Sustainability of the pig and poultry industries in Santa Catarina State, Brazil: Challenges for socio-economic researchers, extension professionals and operators[1]

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Abstract

Despite having successfully introduced technical and economic benchmarking procedures to improve producers' performance, sustainability of the pig and poultry industries in Santa Catarina, Brazil might not be assured, because of significant problems such as poor waste management under current production systems.

This study employed a comprehensive methodology, combining quantitative (life cycle assessment), qualitative (survey and focus groups), and economic approaches, including an assessment of externalities, to identify a set of core sustainability indicators. They have been group into economic, environmental and social categories, according to their relevance to stakeholders. The challenge for professionals servicing these industries lies in developing policies and designing production systems that meet the social and environmental specifications incorporated in the sustainability indicators, rather than relying solely on conventional technical and economic benchmarks.

Key words: pigs, poultry, sustainability.

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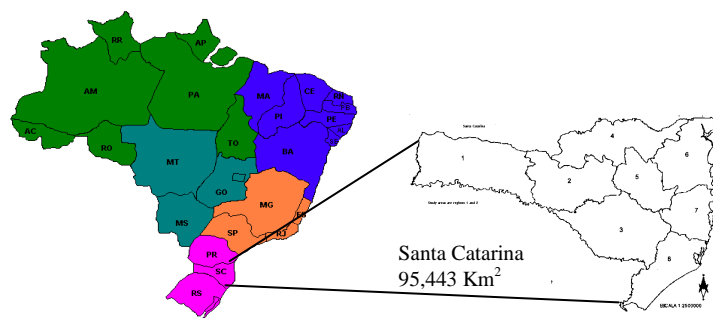
1   Introduction

The pig and poultry (P&P) industries in Santa Catarina State (SC) South of Brazil are undergoing major changes, with a trend towards concentration of production on large, specialised farms. The full consequences of this process are still unknown but it is clear that P&P production in a vertically integrated system with large-scale producers is displacing thousands of small farmers, and concentrating production geographically. From technical and economic perspectives, this move has proven successful, as the industries improved their competitive position in global markets but environmental degradation has become a major concern. In addition to the excessive amount of animal waste produced by these industries, the lack of suitable land for crops has forced farmers to use and dispose of high amounts of manure on small areas. Hence, it is believed that the amount of waste disposed in many parts of the region is beyond the assimilation capacity of the environment. This study sought to identify a set of core sustainability indicators for the P&P industries in SC, combining qualitative and quantitative methodologies

This paper initially presents background information on the P&P industries in SC, focusing on the important changes that these industries are undergoing over the recent decades and the great challenges for their sustainability. Then, the results of a survey of key stakeholders about their views and perceptions of sustainability are presented and discussed. Finally the results of a Life Cycle Assessment (LCA) study are presented and analysed, and combined with the survey results to suggest a set of key sustainability indicators for these industries.

1.1   Background

The State of SC is the largest P&P producer in Brazil, despite accounting for only 1.1% of the country's 8.5 million km^2 area. Figure 1 shows a map of SC in Brazil.

Figure 1 – Brazil and the location of the Santa Catarina State

In the mid 1980s, SC had 54,000 commercial pig producers but by the mid 1990s, the number was below 25,000. During the same period, total pig meat production increased by 180% (ACCS, 1998). The more recent trend, however, is to reduce this number of producers even more to approximately 12,500 pig and 6,500 poultry farmers. By 2000, there were approximately 20,000 pig farmers and 9,000 poultry farmers operating in SC (Icepa 2000b). Table 1 shows the evolution of pig production, domestic and regional consumption and exports in Brazil and SC since 1996, as well as SC's share in the national production.

Table 1 – Production of pigs in Brazil and SC - 1996 to 2001 and estimates for 2002

Year	Brazil ('000 tonnes of carcass)			Santa Catarina State ('000 tonnes of carcass)			
	Production	Domestic consump-tion	Exports	Production	Regional consump-tion	Exports	SC - % of Brazil's production
1996	1944	1909	58	571	93	50	29.4
1997	1860	1812	65	513	92	55	27.6
1998	2016	1927	83	562	95	68	27.9
1999	2084	2009	75	586	96	70	28.1
2000	2077	1977	135	623	98	95	30.0
2001	2234	1974	260	663	105	170	29.7
2002*	2368	2048	320	712	112	200	30.1

* Estimates.   Source: Adapted from Instituto Icepa (2000a) and Icepa (2001)

Poultry production in Brazil in 2001 reached 6.6 million tonnes and exports 1.25 of million tonnes, to which SC contributed 1.45 and 0.750 million tonnes respectively. Table 2 shows the poultry production, domestic and regional consumption and exports from 1996 to 2001, as well as SC's share in the national production.

