Research, Society and Development, v. 9, n. 12, e24991210871, 2020
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v9i12.10871

Use of sustainability indicators in rural properties: a methodological experience in the training of professionals of Agrarian Sciences

Uso de indicadores de sustentabilidade em propriedades rurais: uma experiência metodológica na formação de profissionais de Ciências Agrárias

Uso de indicadores de sostenibilidad en propiedades rurales: una experiencia metodológica en la formación de profesionales de las Ciencias Agrícolas

Received: 12/04/2020 | Reviewed: 12/11/2020 | Accept: 12/17/2020 | Published: 12/21/2020

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Abstract

The search for sustainability guides several sectors of society, but its effectiveness may seem utopian and inconsistent with the economic and social factors of today's society. Understanding applicable concepts to the current reality, in its simple exercise, may constitute a path to its effectiveness. The experience involved 30 rural properties into Western Santa Catarina and was developed by the students of the undergraduate course in Animal Science of

State University of Santa Catarina - Center for Western Studies - UDESC/CEO, campus of Chapecó. Using the MESMIS methodology, students considered different parameters for the measurement of sustainability indicators in each property, considering the environmental, social and economic dimensions. The maximum scores obtained were concentrated in the economic dimension and the minimum in the social one. The study, in addition to its didactic purpose, pointed out the severity of social conditions in the field (recurrent in studies of succession and aging), as well its lack of training and leisure spaces.

Keywords: Family agriculture; Participatory research; Sustainable development.

Resumo

A busca pela sustentabilidade norteia diversos setores da sociedade, mas sua eficácia pode parecer utópica e inconsistente com os fatores econômicos e sociais da sociedade atual. Compreender conceitos aplicáveis à realidade atual, em seu simples exercício, pode constituir um caminho para sua eficácia. A experiência envolveu 30 propriedades rurais no Oeste de Santa Catarina e foi desenvolvida pelos alunos do curso de graduação em Zootecnia da Universidade do Estado de Santa Catarina – Centro de Estudos do Oeste - UDESC/CEO, campus de Chapecó. Utilizando a metodologia MESMIS, os alunos consideraram diferentes parâmetros para a mensuração dos indicadores de sustentabilidade em cada propriedade, considerando as dimensões ambiental, social e econômica. As pontuações máximas obtidas concentraram-se na dimensão econômica e as mínimas na social. O estudo, além de seu propósito didático, apontou a severidade das condições sociais da área (recorrentes em estudos de sucessão e envelhecimento), bem como a falta de espaços de treinamento e lazer.

Palavras-chave: Agricultura familiar; Pesquisa participativa; Desenvolvimento sustentável.

Resumen

La búsqueda de la sostenibilidad orienta a varios sectores de la sociedad, pero su efectividad puede parecer utópica e inconsistente con los factores económicos y sociales de la sociedad actual. Comprender conceptos aplicables a la realidad actual, en su simple ejercicio, puede constituir un camino hacia su efectividad. El experimento involucró 30 propiedades rurales en el occidente de Santa Catarina y fue desarrollado por los estudiantes de la carrera de Licenciatura en Ciencia Animal de la Universidad Estatal de Santa Catarina - Centro de Estudios Occidentales UDESC/CEO, campus de Chapecó. Utilizando la metodología MESMIS, los estudiantes consideraron diferentes parámetros para medir los indicadores de sostenibilidad en cada propiedad, considerando las dimensiones ambiental, social y

económica. Las puntuaciones máximas obtenidas se concentraron en la dimensión económica y las mínimas en la dimensión social. El estudio, además de su finalidad didáctica, señaló la gravedad de las condiciones sociales de la zona (estudios recurrentes en sucesión y envejecimiento), así como la falta de espacios de formación y ocio.

Palabras clave: Agricultura familiar; Investigación participativa; Desenvolvimiento sustentable.

1. Introduction

The state of Santa Catarina, specifically its Western region, is known for its contrasts. The state is considered extremely important in the production of chicken and pork meat, in milk and grain production, but also houses veiled processes of exclusion and discrimination. Western Santa Catarina has undergone different economic cycles: yerba mate, wood, livestock and recently agroindustrialization (Facco, 2011). It is a reference state in agricultural and agro-industrial terms, with an economy structured by diversified family agriculture and contribution to agroindustry by producing meat, mainly pork and poultry (Cancelier, 2013).

