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Gardens' contribution to people and cities: How urban allotments improve livelihoods and lives in the Bogota city, Colombia

DISSERTATION THESIS

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Declaration

I hereby declare that I have completed this thesis entitled "Gardens' contribution to people and cities: How urban allotments improve livelihoods and lives in the Bogota city, Colombia" independently, all texts in this thesis are original, and that all information sources have been quoted and acknowledged by means of complete references. I also confirm that this work has not been previously submitted, nor is it currently submitted, for any other degree, to this or any other university.

In Prague, February 10th, 2026

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M.Sc. Laura Natalia Rojas Pardo

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Abstract

Urban homegardens are increasingly recognised as multifunctional spaces that enhance food security, help in biodiversity conservation, and promote social well-being, yet their composition, uses and perceived benefits remain poorly documented in many Latin American cities. This study aimed to evaluate the role of homegardens in supporting the livelihoods of gardeners in Bogotá, Colombia. Using a mixed methods approach, 119 semi-structured interviews were conducted between February and June 2021, together with a plant inventory exercise (walk-in-the-woods approach). We documented 253 useful plant species and 2,405 use reports, with food (58%), medicinal (21%) and ornamental (18%) uses predominating. Ethnobotanical indices, including Use Report (UR), Relative Frequency of Citation (RFC), and Cultural Importance (CI), highlighted *Brassica oleracea, Lactuca sativa, Apium graveolens, Beta vulgaris*, and *Ruta graveolens* as the culturally most significant species. Hierarchical cluster analysis identified three functional homegarden types: food (n=28), ornamental (n=26), and multipurpose (n=65), with household size and plant diversity emerging as significant predictors of garden type. Multinomial logistic regression identified household size and overall plant diversity as determinants of homegarden type. Multipurpose gardens were associated with larger household size, whereas ornamental gardens exhibited the highest agrobiodiversity. Motivations to engage in homegardening were multidimensional, with enjoyment (61%), food self-provision (59%), and social connection (50%) as the main drivers. Multivariate probit analysis showed that sociodemographic variables showed limited influence, suggesting that personal preference and lifestyle factors shape engagement more strongly than demographic characteristics. Perceived benefits from homegardens were predominantly non-economic, with nearly all respondents valuing relaxation, stress reduction, environmental protection, and high-quality homegrown food. Ordinal logistic regressions indicated that education, socio-economic strata, household size, and age influenced specific perceived benefits, particularly dietary contributions, reduced food costs and physical activity. Importantly, motivations and perceived benefits were linked to garden type: food gardens aligned with self-provision and dietary benefits, multipurpose gardens with both enjoyment and social connection, and some food-related advantages. Overall, Bogotá´s urban homegardens provide diverse plant resources supporting household food supply, fostering social interactions and enhancing well-being.

Key words: Cluster analysis; Socio-economic strata; Thematic content analysis; Urban agriculture, Urban homegardens.

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List of abbreviations

APG Angiosperm Phylogeny Group

CI Cultural Importance

DMg Margalef Index (species richness)

DANE Departamento Administrativo Nacional de Estadística - Department of National Statistics

FAO Food and Agriculture Organization of the United Nations

FIES Food Insecurity Experience Scale

H´ Shannon diversity index

HPUJ Herbarium of the Pontificia Universidad Javerian

J´ Pielou index (Evenness)

JBB Jardín Botánico de Bogotá José Celestino Mutis - Bogotá´s Botanical Garden

LR Likelihood Ratio

MCA Multiple Correspondence Analysis

OR Odds Ratio

POLR Proportional Odds Logistic Regression

RFC Relative Frequency of Citation

FC Frequency of Citation

UA Urban Agriculture

UHG Urban homegarden

UR Use Report

VIF Variance Inflation Factor

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1. Introduction

Rapid urbanisation is creating unprecedented challenges for food security, environmental sustainability, and social equity in cities. As urban populations grow, the demand for fresh, accessible food increases, while green spaces are often lost. In this context, urban agriculture (UA), defined as the cultivation of plants and/or rearing of livestock within urbanised areas, has emerged as a strategy to enhance urban resilience. Far from being a novel phenomenon, agriculture has historically played a central role in society, contributing to food provision, livelihoods and the resilience of communities (Diehl, 2020; Hsu, 2019; McClintock et al., 2016). By integrating food production into urban landscapes, urban agriculture can reduce dependence on external supply chains and create multifunctional green spaces that enhance both environmental and social resilience.

Among UA practices, homegardens, domestic plots cultivated primarily for household use, are the most widespread. They are multifunctional spaces with the potential to enhance food access and consumption of fresh produce (Palar et al. 2019; Knoff et al. 2022), generate income (Eichemberg & de Mello Amorozo, 2013), improve mental and physical health (Ambrose et al., 2020; Corley et al., 2021; Marques et al., 2021), and serve as reservoirs of agrobiodiversity and agricultural knowledge (Sierra-Guerrero & Amarillo-Suárez, 2017). Globally, research has highlighted their ecological, economic, and socio-cultural roles. However, much of the literature emphasises ecological contributions, particularly species diversity and structural complexity, while their broader social and cultural functions remain underexplored, especially in large urban contexts (Rajagopal et al., 2021). This gap is particularly evident in Latin America, and especially in Bogotá, where rapid urban expansion has incorporated peripheral areas marked by informality and socio-economic vulnerability (Cantor, 2010).

Within this context, this study seeks to generate a comprehensive understanding of the diversity, functions, and dynamics of urban homegardens in Bogotá. By examining these spaces not only as sources of food or agrobiodiversity but also as cultural spaces, the study intends to advance knowledge on how homegardens contribute to urban livelihoods. In doing so, it provides a foundation to better recognise their role in the city and inform current and future initiatives that aim to integrate urban agriculture into broader strategies for sustainable and resilient urban development.

To address this aim, this dissertation compiles and integrates two published peer-reviewed articles together with additional original analyses and results, to provide a more comprehensive analytical framework. The remainder of the document is organised into eight chapters. Chapter 2 presents the background and literature review. Chapter 3 presents the problem statement and aims of the study, and Chapter 4 describes the study site, research design and data collection methods. Chapters 5 and 6 present the results and discussion, respectively. Chapter 7 synthesises the main findings of the study.

2. Background

2.1 Historical perspective on Urban Agriculture

Agriculture is one of humankind´s most transformative achievements, enabling the rise of cities and complex societies. The transition from hunter-gatherer livelihoods to agricultural societies, commonly referred to as the Neolithic Revolution, allowed humans to settle as village-dwellers, cultivate crops, and rear animals for subsistence. As skills in food production, storage, and trade improved, demographic expansion fostered the concentration of people in dense settlements, giving rise to the first cities (Hamilton et al., 2014; Weisdorf, 2005).

For centuries, agriculture remained closely integrated into urban life and served as the primary source of food for city dwellers. This connection persisted until the eighteenth century, when the Industrial Revolution, beginning in Europe and later spreading globally, gradually separated cities from agriculture. Urban land increasingly prioritises industrial and commercial uses, consolidating the perception of agriculture as a predominantly rural activity. From the late twentieth century onward, however, urban agriculture re-emerged on the global agenda as a strategy to address food insecurity, environmental challenges and urban well-being (Dobele & Zvirbule, 2020).

Today, this global revival of urban agriculture must be understood within the broader context of rapid urbanisation. Around 1800, an estimated 2% of the world's population lived in cities, rising to 14% by 1900. By 2007, for the first time in history, the global urban population surpassed the rural population, and current projections estimate that nearly 70% will be urban by 2050. This demographic shift places pressure on urban food systems, particularly in developing countries where migration, poverty, and resource scarcity converge. Urban agriculture has thus gained recognition as a practice that not only supplements food, but also contributes to urban resilience, social inclusion and environmental sustainability (Orsini et al., 2013).

2.2 Urban agriculture in Latin America

UA in Latin America has deep historical and cultural roots. Pre-Columbian civilisations developed sophisticated agricultural systems that integrated food production into urban spaces, illustrating the long-standing interplay between cultivation and city life. For example, the Aztecs integrated chinampas into their cities, floating platforms built in lakes and wetlands for cultivation, while the Incas transformed their landscape with terracing in mountains and irrigation networks in the valleys and plains (Degenhart, 2016; Fontalvo Buelvas et al., 2025; Molina, 2021).

The origins of homegardens in the region, however, remained debated. Some argue that they emerged after European colonisation with the introduction of new crops and livestock, while others trace them back to pre-Hispanic traditions (Pulido et al., 2008). Following colonisation, convents, monasteries and colonial houses frequently incorporated orchards and vegetable plots into their design, in courtyards and patios, for both subsistence and medicinal purposes, while greenery in public streets or squares remained largely absent. Consequently, colonial and early republican cities maintained predominantly private urban green spaces, where agricultural practices continued to be widespread (Molina, 2021).

Historically, UA in Latin America has been framed primarily as a tool for food production and economic growth, with the main objective of addressing hunger and poverty. Today, most countries in the region lack clear legal and institutional frameworks to support urban agriculture initiatives. leaving UA largely an informal practice rather than a strategic component of urban development (Castellarini, 2022; Gray et al., 2020). A notable exception is Cuba, where UA has been elevated to national policy since 1997. The government established a technical advisory board to train producers and technicians, introduce new technologies, and support the diversification of crop varieties and animal breeds. In Havana, for instance, nearly half of the area of the province is dedicated to agriculture, and around 90,000 residents are engaged in UA, with both crop and animal production recognised as legitimate land uses (Buchman, 2009; FAO, 2014).

Across Latin America, UA comprises a wide range of activities adaptable to small spaces, from backyard vegetable gardening to intensive production of flowers and the raising of small animals for eggs and meat. School gardens and backyard family horticulture are the dominant forms of urban food production. Urban farmers come from all age groups, but the majority come from low-income households, for whom UA´s principal benefit lies in improved access to fresh food. Women in particular are recognised as the driving force behind UA in the region, particularly in Bolivia, Ecuador, Honduras, Colombia, and Nicaragua (Córdoba-Balcells et al., 2025; FAO, 2014).

2.3 Urban agriculture in Colombia with special regard to Bogotá

In more recent history, in Colombia, the expansion of UA has been closely tied to rural displacement caused by the armed conflict. Forced migration altered the demographic balance of the country, shifting it from a predominantly rural to a predominantly urban population. Large cities such as Bogotá, Medellín, and Cali absorbed displaced families, who brought with them agricultural knowledge and traditions. In urban and peri-urban environments, these families adapted cultivation practices as a means of securing food and, in some cases, generating income (Cantor, 2010; OEI & JBB, 2022a).

Bogotá's UA is supported by a formal policy framework. The first major institutional step was taken in 2015 with the creation of the Urban and Peri-Urban Agriculture Programme, which explicitly recognised family agriculture and homegardens as important components of urban food production. The programme also framed UA as a contributor to climate change adaptation, biodiversity conservation, and environmental education. It committed the city to promoting sustainable, low-cost agricultural practices adapted to urban conditions and designated the Botanical Garden (Jardín Botánico de Bogotá José Celestino Mutis, JBB) as the lead institution for technical assistance, training, and research on UA (Concejo de Bogotá, 2015). However, the program´s long-term consolidation has faced challenges. To date, it has not been normatively adopted, leaving its continuity and scope dependent on the priorities of each successive four-year administration. More recently, in 2021, the city adopted a formal protocol for managing UA in public spaces, with an emphasis on community initiatives, leaving homegardens largely outside official planning instruments (OEI & JBB, 2022a).

Currently, the JBB frames UA as a climate change adaptation strategy and a tool to reduce hunger, while fostering the inclusion of vulnerable groups who can strengthen their food security through gardening (JBB, 2025). Academic research complements this institutional view, documenting the diversity, structure, and social functions of Bogotá's domestic gardens (Cantor, 2010; Sierra-Guerrero & Amarillo-Suárez, 2017). Nevertheless, homegardens in the city remain poorly documented, leaving the domestic sector largely invisible in both research and policy. This knowledge gap makes it difficult to assess whether the multifunctional goals of Bogotá´s UA policies are being realised in the domestic sphere and underscores the need for the empirical analysis presented in this study.

2.4 Urban homegardens in the context of urban agriculture

Urban agriculture encompasses a wide range of production systems that vary in scale, intensity and purpose. Orsini et al. (2013) classify UA into four main types: (1) extensive monocropping systems for both home consumption and market sale (usually non-irrigated farms found at the periphery of the city), (2) shifting cultivation systems, also called slash-and-burn systems, which involve periodic land-use change (3) intensive cropping systems on medium- or large-scale farms, where the production is strongly market oriented, and (4) mixed farming systems for household consumption and small-scale marketing, including community and homegardens.

Within the diverse spectrum of UA practices, homegardens are a common and one of the oldest land uses worldwide (Taylor et al., 2017; Taylor & Lovell, 2012; Wise, 2014). Defined as household-managed plots located within the residence or on adjacent land (Taylor & Lovell, 2014), homegardens are widely valued for their multifunctionality, meeting diverse livelihood needs. They enhance food provision, diversify diets, provide medicinal resources, generate supplementary income, and contribute to household savings, the preservation of cultural heritage, biodiversity conservation and the provision of ecosystem services (Balooni et al., 2014; Caballero-Serrano et al., 2016; Carniello et al., 2010; Lal, 2020; Mosina & Maroyi, 2016; Siviero et al., 2014).

Urban homegardens emerge as essential resources for food, subsistence, and well-being for city dwellers. Compared with rural homegardens, urban ones often contain a higher proportion of ornamental species, yet they still have the capacity to provide food products that enhance food security and diversify urban diets (Lal, 2020; Poot–Pool et al., 2015; Spiler et al., 2016). From a socio-ecological perspective, homegardens are not isolated production units but integral components of urban landscapes. They connect ecological, cultural, and economic functions, contributing to urban resilience and sustainability (Šiftová, 2021).

Globally, research on homegardens highlights its multifunctional role in ecological, economic, and socio-cultural dimensions. Most studies focus on ecological contributions, especially species diversity, structural and functional complexity, while fewer studies examine economic, cultural, or social functions. This underscores that, although well-studied for biodiversity, homegardens´ full multifunctional potential remains underexplored, particularly in urban contexts (Rajagopal et al., 2021).

Despite the importance of homegardens, research has focused predominantly on rural areas and tropical regions, leaving a gap in the understanding of how they function within urban environments (Mattalia et al., 2018; Panyadee et al., 2016). This gap is particularly evident in Bogotá, where urban agriculture is institutionally promoted and supported by the Botanical Garden.

Local policies explicitly recognise family agriculture and homegardens as contributors to food provision (Alcaldía Mayor de Bogotá, 2021a,b; Concejo de Bogotá, 2015). Yet, empirical data remain limited. Existing studies are restricted to partial plant inventories or a single analysis of cultural uses in a subset of districts (Molina et al., 1998; Sierra-Guerrero & Amarillo-Suárez, 2014, 2017). Notably, Sierra-Guerrero & Amarillo-Suárez (2017) demonstrated that homegardens play an important aesthetic role and that their function may vary with socio-economic status, aligning with broader evidence that crop production systems are shaped by household needs and preferences (Mwavu et al., 2016; Serrano-Ysunza et al., 2018; Sotelo-Barrera et al., 2017).

2.5 Plant diversity in urban homegardens

Urban homegardens are multifunctional spaces, primarily due to the high plant species diversity they host. This diversity is a common feature across different cities, as households adapt their gardens to meet a variety of needs. This dynamic adaptation allows homegardens to serve productive, recreational, and aesthetic purposes, while also functioning as hubs for social networks and cultural expression (Nemudzudzanyi et al., 2010; Panyadee et al., 2016; Peroni et al., 2016; Ranieri & Zanirato, 2018; Siviero et al., 2014; WinklerPrins & de Souza, 2010).

Households actively alter the floristic composition of their homegardens in response to contingencies, deliberately selecting species for the goods and services they provide (Balooni et al., 2014; Mosina & Maroyi, 2016; Vila-Ruiz et al., 2014). Patterns of plant diversity in urban homegardens are often influenced by socio-economic context. In wealthier districts, gardens tend to feature a higher proportion of ornamental species, reflecting aesthetic priorities, whereas lower-income areas typically host a greater proportion of food and medicinal plants, which serve subsistence and health needs (Bigirimana et al., 2012; Clarke et al., 2014; Lubbe et al., 2010; Sierra-Guerrero & Amarillo-Suárez, 2017). This socio-economic gradient in plant use underscores the need to interpret biodiversity patterns through a livelihood lens rather than purely ecological metrics.

Urban homegardens also function as biodiversity hotspots, with potential contributions to the conservation of crop wild relatives and threatened species (FAO, 2019; Salako et al., 2014). Despite their smaller average size compared with rural homegardens, as a consequence of the competition for space with housing and infrastructure development, urban gardens are not necessarily less diverse; instead, the plant composition changes (Poot–Pool et al., 2015; Salako et al., 2014). This is shown, for example, for medicinal plants in Uruguay, where the difference in diversity between rural and urban areas was not significant (Castiñeira et al., 2018), suggesting that spatial constraints do not inevitably lead to lower functional capacity.

One consistent trend is a decrease in tree and bush diversity and a corresponding increase in herbs in urban homegardens. This shift may be linked to higher incomes from non-agricultural activities, which reduce the time available for garden management and favour aesthetic ornamental plants over species that provide timber, fodder, or firewood (da Cunha Ávila et al., 2017; Poot–Pool et al., 2015; Rayol et al., 2019; Taylor et al., 2017).

Another recurrent feature of urban homegardens is the prevalence of exotic species, especially ornamental and herbaceous plants. Despite the potential benefits of increased aesthetic value and diversification of uses, concerns have been raised regarding the potential negative impacts that exotic species could pose to native biodiversity. This issue necessitates an enhancement in public awareness and the implementation of management interventions (Castiñeira et al., 2018; da Cunha Ávila et al., 2017; Mosina & Maroyi, 2016; Pereira & Figueiredo Neto, 2015; Peroni et al., 2016; Poot–Pool et al., 2015; Pradeiczuk et al., 2017). An exception to this pattern is São Luis city, Brazil, where 60% of homegarden species are indigenous, illustrating that local cultural preferences and ecological contexts can influence floristic composition and counter global patterns (Akinnifesi et al., 2010).

These patterns underscore that agrobiodiversity among urban homegardens cannot be understood solely as an ecological attribute but is embedded within the socio-economic realities of households.

2.6 Urban homegardens and livelihoods

2.6.1 Food provision and dietary diversity

A fundamental pathway through which homegardens contribute to livelihoods is their capacity to enhance food security by ensuring regular access to fresh, affordable, and culturally appropriate foods. Homegardens complement market purchases, buffer households during periods of food shortage, and improve micronutrient intake (Eichemberg & de Mello Amorozo, 2013; Mosina et al., 2014; Rayol & de Souza, 2019).

The benefits extend beyond the producing household. Through the sharing of harvested products with the community, gardeners build trust, reciprocity, and social cohesion, thereby reinforcing local food networks (Kamiyama et al., 2016; Kortright & Wakefield, 2011; Panyadee et al., 2016; Sant'Anna De Medeiros et al., 2020; Taylor et al., 2017).

Fruits and vegetables are consistently identified as the dominant food groups produced in urban homegardens (Carniello et al., 2010; Castañeda-Navarrete, 2021; Rayol & Silva, 2021; Silva et al., 2019). Quantitative assessments show that access to gardening is associated with greater food access and higher consumption of fresh produce (Alemu et al. 2019; Palar et al. 2019; Knoff et al. 2022).

Nevertheless, homegardening does not guarantee improved food security, and in many urban contexts, it plays a secondary role in supplying households' needs. In Viçosa, Minas Gerais, Brazil, for example, maintaining a garden did not improve the food security status of socially disadvantaged families. Furthermore, growing edible plants failed to reduce concerns about having enough food to eat, especially for individuals who have suffered from hunger (de Medeiros et al., 2019). Similarly, in South Africa, only 10% of gardeners were food secure, largely because fruit and vegetable cultivation was limited by economic and environmental barriers, for which, in many cases, most of the garden space was occupied by lawn (Du Toit et al., 2022).

2.6.2 Economic contributions

Besides supplementing household diets, urban homegardens can improve livelihoods by reducing food expenses and, in some cases, generating cash income through the sale of surplus produce (Eichemberg & de Mello Amorozo, 2013). In California, for example, gardeners produced an average of 1.23 lb of vegetables per square foot annually, saving approximately USD 339 in food costs. The cost-saving effect of self-provision is particularly relevant in low-income settings where purchased food represents a substantial share of household budgets (Algert et al., 2016).

The commercialisation of surplus produce offers an additional, though often supplementary, income stream. In Limpopo Province, South Africa, up to 11% of households sell homegarden produce, with proceeds used to improve their quality of life (Mosina & Maroyi, 2016). In Hawassa City, Ethiopia, sales from homegardens contribute approximately 35% of total annual household income (Reta, 2016). Similarly, in northern Thailand, white fig (*Ficus virens*) can yield USD 40 twice a year per tree, requiring minimal investment or maintenance (Panyadee et al., 2016).

However, a focus only on commercialisation could bring the risk of environmental degradation. Market-oriented production can lead to a dominance of a few profitable species, often exotics, reducing overall diversity and, in some cases, increasing environmental pressures through greater input use (Bernholt et al., 2009; Thompson et al., 2010; Williams et al., 2018).

2.6.3 Social benefits

Urban homegardens are spaces for enhancing mental, physical, and social well-being. Gardening is linked to a reduction in stress, anxiety, and depression (Soga et al., 2017). Engaging in homegardening can lead to a significant decrease in perceived stress, which aligns with improved physiological indicators such as healthier cortisol patterns. The psychological benefits extend to increased positive emotions, a sense of pride, restorativeness and sleep quality, and enhanced cognitive function (Ambrose et al., 2020; Cervinka et al., 2016; Chalmin-Pui et al., 2021; Corley et al., 2021).

The importance of these benefits was particularly highlighted during the COVID-19 pandemic, where homegardens proved to be one of the most effective forms of urban green space for mitigating mental distress. This, not just from passive exposure to nature, but from the purposeful and active contact with plants (Egerer et al., 2022; Marques et al., 2021).

Homegardens also play a role in fostering social cohesion and cultural identity. They serve as sites for social relationships and networking, where gardeners can exchange products and knowledge with their community and family. This interaction strengthens reciprocity, builds community cohesions, and reinforces intergenerational and familial bonds, providing residents with a sense of place and belonging (Ghahremani et al., 2024; Kortright & Wakefield, 2011; Taylor & Lovell, 2015).

2.7 Motivations and perceptions

Importantly, homegardening is a socially and culturally embedded practice shaped by a variety of motivations. These motivations differ across cities, cultures and socio-economic contexts. In developing countries, the focus often revolves around improving access to fresh, healthy food and reducing household expenses, whereas in developed countries, recreational, aesthetic, or environmental reasons tend to be more prominent (Ruggeri et al., 2016). Understanding these motivations is essential for explaining the persistence of homegardening and for recognising its role in urban livelihoods. Likewise, gardeners´ perceptions of the benefits and challenges of homegardening offer valuable insights into how gardens are experienced and valued by their direct beneficiaries.

In psychology, motivation refers to the process that sparks, guides, and sustains goal-oriented behaviours, influenced by biological, emotional, social and cognitive forces (Partalidou & Anthopoulou, 2017).

Different theories have tried to describe what prompts human behaviour. Attention Restoration Theory (ART) (Kaplan, 1995) argues that humans respond positively to natural environments and prefer natural rather than urban environments because of reduced mental fatigue and cognitive restorative effects. The psychophysiological stress recovery theory (Ulrich et al., 1991) states that contact with unthreatening natural environments leads to greater stress recovery than contact with urban settings does (González & Miranda, 2024; Koay & Dillon, 2020). These theories frame gardening as a behaviour partly motivated by the pursuit of restorative and stress-reducing experiences.

