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Diverse food in urban gardens in the promotion of food and nutrition security in Brazil: a review

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Abstract

Food and nutrition security can be supported by an urban garden. The present study comprises a critical reflection on the difficulty of producing food in urban gardens in Brazil and shows the potential of food production and the obstacles to its expansion. In addition, issues related to the agroecological management of gardens are addressed and suggestions are made to improve the proposed public policies. Urban gardens are multifunctional and have social, economic and environmental impacts. They are strategically important for supporting low-income families and urban development. Through urban gardens, diverse foods and quality foods can be produced for self-consumption. This review highlights the importance of generating detailed information on urban gardens in Brazil to support policies aimed at this sector. Long-term and multidisciplinary studies are needed to evaluate the relationship between food production in urban gardens and household food and nutrition security. This approach revealed a lack of information on the amount of food produced by Brazilians in their gardens and consumed by the household. In addition, there is little information on the management of production. There is a gap relating to the impact of food produced in urban gardens and the prevalence of food and nutrition security.

Keywords: urban development; agroecology; urban agriculture; alternative practices

INTRODUCTION

Urban agriculture is widely defined as the cultivation of food in an urban environment, that is, areas within or near cities, including urban farms, school gardens and community associations.[1,2] Public schools and other areas available within the urban perimeter are used for urban agriculture with the help of public policies.[3] Urban agriculture aims to meet local and/or regional consumption and is practised on public and/or private properties, especially community gardens.[4] Here, manual labor has traditionally been provided by cooperative members and private contractors. In urban agriculture, a range of technologies are used, including aquaponics (the combination of fish and vegetable production) and hydroponics (the cultivation of vegetables in nutrient solution),[5] which contain commercial and entrepreneur characteristics.

Although urban gardens fall under the category of 'urban agriculture', they have contrasting characteristics. Manual labor is provided by the family, mainly by the elderly, women and children. The capital investment and area of cultivation are smaller because food production is mainly for self-consumption or subsistence, mineral fertilizers and/or pesticides are rarely used, and there are no public policies. Domestic urban gardens are regarded as private agroecosystems aimed at meeting family demands and include the rearing of plants and small domestic animals on the land surrounding a house.[6,7] Urban gardens represent those activities of agrarian societies that were re-created on a smaller scale, when transferred to the urban environment, by retaining certain cultural traits and agricultural production practices.[8,9]

Depending on the type of community, gardens need to be understood as territorial units with different boundaries, each with characteristics defined by socioeconomic conditions, religion, beliefs and customs that influence both the composition and diversity of species native to each area.[7,10] The garden is a prominent element throughout the history of urban agglomeration, and is characteristic of the Brazilian residential environment, in both physical and symbolic terms. Many species occur in urban gardens, where man interacts with nature to fulfill his specific economic, social and cultural needs.[7]

Global food and nutrition security have been affected by obesity, food shortages and nutrient deficiencies that impact approximately one-third of the world's population.[11,12] Urban gardens have a high potential for agroecological food production, aiming particularly at improving food and nutrition security.[13,14] Thus, they are widely used by economically vulnerable families to produce food for self-consumption.[15] The agroecological perspective of urban gardens is multifunctional: generating social welfare, encouraging healthy eating, and providing food and environmental education to families.[4] Urban gardens also

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provide other benefits to their environments: they contribute to sustainability by using the organic waste produced by domestic environments and they reduce food expenses. Additionally, the cultivation of food in urban gardens may reduce food and nutrition insecurity in relation to three important aspects: food sovereignty, accessibility and quality.[16] Despite this, 23.3% of the urban families in Brazil are still suffering from food and nutrition insecurity.[17]

Even with the benefits of growing food in urban gardens, consumers must be aware of the various contamination risks to these foods and the subsequent harmful health effects. In general, risks can occur via soil or leaves contaminated by polluted air and water, via the application of organic fertilizers used for plant nutrition, or via the use of pathogen control products.[18,19] Thus, proper cultivation techniques are required to ensure that food remains free from contamination.

Although agricultural strategies have been extended to domestic urban gardens, especially in the suburbs of large and medium-sized cities, further extension is needed.[20] Despite Brazil being one of the largest food producers in the world, a significant proportion of the population cannot fully access the food produced, especially good quality, contaminant-free and nutritious food.[14] Therefore, food security policies and programs for urban areas could contribute to income generation, better food quality, healthier eating habits and an improved access to food for combating nutritional deficiencies.[21]

This review aims to assess food diversification in Brazilian urban gardens from an agroecological perspective. The importance of urban gardens in the promotion of food and nutrition security among economically vulnerable families is also discussed.

