

WOMEN'S AGENCY AND SOCIAL TECHNOLOGIES FOR LIVING WITH THE SEMI-ARID REGION

Protagonismo feminino e tecnologias sociais na convivência com o Semiárido

Protagonismo femenino y tecnologías sociales en la convivencia con el Semiárido



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ABSTRACT

The paradigm of living with the Semi-Arid Region expresses the need for development strategies that are responsive to the specific socio-environmental conditions of semi-arid territories. Within this perspective, social technologies have emerged as instruments capable of addressing territorial demands while fostering alternative pathways for development rooted in the particularities of the Semi-Arid region. Among their most significant contributions is the recognition and strengthening of women's work, reaffirming their active participation in local development while generating social, environmental, and economic benefits. In this context, this study investigates the contributions of women's agency in the management of social technologies designed for living with the Semi-Arid Region through a case study conducted in the Macambira Quilombola Community, Rio Grande do Norte, Brazil. Methodologically, the research adopted qualitative procedures based on conversation circles and semi-structured interviews with women from the quilombola community. The findings highlight the central role played by women in managing and maintaining the social technologies implemented in the community, including greywater reuse systems (bioágua), biodigesters, and water-efficient raised garden beds (canteiros econômicos). The study concludes that women's engagement in the management of these social technologies makes a substantial contribution to enhancing the paradigm of living with the Semi-Arid Region.

Keywords: Quilombola community; Peasant agriculture; Women's groups; Women's labor.

Article History

Received: 27 march, 2026
Accepted: 07 july, 2026
Published: 11 august, 2026

<https://doi.org/10.33237/2236-255X.2026.7920>



RESUMO

O paradigma de convivência com o Semiárido exprime a necessidade de alternativas de desenvolvimento contextualizadas à realidade da região. É nesse viés que as tecnologias sociais emergem enquanto instrumentos que oferecem resultados às demandas dos territórios, possibilitando outras formas de desenvolvimento a partir das singularidades do Semiárido. Dentre as potencialidades das tecnologias sociais, destaca-se a valorização do trabalho feminino, de modo a reafirmar a participação ativa das mulheres e proporcionar benefícios sociais, ambientais e econômicos. Nesse contexto, busca-se investigar as contribuições do protagonismo feminino no manejo de tecnologias sociais de convivência com o Semiárido, a partir de um estudo de caso realizado na Comunidade Quilombola Macambira (RN). Metodologicamente, a pesquisa foi realizada por meio de rodas de conversa e entrevistas semiestruturadas com mulheres da comunidade quilombola. Como resultados, nota-se a centralidade do manejo e da gestão feminina nas tecnologias sociais encontradas na comunidade, como bioágua, biodigestor e canteiro econômico. Conclui-se que o trabalho realizado pelas mulheres no manejo das tecnologias sociais corrobora de forma significativa para o fortalecimento da convivência com o Semiárido.

Palavras-chave: Comunidade quilombola; Agricultura camponesa; Grupos de mulheres; Trabalho das mulheres.

RESUMEN

El paradigma de la convivencia con el Semiárido expresa la necesidad de alternativas de desarrollo contextualizadas a la realidad de la región. En esta perspectiva, las tecnologías sociales emergen como instrumentos que responden a las demandas territoriales, posibilitando otras formas de desarrollo basadas en las singularidades del ambiente semiárido. Entre las potencialidades de las tecnologías sociales, destaca la valorización del trabajo femenino, reafirmando la participación activa de las mujeres y generando beneficios sociales, ambientales y económicos. En este contexto, el estudio busca investigar las contribuciones del protagonismo femenino en el manejo de tecnologías sociales de convivencia con el Semiárido, a partir de un estudio de caso realizado en la Comunidad Quilombola Macambira, Brasil. Metodológicamente, la investigación se llevó a cabo mediante círculos de conversación y entrevistas semiestructuradas con mujeres de la comunidad quilombola. Los resultados evidencian la centralidad del manejo y la gestión femenina en las tecnologías sociales presentes en la comunidad, tales como bioagua, biodigestor y bancal económico. Se concluye que el trabajo desarrollado por las mujeres en el manejo de estas tecnologías sociales contribuye significativamente al fortalecimiento de la convivencia con el Semiárido.

