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SITIO SÃO JOSÉ AGROECOSYSTEM (TUCANO, STATE OF BAHIA, BRAZIL): A SUSTAINABILITY ANALYSIS

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Abstract: The Brazilian semi-arid areas are changed in recent years, especially the social and environmental ones. In this areas, the rural exodus migrations are based by many social and political problems. Therefore, analyzing agroecosystems can be an important key so that actions can be implemented to improve the social and environmental quality in these locations. Thus, the aims of this paper were to carry out an ecological, economic and social analysis from Sitio São José agroecosystem (municipality of Tucano, Bahia State, Brazil), through these methods: Agroecological, SWAT and ASPTA method. The results were treated by quantitative statistical methods. As a result, it can be said that there are many possibilities of work and action in this agroecosystem, with emphasis on sustainable management. However, according to the information related to this study, agroecosystem is being underutilized and if this scenario is not reversed, it will probably be even more vulnerable to unsustainability and therefore also to its finiteness and uselessness.

Keywords: Ecology, Agroecology, Rural Development, Caatinga.

ANALISE DA SUSTENTABILIDADE DE AGROECOSSISTEMA INSERIDO EM ÁREA SEMIÁRIDA (MUNICÍPIO DE TUCANO, ESTADO DA BAHIA, BRASIL)

Resumo: As mudanças na área do semiárido brasileiro nos últimos anos, principalmente as sociais e ambientais, têm requerido muitos entraves nas localidades e tem ainda o êxodo rural. Portanto, analisar agroecossistemas pode ser uma chave importante para que possam ser implementadas ações de melhorias na qualidade social e ambiental destas localidades. Assim, o objetivo deste trabalho foi realizar uma análise ecológica, econômica e social de agroecossistema em área semiárida no município de Tucano (Estado da Bahia – Brasil). Para tal, lançou-se mão de uma pesquisa quali-quantitativa, apoiada em metodologias de análise de sistemas sociais e agrícolas. Como resultados, pode-se afirmar que existem muitas possibilidades de trabalho e ação no referido agroecossistema, com ênfase ao manejo sustentável. Contudo, de acordo com as informações relacionadas nesta pesquisa pode-se afirmar que o agroecossistema está sendo subutilizado e que se este quadro não for revertido, provavelmente, este estará sendo mais vulnerável ainda a insustentabilidade, também, portanto, a sua finitude e inutilidade.

Palavras-chave: Ecologia, Sustentabilidade, Desenvolvimento Rural, Caatinga.

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INTRODUÇÃO

The Brazilian semiarid region correspond to about 53.1% (Brazilian Northeastern region), which represents about 882,081 km^2. Thereabout, 20 million people living in this location (Albuquerque *et al.*, 2019, Bezerra *et al.*, 2018) and in this area dry season periods and xerophytic species were occurred (Caatinga – Brazilian dry season forest) (Silva *et al.*, 2018; Medeiros *et al.*, 2017; Miguéis *et al.*, 2019).

Among the many natural and anthropized landscapes occurring in this region, among them, the region called as "Sertão" was one of the most described in the literature as an area with special needs, given its socioeconomic and environmental conditions, where there is an expressive production of food, energy and fibers, in addition to extensive areas of cattle rising (Petersen *et al.*, 2017).

Currently, a small population lives in rural areas and have occupation works related to agriculture, cattle raising and social services. Therefore, land ownership concentrations, few publics politics, climate changes and outers socioeconomical problems were significant process to improve the rural exodus migration. Due to several aspects the population migration from this region to the most diverse regions of the country, the search for better living conditions, exercising or not functions linked to the countryside (Moreno-Calles *et al.*, 2016).

Such information described above configures the basic figure of the landscape and energy and social flows found in agroecosystems in the Brazilian semiarid region. Many times, it can be evidenced that such exploitation of natural resources was massive and unsustainable, besides not being a factor of human settlement in the countryside (Nascimento *et al.*, 2018).

The changes in these social problems can be moved the improvement of public politics that favored this populations and the agroecosystem analysis. It is an important gate to product a deep reflection, more coherent and concise, about the management of the natural and human resources from the agroecosystems in Brazilian semiarid area, as reported in Nunes *et al.* (2015) and Oliveira *et al.* (2019). According to these authors, the existence of problems related to the management of environments in which action on the environment is a priority, such as rural properties. These points can be studied and worked in according to knowledge perspectives from sustainable management. Thus, allowing the effective and sustainable methods, to improve the better environment harnessing.

