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Rural Waste and Energy: State-of-the-art and Document Analysis of the Implementation of Public Policies in Brazil

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ABSTRACT

Objective – To present state-of-the-art contributions on rural waste and energy from an international viewpoint and analyze the role of street-level bureaucrats in implementing public policies on the theme in Brazil. Methodology – For the state-of-the-art, systematic literature mapping was used and, to analyze the performance of street-level bureaucrats, documentary research was carried out on institutional documents and the relevance of the theory of Bonelli *et al* (2019) was considered from the structural, individual action and relational perspectives. Originality/relevance – The gap in the study lies in the search for the terms "rural waste" and "energy", as hitherto there was no state-of-the-art or a state of knowledge on the subject. Furthermore, o analysis of the theory of Bonelli *et al*. (2019) was identified regarding the role of street-level bureaucrats in documentary research, demonstrating the academic relevance of the study. Results – The state-of-the-art points to important issues such as diagnosis of rural waste, involvement of the state, community, experts and decision makers, and the development of technologies and techniques, with an analysis of economic viability and barriers concerning the subject. The application of the theory of Bonelli *et al.* (2019) allowed us to partially evaluate the potential for implementing public policy on the topic. Theoretical/methodological contributions – it was possible to apply the theory of Bonelli *et al*. (2019) in the document research. Social and environmental contributions – academic debates, future research and studies on the implementation of public policies related to the subject are envisioned.

KEY WORDS: Rural waste. Energy use. State-of-the-art and implementing public policies.

1. INTRODUCTION

In Brazil, it is estimated that approximately 775 million tons of agrosilvopastoral waste are generated, which are those related to agricultural activities and their inputs (BRASIL, 2022, p. 105). However, rural waste, in the sense of being produced in rural areas, has a broader scope, as household, urban, agrosilvopastoral and civil construction waste can be included (ALMEIDA, 2023, p. 22).

The Brazilian Agricultural Research Corporation (Embrapa Agroenergia) has several projects related to biogas, such as using cattle waste in biodigestion systems, integration of processes in the biogas production chain using fruit and vegetable waste and effluents from palm oil cultivation as substrate, sustainable production of biogas, biomethane and biofertilizers with the intelligent use of biomass, waste and effluents from Brazilian agribusiness (EMBRAPA, 2022, p. 22-24).

In this context, research carried out in the Scopus and Web of Science journal databases, in August 2023, on the relationship between rural waste and energy, identified 54 documents, of which approximately 67% were published from 2018 onwards. However, When relating the terms to the state-of-the-art or state of knowledge, no scientific works were identified. Given this, the first research question arose: What are the contributions of the state-of-the-art to the relationship between rural waste and its use in energy at an international level?

In Brazil, the Agricultural Policy (BRASIL, 1991) and the National Solid Waste Policy (PNRS) (BRASIL, 2010) were established by law. However, the National Solid Waste Plan (Planares) was passed in 2022, and contains a national diagnosis, established guidelines and strategies on solid waste, including agrosilvopastoral waste (BRASIL, 2022). Given this, the second research question arose: is it possible to analyze the implementation of public policies

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on the topic from the perspective of Bonelli *et al*. (2019) based on the analysis of institutional documents?

Bonelli *et al*. (2019) reported that public policy studies are incipient in Brazil. However, they clarified the existence of evolution in aspects of the public policy cycle. From the concept of implementation, they highlighted the importance of the distinction between top-down and bottom-up approaches, and presented the three generations of studies related to the theme of implementation, and discussed the importance of rules and discretion in the actions of street-level bureaucrats.

In this way, the authors developed an expanded analysis model on the implementation of public policies, proposing the evaluation of three dimensions/perspectives: i) structural, related to the agency and the rules that condition the performance of street-level bureaucrats; ii) individual action, relevant for analyzing the extrinsic or intrinsic benefits or incentives offered to these bureaucrats; and iii) relational, concerning the formal or informal, internal or external relationships that these bureaucrats establish among themselves and with others.

Thus, this article, in addition to this introduction, is organized as follows: the second section is dedicated to the presentation of the objectives; the third presents the methodological procedures; the fourth section includes the analysis and discussion of the results; and, the fifth presents the conclusions and limitations of this study.

