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Sustainability Indicators for a Small-Scale Goat Cheese Industry

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ABSTRACT

Background: Goat dairy productions have a growth perspective in the future, provided sustainable strategies are developed. However, the topic of sustainability in the dairy industry is nascent, and research on the development of sustainability indicators is scarce. **Aim.** To propose sustainability indicators for the small-scale goat cheese industry in the municipality of Baraguá through the application of the Delphi method. **Methods:** The work was carried out from September to June 2021. The Delphi method was applied in three stages: preparatory, exploratory, and consensus. **Results:** The employed methodology enabled the proposal of an indicator system as a diagnostic tool for the environmental, social, and economic situation of the small-scale goat cheese industry in Baraguá, to formulate improvement strategies focused on sustainable dairy sector practices. **Conclusions:** The relevance of the Delphi method was corroborated to guide under the pillar of science, collective protagonism, learning in action, and the participative dialogue required for the development of local food systems, as a key element in the systemic transformations that Cuban agriculture must undertake.

Keywords: agroindustry, indicators, goat cheese, sustainability, milk transformation (*Source*: *AGROVOC*)

INTRODUCTION

In recent years, globally, goat cheese has shown a steadily increasing demand, with the perspective of continued growth in the future, provided sustainable strategies are developed (Sepe and Argüello, 2019). According to Zanin *et al*. (2020), sustainability should be understood from a multidimensional perspective, encompassing three fundamental dimensions: economic, social,

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and environmental. However, the topic of sustainability in the dairy industry is nascent, and research on the development of sustainability indicators is scarce.

According to Wilches *et al*. (2016) and Feil *et al*. (2020), to design improvement strategies focused on the dairy sector, supported by sustainability indicators, it is necessary to gather and consolidate the criteria of its actors. The Delphi method represents a highly useful tool for this purpose, as it gathers the opinions and perceptions of experts in the dairy sector to reach a consensus among them.

In 2016, the first small-scale goat cheese industry in the country was opened in the municipality of Baraguá, Ciego de Ávila province. Given the importance of this small-scale industry from a socio-economic and environmental perspective in the region, this paper aims to propose sustainability indicators for the small-scale goat cheese industry in the municipality of Baraguá through the application of the Delphi method.

MATERIALS AND METHODS

The work was conducted as a continuation of the generalization of the results obtained in the Research and Development (R&D) project "Application of technologies that contribute to the increased production of goat milk and the development of secondary products in the agro-industrial chain" of the National Human Food Program.

The research is a quantitative, non-experimental, cross-sectional descriptive study. Participant observation was performed from February to June 2021, and the case study selected was the "El Guajiro" goat cheese factory in the municipality of Baraguá, Ciego de Ávila province. The Delphi method was used, considering the methodological procedures carried out by Wilches *et al*. (2016) and Allen *et al*. (2019) in the dairy sector. Three main stages were followed: preparatory (preliminary), exploratory (consultative), and consensus (Table 1).

RESULTS AND DISCUSSION

Stage 1. Preparatory

Composition of the coordinating group: The coordinating group was composed of six members, four from the University of Camagüey and two from the study area.

Selection of experts: Initially, 26 potential experts were identified. Of them, 21 accepted to be part of the study after receiving the official invitation. In the evaluation of the level of competence, 16 of them obtained a coefficient above 0.80, classifying as highly competent experts. The selected experts belong to various areas of specialty, ensuring compliance with the requirement of the heterogeneity of the panel.

Questionnaire design: A review of specialized literature conducted in this research did not find scientific publications on sustainability indicators for the goat dairy industry. In research on the goat sector, sustainability has focused on livestock activity (rearing and milk production), with publications predominantly on economic indicators (Tsiouni *et al*., 2021).

Generally, the literature on developing sustainability indicators in the dairy industry is scarce (Feil *et al*., 2020). The authors assumed as valid the bibliographic references on sustainability indicators in the bovine dairy industry; both internationally (Feil *et al*., 2020; Wilches *et al*., 2016; Zanin *et al*. 2020), and nationally (Arias and Cárdenas, 2016; Chou *et al*., 2018; Mastrapa and Sánchez, 2019; Núñez and Curbelo, 2020). National research has focused on analyzing and evaluating the environmental impacts of the dairy sector and the efficiency of its processes. This leads to a fragmented and insufficient vision of sustainability from a multidimensional perspective.