Therefore, the Brazilian semiarid agroecosystems should be analyses to improve quality of life of its population (Ferreira et al., 2014).

Consequentaly, as a basis for understanding these socioeconomic and environmental standards, taking into account the possibility of (re)construction of better managed and sustainable agroecosystems, it is necessary to study more closely the particularities of agroecosystems. In order to better understand their dynamics, there is thus a greater and better cohesion between the planning of social and governmental actions, which in turn, can be active in enabling changes in society, especially those living in the countrys ide, with a view to sustainable regional development and combating the rural exodus (Petersen *et al.*, 2017).Accordingly, the themes of this work were to describe the particularities of different areas worked as agroecosystems in the Brazilian semiarid region, thus enabling a better understanding of the energy flow occurring in the locality in question and a more accurate discussion of its sociais, environmental and economic relations from the perspective of sustainable development.

Hence the objective of this work was to carry out an ecological, economic and social analysis of the agroecosystem in a Brazilian semi-arid area in the municipality of Tucano (Bahia State, Brazil).

MATERIAL AND METHODS

Study area

The municipality of Tucano (10° 57' 45" S; 38° 47' 25" W), Bahia state (Brazil), located in the area delimited as Brazilian semi-arid, with vegetation of Caatinga (brasilian season dry forest), average annual rainfall of 650 mm, average temperature of 24.5ºC, with most of the areas composed of soil classified as “Luvissolo Crômico” or “Planossolo” (Current Brazilian soil classification) and with an altitude of 209 m (Nascimento *et al.*, 2019). Total geographical area of 2.8 mi of km², GINI 0.65, IDH-M of 0.579, presents as a strong point of the economy the tourism in hydromineral resorts, in addition to agriculture and crafts. This municipality is located approximately 252 km away from Salvador, capital of the state of Bahia (IBGE, 2018).

Data collection and analysis

The locality in question, called Sítio São José, inserted in that municipality, was analyzed using the methodologies: semi-structured questionnaire (Medeiros et al, 2017);

Ecological flow (Cornan *et al*, 2019), SWAP (Mendonça *et al*, 2019), Venn diagram (Duarte *et al*, 2019), social description (Soldati *et al*, 2015), interdisciplinary relationships (Caetano *et al.* , 2014), ethnobotany (Silva *et al.*, 2019; Monteifar and Ayala, 2019) and ASPTA analysis (Petersen *et al.* , 2017). The data were tabulated in Microsolft applications and in the R program. The results will be presented describing large groups of information that could be gathered in this locality.

RESULTS AND DISCUSSIONS

The highlighted area is worked in an employer way, with the male figures being the main source of manual labor (agriculture and cattle raising), and the female figures for tasks related to the home and family. The family structure was composed of the parents, their children and grandchildren and the other households. These children were born and raised on the property, who currently no longer live in the locality, exercising non-agricultural activities in the municipal headquarters.

In this agroecosystem there was an intense appreciation of the study, in which all the children were able to complete even higher education courses in the areas of human and social sciences. This agroecosystem was acquired through purchase in the late 1980s, and only in mid-2010 did electricity arrive in the locality.

Currently, this location has been used as a place of leisure and food production in a seasonal manner by most of the former residents. Only if they are inhabited by the older actors who cultivate and raise in this locality, do the other actors work in urban areas in the municipality. When necessary, rural workers are hired to complement the workforce.

Socially, there is an analogy that there were moments of apogee, with the employment of the workforce of all those involved in the system, they left the locality for various reasons and today such systems have been managed simply for a maintenance, by forces of social attachment, and for the leisure of former residents and workers.

To resume these characters, observe the next scheme about the principal social and historical movements, in Sitio São José agroecosystem.