Table 2 – Production of poultry in Brazil and SC-1996 to 2001 and estimates for 2002

Year	Brazil ('000 tonnes of carcass)			Santa Catarina State ('000 tonnes of carcass)			
	Production	Domestic consump-tion	Exports	Production	Regional consump-tion	Exports	SC - % of Brazil's production
1996	4051	3481	569	762	154	398	18.8
1997	4462	3810	649	900	168	501	20.2
1998	4500	3865	612	927	180	500	20.6
1999	5200	4440	750	1010	180	600	19.4
2000	5560	4760	800	1150	180	640	20.7
2001	6600	5345	1250	1452	n.a.	750	22.0
2002*	7200	5745	1440	1620	n.a.	864	22.5

* Estimates.   Source: Adapted from Instituto Icepa (2000a) and Icepa (2001)

Poultry production in SC is of high quality and very competitive in world markets, which is reflected by the high proportion of its production that is exported (53%). Brazil is currently the second largest producer and exporter of poultry meat in the world. Exports increased by 56% in 2001 compared to 2000, mostly to European and

the Middle East countries. These activities are highly relevant to the State's socio-economic prosperity, as they contribute with 40% of the SC's gross value of agricultural production. The mad-cow and the foot-and-mouth disease outbreaks in Europe contributed significantly to expand Brazilian exports of poultry. Pork exports also increased by 93% in 2001 over 2000, while the estimates for 2002 are of another 32% increase over the volume exported in 2001, due to access to new markets such as Russia, which absorbed 57% of Brazil's exports (Suino.com 2002). Table 3 presents some of the recent technological improvements achieved in the poultry industry in SC. For example, feed conversion has improved by 15.5% between 1985 and 1998.

Table 3 - Number of chicken growers in SC and key technical coefficients for vertically integrated production systems.

Coefficient	Unit	1985	1998
Poultry producers	Numbers	4,220	9,000
Production	tonnes	494, 000	927,000
Feed conversion	kg ration/kg LW[1]	2.21	1.88
Mortality	(%)	3.00	3.4
Live-weight	kg	2.10	1.98
Carcass weight	kg	1.68	1.58
Age to killing	days	48	37-46[2]

Source: Icepa (2000b). Primary data from the meat industries.
[1]Live weight; [2] Depending on the market

From technical and economic perspectives, these changes have been beneficial for these industries as they have improved their competitive position in global markets, but local communities are now becoming sensitive to the environmental burden caused by the intensive developments of these industries.

1.2   New challenges

Environmental impacts are being felt at three levels: local, regional and global. Locally, the excessive amount of animal waste, and the lack of suitable land for crops have forced farmers to use and dispose of high amounts of manure on small areas. Therefore, it is believed that the amount of waste disposed in many parts of the region is beyond the assimilation capacity of the environment. For example, in the Fragosos Catchment, the cropping and pasture area available can only assimilate 42% of the animal manure produced in the catchment (Pagani da Silva, 2000). Water contamination, with nitrates above 10 mg/l, was found in 37% of the samples tested in

Concórdia region in Western SC and 82% of water samples tested between 1985 and 1998 have shown high levels of *faecal coliform* organisms (SDA 1998).

There are indications that public perceptions and community expectations of these economic activities are changing. Community reaction and eventually outrage against environmental offenders can prove costly for companies and farms. Many operators are learning that compliance with environmental laws may not be sufficient to assure sustainability, as it requires initiative to produce in environmentally sound ways. Decision-making processes of agribusiness firms, particularly those having significant environmental impact, are increasingly influenced by these issues (Pigott 2000).

The recent changes, particularly in Europe, show that economic and technical rationales can no longer be the only drivers for operators and policy makers, as the environmental performance of products is gradually becoming part of the consumers' decision to buy certain products. There is need for the views of stakeholders such as consumers, local communities, employees, farmers and their families, and NGOs to be taken into consideration, because they may hold different perceptions of what is acceptable in terms of environmental and social impacts caused by an industry. By failing to consider the issues that cause negative externalities, corporations can face disastrous outcomes, which ultimately can erode their sustainability that was once taken for granted, given their technical and economic superiority over competitors.