Table 1. Delphi Method Procedure

Stages	Steps	Tools and content
STAGE 1. PREPARATORY	**1.Constitution of the coordinating group**	**Selection of members of the research project to which this work contributed.**
	2.Questionnaire design	**Literature review in databases such as Science Direct, Scopus, Medline, and Scielo, using keywords like "sustainability indicators", "dairy industry", "goat cheese industry" in English and Spanish from 2016 to 2021.**
		Pilot evaluation in focus groups of the list of indicators selected from the literature, according to Allen et al. (2019).
	3. Selection of experts	**Selection based on criteria: 1) Willingness to participate, 2) Experience (academic, research or professional) related to the cheese industry, not less than 10 years, and 3) High competency coefficient ($K \geq 0.80$).**
		Determination of the competency coefficient, according to Wilches et al. (2016).
STAGE 2. EXPLORATORY	**4.Application of the questionnaire for expert consultation**	**Three rounds of expert consultations through direct delivery and email. Expert assessment of the criteria established in the Global Dairy Agenda for Action (2018) for dairies worldwide.**
	5.Statistical processing of responses	**Measurement of expert criteria using a Likert scale, with ratings of: 1 strongly disagree, 2 disagree, 3 neither agree nor disagree, 4 agree, and 5 strongly agree.**
		Determination of the arithmetic mean of the scores for each indicator. Indicators with values between 4 and 5 points were selected.
	6.Feedback of results	**Communication to experts of their previous response, accompanied by the statistical analysis of the group's response. New indicators were added when at least two participants proposed the same or similar ones.**
STAGE 3. CONSENSUS	**7.Determination of consensus in the criteria**	**Determination of Kendall's coefficient of concordance (W) using SPSS version 22 software.**
	8.Reporting results	**Preparation of the final report summarizing the results of the validation process of the final list of indicators.**

The evaluation of indicators gathered from specialized literature in interactive workshops between the coordinating group and focus groups was conducted within the framework of actions carried out in the research project to which this paper contributes.

Some of the experiences obtained in these workshops were disseminated by Matos *et al*. (2017).

Stage 2. Exploratory

Application of the questionnaire for expert consultation: The results obtained in the interactive process during the various rounds conducted in this stage are shown for each dimension in Tables 2, 3, and 4. For the evaluation of environmental dimension indicators (Table 2), only two rounds of expert evaluation were needed, as the selection of indicators in this case showed agreement in the criteria of the majority of the panel, who awarded ratings of 4 and 5.

Table 2. Expert evaluation results for environmental dimension indicators

Indicators	Arithmetic Mean of Expert Panel Scores per Round (R)		
	R1	R2	R3
Water consumption (L/day and L/kg)	4.65	**4.79**	-
Solid emissions (kg/day)	4.12	**4.50**	-
Water eutrophication	3.01		-
Energy consumption (kw/kg)	4.80	**4.91**	-
Fuel consumption (kg/day)	4.32	**4.50**	-
Global warming	2.30		
Water acidification	4.01	**4.22**	-
Liquid emissions (kg/day and kg/kg)	4.02	**4.32**	-
Ozone depletion	3.20		
Ecotoxicity	2.04		
Abiotic depletion	4.23	**4.05**	-
Photochemical oxidation	2.04		

Bolded values: the final proposed indicators.

It is recognized that dairy industries are among the most polluting. High water consumption in dairy processing is associated with the generation of wastewater, such as organic and inorganic discharges, organic by-products, and to a lesser extent, atmospheric emissions. Evidence of the impact of selected indicators on the Cuban dairy sector is available (Arias and Cárdenas, 2016; Chou *et al*. 2018; Mastrapa and Sánchez, 2019).

In the particular case of the small industry under study, which presents a closed-loop organizational scheme, the environmental impact of goat rearing must be considered. In this sense, Cuba has positive experiences in soil conservation, through the introduction of good practices in goat management in closed-loop farming systems (Arencibia and Corrales, 2021).

For the indicators where experts did not show agreement, their argument was based on the fact that they did not meet the previously established selection criteria (they are difficult to measure and complex to analyze), making their application difficult.