The region is strongly linked to national and international economic dynamics, which, in turn, transforms this territory into a space where global trends manifest themselves locally and regionally (Cancelier, 2013), modifying and exerting constant pressure on life forms, production and the landscape. The main economic support, based on rural family production linked to the food industry, gradually became "selective", causing a significant portion of the rural population to migrate to new spaces throughout the country, especially urban ones (Bernardy, Zuanazzi & Monteiro, 2013). This characterizes aspects of production and development focused on the exclusion of traditional lifestyles and production forms, as well as their adaptation to models designed by the food industries.

In this sense, the course of Animal Science, as well as the other ones related to agrarian sciences, play an important role in the training of professionals qualified for animal and plant production, fundamental for both the regional and national economies. The challenge of effecting the discussion on sustainability in daily professional life is great, given not only the dichotomy imposed by industrial production, but also the complex characterization of the productive diversity of family agriculture. The strategy discussed in this study is incorporation, as a didactic tool to the disciplines of undergraduate courses in the area, as well as the use of sustainability indicators, mainly related to practical field classes and work close to the family farmers.

As such, it was essential to understand sustainability as an ethical principle for both the agrarian scientists and the farmers; in addition to broader aspects of the concept, which involves social, economic and environmental dimensions beyond the relationships built by farmers.

The objective of the experience was to provide students with the perception and "measurement" of sustainability in different production systems, also considering their direct contact with the producer and with their conceptions and perspectives on the subject.

2. Theoretical Basis

The measurement of sustainability is an important, constant and complex exercise, that can be considered subjective, given its complexity, the amplitude of scope of each dimension, each parameter and subparameter. These three methodological elements have the function of reducing this complexity until its individuation within the productive complex in the form of an indicator. In parallel, it has also the function of giving the proposed scope to any given parameter and these to the sustainability of the production unit.

> Global sustainability has been defined as the ability to meet the needs of the present without compromising the same ability for future generations. Similarly, sustainable development “is a process for achieving human development [...] in an inclusive, interconnected, egalitarian, prudent and safe way. [...] that contributes to sustainable development by simultaneously generating economic, social and environmental benefits” (Hart & Milstein, 2004).

The complexity and difficulty of the unique concept of sustainability reflects its very dynamism; its premise is founded on the local and sectoral reality of each element to be analyzed. As such, the methodology used in the evaluation of indicators should be based on each reality of study.

In this context, the division into quadrants or dimensions should be seen with the care and methodological specificity, given the need for sustainability not to be fragmented into sectors but to be seen with the necessary totality.

For methodological purposes, the economic dimension involves activities that financially influence the standard of living of individuals; the environmental dimension considers the impacts of activities on the ecosystem, on natural resources; and the social dimension involves the relationships with the individual or institutions with society, besides characteristics and elements that corroborate for these relationships to occur.

An important dimension not contemplated in this study is cultural, which should mainly be considered when the individuals surveyed have different territorial origins; it deals with the ways of life, production and the specificities of social relations and spaces.

The definition of the indicators to be evaluated is also conditioned to the knowledge and understanding of local realities. For Rempel et al. (2012) the methodology should consider the environment, in addition to evaluating the reality in question with the whole system as a perspective.

> Therefore, when a set of indicators is established, it is essential that they privilege the interactions between the components and their dimensions, reflecting the system in its most global form, without disregarding the parts; therefore they should privilege a systemic approach (Rempel et al., 2012, p. 48).

Within this context, indicators are tools for the evaluation process, that can be adopted individually or condensed into indices or even be components of analyses within more complex systems.

> A sustainability indicator is a measurement whose interpretation evidences the condition of a system as either sustainable or non-sustainable, according to the standards established for the analyzed context. While an index is the result of a mathematical manipulation of certain data in order to simplify it, and thus can be formed by various types of indicators, including different themes. Sustainability indicators and indices can contribute to decision-making processes aimed at sustainable development (Cândido et al., 2015, p. 101).