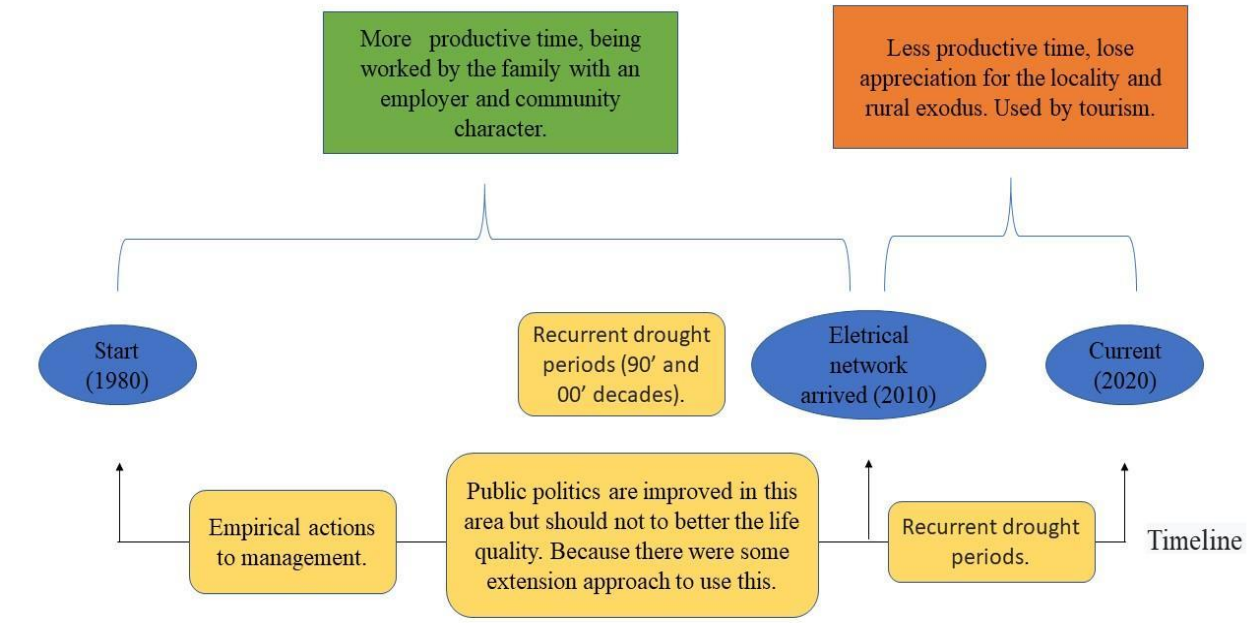

Figure 1- Sitio São José agroecosystem timeline

Medeiros *et al.* (2017) and Soldati *et al.* (2015) describes that the social haste of a social group with an agroecosystem may be one of the most important factors, that may contribute to the establishment of these populations in the system over the years. It can be seen that this haste referred to by such authors is very incipient in this agroecosystem, because it is no longer seen as a place to live and work, but simply as a place of leisure. Currently, this is a disuse and lack of specialized work in this property.

Ethnobotany

In the studied area there is the use of phytotherapeutic medicines produced in the own locality by female figures, being more used the following preparations for the treatment of several pathologies: syrups based on leaves of *Plectranthus amboinicus* or bulbs of *Allium sativum* or *A. cepa* (flu and colds), teas of leaves of *Cymbopogon citratus* or *Peumus boldus* (abdominal pain) and effusion of the shells of *Anarcadium occidentalle* (inflammation in general).

These species, different from those described by Silva and collaborators (2019), when they studied the opinion of a student population in the state of Pernambuco and by Zank and Hanazaki (2017) when they described the use of these species by communities in

Chapada do Araripe area, in the Brazilian semiarid region. Both species are not native to the region, except *A. occidentales* (Lorenzi, 2008).

The species *A. occidentales*, *Anona muricata*, *Mangifera indica* and *Spondia tuberosa* are also a source of income and food for the family nucleus, which produce fruit at certain times of the year and are exploited in an extractive way. Among these species used for feeding purposes, only *M. indica* is not native to the region (Lorenzi, 2008). Medeiros *et al.* (2017) describe that it has been common to observe exotic species in the area of the Brazilian semiarid as being an integral part of the flora used by the inhabitants of the Brazilian semiarid for food and herbal medicine.

In both uses, the transmission of knowledge about the usefulness of these plant species, in the highlighted agroecosystem, is performed through orality between generations according to the need and experiences promoted through time through the environment described in the region (Soldati *et al.*, 2017, Souza *et al.*, 2018, Albuquerque *et al.*, 2019; Oliveira *et al.*, 2019).

Ecological and economic flow

The property, Sitio São José, is worked with the perspective of coexistence with the semiarid based on family agriculture. This has a total area of 20 ha.

The following species are cultivated during the rainy season (May - August): *Phaseolus vulgaris, Vigna unguiculata, Opuntia* spp. and *Manihot esculenta*. The planting of these food plants was always done manually and then began to be carried out with the use of agricultural machinery (ploughing) for occasional services, it should be noted that such use is a result of a local public policy for the development of family farming. Fruitful specimens were also found on the property and were used as a source of auxiliary income in their respective harvest periods: *Anarcadium occidentales, Anona* spp., *Mangifera indica* and *Spondia tuberosa*, both fruits were obtained in an extractive manner, used for consumption and/or sold in local commerce.

