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Sustainability of Swine Production from the Evaluation of Externalities

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Summary

The study aims to analyze the sustainability of pig production developed in two rural properties, based on the Management System for the Assessment of the Sustainability of Pig Farming (SIGEASS). As for the methodology, the study is of a descriptive nature, carried out through a multicase study and of a qualitative nature. The application of SIGEASS was carried out in two rural properties, one located in the city of Seara-SC and the other in the city of Xaxim-SC. The results indicate that in the rural property of Seara the negative externalities refer to the environmental indicators related to the Soil, Energy and Air/Greenhouse Effect, whereas the economic-financial aspects were observed as positive externalities. Aspects related to social indicators, it was identified that human capital also has weaknesses. In the rural property of Xaxim it was possible to observe as negative externalities the environmental indicators related to Water, Air/Greenhouse Effect and Energy, as positive externalities it was observed the economic-financial indicators, in addition to human capital and social interaction. In general, the results show the importance of analyzing pig production practices, in order to minimize negative externalities.

Keywords: Sustainability indicators; Evaluation of externalities; Pig production

Introduction

Global issues and concerns about life on the planet motivated the creation of the Brundtland Report , which highlights sustainable development aimed at issues of social equity, environmental protection and economic development by meeting basic needs [1]. There are also the Sustainable Development Goals (SDGs), which show economic growth from a new perspective, using natural resources consciously [2]. In addition to meeting the current basic needs without affecting future generations, so that they can also meet their needs, aiming at improving the quality of life [1]. Sustainable development can be understood as the possibility of meeting human needs without affecting the environment, ensuring that future generations can also meet their needs without being affected [3]. However, sustainability is not limited to just caring for the environment, according to Silva [4], one can perceive issues related to the quality of life, use of clean technologies, the rational use of natural resources, social responsibility, concern for people, among others. Companies also perceived sustainability as a way of remaining in the market, as in addition to profit for the company, it is necessary to highlight the benefits for society and other related parties or stakeholders, in addition to the preservation of natural resources [5,6].

For the analysis of sustainability, indicators were developed that serve to evaluate the performance of the entity in a given dimension and enable the improvement of negative points (weaknesses or negative externalities) or, enhance the positive externalities, which enable the planning of actions that help in taking action decision of managers seeking continuous improvement, in favor of effective sustainability [7-9]. Sustainability contributes to the performance of companies (decrease in costs and increase in revenue generation), cooperating for differentiation in the face of the consumer market, as it is increasingly present in organizations that aim to preserve natural resources, as observed by [10]. One can understand sustainability from the set of three dimensions: economic, environmental and social, which allow the assessment of the level of sustainability of entities, as evidenced by Elkington [11], calling them the tripod of sustainability, considering the environmental, social and economic-financial dimensions.

Paz and Kipper [10], highlight that sustainability refers to the balance of economic, social and environmental aspects, which should prioritize the benefits for future generations. Sustainability is also seen as the balance between quality of life and the

preservation of natural resources so that both are not harmed [2]. Indicators help entities to assess which points should be changed to achieve the best level of sustainability [10,12,13]. Sustainability indicators serve to guarantee the development of the company in relation to the economic, environmental and social dimensions [5]. Sustainability indicators contribute to the analysis by helping rural managers to plan the ways in which certain activities should be carried out, aiming, in addition to better results, also the analysis of specific indicators by activity developed [14]. The pig farming sustainability indicators serve to analyze the level of sustainability of rural properties, considering the impacts on the economic, environmental and social dimensions [8,15]. The Sustainable Development Goals (SDGs) also show economic growth under a new vision, using natural resources consciously [2], in addition to meeting current basic needs without affecting future generations, so that they can also can meet their needs, aiming at improving the quality of life on the planet and its continuity [1]. According to Diniz and Callado [5], companies should seek actions that demonstrate their commitment to the Sustainable Development Goals.