Palabras clave: Comunidad quilombola; Agricultura campesina; Grupos de mujeres; Trabajo femenino.

1. INTRODUCTION

By the end of the twentieth century, the Brazilian Semi-Arid region had become the setting for a socio-political movement that proposed a new way of understanding the region through the paradigm of *Living with the Semi-Arid Region (Convivência com o Semiárido)* (Silva, 2022; Carvalho, 2011). This paradigm represents a profound shift in the perception of the region's environmental and territorial complexity, promoting more harmonious forms of coexistence between society and nature (Silva, 2003). Rather than attributing regional



problems exclusively to drought, this perspective recognizes semi-aridity as an inherent environmental characteristic rather than an unavoidable misfortune (Conti & Pontel, 2013).

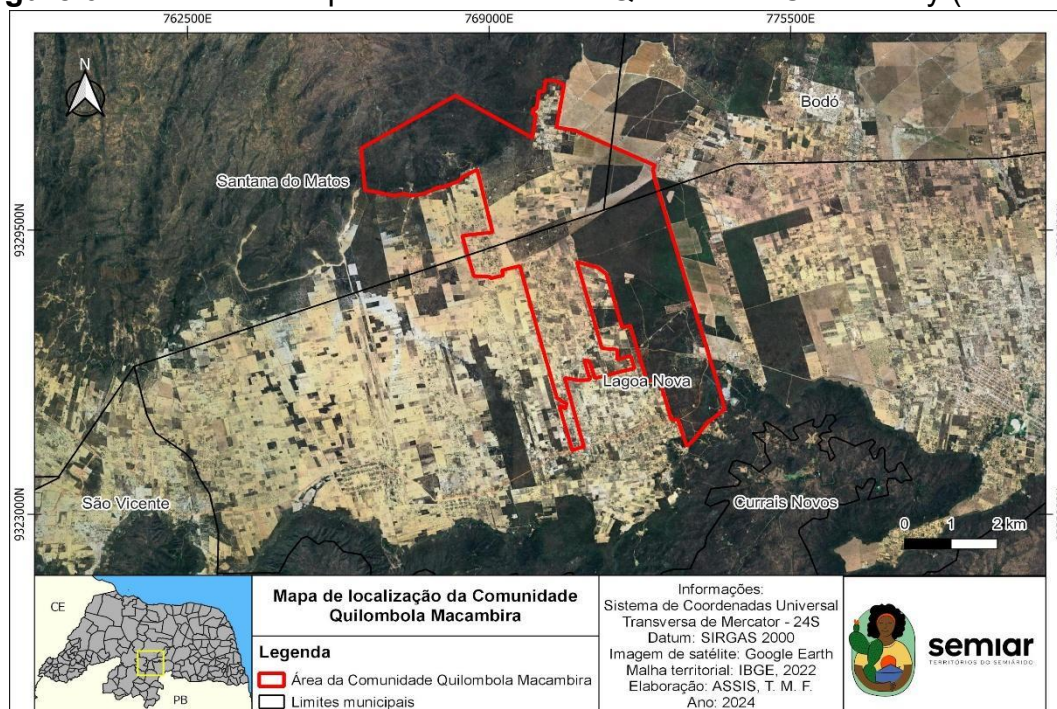
The conceptual framework underpinning the paradigm of living with the Semi-Arid is grounded in the promotion of citizenship, gender equity, and the appreciation of local knowledge, among other principles (Baptista & Campos, 2013). According to Silva (2003), the effective implementation of this paradigm requires integrated public policies specifically designed to address the socio-environmental conditions of the region, combining secure access to land and water with the dissemination of social technologies.

Social technologies are understood as simple, yet innovative practices developed by local communities that play a central role in strengthening coexistence with semi-arid environments. Their relevance lies in combining affordability, respect for community identity, and the promotion of *Buen Vivir* while fostering socially appropriate forms of development (Ventura, Fernandez, & Andrade, 2013). Henig, Santos, and Mendes (2019) further argue that social technologies constitute an alternative development model capable of promoting gender equity in the Semi-Arid.

Within this framework, Silva (2006) highlights the recognition of women's labor through the implementation of social technologies in rural communities, emphasizing that these initiatives are planned and carried out with women's active participation. Likewise, Rapozo (2017) argues that such technologies foster forms of relative autonomy, particularly in economic and environmental terms, contributing to higher household incomes, enhanced self-esteem, and the creation of collective spaces where peasant women exchange knowledge and experiences acquired through the management of social technologies.

