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Article

Perception of the Sustainable Cattle Ranching Concept in Pro-Ducers, Extension Agents and Officials of Oaxaca, Mexico

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Abstract: The sustainability concept has acquired a variety of meanings according to different currents of thought and the context in which it is used. The aim of this research was to characterize the perception of producers, extension agents and officials regarding sustainable cattle ranching (SCR) in an area where tropical cattle ranching is practiced. A survey was applied to producers chosen through stratified random sampling, and to extension agents and officials selected using the snowball technique. The perception of SCR was determined under two contexts: 1) the idea or interpretation of the individual and 2) the assessment (positive or negative) of this type of cattle ranching (net perception index, NPI). The extension agents oriented their perception of SCR mainly in economic (52.2%) and environmental (47.8%) aspects, similar to the producers (48.4% and 21.3% respectively), while the officials related it more to an environmental dimension (71.4%). It is concluded that the perception of SCR in general is positive, but its conceptualization is differentiated, according to the role the individuals play in the activity, their academic training and their expectations.

Keywords: tropical cattle ranching; sustainability; cognitive psychology; environmental assessment

1. Introduction

Cattle ranching is an activity of socioeconomic and environmental importance globally. It is estimated that 1.3 billion people in the world are directly or indirectly involved in this economic activity, of which 800 million are smallholder producers located in developing countries [1]. FAO statistics indicate that in 2020, 337 million tons of meat and 887 million tons of milk were produced in the world; thus, this activity contributes to global food security [2].

Even with this socioeconomic importance, this activity has been judged to be the main contributor to environmental deterioration, due to using largely unsustainable technologies highly dependent on external inputs and carrying out inappropriate practices that have generated deforestation, destruction of landscapes, desertification, degradation of natural resources and biodiversity loss [3–5]. In addition, other causes that have led to the above effects are the change in land use, inadequate grazing management, irrational use of agrochemicals, uncontrolled burning, absence of plant cover in paddocks and lack of training and economic incentives appropriate to the producer [4–7]; however, a deterioration in the culture and ethics of the social actors involved, from producers to political decision-makers, is also pointed out [8–10].

In the Mexican tropics, the development of traditional livestock systems was achieved at the cost of the destruction of large areas of forests and jungles to make way for monoculture pastures, which

led to a severe reduction in plant and animal biodiversity [5,11–13]. Currently, this type of cattle ranching (rainfed, with low animal load and with little incorporation of modern technologies) has a low productivity per animal and per surface unit due to various biological, environmental and socioeconomic limitations that restrict the expression of the maximum productive potential. The result is low profitability and competitiveness and the consequent importation of animal products from abroad to cover the demand for animal protein of the Mexican population [6,14,15].

Other deficiencies are the almost non-existent technical assistance that does not start from a technological development based on research designed to solve the problems of the agroecosystem. The practices of reproductive and preventive medicine, genetic improvement and the management of forage resources have a great margin for improvement [16–18]. There is a high degree of polarization with a small sector of large producers and a large population of small cattle ranchers with limited and fragile links to the market, and who face difficulties in maintaining their profitability; for example, accessing government credits and subsidies [6,14,15]. On the other hand, research for technological development is generally disconnected from social research, and often from environmental issues, as well as from aspects related to food safety; it also tends not to consider the knowledge of the producer and the productivist vision prevails over the integral approach [6,15,19]. This approach has shown clear evidence of unsustainability, due to the associated effects through soil degradation, contamination of natural resources, high risk of acute or chronic poisoning due to the use of agrotoxins, loss of agrobiodiversity, socioeconomic polarization, abandonment of the activity and migration, as a result of a purely economic model. in addition to the contribution of greenhouse gases [5,7,12,20].

On the other hand, notions of sustainability have been considered since ancient times by philosophers and scientists interested in a utopian world and concerned about population growth, the appropriation of nature and human survival on the planet [21]. More recently, in the context of the environmental debate, there have been various versions of the concept of sustainability: institutional, ideological and academic and its various interpretations (e.g., as an ideology, a set of strategies, the ability to meet goals and the ability to continue over time) [19,21–23]. Other interpretations of agricultural sustainability in particular consider it as the reconciliation of two basic future needs (increased food production and greater environmental protection), which implies developing new strategies that take advantage of ecological interactions in agroecosystems [19,24]. In the case of sustainability in cattle ranching, Vavra [25] pointed out that this can mean the ability to indefinitely obtain the same amount of meat, milk or fiber from the base of a given soil, satisfying current production goals, without compromising the future in terms of deterioration of natural resources. Based on our experience and an exhaustive literature review [1,6,21,25–28], for the purpose of this study, we define sustainable cattle ranching as a set of appropriate practices and technologies for cattle management, which contribute to the permanent productivity of the ranch, based on the rational use of natural resources that support this economic activity. This form of production contributes to reducing greenhouse gas emissions and at the same time fosters livestock agroecosystems that are resilient to the effects of global climate change [5,12,29,30].

