

PERCEPÇÃO DE PRODUTORES DE BÁRUÈ SOB A UTILIZAÇÃO DE FONTES ALTERNATIVAS DE BIOGÁS

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RESUMO: O estudo foi realizado no distrito de Báruè, província de Manica - Moçambique, nas localidades de Nhassacara, Nabuto e no posto administrativo de Nhampassa, com objetivo de avaliar o uso da tecnologia dos digestores como alternativa à produção de energia e redução do desmatamento. Foram entrevistados 79 criadores de gado bovino, suíno e caprino sobre a percepção dos efeitos negativos do desmatamento, as principais fontes de energia usada para a cozinha e a percepção sobre digestores de biogás. Os pontos de amostragem foram marcados com o auxílio de um GPS. A maior parte dos entrevistados tem a lenha como a principal fonte de energia para a cozinha. Constatou-se que apenas 37% dos entrevistados têm informação dos problemas causados pelo desmatamento ao meio ambiente e 63% disseram não conhecer os problemas. Apenas 5% dos entrevistados responderam saber da existência de outras fontes de energia, como o biogás. Concluiu-se que Báruè apresenta potencial de produção de energia proveniente do biogás.

Palavras-chaves: energia renovável, lenha, poluição ambiental.

PERCEPTION OF BÁRUÈ PRODUCTS UNDER THE USE OF ALTERNATIVE BIOGAS SOURCES

ABSTRACT: The study was carried out in the district of Báruè, province of Manica, in the localities of Nhassacara, Nabuto and in the administrative post of Nhampassa, with the objective of evaluating the use of digester technology as an alternative to energy production and reduction of deforestation. 79 cattle, swine and goat farmers were interviewed about the perception of the negative effects of deforestation, the main sources of energy used for cooking and the perception of biogas digesters. The sampling points were marked with the aid of a GPS. Most of the interviewees have firewood as the main source of energy for the kitchen. It was found that only 37% of respondents have information about the problems caused by deforestation to the environment and 63% said they did not know about the problems. Only 5% of respondents said they knew about the existence of other energy sources, such as biogas. It is concluded that Báruè has the potential to produce energy from biogas.

Keywords: renewable energy, firewood, environment pollution.

1 INTRODUCTION

The need to generate new energy sources is an important factor in the search for environmental sustainability. In many Mozambican regions, energy sources for productive purposes, cooling, heating and lighting are scarce, which has led many residents to use firewood as a common heat

source for use in the kitchen. Firewood is a natural resource that must be preserved, as its domestic use causes deforestation and soil degradation through erosion, endangering the flora and fauna of the ecosystem (MINISTERIO DA TERRA, AMBIENTE E DESENVOLVIMENTO RURAL, 2018).

Mozambique is a country with a vast expanse of forests, estimated at approximately

34 million hectares, representing 43% of the national territory (AQUINO *et al.*, 2018). Forests contribute to the regulation of the water regime, energy flow in ecosystems, conservation of the natural genetic heritage that guarantees species biodiversity, and other products and services that benefit humans.

The Mozambican population is 28 million inhabitants, with an estimated 34 million inhabitants in the year 2024 (INE, 2019). This trend of population growth will contribute to an increase in the demand for energy, particularly firewood and charcoal, which are the main sources of energy for preparing food in Mozambican kitchens. As a result, there may be an increase in deforestation if there are no alternatives, such as the use of energy from renewable sources.

The fermentation of animal manure in anaerobic reactors presents an excellent alternative, as in addition to reducing the rate of pollution and contamination of the production cycle, it promotes the generation of biogas used as a source of thermal, mechanical and electrical energy (ZHANG *et al.*, 2022). It is an efficient, low-cost process adjusted to the reality of Mozambican. Furthermore, the final residue from this process can be used as biofertilizer.

Biogas from animal manure is a gaseous mixture of several substances, the main of which are methane gas (CH₄ - 55 to 70%) and carbon dioxide (CO₂ - 25 to 40%), which are obtained through the decomposition of organic matter by microorganisms in the absence of free

oxygen (CASSINI; COELHO; PECORA, 2014).