Considering the central role played by women in family reproduction and collective territorial organization within the Semi-Arid, this study investigates the relationship between women's management of social technologies in the Macambira Quilombola Community, located in the state of Rio Grande do Norte, Brazil (Figure 01). In this community, the Diocesan Caritas of Caicó has implemented both collective and household-level social technologies - including biodigesters, greywater reuse systems (*bioágua*), and water-efficient raised garden beds (*canteiros econômicos*) - which are managed by quilombola peasant women organized into local women's groups.



Figure 01 – Location map of the Macambira Quilombola Community (RN - Brazil)

Source: Prepared by the authors (2024).

Against this background, this study seeks to answer the following research question: How does the management of social technologies by quilombola peasant women in Macambira contribute to strengthening the paradigm of living with the Semi-Arid? To address this question, the study analyzes the contributions of women's agency to the management of social technologies and to the consolidation of this development paradigm within the community. The relevance of this research lies in highlighting community-based practices led by women whose management of social technologies constitutes an important mechanism for reinforcing sustainable coexistence with the Semi-Arid environment.

2. METHODOLOGY

This study adopts a qualitative research approach within the field of social research, based on fieldwork followed by the systematization and analysis of primary data. Fieldwork was conducted between 2024 and 2025 in the Macambira Quilombola Community, located in the state of Rio Grande do Norte, Brazil. Data collection involved visits to the households of women responsible for managing social technologies and affiliated with the four women's groups established in the community (Table 01).



Table 01 – Characteristics of the women's groups in the Macambira Quilombola Community (Rio Grande do Norte, Brazil)

Women's Group	Women's Group	Women's Group	Women's Group
Flores de Macambira	23	Macambira III	2021
Flores do Campo	14	Cabeço dos Ferreira	2021
Mulheres Renovadas	25	Macambira do Ludugero	2016
Mulheres de Maria	25	Macambira II	2022

Source: Prepared by the authors (2025).

Data collection consisted of four conversation circles and seventeen semi-structured interviews conducted with members of the women's groups. According to Moura and Lima (2014), conversation circles generate data through dialogue structured around a shared thematic focus. A total of forty-two quilombola peasant women participated in these collective discussions. The selection of the seventeen interviewees followed three criteria: (a) active involvement in managing at least one of the social technologies implemented in the community (biodigester, bioágua greywater reuse system, or water-efficient raised garden bed); (b) proportional representation of the four women's groups (three to five participants from each group); and (c) willingness to participate in an interview conducted at their residence, specifically in the backyard where the social technology had been installed.

The interviews were conducted individually and lasted approximately 30 to 40 minutes. A semi-structured interview guide composed of open-ended questions was used to explore participants' trajectories within the women's groups, their experiences in managing social technologies, and their perceptions regarding the importance of these technologies and their contributions to the paradigm of living with the Semi-Arid. All interviews were audio-recorded following the participants' free and informed consent and were subsequently transcribed for analysis.

Data were organized and analyzed using the analytical framework proposed by Moura and Lima (2014), which involves the transcription of participants' narratives, the organization of data into thematic categories, and the critical interpretation of the findings in dialogue with the theoretical framework underpinning the study.



3. SOCIAL TECHNOLOGIES AND WOMEN'S AGENCY IN STRENGTHENING THE PARADIGM OF LIVING WITH THE SEMI-ARID

3.1 Living with the Semi-Arid and Social Technologies

Silva and Pereira (2020) argue that the Brazilian Semi-Arid Region has historically been neglected by the State through decontextualized public policies that failed to address the specific socio-environmental conditions of the region and the needs of its inhabitants. Moreover, the discourse surrounding the so-called drought industry constructed an imaginary of the Semi-Arid as an abandoned, marginalized, and impoverished region that depended on state intervention to overcome the effects of drought (Silva & Pereira, 2020). In this regard, the authors argue that the logic of "combating drought" has functioned as a mechanism for colonizing and controlling nature, while the drought industry has operated as a form of "the colonality of power, knowledge, and being by disregarding local populations", their knowledge systems, and their long-standing strategies for living with semi-arid environments (Silva & Pereira, 2020).