Despite its ambiguity and operational vagueness, the concept of sustainability has been accepted as a guide in the development of various sectors [31]. In particular, the application of the sustainability paradigm to cattle ranching to assess economic viability, environmental conservation and social benefits dates from the 1990s, using various approaches and methodologies, attributed to a diversity of schools of thought [19,21]. According to an analysis of research carried out with a sustainable cattle ranching focus, four epistemological perspectives (neo-economical, ecological–environmental, socio-anthropological, and technical–biological) were identified. The main topics addressed in these studies were the evaluation of economic sustainability, feasibility of renewable energy production, payment for environmental services, evaluation of negative impacts on the environment, energy efficiency, effects of overgrazing, methane emission, local knowledge in the use of natural resources, comparative and longitudinal profiles of sustainability, compliance with organic regulations, silvopastoral systems and the behavior of ruminants in diversified grazing environments [21].

These studies are considered important for taking decisions and actions that allow a transition towards the sustainability of cattle ranching; however, few studies have focused on characterizing the knowledge, opinion and perception of sustainable cattle farming by the producer and other social actors as a whole, given that the sustainability process implies not only the application of appropriate agronomic practices, but also the challenge to producers and society in general to change their attitude and behavior to implement them [8,10,32]. In this sense, it is necessary to know how the concept of sustainability has permeated the culture of these social actors and if there are differences in their perspectives, given that perceptions are constructed according to the frame of reference of each individual, which is influenced by their convictions, values, norms, knowledge and particular interests [33–35]. Therefore, the aim of this research was to characterize the perception of producers, extension agents and officials about the concept of sustainable cattle ranching in an area where dual-purpose cattle farming is practiced.

2. Materials and Methods

2.1. Location and Characteristics of the Study Area

The research was conducted from February to July 2013 in Santiago Pinotepa Nacional municipality, Oaxaca, Mexico, located between the parallels 16° 06' and 16° 29' NL and 97° 57' and 98° 20' WL, in an elevation range between 0 and 800 masl (Figure 1). This municipality covers a 719.56 km² area, which represents 0.75% of the state of Oaxaca and its approximate distance to the capital is 397 km. The municipality has an Aw₁ climate (warm subhumid with rain in summer), with average annual rainfall of 1,237.5 mm distributed in the period from June to October. The average annual temperature is 27 °C, with June being the warmest month and February the coldest. The type of vegetation is low deciduous forest and the dominant soils are regosol, gleysol and phaeozem [36].

In 2020, this municipality had a total population of 55,840 inhabitants, of which 48.7% were men and 51.3% women. The proportion of the economically active population is 64.4% and of this, 59% are men and 41% women. Regarding the educational level, the population aged 15 years and older is distributed as follows: 11% without schooling, 53.8% with basic education, 21.1% with upper secondary education and only 13.9% with university studies [37]. In the coastal region of Oaxaca, 57.8% of the population is economically active and works in the agricultural (31.7%), industrial and construction (19.9%) and commerce and services (48.4%) sectors [38]. It should be noted that the agricultural sector has experienced a reduction in its economically active population, going from 40.9% in 2000 to 27.2% in 2015; in contrast to the trade and services sector, which increased from 37.9% in 2000 to 52.5% in 2015 [39]. Regarding the income level of people working in the agricultural sector in the region, it is reported that more than 53.2% receive no income, 26.1% receive up to a minimum wage, 14.1% between 1 and 2 minimum wages, and the rest between 2 and 5 minimum wages. Regarding the level of schooling, the majority of this population (94.9%) only has basic education (primary and secondary), while 4.3% have upper secondary studies and only 0.6% have university education [38].

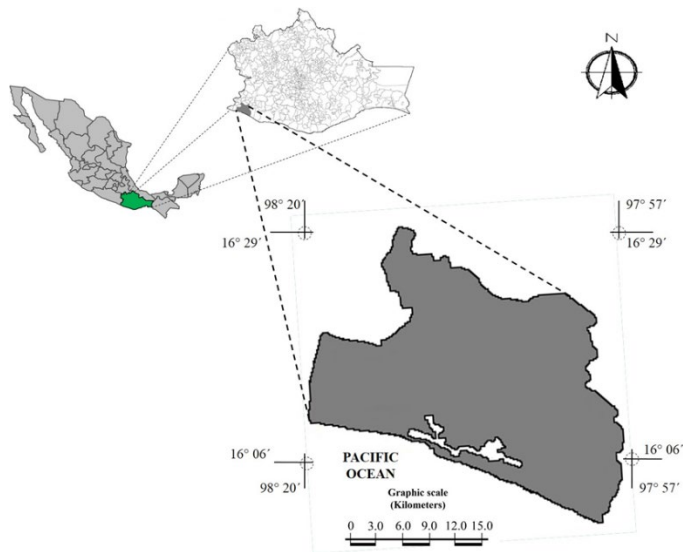


Figure 1. Geographic location of Santiago Pinotepa Nacional municipality, Oaxaca, Mexico.