A broader and widely cited framework, and the one supporting this research, is Maslow's hierarchy of needs (Maslow, 1943). This theory suggests that people´s motivations are hierarchical; material needs (e.g., water and food), safety needs (e.g., financial security), love and belonging (e.g., friendship and acceptance), and self-esteem constitute basic needs, and only when they are met, will people seek to grow as a person through, for instance, knowledge acquisition. Applied to homegardening, this implies that gardeners´ motivations will align with their most pressing unmet needs. For example, lower-income gardeners with unmet basic needs may be primarily motivated by food self-provision, whereas higher-income households, whose food needs are met through the market, may focus on aesthetic, recreational, or cultural desires (Clarke et al., 2014; Clarke & Jenerette, 2015; Partalidou & Anthopoulou, 2017).

In fact, engagement in urban homegardens is explained by multiple motivations that vary across different contexts. In developing countries, improved access to fresh and healthy food, together with cost savings or income generation, are often primary drivers (Pham & Turner, 2020; Ranieri & Zanirato, 2018). In contrast, in developed countries, motivations more frequently include recreation, mental health benefits, and environmental stewardship. For example, in Milan, Italy, most respondents emphasised personal wellness and healthier food as their main reasons for homegardening (Ruggeri et al., 2016), while in the UK, enjoyment of physical activity and stress reduction were more prominent (Murtagh & Frost, 2023). In Tasmania, motivations ranged from better-tasting vegetables from gardens to activism seeking social change for a sustainable future (Kirkpatrick & Davison, 2018).

Alongside motivations, perceptions of homegardening are critical to understanding its value. Regardless of the primary driver, homegardening is generally perceived as a positive activity, and is said to encourage good mood, feelings of satisfaction, and a sense of achievement (Chalmin-Pui et al., 2021; Lewis et al., 2018). It has been described as therapeutic, linked to reductions in emotional, social, and behavioural difficulties (McFarland et al., 2018; Richardson et al., 2017). Gardeners also perceived benefits beyond their immediate needs, such as contributing to environmental health, strengthening cultural traditions.

Perceptions, unlike purely quantitative measures, provide essential insight into how beneficiaries themselves define the success or shortcomings of urban agriculture initiatives and comprehend support or discontent towards any initiative (Bennett, 2016).

Understanding both motivations (what drives engagement) and perceptions (how benefits and challenges are experienced) is crucial for policy design (Alam et al., 2010). Overlooking them risks missing social, cultural, and psychological benefits that sustain participation over time.

Ultimately, urban agriculture is highly dependent on local conditions. Identifying the motivations behind the engagement in homegardening is crucial for engaging diverse demographic groups, and for designing policy interventions that effectively leverage homegardens for both ecological and social benefits (Al-Mayahi et al., 2019; Wadumestrige Dona et al., 2021; Zainuddin & Mercer, 2014; Zasada et al., 2020).

In sum, the literature consistently positions urban homegardens as complex, multifunctional spaces where plant diversity is shaped by socio-economic context and where motivations range from subsistence needs to cultural and recreational aspirations. Their contributions extend beyond food provision to include income generation, mental and social well-being, and biodiversity conservation.

3. Aims of the study

3.1 Problem statement

In Colombia, urban population has been steadily increasing since 1930, with a major transition from a predominantly rural to a predominantly urban population occurring in the 1960s. By 2050, it is projected that 86% of the Colombian population will live in urban areas, with the largest concentrations in Medellín, Cali, Barranquilla and predominantly Bogotá. Internal migration has been driven not only by the search for better living conditions, but also by violence and territorial conflicts, leading to forced displacement (Bernal Pedraza & Licona Calpe, 2024; Ruiz, 2008). The rapid growth urban populations has generated multiple pressures, including rising food demand and intensified environmental challenges such as pollution, habitat loss and declining biodiversity.

Urban agriculture offers a strategy to mitigate these pressures by producing food locally, recycling organic waste, creating green spaces, and enhancing urban resilience. Among urban agriculture practices, homegardens are the most common and have the potential to deliver multiple benefits, including generation of supplementary income, provision of edible and medicinal plans, dietary diversity, cultural practices and social cohesion (FAO, 2019; Lal, 2020; Taylor et al., 2017.)

Despite their potential, empirical knowledge about the diversity, functions, and social dynamics of homegardens in Bogotá remains limited. The city´s Urban and Peri-Urban Agriculture Programme, established in 2015, formally recognizes homegardens (*huertos familiares*) as contributors to food provision and frames them within the city's vision of urban agriculture as a tool to climate change adaptation, biodiversity conservation, and environmental education (Concejo de Bogotá, 2015). However, no comprehensive city-wide baseline captures their agrobiodiversity, household uses, or social functions. Existing studies are fragmented, limited to small-scale inventories or isolated case studies in a few districts, and fail to reflect the heterogeneity of Bogota´s context.

Without such evidence, the multifunctional potential of homegardens remains largely aspirational rather than operational, limiting their capacity to support food security, environmental sustainability, and social well-being. This knowledge gap underscores the need for systematic, city-wide research to characterize Bogotá´s homegardens, their functional diversity, and the social and household factors that drive engagement. By filling this gap, research can inform policy and planning, strengthen institutional support, and enable the operationalization of homegardens as a recognized and evidence-based resource.

To address this gap, this study examines homegarden functional agrobiodiversity, household uses and the motivations that shape engagement. The study is guided by three central questions:

1. What is the functional agrobiodiversity of urban homegardens in Bogotá, how is it used, and in what ways does it contribute to gardeners´ livelihoods?
2. What distinct functional types of homegardens exist in the city, and how do these types relate to gardeners' sociodemographic characteristics?
3. What motivations drive engagement in homegardening and how do gardeners perceive homegarden benefits?

3.2 Aim of the thesis

The overarching goal of this study is to evaluate the role of urban homegardens in supporting the livelihoods of gardeners in Bogotá, Colombia.

Specific objectives are to:

1. Assess the functional agrobiodiversity of urban homegardens across Bogotá and how it is used by gardeners,

2. Identify distinct types of homegardens and examine their association with gardeners´ sociodemographic characteristics,

3. Analyse gardeners´ motivations for engaging in homegardening and their perceptions of associated benefits.

Based on the literature, it was hypothesised that:

1. Homegarden typologies differ according to gardeners' sociodemographic characteristics and agrobiodiversity. Lower socio-economic groups are more likely to cultivate for food supply, while higher socio-economic groups may prioritise other functions such as aesthetics or recreation (Al-Kofahi et al., 2019;

Jaganmohan et al., 2012; Kabir et al., 2016; Lubbe et al., 2010; Mosina et al., 2014; Sierra-Guerrero & Amarillo-Suárez, 2017).

2. Gardeners' motivations and perceived benefits vary according to sociodemographic characteristics; those from more vulnerable backgrounds prioritise food supply, whereas better-off gardeners may prioritise non-food reasons and benefits (Chalmin-Pui et al., 2021; Lemma & Sharma, 2024; Ruggeri et al., 2016)

4. Methodology

4.1 Study site characteristics

The study was conducted in Bogotá, the capital of Colombia, located in the eastern range of the Andean Mountain System at an altitude exceeding 2600 meters above sea level.

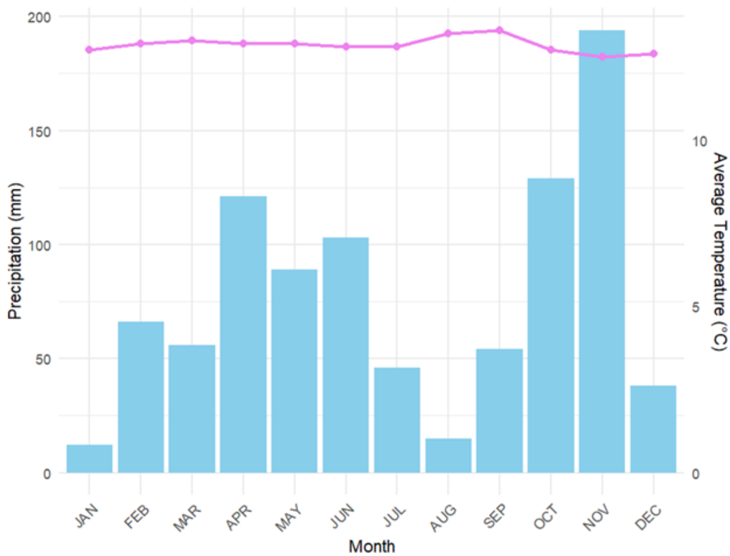

Figure 1. Annual average rainfall and temperature in Bogotá, Colombia.
The diagram illustrates the bimodal precipitation pattern (left axis), with peaks occurring between April-June and October-November. The right axis shows the stable temperate climate, with an average temperature ranging between 12°C and 16°C year-round. Data adapted from IDEAM (2018).

The city has an average temperature of 14°C and annual precipitation of 840 mm (Figure 1), with a bimodal rainfall distribution, and presents a temperate oceanic climate (cfb), according to the Köppen-Geiger climate classification (IDEAM, 2018).

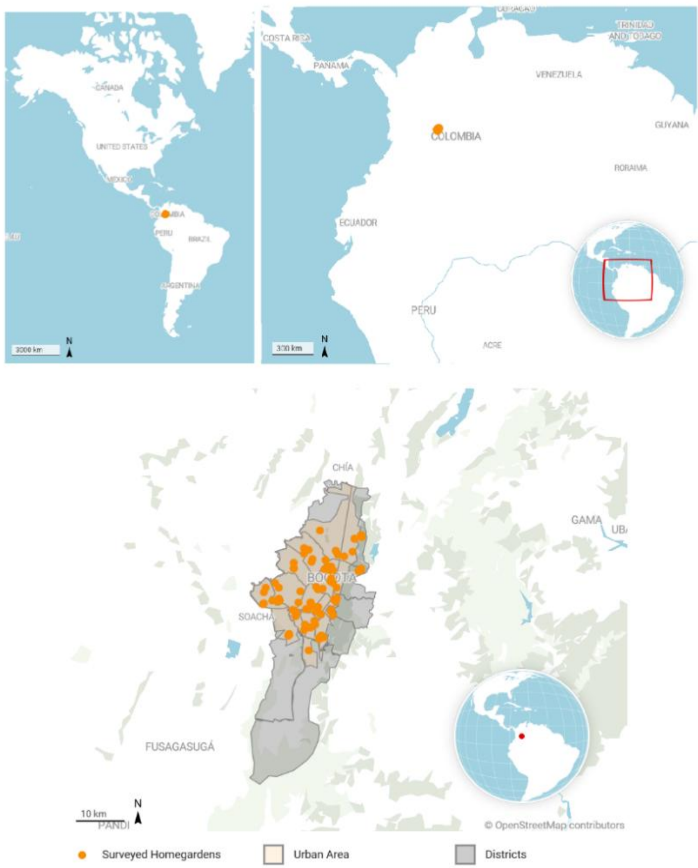

Figure 2. Map of the study area showing the distribution of surveyed homegardens across Bogotá.
District boundaries are outlined in dark grey, with the urban area highlighted in light orange. Orange dots represent the locations of the surveyed homegardens within the city´s urban area. The maps above indicate Colombia's location within the continent, while the inset globe shows Bogotá´s location in South America.

Bogotá is divided into 20 districts, with wealthier zones primarily located in the north and lower-income zones in the south and west (Figure 2) (Alcaldía de Bogotá, 2019a; Escobedo et al., 2015). Sumapaz, the largest district, was excluded from the study because it is entirely rural.

In Colombia, residential properties are assigned to one of six official socio-economic strata (1=lowest, 6=highest), under a classification established by the national government. The methodology is designed and regulated by the Department of National Statistics (Departamento Administrativo Nacional de Estadística - DANE) in accordance with the legal framework and implemented at the local level by municipal governments through their permanent committees for stratification (DANE, 2015a; Günther, 2025).

The classification, in use nationwide since the early 1990s, relies on observable characteristics of each dwelling and its immediate surroundings. The variables include: physical characteristics of the dwelling (construction materials, façade condition, general state of conservation), urbanization and infrastructure, public services (availability, type, and quality of water, sewerage and electricity connections), predominant land use of the area (residential, commercial, mixed), environmental and location features (paved roads, sidewalks, street lighting, green areas), and public service access (availability, quality of water supply, sewerage, electricity and other utilities). Using cluster analysis, properties with similar profiles are grouped together and assigned a stratum from 1 to 6 (DANE, 2015a, b).

The underlying premise is that the dwelling´s physical and surrounding conditions serve as reliable proxies for the socio-economic status of its occupants. This assumption has been validated by DANE through correspondence analyses and statistical tests showing strong associations between housing characteristics and indicators such as household income, education level, and consumption capacity (Cantillo-García et al., 2019; DANE, 2015a).

For this study, and in line with common official practice, the six strata are grouped into three broader categories: Lower strata (1-3), Medium stratum (4), and Higher strata (5-6). While other variables, such as home ownership, education level, and employment status, were also collected and analysed, strata classification is retained as a robust, standardised, and policy-embedded national indicator. By integrating multiple dimensions of the living environment into a single measure, it provides a contextual socio-economic proxy that complements individual-level indicators (DANE, 2015b, 2024).

Officially, stratification serves to allocate subsidies to households in lower strata, levy contributions on those in higher strata, and guide public investment planning, helping to prioritise infrastructure, health, sanitation, and education programmes in areas of greatest need. The classification is periodically reviewed and updated by local authorities to maintain accuracy (DANE, 2015a).

In Bogotá, most of the population (84%) resides in lower strata (1-3), 10% in middle strata (4), and 6% in the higher strata (5-6) (Alcaldía Mayor de Bogotá, 2024).

Furthermore, the city´s population is slightly female dominated (52%), with an average age of 35 years. Nearly half of residents (48%) are between 25 and 59 years old. Bogotá has the highest level of educational attainment in Colombia, with approximately 47% of the population holding a tertiary degree. The employment rate is around 55%, and the average household size is three people. Homeownership accounts for 43% of households. An estimated 25.3% of households experience moderate or severe food insecurity (Alcaldía Mayor de Bogotá, 2021c; DANE 2023).

4.2 Research design

This study followed a mixed-methods approach to address its three objectives. Quantitative data were collected on plant diversity, uses and household characteristics, while qualitative data captured gardener's motivations and perceptions. Integrating these strands allowed for a more comprehensive understanding of the multifunctional role of homegardens.

4.2.1 Data collection

Data collection took place from February to June 2021, in cooperation with the Botanical Garden of Bogotá (Jardín Botánico de Bogotá José Celestino Mutis, JBB), which facilitated initial contact with gardeners and provided accompaniment during the visits. This period coincided with the COVID-19 pandemic, during which public health authorities enforced physical distancing and restricted movement in the city, as well as with episodes of civil unrest in Bogotá linked to nationwide protests triggered by a tax reform proposal, which further disrupted daily activities and limited access to some areas.

Under these challenging circumstances, conducting a fully randomised sampling was not feasible. Consequently, a purposive and snowball sampling strategy was used to ensure the inclusion of respondents who (1) were eighteen years of age or older, (2) had the time availability to be interviewed, and (3) were actively engaged in homegardening in Bogotá. Although this non-probabilistic approach does not allow statistical generalisations to all Bogotá homegardens, it provided a diverse set of participants and is consistent with methods used in other urban agriculture studies (Castiñeira et al., 2018; Kanosvamhira & Tevera, 2023).

For the quantitative components (Objectives 1 and 2), we aimed to obtain a sample size that would provide sufficient statistical power for the analyses. While a traditional random sample from the total population of 47,236 gardeners who have received technical assistance from the Botanical Garden was not feasible, this figure was used to inform our target sample size. The minimum sample size of 104 was calculated using the following formula:

$$n = \frac{\frac{Z^2 \times p(1-p)}{e^2}}{1 + \frac{Z^2 \times p(1-p)}{e^2 N}} \tag{1}$$

where, N is the population size, Z is the z-score at the 95% confidence level (Z=1.96), p is the estimated proportion of an attribute that is present in the population (p=0.5), and *e* is the margin of error (e= 0.1) (Alcaldía Mayor de Bogotá, 2021b; Israel, 1992). An additional 15% of observations was added to account for a non-response rate, resulting in a sample size of 119. Although purposive and snowball sampling were applied, this formula helped ensure that the achieved sample size was sufficiently large to support the study´s quantitative analyses and detect statistically significant effects if present (Mohanasundaram & Harsha, 2024).

Data collection involved individual, face-to-face semi-structured interviews with the persons in charge of the homegardens to document sociodemographic characteristics of the households, gardening practices, and produce commercialisation (Kortright & Wakefield, 2011). During the interviews, the FAO´s Food Insecurity Experience Scale (FIES) was included to assess whether there is a relationship between food security and urban homegardens in Bogotá as reported elsewhere (Audate et al., 2019; Kortright & Wakefield, 2011; Warren et al., 2015). FIES is an 8-item standard tool that provides internationally comparable results for food security status (FAO, 2017; Saint Ville et al., 2019). Informed consent was obtained from each participant prior to data collection.

Additionally, all cultivated and tolerated plant species were registered in an inventory of useful plants for each homegarden via the walk-in-the-woods technique (Thomas et al., 2007). All species were documented through detailed colour photographs (Greene et al., 2023; Kiefer et al., 2015) and taxonomically identified on-site using published catalogues (Guerra, 2019; Mahecha et al., 2012; Sierra-Guerrero & Amarillo-Suárez, 2014). In the few cases when on-site taxonomic identification was not possible, the photographic material was used in consultation with the curator of the Herbarium of the Pontificia Universidad Javeriana (HPUJ) to help with species identification. Plant nomenclature follows the Plants of the World Online database (https://powo.science. kew.org/), and the family assignments are consistent with the Angiosperm Phylogeny Group (APG) IV (Stevens, 2017). For each garden, the number of species and their uses were recorded, classifying plants into food, aesthetic, medicinal and other complementary uses (e.g., lucky charm, insect-repellent) as reported by the gardener. Produce quantities were not taken into consideration since only 21 anecdotal estimates were obtained, as interviewees did not keep harvest records (Thomas et al., 2007; Thomas & Van Damme, 2010; Milow et al., 2013).

The interview also included open-ended questions about participants' motivations for engaging in homegardening and the reasons that might lead them to stop gardening (Audate et al., 2021). Additionally, the questionnaire included a set of brief statements rated by the respondents on a five-step Likert scale (1= strongly disagree, 2 = partially disagree, 3 = neutral, 4 = partially agree, 5 = strongly agree) regarding their perceptions of the benefits associated with homegardening. Participants were encouraged to elaborate on their responses to offer richer contextual insights and allow more nuanced interpretation (Galhena, 2012; Scott et al., 2020).

4.2.2 Data analysis

4.2.2.1 Plant diversity and ethnobotanical analysis

Plant species data from the surveyed homegardens were used to assess agrobiodiversity through three complementary metrics. Species richness was calculated with the Margalef index:

$$\mathrm{DMg} = \frac{\mathrm{S} - 1}{\ln \mathrm{N}} \tag{2}$$

Diversity was computed with the Shannon index:

$$\mathrm{H'} = -\sum \mathrm{pi} \ln \mathrm{pi} \tag{3}$$

Evenness was calculated with the Pielou index:

$$\mathrm{J'} = \frac{\mathrm{H'}}{\ln \mathrm{S}} \tag{4}$$

where S is the number of species, N is the total number of individuals, and p_i is the proportion of individuals belonging to species i. Following common interpretation guidelines, Margalef values below 2 indicate low species richness, Shannon values close to 0 indicate strong dominance of a few species, and Pielou values close to 1 indicate equal abundance across species (Montenegro et al., 2017; Park et al., 2019; Williams et al., 2018).

Plant uses were categorised based on gardeners´ reports into four broad categories: ornamental, food, medicinal, and "other" (e.g., lucky charm, insect-repellent). Culturally significant plants were assessed using three ethnobotanical indices: Use Report (UR), Cultural Importance (CI) and Relative Frequency of Citation (RFC) ethnobotanical indices (Tardío & Pardo de Santayana, 2008). A UR was recorded each time a species was mentioned for a specific use; multiple uses of the same species generated multiple URs, so if the same species was said to have different uses, each use was recorded as an individual use report. CI was calculated as:

$$CI = \frac{UR}{N} \quad (5)$$

and RFC as:

$$RFC = \frac{FC}{N} \quad (6)$$

where N is the total number of informants, and FC is the number of informants who mentioned the species. Higher values of these indices reflect greater cultural relevance of the species (Ojha et al., 2020; Shuaib et al., 2023; Tardío & Pardo de Santayana, 2008).

4.2.2.2 Homegarden typology and determinants

To develop a typology of homegardens (Objective 2), hierarchical cluster analysis was performed using squared Euclidean distances as a measure of dissimilarity and the Ward method (Ward, 1963) to sort homegardens into similar groups that minimise within-group differences (Zhang et al., 2017). Multipurpose species were counted in all relevant use categories. This approach has been used to identify functional homegardens classification in diverse contexts (Gbedomon et al., 2017; Thompson et al., 2010). Stepwise discriminant analysis was then performed to determine the strength of the classification model (Gbedomon et al., 2017; George & Christopher, 2020; Wiehle et al., 2014).

To assess the association between sociodemographic characteristics of respondents and plant diversity across homegarden clusters, Fisher's exact test for categorical variables, one-way ANOVA with Tukey post-hoc tests or the Kruskal-Wallis test with pairwise Wilcoxon comparisons when normality assumptions were not met (Bernholt et al., 2009; Bigirimana et al., 2012). To further identify the determinants of homegarden type, a multinomial logistic regression model was applied. This approach is suitable because the dependent variable comprises more than two unordered categories. The model estimates the probability of a household belonging to one garden type relative to a reference group by computing odds ratios (ORs) for each explanatory variable. This allows for direct comparison across categories and helps identify the factors shaping garden type (Alarcón-Segura et al., 2023; Gbedomon et al., 2015).

The multinomial model is expressed as:

$$P\ (Yi = m) = \frac{\exp(Xi\beta m)}{1 + \sum_{k=1}^{M} \exp(Xi\beta k)}, m1, \dots, M \qquad (7)$$

$$P\ (Yi = 0) = \frac{1}{1 + \sum_{k=1}^{M} \exp(Xi\beta k)}$$

where Yi is the type of homegarden (ornamental, multipurpose, food-oriented) for household i, Xi is the vector of explanatory variables (Table 1), βm represents the parameter vector associated with each homegarden type relative to the reference category, and M is the total number of categories minus one.

Table 1. Explanatory variables included in the multinomial regression model of homegarden type.

Variable	Description	Measurement	References
Plant diversity	Plant species diversity measured using the Shannon diversity index (H´)	Continuous	Dogbo et al., 2024; George & Christopher, 2020; Kassa et al., 2023
Household size	Number of people living in the household	Continuous	Bernholt et al., 2009; Kassa et al., 2023
Socio-economic strata	Official classification of dwellings used as contextual proxy for income	0= Low 1 = Medium-High	Bigirimana et al., 2012; Wiehle et al., 2014
Food security status	Household food security status measured with FIES	Continuous	Mokone et al., 2025
Education	Highest level of formal education attained by the gardener	0 = Primary 1 = Secondary 2 = Tertiary	Bernholt et al., 2009; Gbedomon et al., 2015, 2017
Gender	Gender of the gardener	0 = Male 1 = Female	Gbedomon et al., 2015, 2017
Livestock	Presence of livestock in the homegarden	0 = No livestock 1 = Livestock present	Wiehle et al., 2014

Note: The table presents the explanatory variables included in the multinomial regression model, with details on their description, measurement scale, and key references. Variables cover plant diversity, household characteristics and gardener demographics, all of which were used to identify the factors influencing the type of homegarden. Medium-high strata were merged to address small sample size and ensure model robustness.