Building on this perspective, Cavalcante (2024) criticizes these stereotypical representations, arguing that they obscure the region's rich socio-biogeographical diversity and the plurality of knowledge systems developed by its inhabitants. Within this framework, Cavalcante (2024:283) conceptualizes living with the Semi-Arid as:

"[...] a set of actions and social relations grounded in the perspective of Buen Vivir, developed through practices that recognize both the limitations and the potentialities of the semi-arid environment, supported by specific public policies, social technologies for water harvesting and storage, universal access to land and water, guarantees of quality healthcare and education, the creation of employment and income opportunities, the dissemination of agroecology and solidarity economy initiatives, the participation of community-based and civil society organizations, the sustainable management of natural resources, and access to culture and the arts, among other dimensions."

Silva (2003), Malvezzi (2007), and Carvalho (2011) emphasize that living with the Semi-Arid entails a cultural and educational process through which the Semi-Arid is re-signified. Gomes (2018) further argues that this process of territorial reappropriation challenges the representation of drought as an unavoidable natural disaster, repositioning local populations as protagonists in their own development. Conti and Pontel (2013) summarize this paradigm shift by arguing that, rather than fighting drought, societies should learn to live with it. Accordingly, the paradigm of living with the Semi-Arid is intrinsically linked to the construction of an environmentally sustainable and socially just society (Henig,



Santos, & Mendes, 2019), while simultaneously promoting the decolonization of hegemonic discourses about the region and recognizing centuries-old practices of peasant resistance to capitalist development models (Silva & Pereira, 2020).

Within this perspective, social technologies constitute development alternatives specifically designed for the socio-environmental realities of the Semi-Arid and are promoted through participatory community-based processes. Silva (2006) argues that these technologies reconcile traditional *sertanejo* knowledge with technological innovations adapted to local conditions, thereby challenging historical structures of land, water, and power concentration. Likewise, Henig, Santos, and Mendes (2019) contend that social technologies are fundamentally committed to social transformation by expanding existing innovations and promoting broader forms of citizenship among participating communities.

Furthermore, according to Silva (2006), the primary objective of social technologies is to foster innovative and productive practices grounded in the sustainable management of natural resources and adapted to the ecological conditions of semi-arid environments. Duque (2008) reinforces this perspective by emphasizing that the economic, environmental, and social sustainability of these technologies depends on their low implementation costs, environmental compatibility, and pedagogical processes capable of engaging with the knowledge of farming families, enabling them to appropriate, adapt, and disseminate these practices autonomously.

3.2 Social Technologies and Women's Agency in Macambira

Rapozo (2017) highlights that a wide range of technical assistance and rural extension services in the Brazilian Semi-Arid are provided by social movements and civil society organizations committed to transforming rural territories. Rural extension initiatives are frequently associated with the implementation of social technologies aimed at promoting healthy food production and improving the quality of life of farming families, as exemplified by the initiatives carried out by the Diocesan Caritas of Caicó in the Macambira Quilombola Community.

Since 2021, the Diocesan Caritas of Caicó has implemented social technologies designed to strengthen living with the Semi-Arid within the Macambira Quilombola Community. These initiatives have been distributed among the four women's groups operating in the community. By 2025, a total of thirty social technologies—including *Bioágua*



greywater reuse systems, biodigesters, and water-efficient raised garden beds (*canteiros econômicos*)—had been installed, as shown in Table 01

Table 01 – Distribution of Social Technologies among the Women's Groups in the Macambira Quilombola Community, Implemented by the Diocesan Caritas of Caicó (2021–2025)

Women's Group	Bioágua System	Biodigester	Water-Efficient Raised Garden Beds	Total Social Technologies
Flores de Macambira	1	0	7	8
Flores do Campo	0	0	5	5
Mulheres Renovadas	2	2	6	10
Mulheres de Maria	0	1	6	7

Source: Prepared by the authors (2025).