In the livestock context, the state of Oaxaca reported an inventory of 1,844,891 heads of cattle for the year 2023, which represents 5.1% of the national inventory [40]. In the Costa, Isthmus and Papaloapan regions (dry and sub-humid tropics), dual-purpose livestock farming is more developed [6,41,42]; this is characterized by minimal use of technology and the basis of cattle feeding is mainly induced tropical pastures, with strategic supplementation in the dry or flood season. The type of cattle most used in these systems are genetic crosses of the Zebu breed with the Holstein, Brown Swiss and Simmental breeds. Milking is carried out in rustic facilities generally by hand in the morning with the support of the calf and four teats are milked not thoroughly or three teats to ensure enough milk for the calf. The milk sold constitutes the main source of income and is mainly used to maintain the operation of the farm; Milk production has three main uses: for consumption as raw milk, for the production of cheese using artisanal technology, and for processing in agro-industrial companies [17,18,43].

The Costa region of the state of Oaxaca has been an important livestock area; in 2018, it was ranked third in milk production and second in carcass meat production at the state level. It produces 15,701 t of carcass beef annually, with a value of MXN \$1,278,635,950.00. Regarding milk production, 25,082,770 L of bovine milk are generated annually, representing MXN \$175,906,280.00 [44]. By 2023, the municipality of Santiago Pinotepa Nacional registered an inventory of 6880 heads and had a production of 2,845,204 t of live cattle, with a value of MXN \$ 121,656,973.00, representing 6th place in the state of Oaxaca and 3rd place in the Costa region of Oaxaca, after the municipalities of San Pedro Mixtepec and Villa de Tututepec de Melchor Ocampo [40].

2.2. Sampling and Information Gathering

To obtain the information, three types of agents (units of analysis) involved in the cattle ranching productive process in the study area were defined and interviewed (Table 1).

Table 1. Description of the units of analysis evaluated in the research.

Unit of analysis	Description
Producer	Producer of milk, meat or dual-purpose cattle
Extension agent	Extension technician (Veterinarian or Zootechnician Agronomist) who advises farmers in a private or governmental way.
Official	Executives of institutions related to cattle farming in the study area, for example SAGARPA, Rural Finance

Authority, FIRA, Regional Social Development Module,
ICAPET, UGRCO and AGL.

The calculation of the sample size was based on a sampling frame consisting of the Sustainable Livestock Production and Livestock and Beekeeping Management (PROGAN) program’s registry of beneficiaries in 2012 for the municipality under study (N = 1084). The number of cattle owned by each producer ($S^2 = 846.9$) was considered as the associated sampling variable and a stratified random sampling with Neyman allocation was used [45], in order to increase the accuracy of the estimators (Equations 1 and 2).

$$n = \frac{(\sum_i^L N_i S_{Ni}^2)^2}{N^2 D^2 + \sum_i^L N_i S_{Ni}^2}$$

where: n is sample size, N is total population, N_i is population in the stratum i , S^2 is variance in the number of cattle owned by each producer, and $D = d^2/4$ is utilized for estimate mean, includes error and 95% reliability. Once the sample size was obtained ($n = 155$), the selected producers were assigned to one of four strata, according to the number of cattle they own: Small ($n_1 = 66$), Medium ($n_2 = 23$), Large ($n_3 = 43$) and Very Large ($n_4 = 23$) (Table 2). For this procedure, we used the Neyman Allocation, whose distribution of the sample to the strata is proportional to the size and variance of the strata.

$$n_i = \frac{N_i S_{Ni}}{\sum_i^L N_i S_{Ni}} . n$$

where: n_i is sample size in each stratum, N is total population, N_i is population in the stratum i , S is standar deviation of the number of cattle owned by each producer, and n is sample size.

Table 2. Total of producers and herd average according to the classification into strata.

Stratum	No. de Producers	Mean (No. of cattle)	Standard deviation	n_i
Small (1 – 20)	704	9.86	5.21	66
Medium (21– 40)	228	29.39	5.65	23
Large (41– 100)	130	66.49	18.32	43
Very large (> 100)	22	154.16	57.88	23
Total/Average	1084	64.97	21.76	155

A direct survey was conducted with the selected producers in each stratum on a random basis, visiting 25 communities and making periodic field trips in the corresponding ranches. The selection of the extension agents surveyed was carried out using the snowball technique [46], in which the producers and the representatives of the livestock organizations of the municipality were asked to identify the technical advisors (private and public institutions) that have worked with producers in the study area, obtaining a sample of $n = 23$ technicians. The officials were the representatives (director, coordinator or department head) of the main agricultural institutions involved in the livestock activity of the study area: Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), Rural Financing Authority, Institutional Trusts in Relation to Agriculture (FIRA), Regional Social Development Module, Institute of Training and Productivity for Labor of the State of Oaxaca (ICAPET), Regional Livestock Union of the Coast of Oaxaca (UGRCO), Local Livestock Association (AGL), Secretariat of Agricultural and Forestry Development of the Government of the State of Oaxaca (SEDAF), National Support Fund for Companies in Solidarity (FONAES), Technological Institute of Pinotepa and Technological Agriculture High School Center No. 10 (CBTa No. 10) (Table 1). According to their willingness to participate in the survey, a response rate of 64% of the invited institutions was obtained.