Among the methodologies for the use of sustainability indicators, available and tested in their adaptation to production systems, is the MESMIS *(Marco de Evaluación de Sistemas de Manejo Incorporando Indicadores de Sustentabilidad*), which according to Souza et al. (2015), was developed in the 1990s by the Interdisciplinary Group of Appropriate Rural Technology (GIRA - *Grupo Interdisciplinario de Tecnología Rural Apropiada*) in Mexico, with the objective of evaluating the sustainability of agricultural activities. The characteristic method is the possibility of incorporating the reality and specificity of each system, describing and evaluating the actions developed within the chosen agroecosystem.

Among the characteristics of MESMIS is the cyclical, participatory, multiple-scale format, considered for its flexibility, systemic approach and adaptation to reality and diversities.

> The method consists of six-step evaluation cycles. First, the analyzed system is characterized, identifying the aspects of the management system and its socioeconomic and environmental context. Then an analysis of the critical points of the agroecosystem is made in order to identify the limiting and favorable factors for sustainability. The third step is the determination of diagnostic criteria associated with sustainability attributes (productivity, stability, resilience, reliability, adaptability, equity and self-management). Based on the diagnostic criteria, sustainability indicators are determined. The fourth step refers to the measurement and monitoring of indicators over time; in the fifth step, the results are integrated and presented and, finally, after the critical analysis of the system, conclusions and recommendations deemed important for the improvement of sustainability in the management system are made (Cândido et al., 2015, p. 107).

In summation, it is important to remember the objective of sustainability indicators within the context of rural properties, bearing in mind that its applicability lies in understanding sustainability within a given context in order to plan, assess and correct actions and practices in a given space and time. Sustainability is thus an objective to achieve, that under satisfactory conditions needs to be monitored and maintained. To this end, analyses such as this one should be part of the investment of the production system itself.

3. Metodology

This study is characterized as descriptive and exploratory, developed as a didactic component on the undergraduate course of Animal Science of UDESC/CEO, Universidade do Estado de Santa Catarina, Center for Higher Education in the West. The data were based on activities developed in 12 municipalities in Western Santa Catarina, in rural properties chosen by the students of this course, arranged in groups to carry out the study. The municipalities were chosen by the students according to their residence relationships and local contacts, considering the existence of the animal component in the production system of the analyzed properties.

The experiment was conducted between 2016 and 2019, involving 160 students. For this study, the results of 30 rural properties were systematized, that were selected according to the parity of indicators built during the survey.

The productive systems of the participating properties are characteristic of family farming, composed of a diversity of productive activities, the predominant use of family labor and the limited area for production. All the properties considered in the research have the animal component in their production system and part of them is a participant in the vertical system of agro-industrial integration for the supply of animal raw materials, such as

milk, pork, chickens and eggs for regional and national cooperatives, with the aim of main export destination.

For the effectiveness, some interdependent and complementary steps were determined, such as bibliographic research to obtain theoretical basis and documentary research in the collection of data and previous information about the property. The-information to be collected was defined through a previous visit, which aimed to present the work proposal and the survey of information about the productive activity, in addition to the establishment of critical points of the productive system. As a methodological tool, interviews were conducted with all those involved in the productive system, following a semi-structured script adapted from Rempel et al. (2012). The development sequence followed the steps described below, determined according to the indications of the MESMIS methodology, in Masera, Astier & López-Ridaura (2000).

1) Determination of the study environment.

2) Determination of the critical points of the agroecosystem.

3) Selection of indicators, establishment of parameters and subparameters relevant to the agroecosystem in question.

4) Measurement and monitoring of indicators and quantitative evaluation of the collected information.

5) Analysis, integration and interpretation of results.

On-site visits were carried out with landowners, with the objective of surveying land cover, use of land, water resources, improvements and other relevant data points for the crafting of the land use and land cover map. This tool was important for delimiting environmental and productive aspects that make up the measurement process of the indicators.

The indicators were constructed integrating the information obtained in various stages, considering the social, environmental and economic dimensions. The number of parameters and subparameters were constructed specifically for each production unit, with 18 parameters and 57 subparameters used on average, to which grades from 0 to 10 were assigned according to the analyses considered individually.