URBAN GARDENS IN BRAZIL

More than 54% of the world's population resides in urban areas and this is expected to rise to 66% by 2050.[22] During this process of urbanization, it is necessary to implement and encourage urban agriculture as an auxiliary practice for promoting the food and nutrition security of families.

Urban and peri-urban agricultural initiatives have been identified and characterized in the metropolitan areas of Brazil that are supported by local communities, universities, the private sector and three government levels (federal, state and municipal).[23] Several urban and rural social movements that support and help develop urban agricultural practices have also been identified.[20] These surveys show that urban and peri-urban food production occurs in all regions of Brazil, identifying over 600 initiatives for both self-consumption and commercial purposes. Although few studies have documented the production of food in urban gardens, this can be widely extended and consolidated as a permanent and multifunctional way of improving local food and nutrition security.[23]

Maintaining urban gardens also facilitates social practices that have immense value, such as the pleasure gained from growing a garden, creating areas for leisure and well-being, and the improved ambience and landscape provided by trees. Research into these urban landscape units may support the development of public policies for better food security, public health, conservation of genetic resources and income generation.[4,24] The benefits that agricultural practices offer to urban development suggest that urban gardens should be appreciated and incorporated into food and nutrition security policies, especially those on urban planning.

Several experiments with urban gardens have been documented in different regions of Brazil (Table 1). These involve the size of the garden, quantity and variety of plant species, percentage of food produced, whether or not the plants are fructiferous, the level of greenery, and the medicinal and ornamental use varies across the country.

The variety, cultivation methods and use of plants grown is related to their owner's needs and interests, household architecture, and the amount of land available.[9] Urban ethnobotanical studies also highlight how the householder's age influences garden management and agrobiodiversity. The relationship between the age of the resident and the diversity of the plant species in their urban garden has been reported.[24]

Various studies reveal the relationship between the respondents and the agricultural practices they use; a significant number of families practicing urban gardening come from rural environments.[37] A study in Mirassol D'Oeste (Mato Grosso state) in the central west region of Brazil in 2004 showed that 82.75% of people had previously lived in rural areas for half of their lives, whereas 73% had been involved in agricultural activity at some stage.[9] In the study by Medeiros[38] in the southeast region, 79.2% of people reported that they have a relationship with the rural environment. This characteristic was found in other studies as well.[35,42]

Despite many urban farming initiatives in several regions of Brazil, there is little information available about food plants in urban gardens, cultivation methods, amounts produced and consumed, and the impact on food and nutrition security. However, studies on the impact of food produced in urban gardens on food and nutrition security have been conducted.[38,42] In a study by Covarrubias,[42] approximately 85% of the people interviewed reported that food production in their gardens was exclusively for their own private consumption. However, 81.1% said they also frequently bought fruit and vegetables. This result shows that food production in urban gardens complements family alimentation. In the study by Medeiros, it was found that 63% of the edible food plants produced in urban gardens were for private consumption.[38]

A study conducted in the city of Rio Claro (São Paulo state)[48] involved a survey on plants grown in gardens, accompanied by a nutritional survey (24-h recall).[37] It was observed that 38% of the 98 food species found in urban gardens appeared in the diet of the respondents, highlighting the importance of linking food production in urban gardens to eating habits.

Over the last decade, urban agriculture has become part of public policies aimed at reducing poverty and promoting food security.[3] However, there are several obstacles to successfully produce food in urban gardens: the lack of technical assistance, capital and space available to residents.[49] To overcome such limitations, public policies and social organizations are essential because they can provide subsidies to improve garden management and allow residents to afford the technologies needed for producing food in urban gardens. Urban gardens differ in many aspects, such as available area, cultivation system, plant types and the amount of food produced. The families who create urban gardens differ in their garden management abilities,[50] education, family structure and size, and time available for gardening.

An example of the attempts made to improve food production in Brazil's urban gardens can be found in a study by Fecondini *et al.*[51] Their study evaluated the outcome after 3 years of training women in simplified hydroponics, plant nutrition, technical and economic management for vegetable production, and human nutrition.