The main variable evaluated was the *perception about the sustainability of cattle ranching*, and this was considered under two contexts: 1) the idea or image that the individual forms on sustainable cattle ranching in a comprehensive manner that includes social, economic and environmental aspects [47–49], and 2) the assessment or importance (positive or negative) given to the sustainability process, based on the advantages and disadvantages perceived from a series of positive and negative statements in the social, economic and environmental dimensions [34,50,51].

To collect the information, questionnaires with open questions and with statements for dichotomous answers were used, obtaining the original interpretation of the social actors on sustainable cattle ranching and its assessment given its technical-productive characteristics in positive and negative statements for each sustainability dimension (Tables 3 and 4). The characteristics in the statements and dimensions of sustainability (social, economic and environmental) were based on the principle of intergenerational solidarity of the popular definition used for sustainable development as “that development that satisfies the needs of the present, without compromising the ability of future generations to satisfy their own needs” [31]; as well as considering some analyses, concepts, criteria and indicators that incorporate the political dimension [19,52,53] and that underpin the approach of sustainable cattle farming [24,25,51,53].

The data were analyzed with the *Statistica* Version 7.1 program [54], generating descriptive statistics and frequency tables for quantitative variables. A net perception index [51] was constructed for each social actor by counting the positive and negative characteristics perceived about SCR, classified in the social, economic and environmental dimensions. This index is equal to the total number of positive responses in one dimension, minus the total number of negative responses in the same dimension. The values were from -3 to +3 depending on the result of the sum of affirmations (3 positive vs 3 negative) in each sustainability dimension. Once the information and the respective averages were obtained, the following equation was used to calculate an overall net perception index (ONPI).

$$ONPI = \frac{NPISoc + NPIEcon + NPIEnv}{3}$$

where: *NPISoc* is Net perception index in the social dimension, *NPIEcon* is Net perception index in the economic dimension, and *NPIEnv* is Net perception index in the environmental dimension.

The ONPI value range was from -3 to +3, depending on the result of the sum of the index values of the sustainability dimensions, where -3 meant the rating conferred to the total of negative attributes and +3 the rating conferred to the total of positive attributes that could have been perceived by social actors from the list of items (Tables 3 and 4). The values of the indices were analyzed using the Kruskal and Wallis H test [55], contrasting the responses between social actors. Additionally, the Spearman rank correlation test was applied to observe the association of the indices with the variables herd size, subsidies (extraordinary financial aid granted by an official institution) and additional income (obtained from activities outside the production unit, e.g., wage earner). The criteria for selecting these variables were the arguments in the literature that establish that there is a greater willingness for organic and sustainable production in those large and subsidized producers [53,56,57] and the purpose was to verify whether the theory of postmaterialism applies in this context, which establishes that it is only the satisfaction of basic needs that enables the emergence of other secondary needs and people assign greater subjective value to those things that they lack the most and as their socioeconomic conditions improve, their priority values change to concerns about the quality of life [58].

With the qualitative information obtained from all social actors, a text analysis was performed, identifying emerging analytical categories; For this purpose, NVivo 11 Pro software for Windows was used, and the content analysis technique was applied to textual citations, according to Kaefer et al. [59]. The total number of textual citations and the analysis determined the emerging analytical categories; in this sense, the results and discussion were obtained from the systematization and qualitative analysis of the textual citations, including in the results some as an example, which contextualize the results in qualitative terms.

Table 3. Response of social actors for positive SCR perceptions.

Dimension	Positive perception items	P	E	O
		%	%	%
Social	SCR meat and milk are healthier	98.7	95.7	100
	Trees in paddocks provide shade and a pleasant climate to the cattle and producer	100	100	100
	A sustainable ranch is more beautiful and orderly in its landscape	98.1	87.0	100
	SCR is more profitable than conventional cattle ranching	77.4	65.2	85.7
Economic	Trees in paddocks provide fruits, forage, firewood and posts	99.4	91.3	85.7
	SCR provides a diversity of income on the ranch	87.1	82.6	100
	Trees help control soil erosion and protect rivers	98.1	100	85.7
	Trees help clean the air	97.4	100	100
Environmental	In SCR, wild animals and plants are conserved and increased	92.9	95.7	100

P: Producer (*n* = 155), E: Extension agent (*n* = 23), O: Official (*n* = 7), SCR: Sustainable cattle ranching.

Table 4. Response of social actors for negative SCR perceptions.

