IWA 17th SWWS AND 9th ROS
10th–14th November, 2024
Curitiba-Brazil

Social perception regarding use of biosolids in agriculture: a systematic review

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Highlights:

- Rural producers exhibit doubt towards biosolids use.
- Producers recognize the benefits of biosolid application and express positivity if biosolids are competitively marketed with technical support.
- Improved education and awareness are crucial for promoting sustainable organic fertilizer practices.

Keywords: land application; public perception; sewage sludge.

INTRODUCTION

The treatment of sewage sludge to produce biosolids is relevant alternative for disposal of this byproduct, especially in situations where landfilling is not allowed or economically viable. Application of biosolids on soil increase the levels of organic matter and nutrients, improving its characteristics and reducing the need for chemical fertilizers. It's also worth highlighting the promotion of a circular economy through resource recovery and reduction of CO_2 emissions from landfills.

However, despite being a solid solution, the use of biosolids in agriculture still faces some barriers regarding its effective application. Among them is the acceptability by producers to use a product derived from sewage.

Considering this, the objective of this study was to map social aspects concerning the acceptance of biosolid use by rural producers, summarize the main barriers, and propose positive approaches to overcome them.

METHODOLOGY

The study was conducted through a systematic literature review using databases such as Scopus and the Biblioteca Digital Brasileira de Teses e Dissertações (BDTD - Brazilian Digital Library of Theses and Dissertations), which encompass Brazilian and international documents. The eligibility criteria for the research methodology were established by analyzing peer-reviewed articles, doctoral theses, and

master's dissertations published between the years 2000 and 2024. The search terms used in the title, abstract, or keywords were "biosolids" OR "sewage sludge" AND "public perception" OR "acceptability" OR "public acceptance" OR "risk perception." Only studies that assessed in detail acceptance of sewage sludge or biosolids (from domestic effluents) were selected.

RESULTS AND CONCLUSIONS

It was possible to notice the scarcity of studies related to the subject. Although many studies mentioned the keywords (1,323 studies found in the databases), only 13 research studies were selected based on the eligibility criteria and the objectives outlined in this research.

Approximately 2,198 individuals participated in the surveys analyzed in this review. Most studies (n = 10) employed the questionnaire methodology, with four utilizing a Likert scale. The study by Novanda et al. (2021) in Indonesia used both questionnaires and in-depth interviews. Rashid et al. (2017) also employed in-depth interviews. In addition to these methods, semi-structured interviews (Krogmann et al., 2001) and focus groups (Chamhum-Silva, 2018) were also identified as data collection techniques. Considering the variability of methods, it is noteworthy that each one has its strengths and limitations, so the approach should be objective-driven. For example, focus groups lead to in-depth discussions with a limited number of participants; on the other hand, structured questionnaires can reach a larger audience with answers strictly tied to the questions.

Most producers in the reviewed studies were men aged 41 to 65. Lima et al. (2024) found that producers in Sweden aged 25 to 60 were more optimistic about using alternative organic fertilizers, while those over 60 were cautious, and younger producers showed less enthusiasm. These generational differences suggest that targeted education and outreach may be needed to increase biosolid adoption.

In the studies reviewed, the most frequently reported crops were the cultivation of food products that are not consumed raw and non-food products (n = 610), along with pastures and forage crops (n = 165). Producers are more comfortable applying biosolids to tree crops, suggesting greater reluctance in its use on crops with direct contact with the soil.

The studies highlighted two major factors influencing producers' decisions regarding biosolid use: i) the price of biosolids commercialization and ii) consumer acceptance (Krogmann et al., 2001; Case et al., 2017; Melo et al., 2019; Nassar et al., 2019; Novanda et al., 2021). Additionally, in Brazil, the certification of biosolids for quality and safety was emphasized (Chamhum-Silva, 2018), underscoring the crucial role of reliable laboratory analyses in guaranteeing these standards.