The odds ratio for each predictor is obtained as exp (βm), which quantifies how changes in the explanatory variables affect the relative probability of belonging to a specific homegarden type compared to the reference group. The null hypothesis states that all coefficients are equal to zero, implying that the explanatory variables as a group have no effect on garden type. At the variable level, the null hypothesis tests whether the coefficient for each predictor is zero, indicating no effect in the relative log-odds of belonging to a given homegarden cluster compared to the reference group. The alternative hypothesis is that the coefficient differs from zero, in which case the odds ratios are used to quantify the magnitude and direction of the effect. The multinomial regression was estimated using the *multinom* function from the *nnet* package in R.

Model performance was assessed with three diagnostics. First, overall model fit was evaluated using the Likelihood Ratio (LR) test, which compares the fit of the full model against a restricted baseline. A statistically significant LR report indicates that the included variables improve explanatory power (Shang et al., 2019). Second, multicollinearity among predictors was examined using variance inflation factors (VIFs). VIF quantifies how much the variance of an estimated regression coefficient is inflated by collinearity with other variables in the model. Common practice treats VIFs below conservative thresholds (VIF < 5) as indicating collinearity is unlikely to bias coefficients (Hair et al., 2019). Third, potential endogeneity of food security status was assessed using a control function, two-stage residual inclusion approach. The instrumental variable in the first-stage regression was the presence of a red piece of fabric displayed on the façade of households during the COVID-19 lockdown in Bogotá. This symbol was widely used by residents as a visible call for help when they were unable to meet basic subsistence needs and thus provides a valid instrument. The variable "Red Fabric" (0 = household did not make use of it, 1 = did use it) is theoretically relevant because it captures exogenous variation in household vulnerability, while not directly affecting the cluster type through its impact on food security status. In the control function test, the residuals from the first-stage regression of food security status on Red Fabric and other exogenous variables were included in the main model. A non-significant residual indicates no statistical evidence of endogeneity, in support of the robustness of the model. This approach accounts for unobserved factors that may simultaneously influence both security and motivations for gardening engagement, reducing the risk of biased coefficient estimates.

4.2.2.3 Analysis of motivations for homegardening engagement

To address the third objective, interview transcripts were analysed using qualitative content analysis. Transcripts were read iteratively to identify recurring patterns and codes, which were refined with field notes and then grouped into categories and themes. This approach ensured the analysis remained rooted in the data gathered rather than in a preconceived analytical scheme (Green et al., 2007; Erlingsson & Brysiewicz, 2017). Descriptive statistics (frequencies and percentages) were used to summarise the prevalence of different homegardening motivations and perceptions of its benefits. Pearson's $\chi 2$ test of independence or Fisher's exact test were adopted to assess the association of the location of the gardens and socio-economic strata with the reported motivations to engage in homegardening. The null hypothesis assumes no association between variables.

Following Lemma & Sharma (2024), a multivariate probit analysis was conducted to explore the socio-economic factors associated with motivations for engaging in homegardening. This model is suitable when individuals may hold multiple motivations simultaneously, represented as binary outcomes, and when correlations between those outcomes are expected. Unlike independent probit models, the multivariate specification accounts for the potential interdependence among motivations.

The model is expressed as:

$$Yij * = Xi\beta j \ + \ \varepsilon ij, \ \text{ with } Yij = 1 \text{ if } Yij *> 0, 0 \text{ otherwise} \quad (8)$$

where Y_{ij} is the latent propensity of the individual i to report motivation j (self-provision, enjoyment, social connection), X_i is the vector of socio-economic explanatory variables, β_j indicates the parameter vector associated with each motivation, and ε_i = (ε_{i1}, ε_{i2}, ε_{i3}) represents a vector of error terms, assumed to follow a multivariate normal distribution with zero mean and covariance matrix Σ. The off-diagonal elements of Σ capture correlations among motivations.

In the multivariate probit model, two sets of hypotheses were tested. At the coefficient level, the null hypothesis was that the effect of each explanatory variable on a given motivation was zero (β_{jm} = 0), implying no influence on the probability of reporting that motivation. The alternative hypothesis was that at least one coefficient differed from zero, At the correlation level, the null hypothesis stated that the error terms across motivation equations were uncorrelated, implying that motivations were independent. The alternative hypothesis allowed for correlations among error terms, consistent with the expectation that motivations may be interdependent.

Model diagnostics paralleled those of the multinomial regression. The LR test was used to confirm overall model fit. Multicollinearity was tested using VIFs. Endogeneity of food security status was tested with the control function-approach.

Variable selection was deliberately limited. Maximum likelihood estimation, which underpins both logistic and probit models, is sensitive to sample size. Including too many predictors relative to the number of respondents can lead to unreliable results. To balance explanatory power with robustness, only a core set of theoretically supported variables was included, aiming for both empirical relevance and model stability (Table 2) (Hair et al., 2019).

Table 2. Explanatory variables used in the multivariate probit analysis of homegardening motivations.

Variable	Description	Measurement	References
Age	Age of the respondent	Continuous	Audate et al., 2021; Cepic et al., 2020; Chen et al., 2024
Household size	Number of people living in the household	Continuous	Lemma & Sharma, 2024; Martinho Da Silva et al., 2016
Socio-economic strata	Official classification of dwellings used as contextual proxy for income	0 = Low 1 = Medium-high	McClintock et al., 2016; Pham & Turner, 2020
Food security status	Household food security status measured using FIES	Continuous	Pham & Turner, 2020
Education	Highest level of formal education attained by the gardener	0 = primary (reference) 1 = secondary 2 = tertiary	Audate et al., 2021; Home & Vieli, 2020; Ruggeri et al., 2016)
Gender	Gender of the gardener	0 = male 1 = female	Al-Mayahi et al., 2019; Cepic et al., 2020; McClintock et al., 2016

Note: The table summarizes the explanatory variables included in the model, detailing their description, measurement scale, and key references. Variables cover respondent demographics (age, gender, education), household characteristics (household size, socioeconomic strata), and food security status, all used to identify the factors influencing multiple homegardening motivations simultaneously.

4.2.2.4 Analysis of perception of homegarden benefits

Fisher's exact test or Mann-Whitney U test were adopted to assess the association of the location of the gardens and socio-economic strata with the perception of homegarden benefits. To analyse the factors associated with these (Table 3), ten proportional odds logistic regressions (POLR) were conducted, one for each perception:

1. Because of my homegarden, my family has more food to eat,
2. Because of my homegarden, my family gets a greater share of vegetables and fruits,
3. Food from the homegarden is fresh and healthy (quality food),
4. Because of my homegarden, we get to eat a wider variety of food items.
5. We feel relaxed in the garden
6. Because of my homegarden, we engage in some physical activity,
7. We were able to start a small business at home using the homegarden produce
8. The homegarden helps conserve the environment
9. The homegarden helps reduce our food costs

10. The homegarden enabled us to earn additional income

This method is appropriate for ordinal data, such as Likert scale responses, without assuming equal distances between categories (Theobald et al., 2019).

The POLR model is expressed as

$$\log\left(\frac{P\ (Y \leq j)}{P\ (Y > j)}\right) = \theta j - \sum_{i=1}^{k} \beta i X i \qquad (8)$$

where Y is the ordinal response variable, Xi are the predictor variables, and k is the number of predictors in the model. The index j denotes the cut point between categories, and Θ_j represents the threshold (or intercept) parameter for each cut point. The coefficients β_i quantify the effect of each predictor. A negative β_i indicates greater odds of being in a higher response category (e.g. stronger agreement), following the model´s specification.

At the coefficient level, the null hypothesis stated that explanatory variables had no influence on the odds of selecting a higher response category, while the alternative hypothesis expected a significant effect.

Table 3. Explanatory variables used in the proportional odds logistic regression models of perceived homegardening benefits.

Variable	Description	Measurement	References
Age	Age of the respondent	Continuous	Chalmin-Pui et al., 2021; Scott et al., 2020; Trac et al., 2025
Household size	Number of people living in the household	Continuous	Naazie et al., 2024
Socio-economic strata	Official classification of dwellings used as contextual proxy for income	0 = Low 1 = Medium-high	Ambrose et al., 2020; Chalmin-Pui et al., 2021; Young et al., 2020
Food security status	Household food security status measured using FIES	Continuous	Du Toit et al., 2022
Education	Highest level of formal education attained by the gardener	0 = primary (reference) 1 = secondary 2 = tertiary	Adebayo et al., 2024; Marie et al., 2024
Gender	Gender of the gardener	0 = male 1 = female	Cervinka et al., 2016; Chalmin-Pui et al., 2021; Soga et al., 2017

Note: The table outlines the explanatory variables included in the proportional odds logistic regression models, specifying their description, measurement scale, and key references. Variables include gardener demographics (age, gender, education), household socioeconomic and food security status, all used to identify the factors influencing respondents´ perceptions of homegardening benefits.

As with the other models, LR tests were used to confirm goodness of fit, multicollinearity was checked using VIFs, and the control function approach was applied to test for possible endogeneity of food security status.

Prior studies confirm the appropriateness of POLR for similar contexts. For example, Hohm et al. (2024) analysed stakeholder attitudes toward beaver reintroduction using Likert-scale data; Ayal & Amo (2024) assessed adoption of climate-smart livestock practices, and Tenbrink & Willcock (2023) examined perceived threats of climate change relative to self-identified rurality. These applications provide strong precedent for using POLR in this study.

Models were estimated in R using the *mvProbit* package for the multivariate probit analysis and the *polr* function in the *MASS* package for ordinal regressions. For all models, results were considered statistically significant when $p < 0.1$.

Finally, to visually integrate the results from the motivations and perceptions regression models with the homegarden typology, a Multiple Correspondence Analysis (MCA) was performed. MCA is suitable for categorical and ordinal data and allows the joint representation of variables and response categories, facilitating the identification of patterns and associations among categories. The MCA plot displays the first two dimensions that capture the most significant associations in the data. Dim 1 accounts for the largest proportion of variance, followed by Dim 2, together capturing the primary relationships among variables (Greenacre, 2017).

The positioning of points along each dimension indicates their association with the underlying factors. Points on the positive side of Dim 1 represent one set of characteristics, while those on the negative side represent contrasting characteristics. The same interpretation applies to Dim 2. The relative positioning of points indicates associations between variables. Points located together are more strongly associated, whereas those farther apart are less related. Distance from the origin indicates the explanatory power of a variable of a category. Points located farther from the origin contribute more to explaining the variance along dimensions and have greater discriminatory power, whereas points near the origin contribute less (Greenacre, 2017).

In our analysis, homegarden clusters, motivations and perceived benefits plotted far from the centre and close to one another indicate strong associations, revealing which motivations or perceptions are more strongly linked to each garden type.

5. Results

The following sections present the results of the study. It should be noted that the sampling was purposive rather than random, and consequently, the results should be interpreted as representative of the homegardens studied and cannot be extrapolated to the broader homegardening population.

5.1 Characteristics of homegardeners

The 119 surveyed homegardeners were, on average, 51 years old (SD = 15.6), with ages ranging from young adults in their early 20s to elderly participants above 80. Women predominated among gardeners, representing about 71% of the sample. Education levels varied from primary education (14%) to completed secondary school (28%), through respondents who held tertiary degrees (58%). Most gardeners were unemployed (52.1%), and among the workers, there were teachers, lawyers or accountants.

Nearly all respondents cultivated their homegardens on land directly associated with their dwelling, either owned (87.4%) or rented (12.6%), with only a few cases involving informal access arrangements. Participants largely belonged to lower socio-economic strata (87%; see Table 4) following a similar pattern to the socio-economic stratification of Bogotá. Households were typically small, averaging 3.7 members.

Table 4. Sociodemographic and household characteristics of homegardeners in Bogotá (n=119).

Variable	Description	Measurement	Mean (SD)
Homegardeners' characteristics			
Age	Gardener's age (years)	Continuous	51 (15.6)
Gender	Gender of gardener	0 = Male 1 = Female	0 = 29.4% 1 = 70.6%
Education level	Highest level of formal education attained by the gardener	0 = Primary 1 = Secondary 2 = Tertiary	0 = 14.3% 1 = 27.7% 2 = 58%
Marital status	Condition of being in a relationship or not	0 = Other 1 = In a relationship	0 = 49.6% 1 = 50.4%
Major occupation	The gardeners' job status	0 = Employed 1 = Unemployed	0 = 47.9% 1 = Unemployed 52.1%
Household characteristics			
Household size	Number of people living in the household	Continuous	3.7 (2.1)
Socio-economic strata	Official classification of dwellings used as contextual proxy for income	0 = Low 1 = Middle-high	0 = 87% 1 = 13%
Household ownership	Possession over the gardeners' dwelling	0 = Rented 1 = Owned	0 = 12.6% 1 = 87.4%
Food Insecurity	Proportion of the population experiencing moderate or severe food insecurity	Continuous	22.8% of moderate-or-severe insecurity
Location	Area of the city where respondents live and run their homegarden	0 = Northern foothills 1= Centre 2= South periphery 3= West 4= Northern periphery	0 = 16% 1 = 26% 2 = 24% 3 = 15% 4 = 19%

Note: Values are presented as mean with standard deviation (SD) for continuous variables and percentages for categorical variables. Coding for categorical variables is indicated in the third column.

Food insecurity was present among respondents: 22.8% of households experienced moderate-or-severe insecurity, and 3.8% severe insecurity, according to the Food Insecurity Experience Scale, with a Rasch reliability of 0.76, reflecting a good model fit. Food insecurity was reflected in experiences such as worrying about running out of food, being unable to afford healthy and nutritious items, relying on a limited variety of foods, skipping meals, eating less than needed, or, in most severe cases, going entire days without eating.

Overall, the profile of gardeners is varied but generally reflects an older, predominantly female group, with diverse educational backgrounds, mostly from lower socio-economic strata. In general, the sample shares key demographic features with the broader population of Bogotá, including the prevalence of food insecurity, socio-economic stratification, and employment rates, while exhibiting a slightly older age structure, higher levels of home ownership and a greater predominance of women.

5.2 Homegardening practices

Gardening was primarily subsistence-oriented, with minimal commercialisation. Only one respondent reported selling up to 50% of their harvest, while twelve gardeners sold up to 30% of the produce. Respondents largely attributed this low commercialisation to limited surplus production and scarce market opportunities. Livestock keeping was also limited, with 28% of gardeners raising mainly chickens and sometimes rabbits, usually for household consumption rather than income generation.

Pest management emerged as a challenge for 67% of respondents, yet only 6% reported using chemical pesticides. Instead, the majority relied on manual control or natural alternatives, including preparations made from potassium soap, tobacco, nettle, garlic or chilli. Similarly, chemical fertilisers were used by only 4% of gardeners, with most preferring organic methods, such as vermicompost, manure, or compost derived from kitchen residues. Besides pest control and fertilisation, respondents frequently engaged in pruning and manual weeding to optimise plant growth.

These practices reflect both cultural preferences for natural inputs and a reduced dependency on external resources, while reinforcing the recycling of organic matter within households. In addition, some gardeners collect rainwater for irrigation, a practice that reduces reliance on municipal supplies, lowers household costs, and enhances the ecological benefits of urban homegardening.

Cultivation took place in a variety of arrangements: directly in the soil, in containers, or in a combination of both. Container gardening was particularly important for households without direct access to soil, allowing them to overcome spatial constraints and still maintain a productive homegarden. The reuse of containers, bottles or repurposed materials was common, demonstrating the creativity and adaptability of gardeners in making the most of limited urban space.

Respondents, however, highlighted several constraints that limit gardening productivity. The most frequently mentioned was the small size of homegardens (82.4%), followed by insufficient knowledge of garden management (47.9%). In addition, a third of respondents (33%) considered the city´s weather conditions to be unfavourable for cultivation. Despite these hurdles, gardeners expressed a strong commitment to the practice; 99% planned to continue gardening, and 98% stated they would encourage others to pursue it.

Figure 3. **Productive practices observed in surveyed urban homegardens.**
The photographs illustrate management strategies, including container gardening, rainwater collection, composting, and small-scale livestock keeping (rabbits and chickens), reflecting gardeners´ adaptability and low input dependency.

5.3 Plant diversity and use

The homegardens surveyed contained high plant species diversity (H´=4.05) and richness (DMg=27.22), with species relatively evenly distributed across the gardens (J´=0.73). In total, 253 species belonging to 72 families, and 177 genera were recorded (**Table 5. Plant species in homegardens in Bogotá and their reported use.**Table 5). The most species-rich families were Crassulaceae (33 species), Asteraceae (23), Lamiaceae (19) and Solanaceae (14), which together accounted for a substantial share of the total flora (Figure 4).

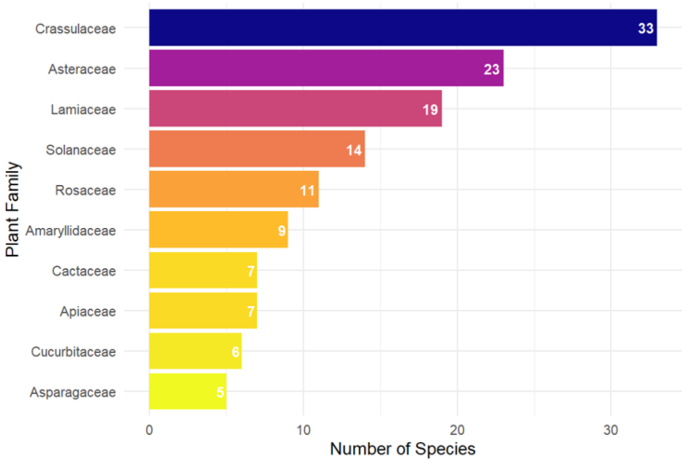

Figure 4. Most abundant families in surveyed urban homegardens.
The bar chart illustrates the number of species recorded for the most species-rich plant families, highlighting Crassulaceae and Asteraceae as the dominant families in the surveyed homegardens.

Use reports totalled 2,405, with food uses dominating (58.4%), followed by medicinal (21.4%) and ornamental (18.2%), whereas plants with other uses such as lucky charm and living fences were less comparatively rare (2%). Multifunctionality was common: 26 species were recorded to have two uses, and five species were reported to have three uses (Figure 5). This multifunctionality illustrates how households maximise the utility of limited space, integrating species that serve overlapping purposes. In this sense, homegardeners become not only productive spaces but also multifunctional landscapes where subsistence, healthcare, aesthetics and cultural values converge.

Among the wide range of species, several stood out as particularly culturally significant. The species with the highest local cultural importance were *Brassica oleracea* (UR=85; CI=0.714; RFC=0.714), *Lactuca sativa* (UR=76; CI=0.639; RFC=0.639), *Apium graveolens* (UR=67; CI=0.563; RFC=0.529), *Beta vulgaris* (UR=66; CI=0.555; RFC=0.555) and *Ruta graveolens* (UR= 65; C8=0.546; RFC=0.529) (Figure 6). These results show that culturally important species are not limited to food crops but also encompass medicinal plants, underscoring the diverse ways in which homegardens respond to household needs.

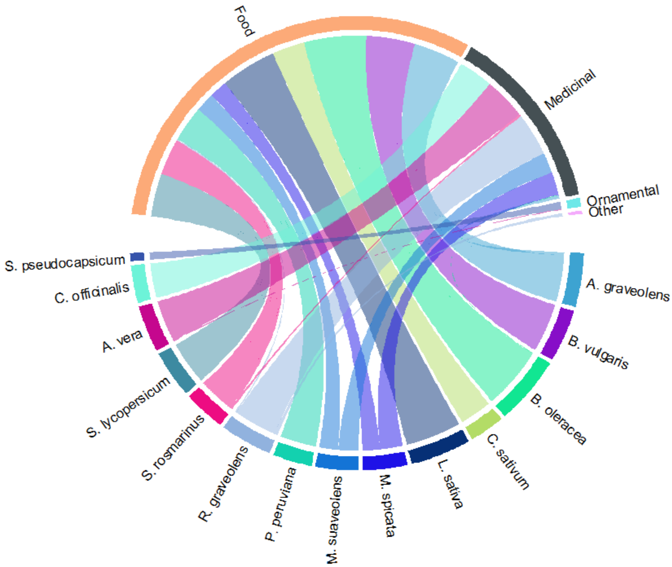

Figure 5. Distribution of use reports (URs) of the plant species with the highest cultural importance in 119 urban homegardens in Bogotá, Colombia.
The top half of the chord diagram represents the four use categories (Food, Medicinal, Ornamental and Other), while the bottom half displays the most culturally important species. Connections between the two halves illustrate how homegardeners reported utilizing these plants.

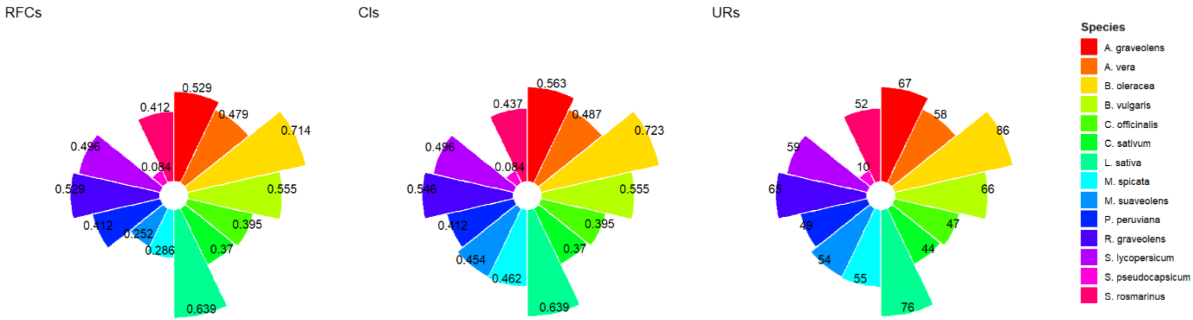

Figure 6. Ethnobotanical indices for the most culturally important plant species in surveyed homegardens in Bogotá.
The figure represents three indices that measure the cultural significance of plant species to the gardeners: Relative Frequency of Citation (RFC), Cultural Importance (CI), and Use Report (UR). Higher scores for each index indicate a greater perceived value of species. The graph allows for a visual comparison of the cultural value of key species in the surveyed gardens.

Table 5. Plant species in homegardens in Bogotá and their reported use.