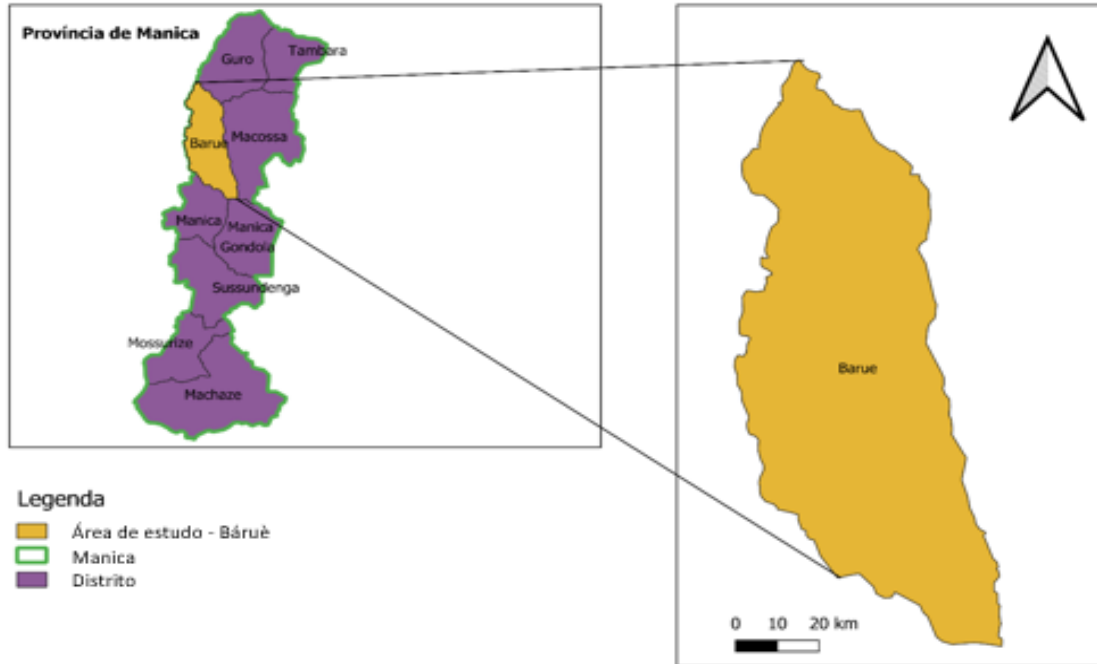
The advantages of using biogas include the use of easily accessible animal manure, the reduction of diseases and contamination generated by exposure to the open sky, and a reduction in greenhouse gas emissions into the environment (ROJAS-DOWNING *et al.*), (2017). On the other hand, the biofertilizer generated from the biogas production process allows for an increase in agricultural production through the supply of nutrients in the fields of family farmers.

Therefore, the objective of the present work was to evaluate the perceptions of cattle, pig and goat farmers in the Báruè district regarding the use of digester technology as an alternative to energy production and reducing deforestation.

2 MATERIALS AND METHODS

The research carried out was characterized, in terms of nature as applied and in terms of objectives, as exploratory and descriptive. The study was carried out in the district of Báruè, in the province of Manica in Mozambique, with the following geographic coordinates: -18° 3'54.16 north latitude and 33° 10'28.23 east longitude. Báruè is located in the central region of the country, west of the province of Manica, limited to the north by the district of Guro, to the west by the Republic of Zimbabwe, to the south by the districts of Manica and Gondola and to the east by the district of Macossa (Figure 1).

Figure 1. Geographic location of the study area, Bárue district, Manica – Mozambique.