The review by Warren *et al.*[52] is considered to comprise the most complete study on the relationship between food security and urban agriculture. Their review reports on three

Table 1. Studies in urban gardens that produce food, in different regions of Brazil

			Analyzed variables								
			number				%			m^2	
Region	County (State)	Reference	Garden	Plant	Specie	Classification	Use	*F*	*V*[1]	Area[2]	Mean[3]
North	Boa Vista (RR)	25	61	4197	424	Food	18.5	11.0	7.5	NA	666
						Medicinal	12.0				
						Ornamental	47.0				
						Mixed use	NA				
						Others	22.5				
	Abaetetuba (PA)	26	54	1361	132	Food	74.0	32.6	41.4	NA	NA
						Medicinal	34.0				
						Ornamental	26.0				
						Mixed use	6.0				
						Others	NA				
	Abaetetuba (PA)	27	40	393	84	Food	47.6	36.6	11.0	NA	NA
						Medicinal	37.0				
						Ornamental	13.1				
						Mixed use	20.0				
						Others	5.9				
	Santarém (PA)	28	25	225	176	Food	46.6	29.0	17.6	NA	NA
						Medicinal	25.6				
						Ornamental	22.7				
						Mixed use	NA				
						Others	5.1				
	Rio Branco (AC)	29	134	NA	288	Food	29.3	15.5	13.8	84.25–398	217
						Medicinal	26.0				
						Ornamental	43.2				
						Mixed use	35.0				
						Others	1.5				
	São Luis (MA)	30	40	NA	186	Food	78.5	35.0	43.5	NA	NA
						Medicinal	7.5				
						Ornamental	NA				
						Mixed use	7.6				
						Others	6.4				
	Lagarto e Aracaju (SE)	31	250	NA	NA	Food	49.5	NA	NA	NA	NA
						Medicinal	27.5				
						Ornamental	23.0				
						Mixed use	NA				
						Others	NA				
Northeast	Jaboatão dos Guararapes (PE)	32	14	220	NA	Food	23.0	NA	NA	9.24–420	NA
						Medicinal	24.0				
						Ornamental	58.0				
						Mixed use	5.0				
						Others	NA				
	Caxias (MA)	33	22	NA	66	Food	71.2	44	27.2	NA	NA
						Medicinal	25.7				
						Ornamental	12.1				
						Mixed use	15.1				
						Others	6.0				

Table 1. Continued

Region	County (State)	Reference	Analyzed variables: number			Classification	%			m²	
			Garden	Plant	Specie		Use	*F*	*V*[1]	Area[2]	Mean[3]
	Cáceres e Cuiabá (MT)	31	250	NA	NA	Food	51.5	NA	NA	NA	NA
						Medicinal	34.0				
						Ornamental	14.5				
						Mixed use	NA				
						Others	NA				
West central	Mirassol D'Oeste (MT)	9	29	397	240	Food	35.0	18.0	17.0	30–575	NA
						Medicinal	29.0				
						Ornamental	35.0				
						Mixed use	19.2				
						Others	1.0				
	Cáceres (MT)	34	7	125	51	Food	82.0	82.0	NA	280-5034	1891
						Medicinal	39.0				
						Ornamental	11.7				
						Mixed use	53.0				
						Others	NA				
	Rosário Oeste (MT)	10	63	NA	266	Food	36.5	17.0	19.5	NA	NA
						Medicinal	38.7				
						Ornamental	29.7				
						Mixed use	11.0				
						Others	5.0				
West central	Rosário Oeste (MT)	35	63	458	94	Food	100	47.0	53.0	NA	622
						Medicinal	27.0				
						Ornamental	NA				
						Mixed use	27.0				
						Others	NA				
	Araguapaz (GO)	36	30	691	262	Food	27.8	15.6	12.2	150-3540	NA
						Medicinal	14.9				
						Ornamental	59.5				
						Mixed use	2.6				
						Others	0.7				
	Rio Claro (SP)	17	17	738	410	Food	24.0	14.0	10.0	428–2000	70
						Medicinal	23.0				
						Ornamental	63.0				
						Mixed use	12.0				
						Others	4.0				
	Viçosa (MG)	38	120	1606	117	Food	89.74	30.0	59.7	5.45-650	84.7
						Medicinal	26.5				
						Ornamental	NA				
						Mixed use	57.2				
						Others	10.2				
	São Paulo (SP)	39	76	NA	NA	Food	25.0	NA	NA	NA	NA
						Medicinal	19.0				
						Ornamental	56.0				
						Mixed use	NA				
						Others	NA				
Southeastern	São Paulo (SP)	40	23	458	71	Food	55.0	31.0	24.0	NA	NA
						Medicinal	38.0				
						Ornamental	38.0				
						Mixed use	39.4				
						Others	4.2				