The recurrent parameters used as the basis of the studies were: social condition, educational basis, household and animal waste, water, use of synthetic and or organic fertilizers, labor productivity, management of the production system, slope and erosion, use and conservation of permanent protection areas and their reference scores. These parameters

were composed of subparameters for a better understanding and were conceptualized according to field observation and characteristics of the productive units.

The number of field visits was determined by the need observed by the students. A minimum of two visits was recommended for each group. Later, we carried out the systematization of data, and experiences were presented and discussed in the classroom with results returned to the farmers by each group.

Table 1 records the main parameters, shared by the groups and used as a basis for determining the sustainability indicators of the experiences in question.

Table 1. Dimensions and main parameters used for the establishment of indicators.

Parameters		
Social	**Environmental**	**Economic**
Water quality and availability	Waste treatment	Use of external inputs
Quality and availability of housing	Water conditions and treatment	Productivity
Schooling level	Permanent Protection Areas	Property management
Access to information	Waste management	Indebtedness
Social participation	Legal Reserve	
Leisure	Soil management	
Succession	Ability to use areas	

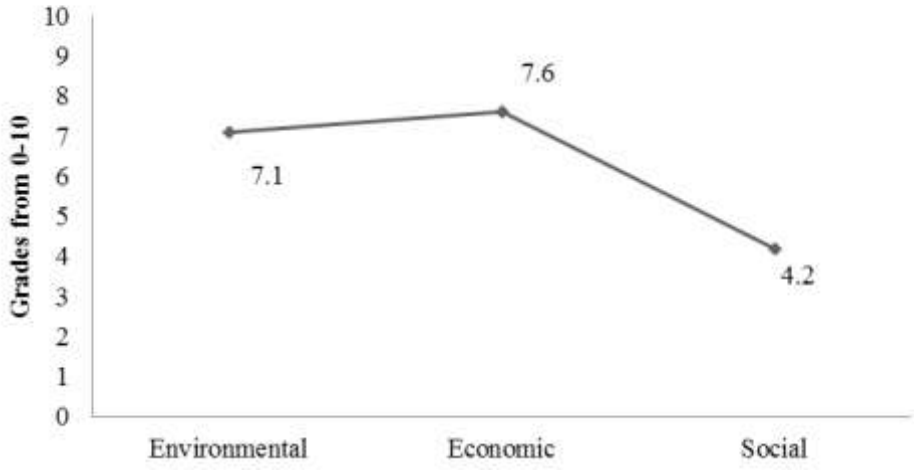
Source: Authors (2019).

The subparameters are specific to each studied reality, but their main purpose was enabling the measurement of the actual parameters. The assigned scores were on the scale from 0 to 10, with concepts determined according to the scale proposed by the MESMIS methodology: score equal to or greater than 9.0, - excellent, 7.0 to 8.9 - good, 5.0 to 6.9 - regular, 2.0 to 4,9 - bad, less than 2.0 - inadequate.

4. Results and Discussions

The indicators were varied, according to each productive system, so the results discussed here will be concentrated in the environmental, social and economic dimensions and on the means attributed to each component indicator of such dimensions (Figure 1).

Figure 1. Mean evaluation of indicators used in the environmental, economic and social dimensions.



Source: Authors (2019).

Observing the results, the dimension of greatest value was the economic dimension, considered in the methodological scale as “good”. This result is probably linked to the integrative forms of commercialization that guarantee the purchase and continuity of production systems; on the other hand, these alternatives reduce the autonomy of the farmer, who is now based on a set of techniques and management skills linked to industrial conglomerates that in turn are dependent on the global capital market. Such dependence makes the conception of sustainability in time and space even more difficult, often reducing the notion to its economic dimension and to the present time.

Among the farmers surveyed, 73% are integrated into large chicken, pork or milk production companies. These farmers establish contracts for production, or integration, as it is commonly called in the region, with companies, providing for partnership time, quantities to be delivered and investment values. For Cielo *et al*. (2020, p. 150), through these contracts, the farmer often becomes a “rental producer”, since he acts only on the fattening of animals and the whole process is controlled by the agro-industry, which is the real owner of the product. In this same aspect, Ribeiro (2011), adds that the contract between the agribusiness and the producer is a way of camouflaging labor relations.