The sustainability indicators evaluate the environmental, social and economic aspects, make it possible to analyze the practices and actions carried out and improve the planning of the activities developed [16]. These indicators must be adapted to the reality of each activity, especially in the context of the rural environment, in view of the specificities of the activities and their form of production [8]. The assessment of sustainability in rural areas allows observing the environmental impacts generated by activities and social impacts, such as rural exodus or social exclusion [17].

The Suinoculture Sustainability Management and Assessment System (SIGEASS) is a method created to serve as a basis for the manager's decision-making regarding the points that need to be improved in the development of the swine activity. SIGEASS makes it possible to assess the positive and negative externalities of pig production, observing indications of improvements in terms of social, environmental and economic-financial aspects. Through the analysis of the indicators, it is possible to identify the level of sustainability and the need for improvements in the pursuit of sustainability [18]. In this sense, the present research has as its problematic: what is the level of sustainability of pig production developed in rural properties? This research aims to analyze the sustainability of pig production developed in rural properties from the Management System for the Assessment of the Sustainability of Pig Farming (SIGEASS).

The research was carried out in two rural properties in western Santa Catarina, one located in the municipality of Xaxim and the other in Seara, in order to compare the positive and negative externalities of the pig production of each one of them. The relevance of the study is justified considering that the production of pigs and the final destination of the manure generate risks of contamination of the soil, the incorrect management of the manure can affect the soil, the water, the animals and the human beings (ALLEGRETTI, 2013) . It also justifies the relevance of the research in order to contribute to the analysis of sustainability and the identification of improvements in each of the analyzed dimensions, in both rural properties studied. In the development of the swine activity, one of the biggest concerns is the waste produced by animals, which are harmful to water, soil, animals and human beings. They are generally used as fertilizer and/or fertilizer for plantations, as well as new technologies that refer to the possibility of using them in the production of agro-energy and biogas, the methods of disposal of waste can become sustainable alternatives, provided that they are used properly, including helping to reduce property costs [15].

Methodological Procedures

This section addresses the methodological procedures of the study. The research is characterized, regarding its objectives, as descriptive, carried out from a multicase study , in two rural properties, using the SIGEASS model, for analysis of the results. As for the approach to the problem, it is characterized qualitatively. As for the objectives , the research is classified as descriptive, as data was collected on rural properties in relation to sustainability and, after analysis, the level of sustainability of each property was described. For data collection, the check was used as an instrument. list of the pig farming sustainability management and assessment system (SIGEASS). The research was carried out in two rural properties in western Santa Catarina, one located in the interior of the municipality of Xaxim and the other in the interior of the municipality of Seara. Both properties have fully family farming, and the couple, two sons and daughter-in-law live on the property located in Xaxim, whereas on the rural property in Seara only the couple lives. The activity carried out on rural properties is pig farming, reproduction being the main objective, and 21-day-old pigs are transferred to other rural properties. The collection of research data was done through the application of the check list of the SIGEASS model [18], through interviews carried out from visits to rural properties. And for data analysis, it is presented from the indicators and externalities of the SIGEASS Model, through tables with the set of evaluation metrics. The data used in the research refer to production practices, historical data on property investment and average revenue and costs with the pig farming activity in the period 2018-2019, from both rural entities studied.

Analysis and Interpretation of Results

This section presents the analysis of the sustainability indicators, in the environmental, social and economic-financial dimensions, after the application of the SIGEASS method in the rural properties of Seara and Xaxim. Initially, we observe in Table 1 the environmental indicators.

It is observed in Table 1, in the soil analysis element, regarding soil conservation, the Xaxim property has no-till planting and

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performs crop rotation, with an average of 4 temporary crops every two years, while the Seara property does not apply the practice of this rotation, planting only corn. Gallo et al. [17] indicates the need for planning for crop rotation, as rotation helps in the absorption of nutrients by the soil, in the productive capacity and in the absorption of waste. Regarding the two indicators of the total area available for the disposal of waste generated by the swine activity, these are items that have a negative externality on both properties, since they do not have enough own area to meet this need, which affects the quality of the soil and the its absorption capacity.