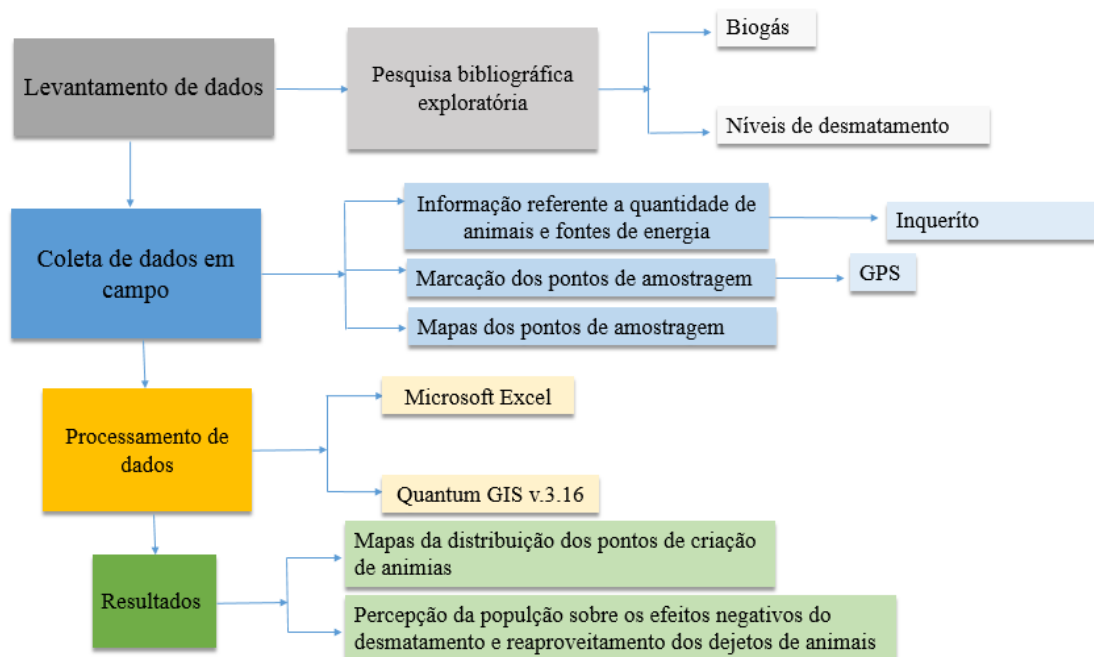


Source: WGS 84/UTM zone 365

The province of Manica has great agroecological potential with respect to climate, soils and favorable relief for agricultural and forestry production; however, it is one of the provinces with the highest rates of deforestation at the national level, with Bárue occupying a prominent position (MITADER, 2018).

The research was divided into four stages, which encompass information gathering based on exploratory bibliographic research, field data collection, data processing and analysis. A flowchart of the synthesis of the procedures carried out to carry out the research is shown in Figure 2.

Figure 2. Flowchart of the synthesis of research procedures.



Source: Authors (2022)

Data collection through a survey applied to 79 cattle breeders was carried out in January 2022, focusing on places with the highest rate of deforestation, namely, the town of Nhassacara (40 breeders), the town of Nabuto

(21 breeders) and the Nhampassa administrative post (18 breeders). The questionnaire administered to breeders is presented in Table 1.

Table 1. The questionnaire was administered to livestock farmers in Báruè, 2022.

1. Do you raise animals? a) yes b) No	2. If yes, what are they? a) Cattle b) Pigs c) Others
3. What categories of animals do they have? (Pigs) a) Breeds (replacement, mating and gestation) b) Sows with piglets c) Reproducer d) Piglets in the nursery (Cattle) a) Steer/Heifer b) Cow c) Ox/Bull	4. What is the main source of energy you use for cooking? a) Firewood b) Coal c) Electric current d) Gas
5. Estimate of the amount of coal used per month? a) 10 kg b) 20 kg c) 30 kg d) More than 30 kg	6. Estimate the amount of firewood used per day? a) 1 kg b) 2 kg c) 3 kg d) More than 3 kg
7. Do you think that deforestation due to the use of firewood and charcoal can create problems for the environment? a) yes b) No	8. Do you use any of these appliances? a) Television b) Freezer c) Refrigerator d) Stove and others
9. How much time do you use per day? a) Television: < 1 hday ⁻¹ ; 1-5 hday ⁻¹ ; 5-10 hday ⁻¹ ; > 10 hday ⁻¹ b) Freezer: <1 hday ⁻¹ ; 1-5 hday ⁻¹ ; 5-10 hday ⁻¹ ; > 10 hday ⁻¹ c) Refrigerator: < 1 hday ⁻¹ ; 1-5 hday ⁻¹ ; 5-10 hday ⁻¹ ; > 10 hday ⁻¹ d) Stove: < 1 hday ⁻¹ ; 1-5 hday ⁻¹ ; 5-10 hday ⁻¹ ; > 10 hday ⁻¹ e) Others: < 1 hday ⁻¹ ; 1-5 hday ⁻¹ ; 5-10 hday ⁻¹ ; >10 hday ⁻¹	10. Have you ever heard of biogas? a) yes b) No
11. If yes. Do you think biogas has the potential to replace other energy sources? a) yes b) No	12. If you had a biodigester, would you stop using firewood? a) yes b) No