2. OBJECTIVES

The objectives of this study are to identify the contributions of the state-of-the-art on the relationship between rural waste and energy at an international level and to analyze the possibility of applying the theory by Bonelli *et al*. (2019) to the role of street-level bureaucrats in implementing public policies through the analysis of Brazilian institutional documents that address the topic in question.

The state-of-the-art of this article must be understood with its limitations, since a researcher will never have control over the object of investigation in an attempt to delimit the corpus to write about scientific production, and may not offer a linear understanding or a logical organization, taking into account that the history of academic production is that proposed by the researcher who reads the state-of-the-art (FERREIRA, 2002).

Furthermore, to Paul *et al*. (2021), the systematic mapping of studies means a cutting-edge understanding of the existing literature and a stimulating agenda for advancing understanding through new literature in the review domain, where "state-of-the-art" is the comprehensive updated mapping and summary that illustrate the development of the literature, while the "stimulating agenda" points out paths and directions for future research to enrich the literature.

The investigation into the potential for implementing public policies is based on the expanded analysis of the performance of street-level bureaucrats, considered as implementers of public policies, for which Bonelli *et al*. (2019) identified the main dimensions or analytical

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perspectives, namely structural, individual action and relational, also proposing an additional investigation into the political, economic and legal scenario.

3. METHODOLOGY

This is exploratory and descriptive research, which uses bibliographic and documentary procedures, with a qualitative approach, which uses systematic mapping to identify scientific works and to present state-of-the-art contributions to the scientific topics under study. The methodology was adapted from Tranfield *et al*. (2003), subdivided into the subsections of planning, conducting and disseminating knowledge.

In the dissemination stage, we opted for the perspective of Paul et. al (2021) in order to present state-of-the-art contributions on the topic in question. Furthermore, to analyze the potential for implementing public policy on the use of energy from rural waste, a documentary procedure was used (LAKATOS; MARCONI, 2017) that was evaluated from the perspective of Bonelli *et al*. (2019). For a substantial examination of the documents, Bardin's content analysis (2011) was used.

In the planning stage, the sources of bibliographic collections were defined, selecting the Scopus and Web of Science journal bases, which, respectively, include more than seven thousand publishers, with more than 1.8 billion cited references (ELSEVIER, 2023), as well as over 34 thousand indexed journals and 1.89 billion cited references (CLARIVATE, 2023). The next step was to define the search terms, as shown in Table 1, which highlights the search strings and the number of works for each journal database.

Table 1: String, research criteria, periodical base and quantity of works.

String	Research criteria *	Base	Quantity
"*rural waste*" AND "*energy*"	*TITLE-ABS-KEY*	*Scopus*	37
	Topic	*Web of Science*	17
Total			**54**

Source: The authors (2023). (*) Both search criteria map results to title, abstract and keywords.

The mapping process was marked by just one inclusion criterion, scientific articles, given that the objective is to identify state-of-the-art contributions on the topic studied. This procedure resulted in 35 works, divided as follows: 12 from Web of Science and 23 from Scopus.

Regarding the exclusion criteria, duplicate works were observed, leaving 23 articles, while the adherence analysis considered the concomitant existence of the two constructs, rural waste and energy, in addition to in-depth reading to choose the final corpus, which resulted in 12 articles, presented in the state-of-the-art.

The documentary analysis was based on laws that established the Brazilian agricultural policy, the national solid waste policy, and the national solid waste plan, in which terms related to the topic under study were searched, such as "waste", "energy", "energetic", "rural" and "agro". Their contexts were then identified, interpreted and described, which was considered

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relevant for analyzing the structural, individual and relational perspectives of Bonelli *et al*. (2019).

The theory of Bonelli *et al*. (2019) suggests empirical studies that can also evaluate the dimensions of individual and relational action, in particular the informal, internal and external relationships, established by and with street-level bureaucrats. This is based on the premise that it is possible to analyze the three dimensions (structural, action individual and relational) based on norms and institutional documents, considering the formal relationships for individual and relational actions, as well as the additional analysis of the economic, political and legal context mentioned by the authors.

In this way, we begin to present the results and discussion as a way of disseminating knowledge for the state-of-the-art, the description derived from an analysis of institutional documents and an analysis of the possibility to apply the theory of Bonelli *et al*. (2019) in documentary research related to rural waste and its use for energy generation.