Table 1: Assessment of environmental indicators of pig production.

Performance indicators		Compensation Rates	Unit	Superior Measures (ordinal)	Lower Measures (ordinal)	Harvest property	Xaxim property	Score by the Seara Interval scale	Score by the Xaxim Interval scale
Evaluation elements	**Environmental performance indicators**								
Ground	Physical/chemical soil analysis	33%							
	- LCA-P (environmental critical limit of Phosphorus)	50%	BR	20%	40%	40%	40%	0	0
	- Phosphor	50%	mg/kg	60	110	110	110	0	0
	Soil conservation practices	33%							
	- No-tillage	50%	factors	90%	70%	100%	100%	150	150
	- Crop rotation	50%	factors	3	two	0	4	-200	200
	land occupation	33%							
	- Total area available / number of animals housed	25%	m3/ha/ year	30	50	328.61	102.08	-200	-200
	- Total own available area / waste production	25%	m3/ha/ year	30	50	328.61	180.14	-200	-200
	- % APP –	25%	mts	50	30	700	250	200	200
	- % Legal reserve	25%	BR	30%	20%	12%	9.68%	-80	-103
Water	Origin of the source used for animal consumption	50%							
	- Natural sources	25%	BR	50%	70%	100%	100%	-150	-150
	- Artificial Fonts	25%	BR	40%	20%	0%	0%	-100	-100
	Distance between springs or effluents installations	50%	mts	50	30	700	250	200	200
	Conscientious use of water	50%							
	Device to avoid wasting water	50%	factors	3	1	0	0	-50	-50
	water reuse	50%	factors	3	1	0	0	-50	-50
air/greenhouse effect	Emissions, Effluents and Waste of greenhouse gases, by weight	50%	m^3	60	40	0	0	-200	-200
	Air quality	50%							
	community satisfaction	50%	BR	10%	30%	5%	5%	125	125
	Windbreaks (air dispersion, if there is a natural barrier)	50%	factors	two	0	0	3	0	100
Energy	total energy use	100%							
	Energy consumption	50%	BR	20%	10%	0	0	-100	-100
	Power generation	50%	BR	20%	10%	0	0	-100	-100
Environmental practices	Waste treatment	20%							
	Process used	50%	factors	3	1	1	1	0	0
	Destination of waste from the activity	50%		4	1	1	1	0	0

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			factors						
	Solid waste disposal	20%	factors	3	BR	3	3	100	100
	disposal of dead animals	20%	factors	3	BR	two	two	67	67
	Environmental regularization	20%							
Environmental practices	Compliance with laws and regulations	50%	factors	3	1	3	3	100	100
	Notifications or fines received	50%	factors	3	1	4	4	150	150
	Animal welfare	20%							
	Area available per animal	25%	mts	2.5	2.1	1.4	1.9	-175	-50
	Housing of sows in collective pens	25%	swine	4	two	3	7	50	200
	Floor type of the premises	25%	factors	3	1	3	3	100	100
	Number of animals per trough	25%	swine	12	10	3	7	200	200

In addition, both properties do not have practices for the conscious use of water, which avoids waste and generates reuse, which is a negative externality that also needs improvement. As for electricity, the lack of biodigestors also negatively affects both properties that do not use efficient energy consumption and therefore do not save the energy that could be generated with the use of biodigestors, in addition to helping in the treatment of waste as which was validated in the research by Soerger, Oliveira and Moraes [19]. It was observed that the rural property of Xaxim has a biodigester, but it is not using it due to problems that require maintenance (it broke down) [20].

As for environmental practices, it can be highlighted as a negative externality the available area per housed animal, which is below the measure suggested in the model, being at least 2.10 mts per animal and the rural property of Seara presented 1.4 mts and the of Xaxim 1.9 mts. The other environmental indicators analyzed have conformity assessment for both rural properties, according to the standard established in SIGEASS. Table 2 presents the evaluation of social indicators.