Source: Authors (2022)

The sampling method used was nonprobabilistic, where it was used to select the elements to which they had access, assuming that these elements may, in some way, represent the universe (PRODANOV; FREITAS, 2013). To determine the sample for this study, individuals were selected based on accessibility considering the assumptions related to the type of sample used in the research, where individuals who practice livestock farming at the three points where the questionnaire was applied were selected.

The survey included multiple-choice open-ended questions. All sampled points were georeferenced, where the geographic coordinates in the UTM were obtained based on GPS. At this stage, we investigated the perceptions of cattle, pig and goat farmers regarding the use of biogas digesters as an alternative to the use of firewood and charcoal in the kitchen and reducing deforestation through digester technology, taking into account the animal potential in the region.

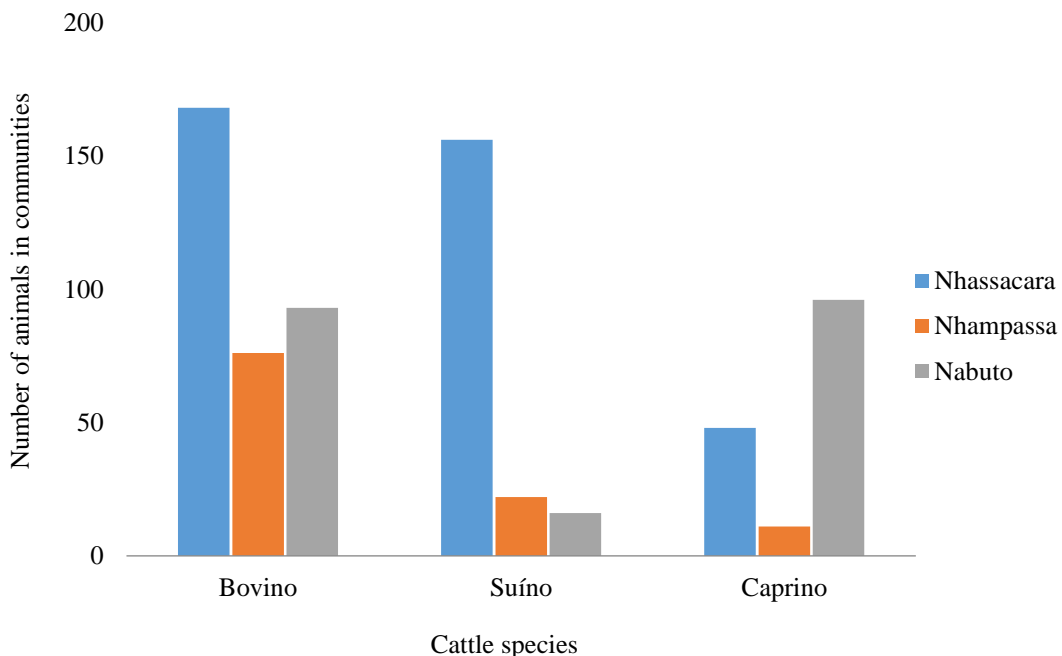
The data were processed using the Excel statistical package and Geographic Information Systems Software “QGIS v.3.16”.

RESULTS AND DISCUSSION

Of the 79 cattle farmers interviewed, 33 were female and 54 were male. The respondents were aged between 23 and 54 years. Approximately 80% of those interviewed had no school education, 9% had completed primary education, and 11% had completed elementary school. Therefore, for the most part, Báruè cattle breeders are characterized by not having school training.