1.3   Objectives

This study sought to identify a set of core sustainability indicators for the P&P industries in SC, combining qualitative and quantitative methodologies. It also aimed to quantify the environmental impact of P&P production, using the LCA approach. Sustainability indicators are increasingly considered as the core element in operationalising the concept of sustainability (Gilbert *et al.* 1991; UNCED 1992; Ostergaard *et al.* 1995; OECD 1997; RIRDC 1997; Bell and Morse 1999; ANZECC 2000). The effective use of indicators requires the formulation of techniques to assess scores for such indicators to assist stakeholders in defining policies and actions to achieve their objectives. The sustainability of the P&P industries in SC can be viewed from the three perspectives: ecological, economic, and social, and by using such indicators, sustainability can be assessed relative to all three simultaneously.

1   Methodology

This study employed an electronic survey (e-survey) and interviews of key stakeholders to identify their views about and perceptions of sustainability principles, as well as issues of concern regarding the sustainability of the P&P industries in SC. The outcomes of this survey were then submitted to discussion in focus group meetings to fine-tune the findings. Subsequently, a LCA study was undertaken to quantify the environmental impact of the P&P industries in SC, under current production and waste management systems adopted by typical producers.

2.1   Stakeholder survey

The stakeholder survey resulted in 265 usable replies to a questionnaire. Initially 252 persons responded to an e-survey, from which 204 replies where usable. In addition, 61 farmers where interviewed, as they had no access to the Internet. Figure 2 shows the numbers of respondents according to their professional links. Some respondents indicated that they belonged to more than one professional group simultaneously.
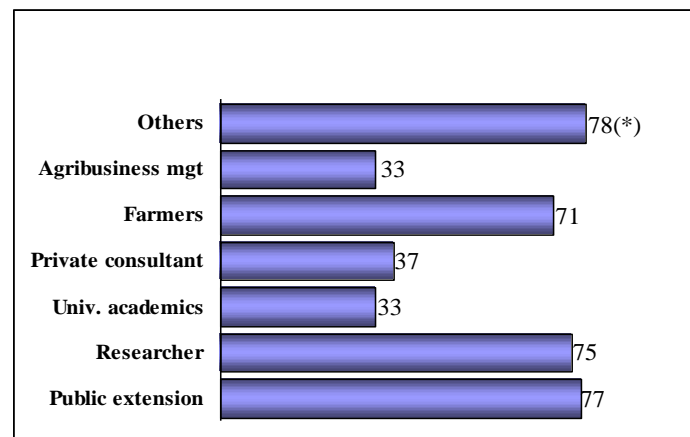
Figure 2 – Respondents by professional group (n = 265 respondents)
(*) Note: "Others" included environmentalists, students, NGOs, policy makers, animal health services suppliers, rural and community leaders, and local, and state and federal authorities

2.2   Focus group meetings

Four focus group meetings with a total of 47 participants were conducted aiming to discuss the outcomes of the survey and to refine the main issues about sustainability raised by the stakeholders survey.

2.3   Life cycle assessment

The LCA study was conducted using the Simapro5 software (PRé Consultants 1997). Published data was collected from available sources as well as from the standard

databases available in Simapro5. The scope of the system under study defined the boundaries as to include all activities and processes involved in the production and supply of inputs, the production of P&P at the farms, and its delivery to the gate of the abattoir. The functional unit (FU) was defined in each case as 1 tonne of live weight (LW), of pigs and of poultry.

2 Results and discussion

3.1 Stakeholders' perceptions of issues and principles of sustainability

Following the five fundamental guiding principles defining sustainability suggested by CSIRO (1998), statements that reflected these principles were presented to respondents to allow them to indicate the importance they attached to each of them, with respect to the sustainability of the P&P industries in SC. These guiding principles were:

- *Farm productivity is sustained or enhanced over the long term*
- *Adverse impacts on the natural resource base of agricultural and associated ecosystems are ameliorated, minimised or enhanced*
- *Residues resulting from the use of chemicals in agriculture are minimised*
- *The net social benefit derived from agriculture is maximised*
- *The farming systems are sufficiently flexible to cope with the risks associated with the vagaries imposed by the market and weather* (CSIRO, 1998 p.4).