From the perspective of ranching, at a given point in time, close to the 2000s, there was intensive production of broiler chicken in a shed structured according to the specifications of a project of the Brazilian federal government (controlled feeding, adequate management and physical structure consistent with the norms of this economic activity). Currently, only chickens are raised for cutting and laying, in extensive regime and cattle for dairy production (in small quantities). These animals are fed with corn bran (purchased in

local trade) and native pasture, for the cattle are still used rackets of *Opuntia* spp. present in the locality.

There is an artesian well drilled by the federal government on behalf of the community, therefore has a community character within the property and serves as the main source of water for it. There are cisterns that collect the water precipitated on the roof of the buildings, but that are not sufficient to meet the demands of the social group as a whole.

Family income, in general, is promoted by the commercialization of the surplus of agricultural production in the market of the municipality itself. There is also seasonal marketing to the municipal government regarding school meals in public schools.

The energy inputs (sunlight and water) enter the system and are absorbed by crops and other vegetables, which feed the animals and humans of the property. Rainwater and well water are stored and feed biotic and abiotic components of the agro-ecosystem. Productive surpluses are taken to the local market and generate profit for the humans inserted in the locality (Figure 1). In the following, the energy interconnections inherent to this agro-ecosystem will be visually described.

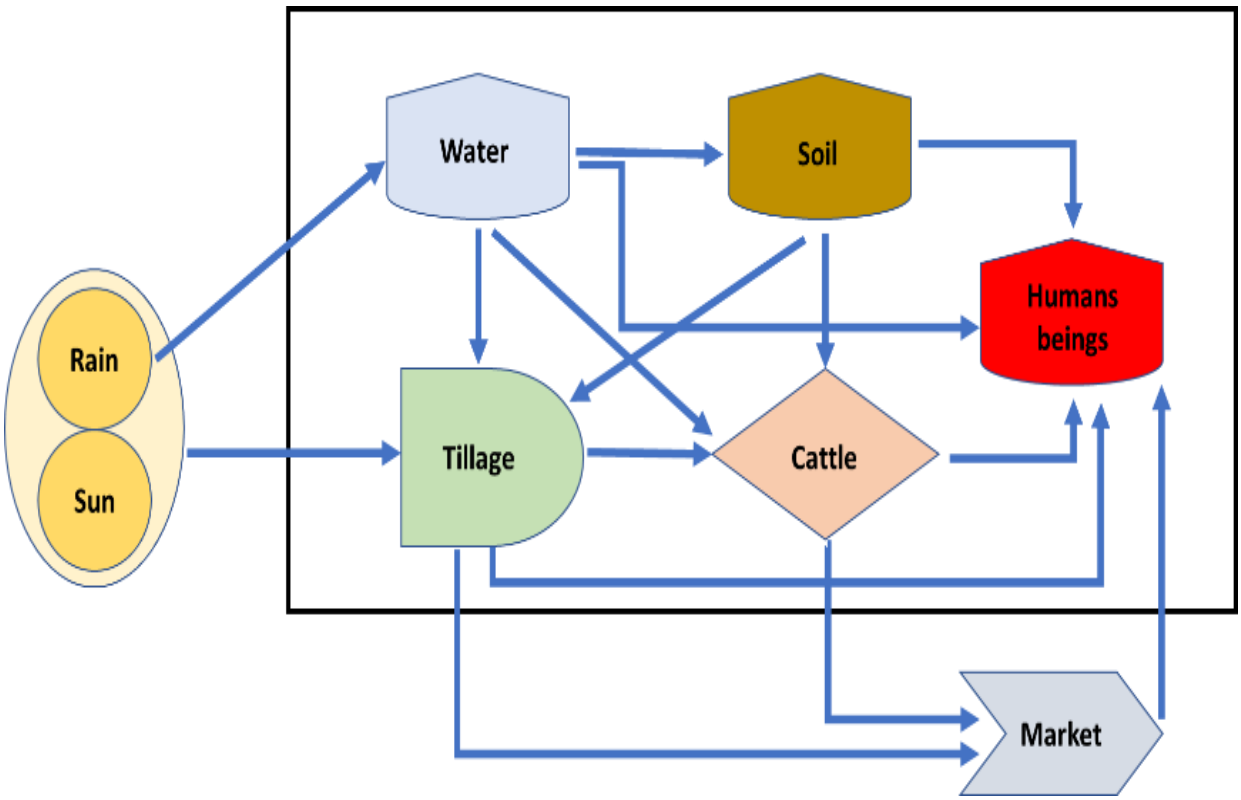

Figure 2- Energetic flow of Sitio São José agroecosystem (Tucano, Bahia State, Brazil).