According to Santos et al. (2016), social technologies constitute cross-sectoral strategies that promote citizenship, autonomy, and community participation while recovering traditional knowledge and fostering environmental justice, social inclusion, and economic equity among rural households. In the Macambira Quilombola Community, the three social technologies examined in this study make direct contributions both to the paradigm of living with the Semi-Arid and to enhancing women's agency. Specifically, the bioágua greywater reuse system, the biodigester, and the water-efficient raised garden beds “contribute to enhancing the sustainability of family farming systems by providing producers with access to healthy food, thereby increasing the value of products marketed by farming households” (Henig, Santos, & Mendes, 2019), while simultaneously advancing broader dimensions associated with sustainable living in the Semi-Arid.

The bioágua system (Figure 2) is a greywater reuse technology that operates through successive treatment stages, including grease separation, solid waste removal, filtration, storage, and subsequent reuse for irrigation (Torres et al., 2020). Beyond reducing household costs and eliminating potential disease vectors, this technology contributes to water conservation and reinforces the appreciation of local knowledge and cultural practices (Santos et al., 2016; Almeida, 2024).



Figure 02 – Bioágua greywater reuse system installed by the Diocesan Caritas of Caicó in the Macambira Quilombola Community



Source: Authors' archive (2025).

Within the context of the Macambira community, greywater reuse through the Bioágua system plays a central role in women's everyday agricultural practices, as the irrigation infrastructure supplies water for forage grasses, forage cactus (*Opuntia spp.*), and fruit trees. Empirical evidence reveals the existence of a cyclical agroecological system in which forage crops are used to feed cattle, whose manure is subsequently returned to household gardens as organic fertilizer. These findings demonstrate that the technology extends well beyond its primary function of wastewater reuse and becomes integrated into a broader agroecological production system. Women's narratives further illustrate the multiple benefits associated with the bioágua system:

"The *Bioágua* system has improved things tremendously. Before, the wastewater remained exposed, attracting mosquitoes. At night there were many frogs and bees around it. Now, after installing the *Bioágua* system, all the water is properly stored. It passes through the grease trap and two additional tanks before reaching the irrigation system. And now we can irrigate forage cactus, grass, and many other plants." (*Statement by a participant in the conversation circle with the Flowers of Macambira Women's Group, 2025.*)



"We feed the forage cactus to the cattle, the cattle produce manure, and that manure goes back to the garden to fertilize the plants."
(Interview with a member of the Flowers of Macambira Women's Group, 2025.)

The women's narratives demonstrate not only the technical effectiveness of the *bioágua* system but also its sanitary benefits, particularly through the elimination of mosquito breeding sites, and its productive function by supporting crop irrigation. These findings are consistent with Silva's (2006) argument that social technologies contribute to expanding human capabilities and improving living conditions. The results further indicate that the use of the *bioágua* system in women's productive backyards is closely associated with the core principles of living with the Semi-Arid, including community participation, the appreciation of local resources and cultural practices, and contributions to soil conservation and greywater reuse (Santos et al., 2016, p. 111).

Silva et al. (2024) argue that social technologies such as the *Bioágua* system are continuously adapted and readapted to meet the specific needs of local communities, thereby generating positive economic and social outcomes for participating households. Likewise, Nascimento (2022) identifies the biodigester as another social technology particularly well suited to the environmental and productive conditions of the Semi-Arid. Considering the longstanding tradition of livestock husbandry among peasant families in the Macambira Quilombola Community, biodigesters contribute to improving the management of animal waste while simultaneously reducing household expenditures.

The *sertanejo* biodigester (Figure 03) converts animal manure into biogas (methane gas) and biofertilizer (Silva & Correia, 2020). Biogas replaces conventional liquefied petroleum gas (LPG) used for cooking, generating substantial savings for households, while the biofertilizer is applied to agricultural production, strengthening food security and reducing dependence on external agricultural inputs (Nascimento, 2022). In the Macambira community, women are primarily responsible for managing this technology, since food preparation and biodigester operation are traditionally considered women's responsibilities. An additional environmental benefit is the reduction of deforestation in the Caatinga biome through decreased reliance on firewood for cooking (Silva & Correia, 2020; Nascimento, 2022).



Figure 03 – Biodigester Installed by the Diocesan Caritas of Caicó in the Macambira Quilombola Community



Source: Authors' archive (2024).

Women operating biodigesters in the Macambira community emphasized the significant benefits provided by this social technology, highlighting improvements in their families' quality of life across economic, social, and productive dimensions. Participants reported that the biofertilizer is applied to all backyard crops, including fruit trees, medicinal plants, and vegetables. In this regard, the use of biofertilizer increases household autonomy by reducing dependence on external agricultural inputs, thereby contributing to "greater agroecosystem resilience and sustainable rural development" (Nascimento, 2022, p. 12).