In relation to the number of animals per community, Nhassacara stands out with 168 heads of cattle, 156 pigs and 48 goats, followed by the town of Nabuto with 93 cattle, 96 goats and 16 pigs. Finally, the Nhampassa administrative post included 76 cattle, 11 goats and 22 pigs. These data reveal the potential for replacing firewood with biogas from animal manure (Graph 1).

Graph 1. Number of animals in communities in Báruè, 2022.



Source: Authors (2022)

However, the greatest potential for biogas production is from cow dung, which potentially reduces the average energy demand of firewood. Depending on the volume of

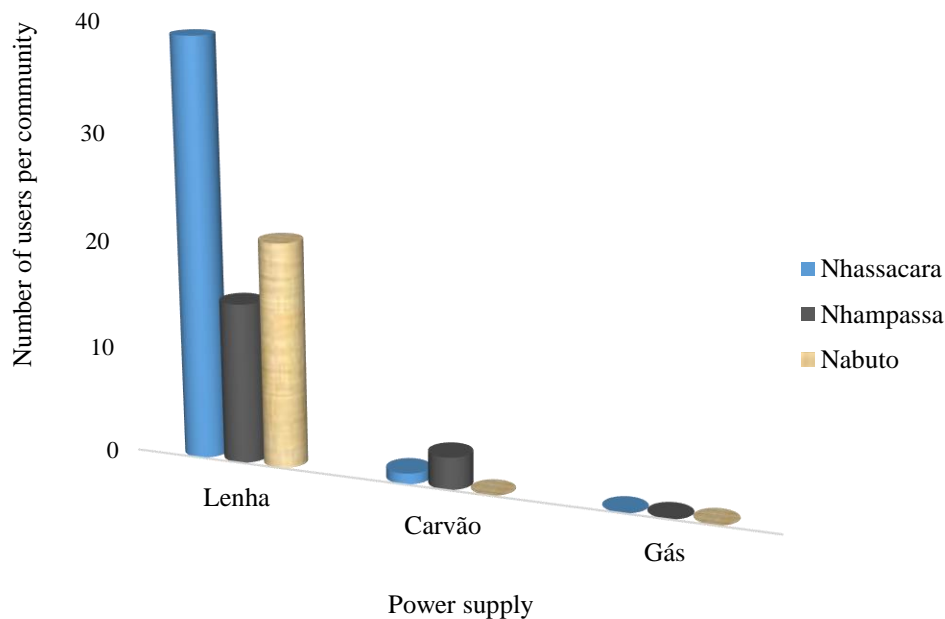
biogas produced per head, the reduction in energy demand due to biogas production from cattle manure can range from 0 to 1% in

Mauritius to 27 to 180% in Botswana (FAOSTAT, 2012).

Almost all of those interviewed in the town of Nhassacara used firewood as the main source of energy for the kitchen, and only one farmer used charcoal. In the town of Nabuto, all the farmers surveyed used firewood as the main source of energy for the kitchen. In the administrative post of Nhampassa, approximately 85% of farmers use firewood as

the main source of energy for cooking, and the remaining farmers use charcoal. On the other hand, none of the breeders used gas for cooking (Graph 2). As you can see, firewood is used as the main source of energy for the kitchen by livestock farmers in Báruè. Firewood is cut in the vast expanses of forests in Báruè, and this procedure has been carried out continuously and without replacing the cut trees, which has increased deforestation rates in this location.

Graph 2. Source of energy for the kitchen in communities, in Báruè, 2022.