Table 1. Continued

Region	County (State)	Reference	Analyzed variables: number Garden	Plant	Specie	Classification	% Use	F	V[1]	m² Area[2]	Mean[3]
	São Paulo (SP)	41	84	NA	121	Food	30.0	NA	NA	NA	NA
						Medicinal	17.5				
						Ornamental	52.5				
						Mixed use	NA				
						Others	NA				
	Porto Ferreira (SP)	42	74	1000	116	Food	72.0	38.0	34.0	43-590	214
						Medicinal	25.0				
						Ornamental	NA				
						Mixed use	NA				
						Others	3.0				
	Rio de Janeiro (RJ)	43	10	222	142	Food	43.0	17.0	26.0	50-200	NA
						Medicinal	17.6				
						Ornamental	61.2				
						Mixed use	16.2				
						Others	NA				
	Irati (PR)	44	20	943	258	Food	36.0	20.0	16.0	75–1300	276
						Medicinal	23.0				
						Ornamental	39.0				
						Mixed use	NA				
						Others	2.0				
	Chapecó (SC)	45	20	NA	372	Food	35.0	NA	NA	NA	700
						Medicinal	18.0				
						Ornamental	47.0				
						Mixed use	NA				
						Others	NA				
South	Curitiba Campo Mourão (PR)	31	250	NA	NA	Food	42.5	NA	NA	NA	NA
						Medicinal	18.5				
						Ornamental	39.0				
						Mixed use	NA				
						Others	NA				
	Maringá (PR)	46	299	NA	506	Food	42.8	23.6	19.1	NA	159
						Medicinal	15.8				
						Ornamental	38.2				
						Mixed use	NA				
						Others	3.3				
	Curitiba (PR)	47	149	NA	339	Food	31.8	11.8	20.0	NA	111
						Medicinal	15.9				
						Ornamental	59.3				
						Mixed use	12.1				
						Others	NA				

F, fruits; V, vegetables. [1]Includes condiments, flavor foods, roots, tubers, and cereals. [2]Area of garden. [3]Gardens mean area. NA, not analyzed. Urban gardens: $n = 2220$; Plants: $n = 13\,034$.

aspects of this relationship: negative, positive and non-existent. Considering all the variables associated with food production, it is necessary to develop further methods with which to evaluate urban gardens.

In general, most plants grown in urban gardens are food plants, ranging from 36% in the south to 75% in the northeast. South was the only region where food plants constituted less than 50% of the plants grown in urban gardens (Fig. 1). Among food plants, fruit plants are more prevalent than vegetable plants in the north and northeast, whereas, in the west-central and southeast, vegetable plants are the most prevalent. The values were similar in the southern region. This result shows the contribution of food plants from urban gardens to the diet of families. The number of plants per garden may be indicative of the potential for

food production. This number ranged from 13 to 47, considering the overall average by region, with the midwest and southern regions having the lowest and highest number of plants, respectively.

AGROECOLOGICAL MANAGEMENT IN URBAN GARDENS

One of the characteristics of urban gardens that has been explored is the diversity of plants. Plants grown for food use include vegetables, condiments, roots, tubers, cereals and fruits. Plants with other uses, such as medicinal, ornamental, herbal and shade, are also grown (Table 1). Such plant diversity over time and within a specific area promotes nutrient cycling in the soil, biological balance between pathogens and 'natural enemies', as well as improved pollination.[53,54] Therefore, urban gardens use several agroecological practices, which may contribute to their maintenance and development. Agroecology is an alternative management practice aimed at balancing the agroecosystem through ecological interactions and synergism between biological components.[55,56]

Despite the various studies mentioned in this review, very few have examined the management methods adopted in the gardens. Management methods comprise soil preparation, planting time, pest control, fertilization, crop rotation, mulching, spacing, lighting and irrigation, etc. In addition, organic household waste, including garden waste and tree pruning, is often composted to produce quality soil fertilizer. There are also techniques used to grow plants both horizontally and vertically, either in the soil or in containers (pots). The variety of vegetables, legumes, fruits, aromatic herbs, and medicinal and ornamentals plants is extensive, and the species are chosen according to the preference of each family, although the ease of their cultivation and the space available are also considered. Spacing between plants must be ensured and the planting season based on the crop calendar has to be followed because temperature, light and rainfall are key to good yields. Plants that grow faster and require less intensive management are preferred, especially if space is limited.