Table 2: Assessment of the social indicators of pig production.

Performance indicators		Compensation Rates	Unit	Superior Measures (ordinal)	Lower Measures (ordinal)	Harvest property	Xaxim property	Score by the Seara Interval scale	Score by the Xaxim Interval scale
Evaluation elements	**Social performance indicators**								
Human capital	Satisfaction with the rural environment	20%	Note	9	7	8	9	50	100
	work system	20%							
	- Family labor	50%	people	4	two	two	5	0	150
	-Third parties/ collaborators	50%	factors	3	1	0	1	-50	0
	People training and development	20%							
	- Technical capacity	50%	hours	20	10	0	50	-100	200
	- Development of human capital	50%	factors	3	1	0	4	-50	150
	Family Health	20%	factors	3	1	3	3	100	100
	family succession	20%	factors	3	1	0	3	-50	100
Social interaction	Quality of life in the community	20%	groups	3	1	3	3	100	100
	social participation	20%	groups	3	1	two	two	50	50
	Social programs	20%	hours	15	5	4	50	-10	200
	Perception of environmental impacts	20%	factors	3	1	3	3	100	100
	Providers	20%	factors	3	1	3	3	100	100

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external indicators	Municipality's IDEB	16.66%	factors	8	5	6.5	6.2	50	40
	Sustainable municipal development index	16.66%	index	0.8	0.5	0.638	0.645	46	48
	sociocultural index	16.67%	index	0.8	0.5	0.771	0.765	90	88
	environmental index	16.67%	index	0.8	0.5	0.537	0.561	12	20
	economic index	16.67%	index	0.8	0.5	0.604	0.521	35	7
	Institutional political index	16.67%	index	0.8	0.5	0.641	0.734	47	78

In Chart 3, the evaluation of the social indicators is observed, in the rural property of Seara, regarding the human capital element, identifying as a negative externality the lack of technical training and development of the family members, in addition to not having third parties to help in the swine activity, and the labor is carried out only by the couple. In addition, the family does not have a successor to continue the activity, which will probably lead to the sale of the property.

The Xaxim rural property, on the other hand, presents excellent results in terms of human capital, and the family members have technical training, in addition to frequently participating in courses offered by the cooperatives to which they are members. The property also has a collaborator who assists in the swine activity. As for the family succession, it is already guaranteed, as the eldest son of the couple already works in the activity together with his wife. Both owners demonstrated that they are satisfied with the rural environment where they live and have good social interaction with the community to which they belong. Furthermore, regarding the external indicators of the municipalities, they are within the standards established in the SIGEASS method. Table 3 shows the evaluation of the economic-financial indicators. In these elements of remuneration of labor and remuneration of capital, both properties presented excellent results.

Table 3: Evaluation of economic and financial indicators of pig production.

Performance indicators		Compensation Rates	Unit	Superior Measures (ordinal)	Lower Measures (ordinal)	Harvest property	Xaxim property	Score by the Seara Interval scale	Score by the Xaxim Interval scale
Evaluation elements	**Economic and financial performance indicators**								
Labor remuneration	Labor remuneration	100%	R$	1.5	0.5	5.6	3.48	200	200
Return on invested capital	Return on invested capital	100%							
	Return on investment per pig housed	33%	R$	750	1,250.00	518.68	657.89	146	118
	Net income from the activity	33%	R$	25%	15%	28.10%	36.76%	131	200
	Payback time on investment	33%	Years	8	12	1.85	1.6	200	200