Dimension	Negative perception items	P	E	O
		%	%	%
Social	SCR requires more organization and training	96.8	78.3	85.7
	Few technicians trained in SCR	81.3	52.2	85.7
	In SCR, cattle management in more difficult	33.5	30.4	57.1
Economic	SCR requires high capital investment	73.5	13.0	28.6
	Trees in paddocks limit the growth of the grass	66.5	30.4	42.9
	With many trees on the ranch, people steal firewood fruits and wood	76.1	65.2	28.6
	With more trees in paddocks there are more pests and diseases on the ranch	29.0	4.3	0.0
Environmental	With more trees in paddocks more snakes abound	53.5	34.8	14.3
	Dry branches and trees fall and hurt the cattle	59.4	34.8	28.6

P: Producer (*n* = 155), E: Extension agent (*n* = 23), O: Official (*n* = 7), SCR: Sustainable cattle ranching.

3. Results and Discussion

3.1. Characteristics of the Social Actors

Of the producers interviewed, 94.2% were men and the rest women, with an average of 57 years of age, 22 years of cattle ranching experience and five of schooling. Leos-Rodríguez, et al. [60] reported similar data (55.5 years of age and 6.4 years of schooling) from a sample of 977 producers in the national registry of PROGAN beneficiaries, information that is true for most of the country’s livestock producers. These schooling averages are far from the national average (9.9 years) for the population aged 15 and over [61], which is considered a constraint on livestock development, since the level of schooling is a key factor in technology adoption processes [62–64].

The total area of these farmers’ ranches ranges from 2 to 300 ha, with an average of 33.4 ha, predominantly ejidal land tenure (89.7%). The main activity of the ranches is 40% agricultural and livestock production, 32.9% dual-purpose (meat and milk) cattle ranching, 25% exclusive production of calves and only 2% is dedicated to the exclusive production of milk. In these systems, the cattle types mainly used are Swiss × Zebu (79.4%), Zebu Brahman (12.3%) and some undefined genotypes. These characteristics of zootechnical purposes and breed pattern are similar to those generally reported for cattle ranching in the Mexican tropics [15,17,65].

Of the 23 extension technicians interviewed, 15 were Zootechnical Veterinarians and eight Agronomists. Age, years of professional experience and monthly income (mean $\pm$ SD) were: 32.7 ($\pm$ 6.6), 8.4 ($\pm$ 5.6) and US \$ 670.04 ($\pm$ 448.7)¹. All of these professionals reported having a bachelor's degree as their highest degree of studies, only two said they also had a diploma and one reported having completed a major in animal production. This maximum degree of studies differs when comparing it to the distribution of this variable (8.9% bachelor's degree, 62% master's degree and 29.1% doctorate) in a sample of extension technicians (n = 79) who participated in a study of perception of the concepts of sustainable agriculture in Iran [66]; however, it is within the education level range of a sample of rural extension agents from 10 Latin American countries: Argentina, Bolivia, Brazil, Chile, Ecuador, El Salvador, Mexico, Paraguay, Peru and Uruguay [67].

Officials from seven institutions that collaborate in regional livestock development participated: 1) Institute of Training and Productivity for Labor, 2) Regional Social Development Module, 3) City Hall of Santiago Pinotepa Nacional, 4) Technological Institute of Pinotepa, 5) Technological Agriculture High School Center No. 10, 6) Institutional Trusts in Relation to Agriculture (FIRA), and 7) Rural Financing Authority. These governmental bodies are located in the city of Pinotepa Nacional, except for FIRA that operates from the city of Puerto Escondido. The average age of these officials was 41 years, their average professional experience was 19 years and their average monthly income was US \$ 1,202.33.

3.2. Perception of Sustainable Cattle Ranching (Idea)

The perception of sustainable cattle ranching was the main variable of this study and the producers showed difficulty in expressing their idea or interpreting this concept; however, 76% of them were able to respond when asked, *What do you understand by sustainable cattle ranching?* In this regard, it should be noted that these people were not previously aided or prompted to elicit a particular response; they were in accordance with their original perception. Some of the comments recorded are presented below:

- "That the farmer can be self-sufficient with better feeding practices";
- "Milk the cows, make the cheese, sell it, take the meat. Everything will be alright with the cattle if you give them their vaccines and deworm them";
- "Manage the cattle so that they do not damage the trees, and do not- use up all the pasture";
- "Produce good quality food with the least possible use of antibiotics and pesticides, and use appropriate techniques to conserve the soil";
- "Give cattle tree seeds that have vitamins";
- "That you benefit, that it gives you the opportunity to live with dignity";
- "Fix the well where the cattle drink water, take care of the environment and don't burn because all the plants get burnt";
- "Live off the cattle, from which I cover my expenses, make sure the cattle have enough to eat";
- "That the cattle give me a little bit of food, that in the dry season I had a creek for the cattle's water and the grass to also be able milk in the dry season";
- "Cattle ranching that is sustained with the least transformation of nature, which does not alter nature with chemicals.