In the study by Gomes,[44] 100% of the gardens studied used organic fertilization created from domestic residue, vegetal residue and manure. The use of composting was reported by 15% of the people interviewed, and one garden used earthworms to process the domestic residue. It was reported that mineral fertilizers was used in 45% of the gardens, in addition to organic fertilizers, for cultivations with a bigger nutritional demand. Manure was used in 77% of the gardens; 32.4% used domestic residues, 32.4% used chemical fertilization and 16.2% did not fertilize the soil.[42] A similar result was obtained by Medeiros,[38] with 81.6% of respondents using organic fertilization in their gardens.

In the study by Gomes,[44] the use of pesticides was not reported and 10% of the people interviewed reported conducting pathogen control by hand picking. Their justification for this was to produce food free of contaminants. Approximately 70% of the people interviewed, reported not having problems with pests.[42] Of the gardens studied, 16% performed pests control with manual collection and 2.7% used alternative pests control products prepared with herbs and biological materials, whereas 10.8% confirmed the use of pesticides. A similar result was obtained by Medeiros.[38] However, 24.2% of the gardens in this study used an insecticide. Pest control can be achieved with alternative insecticides and fungicides using natural extracts, such as the neem plant (*Azadirachta indica* Juss).[57,58] In addition, crop rotation over time is essential to interrupt the cycle of pests and diseases.[55]

Food productivity in gardens and the variety of foods produced are variables that must be accounted for in studies because they directly influence the food and nutrition security of families. Estimates suggest that gardens can produce food up to 50 kg m^2 per year, depending on the types of crops grown and the technologies adopted.[59]

FOOD AND NUTRITION SECURITY

Here, we highlight the concepts and process of building food and nutrition security in Brazil, aiming to better understand the contribution of urban gardens to Brazil's food and nutrition security. The importance of the construction of food and nutrition security is increasing in political relevance across multiple national contexts.

At an international level, Brazil is one of the most advanced countries in consolidating legal and social recognition aimed at the implementation of policies, programs and actions ensuring the universal right to food and nutrition security.[16]

> 'Food and nutrition security refers to the common law of regular and permanent access to food of sufficient quality and quantity without compromising other essential needs, based on health-promoting food practices that respect cultural diversity and are socially, economically, and environmentally sustainable'[21,60]

> 'The wider food and nutrition security approach expresses the food (production, commercialization, and consumption) and nutritional dimensions (the use of food by the body and its relationship with health) from an integrated perspective, which encompasses the way food is produced, commercialized, and consumed, in addition to its impact on political, economic, social, environmental, cultural, health, and living conditions'[61]

Food and nutrition insecurity is highly prevalent among Brazilians: in 2013, approximately 14.7 million private households (22.6%), or approximately 52 million people, were living with some degree of food and nutrition insecurity.[17] Despite this, it is worth noting the advances made to include food and nutrition security within Brazilian public policies: the right to food was incorporated into Article 6 of the Federal Constitution and the Brazilian National Law No. 11.346 on September 15, 2006, whereas the Organic Law of Food and Nutrition Security created the National System of Food and Nutrition Security to ensure the human right to adequate food.[21]

Positive results in reducing food and nutrition insecurity have been achieved in Brazil through such public policies, with indicators showing a reduction in hunger and malnutrition since 2003, when the 'Zero Hunger' (*fome zero*) program was implemented and became a government priority.[3] Indeed, according to the 2014 Food and Agriculture Organization of the United Nations (FAO) report *The State of Food Insecurity in the World*, Brazil was removed from the World Hunger Map. The report showed that, from 2002 to 2013, malnutrition among the Brazilian population declined by 82% to a level below 5% in the *Indicator of Prevalence of Subfeeding*, which is a FAO scale used to size and monitor hunger at the international level; this indicated that, according to the FAO, Brazil had overcome the problem of hunger.[62]