Furthermore, the adoption of biogas has generated substantial financial savings for beneficiary households by eliminating the need to purchase conventional cooking gas cylinders. These savings have enabled families to allocate financial resources to other household needs. This finding is consistent with Silva's (2006) interpretation of the economic sustainability of social technologies, which emphasizes their low implementation costs, replicability, and capacity to improve living conditions. For low-income households, replacing conventional LPG cylinders with biogas effectively increases disposable household income, allowing resources to be redirected toward other essential expenses. One participant described these benefits as follows:

"I am already using biogas. It has made a huge difference because I no longer need to buy gas cylinders—I simply use the gas produced by the biodigester. It has improved my life considerably... The biofertilizer is also



applied to our crops." (*Interview with a member of the Renewed Women Group, 2025.*)

"It's really good because I no longer need to buy LPG cylinders. Last week, we baked five cakes using only the biogas produced by the biodigester." (*Interview with a member of the Renewed Women Group, 2025.*)

From a gender perspective, the use of biodigesters raises important issues within the Macambira community, as rural women play a central role in transforming their agroecosystems, as emphasized by Nascimento (2022). In Macambira, women are responsible for preparing meals and managing the use of biogas, in addition to applying the biofertilizer to agricultural crops. Although this technology has generated substantial benefits for household livelihoods, it also creates new work demands for women, requiring a reorganization of domestic responsibilities and a more equitable division of labor within the family production unit.

Henig, Santos, and Mendes (2019) argue that small-scale farming is fundamentally oriented toward ensuring household subsistence while facilitating the exchange and commercialization of products cultivated by peasant families within their own communities. In this context, agroecology has gained increasing prominence because it enables farmers to produce healthy food through the adoption of social technologies such as water-efficient raised garden beds (*canteiros econômicos*) (Henig, Santos, & Mendes, 2019). Oliveira Filho et al. (2018) describe this innovation as a low-cost technology designed to cultivate vegetables while minimizing water consumption.

Water-efficient raised garden beds are low-cost structures that enable vegetable production using reduced volumes of water through subsurface irrigation delivered by perforated pipes (Rapozo, 2018; Carmo, 2018; Oliveira Filho et al., 2018). In the Macambira Quilombola Community, these structures are built with bricks and cement, without the use of plastic liners, thereby adapting the technology to local environmental and socioeconomic conditions. These raised beds promote crop diversification, improve household nutrition, and generate additional income (Rapozo, 2018). Women market surplus production at local fairs and within the community itself, thereby strengthening their financial autonomy and contributing to food security. Agroecological production in these systems also reinforces values such as solidarity, cultural identity, and collective action, aligning with the principles of the solidarity economy (Rapozo, 2018; Silva et al., 2024). Figure 4 illustrates the water-efficient raised garden beds managed by the women's groups in the Macambira Quilombola Community.



Figure 04 – Water-Efficient Raised Garden Beds Installed by the Diocesan Caritas of Caicó in the Macambira Quilombola Community



Source: Authors' archive (2024).

The women's narratives presented below highlight not only the productive function of this social technology but also its contributions to environmental stewardship and food provisioning. The interview excerpts identify three major benefits associated with the raised garden beds: diversification of agricultural production, improvements in household nutrition, and the reconfiguration of gender relations. Income generated through the sale of agricultural products has enabled women to achieve greater financial autonomy, thereby enhancing their decision-making capacity within the household and the community. One participant explained these broader community benefits as follows:

"It improves the community as a whole. When you have a productive garden bed at home, not only do you consume what you grow, but other people do as well. It also contributes to people's health because the food is healthy." (*Interview with a member of the Flowers of Macambira Women's Group, 2025.*)

"I think it's important because we can grow coriander without pesticides. The coriander we buy is full of chemicals and contamination. We also sell what we produce, and that income helps us pay the water bill or buy food when something is missing at home."



(Interview with a member of the Flowers of Macambira Women's Group, 2025.)

"Before, it was very difficult for us to buy coriander, green onions, lettuce, and other vegetables. We had to travel to the city to purchase them. Now we have these foods right next to our homes, and they are healthy."