Scientific name	Family	Local Name	Reported Use				CI	UR	RFC
			Food	Medicine	Ornamental	Other			
Acanthus mollis L.	Acanthaceae	Acanto			•		0.008	1	0.008
Aphelandra squarrosa Nees	Acanthaceae				•		0.008	1	0.008
Hypoestes phyllostachya Baker	Acanthaceae	Destrancadera, Abrecaminos				•	0.034	4	0.034
Thunbergia alata Bojer ex Sims	Acanthaceae				•		0.008	1	0.008
Agave attenuata Salm-Dyck	Agavaceae	Agave			•		0.008	1	0.008
Delosperma cooperi (Hook.f.) L. Bolus	Aizoceae				•		0.008	1	0.008
Alstroemeria aurea Graham	Alstroemeriaceae	Astromelia			•		0.025	3	0.025
Amaranthus caudatus L.	Amaranthaceae	Amaranto	•				0.017	2	0.017
Beta vulgaris L. *	Amaranthaceae	Acelga, Remolacha	•				0.555	66	0.555
Chenopodium quinoa Willd.	Amaranthaceae	Quinoa	•				0.017	2	0.017
Spinacia oleracea L.	Amaranthaceae	Espinaca	•				0.126	15	0.126
Agapanthus praecox Willd.	Amaryllidaceae	Agapanto			•		0.008	1	0.008
Allium ampeloprasum L.	Amaryllidaceae	Cebolla puerro	•				0.067	8	0.067
Allium cepa L.	Amaryllidaceae	Cebolla cabezona	•				0.160	19	0.160
Allium fistulosum L.	Amaryllidaceae	Cebolla larga	•				0.185	22	0.185
Allium sativum L.	Amaryllidaceae	Ajo	•	•			0.210	25	0.202
Allium schoenoprasum L.	Amaryllidaceae	Cebollín	•				0.050	6	0.050
Clivia miniata (Lindl.) Verschaff.	Amaryllidaceae				•		0.025	3	0.025
Urceolina × *grandiflora* (Planch. & Linden) Traub	Amaryllidaceae				•		0.008	1	0.008
Urceolina subedentata (Baker) Traub	Amaryllidaceae				•		0.042	5	0.042
Apium graveolens L. *	Apiaceae	Apio	•	•			0.563	67	0.529
Arracacia xanthorrhiza Bancr.	Apiaceae	Arracacha	•				0.059	7	0.059
Coriandrum sativum L.	Apiaceae	Cilantro	•				0.370	44	0.370

Daucus carota L.	Apiaceae	Zanahoria	•				0.235	28	0.235
Eryngium foetidum L.	Apiaceae	Cilantro cimarrón	•				0.008	1	0.008
Foeniculum vulgare Mill.	Apiaceae	Eneldo, Hinojo	•	•			0.160	19	0.151
Petroselinum crispum (Mill.) Fuss	Apiaceae	Perejil	•				0.378	45	0.378
Mandevilla sanderi (Hemsl.) Woodson	Apocynaceae				•		0.008	1	0.008
Vinca major L.	Apocynaceae				•		0.008	1	0.008
Colocasia esculenta (L.) Schott	Araceae	Bore, Malanga	•				0.008	1	0.008
Monstera deliciosa Liebm.	Araceae	Monstera, Balazo	•		•		0.034	4	0.034
Spathiphyllum wallisii Regel	Araceae				•		0.008	1	0.008
Zantedeschia aethiopica (L.) Spreng.	Araceae	Cartucho			•		0.168	20	0.168
Hedera helix L.	Araliaceae	Hiedra			•		0.017	2	0.017
Heptapleurum arboricola Hayata	Araliaceae				•		0.025	3	0.025
Polyscias scutellaria (Burm.f.) Fosberg	Araliaceae	Millonaria				•	0.008	1	0.008
Chrysalidocarpus lutescens H. Wendl.	Arecaceae				•		0.025	3	0.025
Agave americana L.	Asparagaceae	Agave			•		0.017	2	0.017
Chlorophytum comosum (Thunb.) Jacques	Asparagaceae				•		0.008	1	0.008
Dracaena fragrans (L.) Ker Gawl.	Asparagaceae				•		0.084	10	0.084
Dracaena hyacinthoides (L.) Mabb.	Asparagaceae				•		0.008	1	0.008
Ledebouria socialis (Baker) Jessop	Asparagaceae				•		0.008	1	0.008
*Aloe vera (*L.) Burm. f.	Asphodelaceae	Sábila		•	•		0.487	58	0.479
Kniphofia uvaria (L.) Oken	Asphodelaceae				•		0.008	1	0.008
Asplenium nidus L.	Aspleniaceae				•		0.017	2	0.017
Achillea millefolium L.	Asteraceae	Milenrama		•			0.008	1	0.008
Ambrosia artemisiifolia L.	Asteraceae	Altamisa		•			0.034	4	0.034
Artemisia absinthium L.	Asteraceae	Ajenjo				•	0.025	3	0.025
Bidens pilosa L.	Asteraceae	Chipaca		•			0.034	4	0.034

Calendula officinalis L.	Asteraceae	Caléndula		•		0.395	47	0.395
Chrysanthemum × morifolium (Ramat.) Hemsl.	Asteraceae	Crisantemo			•	0.008	1	0.008
Chrysanthemum indicum L.	Asteraceae				•	0.008	1	0.008
Curio citriformis (G. D. Rowley) P. V. Heath	Asteraceae				•	0.008	1	0.008
Curio rowleyanus (H. Jacobsen) P. V. Heath	Asteraceae				•	0.008	1	0.008
Cynara cardunculus L.	Asteraceae	Alcachofa	•			0.008	1	0.008
Dahlia imperialis Roezl ex Ortgies	Asteraceae				•	0.008	1	0.008
Dahlia pinnata Cav.	Asteraceae				•	0.008	1	0.008
Dimorphotheca ecklonis DC.	Asteraceae	Margarita			•	0.076	9	0.076
Galinsoga parviflora Cav.	Asteraceae	Guascas	•			0.050	6	0.050
Helianthus annuus L.	Asteraceae	Girasol			•	0.034	4	0.034
Heliopsis buphthalmoides (Jacq.) Dunal	Asteraceae	Guacas	•			0.008	1	0.008
Lactuca sativa L. *	Asteraceae	Lechuga	•			0.639	76	0.639
Matricaria chamomilla L.	Asteraceae	Manzanilla amarga	•	•		0.143	17	0.109
Senecio sp. L.	Asteraceae				•	0.008	1	0.008
Smallanthus sonchifolius (Poepp.) H.Rob.	Asteraceae	Yacón	•	•		0.143	17	0.092
Tagetes erecta L.	Asteraceae				•	0.008	1	0.008
Tanacetum parthenium (L.) Sch.Bip.	Asteraceae	Manzanilla dulce	•	•		0.261	31	0.202
Taraxacum sect. *Taraxacum* F.H. Wigg.	Asteraceae	Diente de león	•	•		0.193	23	0.151
Impatiens walleriana Hook. F.	Balsaminaceae				•	0.050	6	0.050
Begonia sp. L.	Begoniaceae				•	0.025	3	0.025
Borago officinalis L.	Boraginaceae	Borraja		•		0.025	3	0.025
Brassica oleracea L.*	Brassicaceae	Tallo, Repollo, Coliflor, Kale, Brócoli	•	•		0.714	85	0.714

Brassica rapa L.	Brassicaceae	Nabo	•				0.034	4	0.034
Eruca vesicaria (L.) Cav.	Brassicaceae	Rúgula	•				0.034	4	0.034
Raphanus raphanistrum L.	Brassicaceae	Rábano	•				0.168	20	0.168
Aechmea calyculata (É. Morren) Baker	Bromeliaceae				•		0.008	1	0.008
Ananas comosus (L.) Merr.	Bromeliaceae	Piña	•				0.025	3	0.025
Goudaea ospinae (H. Luther) W. Till & Barfuss	Bromeliaceae				•		0.008	1	0.008
Guzmania monostachia (L.) Rusby ex Mez	Bromeliaceae				•		0.042	5	0.042
Austrocylindropuntia cylindrica (Lam.) Backeb.	Cactaceae	Cactus			•		0.025	3	0.025
Brasiliopuntia brasiliensis (Willd.) A.Berger	Cactaceae	Cactus			•		0.008	1	0.008
Cephalocereus sp. Pfeiff	Cactaceae	Cactus			•		0.008	1	0.008
Echinopsis sp. Zucc.	Cactaceae				•		0.008	1	0.008
Epiphyllum phyllanthus (L.) Haw.	Cactaceae	Cactus			•		0.050	6	0.050
Opuntia ficus-indica (L.) Mill.	Cactaceae	Cactus, Nopal	•		•		0.025	3	0.025
Schlumbergera truncata (Haw.) Moran	Cactaceae	Cactus			•		0.126	15	0.126
Cannabis sativa L.	Cannabaceae	Cannabis, Marihuana		•			0.202	24	0.202
Canna indica L.	Cannaceae	Achira			•		0.059	7	0.059
Vasconcellea pubescens A.DC.	Caricaceae	Papayuela	•				0.126	15	0.126
Dianthus caryophyllus L.	Caryophyllaceae	Clavel			•		0.059	7	0.059
Dianthus chinensis L.	Caryophyllaceae				•		0.008	1	0.008
Tradescantia fluminensis Vell.	Commelinaceae	Suelda consuelda		•		•	0.101	12	0.101
Tradescantia zebrina Bosse	Commelinaceae	Zebra			•		0.017	2	0.017
Aeonium arboreum (L.) Webb & Berthel.	Crassulaceae	Suculenta			•		0.059	7	0.059
Aeonium sp. Webb & Berthel.	Crassulaceae	Suculenta			•		0.008	1	0.008
Crassula capitella Thunb.	Crassulaceae	Origami			•		0.025	3	0.025

Crassula ovata (Mill.) Druce	Crassulaceae	Jade	•	0.109	13	0.109
Dudleya edulis (Nutt.) Moran	Crassulaceae		•	0.008	1	0.008
Dudleya sp.1 Britton & Rose	Crassulaceae		•	0.008	1	0.008
Dudleya sp.2 Britton & Rose	Crassulaceae		•	0.008	1	0.008
Echeveria elegans (Rose) A. Berger	Crassulaceae	Roseta	•	0.092	11	0.092
Echeveria gigantea Rose & Purpus	Crassulaceae		•	0.017	2	0.017
Echeveria pallida E. Walther	Crassulaceae		•	0.008	1	0.008
Echeveria pulidonis E. Walther	Crassulaceae		•	0.008	1	0.008
Echeveria secunda Booth ex Lindl.	Crassulaceae		•	0.008	1	0.008
Echeveria sp. DC	Crassulaceae		•	0.008	1	0.008
Graptopetalum paraguayense (N.E.Br) E. Walther	Crassulaceae		•	0.034	4	0.034
Kalanchoe beharensis Drake	Crassulaceae		•	0.008	1	0.008
Kalanchoe blossfeldiana Poelln.	Crassulaceae	Kalanchoe	•	0.042	5	0.042
Kalanchoe daigremontiana Raym.-Hamet & H.Perrier	Crassulaceae		•	0.008	1	0.008
Kalanchoe pumila Baker	Crassulaceae		•	0.017	2	0.017
Kalanchoe tomentosa Baker	Crassulaceae	Oreja de elefante	•	0.017	2	0.017
Malephora crocea (Jacq.) Schwantes	Crassulaceae		•	0.008	1	0.008
Pachyphytum hookeri (Salm-Dyck) A. Berger	Crassulaceae		•	0.008	1	0.008
Pachyphytum oviferum J. A. Purpus	Crassulaceae		•	0.008	1	0.008
Sedum album L.	Crassulaceae		•	0.017	2	0.017
Sedum dasyphyllum L.	Crassulaceae		•	0.008	1	0.008
Sedum mendozae (Glass & Cházaro) V. V. Byalt	Crassulaceae		•	0.008	1	0.008
Sedum morganianum E. Walther	Crassulaceae		•	0.042	5	0.042
Sedum pachyphyllum Rose	Crassulaceae		•	0.025	3	0.025

Sedum palmeri S. Watson	Crassulaceae				•	0.025	3	0.025
Petrosedum sediforme (Jacq.) Grulich	Crassulaceae				•	0.008	1	0.008
Sedum sexangulare L.	Crassulaceae				•	0.017	2	0.017
Sedum sp. 1 L.	Crassulaceae				•	0.008	1	0.008
Sedum sp. 2 L.	Crassulaceae				•	0.008	1	0.008
Sedum sp. 3 L.	Crassulaceae				•	0.008	1	0.008
Cucumis sativus L.	Cucurbitaceae	Pepino cohombro	•			0.008	1	0.008
Cucurbita ficifolia Bouché	Cucurbitaceae	Calabaza	•			0.025	3	0.025
Cucurbita maxima Duchesne	Cucurbitaceae	Ahuyama	•			0.109	13	0.109
Cucurbita pepo L.	Cucurbitaceae	Calabacín	•			0.101	12	0.101
Cyclanthera pedata (L.) Schrad.	Cucurbitaceae	Pepino de guiso	•			0.151	18	0.151
Sicyos edulis Jacq.	Cucurbitaceae	Guatila, Cidra	•			0.017	2	0.017
Platycladus orientalis (L.) Franco	Cupressaceae	Pino			•	0.017	2	0.017
Gaultheria erecta Vent.	Ericaceae	Agraz	•			0.008	1	0.008
Rhododendron simsii Planch.	Ericaceae	Azalea			•	0.034	4	0.034
Euphorbia milii Des Moul.	Euphorbiaceae	Corona de Cristo			•	0.042	5	0.042
Euphorbia pulcherrima Willd. Ex Klotzsch	Euphorbiaceae	Árbol de navidad			•	0.017	2	0.017
Ricinus communis L.	Euphorbiaceae	Higuerilla		•		0.008	1	0.008
Lathyrus oleraceus Lam.	Fabaceae	Arveja	•			0.185	22	0.185
Phaseolus vulgaris L.	Fabaceae	Fríjol, Habichuela	•			0.202	24	0.202
Vicia faba L.	Fabaceae	haba	•			0.118	14	0.118
Vicia lens (L.) Coss. & Germ.	Fabaceae	lenteja	•			0.008	1	0.008
Quercus humboldtii Bonpl.	Fagaceae	Roble			•	0.008	1	0.008
Pelargonium graveolens L´Hér	Geraniaceae	Aroma, Citronela			•	0.176	21	0.176
Pelargonium zonale (L.) L´Hér.	Geraniaceae	Novio, Geranio			•	0.277	33	0.277
Nematanthus gregarius D.L. Denham	Gesneriaceae	Pescadito	•			0.067	8	0.067

Sinningia speciosa (G.Lodd. ex Ker Gawl.) Hiern	Gesneriaceae				•		0.008	1	0.008
Hydrangea macrophylla (Thunb.) Ser.	Hydrangeaceae	Hortensia			•		0.025	3	0.025
Gladiolus communis L.	Iridaceae	Gladiolo			•		0.017	2	0.017
Iris sp. Tourn. ex L.	Iridaceae	Flor de un día			•		0.059	7	0.059
Coleus amboinicus Lour.	Lamiaceae	Orégano, Oreganon	•				0.092	11	0.092
Coleus forsteri (Benth.) A.J. Paton	Lamiaceae	Incienso		•	•	•	0.050	6	0.025
Coleus madagascariensis (Pers.) A. Chev.	Lamiaceae	Incienso			•		0.017	2	0.017
Coleus scutellarioides (L.) Benth.	Lamiaceae				•		0.025	3	0.025
Lavandula angustifolia Mill.	Lamiaceae	Lavanda		•		•	0.067	8	0.067
Melissa officinalis L.	Lamiaceae	Toronjil	•	•			0.210	25	0.143
Mentha × piperita L.	Lamiaceae	Menta	•	•			0.210	25	0.151
Mentha × *rotundifolia (*L.) Huds.	Lamiaceae	Yerbabuena	•	•			0.025	3	0.025
Mentha pulegium L.	Lamiaceae	Poleo		•			0.034	4	0.034
Mentha spicata L.	Lamiaceae	Yerbabuena	•	•			0.462	55	0.286
Mentha suaveolens Ehrh.	Lamiaceae	Menta, Yerbabuena	•	•			0.454	54	0.252
Ocimum basilicum L.	Lamiaceae	Albahaca	•				0.185	22	0.185
Origanum majorana L.	Lamiaceae	Mejorana		•			0.050	6	0.050
Origanum vulgare L.	Lamiaceae	Orégano	•				0.067	8	0.067
Salvia leucantha Cav.	Lamiaceae	Salvia		•			0.050	6	0.050
Salvia officinalis L.	Lamiaceae	Salvia		•			0.042	5	0.042
Salvia rosmarinus Spenn.	Lamiaceae	Romero	•	•			0.437	52	0.412
Salvia splendens Sellow ex Nees	Lamiaceae				•		0.008	1	0.008
Thymus vulgaris L.	Lamiaceae	Tomillo	•				0.176	21	0.176
Laurus nobilis L.	Lauraceae	Laurel			•		0.034	4	0.034
Persea americana Mill.	Lauraceae	Aguacate	•		•		0.109	13	0.109
Lilium candidum L.	Liliaceae	Lirio, Azucena			•		0.050	6	0.050

Linum usitatissimum L.	Linaceae	Linaza	•				0.025	3	0.025
Alcea rosea L.	Malvaceae	Malva			•		0.017	2	0.017
Hibiscus rosa-sinensis L.	Malvaceae				•		0.025	3	0.025
Malva arborea (L.) Webb & Berthel.	Malvaceae	Malva			•		0.008	1	0.008
Malva parviflora L.	Malvaceae	Malva		•			0.025	3	0.025
Ctenanthe setosa (Roscoe) Eichler	Marantaceae				•		0.008	1	0.008
Maranta leuconeura É. Morren	Marantaceae				•		0.008	1	0.008
Centradenia grandifolia (Schltdl.) Endl.	Melastomataceae	Siete cueros			•		0.008	1	0.008
Ficus carica L.	Moraceae	Breva	•				0.126	15	0.126
Ficus elastica Roxb. Ex Hornem.	Moraceae	Caucho			•		0.008	1	0.008
Musa acuminata Colla	Musaceae	Sagú	•				0.017	2	0.017
Eugenia uniflora L.	Myrtaceae	Eugenia	•		•	•	0.067	8	0.050
Feijoa sellowiana (O. Berg) O. Berg	Myrtaceae	Feijoa	•				0.143	17	0.143
Psidium guajava L.	Myrtaceae	Guayabo	•				0.008	1	0.008
Bougainvillea glabra Choisy	Nyctaginaceae	Buganvil			•		0.067	8	0.067
Jasminum officinale L.	Oleaceae	Jazmín			•		0.008	1	0.008
Fuchsia boliviana Carrière	Onagraceae	Fucsia			•		0.067	8	0.067
Fuchsia sp. Plum. ex. L.	Onagraceae	Fucsia			•		0.042	5	0.042
Oxalis triangularis A. St.-Hil.	Oxalidaceae				•		0.017	2	0.017
Eschscholzia californica Cham.	Papaveraceae	Rasete		•			0.008	1	0.008
Papaver rhoeas L.	Papaveraceae	Amapola	•				0.008	1	0.008
Papaver somniferum L.	Papaveraceae	Amapola			•		0.008	1	0.008
Passiflora edulis Sims	Passifloraceae	Maracuyá	•				0.034	4	0.034
Passiflora ligularis Juss.	Passifloraceae	Granadilla	•				0.067	8	0.067
Passiflora tripartita (Juss.) Poir	Passifloraceae	Curuba	•				0.101	12	0.101
Peperomia subspathulata Yunck.	Piperaceae	Canelón	•	•			0.227	27	0.202

Plantago major L.	Plantaginaceae	Llantén		•		0.185	22	0.185
Cymbopogon citratus (DC.) Stapf	Poaceae	Limonaria	•	•		0.176	21	0.092
Triticum aestivum L.	Poaceae	Trigo	•			0.008	1	0.008
Zea mays L.	Poaceae	Maíz	•			0.176	21	0.176
Persicaria capitata (Buch-Hum. ex D.Don) H. Gross	Polygonaceae	Confeti			•	0.025	3	0.025
Rheum palmatum L.	Polygonaceae	Ruibarbo	•			0.042	5	0.042
Rumex obtusifolius L.	Polygonaceae	Lengua de vaca		•		0.050	6	0.050
Platycerium bifurcatum (Cav.) C. Chr.	Polypodiaceae	Cacho de venado			•	0.050	6	0.050
Portulaca oleracea L.	Portulaceae	Verdolaga		•	•	0.025	3	0.017
Cyclamen persicum Mill.	Primulaceae	Violeta de Los Alpes			•	0.008	1	0.008
Primula obconica Hance	Primulaceae	Primavera			•	0.008	1	0.008
Primula vulgaris Huds.	Primulaceae	Jacinto			•	0.025	3	0.025
Eriobotrya japonica (Thunb.) Lindl.	Rosaceae	Níspero	•			0.008	1	0.008
Fragaria vesca L.	Rosaceae	Fresa	•			0.361	43	0.361
Malus domestica (Suckow) Borkh.	Rosaceae	Manzana	•	•		0.017	2	0.008
Prunus domestica L.	Rosaceae	Ciruelo	•			0.050	6	0.050
Prunus persica (L.) Batsch	Rosaceae	Durazno	•			0.084	10	0.084
Prunus serotina Ehrh.	Rosaceae	Cerezo	•			0.084	10	0.084
Pyrus communis L.	Rosaceae	Pera	•			0.017	2	0.017
Rosa chinensis Jacq.	Rosaceae	Rosa			•	0.134	16	0.134
Rubus idaeus L.	Rosaceae	Frambuesa	•			0.101	12	0.101
Rubus rosifolius Sm.	Rosaceae	Frambuesa	•			0.008	1	0.008
Rubus ulmifolius Schott	Rosaceae	Mora	•			0.034	4	0.034
Coffea arabica L.	Rubiaceae	Café	•			0.076	9	0.076
Citrus × *aurantium* L.	Rutaceae	Naranjo	•			0.076	9	0.076
Citrus × *limon* (L.) Osbek	Rutaceae	Limón	•			0.042	5	0.042

Coleonema album (Thunb.) Bart. & H.L. Wendl.	Rutaceae	Diosme			•		0.017	2	0.017
Ruta graveolens L. *	Rutaceae	Ruda	•	•		•	0.546	65	0.529
Brugmansia suaveolens (Humb. & Bonpl. Ex Willd.) Sweet	Solanaceae	Borrachero			•		0.017	2	0.017
Capsicum annuum L.	Solanaceae	Ají, Pimentón	•				0.210	25	0.210
Capsicum pubescens Ruiz & Pav.	Solanaceae	Ají rocoto	•				0.034	4	0.034
Cestrum nocturnum L.	Solanaceae	Caballero de la noche			•	•	0.059	7	0.042
Nicotiana tabacum L.	Solanaceae	Tabaco		•		•	0.067	8	0.067
Physalis peruviana L.	Solanaceae	Uchuva	•				0.412	49	0.412
Solanum betaceum Cav.	Solanaceae	Tomate de árbol	•				0.092	11	0.092
Solanum laxum Spreng.	Solanaceae	Manto de María			•		0.008	1	0.008
Solanum lycopersicum L.	Solanaceae	Tomate	•				0.496	59	0.496
Solanum melongena L.	Solanaceae	Berenjena	•				0.008	1	0.008
Solanum muricatum Aiton	Solanaceae	Pepino dulce	•				0.025	3	0.025
Solanum pseudocapsicum L.	Solanaceae	Mirto	•				0.084	10	0.084
Solanum quitoense Lam.	Solanaceae	Lulo	•				0.227	27	0.227
Solanum tuberosum L.	Solanaceae	Papa	•				0.395	47	0.395
Oxalis tuberosa Molina	Tropaeolaceae	Ibias	•				0.008	1	0.008
Tropaeolum majus L.	Tropaeolaceae		•				0.008	1	0.008
Tropaeolum tuberosum Ruiz & Pav.	Tropaeolaceae	Cubios	•				0.076	9	0.076
Urtica dioica L.	Urticaceae	Ortiga	•	•		•	0.092	11	0.076
Urtica urens L.	Urticaceae	Ortiga	•	•		•	0.160	19	0.134
Aloysia citrodora Paláu	Verbenaceae	Cidrón	•	•			0.345	41	0.261
Duranta erecta L.	Verbenaceae	Duranta			•		0.025	3	0.025
Lippia alba (Mill.) N.E.Br. ex Britton & P.Wilson	Verbenaceae	Pronto alivio		•			0.017	2	0.017

Sambucus nigra L.	Viburnaceae	Sauco		•			0.067	8	0.067
Viola × *wittrockiana* Gams	Violaceae	Pensamiento			•		0.008	1	0.008
Cissus verticillata (L.) Nicolson & C.E.Jarvis	Vitaceae	Insulina		•			0.034	4	0.034
Curcuma longa L.	Zingiberaceae	Cúrcuma	•				0.008	1	0.008

Note: The table presents the complete list of species found in the surveyed homegardens. Reported use categories included food, medicine, ornamental and other (cultural, ecological). A filled circle (·) indicates the presence of a reported use. CI = Cultural importance index, calculated as the sum of use-reports for a species divided by the total number of respondents; UR = Use reports, the total number of ties a species was mentioned for any use; RFC = Relative Frequency of Citation, calculated as the proportion of respondents mentioning the species. Species marked with * were among the 10 most frequently cited plants.

5.3.1 Food plants

A total of 100 food plant species belonging to 75 genera and 30 families were recorded from 117 homegardens. Lamiaceae and Asteraceae were the most representative botanical families with ten species each. On average, gardeners cultivated 12 (±7) food species per homegarden.