According to Table 3, the rural property of Seara presented a higher indicator than that of Xaxim in relation to the remuneration of the workforce, however it is worth noting that in the property of Seara only two people work in the activity, while in the property of Xaxim six people work in the activity. In this way, the rural activity is able to remunerate the families, which generates the satisfaction and interest of the families in staying in the rural environment, which is related to the questioning of the grades for this item (8 were observed in Seara and 9 in Xaxim). As for the return on invested capital, the results are very close and both obtain the return on invested capital in less than 2 years. In Seara's property, the investment made was R$ 250,000.00, and they have a monthly income of approximately R$ 40,000.00, with an average net profit of R$ 134,856.00, the return on investment occurs in 1.85 years old. Regarding the Xaxim property, this investment was R$ 400,000.00, with an average monthly revenue of R$ 56,700.00, presented a net profit of an average of R$ 250,000.00, which allows the return on investment occur in 1.6 years. From the evaluation indicators of the management system and evaluation of the sustainability of pig farming (SIGEASS), the comparative Status Quo between the analyzed rural properties is presented, observing the externalities of pig production.

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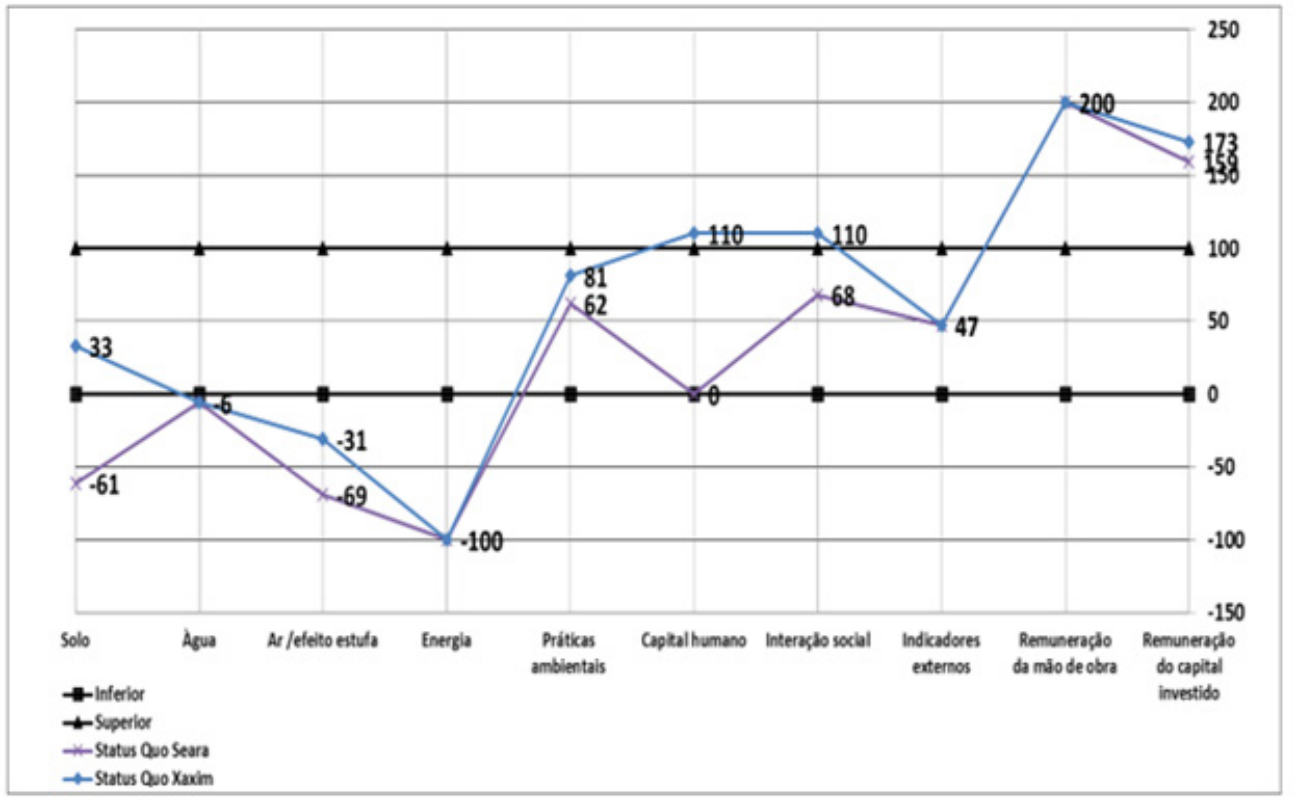

Source: SIGEASS (2019) with survey data.
Graph 1: Comparative analysis of results by Status Quo of rural properties.