Table 4 - Respondents' perceptions of the guiding principles of sustainability

Respondents' Choices	Need to increase productivity continuously		P&P industries impact adversely nat. resource base		Chemical residues from the P&P are a major problem		There is a large net social benefit derived from P&P		P&P systems are sufficiently flexibly to cope with risk	
	N*	%	N	%	N	%	N	%	N	%
Strongly disagree	38	14	6	2	15	6	15	6	61	23
Disagree	38	14	2	1	10	4	18	7	55	21
Slightly disagree	14	5	11	4	16	6	19	7	39	15
Neutral	23	9	7	3	22	8	10	4	43	16
Slightly agree	33	12	33	12	39	15	28	11	27	10
Agree	54	20	97	37	89	34	72	27	33	12
Strongly agree	61	23	105	40	70	26	96	36	2	1
Missing cases	4	2	4	2	4	2	7	3	5	2
Total	265	100	265	100	265	100	265	100	265	100

* = Numbers of respondents

Table 4 shows the results of how the stakeholders view the performance of current P&P production systems in SC in regard to the sustainability principles. When cross-analysed, the results show that respondents linked to private organisations placed higher importance on the need to increase physical productivity and technical and economic efficiency, than those from the public sector. On the other hand, respondents from public sectors placed higher importance on environmental and social aspects. Stakeholders' responses provide some clear indications that the P&P industries in SC are not meeting some essential conditions for sustainability, despite contributing a large net social benefit to the communities. While 43% of respondents either agree or strongly agree that there is still a need to increase physical productivity over time, the majority (77%) either agree or strongly agree that the P&P industries are imposing detrimental impacts on the environment. Also, 60% agree or strongly agree that the chemical residues from the production of pigs and poultry, including the chemicals used in the production of maize and soybeans, are a major environmental concern. Another indication of weak sustainability is expressed in stakeholders' responses to the question about flexibility for coping with risk, as 44% think that the current production systems are not sufficiently flexible to manage the market and climatic risks.

3.2   Stakeholders' response to measuring externalities

To be sustainable, the P&P industries must achieve the objective of being environmentally sound, technically and economically efficient, as well as contributing to the social well being of the general community. There is strong agreement that externalities should be assessed (88% of respondents) and included in any economic analysis of the pig industry (78% of respondents). This means that, to be sustainable, the industries must incorporate environmental costs into their true cost of production, i.e., including any environmental cost imposed on the general community.

The survey also shows the extent to which some World Best Practice in Environmental Management (BPEM) are not yet considered to be as relevant in SC as they are in other countries such as Australia and most European countries. Indicators related to soil conditions and excess of nitrates were not included by survey respondents amongst the most relevant indicators. As a consequence, emphasis was

given to distribution of pig manure on agriculture land, rather than to treatment in closed systems such as biodigestors.

3.3 Outcomes of the focus group meetings

The focus group meetings were conducted aiming to refine the outcomes of the stakeholder survey. The key outcomes of these focus group meetings were:

- P&P producers are aware of the environmental problems caused by poor waste management, particularly those that have a severe local impact, such as odours, blackflies (*Simulium spp*) and reduction of water quality. However, there is a lack of understanding about many of the processes and implications of pollution (eg nitrates, heavy metals, greenhouse gases, and other negative externalities).

- P&P producers consider the cost of efficient waste treatment and the interest rates charged on such investments too high, making it unaffordable under current low profit margins and unstable prices. Profits are reinvested to increase scale and production efficiency.

- The P&P industries are starting to feel the pressure coming from affected communities with reactions, sometimes even outrage displayed when their quality of life is affected by P&P production. This includes growing conflict in areas where urban developments are spreading towards P&P farms established for a long time in the area.

- Environmental issues are becoming part of the agenda for marketing P&P products, particularly for exports to European countries, which are demanding similar environmental performance as those imposed on their own producers. Environmental barriers can become the region's major marketing problem.

- The geographical concentration of production is pushing farmers to dispose of high amounts of waste into small areas of agricultural land.

- The number of producers in the region will continue to fall, while total production is expected to grow (eg, in 2001 poultry production increased by 17%).

- Due to geographical concentration of production, some small rural communities will collapse creating a significant social problem.

- Most producers do not have enough waste storage capacity, and therefore waste is not treated, nor disposed of adequately.