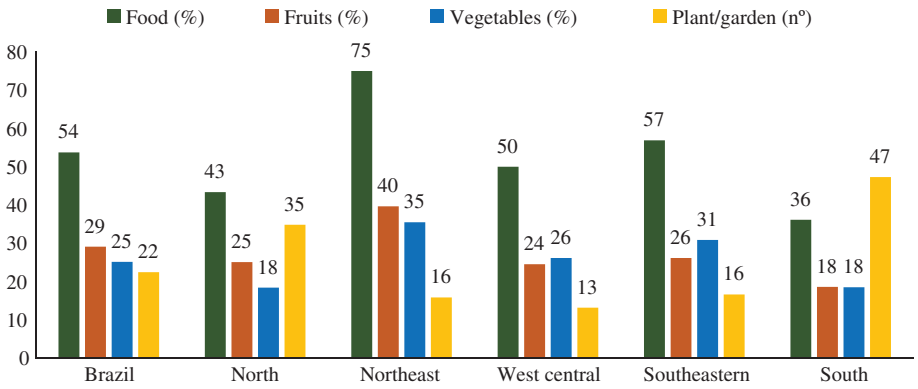

Figure 1. Percentage of food plants and number of plants per urban garden in different regions of Brazil.

To better understand food and nutrition security, the concept is best analyzed in four dimensions: (i) food availability; (ii) access (physical and economic) to food; (iii) use of nutrients; and (iv) stability of the availability, access to and use of food. However, the very first step to achieving food and nutrition security is ensuring the production of food.[63]

Several studies suggest that urban gardens may contribute to food and nutrition security by producing greater varieties of food for household consumption.[2,14] However, studies have shown that food insecurity in families that produce food for private consumption in the urban environment is still significant. A study showed that, in a sample of 6,222 families in 11 cities who cultivate food for their subsistence in urban environments, 77% reported food insecurity.[64]

In a study conducted with 6,453 households in 11 cities in the south of Africa, no significant correlations between urban agriculture and food security were found.[65] It was highlighted the need for further research to better understand the relationships between urban agriculture and food security. In Brazil, Medeiros[38] reported similar results. Simple associations between dependent variables might not capture the multiplicity that involves the food and nutrition security of families.[66] It was suggested that incorporating geospatial information involving the historical context creates a better association between urban gardens and food security.

Urban gardens help to reduce food expenses, improve and diversify diet and eating habits, recover native crops with a high nutritional value, and increase the availability of food that is fresh, rich in micronutrients, as well as available at competitive prices in local markets.[23]

The National Policy for Food and Nutrition Security, established by Presidential Decree 7272/2010, provides guidelines for the preparation of the National System for Food and Nutrition Security.[60] Among these, Guideline II is of particular relevance because it concerns the promotion of sustainable, decentralized, agroecologically-based systems for the production, extraction, processing and distribution of food. Guideline II aims to:

> 'Foster food supply as a way to consolidate the organization of local and regional circuits of production, supply, and consumption to guarantee the regular and permanent access of the Brazilian population to food, in sufficient quantity, quality, and diversity, based on eating practices promoting health and respecting cultural and environmental aspects'[21]

The third National Food Security Conference, held in July 2007, saw advances in the discussion of urban agriculture as a guideline in the implementation of the National Urban Agriculture Policy.[3] However, the production of food specifically in urban gardens has not yet been recognized.

CONCLUSIONS

Urban gardens should be included in urban planning and development policies, at the same time as ensuring that local knowledge and intrinsic cultural aspects are appreciated. Given the potential of domestic urban gardens to produce a sufficient quantity, variety and quality of food, families should be assured of receiving technical assistance and instruction in managing these gardens. Public policies for this sector are strategically important in urban development because these gardens influence social, economic and environmental aspects.

The use of urban gardens as productive spaces may also function as a supplementary strategy for promoting family food and nutrition security, particularly among low-income families. However, interdepartmental discussions are needed at different levels of government as well as with research institutions, organized civil and agricultural societies, and farmers, to consolidate and implement agricultural production practices in urban areas, especially regarding public policies, food and nutrition security actions, and housing and urban planning.

This review article demonstrates the importance of generating detailed information on urban gardens in Brazil to support policies aimed at this sector. Multidisciplinary and long-term studies are necessary because simple associations between dependent variables might not capture the various aspects involved in the food and nutrition security of families.

This examination has revealed a lack of information on the amount of food produced in Brazilian gardens and consumed by households. In addition, there is little information on the management directly impacting production. This creates a gap related to the impact of food production in urban gardens and the prevalence of food and nutrition security. Based on the amount of food produced in urban gardens and the yards generally being smaller spaces, it is possible to implement strategies to improve management practices and increase production efficiency.

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AUTHOR CONTRIBUTIONS

SEP and RHSS conceived and designed the study. NSAM conducted the study and provided conceptual and analytical advice. NSAM and DLC wrote most of the paper. SEP and RHSS contributed to the discussion.

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