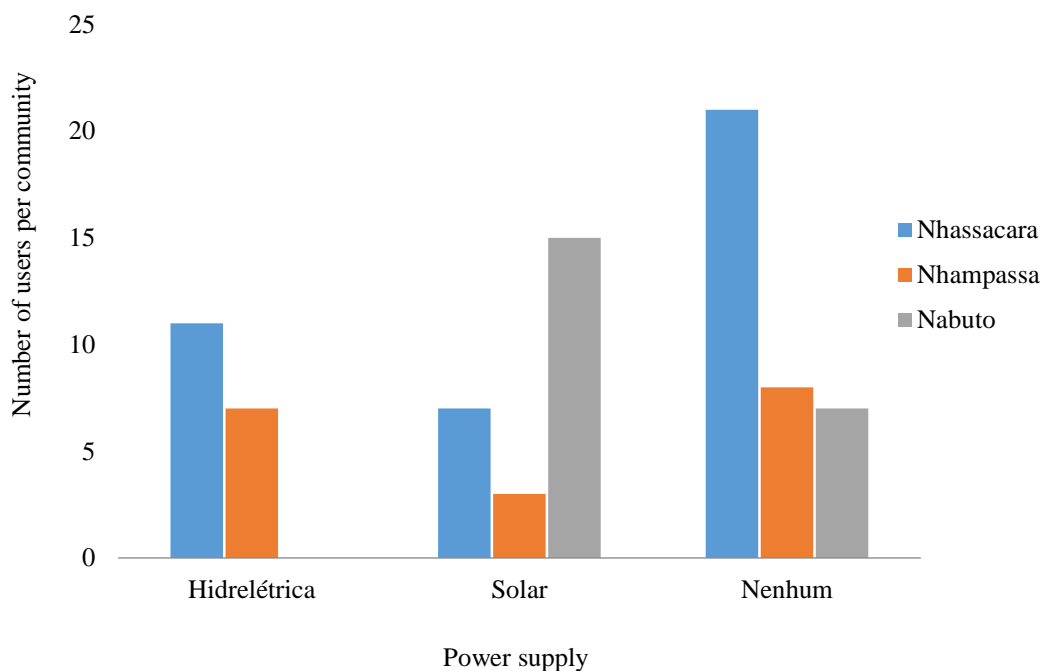


Source: Authors (2022)

However, the intensity of firewood exploitation for use in rural areas is still low due to the low population density, which is typical of villages. In these places, the greatest contribution to deforestation is associated with firewood cuts for the manufacture of charcoal and sale in large urban centers, which are generally far from rural areas. In urban areas, coal is the dominant form of domestic wood fuel. The exploitation of firewood and the manufacture of charcoal for urban consumption are carried out intensively, and trees are felled in a nonselective manner in relation to species and size (SITOE; SALOMÃO; WERTZ-KANOUNNIKOFF, 2012).

Regarding lighting energy and the use of household appliances, 32% of the respondents used solar energy as their main source, 23% used hydroelectric current, and 45% did not have lighting (Graph 3). The lack of knowledge about the existence of alternative sources for generating energy that can be used for lighting and cooking has caused livestock farmers to waste large amounts of raw material (animal waste), which, if used well, can contribute significantly to mitigating energy shortages, in addition to being clean and inexpensive.

Graph 3. Source of energy for lighting in communities, in Báruè, 2022.



Source: Authors (2022)

Studies of the causes of deforestation carried out by Mitader (2018) point to agriculture as the main cause of change in land use in the country, followed by the exploitation of wood, charcoal and firewood. This scenario was observed in the communities where this research was carried out, where it was found that the majority of the population uses firewood and charcoal as the main sources of energy for cooking, and more than 95% of the population practices agriculture as the main source of income. In Mozambique, agriculture constitutes the economic activity practiced by a significant part of the population, reaching more than 75% of people (INE, 2019). The predominant systems are traditional, low-tech and based on extensification.

Approximately 37% of those interviewed said they were aware of the environmental problems caused by deforestation. This low percentage of respondents with knowledge about the negative effects of deforestation is probably associated with the low level of education on the part of those interviewed. Respondents are aware that when cutting trees, the period for forest restoration is long and that they can contribute to the destruction of the habitat of certain animals. Even so, they claim to practice deforestation because firewood is the main source of energy for cooking in the region.

The Bárue district is rich in timber and nontimber forest species. The forestry sector contributes 15% of national deforestation, of which 7% results from the exploitation of firewood and charcoal and 8% from the exploitation of timber forestry products (MINISTERIO DA TERRA, AMBIENTE E DESENVOLVIMENTO RURAL, 2018).