- To be sustainable, the P&P systems need to be balanced as far as inputs and outputs go. Currently the amount of organic matter and minerals brought into the region exceeds the amount that is taken out and this is causing eutrophication.

- Herd sizes and geographical redistribution must be reassessed.

- Up to 70% of pig producers in the western region of SC are not complying with the environmental law.

- The environmental costs (negative externalities) should be measured and be part of the cost of production and economic analysis of the industries.

- There is a lack of data about impacts and indicators are urgently needed.

- The meat processing firms need to be engaged in the solution of farmers' waste disposal problems. An industry-based fund to support waste management is suggested.

- Research to develop affordable efficient waste management systems is needed.

- There is a lack of co-operation among producers and between producers and policy makers. The waste problem is an issue for the whole society, because the positive externalities of the P&P industries also benefit the broad community.

- To reverse the current situation, commitment and pressure from the whole society is needed. There is a lack of environmental awareness. Environmental eduction is urgently needed. This requires well-prepared extension officers.

3.4   Results of the Life Cycle Assessment

In this LCA study, the "cradle-to-gate" approach was used, in which the boundaries for the LCA included all inputs and use of natural resources, through the operations of production and delivery to the gate of the abattoir of 1 tonne of live-weight (LW) of animals (pigs or chickens), as well as the disposal of wastes. The results for the characterisation of impacts of the LCA are shown in Table 5 and Table 6 for pigs and poultry, respectively. The impact assessment method used was the Eco-indicator 95-e (Goedkoop 1995).

All results shown in Table 5 and Table 6 include activities and processes required to produce feed (soybeans, soymeal, maize, *premix* and minerals) and transportation at all stages. The production of 1 tonne of LW of pigs and its delivery to the abattoir generates greenhouse gases equivalent to 3,750 kg of CO_2. Most of the environmental impact comes from the ration production chain. The use of manure as fertiliser

reduces the need to produce inorganic fertilisers and therefore provides an environmental credit in the LCA.

Table 5: Environmental impact from the production of 1 tonne of live weight of pigs in SC, delivered to the abattoir. Method: Eco-indicator 95.

Impact category	Unit (equivalent)	Production of pigs	Veterinary products	Treated pig waste	Ration pigs (mixture)	Electricity SC LV	Transport Ration + Pigs	Fertilisers avoided by manure use	Total
Greenhouse	kg CO2	260	44.7	20	3360	114	137	-190	3750
Ozone layer	kg CFC11	-	3.04E-06	0.000156	0.000418	-	-	-	0.000577
Acidification	kg SO2	10	0.335	130	20.2	0.679	1.95	-3	160
Eutrophication	kg PO4	69.3	0.0295	65.4	310	0.0629	0.314	-8.11	437
Heavy metals	kg Pb	-	0.0000404	0.000399	0.0168	0.0000877	0.000198	-0.00743	0.0101
Carcinogens	kg B(a)P	-	2.75E-07	0.00000102	0.0000125	7.14E-07	1.62E-07	-2.85E-07	0.0000144
Pesticides	kg act.subst	-	-	-	1.71	-	-	-	1.71
Energy resources	MJ LHV	-	289	3.6	15800	836	1850	-1910	16800
Solid waste	Kg	-	0.0382	-	28.7	0.000242	0.0665	-0.0527	29

Table 6: Environmental impact from the production of 1 tonne of live weight of poultry in SC, delivered to the abattoir. Method: Eco-indicator 95.

Impact category	Unit (equiv.-lent)	Production of poultry	Ration for poultry	Veterinary products for poultry	Treated poultry litter	LPG for heating	Electricity SC LV	Transport Ration + chickens	Fertilisers avoided by manure	Total
Greenhouse	kg CO2	260	2150	27.7	1.25	12.2	10.5	267	-141	2588
Ozone layer	kg CFC11	-	0.000375	1.88E-06	9.77E-06	-	-	-	-1.2E-05	0.000375
Acidification	kg SO2	10	13.4	0.208	8.13	0.0386	0.0623	3.94	-1.57	34
Eutrophication	kg PO4	69.3	134	0.0183	4.08	0.00445	0.00578	0.642	-3.22	204
Heavy metals	kg Pb	-	0.0111	2.51E-05	2.49E-05	6.05E-06	8.05E-06	0.000244	-0.00407	0.007338
Carcinogens	kg B(a)P	-	9.71E-06	1.71E-07	6.37E-08	1.66E-09	6.55E-08	3.52E-07	-1.1E-06	9.31E-06
Pesticides	kg act.subst	-	1.96	-	-	-	-	-	-	1.96
Energy resources	MJ LHV	5020	13700	179	0.225	855	76.7	3480	-1160	22151
Solid waste	kg	-	27.6	0.0237	-	0.0713	2.22E-05	0.119	-3.03	25