(Interview with a member of the Flowers of the Countryside Women's Group, 2025.)

"We sell the vegetables, and the money we earn allows us to buy other food for our families. It supplements our household income so that we don't have to depend solely on our husbands." *(Interview with a member of the Flowers of the Countryside Women's Group, 2025.)*

The management of water-efficient raised garden beds by women reinforces key principles of the living with the Semi-Arid paradigm, particularly by strengthening community food security. From a gender perspective, the statement that women "do not have to depend solely on their husbands" reflects a shift away from financial dependence on male household members. Income generated through the sale of agricultural products enables women to exercise greater control over financial resources and household expenditures. This finding supports what Silva (2006) and Rapozo (2017) describe as relative autonomy—a form of empowerment that, although still constrained by broader structural inequalities, represents a meaningful advance in gender relations within rural contexts.

Regarding the commercialization of agricultural production, women's agency could be strengthened even further were it not for the structural barriers faced by peasant women participating in these groups. While selling produce within the community contributes to the local economy, the absence of stable consumer markets and the limited integration of these women into public procurement and commercialization policies for family farming products constrain the productive potential of the raised garden beds.

Despite these limitations, water-efficient raised garden beds have generated significant improvements in reinforcing both the solidarity economy and women's collective organization. Collective food production has created spaces for social interaction, mutual learning, and the exchange of experiences among women, reinforcing community ties and collective self-esteem. Furthermore, marketing produce within the community promotes healthier diets while reducing dependence on industrialized foods and products cultivated with synthetic pesticides, thereby contributing to greater food sovereignty (Cruz et al., 2026).

Finally, the provision of technical assistance and the implementation of projects by the Diocesan Caritas of Caicó aimed at promoting living with the Semi-Arid have fostered significant transformations in the social position of women within the Macambira Quilombola



Community. One of the clearest examples is the establishment of a solidarity economy network organized through the women's groups. In addition, both the biodigester and the *bioágua* greywater reuse system have become integral to women's daily lives by supplying reclaimed water for crop irrigation while producing biofertilizer that enhances plant growth, thereby promoting the productivity of women's agroecological home gardens.

4 CONCLUSIONS

This study examined the contributions of women from the Macambira Quilombola Community to the management of social technologies aimed at strengthening living with the Semi-Arid. The empirical findings demonstrate that women's management of the *bioágua* greywater reuse system, the biodigester, and the water-efficient raised garden beds contributes not only to the productive dimensions of this paradigm but also to redefining women's roles within both household and community dynamics. Overall, the findings indicate that these social technologies have generated significant improvements across multiple dimensions of the living with the Semi-Arid paradigm.

The *bioágua* system functions as a cyclical technology integrated into women's agroecological home gardens, strengthening practices consistent with agroecological principles. The biodigester has generated substantial economic benefits by replacing conventional liquefied petroleum gas while simultaneously producing biofertilizer that supplies essential agricultural inputs and reinforces the resilience of local agroecosystems. Likewise, the water-efficient raised garden beds promote crop diversification, strengthen food security, and enhance women's relative financial autonomy through the commercialization of surplus vegetable production.

With respect to women's agency, the study demonstrates that women in the Macambira Quilombola Community play a central role in managing social technologies designed for living with the Semi-Arid. Their responsibilities encompass maintaining these technologies, applying biofertilizers, operating the biodigester and using the biogas produced, as well as managing cultivation in the raised garden beds. However, the management of these technologies does not necessarily translate into full autonomy for women. The unequal distribution of social technologies, continued dependence on technical assistance provided by the Diocesan Caritas of Caicó, and the additional workload imposed on women reveal the structural limitations affecting the agency of quilombola peasant women. Consequently, the implementation of social technologies should be accompanied



by broader transformations in community social relations, particularly through a more equitable redistribution of domestic and productive labor within rural households.

Finally, this study demonstrates that social technologies should be examined through an intersectional analytical perspective that considers the power relations and structural inequalities shaping the experiences of beneficiary communities. Despite the limitations identified, the social technologies implemented in the Macambira Quilombola Community—and particularly their management by women—constitute an important means of advancing the living with the Semi-Arid paradigm, as they simultaneously contribute to its environmental, social, economic, and territorial dimensions.

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