4. RESULTS AND DISCUSSION

This section is subdivided into three subsections: the first presents state-of-the-art contributions on the topic; the second describes the analysis of federal government institutional documents; and the third subsection investigates the possibility of applying the theory of Bonelli *et al.* (2019) in document analysis.

4.1. State-of-the-art contributions

A study carried out in a village with 510 inhabitants in South India, based on the assessment of the amount of waste, the types that were generated and how they were managed aimed to identify the appropriate technologies that could add value in relation to waste produced and improve the economic conditions of the rural population. It was observed that 77% of the waste was used as domestic fuel, animal fodder and fertilizers, and that only 23% was sent to the field to decompose naturally. This survey allowed us to infer that the village could produce 82% of its domestic energy by adopting the anaerobic digestion process of animal manure and human excrement (GOWDA *et al*., 1995).

In southern Iran and the northern Persian Gulf, research was carried out on solid waste management in 21 villages in Bushehr province. When evaluating the amount of waste generated in villages, Abduli *et al*. (2008) highlighted the existence of an obstacle in the implementation of recycling due to a lack of separation, which is why they recommended separating waste at source into two five-year periods: in the first, degradable and dry waste (paper, plastics and metals) and in the second, other waste (wood, rubber, glass and textiles). Regarding degradable matter, they suggested the use of low-cost composting, as they considered the quantities of waste insufficient to manage the process separately, suggesting regional management of solid waste with the inclusion of nearby villages.

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With the aim of solving pollution caused by rural waste and building new rural areas that could transform this waste into cleaner energy, a centralized biogas project was proposed in Chongming County, Shanghai, China, which was approved by the Shanghai Municipal Agricultural Commission and later expanded to an administrative center in the city, to collect dispersed biomass and use it on a large scale in the centralized biogas project (ZHU, 2012).

In rural communities in Ensenada, Baja California, in the United States, the high generation of solid waste per capita and the resulting environmental problems have driven authorities to seek alternative treatments. Given this, Taboada-González *et al*. (2014) analyzed three technologies (anaerobic digester, downdraft gasifier and plasma gasifier) from social, political, economic and environmental aspects, through interviews with the community, experts and decision makers, in addition to considering studies related to technologies. As a result, the researchers identified that the anaerobic digester was the technology chosen for the area because it obtained a high rating in relation to the others.

Ren *et al*. (2019) reported on PGAS technology as an alternative for the destination and treatment of rural waste for energy generation, based on biodegradation and automatic sorting of waste, obtaining inorganic materials (sand and glass), cellulose and others (fabrics bamboo, plastic), which, after processing, are in acceptable conditions for the industrial market. This is because they are able to produce hollow blocks, paving and sponge bricks, cardboard and corrugated paper. The plastic can also be sold and used in petroleum refining. Due to the chemical classification, it can be used for the production of energy particles, as well as the paste derived from anaerobic fermentation for use as granulated or powdered fertilizer.

Furthermore, the authors reported that with this technology, used in 2 cities and 3 districts with around 100,000 inhabitants in another project completed in 2017, in Yuanqu County, Shanxi Province, the treatment of 1 ton produces "65 kg of organic fertilizer, 105 kg of pulp, 124 kg of plastic, 133 kg of fuel derived from waste, 135 kg of sand, 55 kg of methane and 11 kg of metal". When evaluating the cost of the technology in comparison with incineration, they found that the Investment in technology was almost 40% lower and the removal rate of various pollution factors reached an average of 88.76% after sewage treatment.

When investigating the process of self-heating, decomposition, properties of intermediate products and microbial communities, through a sequential batch dry anaerobic fermentation system, considered an important technology for the large-scale processing of agricultural and rural waste for the clean energy production, Yu *et al*. (2020) identified that the presence of oxygen in small quantities accelerates the heating rate of materials in the reactor. Consequently, it reaches a temperature 27.12% higher than a non-aerated environment. Furthermore, the temperature required for methanogenesis can be maintained above 42.48°C without the need for external heating.

The direct production of electricity by a spatiotemporally anaerobic/semi-aerobic bioreactor system (STASAB) is recommended for energy use with a 38.38% reduction in greenhouse gas emissions and the elimination potential of rural waste, through the use of biogas. Therefore, in China, an analysis of this technology, using three bioreactors, identified

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greater energy potential than conventional landfills and sequentially anaerobic/semi-aerobic bioreactors (SHI *et al.*, 2020).