These comments revealed a general idea about SCR, prioritizing the implementation of appropriate management practices, based on a healthy and adequate feeding of cattle during the year to obtain higher production and better sales, resulting in improved family subsistence (Figure 2). However, no one had a complete and clear concept that simultaneously expressed expectations in the basic dimensions of sustainability (social, economic and environmental). One of the most revealing things in these statements was that the very large producers did not express concern or interest in issues such as "good production and better market", possibly because they have already resolved this situation, and neither was it a priority for them to establish "best management practices" or that sustainability means "better cattle feeding", but these producers did emphasize a greater

¹ The exchange rate used during the study was MEX \$ 13.4 per US \$ 1.

integration of their perception on the concept of sustainability by stating that “the ranch is maintained with its own resources” and that it is “profitable and with good management of its natural resources”. In the case of small and medium producers, those who considered the sustainability of cattle ranching as “best management practices”, “good production and better market” and “better cattle feeding” in their perceptions; possibly because it is something that they have yet to achieve in their production units. A similar situation was reported by Gargiulo et al. [68] who found that Australian dairy farmers with larger herds have adopted more precision technologies compared to those with smaller herds, which could reflect these farmers’ attempts to address labour issues (availability, cost, skill level and efficiency) as well as ensure routines and protocols to monitor and manage larger scales of operation. The authors conclude that the use of new technologies presents an opportunity to improve livestock productivity and address future challenges related to environmental, animal care and socio-ethical issues. Meanwhile, Zanin et al. [69] reported that investment and implementation of new technologies in rural dairy farmers in Brazil play a positive role in the sustainability of dairy businesses. They also found that, from the perception of this type of producers, who have abundant natural resources on their farms, issues related to the sustainability of the supply chain as a whole are not as important or intelligible.

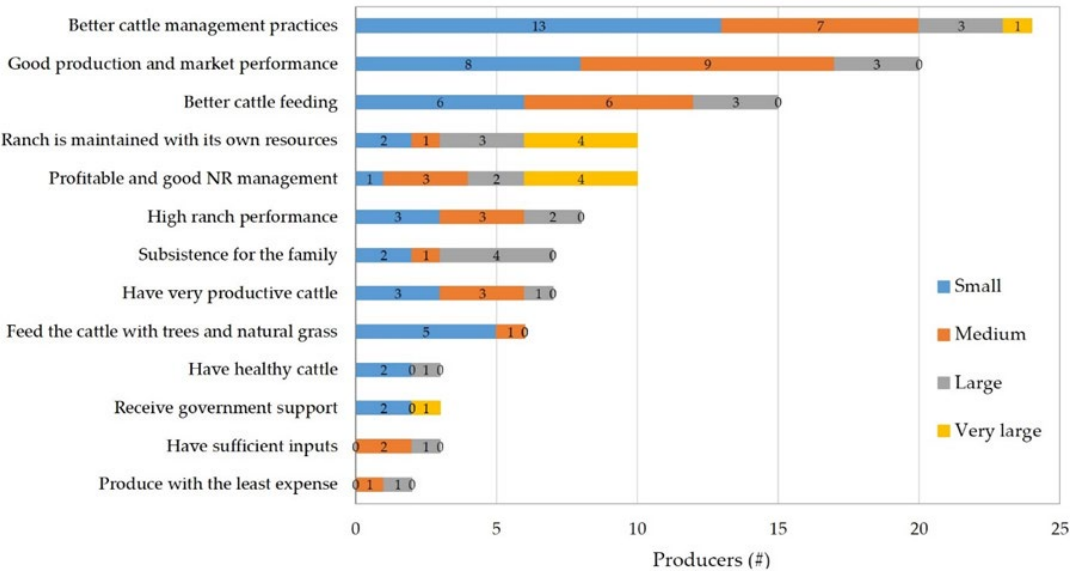


Figure 2. Perception of sustainable cattle ranching by producers in the study area.

The extension agents’ main perceptions of SCR were: a) a company that is self-sufficient and does not affect its environment (21.7%), b) cattle ranching that takes advantage of local resources (17.4%), c) cattle ranching with profitability and conservation of natural resources (17.4%); and d) cattle ranching in harmony with the environment (13%). In the case of the officials, the responses were: a) cattle ranching that is practiced without damaging the environment (28.5%), b) cattle ranching with appropriate stocking rate, local resources and productivity (14.3%), c) cattle ranching for highly developed European countries (14.3%), d) cattle ranching that is neither invasive nor extensive (14.3%), e) cattle ranching with efficient use of natural resources (14.3%), and f) cattle ranching with environmentally friendly technologies (14.3%).

Considering the dimensions of sustainability, Figure 3 shows that producers orient their perception of SCR more towards economic (48.4%) and environmental (21.3%) aspects. Extension agents are also more oriented towards economic (52.2%) and environmental (47.8%) aspects, while officials relate it more to the environmental dimension (71.4%). In this sense, the producers stated that for cattle ranching to be sustainable it must be productive and have a favorable market performance to generate income. The extension agents revealed a more comprehensive notion, recognizing that simultaneously there should be productivity and conservation of natural resources.

For their part, the officials expressed a more environmentalist notion for this type of cattle ranching. It was observed that the producers with a profession, like the extension agents and officials, formulated a more comprehensive idea about SCR, by simultaneously indicating production, environmental conservation and ranch self-sufficiency. This result is consistent with that reported by Borroto et al. [70], whose study identified greater environmental vision in groups of university students and managers, compared with workers, peasants, housewives, retirees and students; this can be explained by the fact that individuals with more education tend to think about other aspects of life once they satisfy their primary needs [58], in addition to having a greater basic knowledge of ecology and the environment, as well as aspects of global competence [49].