Graph 1 demonstrates the Status Quo of rural properties, it is observed that the indicators that are below zero are negative externalities, between zero and one hundred are in compliance, but can be improved, whereas the indicators above one hundred refer to the conditions favorable, and can be considered as positive externalities. The greatest negative externality is found in environmental indicators in terms of energy, it is suggested that owners implement the use of biodigesters to improve sustainability, and according to the study by Allegretti, Machado and Schmidt [16] biodigesters reduce the environmental impacts, raising the level of sustainability of the property and also through the methane gas caused by the decomposition of the desires produced by the activity can be used in the generation of electric energy. And although both rural properties in the present study are in compliance with the Regular Environmental License, Rural Environmental Registry (CAR) in addition to participating in the Environmental Regularization Program (PRA), environmental practices represent negative externalities. Such results complement the findings by Lizot et al. [15], highlighting the importance of assessing sustainability in rural areas. The study validates the importance of analyzing sustainability in pig production, aiming at improvements in the development of the activity, as well as evidence from the study by Kruger and Petri [9], through the use of SIGEASS to assess negative externalities, improvements can be proposed needed. In general, the results corroborate the findings of Kruger and Petri [9] showing, through the comparison between two properties of different locations, the identification of positive and negative externalities, which demonstrates the importance of using SIGEASS in the analysis of sustainability in production pig farming, making it possible to improve the activity and quality of properties in favor of preserving natural resources and quality of life for future generations.

Final Considerations

The study identified the positive and negative externalities of the swine activity, developed in two rural properties, which allows them to seek to improve the negative aspects to achieve sustainability. When observing the rural property of Seara, regarding the environmental performance indicators, it was identified in the aspects related to the soil, the non-performing of the rotation of the temporary crops, which hinders the absorption of nutrients in the soil and, consequently, of the waste. In addition, the property only uses water from sources of natural resources to carry out the activity, it does not have a way of capturing and reusing water. Also, in terms of environmental aspects, the property does not have a biodigester to enable the reduction of environmental impacts caused by gases in terms of the greenhouse effect, in addition to also impacting on the reduction of energy

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consumption. In the rural property of Seara, it was possible to identify, regarding the social aspects, the lack of technical capacity of the managers, despite the participation in annual training of 04 hours, carried out in the community. Still, only the couple works in the activity and they have no family successors. As for the economic-financial aspects , positive externalities were observed, showing that the activity remunerates managers and has economic-financial viability.

In the rural property of Xaxim, it stands out in terms of environmental aspects, water and energy are negative externalities, as it does not have water reuse practices and uses only natural resource sources for pig production, and in terms of energy there is a biodigester that is not working. As for the available area per housed animal, the property has less than the minimum footage, which is detrimental to animal welfare, which also requires improvement. As for the social aspects in the rural property of Xaxim, human capital and social interaction are positive externalities. Regarding economic and financial aspects, the property also presents positive externalities, demonstrating its viability and return to managers. It is observed that the positive externalities refer to the indicators of the economic-financial dimension, while the environmental and social dimensions present weaknesses and need improvements and the implementation of better production practices, aiming at the sustainable balance of the development of the swine activity. It is recommended that managers implement and evaluate the improvements regarding the negative externalities identified in each rural property, aiming at minimizing the negative externalities in favor of the sustainability of the swine activity. In addition, it is recommended for future research to apply the model in other rural entities, in addition to the possibility of computerizing the model as a system for identifying sustainability indicators, so as to streamline and standardize the process of analyzing results, in addition to already compare the analyzed properties.

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