The high rate of forest loss in Bárue draws attention. This scenario has contributed significantly to climate change, with an emphasis on the increase in temperature in the region, as witnessed by interviews. Trees play a fundamental role in fixing atmospheric CO₂, reducing the negative effects of this greenhouse gas. Furthermore, trees participate in the hydrological cycle, in the emission of oxygen into the environment and as a habitat for certain animals. In other words, the deforestation of forests leads to the impoverishment of biodiversity, the suppression of rainfall and a decrease in evapotranspiration.

Most of those interviewed, approximately 95%, did not have information about the ability of biogas digesters to produce energy for cooking. A biogas digester is an alternative to firewood and charcoal in a kitchen. This equipment, which is simple to manufacture and accessible to rural communities, can significantly contribute to generating energy for populations (CLEMENS

et al., 2018). The region studied is rich in animal production, and animal waste can be used to generate energy through the use of digesters. Energy generation through the use of biogas produced from the treatment of livestock waste can improve the quality of life of rural residents.

The waste produced by animals has a high load of pollutants that cause damage to the environment, which requires improvements in production processes and systems and adequate management of this waste to avoid possible damage to the environment (FANGUEIRO *et al.*, 2015; CAO *et al.*, 2020). Effluents from the livestock sector are identified as one of the main sources of pollution to water resources, even surpassing those emitted by industries, which are considered major causes of environmental degradation (MITO, 2015; BAI *et al.*, 2017). The use of digesters to produce gas from animal manure is an alternative, as it uses a significant

portion of the animal waste found in the environment.

The amount of biogas produced per animal depends on the type of animal, food intake, size and breed. It is estimated that manure from dairy and beef cattle can produce more than 2 m³/day per head, while manure from feedlot cattle can produce as little as 0.3 m³/day per head; thus, 25 kg of cow manure can produce 0.8 to 1.0 m³ of biogas (HEEGDE; SONDER, 2007). Table 2 shows the estimated biogas production based on cattle found in the present study in Báruè. With the amount of animals that communities have, it is possible to enhance the production of energy from biogas and likely replace firewood and coal with biogas. In this way, it is possible to reduce the pressure on forests in the search for firewood and charcoal, which will result in the protection of the environment and the protection of ecosystems and biodiversity in forests.

Table 2. Estimated electrical energy produced by the community in Báruè, 2022.

Community	Animal species		
	Cattle	Pigs	Total
Nhassacara	1079.56Kwh	88.09Wkh	1167.65Kwh
Nabuto	597.21Kwh	8.72Kwh	606.33Kwh
Nhampassa	488.3Kwh	10.88Kwh	499.25Kwh

Source: Adapted from the Rural Biogas Construction Manual, 2012

In this study, a simulation of the conversion of the theoretical biogas potential for the generation of electrical energy was carried out, and encouraging and possible results were found for the reality of Báruè. The conversion of the theoretical biogas potential (m³) to electrical energy generation (KWh) was determined as recommended by Sganzerla

(1983), who determined that one cubic meter of biogas for electrical energy generation is equivalent to 1.428 kWh. In this study, the electrical energy generation potential was compared with the average monthly electrical energy consumption by the communities (Table 3).

Table 3. Devices used in communities, their power and operating costs.

Equipment	Power (W)	Power (KW)	Time (h)	Time/mo nth (h)	Spend/day (KW)	Expenses/m onth (R\$)
TV	90	0.09	7	210	0.63	12.28
Freezer	200	0.2	24	720	2.0	39.00
cell charger	4	0.04	0.5	15	0.002	0.04
Light bulb	100	0.1	6	180	0.6	11.70

Batteries	350	0.35	0.1	3	0.035	0.68
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Source: Adapted from the Rural Biogas Construction Manual, 2012

As shown in Table 3, biogas, in addition to being an important source of energy for preparing food, is used to produce electricity and operate different household appliances. As it is a region where part of the population does not have access to energy, the use of digesters to produce biogas is a possible solution for the Bárue district.

4 CONCLUSIONS

The results obtained through this study show that the main factor causing deforestation in Bárue is the search for firewood to make food. However, even though firewood is the main source of energy in the region, it can be easily replaced by a biogas digester through the use of available animal manure to generate energy.

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