The results from in the social dimension are shown in Table 3. Expert criteria showed agreement with most of the proposed indicators, except for the level of labor polyvalence (%).

Table 3. Results of Expert Evaluation for Social Dimension Indicators

Indicators	Arithmetic Mean of Expert Panel Scores per Round (R)		
	R1	**R2**	**R3**
Client satisfaction level	4.21	4.02	**4.9**
Cheese availability for the population according to their purchasing power	4.05	4.06	**4.81**
Compliance with traceability system standards (%)	4.02	4.08	**4.02**
Accessibility to goat cheese (%)	4.06	4.06	**4.05**
Compliance with dairy product safety regulations	4.72	4.55	**4.70**
Number of jobs created	4.23	4.25	**4.21**
Compliance with employee health and safety regulations (%)	4.32	4.02	**4.15**
Labor polyvalence level (%)	3.01	-	**-**
Added Indicators	Number of training actions received by workers related to their work	4.5	**4.54**
	Compliance with gender equity policies (number of employed women)	4.22	**4.51**

Bolded values: the final proposed indicators.

The added indicators by the experts cover a gap identified in the consulted bibliographic references, as proposed by Feil *et al*. (2020).

In the small-scale goat cheese industry under study, women's participation was confirmed, representing 38% of the total employees, notably in key positions such as the cheese master.

The contribution of the small-scale goat cheese industry to indicators related to food and nutritional security of the Cuban population, job creation, and gender equity, represent priorities defined in keeping with the national interests.

The economic indicators proposed to the experts are predominant criteria in the consulted specialized literature. However, the expert panel agreed that it will be pertinent to consider the added indicators, which were evaluated with scores of 4 and 5 (Table 4).

Table 4. Results of Expert Evaluation for Economic Indicators

Indicators		Arithmetic Mean of Expert Panel Scores per Round (R)		
		R1	R2	R3
Economic profitability		4.90	4.87	4.85
Financial profitability		4.51	4.55	4.66
Performance index		4.32	4.74	4.65
Investment cost of the small-scale cheese industry ($)		4.51	4.62	4.60
Cheese yield (kg/l of milk)		4.60	4.59	4.71
Amount of cheese produced (kg/day)		3.75		
Production capacity utilization (%)		3.62		
Technological obsolescence of equipment		4.01	4.12	4.08
Added Indicators	Amount of goat milk (raw material) (kg/day)	4.64	4.73	
	Level of use of by-products generated by production (%)	4.92	4.87	
	Level of reduction in energy dependency	4.5	4.63	
	Financial resources generated by the export of goat cheeses	4.8	4.9	
	Substitution of financial resources dedicated to goat cheese imports (%)	4.91	4.84	

The proposal for the indicator "amount of milk (raw material)" has a particular character for the small-scale industry under study, considering its organizational scheme. The indicators proposed regarding import substitution and export generation stand out, given their contribution to the Cuban economy, necessary to meet sustainable development goals.

Stage 3. Consensus

The concordance test through Kendall's coefficient, produced a value close to one (W=0.833), concluding that it is significantly different from zero, with a calculated X2 value equal to 413.113 ($P<0.01$). All the above indicates that there is agreement among the experts' criteria. This result is associated with the heterogeneity in the academic and professional background of the coordinating group members and the expert panel, the interaction between different types of knowledge (technical, empirical, scientific), and their integrated role during the research process.

The usefulness of the Delphi method was corroborated as a tool to manage from science, collective protagonism, learning in action, and participatory discussions required for the sustainable development of local food systems, in the current context of Cuban agriculture.

CONCLUSION

The methodology enabled the proposal of an indicator system as a diagnostic tool for the environmental, social, and economic situation of a small-scale goat cheese industry, to formulate improvement strategies focused on sustainable dairy sector practices.

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AUTHOR CONTRIBUTION STATEMENT

Research conception and design: ONA, LCZ, LMM, RGZ, NLC; data analysis and data interpretation: ONA, LCZ, LMM, RGZ, NLC; redaction of the manuscript: ONA, LCZ, LMM, RGZ, NLC.

CONFLICT OF INTEREST STATEMENT

The authors state there are no conflicts of interest whatsoever.