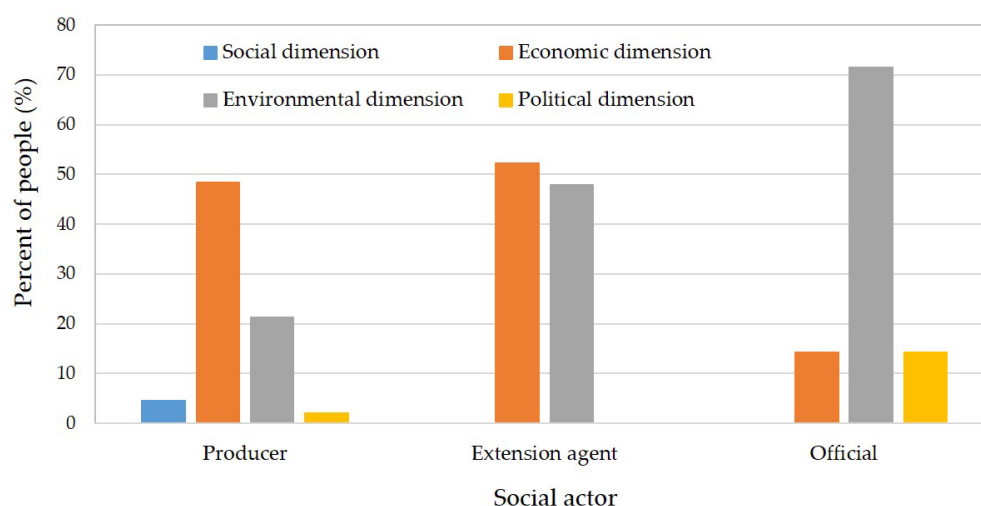


Figure 3. Sustainability dimension to which the perception of social actors on sustainable cattle ranching is oriented. Producer (n = 155), Extension agent (n = 23) and Official (n = 7).

3.3. Perception of Sustainable Cattle Ranching (Assessment)

Positive perceptions in the social dimension were accepted by almost the entire study population, finding only a few cases of producers and extension agents who disagreed and mostly with the statement “A sustainable ranch is more beautiful and ordered in its landscape” (Table 3), stating that a sustainable ranch can not necessarily be beautiful and ordered in its landscape, since also a conventional ranch can have the same appearance. In the economic dimension, the affirmative response percentage was not very high for producers and extension agents, particularly in the items “SCR is more profitable than conventional cattle ranching” and “SCR provides a diversity of income in the ranch.” In the environmental dimension, for most of the items and in all social actors, the affirmative response percentage was higher than 95.7%, except for the item “In SCR, wild animals and plants are conserved and increased,” being 92.9 % in the producers, whereas the rest was not convinced of such an assertion.

Although the results in positive perceptions are not so unfavorable, in order to promote greater knowledge among social actors, it is recommended to establish in the study area some demonstration plots with basic elements of sustainable cattle farming, such as silvopastoral systems (living fences, trees dispersed in pastures, forage banks, riparian forests, etc.), intensive rotational grazing, integrated crop and livestock systems, animal welfare criteria and reduction of the carbon footprint on ranches; conducting studies to validate the profitability [5,65,71] and the provision of ecosystem services of this type of livestock [72–74].

In the case of negative SCR perceptions (Table 4), a high percentage of responses that affirmed the disadvantages of this type of cattle ranching, mainly in the economic and social dimensions, was found. For example, all social actors identified two items as a social disadvantage, that “SCR requires more organization and training” and that there are “few technicians trained in SCR in the region”. The three items of negative perception in the economic dimension were affirmed as a disadvantage,

mainly by producers and to a lesser extent by extension agents and officials. In the environmental dimension, no major disadvantages were noted by social actors, except in the items “With more trees in paddocks more snakes abound” and “Dry branches and trees fall and hurt cattle,” this on the part of producers.

In general, social actors observed social constraints to develop SCR and also contended that this type of cattle ranching could not be economically profitable because it demands more investment and has productive limitations, attributing in this sense more environmental than socioeconomic benefits (Table 5). A positive assessment was found in all sustainability dimensions (social, economic and environmental); however, there were significant statistical differences among the social actors, with the officials assigning lower values in the social dimension and the producers in the economic dimension. The extension agents assigned high positive values in all dimensions, although they placed more emphasis on the environmental dimension, as did the officials.

Table 5. Net perception index in each sustainability dimension of cattle ranching and in each social actor.