Poultry production has less impact in all categories than pigs, except for pesticides and energy resources. The reason for this is that poultry have a better feed conversion than pigs (1.88 kg of ration for 1 kg of LW, while pigs require 3.18 kg of ration per kg of LW). However, the ration for poultry requires more soymeal, which is a product derived from the production of soybeans and extraction of oil, processes that require high quantities of pesticides and energy. The LCA study was able to quantify the flows of material and energy and to establish the environmental burdens of P&P production. However there are other problems that have not been quantified in this

LCA, such as land use, blackflies, flies, offensive odours, and faecal coliform contaminants, which were considered important issues by the stakeholders in the survey and raised again in the focus group meetings. This needs to be taken into consideration when overall industry sustainability is assessed. For local communities, the contribution of the P&P industries to global warming may not be an important issue, but the nuisance caused by offensive odours or blackflies could be a much more important issue. This justifies the use of a comprehensive methodology that can incorporate social, economic, and environmental issues.

3.5 Suggested indicators to measure sustainability of P&P industries in SC

Indicators of sustainability suggested in survey are presented in Table 7, and have been grouped into three categories, economic, environmental and social.

Table 7 - Sustainability indicators suggested for the P&P industries in SC

Indicators	Extremely relevant[2]	Relevant[3]	Moderately relevant[4]
Economic Sustainability indicators	- Cost of production - Total fixed costs - Net farm profit - Disposable income per household - The industry's national and international competitiveness	- Producers' total net farm income - Total factor productivity - Gross margins - Variable costs - Cost of financing as a % of total costs - Internal rate of return	- Pig producers' terms of trade - Non farm income
Environmental indicators (physical)	- Condition of water (bio, organic, chemical) - Water pollution by faecal *coliform bacteria* - The impact of chemical residues - The frequency and extent of animal diseases outbreaks - Physical productivity indices	- Monitoring aquatic species such as fish in the regions' rivers. - Technical performance indicators such as feed conversion - Capacity and efficiency of waste treatment systems - Volume of animal waste per ha of land	- Condition of soil used for grain production and disposal of wastes – determined by soils tests. - Numbers and nature of complains of nuisances caused by the industries to surrounding communities.
Social indicators	- Producers' access to basic services such as education, transport, communication, health services	- Farmers' level of education and managerial skills - Farmers' level and frequency of training - Farmers' use BPEM	-Numbers and trend of producers - Age, and gender structure of producers

[2] Extremely relevant – the majority of respondents selected "extremely or very important" as their response to the suggested indicator.

[3] Relevant – majority of respondents selected "important" as their response to the suggested indicator

[4] Moderately relevant – the majority of respondents selected "moderately important" as their response to the suggested indicator.

4   Conclusion

The P&P industries in SC are among the most successful agribusiness developments in Brazil, as far as its technical and economic performance is concerned. The long-term sustainability of these industries, however, relies on their capacity to adjust to cope with the new challenges imposed by society and markets which are getting continuously less tolerant of negative environmental and social impacts. The cost imposed on other economic activities, such as tourism, as well as the reduction in the quality of life as a consequence of poor waste management are now seen in a different manner than they were in the past.

This study concludes that to be sustainable, the industries need to improve their environmental performance, by implementing waste treatment systems that reduce the current negative externalities. For socio-economic researchers, rural extension officers, and operators in these industries, this requires going beyond the traditional approach of using solely technical and economic benchmarks to make decisions and to establish policies.

The survey has shown that stakeholders, including consumers, are increasingly concerned about the negative externalities imposed by the industries on the general community and that they will not be tolerated indefinitely. This, in turn, means new opportunities to design strategies and waste management systems suitable for the region, at an affordable cost to producers. Sustainability indicators are useful to indicate the state of the variables affecting the industries' future sustainability, as well as helping to identify the pressure or driving forces that are creating such environmental and social impact.

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