Research intended to analyze the anaerobic digestion of common rural waste (human feces, food waste and grass) demonstrated that the co-digestion of multiple substrates achieved high digestion performance for three purposes: to meet a significant percentage of the demand for energy of the rural community or even exceed it (52% to 109%); to fully meet the demand for azoto needed to fertilize lawns; and to effectively recycle that organic waste from rural areas through anaerobic digestion (CAI *et al.*, 2022).

In rural areas of India, a study identified and classified 19 barriers in relation to the adoption of domestic biogas systems, the results of which showed that the economic dimension is the major barrier, with the high installation cost being one of the most significant. The disparity in the cost of capital must also be considered, in addition to the lack of payment capacity and the lack of easy access to credit, respectively (YADAV et al., 2022).

Olokede *et al*. (2023) investigated conservation techniques in chicken manure and sewage sludge – fresh frozen, air-dried and roasted – considering that the co-digestion of these residues with lignocellulose improves the performance of biomass conversion in anaerobic digestion with the retention of methane, converted into carboxylic acids, which can be transformed into industrial chemicals and liquid fuels.

Thus, fresh substrates resulted in higher acid yields and higher biomass conversion compared with dry substrates. Oven drying chicken manure reduced digestibility, leading to a reduction in conversion and total acid production. Using the Continuous Particle Distribution Model (CPDM) and co-digesting office paper and wet chicken manure under certain conditions, the model predicted a high total acid concentration and effective conversion of volatile solids (OLOKEDE *et al.*, 2023).

With the aim of using poultry manure, considered a rural residue, as a catalyst for water purification, without adding other products, in relation to emerging contaminants – substances that were not previously monitored or considered pollutants –, the results were considered excellent due to the removal of various emerging contaminants, since the degradation rate can be greater than 94.3% after 10,000 cycles, that is, repetitions of the purification process (HAN *et al.*, 2023).

Due to the increase in modern rural industries in agriculture, livestock farming and agricultural product processing, Li *et al.* (2022) proposed the use of animal manure from the livestock industry to produce gas and the generation of renewable energy through the gasification of waste by pyrolysis, prospecting models for supplying electricity, gas and thermal energy in rural waste treatment facilities. The results demonstrated that the proposed method allows the efficient use of rural resources, promotes synergy between various rural industries and improves the economic benefits of the community.

4.2. Rural waste in Brazil in institutional documents

4.2.1. Normative basis

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Brazilian agricultural policy, established by Law Nº 8,171, of January 17, 1991, establishes a series of assumptions that the agricultural sector is made up of production, inputs, agroindustry, commerce, supply and others, which react to public policies and market forces in different ways, and that agricultural development must provide essential services to the "country man", for example, health and sanitation (BRASIL, 1991).

The term "waste" in this law, in the context of energy, appears in the chapter that deals with rural electrification, whose policy encompasses energy reforestation and the production of fuels from agricultural waste, crops and biomass, regardless of the source of energy generation. They are considered relevant both in the context of agricultural production and productivity and the social well-being of farmers and rural workers, highlighting that the implementation of this policy is the responsibility of the public authorities. The law relies on the participation of farmers, cooperatives and other associations, prioritizing incentives for the latter two entities in the construction of small hydroelectric and thermoelectric plants with a view to using agricultural waste for rural electrification (BRASIL, 1991).

Another legal framework that deserves to be highlighted is the National Solid Waste Policy (PNRS), which establishes an order of priority for waste management, so that it is only possible to move on to the subsequent stage if it is impossible to resolve the present stage. The order of priority is as follows: non-generation, reduction, reuse, recycling, treatment of solid waste and environmentally adequate final disposal of waste (BRASIL, 2010).

In the "agro" context, the law establishes inspection and monitoring as instruments of the PNRS. Agrosilvopastoral waste is classified as solid waste that is generated in agricultural and forestry activities, including its inputs, subjecting those responsible for these activities to comply with the Solid Waste Management Plan, when required by the competent body, defining a minimum content for said document. This includes the diagnosis of the generated solid waste, indicating the volume and characterization of this waste, except for pesticides, as well as its waste and packaging. This is because manufacturers, importers, distributors and traders must, independently of the public authorities, structure a reverse logistics system (BRASIL, 2010).