Net perception index	Producer (n = 155)				Extension agent (n = 23)				Official (n = 7)			
	$\bar{x}$	SD	Min	Max	$\bar{x}$	SD	Min	Max	$\bar{x}$	SD	Min	Max
Social*	0.9 ^b	0.7	-1.0	3.0	1.2 ^a	1.0	-1.0	3.0	0.7 ^b	0.8	0.0	2.0
Economic**	0.5 ^b	1.1	-2.0	3.0	1.3 ^a	1.3	-1.0	3.0	1.7 ^a	1.0	0.0	3.0
Environmental**	1.5 ^b	1.1	-2.0	3.0	2.2 ^a	1.0	-1.0	3.0	2.4 ^a	0.5	2.0	3.0
ONPI**	0.9 ^b	0.7	-1.0	3.0	1.6 ^a	0.9	-0.7	2.7	1.6 ^a	0.5	0.7	2.0

ONPI = Overall net perception index; SD = Standard Deviation. *, ** Different letters between columns indicate significant difference with $p < 0.10$ and $p < 0.01$, respectively.

These results can be explained by the scope of the components in each individual’s perceptual frame of reference (values, norms, knowledge, interests and convictions). Why did extension agents and officials attribute greater absolute value to the importance of SCR, compared to producers? According to Vanhonacker et al. [34], this occurs in the case of opinion questions, rather than questions based on facts or knowledge. Therefore, it is assumed that the extension agents and officials responded from a perceptual perspective, while the producers possibly based their answers more on their work experience within the cattle ranching activity.

A positive relationship was observed between the producers’ *Overall Net Perception Index* and the variables *herd size* ($r = 0.222$), *PROGAN subsidy* ($r = 0.248$) and *additional income* outside the ranch ($r = 0.467$) ($p < 0.01$). These associations were not corroborated in the extension agents and officials with their respective socioeconomic variables, which suggests that the positive perception of SCR is independent of their socioeconomic status. These findings can be explained by the sociological theory of post-materialism, which states that it is only the satisfaction of basic needs that enables the emergence of other secondary ones. In this sense, people assign greater subjective value to those things that they lack the most and as their socioeconomic conditions improve, their priority values change from needs linked to physical sustenance to concerns about the quality of life [58]. Herein lies the importance of promoting incentives aimed at encouraging producers to think about and act with sustainable practices [35,75].

In a joint analysis of the producers’ SCR idea and assessment, compatibility was observed by revealing that as an idea the SCR system is mainly seen as one that provides more socioeconomic benefits (greater productivity, good market performance and a de-cent life), while in the assessment it was precisely those same elements that were iden-tified, by means of a score, as the disadvantages to this type of cattle ranching. In this sense, all social actors pointed out the expectation in the idea component of the study and SCR deficiencies in the assessment one. This reveals that the expectation concerning SCR, mainly among producers, is oriented towards socioeconomic aspects rather than envi-ronmental benefits.

In summary, the order of importance in terms of the expected impact of SCR on producers was firstly economic benefits, followed by social and finally environmental benefits; the opposite result was true for extension agents and officials, where the order was inverse (environmental rather than economic and social benefits). These results differ slightly from those reported by Zanin et al. [69] who observed that the economic dimension contributes 60% to the perception of sustainability in dairy farming in the West region of Santa Catarina, Brazil, followed by the social dimension. These drivers mostly refer to management practices, followed by improvements in production techniques and public policies. In this sense, it is seen that the concern of rural producers with the application of management control tools is very important in promoting sustainability. The environmental dimension makes a much smaller contribution.

In addition, Silici et al. [76] describe that, while farmers understand and agree on the need to preserve the natural resource base, they may not be fully motivated to pursue these approaches if other priorities, such as irrigation, access to credit and infrastructure, are more pertinent to them. As the increase in yields may take some time to realise, farmers may not appreciate these benefits against the investments in time and resources that are due upfront. Similarly, unless they are severely affected by any environmental pressure, it is difficult for farmers as individuals to take into consideration the positive externalities, the social benefits that sustainable agriculture brings about for the environment and the society.

3. Conclusions

The main idea that the study area's producers have about sustainable cattle ranching focuses specifically on the implementation of appropriate management practices, based on a healthy and adequate feeding of the cattle during the year to obtain greater production and better market performance for improved family subsistence. In their case, the extension agents perceive a cattle ranching operation that is self-sufficient, does not affect its environment and takes advantage of local resources while maintaining profitability and harmony with the environment. The officials, on the other hand, perceive a cattle ranch with an appropriate stocking rate, local resources and productivity, operating without damaging the environment, using environmentally friendly technologies and making efficient use of natural resources.

The perception of sustainable cattle ranching among the social actors evaluated is positive; however, its conceptualization is differentiated according to the role they play in the activity, their academic training, the scale and support for production and their expectations. The expectations of the producers are mainly of a socioeconomic rather than environmental type, while the extension agents have a more comprehensive perspective that includes all aspects of sustainability (social, economic and environmental) and the officials have a more environmentalist notion.

The differences in the perception of social actors identified in this study reveal the lack of dissemination and appropriation of knowledge and practice of sustainable cattle farming and a diversity of individual interests and goals in cattle farming. This implies greater complexity for the dissemination and adoption of alternative production approaches, technical support and relevant public policies that promote the sustainable development of cattle farming in the study area.

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