The most frequent negative factors raised by interviewees were heavy metals, public health concerns, insufficient information, odor, and aversion (Figure 1A). However, out of 485 participants in all studies reviewed, only 84 would reject biosolids application in agriculture. 401 expressed a positive perception towards sustainable organic fertilizer, highlighting increased productivity and soil improvement as main advantages (Figure 1B). Producers were more comfortable using biosolids in crops without direct contact with the material.

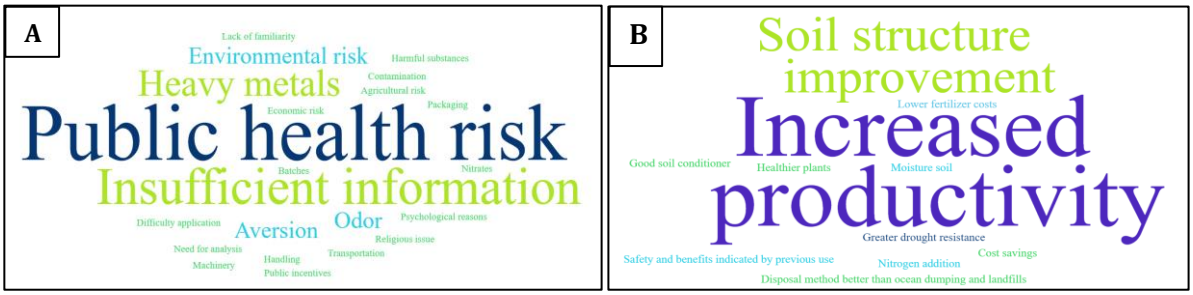

Figure 1: Word cloud with the main negative and positive points considered by rural producers regarding the use of sewage sludge in agriculture.

In the study by Nassar et al. (2019), respondents also raised concerns about the availability of biosolids in the market, possibly indicating that if it were a product with limited accessibility, the preference would shift toward other types of fertilizers. Producers only expressed environmental concerns when directly asked, suggesting that their decision-making priorities are primarily based on economic factors, followed by consumer acceptance, and finally, environmental reasons (Krogmann et al., 2001; Case et al., 2017; Nassar et al., 2019).

An important point highlighted is the difficulty some farmers face in planning the use of biosolids due to a lack of information and guidance on how to apply this type of fertilizer (Case et al., 2017). In contrast, chemical fertilizers have well-established and straightforward agronomic instructions, which simplify their application (Case et al., 2017; Nassar et al., 2019). Additionally, some producers indicate that the lack of specialized machinery can also be a barrier. Further support and infrastructure are needed to facilitate its adoption by farmers.

Producers have concerns about biosolid use due to a lack of information and cultural biases associating sewage with disease and pollutants. In Brazil, it was observed that farmers with lower levels of education exhibited greater resistance (Pegorini, 2002). Similarly, it was noted that even in countries with advanced agricultural structures, such as Canada, where high mechanization and policies support biosolid use (Whitehouse et al., 2022), rural producers, particularly those on smaller, family-owned farms, remain skeptical.

This suggests that skepticism towards biosolid application may not solely be influenced by technological advancements or policy frameworks, but also by educational and cultural factors across different regions. Nonetheless, some producers acknowledge the benefits of biosolids and express a willingness to adopt them, especially when biosolids are competitively marketed. To foster more sustainable practices regarding organic fertilizers, enhanced environmental education is essential. In this context, Chamhum-Silva (2018) underscores the importance of technical guidance for the proper disposal and application of biosolids, as failure to adequately address these steps can result in environmental degradation, health risks for producers, and ultimately compromise food safety for consumers.

ACKNOWLEDGMENTS

The authors would like to acknowledge the support obtained from the Research, Development and Innovation Regulatory Program from the Water Supply and Sanitation Services Regulatory Agency of the State of Minas Gerais – ARSAE-MG and the Sanitation Company of the State of Minas Gerais – COPASA.

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