From the point of view of "energy" related to waste, energy use is considered an environmentally appropriate final destination, as long as the rules to avoid damage or risks to public health, safety and the reduction of environmental impacts are observed. The PNRS aims to encourage the development of environmental and business management systems for this purpose, in addition to determining the establishment of goals to take advantage of the energy from gases generated in solid waste final disposal units, which must be included in the National Solid Waste Plan and in the States Solid Waste Plans. These are updated every four years and prepared for a twenty-year horizon (BRASIL, 2010).

4.2.2. Diagnosis, guidelines and strategies on agrosilvopastoral waste

The Brazilian National Solid Waste Plan (Planares) informs that the coverage rate of the household waste collection service in relation to the total population of the municipality is

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deficient in rural areas, assuming the existence of disparities for conventional collection not only between rural areas and urban, but also between the size of the municipalities in relation to the population (BRASIL, 2022, p. 22).

Regarding agrosilvopastoral waste, the Planares (BRASIL, 2022, p. 104-107) considered, for energy purposes, waste that would not be subject to other types of use, excluded organic waste separated in harvests and remaining in the field, animal waste in pasture systems and forest residues abandoned in the field. Thus, with data from 2015, it was estimated that approximately 775 million tons of waste were generated in Brazil, approximately 443 million tons of which were sugarcane vinasse, which was estimated based on ethanol production.

Furthermore, with sources dating back to 2011, the Planares considered the potential for biogas production from waste generated in agricultural production (coffee, banana, bay coconut, cashew nut and rice peels; orange pomace; grape waste, soybeans, corn, beans and cassava; and vinasse from ethanol., Meanwhile energy generation was considered for cocoa shells and sugarcane bagasse, the former for having low water content, and the latter to be used as fuel for by burning in furnaces and boilers.

The guidelines, strategies and those responsible for managing agrosilvopastoral waste – RASP were compiled in Table 2:

Table 2: Guidelines, strategies and those responsible for managing RASP

Guidelines	Strategies	Responsible
Standardize and systematize information about RASP	1 – Include, in the agricultural census, the collection of information regarding RASP and its destination.	Federal Government (IBGE and MAPA)
	2 – Integrate the information collected in the agricultural census into the National Information System on Solid Waste Management (SINIR).	Federal Government (MMA, IBGE and MAPA)
Increase recycling and recovery of RASP	3 – Prepare, in partnership with the production sector, a technical-economic feasibility study of energy use, composting and on-site anaerobic biodigestion of the different types of RASP for different production scales.	Federal Government (MMA and MAPA) and productive sector
	4 – Stimulate innovative projects for the transformation of agrosilvopastoral waste into new by-products and clean energy, including the production of biogas and biomethane, using the principles of bioeconomy.	Federal Government (MMA and MAPA)
	5 – Create economic instruments and provide lines of credit for the acquisition of equipment and systems for energy use and composting.	Support: Federal Government (MMA, MAPA and ME) Execution: Financial Institution
	6 – Train rural extension agents, farmer associations and cooperatives to implement composting units and anaerobic digestion units for organic waste.	Support: Federal Government (MMA and MAPA) Execution: "S" System and OSC

Source: BRASIL, 2022, p. 172 and 178. Adapted by the authors (2023).

Thus, the Planares defined those responsible for each of the strategies, covering bodies and entities of the federal government, the Brazilian Institute of Geography and Statistics (IBGE), the Ministry of Agriculture, Livestock and Supply (MAPA), the Ministry of the Environment (MMA), the Ministry of the Economy (ME), with a partnership with the productive sector for

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strategy 3, the provision of funding by financial institutions for investment in technologies that allow energy use and composting for strategy 5, as well as the "S" System and Organizations of Civil Society – OSC for strategy 6.

The "S" System was created in 1942, by President Getúlio Vargas, with the National Industrial Learning Service (Senai). Over the years it was expanded and today, in addition to Senai, there is the National Commerce Learning Service (Senac), Social Services for Commerce (Sesc), Social Services for Industry (Sesi), Brazilian Support Service for Micro and Small Businesses (Sebrae), National Rural Learning Service (Senar), National Cooperative Learning Service (Sescoop), Social Transport Learning Service (Senat) and the Social Transport Service (Sest) (BRASIL, 2023a).

These entities are maintained by the corresponding sectors, the government collects resources from the payroll of these sectors and passes them on to the entities, which have several objectives in addition to improving the quality of life of workers, as they offer services to the population such as schools, technical courses, professional training, specialization, training, cultural activities, event programming, sports and research centers (BRASIL, 2023).