The most common edible species were *Brassica oleracea* (present in 85 homegardens), *Lactuca sativa* (76) and *Beta vulgaris* (66) (Figure 7), good sources of essential micronutrients such as vitamin A, vitamin C and folate, as well as dietary fibre. Together with fast-growing species such as *Coriandrum sativum* and *Raphanus raphanistrum*, these crops provide staggered harvests, well-suited to urban plots, while perennials such as *Passiflora edulis* complement them with long-term yields.

For 23 food plant species gardeners reported additional uses, most often medicinal, showing how food plants contribute simultaneously to nutrition and health. They also dominate cultural importance, being the most widely planted and frequently used species. Food plant species diversity was high (H´=3.48; DMg=10.92), with even distribution across species (J´=0.76), indicating that households cultivate a broad set of food plants for dietary variety.

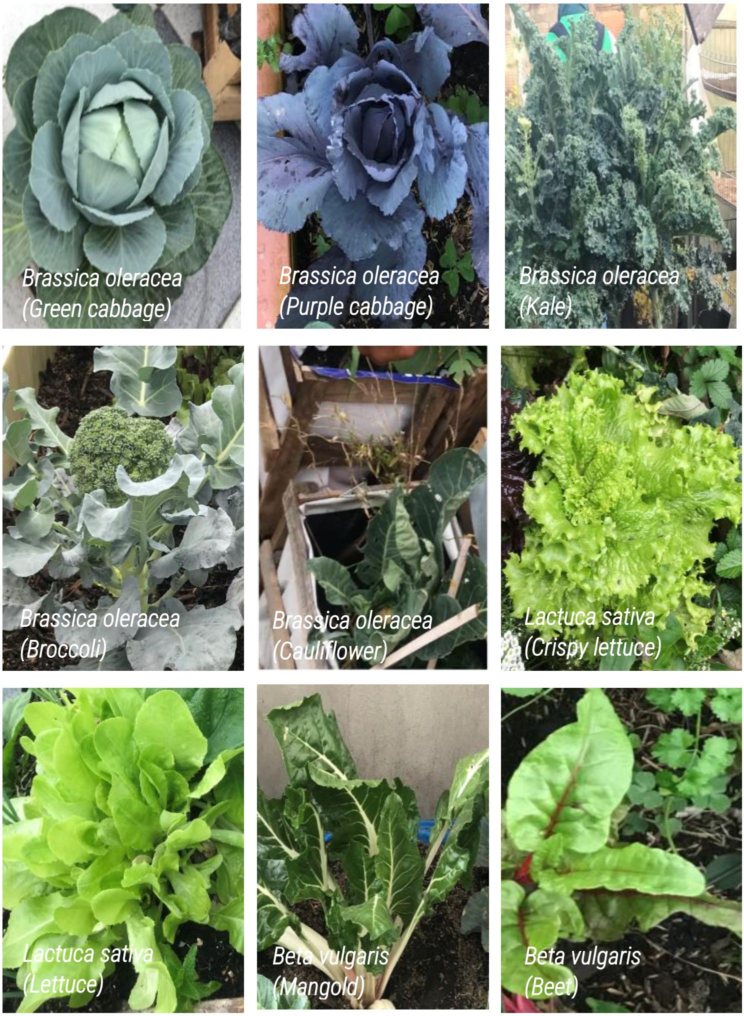

Figure 7. The most common food plants in the surveyed homegardens.
This collage of photographs shows different varieties of cultivars of the key food species identified in the study. The plants are labelled to show *Brassica* oleracea (Cabbage, Kale, Broccoli and Cauliflower), *Lactuca sativa* (Lettuce), and *Beta vulgaris* (Mangold, Beet).

5.3.2 Medicinal plants

Forty-six species (18% of the total recorded species) were reported as medicinal, spanning 39 genera and 24 families. For 26 of these species, gardeners mentioned additional uses beyond healthcare. Lamiaceae (13 species) and Asteraceae (8) were the most representative botanical families.

Medicinal plant species diversity (H´=3.12) and richness (DMg=5.62) were high, and all species had similar abundance (J´=0.81). Medicinal plants were common to 111 homegardens, with a mean of 5 (±3) species per homegarden. Only three homegardens were used mainly for medicinal purposes. The widespread inclusion of medicinal species across homegardens highlights their role as an essential, complementary component of the system, reinforcing both health and cultural traditions. These plants were typically used for everyday ailments such as digestive problems, skin care and colds, demonstrating their importance for accessible household healthcare.

While less abundant than food species, medicinal plants are nearly ubiquitous across homegardens and often overlap with edible uses, their widespread presence suggest a strong self-care component in gardening, enabling access to trusted remedies for common ailments.

Figure 8. The most common medicinal plants in the surveyed homegardens. This collage of photographs shows the key medicinal species identified in the study. The plants are labelled to show *Ruta graveolens (Rue*), *Aloe vera* (Aloe), and *Calendula officinalis* (Marigold).

The most frequent species with medicinal use were *Ruta graveolens* (present in 59 homegardens), *Aloe vera* (57) and *Calendula officinalis* (47) (Figure 8). Multifunctional species such as *Aloe vera* and *Calendula officinalis* further illustrate how medicinal plants overlap with other domains of use, enhancing the multifunctionality of homegardens.

5.3.3 Ornamental plants

The ornamental plant use category was the most taxonomically diverse, with 130 species from 50 families and 92 genera. For seven of these plant species, gardeners mentioned additional uses. Crassulaceae (33 species) and Asteraceae (10) were the most representative botanical families.

The most frequent species were *Pelargonium zonale* (present in 33 homegardens), *Pelargonium graveolens* (21) and *Zantedeschia aethiopica* (20).

Ornamental plants were present in 89 (75%) homegardens and a large number of species (86) were grown in just one or two homegardens. Only 3 homegardens had ≥80% ornamental plants. The mean number of species in this use category was 5 (±4) per homegarden. Diversity (H´=3.94) and richness (DMg=17.83) were high, with balanced representation of species (J´=0.81).

Ornamentals enhance the visual, cultural, and recreational value of homegardens. Their broad taxonomic representation, combined with low frequency per species, highlights how aesthetic planting choices reflect personal taste, identity, and creativity, adding another layer of functionality to the homegarden system.

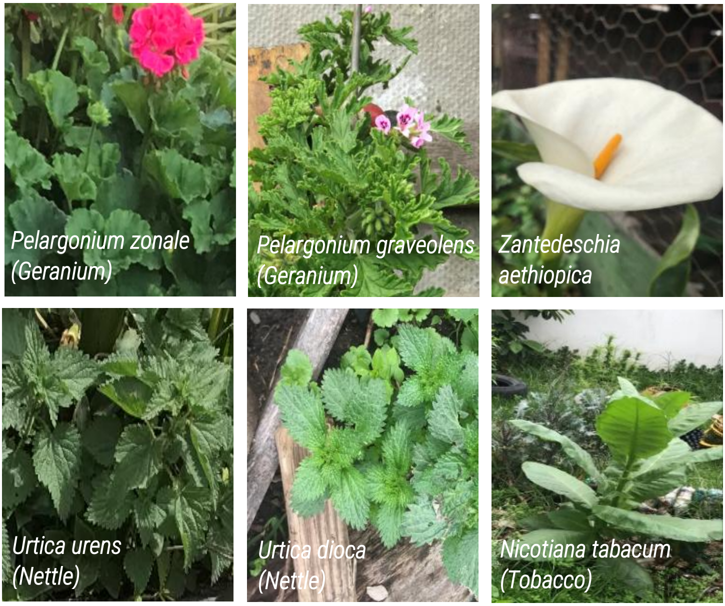

Figure 9. The most common ornamental and "other" plant species in the surveyed homegardens.

This collage of photographs shows the key species identified in the study for two categories. The plants in the top row, representing ornamental species, are *Pelargonium zonale* (Geranium), *Pelargonium graveolens* (Geranium), and *Zantedeschia aethiopica* (Calla Lily). The plants in the bottom row, representing the species in the "other" category, are *Urtica urens* (Nettle), *Urtica dioica* (Nettle), *Nicotiana tabacum* (Tobacco).

5.3.4 Other uses

Twelve of the 253 recorded species had complementary uses such as living fences, repellents, or lucky charms. These species were present in 43 homegardens and belonged to 9 families and 11 genera. Urticaceae was the most representative family with two species. The most common species within this use category were *Urtica urens* (present in 12 homegardens), *Urtica dioica* (8) and *Nicotiana tabacum* (7) (Figure 9).

Although less common than other use categories, this category demonstrates that homegardens also sustain symbolic, protective, and ecological functions, reinforcing their multifunctionality. Diversity and richness were lower than in other categories (H´=1.84; DMg=1.80), with relatively even distribution across (J´=0.74).

5.4 Functional types of gardens

Cluster analysis identified three distinct functional types of homegardens: food-oriented (n=28), ornamental (n=26) and multipurpose (n=65) (Figure 10). The discriminant analysis confirmed the robustness of this typology, correctly assigning 93.3% of gardens to their clusters.

As expected, the clusters differ in their dominant plant uses (Figure 11). Food-oriented gardens allocated 85% of species to edible uses, confirming their subsistence role. Ornamental gardens emphasised decorative species (43%) and had relatively little food orientation (36%). Multipurpose gardens showed a more balanced profile, with food (59%) and medicinal (27%) plants dominating, alongside occasional symbolic or ecological functions. These functional contrasts illustrate that urban gardening is not a homogeneous activity but rather reflects distinct priorities among households.

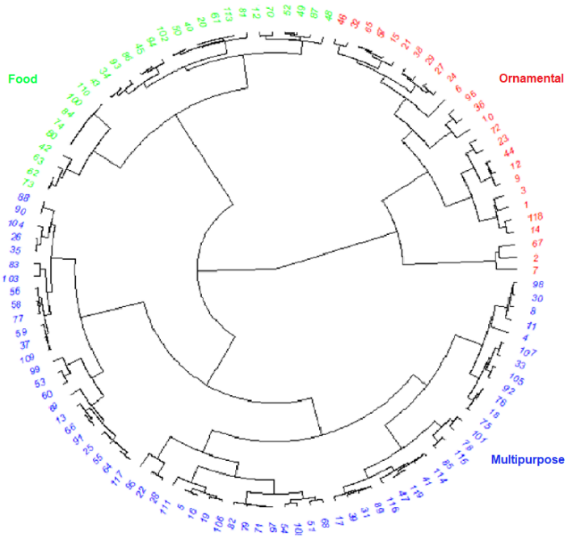

Figure 10. Hierarchical cluster analysis of 119 urban homegardens in Bogotá. The dendrogram illustrates how homegardens in the study were grouped into three distinct functional groups: Ornamental (red), Multipurpose (blue), and Food (green). This classification provides insights into the diverse roles that urban homegardens play for their managers. Each number represents a specific homegarden.

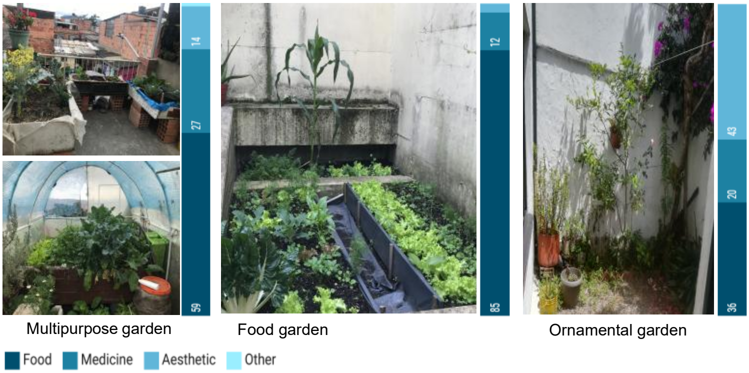

Figure 11. Plant use distribution by homegarden cluster in Bogotá.
The figure shows a visual reference of homegardens from the identified clusters (Ornamental, Multipurpose, and Food-oriented). Stacked bars display the percentage of plants used for different purposes within each cluster.

Species composition further reinforced the differentiation among clusters. A total of 65 species were shared across all three homegarden types, forming a common core of widely cultivated plants (Figure 12). The shared species pool includes representatives from 56 genera, most notably Allium and Mentha, and 28 families, particularly Lamiaceae and Apiaceae. Jaccard distance showed the greatest dissimilarity happens between ornamental and food-oriented gardens, with a Jaccard distance of 0.67, followed by a multipurpose and food-oriented gardens (0.57), and ornamental and multipurpose gardens (0.49). In other words, food-oriented and ornamental gardens are the more distinct, while multipurpose gardens form an intermediate bridge between the two.

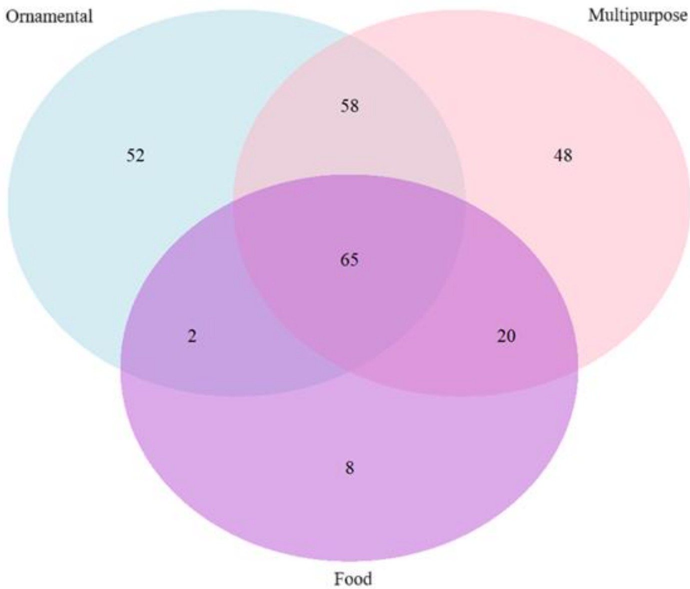

Figure 12. Venn diagram showing shared and unique species among urban homegarden clusters in Bogotá.

The diagram illustrates the species overlap between Ornamental, Multipurpose and Food oriented gardens. Numbers in the overlapping sections indicate the count of species shared by two or three clusters, while non-overlapping sections show the number of species unique to each cluster. The figure highlights that a core set of 65 species is common to all three garden types.

These patterns are further supported by plant diversity metrics (

Table *6*). Food homegardens exhibited significantly lower species richness (DMg = 3.62) than both ornamental ($p = 0.018$) and multipurpose homegardens ($p = 0.003$). The multipurpose cluster had a significantly higher number of species (S) than the food cluster ($p = 0.004$) and significantly higher number of plants (N) than the ornamental cluster (0.012). In contrast, the ornamental cluster showed significantly higher overall diversity (H´; $p = 0.008$) and evenness (J´; $p = 0.013$) than the multipurpose cluster, indicating that ornamental homegardens maintain greater diversity and more even species distribution, whereas food homegardens are more specialised.

There was also a statistically significant association between the area where the homegardens were located and the cluster ($\chi2=17.843$, $p<0.05$). The location captures meaningful socioeconomic differences with better-off households in northern areas and a larger share of lower-income households in the southern and western areas.

These findings highlight that while homegardens in Bogotá share a baseline of common species, their broader composition diverges substantially depending on household priorities and garden function.

Table 6. Characteristics of homegardeners, households and plant diversity by homegarden cluster

Variable	Description	Homegarden cluster		
		Orn. (n=26)	Mult. (n=65)	Food (n=28)
Homegardener characteristics				
Age	Gardener's age (years)	56 (28-83)	49 (20-85)	50 (22-78)
Gender	Gender of the gardener			
Male		7	21	7
Female		19	44	21
Marital status	Condition of being in a relationship or not			
In a relationship		11	33	16
Other		15	32	12
Occupation	Gardeners' job status			
Unemployed		15	34	13
Employed		11	31	15
Education	Highest level of formal education that the gardener has received			
Primary		6	8	3
Secondary		6	17	10
Tertiary		14	40	15
Household characteristics				
Socio-economic Strata	Stratification denoting low to high-income dwellings			
Low		21	56	26
Medium-High		5	9	2
Household size	Number of people living in the household	3 (1-6)*	4 (1-11)*	4 (1-11)
Food insecurity status	Proportion of population experiencing moderate or	20.67	19.19	22.30

	severe food insecurity			
Plant diversity				
S	Number of species	18 (5-34)	21 (6-48)*	15 (6-42)*
N	Number of plants	55 (9-185)*	104 (13-497)*	95 (10-798)
DMg - Margalef index	Species richness	4.7 (2.3-6.8)	4.7 (1.6-8.0)	3.6 (1.9-7.4)*
H´ - Shannon index	Species diversity	2.58 (1.3-3.2)*	2.25 (1.2-3.1)*	2.43 (1.3-3.3)
J´ - Pielou index	Species evenness	0.88 (0.7-0.9)*	0.82 (0.6-0.9)*	0.84 (0.6-0.9)

Notes: 1. Categorial variables were analysed with Fisher´s exact test, DMg was analysed using one-way ANOVA followed by Tukey´s HSD test. Variables that did not meet normality assumptions were analysed using the Kruskal-Wallis test, followed by a pairwise Wilcoxon test. **2.** * indicates a statistically significant difference between clusters (at $p<0.05$), based on post-hoc comparisons. For DMg, the food cluster differs from the other two clusters, which do not differ from each other.

5.4.1 Ornamental homegardens (n = 26)

Ornamental homegardens are primarily oriented toward aesthetic and recreational functions, maintained by older gardeners with a mean age of 56 years (range 28 – 83). These gardens are relatively small in terms of number of species (average 55 plants and 18 species per homegarden) but exhibit the highest diversity and evenness among clusters (H´ = 2.58; J´= 0.88), significantly higher than in multipurpose homegardens. This reflects a balanced mix of species with no single species dominating.

Households tended to be smaller (mean 3 members, range 1-6), with 20.7% experiencing moderate or severe food insecurity. Most gardeners were female (19 out of 26), and slightly more than half were not in a relationship (15). Most gardeners were unemployed (15), and education levels are generally higher, with 14 respondents having tertiary education (primary = 6, secondary = 6). Most households belonged to the lower social strata (21 out of 26).

5.4.2 Multipurpose homegardens (n = 65)

This was the largest cluster and combines food, medicinal and ornamental plants, with occasional cultural and ecological uses. Multipurpose homegardens hosted the highest species richness and abundance, with significantly more species than food homegardens and significantly more plants than ornamental homegardens, averaging 21 species and 104 plants per homegarden. However, their plant diversity was significantly lower than in the ornamental gardens (H´= 2.25; J´= 0.82), indicating some dominant species but maintaining balance.

Gardeners were younger than in the ornamental cluster, with a mean age of 49 years (range 20 – 85). Households were slightly larger (mean 4 members, range 1-11), with 19.8% experiencing moderate or severe food insecurity. As with other clusters, most gardeners were female (44 out of 65), from lower strata (56 out of 65), and had tertiary educations (40 gardeners). Occupational status was mixed, with nearly half unemployed (34).

5.4.3 Food-oriented homegardens (n=28)

These gardens focus primarily on household nutrition and food security, prioritising edible species over other uses. Food-oriented homegardens averaged 95 plants and 15 species per garden, with diversity metrics reflecting a concentration on a smaller set of key crops (DMg = 3.52, H´= 2.43, J´= 0.84). They exhibited significantly lower species richness (DMg) compared to both ornamental ($p = 0.018$) and multipurpose homegardens ($p = 0.003$).

Gardeners had a mean age of 50 years (range 22 – 78), are primarily female (21 out of 28) and predominantly from lower social strata (26/28). Slightly more than half were in a relationship (16), and the majority were employed (15), holding tertiary education levels. Households averaged four members (range 1-11), and 22.3% experienced moderate or severe food insecurity, the highest prevalence among clusters.

5.5 Factors determining the type of homegarden

The cluster analysis presented above revealed functional differences among the three homegarden clusters. To identify the factors driving these differences, a multinomial regression was estimated with the ornamental cluster as the reference category.

Among the variables tested, household size and plant diversity showed the greatest influence in distinguishing between homegarden types (Table 7). Household size was positively associated with the cultivation of multipurpose homegardens: for each additional household member, the odds of maintaining a multipurpose homegarden rather than an ornamental one increased by 66.2% (OR = 1.66, p = 0.009). This finding suggests that larger households are more likely to require multifunctional gardens to capable of addressing diverse needs.

Plant diversity, on the contrary, was negatively associated with both multipurpose and food homegardens. Higher plant diversity decreased the odds of cultivating both multipurpose (OR = 0.140, p = 0.002) and food homegardens (OR = 0.32, p = 0.098) compared to ornamental gardens. This indicates that ornamental homegardens tended to host higher plant species diversity, most likely due to the inclusion of a wide array of decorative species selected for aesthetic value. By contrast, food and multipurpose gardens are more selective in their plant composition, prioritising edible and medicinal species that are directly useful to the household.

Other variables, including age, education, gender, food security status, and socio-economic status, were not significantly associated with garden type. Descriptive statistics suggested some trends, for instance, food gardens were concentrated in lower socio-economic strata (26 out of 28 gardens), yet this relationship did not reach statistical significance in the regression model.

The model was statistically significant (p = 0.020), as indicated by the likelihood ratio tests. Diagnostics further revealed no issues with multicollinearity or endogeneity, confirming the robustness of the results (see Appendix 3.1for details).

Table 7. Multinomial regression estimates of factors shaping homegarden functional types in Bogotá.

	Multipurpose				Food			
Variable	B	S.E.	p-value	OR	B	S.E.	p-value	OR
(Intercept)	5.821	2.247	0.010	337.391	3.729	2.456	0.129	41.626
Plant diversity	-1.963	0.641	**0.002**	0.140	-1.136	0.687	**0.098**	0.321
Age	-0.028	0.019	0.140	0.973	-0.030	0.021	0.151	0.971
Household Size	0.508	0.193	**0.009**	1.662	0.226	0.206	0.274	1.253
Socio-economic strata	-0.862	0.800	0.281	0.422	-1.584	1.005	0.115	0.205
Food security status	-0.783	0.761	0.303	0.457	-0.619	0.814	0.447	0.538
Education (secondary)	0.178	0.879	0.840	1.194	0.749	0.983	0.446	2.115
Education (tertiary)	0.898	0.757	0.235	2.455	0.881	0.879	0.316	2.413
Gender (female)	-0.472	0.606	0.436	0.624	-0.084	0.683	0.902	0.919
Livestock	-0.958	0.623	0.125	0.384	-0.671	0.673	0.319	0.511

Note: The table reports estimated coefficients (B), standard errors (S.E.), p-values, and odd ratios (OR) for factors shaping homegarden type. The ornamental cluster serves as the reference category, with results shown for multipurpose and food-oriented gardens. Statistically significant results ($p<0.1$) are highlighted in bold.

5.6 Motivations to engage in homegardening

Thematic content analysis of the 119 interviews revealed nine primary motivations for homegardening among respondents (Figure 13). Only 3% cited one motivation, while the rest reported more than one. The top three drivers described by respondents were enjoyment of gardening (61%), food self-provision (59%) and social interaction (50%). These findings highlight that homegardening is not only a subsistence activity but also a source of personal fulfilment and social connection. Additionally, approximately one-third of respondents highlighted aesthetic (34%) and learning (29%) reasons to drive their interest in homegardening. Other less-reported reasons were economic constraints (22%), well-being (15%), environmental concerns (13%) and the tangible outcome of gardening activities (8%).

The primary motivation for respondents was the joy they found in gardening and their deep connection with the activity. Many mentioned the satisfaction derived from their interactions with nature, soil, and plants. For some, homegardening offered comfort by reconnecting them with their rural origins, whereas others simply enjoyed the practice, expressing that it brought pleasure to their lives.

Figure 13. Motivations for engaging in homegardening in Bogotá.
The radar chart illustrates the percentage of respondents who cited various motivations for engaging in gardening. The most frequently cited motivations were enjoyment (61%), self-provision (59%), and social connection (50%).