The environmental dimension, also evaluated as "good", refers to two perspectives: that of the limit of our own parameters, considering the diversity of productive forms in family agriculture; and that qualified by the 7.1 rating, which despite being considered as

"good", is at the limit of a negative evaluation, and should be viewed with concern, understanding that this dimension is directly linked to sustainability in time and space and is the basis of the natural resources necessary for production systems.

There is a correlation between the risk of environmental unsustainability and the adoption of processes of homogenization of rural production, here represented by the integration into the agribusiness of animal production derivatives, and its incentive and even demand, of large-scale production, which caused pollution the environment, especially water due to the excess production of animal waste (Moretto; Brandt, 2019), and reduction of biodiversity. The difficulty in adapting to environmental legislation and the attribution of this responsibility solely to the farmer is also a reason for exclusion and lack of succession in rural areas (Alles, 2017).

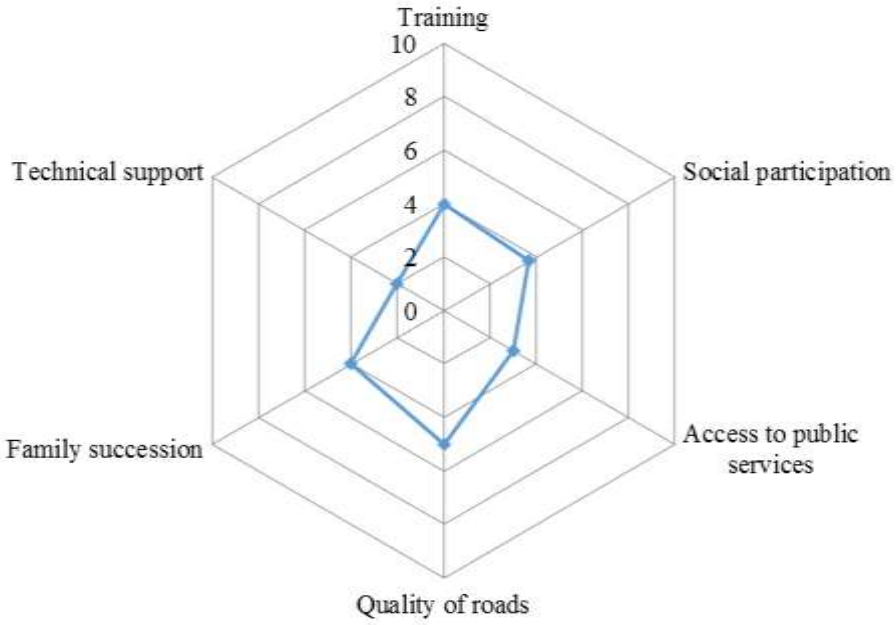
The treatment given to residues, domestic and animals, received a score below 6 in 75.4% of the properties, which reflects a characteristic problem of the region still lacking in problem-solving actions. Use of pesticides also had an indicator below 7 in 72.6% of the properties and is mostly associated with its application near watercourses without any reasonable criteria or the lack of personal protective equipment, which also has implications in the social dimension.

Waste disposal is also another recurrent indicator with score below 5 in 80.3% of properties; considering here the disposal of animal carcasses (score below 4 in 95% of the 22 properties in which the indicator was assessed) as well as domestic and work-related waste (bags, medicine containers, boxes etc.).

According to data from the National Solid Waste Plan MMA (2011), only 31.6% of rural households receive garbage collection services, the remaining 70% end up looking for alternatives, through burning, burying or even throwing the waste on vacant land, rivers, lakes, streams and dams. Even in this percentage that receives the garbage collection service, the problem of disposing of dead animals persists. The correct thing would be to install a composting system, but a large part of the farmers only bury the animals, which can cause contamination of water resources

However, it is clear in the results that the means obtained by the evaluation in the social dimension were lower than the other dimensions. In this sense, Figure 2 shows the social indicators used by all groups and exposes the mean evaluations of the six indicators that most contributed to the final mean of this dimension.

Figure 2. Mean of the indicators used for the social dimension in the evaluation process of 30 rural properties in Western Santa Catarina.