OSCs, under the current legislation, are private non-profit entities that do not distribute profit among their partners or associates, which include cooperative societies formed by people at risk or in personal or social vulnerability, or that are covered by programs and actions of combating poverty and generating work and income, as well as those aimed at promoting, educating, and training rural workers or technical assistance and rural extension agents, and others (BRASIL, 2015).

4.3. Potential for implementing public policies

The implementation of public policies depends on the formation of an agenda. Capella (2016) studied the theoretical perspectives on the formation of an agenda according to the models of Kingdon (2003) and Baumgartner and Jones (1993). In short, the author analyzed and differentiated the elements of problems, solutions, political-institutional dynamics, actors and changes in the agenda (CAPELLA, 2016, p. 46).

It turns out that the topic in question, through the document analysis of the previous subsection, especially Table 1, revealed guidelines and strategies drawn up by the federal government that denote, at least in theory, the formation of an agenda aimed at diagnosing rural waste and determining the corresponding energy use.

In view of this, it is interesting to evaluate the point of view of the implementation of public policies on the energy use of rural waste, especially analyzing the applicability of the theory by Bonelli *et al*. (2019) in documentary research in order to identify the actions of street-level bureaucrats in institutional documents as a potential for the implementation of public policies on the topic under study.

In this context, generating alternatives for public policies to compose an agenda depends on experts, whose group is theoretically composed of "researchers, parliamentary advisors, academics, public servants, analysts belonging to interest groups, among others"

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(CAPELLA, 2016, p . 28), who can be considered street-level bureaucrats in studies related to the implementation of public policies.

4.3.1. Analysis of the structural perspective/dimension

The structural dimension refers to obedience to formal rules, making it necessary to know and analyze the organization of the agency in question, its structure and its norms, so that, through the logic of adequacy, actors may find themselves conditioned by predefined institutional roles. This is hypothesis I of Bonelli *et al*. (2019), which assumes that "street-level bureaucrats' adherence to established rules and structures affects the implementation of public policies".

The responsible government agencies in Table 2 have their own organization, defined by the Federal Government, and operate in their respective areas of competence: agriculture, livestock and supply; environment; economy; research and dissemination of statistical information from a demographic, social and economic point of view, in addition to geographic, cartographic, geodetic and environmental information.

Furthermore, they are governed by rules derived from laws, such as internal regulations, ordinances, manuals, among other documents that can be accessed on the respective institutional websites. These rules establish procedures to be observed by street-level bureaucrats, in this case, public agents implementing public policies on the topic under study.

The Planares (BRASIL, 2022) mentions the norms that condition the actions of street-level bureaucrats. By way of example, the 199-page document mentions "law nº" 51 times, "decree" 23 times and "ordinance" 19. It should be noted that the public administration and its agents, before and during their activities, must observe the principle of legality, that is, they need to act in accordance with the laws and rules and, in theory, only do what is authorized by the rules (BRASIL, 1988).

4.3.2. Analysis of the perspective/dimension of individual action

The perspective of individual action is analyzed by the relevance of incentives – extrinsic or intrinsic – in the actions of street-level bureaucrats responsible for implementing public policies, which is why hypothesis II of Bonelli *et al*. (2019) assumes that "the individual actions of street-level bureaucrats affect the implementation of public policies".

From document analysis, it is not possible to identify the presence of intrinsic incentives such as adverse selection (hidden information) or moral hazard (hidden actions), reputation, autonomy, job satisfaction, or even interpretation/choices based on their ideas, judgments, values, and beliefs. However, an intrinsic incentive of possible inference for public agents and public career researchers is the stability in the public service resulting from a public examination, as provided for in the Federal Constitution of 1988 and in Law No. 8,112, of December 11, 1990 (BRASIL, 1988; BRASIL, 1990).

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Public servants achieve stability 3 years in their positions, with the advantage of only eing able to lose their jobs through a final and unappealable court ruling, an administrative disciplinary process in which full defense is ensured, and through the periodic evaluation procedure of performance (BRASIL, 1988). In other words, a change of government does not mean that these public agents to be replaced, which, to some extent, enables the continuity of public policies, since public agents, street-level bureaucrats, including researchers, continue to contribute, either to the formation of an agenda and/or for the implementation of public policies.

