that are more technically grounded with shared resources. It is also important to consider all technical assistance and economic support offered by international organizations, since several of them are constantly looking for long-term plans in developing countries. This, once again, shows the value of collaborative processes in foresight, not only in the study phases, but also during implementation.

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