Souza *et al.* (2019), Albuquerque *et al.* (2019), Silva *et al.* (2019) when describing results obtained with the analysis of agroecosystems inserted in the Brazilian semiarid region attest that the capacity of interconnection of the components of an agroecosystem under the presented conditions is often fragile. Greater efforts are needed to better implement work and management technologies that promote the sustainability of the locality. As can be seen in the described agroecosystem, the simplicity of the energy relations visualized in the locality can be the main source of lack of interest of the characters who once lived in the locality in detriment to their exodus.

It is necessary to describe that such a property is a place where few political actions related to the settlement of man in the countryside are implemented. It can also be described as the destruction of native flora for various purposes, generating security to the system, as described by Silva *et al.* (2019) and Oliveira *et al.* (2019).

SWOT matrix

According to the indications of strengths of the property, the family coexistence in the locality that still allows the construction of the agroecosystem was described, there are no opportunities for the locality, such as weaknesses, the coexistence with droughts seasons and a government deficient extension. The opportunities are production of fish and bees, use for ecotourism, production of xerophilic vegetation species (dragon fruit, salt grass and cacti). And as threats are diverse, but resume in to allow the promotion of sustainable work actions. Observe these results in the Table 1.

Table 1 - SWOT matrix from Sitio São José agroecosystem (Tucano, Bahia State, Brazil).

Strength	**Weakness**
The family coexistence in the locality can be improve a change in management of agroecosystem.	Resistance to new technologies of coexistence with the semi-arid region; Low local technical knowledge(dependent on technical assistance from outside the property.
Opportunities	**Threats**
Production of fish and bees, use for ecotourism, production of xerophilic vegetation species (dragon fruit, salt grass and cacti) to live with aridity.	Government disinterest in relation to the points: basic health, education, rural assistance, logistics); Reduction of government incentives for the promotion of family agriculture in the semi-arid region; The lack of basic school infrastructure the sale of products by middlemen and lack of capital, besides were identified.

Zank *et al.* (2017), Migueis *et al.* (2019), Nunes *et al.* (2019) and Montufar and Ayaa (2019) are emphatic in describing the potentialities of using natural resources in a rural agroecosystem can be challenging, but are numerous. Taking into account, for example, the use of the wooded areas of this property for beekeeping. According to these authors, failure to make use of these available resources could be harmful to the agricultural system and could also promote rural exodus, as mentioned earlier in these results.

Shen *et al.* (2017) and Moreno-Calles *et al.* (2016) argue that properties in semi-arid areas can be managed sustainably and can generate profit for farmers. However, it is necessary to take work that relates the needs of work, which can be seen as the opportunities and strengths of this property described above, to the detriment of the factors that threaten this system.

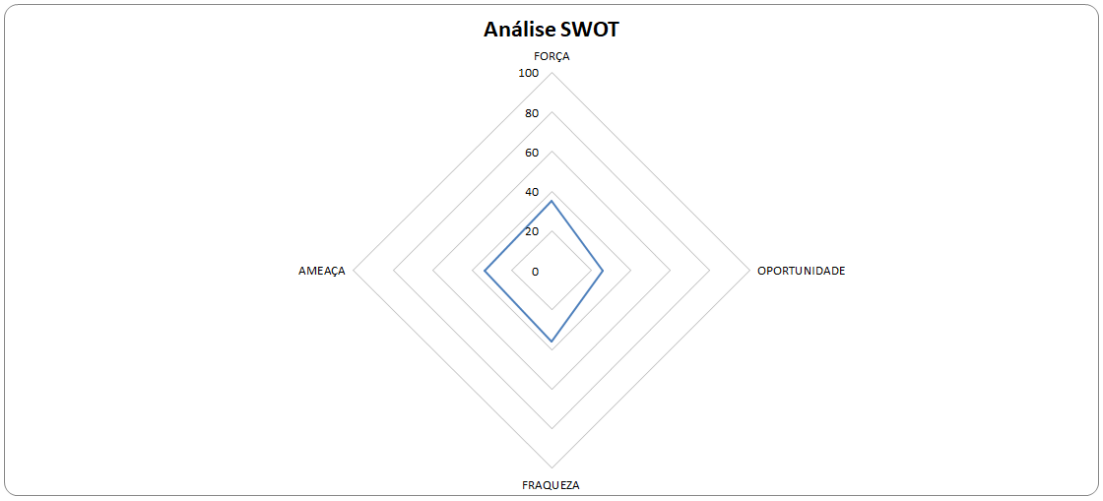

Figure 3 - Swot analysis about São Jose Agroecosystem.