Respondents often mentioned that homegardening was a passion and that they “loved” it. Additionally, homegardens were regarded as spaces where respondents entertained themselves, made their leisure time productive and escaped from daily affairs. Gardening kept them active and occupied and gave pensioners “something to do”.

When things are quiet at home, my husband and I tend to spend time in the garden. It is a lovely way to entertain ourselves, and at the same time, we take care of the plants.

I am grateful for the garden. It is in the garden where I connect with plants, with the earth. I think my life without gardening would not be a nice life anymore.

We like gardening in here; that is why we do it. We come from the countryside, and we miss it. I have the conviction of continuing to be a farmer, of keeping a part of the countryside in the city.

Respondents who disclosed food self-provision as a motivation (59%) viewed gardening as a way to understand where their food came from and to consume organic produce. One respondent noted that, in addition to nourishment, eating homegrown food gave them a sense of consuming safe, pesticide-free products. There was a widespread belief that homegrown produce is healthier and cleaner than store-bought alternatives. Growing their own vegetables and herbs not only provided satisfaction but also ensured access to fresh, delicious, and nutritious food.

I turned to gardening because I like to eat what I grow. I love to produce my own food. I truly think it is great that I can *consume my own beets, celery, you name it. Having food that is organic and healthy seems wonderful to me.*

It is very nice to have homemade infusions. You know where the ingredients came from, how you fed your plants.

I feel safer by consuming what I grow. I know my plants do not receive any kind of chemicals, whereas when I buy food in the store, that is not the case.

Half of the respondents reported that social interactions were an important motivation for them. Some were introduced to gardening by family and friends, whereas others viewed gardening as a way to carry on the legacy of their loved ones.

I knew about urban homegardens from the experience of some friends. They gave me a few seedlings, and I started from there.

I have my homegarden, my neighbour has his, so we can share the produce and integrate with others. By talking to each other, we can build an atmosphere of camaraderie.

My parents started with the garden. They wanted to teach their kids and other children to grow their own food. My mom is 101 *years old now. She started the garden, and I am not letting it disappear.*

Community gardens were also mentioned as the origin of interest to some respondents to have their homegardens. In contrast, some manifested that their homegardens have inspired others to have their own cultivating spaces at home and wanted to keep inspiring others. Furthermore, gardening was seen as a way to engage with others and strengthen social connections.

For those motivated by aesthetics (34%), making their space more pleasant and "having some green" at home was vital. Plants helped them "dress up" and create a beautiful atmosphere at home.

We wanted to have some more green at home. In the mornings, we can have a coffee and look at the plants. That's why we always make this look green.

There were homeless people and trash around my house, so I thought I'd better use the space to grow plants and make the place more amicable.

Additionally, approximately one-third (29%) of respondents indicated that learning and teaching drove their involvement in gardening. Some people were inspired by a desire to learn and/or apply their knowledge in the garden, driven by curiosity and experimentation, while others sought to share their expertise, often with children. To highlight is the role of the Botanical Garden, which, through permanent and cost-free training, builds skills and provides guidance to those interested in urban agriculture in the city.

I started to try and experiment, first with Physalis. I saw the plants grow, so I started to plant more things to see what happened.

It all started out of curiosity. It has been truly motivating to learn how to sow, how to harvest. As a child, I only learned to read and count, but not this.

In school, you learn about the leaves, the roots and the stem. In the garden, that knowledge becomes tangible.

Nearly a quarter (22%) of respondents cited economic constraints as their reason for gardening. They relied on garden produce during times of financial strain or used it as a way to save money by avoiding the high costs of items like lettuce, kale and paprika (among other products) at the grocery store. Occasionally, respondents earned some money by selling products to their neighbours. Overall, they viewed gardening as a way to have a buffer during times of crisis.

I do not have to go and buy any vegetables; I just come to the garden and see what to do for lunch today. Just the other day, I needed some cilantro, my cousin went upstairs to the garden and brought it to the kitchen, and we did not need to look for money to buy it.

Food is often expensive or scarce, as it was during the pandemic. However, I have my plants.

With the garden, even when there is no money, I have food. Wherever you look, there is food. It is of help to my pocket.

Respondents also mentioned health- and well-being-related motivations. Physical exercise, stress relief, energy cleaning, meditation and tranquillity were brought up. Also, gardening was considered therapeutic.

I had health issues, and when I started gardening, they all disappeared, as I kept good care of the plants and ate their produce.

Here I get to clean my energy. Sometimes I have hard weeks, so the weekend is for gardening and leaving behind negative thoughts.

Next in rank are environmental concerns. The respondents explained that by gardening, they wanted to help the environment, mitigate contamination, and use their organic residues that would otherwise go to the dump.

It is not just for my consumption; I am contributing to the planet. The kitchen residues that I threw away before are now turned into compost and go afterwards to the garden.

I was looking for a way to help the environment. I do not use any pesticides, and I try to reuse rainwater for my plants.

The least common motivation to engage in homegardening is the outcome of gardening. Within this category, we grouped responses explaining that seeing the effort put into the garden "paid off". Seeds, yield and healthy plants were the ultimate rewards for the gardening activities.

I come to work in the garden because I want to see the result in the form of seeds, seeds that the plants I planted are giving me. I want to produce and keep my own seeds.

The plants you see and the harvest I get every so often are the aftermath of my time spent in the garden. It is exciting to look at the garden and see it being fruitful, that's why I keep gardening.

Seventeen of the 119 respondents cited the pandemic and lockdowns as motivations for engaging in homegardening.

However, as they elaborated, the underlying factors were having too much free time and a need for easily accessible food, which we interpreted as their primary motivations. Similarly, a quarter of the answers we registered regarded the support received, mainly provided by the city's Botanical Garden, as a determinant of the respondents´ engagement in gardening. Yet, the core motivation was their desire to learn and the opportunity to obtain supplies for free or at lower prices than in the market.

In summary, the findings indicate that motivations for homegardening are multiple and overlapping, combining personal, social, economic, and environmental factors. While enjoyment, food self-provision, and social interaction were the dominant drivers, respondents also valued learning, aesthetics, well-being, and environmental stewardship. The diversity of motivations highlights that homegardening serves both practical and personal purposes, offering joy, social connection, and a means to secure fresh, safe, and affordable food.

Furthermore, when participants were asked for the reasons that could cause them to quit gardening, most of the respondents gave only one reason to do so. As shown in Figure 14, only two respondents gave two or more reasons to quit. Sixty-two per cent (n=74) of the respondents would not quit gardening, while 22%

(n=26) would quit if they lost the cultivation space, 10% (n=12) would quit for health reasons that prevented them from gardening, and 5% (n=6) would quit gardening if they did not have enough time to spend in the garden. Only one person (1%) considered quitting if the yield was too small, another one if gardening was too much work, and two interviewees (2%) would quit if their garden became unsettling for their neighbours.

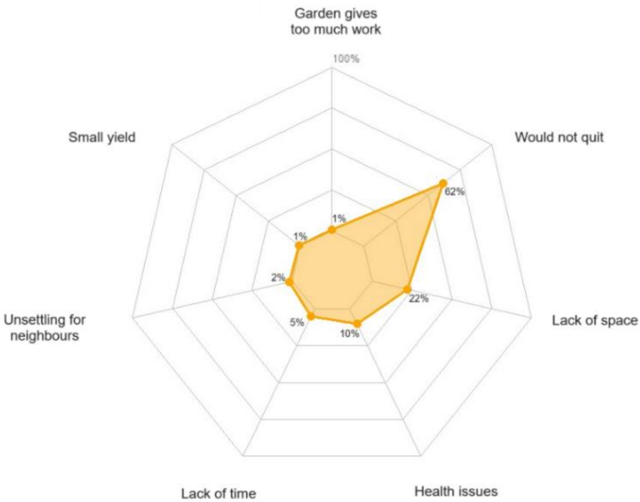

Figure 14. Reasons to stop engaging in homegardening in Bogotá.
The radar chart illustrates the percentage of respondents who cited various reasons for potentially ceasing their homegardening activities. The most common reasons to consider quitting were "Lack of space" (22%) and "Health issues" (10%). The figure´s most notable finding is that 62% of respondents stated they would not quit homegardening

Most motivations did not differ by socio-economic strata (low vs. middle-high) or location of the garden. Table 8 shows that there is a relationship between socioeconomic strata and gardening for economic reasons (χ^2=3.795, p = 0.021). About one quarter (25%) of low-income gardeners reported gardening for economic reasons, whereas none of the middle-high income gardeners did.

Table 8. Motivations (%) of 119 respondents for engaging in homegardening, by socio-economic strata in Bogotá (Pearson χ^2 test of independence)

Motivation	Low	Middle-High	χ2	p-value
Enjoyment	59	69	0.203	0.652
Self-provisioning	55	81	3.838	0.192
Social connection	50	56	0.054	0.816
Aesthetic	33	38	0.005	0.945
Learn and teach	28	31	0.722	0.388_a
Environmental concerns	12	19	0.153	0.424_a
Productivity	8	6	1.512	0.607_a
Economy	25	0	3.795	**0.021_a**
Well-being	16	6	0.364	0.463_a

Note: Values represent the percentage of gardeners within each socio-economic stratum who reported each motivation. Significant associations are highlighted in bold (p < 0.1). Subscript a denotes Fisher´s exact test.

Table 9 shows there are statistically significant associations between the area where the gardens are located and four out of the nine identified motivations to engage in homegardening, namely enjoyment of the activity (χ2=10.947, p<0.05), a desire to learn and teach (χ2=9.154, p<0.1), and aesthetic (χ2=8.496, p<0.1) as well as economy (χ2=8.591, p<0.1) reasons. Enjoyment was brought up as a motivation for homegardening by over 70% of respondents in the centre and northern periphery, while economic reasons were mainly brought up by gardeners in the south periphery. Furthermore, the desire to learn and teach through gardening was mentioned by 55% of respondents in the northern periphery of Bogota. However, respondents from the south periphery were more motivated to engage in homegardening for aesthetics that in any other area of the city.

Table 9. Motivations (%) of 119 respondents for homegardening engagement by various zones in Bogota City (Pearson χ2 test of independence).

Motivation	Northern foothills	Centre	South periphery	West	Northern periphery	χ2	p-value
Enjoyment	58	71	62	28	73	10.947	0.027
Self-provisioning	58	68	59	61	46	2.688	0.611
Social connection	53	42	62	44	59	2.763	0.598
Aesthetic	37	39	48	11	23	8.496	0.075
Learn and teach	21	26	21	22	55	9.154	0.057
Environmental concern	11	16	7	18	14	1.573	0.818a
Productivity	5	7	10	11	5	1.130	0.895a
Economy	5	16	38	28	18	8.591	0.072
Well-being	0	20	10	18	23	5.549	0.187

Note: a Fisher´s exact test.

5.7 Factors determining the motivations for engaging in homegardening

The multivariate probit model, including sociodemographic explanatory variables, produced a likelihood ratio statistic of

29.184 (df = 21, p = 0.109), indicating that the explanatory power of the model was modest. In other words, while the set of variables captured some of the variation in homegardeners´ motivations, a substantial proportion remained unexplained, pointing to the likely importance of factors such as lifestyle preferences and subjective experiences of gardening. Model diagnostics confirmed its adequacy. All VIF values were below 1.2, ruling out multicollinearity concerns, and the Hausman test showed no evidence of endogeneity across motivations (all p-values > 0.28), ensuring the robustness of the estimates (see Appendix 3.2 for details).

Most variables were not statistically significant predictors of motivations. However, tertiary education was associated with a lower likelihood of gardening for enjoyment (β = -0.819, p = 0.097), indicating that respondents with higher education were less likely to report enjoyment as a motivation (Table 10Table 10). Additionally, a significant negative correlation was observed between self-provision and enjoyment (R = -0.819, p = 0.009), suggesting that individuals who garden to produce food are less likely to do so for enjoyment, highlighting a tension between utilitarian and recreational orientations toward homegardening.

To further explore how motivations relate to homegarden typologies, a multiple correspondence analysis (MCA) was conducted using the three most common motivations (self-provision, enjoyment, social connection) and the homegarden clusters. The biplot (Figure 15) reveals that ornamental homegardens (Custer 1) are negatively associated with social connection as a motivation, suggesting that their drivers are likely more focused on aesthetics or personal satisfaction. Multipurpose gardens (Cluster 2), by contrast, are linked to both enjoyment and social connection, reflecting their multifunctional nature, while food gardens (Cluster 3) are closely aligned with self-provision and negatively associated with enjoyment, confirming their instrumental orientation towards household food supply rather than recreation.

Overall, enjoyment, self-provision, and social connection emerge as the key factors that sustain active engagement in urban homegardens in Bogotá. The combination of qualitative insights and quantitative evidence confirms that homegardening serves multiple, sometimes overlapping, personal, social and functional purposes for urban dwellers.

Table 10. Results of the multivariate probit model for gardening motivations.

Variable	β	S.E.	t-value	p-value
Motivation 1 (M1): Self-provision				
Intercept	0.806	0.702	1.149	0.251
Age	-0.012	0.009	-1.366	0.172
Household size	-0.029	0.065	-0.439	0.660
Socio-economic strata	0.695	0.459	1.515	0.130
Food security status	-0.273	0.362	-0.755	0.450
Education (secondary)	0.531	0.489	1.086	0.277
Education (tertiary)	0.000	0.419	0.001	0.999
Gender (female)	-0.018	0.299	-0.059	0.953
Motivation 2 (M2): Social connection				
Intercept	-1.380	0.799	-1.726	0.084
Age	0.010	0.009	1.090	0.276
Household size	0.114	0.079	1.454	0.146
Socio-economic strata	0.337	0.410	0.822	0.411
Food security status	0.544	0.397	1.370	0.171
Education (secondary)	0.278	0.471	0.592	0.554
Education (tertiary)	0.629	0.429	1.466	0.143
Gender (female)	-0.190	0.294	-0.646	0.518
Motivation 3 (M3): Enjoyment				
Intercept	0.956	0.785	1.217	0.224
Age	0.003	0.009	0.291	0.771
Household size	-0.067	0.063	-1.060	0.289
Socio-economic strata	0.314	0.410	0.765	0.444
Food security status	-0.073	0.397	-0.185	0.853
Education (secondary)	-0.538	0.542	-0.993	0.321
Education (tertiary)	-0.819	0.494	-1.658	**0.097**
Gender (female)	0.055	0.303	0.182	0.855
Correlations				
M1 vs M2	-0.049	0.162	-0.305	0.760
M1 vs M3	-0.342	0.167	-2.049	**0.040**
M2 vs M3	0.116	0.161	0.724	0.469

Note: The table shows coefficients (β), standard errors (S.E.), t- and p-values for socio-economic variables across gardening motivations (self-provision, social connection, enjoyment). Correlations (R) indicate interdependence. Statistically significant results ($p<0.1$) are in bold.

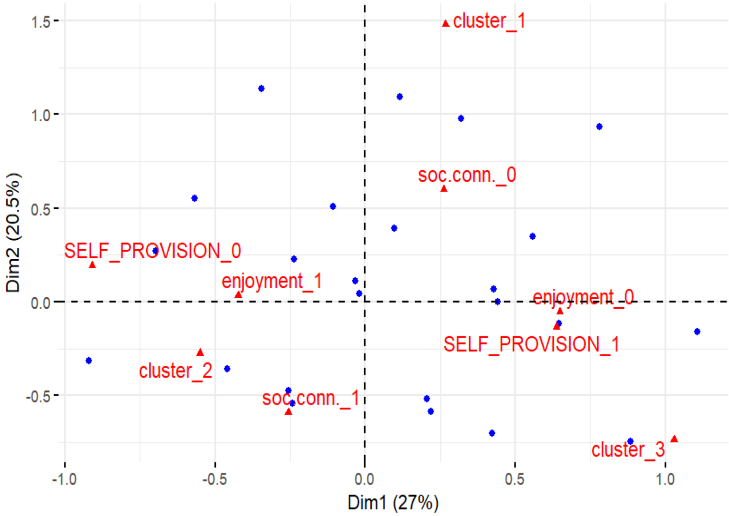

Figure 15. Multiple correspondence analysis illustrating the relationship between the main homegardening motivations and homegarden clusters.
In the plot, blue dots represent individual observations (homegardens), and the red triangles indicate the categories of the analysed variables (motivations and clusters). For motivation values are coded as 0 = not having the motivation and 1 = having the motivation. The closer a cluster (1= Ornamental, 2 = Multipurpose, 3 = Food-oriented) is to a motivation, the stronger their positive association.

5.8 Perceived benefits of homegardens

Respondents widely perceived their homegardens as beneficial for relaxation, stress reduction, and environmental protection (Figure 16). Nearly all respondents (99%) strongly agreed that gardening helped them relax and protect the environment, often highlighting practices such as pesticide-free cultivation and the use of organic residues as fertiliser. Dietary benefits were also recognised: 62% strongly agreed that their homegarden provided more food to eat, 53% strongly agreed it increased their share of vegetables and fruits, and nearly all respondents (99%) strongly agreed their garden supplied high-quality food.

Economic benefits were less prominent. While many respondents felt their garden reduced household food expenses (71% strongly agreed) and enabled them to better afford non-food items (61%), most respondents (72%) disagreed that their garden provided additional income. As yields were generally small, produce was more often consumed at home or shared rather than sold. These findings suggest that in Bogotá, homegardens are valued primarily for well-being, environmental, and dietary contributions, rather than income generation.

Besides these benefits, respondents also highlighted social and educational advantages. The homegarden was frequently described as a place that provides the opportunity to show children where food comes from, to improve gardening skills, and to promote awareness of sustainable practices.

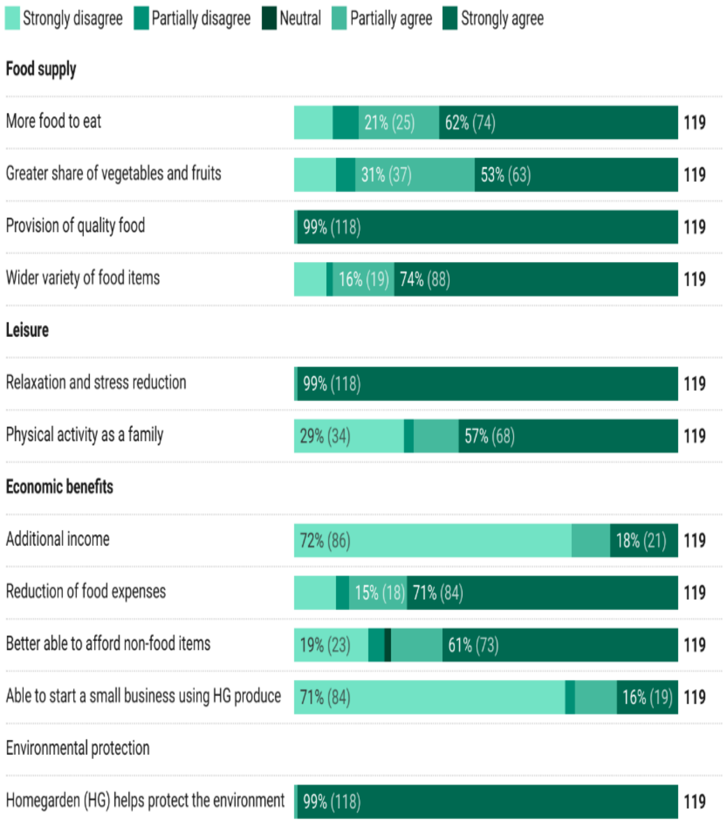

Figure 16. Perceived benefits of urban homegardens in Bogotá (n=119).
Bars show the percentage of respondents selecting each response category (Strongly disagree to Strongly agree) for eleven statements regarding the benefits they get from their homegardens. The strongest consensus was observed for relaxation and stress reduction and environmental protection (both 99% agreement). Economic benefits, such as additional income received or opportunities to start a small business, received the lowest agreement, highlighting that in this context, homegardens are valued more for their contributions to well-being, the environment, and diet than for income generation.

Fisher´s exact test was used to assess the association between gardeners´ perceptions of homegarden benefits and socio-economic strata (Figure 17) and the location of the gardens (Figure 18).

Most perceived benefits did not differ; however, the perception that homegardens reduce food expenses was significantly associated with socio-economic strata (χ^2= 17.654, p = 0.001) and the gardens´ location was significantly associated with the perception of having a higher share of food (p=0.013) and more food to eat (p=0.047).

Additionally, a Mann-Whitney U test was conducted to assess whether the perception of having a greater ability to afford non-food items due to the homegarden varied across socioeconomic strata. The results indicated significance at p = 0.056.

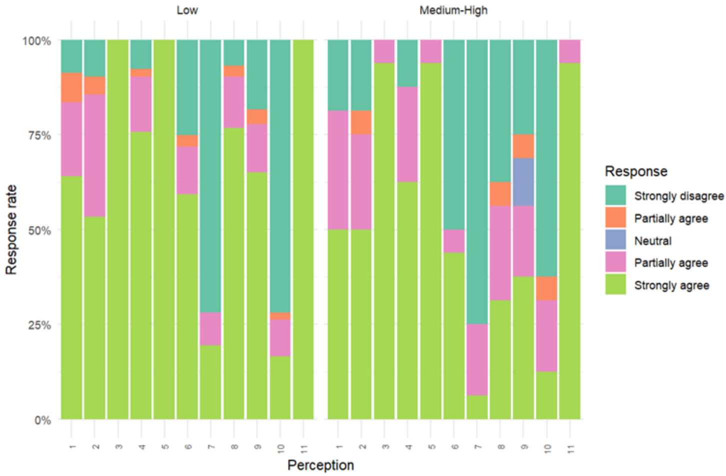

Figure 17. Gardeners´ perceptions across socio-economic strata (Low, Medium-High).

Bars represent the percentage of respondents in each response category (strongly disagree to strongly agree). The numbers on the x-axis correspond to specific statements gardeners reacted to: (1) More food to eat, (2) Higher share of vegetables and fruits, (3) Quality food, (4) Wider variety of food items, (5) Relaxation and stress reduction, (6) Physical activity as a family, (7) Additional income, (8) Reduction of food expenses, (9) Better able to afford non-food items, (10) Able to start a small business using homegarden produce, and (11) HG helps protect the environment.

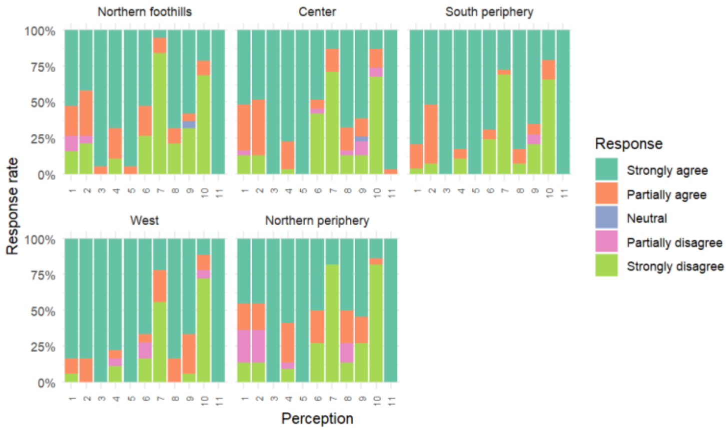

Figure 18. Gardeners´ perceptions across different city areas.
Bars represent the percentage of respondents in each response category (Strongly agree to Strongly disagree). The numbers on the x-axis correspond to specific statements gardeners reacted to: (1) More food to eat, (2) Higher share of vegetables and fruits, (3) Quality food, (4) Wider variety of food items, (5) Relaxation and stress reduction, (6) Physical activity as a family, (7) Additional income, (8) Reduction of food expenses, (9) Better able to afford non-food items, (10) Able to start a small business using homegarden (HG) produce, and (11) HG helps protect the environment.