4.3.3. Analysis of the relational perspective/dimension

The relational dimension is linked to the multiple relationships between street-level bureaucrats and other social actors (such as politicians, inspectors, and users), making it necessary to evaluate the intensity and frequency of interactions, as well as the quality and quantity of information shared in the program in question. Thus, Bonelli *et al*. (2019) presupposed hypothesis III, in which "the interactions of street-level bureaucrats with each other and with other actors involved affect the implementation of public policies".

The document analysis did not allow us to directly evaluate the informal relationships of street-level bureaucrats between social actors, nor the intensity and frequency of interactions (internal or external). However, the Planares (BRASIL, 2022, p. 12) reported that the document received contributions from "ministries directly related to the topic", which is why it can be inferred, at least hypothetically, that there were interactions to some degree between street-level bureaucrats, as they are the executors of government actions, who normally interact with mid-level bureaucrats, such as directors and coordinators. It is possible that formal interactions occurred in internal systems, although this falls outside the scope of analysis established in this study.

In formal external relations, the document, on the same page, clarifies other contributions obtained through public hearings (regional and national), in face-to-face and virtual formats, in addition to public consultation on the internet, highlighting social participation in the process of drafting the Planares.

Furthermore, according to Table 1, the Planares prospects the involvement of OSCs and "S" System entities, contemplating the participation of non-state organizations, which Bonelli *et al*. (2019) referred to in the most recent literature as street-level organizations.

4.3.4. Analysis of legal, political and economic scenarios

Bonelli *et al*. (2019) suggested an additional analysis of institutional factors linked to public policies, such as the "political, economic, and legal environment". From a legal perspective, there is a favorable environment for implementation, as there is a normative framework (subsection 4.2.1) capable of supporting public policies for the use of rural waste for energy.

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In relation to the economy, it is understood that the scenario is also favorable, since Gross Domestic Product (GDP) increased by 0.9% in the second quarter of this year compared with the previous quarter, whose interannual comparison obtained a positive result, with an increase of 3.4% over the second quarter of 2022 (IPEA, 2023).

Furthermore, the 2024 Annual Budget Law Bill (PLOA 2024) (BRASIL, 2023b) foresees the program called "Bioeconomy for a New Cycle of Prosperity" in the priorities "fighting hunger and reducing inequalities" and "neoindustrialization, work , employment and income", for which the Ministry of Environment and Climate Change is responsible, with actions such as Support for Environmental Conservation and the Eradication of Extreme Poverty, Socio-environmental Management of Natural Resources in Territories of Traditional Peoples and Communities and Family Farmers, Development of the Bioeconomy and Promotion of Sustainable Development and Environmental Conservation Projects, highlighting a possible political environment favorable to the implementation of public policies for the use of rural waste as energy.

This possibility can be reinforced by consulting the evaluation of the public policy known as the National Program for Strengthening Family Agriculture (Pronaf), carried out by the Public Policy Monitoring and Evaluation Council (CMAP) (BRASIL, 2023c, p. 104), which foresees the possibility of financing related to the bioeconomy, in the Pronaf Eco line, for environmental technologies for the reuse of effluents and waste, among others.

5. CONCLUSIONS

The state-of-the-art demonstrated the importance of surveying the quantities and types of rural waste, the development of technologies and the involvement of the state, the community, decision-makers and experts in choosing viable technologies for rural waste management. The studies also demonstrated the relevance of analyzing socioeconomic viability and investigating possible barriers, such as access to credit, for the implementation of technologies for the use of rural waste for energy.

The document research highlighted the need for studies and state action in order to carry out diagnoses on the types and quantities of agrosilvopastoral waste for its adequate use for energy, given that diagnostic data on the subject in question are from 2011 and 2015. The survey of data is essential, as the analysis of socioeconomic viability in the implementation of technologies depends on this, including for the implementation of public policies on the use of this waste.

The analysis of the possibility applying the expanded theory to the performance of street-level bureaucrats in document research proved to be adaptable to the formal relationships established in the structural, individual and relational dimensions. The limitations of this work are informal relationships and subjective elements of bureaucrats, especially the perspective of individual action, which can be studied in the future by consulting street-level bureaucrats on established informal relationships and intrinsic and extrinsic incentives, with a view to expanding the researched scenario.

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