ASPTA Analysis

According to the analyses carried out, viewing the property according to the reported methodology, with reference to the years 2000 (apogee of the agricultural system) and 2019, it can be seen that the agroecosystem declined strongly in recent years in all the sampled points, as previously reported. Taking into account the following marked indices. In 2019, the local sustainability index averaged 0.42, while in the reference year it was 0.52, more than double. Also, in the reference year there was greater equity among the components of the index, different from the year 2020, in which the autonomy and actions taken in favor of gender equity and feminism. To resume the index, see the next figure 4.

However, be necessary to affirm that in 2020 the sustainable index is better than 2000, but this accountment, probably, it is related to a greater opening of the participants of this agroecosystem to new technologies and changes of lifestyle. Bezerra *et al.* (2018) discussing properties in the Brazilian semi-arid region through data treated with this tool describe that the properties researched present a much greater synergism between the social and environmental actions of the system, thus promoting a more adjusted and consistent sustainability. They also describe that, contrary to what is being exposed in these results, the groups of properties studied are almost totally autonomous in their possibilities.

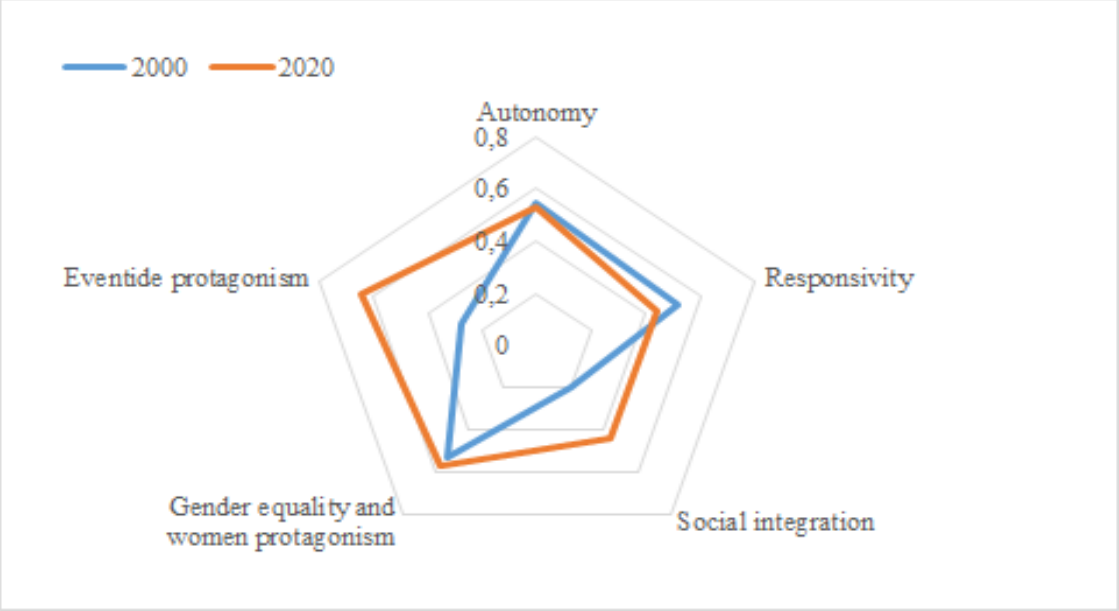

Figure 4 - ASPTA analysis about São Jose Agroecosystem.

CONCLUSIONS

Through the results described in this research, leading to conspiracy of the economic and social propositions related to the results obtained, it can be affirmed that the property studied is in a complicated process of deactivation of activities, culminating in rural exodus and thus in disinterest on the part of the actors who were formerly inserted in this agroecosystem. However, according to the information related to this study, agroecosystem is being underutilized and if this scenario is not reversed, it will probably be even more vulnerable to unsustainability, and therefore also to its finiteness and uselessness.

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