5.8.1 Factors determining the perceived benefits from homegardens

Ordinal logistic regressions were conducted to evaluate how socio-economic and household factors relate to gardeners´ perceptions of benefits provided by their homegardens. For three perceptions, “food from the garden is fresh and healthy”, “we feel relaxed”, and “homegardens help conserve my environment”, response homogeneity prevented model estimation. Additional models for other perceived benefits were run but did not reach overall statistical significance ($p < 0.1$) and are reported in Appendix 3.3.

The models presented here were overall statistically significant ($p < 0.1$), as indicated by the likelihood ratio tests: a greater share of fruits and vegetables ($p = 0.095$), reduced food cost ($p = 0.006$), and physical activity ($p < 0.001$). Diagnostics revealed no issues with multicollinearity or endogeneity, as presented in detail in the appendix.

For the perception that homegardens contribute to a greater share of fruits and vegetables, education was a strong determinant. Respondents with secondary education had 2.8 times higher odds of agreeing with this perception compared to those with up to primary education (base category, OR = 2.80, $p = 0.082$). Similarly, respondents with tertiary education had nearly three times the odds (OR = 2.88, $p = 0.049$). Additionally, higher levels of food insecurity were associated with lower odds of perceiving homegardens as a significant source of fruits and vegetables (OR = 0.37, $p = 0.058$). An increase in one year of age, increased the odds of perceiving a greater share fruits and vegetables (OR = 1.03, $p = 0.018$)

For the perception that homegardens help to reduce food costs, socio-economic strata were the most important factor.

Households in the medium-high socio-economic category were 81% less likely to perceive this benefit compared to households in the lower category (OR = 0.19, p =0.006), suggesting that food cost reductions are more relevant for lower-strata households. Age was positively associated with this perception (OR = 1.04, p = 0.024), indicating that each additional year of the gardener increased the odds of perceiving a reduction in food cost by 3.4%.

For the perception that homegardens provide physical activity, age was negatively associated with agreement (OR = 0.97, p = 0.042), indicating that older respondents were less likely to view gardening as a form of exercise. Household size was positively associated (OR = 1.28, p = 0.031), meaning each additional household member increased the odds of perceiving physical activity as a benefit by 28%. Higher levels of food insecurity also reduced the odds of perceiving homegardens as a source of physical activity (OR = 0.39, p = 0.095).

In sum, the models indicate that gardeners´ education shapes perceptions of homegardens as sources of fruits and vegetables, socio-economic strata influence perceptions of reduced food costs, and household size and age most strongly affect the perception of physical activity. Gardeners from lower socioeconomic strata tend to perceive homegardens as providing meaningful dietary contributions, although their relative share of fruits may remain limited. For these households, even modest outputs from a homegarden represent valuable cost savings, although limited resources may constrain the variety of crops they can cultivate.

To further explore how gardeners´ perceptions relate to the functional types of homegardens, an MCA was conducted. The MCA plots (Figure 19) reveal that the ornamental cluster is characterised by disagreement with most food and income-related benefits, indicating that these gardens are primarily maintained for personal, or non-monetary purposes rather than economic gain. The food cluster shows strong agreement with benefits related to reducing food expenses and increasing dietary diversity, but lower relevance for physical activity, suggesting a focus on personal food supply. The multipurpose cluster exhibits mixed perceptions with some agreement on both diversified food and reduced food expenses benefits, but an overlook on the environmental protection contribution of the homegardens. These patterns complement the POLR results. Together, the MCA and regression analyses highlight that perceptions of homegarden benefits are multidimensional, with functional garden types reflecting distinct combinations of personal, economic dimensions.

Table 11. Determinants of perceived benefits from homegardens: evidence from Ordinal Logistic Regressions (POLR)

Variable	Log-odds	S.E.	t-value	p-value	Odds Ratio
Perception: Greater share of fruits and vegetables					
Age	0.032	0.014	2.363	**0.018**	1.033
Household size	0.029	0.088	0.327	0.744	1.029
Socio-economic strata	-0.388	0.589	-0.659	0.511	0.678
Food security status	-0.985	0.519	-1.898	**0.058**	0.374
Education (secondary)	1.030	0.591	1.742	**0.082**	2.800
Education (tertiary)	1.059	0.537	1.971	**0.049**	2.884
Gender (female)	-0.691	0.427	-1.617	0.106	0.501
Perception: Reduce food cost					
Age	0.034	0.015	2.263	**0.024**	1.035
Household size	0.051	0.115	0.445	0.656	1.053
Socio-economic strata	-1.640	0.595	-2.756	**0.006**	0.194
Food security status	0.075	0.659	0.113	0.910	1.077
Education (secondary)	0.045	0.767	0.059	0.953	1.046
Education (tertiary)	-0.117	0.686	-0.171	0.864	0.889
Gender (female)	-0.285	0.478	-0.596	0.551	0.752
Perception: Physical activity					
Age	-0.028	0.014	-2.030	**0.042**	0.972
Household size	0.245	0.114	2.156	**0.031**	1.278
Socio-economic strata	-0.978	0.608	-1.609	0.108	0.376
Food security status	-0.933	0.559	-1.670	**0.095**	0.393
Education (secondary)	0.215	0.639	0.337	0.736	1.240
Education (tertiary)	0.027	0.562	0.048	0.962	1.027
Gender (female)	0.121	0.424	0.285	0.776	1.129

Note: The table reports estimated log-odds, standard errors (S.E.), t-values, p-values, and odds ratios from POLR models on three perceived benefits derived from homegardens. Positive coefficients indicate higher odds of agreement; negative coefficients indicate lower odds. Statistically significant effects ($p<0.1$) are in bold.

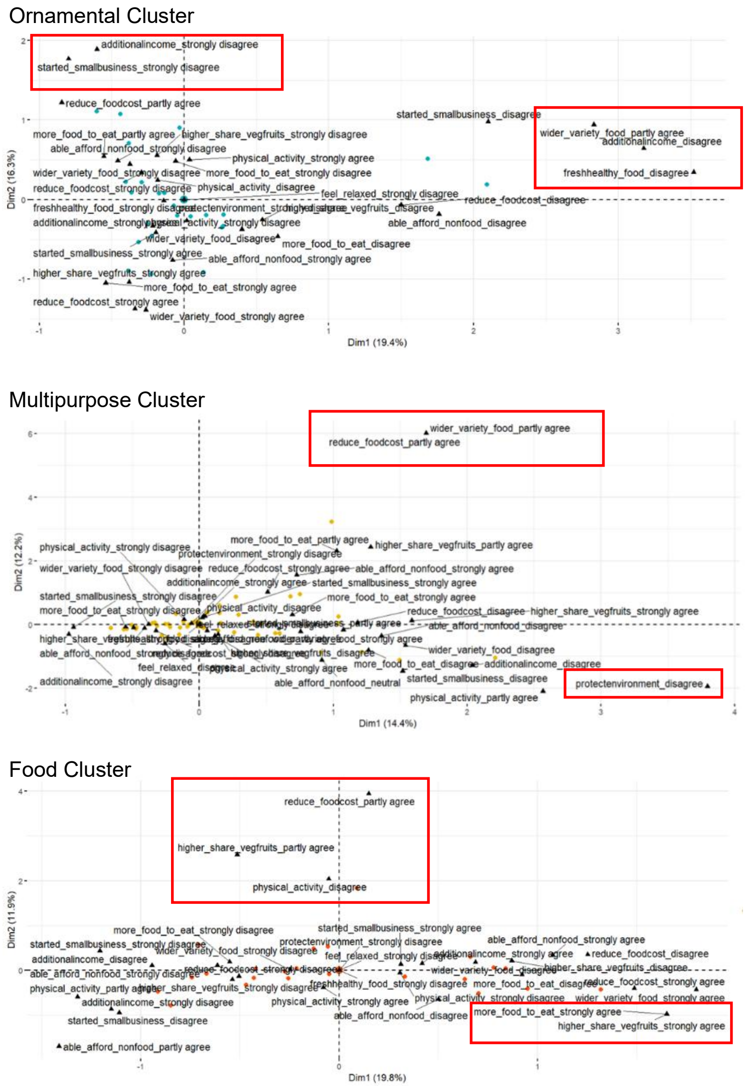

Figure 19. Multiple correspondence analysis of perceived homegarden benefits and cluster membership.

In the plot, the red box emphasises the perceptions most associated with each cluster.

6. Discussion

This thesis responds to the underrepresentation of homegardens in Bogotá in both research and policy. While institutional initiatives such as the Urban and Peri-urban Agriculture programme articulate multifunctional aspirations for urban agriculture, the dominant form of cultivation -the homegarden- remains largely absent from monitoring and planning. The findings presented here demonstrate that urban homegardens in Bogotá are highly diverse, multifunctional systems that combine food, medicinal, ornamental, and cultural roles, and therefore must be included in both scholarly and policy discussions of urban agriculture. By integrating plant diversity, socio-economic patterns, motivations to engage in homegardening, and perceived benefits of homegardens into a single analysis, this thesis provides the first city-wide evidence of how homegardens contribute to food resilience and social well-being in Bogotá, and in doing so addresses the research objectives.

Focusing on homegardens is relevant not only because they are the most widespread form of urban agriculture, but also because their multifunctionality positions them as the everyday infrastructure of resilience by promoting individual well-being, food security and environmental quality (Ghahremani et al., 2024).

They simultaneously address fundamental needs such as food provision and well-being while also providing spaces for social connection and biodiversity conservation. In this sense, engaging citizens in homegarden is more than a lifestyle choice; it represents a collective pathway toward more resilient, sustainable cities (Gunapala et al., 2025; Huq & Deacon, 2025).

The sociodemographic profile of the surveyed gardeners in Bogotá aligns with patterns observed in other Latin American cities, where urban agriculture tends to be driven by older, predominantly female participants (Audate et al., 2021; Cardoso Palheta et al., 2017; Peinado-Guevara et al., 2024; WinklerPrins & de Souza, 2010). What distinguishes Bogotá, however, is the relatively high proportion of tertiary education among gardeners, contrasting with many homegarden studies where lower education levels prevail. The limited use of chemical inputs mirrors global trends in urban agriculture, where gardeners often highlight health and ecological concerns (Audate et al., 2021; Castiñeira et al., 2018). Nonetheless, generalised constraints such as small garden size and knowledge gaps limit the productivity and point to the need for institutional support, including technical assistance and improved access to space. Other barriers frequently cited in Latin American cities, such as limited access to land, time scarcity, water availability, and soil contamination, likely affect Bogotá's gardeners as well (Castiñeira et al., 2018; da Silva et al., 2022; Orsini et al., 2013).

Although agrobiodiversity in homegardens has been widely documented around the world, research has concentrated primarily on rural gardens, with urban gardens comparatively understudied (WinklerPrins & de Souza, 2010). This study expands that scope and shows that Bogotá´s homegardens host remarkably high levels of plant diversity (H´=4.05, DMg=27.22), with 253 species across 72 families, values that confirm the potential of homegardens to act as reservoirs of urban agrobiodiversity. Identified plant species served food, medicinal, ornamental, ecological and spiritual functions. Medicinal plants were present in nearly all gardens, with medicinal plants in particular highlighting the persistence of traditional knowledge and the search for affordable alternatives to pharmaceuticals, reinforcing community resilience in health care (Castiñeira et al. 2018; Thiel and Quinlan 2022; WinklerPrins and de Souza 2010). The five most culturally important species were all food plants, many of which also served medicinal or ecological functions such as pest control. Our findings highlight that urban homegardens provide convenient and direct access to diverse species that simultaneously deliver food, medicine, ornamentation and biodiversity refuges. Additionally, by sharing harvested products with the community, gardeners build and strengthen social networks, fostering community cohesion and solidarity (Diekmann et al. 2018; López-Almirall et at., 2025; Panyadee et al. 2018; Taylor et al. 2017).

Hierarchical cluster analysis identified three main functional types of gardens: food-oriented, ornamental, and multipurpose. Most gardens in the ornamental cluster were located in the Usaquén district, consistent with Sierra-Guerrero and Amarillo-Suárez (2017), who reported that homegardens in this high-income district were composed of 93% ornamental plants. Multipurpose gardens were associated with larger households. This pattern mirrors broader evidence in Latin America and beyond that garden composition reflects households' priorities: subsistence and budget relief for low-income groups versus aesthetic and leisure purposes for wealthier ones (Al-Kofahi et al., 2019; Angeoletto et al. 2017; Bigirimana et al. 2012; Caballero-Serrano et al. 2016; Clarke et al. 2014; Lubbe et al. 2010).

Across Bogotá, food production emerged as the most common use across the city, with only 22% dominated by ornamentals. This contrast with earlier research in the city that reported gardens dominated by ornamentals, alongside a larger proportion of edible and medicinal plants in lower-income homegardens (Sierra-Guerrero and Amarillo-Suárez 2017). Nevertheless, the socio-economic pattern persists. Importantly, the predominance of lower strata gardeners in this study reflects Bogotá´s actual demographic distribution, where over 80% of residents belong to lower strata and only 6% to higher strata (Alcaldía Mayor de Bogotá, 2024).

Beyond garden purposes, plant diversity composition also varied significantly across clusters. Jaccard distances revealed that ornamental and food gardens were the most distinct from one another, while multipurpose gardens occupied an intermediate position, being closer to both food and ornamental gardens. This pattern reinforces the idea that multipurpose gardens function as hybrids, integrating subsistence and lifestyle-oriented practices. Their role as a bridge highlight how homegardening can simultaneously address basic needs and higher-order aspirations, depending on household characteristics. Furthermore, the significant association of multipurpose gardens with larger households suggests that family size influences garden use and management, consistent with other studies showing that smaller households cultivate fewer plants (Adeosun et al., 2025; Balooni et al., 2014).

Food insecurity prevalence was highest among food-oriented homegardens. Respondents reported reducing portion sizes, skipping meals, or, in the most severe cases, going whole days without eating. These experiences illustrate that while homegardens cannot fully eliminate food insecurity, they function as critical coping mechanisms that complement household food security rather than being the sole source of nutrition (Castañeda-Navarrete, 2021). In this sense, their contribution lies in enhancing availability, accessibility, cultural appropriateness of food and autonomy of gardeners in making food choices (Diekman 2020). However, homegardens can only complement, not substitute for, broader structural measures such as social protection systems and affordable food markets (Du Toit et al., 2022; Lee et al., 2023). Although dietary intake was not measured here, the diversity of edible plants recorded, including culturally important species such as *Brassica oleracea*, *Lactuca sativa* and *Beta vulgaris*, suggests meaningful contributions to household diets. Global studies highlight the role of homegardens in ensuring continuous access to diverse foods, particularly during times of crisis (Galhena, 2013, Mougeot, 2015; Poulsen et al., 2015), and show that institutional support can further increase fruit and vegetable intake (Algert et al., 2016; Schreinemachers et al., 2025).

It is worth noting that the food function of homegardens is not necessarily merely utilitarian or economic. Food also serves as a channel through which gardeners express heritage, link generations through shared knowledge and practices, and maintain culinary traditions (Ranieri & Zanirato, 2018).

Motivations to engage in homegardening further confirm the multidimensional character of this practice. The nine identified motivations illustrate that engagement in homegardening is driven by more than subsistence. Enjoyment, food self-provision, and social connection emerged as the most frequent drivers, highlighting that homegardening is also deeply tied to leisure, lifestyle and well-being.

The negative correlation between enjoyment and self-provision suggests two distinct gardener profiles: one primarily motivated by subsistence and another drawn by leisure. The multiple correspondence analysis reinforces this interpretation, associating food gardens with self-provision, and ornamental gardens with personal satisfaction. Those who prioritise self-provision tend to engage in gardening with a practical, utilitarian focus, while those who prioritise enjoyment approach gardening more as a lifestyle than a means to an end. The divide reflects the trade-off between self-production and relaxation; the same individual is unlikely to simultaneously prioritise both. Pursuing economic gain often demands a focus on efficiency, which may reduce the time, enjoyment or relaxation that contributes to well-being. Conversely, those gardening for well-being may deliberately avoid the pressures of maximising productivity or income (Lemma & Sharma, 2024).

These results can also be interpreted through Maslow´s hierarchy of needs. Households with resource constraints tend to engage in homegardening to meet basic needs, whereas better-off households pursue it for higher-order aspirations such as leisure, learning and cultural fulfilment (Clarke et al., 2014; Partalidou & Anthopoulou, 2017). This interpretation is reinforced by our results: one quarter of gardeners from lower socioeconomic strata reported gardening for economic reasons, whereas none of the middle- to high-income gardeners did, illustrating how households facing economic constraints tend to prioritise basic needs. Maslow´s hierarchy of needs is used here as an interpretive lens rather than as a predictive or definite model. In line with previous studies, our findings indicate that gardening motivations are multiple and coexistent, without a fixed order. Gardeners´ often pursue multiple needs concurrently rather than moving step-by-step from physiological to self-actualization needs, and the priorities are often culturally and contextually sensitive. For Bogota´s gardeners, homegardening transcends food supply, simultaneously serving as vehicle for knowledge acquisition and aesthetic expression (Partalidou & Anthopoulou, 2017).

Moreover, our findings are consistent with other studies. Our results showed 61% engaged in homegardening because they considered homegardening to be gratifying, full of pleasure and an activity that they loved, and 59% gardened due to the convenient access to fresh and healthy food. Previous research has noted that enjoyment and growing food are the most prevalent reasons for gardening motivations for spending time gardening (McFarland et al. 2018; Chalmin-Pui et al. 2021; Pourias et al. 2016).

An interesting point of our analysis is that home- and community gardens are also a source of inspiration for others to start their own urban agriculture practice. As mentioned by some respondents in what we classified as social connection motivation, they began to cultivate because they knew other people had positive experiences with gardening, and some respondents were sources of inspiration for their acquaintances to start gardening. There is evidence that non-growers are encouraged to try urban agriculture after they learn about other people's experiences (Ayoni et al. 2023). Gardens are dynamic spaces where people can develop a sense of attachment, comfort and belonging that contribute to individual health and community construction (Hooykaas 2021). In addition, homegardens provide a safe place to acquire, maintain and pass on knowledge, leading to increased social capital and strengthening family and community relationships (Ranieri and Zanirato 2018; Eng et al. 2019).

Perceptions of homegarden benefits further echo these findings. Nearly all respondents recognised that their homegardens provided quality food, opportunities for relaxation, and environmental protection. More than 60% perceived that an enhanced food supply increased physical activity, reduced food expenses, and improved the ability to afford non-food items. However, over 70% disagreed that their homegardens provided additional income or means to start a small business, reinforcing the point that Bogotá´s homegardens are valued more as spaces of well-being and food provision than as sources of commercial gain. Nonetheless, the perceived reduction of food expenses and a greater ability to afford non-food items were statistically more relevant for lower-income gardeners, highlighting their economic relevance for households with limited economic resources. Education was linked to greater awareness of dietary benefits, while age and household size shaped perception of physical activity. Interestingly, although older adults in other studies often value gardening for its physical activity benefits (Kortright & Wakefield, 2011), our results showed a negative association between age and perceiving gardening as exercise. This may reflect lower intensity practices among older respondents, or a greater focus on other benefits such as reduced food expenses or vegetable availability. This does not imply that older adults do not gain physical activity benefits; rather, it may reflect a lower intensity of gardening among older participants or a greater focus on other benefits, such as reduction of food expenses or number of vegetables and fruits, rather than on exercise itself.

Ultimately, the broader significance of homegardens lies in their ability to bridge multiple domains: they serve as food-producing spaces, therapeutic environments, biodiversity habitats, and cultural hubs. In this sense, homegardens can be seen as urban spaces where Maslow´s hierarchy of needs is enacted in practice, from securing food to fulfilling identity and knowledge acquisition.

These findings resonate with ecosystem services frameworks that conceptualise urban agriculture as a multifunctional practice, generating material, regulating, cultural and health-related benefits (Mohri et al., 2013; Partalidou & Anthopoulou, 2017).

This study advances understanding of homegardening in Bogotá in three ways. First, by providing the first city-wide evidence of its agrobiodiversity, typologies and multifunctional benefits, it makes visible a practice that has long remained underrepresented in both academic studies and policy agendas. Second, by documenting gardener´s motivations and perceptions across socio-economic contexts, it highlights the diverse ways in which households engage with homegardening reflecting different interests and needs. Third, by framing homegardens as systems that contribute simultaneously to food provision, well-being, community cohesion and biodiversity conservation, this study positions homegardens as an everyday urban infrastructure of a resilient, sustainable city.

The insights presented here should be read with caution. Gardeners included in this research were reached through purposive rather than random sampling, a decision shaped by the disruptions of the COVID-19 pandemic and social unrest in the city. As noted in the literature, purposive samples cannot be considered statistically representative of the wider population, meaning that results should be understood as illustrative rather than generalisable. This does not diminish the value of the study (Andrade, 2021; Tajik et al., 2024). Purposive approaches are common in exploratory research on urban agriculture (Castiñeira et al., 2018; Kanosvamhira & Tevera, 2023), but they require caution when extrapolating relationships.

6.1 Practical relevance

The findings of this study carry important implications for policy and practice. At present, homegardens are largely absent from formal monitoring and planning frameworks, which limits recognition of their contributions to food security, public health, cultural heritage, and biodiversity. Incorporating homegardens into official urban agriculture statistics and mapping would allow planners to better account for their scale, diversity, and multifunctionality.

Targeted support could further strengthen their role. Provide unrestricted, widespread technical support would enhance the productivity of homegardens. Policies could also improve access to land and resources, integrate urban agriculture to public health, and foster skills and knowledge transfer (Audate et al., 2021).

Recognising homegardens as cultural and ecological assets also opens opportunities to integrate them into broader strategies for climate adaptation and health promotion. As Angeoletto et al. (2017) note, successful planning requires understanding the environmental, cultural, and socio-economic factors that shape garden configurations. Our study demonstrates that food production is not the sole purpose or motivation for homegardening. Policy must therefore avoid reducing homegardens to food security alone, instead embracing their multifunctionality.

The differentiated motivations observed across socio-economic groups further highlight the need for tailored approaches. Households from lower socioeconomic strata benefit more from measures that strengthen food supply and affordability, whereas higher strata gardeners may be more effectively engaged through initiatives emphasising biodiversity, cultural value, and environmental education. In this sense, policies should be sensitive to cultural priorities and balance food production with other practices and values (Du Toit et al., 2022).

6.2 Limitations and future research

This research provides novel insights into urban homegardening in Bogotá, yet certain limitations must be acknowledged.

First, subtle morphological plant characteristics may have been overlooked by relying on photographic documentation rather than physical plant vouchers, which could have potentially affected taxonomic accuracy. Future work could complement photographic inventories with physical specimens for verification in herbaria. Additionally, although the plant inventory and diversity analysis provide data to identify exotic species in sampled homegardens, this study did not specifically assess their prevalence or distribution. Future research could use the existing data to explore the balance between the contribution and potential risks of the species. Exploring this in more depth would be a valuable avenue for future research, as it could inform biodiversity management and urban planning strategies.

Second, the absence of quantitative data on crop yields restricted our ability to assess homegarden productivity and their exact contribution to household food security, nutrient intake, and household economy. While our findings strongly suggest a role in food accessibility and dietary diversity, integrating standardised yield measurements and tracking inputs/outputs over time would enable a more rigorous evaluation of economic and nutritional benefits.

Third, the study design was non-probabilistic, shaped by the constraints of COVID-19 restrictions and civil unrest. As a result, the sample cannot be considered fully representative of all homegardens in Bogotá. Random sampling, where feasible, would strengthen the generalisation of findings.

Finally, this study focused on a single metropolitan area. Extending this analysis to other Colombian and Latin American cities, would enable comparative assessments and clarify whether the patterns observed here are widespread or locally specific. Such comparative approaches would deepen understanding of how urban homegardens function as socio-ecological systems.