Source: Authors (2019).

This dimension should not be seen in isolation, but it was the only one that presented the highest number of common indicators among the groups and the lowest evaluation among the dimensions surveyed. This is an exercise of "looking" at these indicators and their perception in the context of sustainability.

The indicators and their valuation reflect the difficulties in technical assistance, access to public services, road quality, social participation, succession and training, consecutively from the worst evaluation to grade 5, as proposed in the evaluation of the results.

For Dimenstein *et al*. (2017), rural populations are the most affected by the lack of basic infrastructure, isolation, illiteracy, among other problems typical of the lack of social development. For the authors, these groups are more affected, less visible and more difficult to reach by public policies.

It is important to consider that the values attributed to technical assistance correspond to the systemic rather than segmented understanding of the productive system, as is normally found in the studied properties. This takes into account the relationships already mentioned with the agro-industrial complexes, mainly of meat production. In this aspect, some recurrent points in the evaluations are the high requirement of technologies, imposed and inflexible management practices and the time of absorption of activities related to integrated meat production within the family agriculture productive system.

In this item, the most generalized visualization between the local and the global is important. The activities of integrated production of meat and meat products, receive large and intense impositions given under a command that is global, which are transmitted horizontally by technical assistance, segmented for this determined area and paid for by the integrating companies (Elias, 2011), the singularities of each production unit, the context of a family farm, its diversity, its connection with the territory, none of this is part of the technical considerations provided by the companies.

Regarding access to public services, it is possible to highlight the services of education, health, and basic sanitation, in interrelation to the quality of roads. This is also linked to the economic dimension via flow of production (Gazolla; Schneider, 2015), considering the need for farmers to transport their products and in the specific case of integrations this need is even more valued by the delivery of animal feed and removal of large loads of animals. For Sehnem *et al*. (2020) it is important to evaluate with criteria the differences between rural and urban areas considering the need and specificity of demands for public services, according to the authors these differences result in inequalities of access and are connected with the distinction of levels of development.

In this sense Andreatta *et al*. (2020) list the infrastructure of the rural area as an important aspect for the continuation of the activity and highlight that strategies developed by the public institutions for the improvement of transport services, access, health services, are connected to the renovation of generations in the rural environment.

Indicators of social participation, succession and training had better evaluations, although were still lackluster. All of these lead to ample discussions, which in a way reflect the isolation of the rural environment not in a physical or geographical way, but in a conception of society, rooted in the dichotomy between rural and urban and in the recognition of the farmer within this context (Ribeiro Neto, 2018).

It is important to note that among the best evaluated social indicators are housing and food quality, followed by quality and access to water and access to information. Generally, these can be related to the environment and the access to telephones, televisions and internet services, which are increasingly present in the rural environment, at least within the proposed regional section.

Sehnem *et al*. (2020), in his studies on motivations for generational continuity in rural areas, points out that access to communication technology is an important element in defining permanence in rural areas, to which one can add the link to the search for training, new ways partnerships and commercialization in new contexts of food production.

5. Final Considerations

The use of sustainability indicators as a didactic practice was able to promote large-scale discussions either as a tool for understanding sustainability or as a determination of the importance of the action of professionals towards the concept.

The bad mean for social sustainability parameters indicates to us in a comprehensive way the need for technical and institutional assistance, conscious of its limitations, but relating to social solutions, networks and productive chains that promote community relations, and the valorization of the family farmer as a central element of production processes reducing the distances and polarities between rural and urban environments.

In order to consider the importance of the activity for the undergraduates involved, the methodology was able to reinforce the responsibility of agrarian scientists in the face of the development of actions capable of modifying/improving these indicators over time, or in a more basal aspect, at least to consider them in the planning and execution of their activities.

At another point, the sustainability analysis aided the farmer and scholars in visualizing each component of the productive system and each indicator in isolation, as well as in measuring its influence on each property's sustainability. The exercise of measuring the indicators also allowed the valorization of components, within the context of the sustainability, which in the daily routine of work may not be given due attention as an indicator that could compromise its support in space and time.

Acknowledgments

To UDESC CEO and the scholars of the Animal Science course for their availability and commitment.

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