7. Conclusion

This thesis investigated the role of urban homegardens in Bogotá by assessing their agrobiodiversity and typology as well as gardener motivations and perceived benefits. The findings demonstrate that homegardens in the city are multifunctional socio-ecological systems that simultaneously support food provision, well-being, biodiversity and cultural practices. The near ubiquity of food and medicinal plants underscores their role as repositories of traditional knowledge and cost-effective alternatives for food and primary health care for households, reinforcing resilience in rapidly urbanising contexts. Far from market-oriented enterprises, Bogotá´s homegardens primarily serve subsistence and lifestyle purposes.

The study´s participants were predominantly women and mostly from lower socioeconomic strata, reflecting the city´s broader demographic composition and showing urban homegardening is practiced by a socio-demographically diverse group, though skewed toward older women in low-income households.

Cluster analysis identified three distinct types of homegardens. Ornamental gardens prioritise aesthetic and recreational values. Multipurpose gardens, often maintained by larger households, integrate food, medicinal, and ornamental species with ecological and cultural significance. Food-oriented gardens, significantly less diverse, prioritise edible species to support household food supply. These patterns reflect how household priorities and resources shape garden composition and function, consistent with observations from urban agriculture studies across Latin America and beyond.

Gardener´s motivations to engage in homegardening further reveal the multifunctional nature of homegardens. Enjoyment, food self-provision, and social interaction emerge as key drivers of engagement, yet their alignment varies by garden type. Ornamental gardens aligned with personal satisfaction, multipurpose gardens combined enjoyment and social connection, and food-oriented homegardens prioritise food supply. The trade-off between recreational and utilitarian orientations illustrates the various ways households experience and value homegardening.

Perceived benefits from homegardens reinforce these patterns. Gardeners generally recognised contributions to stress reduction, environmental protection, and access to fresh, high-quality food, while economic benefits were most relevant for lower-income households. Respondents from the lower socio-economic strata were 81% more likely to perceive homegardens as reducing food costs, and larger households and younger gardeners more frequently recognise physical activity as a benefit. Collectively, these findings indicate that homegardens deliver benefits that are both practical and personal and illustrate how the same practice can fulfil distinct layers of human needs.

Recognising homegardens within Bogotá´s urban agriculture frameworks would enhance their contributions to food provision, public health, and biodiversity. Policies should embrace their multifunctionality and not reduce them to food provision alone and consider the differentiated motivations and socio-economic circumstances of gardeners. Doing so would enable the city to leverage homegardens as everyday spaces of resilience, supporting both household well-being and broader urban sustainability.

Future research should include quantitative yield assessments and comparative studies across Colombian and Latin American cities to further clarify the contributions of homegardens to urban resilience. By combining ecological, social, and cultural perspectives, homegardens can be understood and supported as critical spaces for a sustainable urban life.

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Author's scientific contributions

This study led to the publication of two research articles:

1. Rojas-Pardo, L., Verner, V., Pilařová, T., Van Damme, P., Polesný, Z. (2025). Exploring the links between agrobiodiversity and socioeconomic factors in urban homegardens of Bogotá, Colombia. *Urban Forestry & Urban Greening* 108: 128824. https://doi.org/10.1016/j.ufug.2025.128824

2. Rojas-Pardo, L., Pilařová, T., Ibrahim, K., Van Damme, P., Verner, V. (2025). Does Gardening make us feel better? Assessing the Motivations and Perceptions of Urban Gardeners in Bogotá, Colombia. *Local Environment* (under review at the moment of thesis submission).

In addition, the author of this thesis participated in the following conferences:

1. Rojas, L., Verner, V., & Van Damme, P. (2022). Urban homegardens for times of crisis in Bogotá, Colombia. Agriculture for Life, Life for Agriculture. 2-4 June 2022.

2. Rojas, L., Verner, V., & Van Damme, P. (2022) Urban homegardens in Bogotá: Linking science and voluntary public

engagement. 16th International Technology, Education and Development Conference. INTED. 7-8 March 2022.

3. Rojas, L., Verner, V., & Van Damme, P. (2021). Food plants species diversity in urban homegardens of Bogotá, Colombia. 2nd International Agrobiodiversity Congress. 15-18 November 2021.

4. Rojas, L., Verner, V., & Van Damme, P. (2021). Inventory of food and medicinal plant species in urban homegardens of Bogotá, Colombia. 6th Global Biodiversity Conservation Conference. The world after 2020, from crisis to biodiversity conservation. 10-12 November 2021.

5.Rojas, L., Verner, V., & Van Damme, P. (2020). Urban homegardens: Agrobiodiversity, food security, and commercialization – A Review. ELLS Scientific Student Conference. The world of tomorrow - A green and sustainable society. 20-21 November 2020.

6. Rojas, L., Verner, V., & Van Damme, P. (2020). Plant Use and Diversity in Urban Homegardens in Latin America - A Review. 2nd International Symposium on Biodiversity Research. 18-20 November 2020.

Appendix

Appendix 1. Declaration of author's contribution

Ibrahim Kindah: Methodology, Formal analysis, Data curation. **Pilařová Tereza:** Methodology, Formal analysis, Data curation. **Polesný Zbyněk:** Methodology, Conceptualization. **Rojas-Pardo Laura:** Writing, Visualization, Software, Investigation, Formal analysis, Data curation, Conceptualization. **Van Damme Patrick:** Supervision, Methodology, Conceptualization. **Verner Vladimír:** Supervision, Methodology, Funding acquisition, Conceptualization.

Appendix 2. Questionnaire used for data collection

Date: District: Social Class: Garden size:

I. Household characteristics

1. Please share information on

	1	2	3	4	5	6	7	8	9
People who live together with you in a household most of the year:	Age/ Year of birth	Gender	Place of birth	If not Bogotá, reason to come	Education level	Working on HG	Experience in farming (years)	Home ownership	Main occupation

2. Please estimate your cash income from last year (2020) from the activities listed below

HG	Livestock	Own business	Regular wage/salary	Remittances	Other, please specify

3. Use of income from homegarden.
Please estimate how you use extra income from homegardens [%]

HG	Household	Health care	Education	Paying back for credit	Other

II. Motivation, perceptions, and production

1. How was your first approximation to HG?

2. What motivated you to start a HG? Is this reason still important?
3. What motivates you to keep having a HG?
4. What would cause you to stop having a homegarden?
5. Which problems of HG management have you identified?
6. Which inputs do you use (seeds, fertilizers, pesticides, gardening tools...) in your HG? How frequent?
7. How do you obtain such inputs?
8. Do you know any organization that can assist you with homegardening through information, inputs provision, etc.? Which one(s)?
9. Are you receiving any type of help from such organizations?
10. Please share your ideas about:

	Because of my HG	Strongly agree	Partly agree	Neither/nor	Partly disagree	Strongly disagree
a.	my family has more food to eat					
b.	my family gets a higher share of vegetables and fruits					
c.	food from HG is fresh and healthy (quality food)					
d	we get to eat a wider variety of food items					
e.	we are better able to afford non-food items					
f.	we feel relaxed in the garden					
g.	we are engaged in some physical activity					
h.	we were able to start a small business at home using the product from my HG					
i.	HG help conserve the environment					
j.	HG help reduce our food cost					
k.	HG enable us to earn additional income					
l.	homegardening has benefited my family					
m.	I intend to continue to pursue homegardening activities					
n.	I would encourage others to pursue homegardening					

Adapted from (Galhena, 2012))

III. Homegarden composition and usage

1. When was your HG established?
2. What activities you do in the HG?
3. Livestock: YES (which)______________NO__
4. What is the destination/harvest of the HG production? (go product by product)
5. Which are the marketing channels you use, and why you chose them
6. How often do you sell HG produce?
7. At what price do you sell the produce? Share (%) of household income coming from the HG?
8. With whom do you share your production?
9. How long does the food kept for household consumption last until consumed?
10. Please share your knowledge on:

	Product	Harvest	Proportion	Reason
Self-consumption				
Trade				
Sell				

IV. Constraints and Barriers

Please indicate your level of agreement to the following statements regarding constraints and barriers of homegardening

Perception Statements	Strongly agree	Partly agree	Neither / nor	Partly disagree	Strongly disagree
Pest control is a challenge in my HG					
There is a lack of a support system to Urban Agriculture					
Lack of labour (both household or hired)					
Lack of space (small size of homegarden)					

Lack of space for HG work					
Weather conditions are unfavourable					
Limited market opportunities					
Lack of knowledge on HG management					
Not enough produce from HG to be commercialized					

V. Food Security (FIES)

During the last 12 months, was there a time when, because of lack of money or other resources:

	YES	NO
1. You were worried you would not have enough food to eat?		
2. You were unable to eat healthy and nutritious food?		
3. You ate only a few kinds of foods?		
4. You had to skip a meal?		
5. You ate less than you thought you should?		
6. Your household ran out of food?		
7. You were hungry but did not eat?		
8. You went without eating for a whole day		

VI. Crisis

During the COVID-19 pandemic, did you use the red fabric as a call for help? Why?

Appendix 3. Statistical model diagnostics

3.1 Multinomial model

The full model presented in Table 7 provided a good fit as indicated by the likelihood ratio test, LR (18) = 32.34, p = 0.020., indicating that the included variables jointly improve model fit.

3.1.1 Multicollinearity diagnostics

Table I. Results of the multicollinearity test

Variable	GVIF	Df	GVIF^(1/(2*Df))
Plant diversity	1.039	1	1.019
Age	1.29	1	1.139
Household size	1.188	1	1.090
Socio-economic strata	1.229	1	1.108
Food security	1.074	1	1.036
Education	1.243	2	1.056
Gender	1.080	1	1.039
Livestock	1.095	1	1.046

Note: The generalized variance inflation factor (GVIF) and its adjusted form GVIF^(1/(2*Df)) were examined to assess multicollinearity among variables. Values close to 1 indicate low collinearity, while values above 5 (or, in some guidelines, above 10) may suggest problematic multicollinearity. In this analysis, all GVIF values indicate multicollinearity is not a problem.

3.1.2 Endogeneity test

In the first stage regression (Table II), the instrument (red fabric) was a significant predictor of food insecurity status (β = 0.187, p = 0.077).

Table II. First-stage regression results (dependent variable: Food security status)

Variable	Estimate	S.E.	t-value	p-value
Intercept	-0.137	0.251	-0.546	0.568
Red Fabric	0.187	0.105	1.783	0.077
Plant diversity	0.083	0.067	1.238	0.218
Age	0.001	0.002	0.365	0.716
Household size	0.006	0.016	0.391	0.696
Socio-economic strata	-0.135	0.101	-1.331	0.186
Education (secondary)	0.083	0.108	0.772	0.442
Education (tertiary)	0.116	0.098	1.182	0.240
Gender (female)	-0.033	0.071	-0.463	0.644
Livestock	0.062	0.073	0.855	0.395

Note: The coefficient for the instrument (Red Fabric) is a significant predictor of food insecurity status ($p < 0.10$).

The second stage test examined whether the residuals from the first stage were significantly correlated with the explanatory variables. Non-significant coefficients ($p > 0.10$) indicated no evidence of endogeneity.

Table III. Second-stage regression results (dependent variable: Food security status)

Cluster	Coef.Residuals	S.E.	z	p_value
Multipurpose	3.00	5.202	0.577	0.564
Food	-4.594	4.818	-0.954	0.340

Note: Non-significant coefficients ($p > 0.1$) indicate the endogeneity is not present. In this analysis, the coefficients for both clusters (Multipurpose and food) are not statistically significant, suggesting no evidence of endogeneity in the model.

3.2 Multivariate probit analysis

The overall fit of the model presented in Table 10 as indicated by the likelihood ratio test was LR (21) = 29.18, p = 0.0109., indicating that the explanatory power of the model was modest.

3.2.1 Multicollinearity diagnostics

Table IV. Results of the multicollinearity test

Variable	GVIF	Df	GVIF^(1/(2*Df))
Age	1.246	1	1.116
Household size	1.167	1	1.080
Socio-economic strata	1.217	1	1.103
Food security	1.044	1	1.022
Education	1.231	2	1.053
Gender	1.079	1	1.039

Note: The generalized variance inflation factor (GVIF) and its adjusted form GVIF^(1/(2*Df)) were examined to assess multicollinearity among variables. Values close to 1 indicate low collinearity, while values above 5 (or, in some guidelines, above 10) may suggest problematic multicollinearity. In this analysis, all GVIF values indicate multicollinearity is not a problem.

3.2.2 Endogeneity test

The potential endogeneity of food insecurity status was tested using the control function approach. The instrument used was Red Fabric, and the other socio-economic variables were included as controls. All three first-stage regressions are identical because the endogenous and the instrument variables are the same (Table V). The second stage regressions included the residuals from the first-stage regression as an additional regressor for each motivation. The results (Table VI) showed no evidence of endogeneity.

Table V. First-stage regression results (dependent variable: Food security status)

Variable	Estimate	S.E.	t-value	p-value
Intercept	0.065	0.191	0.341	0.734
Age	0.001	0.002	0.322	0.748
Household size	0.006	0.016	0.373	0.710
Socio-economic strata	-0.143	0.101	-1.408	0.162
Education (secondary)	0.085	0.108	0.786	0.434
Education (tertiary)	0.114	0.098	1.155	0.250
Gender (female)	-0.035	0.072	-0.498	0.622
Livestock	0.066	0.073	0.902	0.369
Red Fabric	0.204	0.104	1.950	0.054

Note: The coefficient for the instrument (Red Fabric) is a significant predictor of food insecurity status ($p < 0.10$).

Table VI. Second-stage regression results (dependent variable: Food security status)

Motivations	Coef. Residual	S.E.	z	p-value
Self-provision	-0.103	0.731	-0.141	0.888
Social connection	0.664	0.744	0.894	0.373
Enjoyment	0.772	0.732	1.056	0.293

Note: Non-significant coefficients ($p > 0.1$) indicate the endogeneity is not present. In this analysis, the coefficients for the assessed motivations (self-provision, social connection, enjoyment) are not statistically significant, suggesting no evidence of endogeneity in the model.

3.3 POLR Models

3.3.1 Multicollinearity diagnostics

The POLR models use the same variables as the multivariate probit model, therefore, the multicollinearity results are the same as the one presented above in Table V.

3.3.2 Endogeneity tests

To assess whether food security status was endogenous in the ordinal (POLR) models presented in Table 8, a control function was applied. In the first stage, a linear regression was fitted with food insecurity status as the dependent variable, using the instrument "Red Fabric" and covariates. The instrument was significantly associated with food insecurity status, indicating it satisfies the relevance condition (coef = 0.208, p = 0.048).

In the second stage, POLR models were estimated for each perception, including the residuals from the first stage as an additional regressor. The coefficients of the residual were not significant for any perception, indicating no evidence of endogeneity (Table VII), indicating the coefficients in the POLR can be interpreted as direct associations.

Table VII. Endogeneity test results for POLR models

Perception	Coef. residual	S.E.	z	p-value
Greater share of fruits and vegetables	0.132	2.812	0.471	0.638
Reduction of food expenses	0.316	3.413	0.092	0.926
Physical activity	1.006	2.948	0.321	0.733

Note: Non-significant coefficients (p > 0.1) indicate no evidence of endogeneity. For all three perceptions, the residuals were not statistically significant, suggesting that the POLR models estimates can be interpreted as direct associations.

Appendix 4. Perceived benefits of homegardens (non-significant POLR models)

Table VIII. Determinants of perceived benefits from homegardens: evidence from Ordinal Logistic Regressions (POLR) – Overall non-significant models

Variable	Log-odds	S.E.	t-value	p-value	Odds Ratio
Perception: Homegarden provides more food to eat (p = 0.118)					
Age	0.027	0.014	1.903	0.057	1.028
Household size	-0.027	0.095	-0.280	0.779	0.974
Socio-economic strata	0.287	0.588	0.489	0.625	1.333
Food security status	0.325	0.577	0.564	0.573	1.384
Education (secondary)	-0.090	0.716	-0.126	0.900	0.914
Education (tertiary)	-0.779	0.647	-1.204	0.229	0.459
Gender (female)	-0.834	0.464	-1.798	0.072	0.434
Perception: Homegarden provides wider variety of food (p = 0.149)					
Age	0.042	0.016	2.612	0.009	1.043
Household size	0.106	0.118	0.901	0.368	1.112
Socio-economic strata	-0.264	0.648	-0.407	0.684	0.768
Food security status	0.894	0.727	1.230	0.219	2.444
Education (secondary)	0.389	0.763	0.510	0.610	1.475
Education (tertiary)	0.018	0.657	0.027	0.979	1.018
Gender (female)	0.041	0.474	0.087	0.931	1.042
Perception: Homegarden enables me to earn additional income (p = 0.973)					
Age	0.004	0.015	0.303	0.762	1.004
Household size	0.029	0.108	0.270	0.787	1.029
Socio-economic strata	0.251	0.673	0.373	0.709	1.286
Food security status	-0.283	0.617	-0.459	0.646	0.753
Education (secondary)	-0.318	0.704	-0.452	0.651	0.727
Education (tertiary)	-0.014	0.623	-0.022	0.982	0.986
Gender (female)	0.351	0.475	0.738	0.460	1.420
Perception: Homegarden enables me to afford non-food items (p = 0.449)					
Age	0.014	0.013	1.062	0.288	1.014
Household size	0.167	0.110	1.519	0.129	1.182
Socio-economic strata	0.632	0.546	1.157	0.247	1.881
Food security status	-0.065	0.558	-0.117	0.907	0.937
Education (secondary)	0.468	0.649	0.722	0.471	1.597
Education (tertiary)	0.498	0.583	0.855	0.393	1.646
Gender (female)	-0.122	0.417	-0.293	0.770	0.885

Variable	Log-odds	S.E.	t-value	p-value	Odds Ratio
Perception: Homegarden enabled me to start a small business (p = 0.925)					
Age	-0.016	0.015	-1.104	0.270	0.984
Household size	0.051	0.100	0.509	0.611	1.052
Socio-economic strata	-0.124	0.614	-0.201	0.841	0.884
Food security status	-0.393	0.622	-0.632	0.528	0.675
Education (secondary)	-0.165	0.678	-0.244	0.807	0.848
Education (tertiary)	-0.200	0.616	-0.324	0.746	0.819
Gender (female)	-0.016	0.450	-0.035	0.972	0.984

Note: The table reports estimated log-odds, standard errors (S.E), t-values, p-values, and odd ratios from POLR models on five perceived benefits derived from homegardens. Positive coefficients indicate higher odds of agreement; negative coefficients indicate lower odds. The overall significance of the individual models was p > 0.1.

The multicollinearity diagnostics follow the same pattern presented in Table V , indicating multicollinearity is not a problem. Endogeneity was assessed as described above for the POLR models with p < 0.1. The results indicated no evidence of endogeneity (Table VIII).

Table IX. Endogeneity test results for POLR models

Perception	Coef. residual	S.E.	z	p-value
Homegarden provides more food to eat	-0.123	3.093	-0.040	0.968
Homegarden provides wider variety of food	2.087	3.466	0.602	0.547
Homegarden enables me to earn additional income	1.306	3.509	0.372	0.710
Homegarden enables me to afford non-food items	0.740	3.142	0.236	0.814
Homegarden enabled me to start a small business	-0.957	3.243	-0.295	0.768

Note: Non-significant coefficients (p > 0.1) indicate no evidence of endogeneity. For all three perceptions, the residuals were not statistically significant, suggesting that the POLR models estimates can be interpreted as direct associations.

Appendix 5. Multinomial regression and multivariate probit models robustness check

To assess the robustness of the multinomial regression, binary logistic regressions were estimated for each homegarden cluster separately (Table X). Key predictors identified in the multinomial model, namely household size and plant diversity, retained similar effect direction and significance in the binary models, supporting the reliability of the findings despite the moderate sample size.

Similarly, to assess robustness of the multivariate probit estimates, separate binary logistic regressions were conducted for each motivation (Table XI). The results show the direction and magnitude of the coefficients were consistent across specifications, and the same predictor, tertiary education, reached statistical significance. This convergence suggest that the multivariate probit model is robust.

Table X. Binary logistic regression results for homegarden clusters in Bogotá

Variable	B	S.E.	p-value	OR
Ornamental cluster				
(Intercept)	-5.76	2.13	0.00	0.00
Plant diversity	1.66	0.61	**0.00**	5.28
Age	0.03	0.12	0.11	1.03
Household Size	-0.41	0.18	**0.03**	0.67
Socio-economic strata	1.10	0.76	1.15	3.00
Food security status	0.72	0.70	0.30	2.06
Education (secondary)	-0.42	0.81	0.61	0.66
Education (tertiary)	-0.91	0.70	0.19	0.40
Gender (female)	0.35	0.57	0.55	1.41
Livestock	0.87	0.59	0.14	2.38
Multipurpose cluster				
(Intercept)	2.83	1.62	0.08	16.9
Plant diversity	-1.28	0.45	**0.00**	0.27
Age	-0.01	0.02	0.46	0.99
Household Size	0.37	0.13	**0.00**	1.44
Socio-economic strata	-0.06	0.65	0.92	0.94
Food security status	-0.37	0.61	0.54	0.69
Education (secondary)	-0.21	0.69	0.76	0.81
Education (tertiary)	0.42	0.63	0.50	1.52
Gender (female)	-0.41	0.47	0.38	0.67
Livestock	-0.53	0.47	0.26	0.59
Food cluster				
(Intercept)	-1.19	1.78	0.50	0.31
Plant diversity	0.29	0.47	0.53	1.35
Age	0.01	0.02	0.53	0.99
Household Size	-0.17	0.13	0.19	0.85
Socio-economic strata	-0.99	0.85	0.25	0.37
Food security status	-0.04	0.65	0.95	0.96
Education (secondary)	0.68	0.79	0.39	1.97
Education (tertiary)	0.23	0.74	0.76	1.25
Gender (female)	0.27	0.52	0.61	1.31
Livestock	0.07	0.51	0.89	1.07

Note: Each binary regression models the likelihood of a homegarden belonging to a given cluster (ornamental, multipurpose, food). Reported are the coefficients (B), standard errors (S.E), p-values, and odd ratios (OR) are reported. These regressions complement the multinomial model by assessing the robustness of its results.

Table XI. Binary logistic regression results for homegardening motivations

Variable	B	S.E.	p-value	OR
Motivation: Self provision				
(Intercept)	1.41	1.17	0.22	4.18
Age	-0.02	0.02	0.15	0.98
Household Size	-0.05	0.09	0.59	0.95
Socio-economic strata	1.17	0.72	0.11	3.21
Food security status	-0.42	0.56	0.45	0.65
Education (secondary)	0.83	0.67	0.21	2.29
Education (tertiary)	-0.02	0.60	0.98	0.99
Gender (female)	-0.04	0.45	0.92	0.95
Motivation: Social connection				
(Intercept)	-2.20	1.16	0.06	0.11
Age	0.02	0.01	0.25	1.02
Household Size	0.18	0.10	0.12	1.20
Socio-economic strata	0.51	0.62	0.41	1.67
Food security status	0.87	0.59	0.14	2.38
Education (secondary)	0.43	0.68	0.52	1.54
Education (tertiary)	1.01	0.61	0.10	2.71
Gender (female)	-0.30	0.44	0.49	0.74
Motivation: Enjoyment				
(Intercept)	1.20	1.20	0.18	4.97
Age	0.00	0.12	0.76	1.00
Household Size	-0.12	0.10	0.24	0.89
Socio-economic strata	0.52	0.64	0.41	1.69
Food security status	-0.09	0.57	0.88	0.92
Education (secondary)	-0.94	0.77	0.22	0.39
Education (tertiary)	-1.38	0.72	**0.06**	0.25
Gender (female)	0.13	0.45	0.77	1.14

Note: Each binary regression models the likelihood of reporting a given motivation for homegardening (self-provision, social connection, or enjoyment). Reported are the coefficients (B), standard errors (S.E), p-values, and odd ratios (OR) are reported. These regressions complement the multivariate probit analysis by providing additional insights into how variables influence the probability of each motivation and showing the robustness of its results.