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Challenges of Home Gardening and the Proposed Role of Hydroponic Solutions: Colombo Divisional Secretariat Division

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1. Introduction

Urban home gardening refers to a sustainable environment within small or large land areas within urban or suburban boundaries, where plants, animals, and sometimes fish farming can be practiced (Weerahewa et al., 2012). These gardens typically include a variety of plant species such as vegetables, fruits, herbs, fragrant plants, and ornamental plants. Urban home gardening offers opportunities and challenges for households seeking to grow their own food in limited spaces. Rapid urbanization, population growth, socioeconomic factors leading to income fluctuations, urbanization and industrialization, agricultural technologies, farmers' unstable incomes, open economies, lifestyle changes, environmental issues, government policies, and gender inequality are among the reasons that hinder the proper practice of home gardening. Common challenges include poor soil quality, lack of sunlight, and limited space for traditional gardening methods. To overcome these challenges, alternative solutions like container gardening, vertical gardening, and hydroponics can be adopted.

Hydroponics is transforming urban agriculture by providing a soilless cultivation method that leverages nutrient-rich water solutions to enhance plant growth. This innovative method has gained popularity in urban environments where space is limited and the demand for fresh produce is on the rise. Hydroponics not only optimizes the use of available space but also conserves water, making it an environmentally friendly choice for urban gardeners. Hydroponic systems offer a significant advantage in water conservation, using 50% to 90% less water than traditional farming methods. This is due to their innovative recirculating design, which makes them particularly beneficial for cities struggling with water scarcity. (Hydroponics and Its Role in Urban Agriculture, 2021).

One of the significant benefits of hydroponics is its ability to be implemented in various settings, including balconies, rooftops, and indoor spaces, making it ideal for densely populated areas. Additionally, this method reduces the reliance on chemical fertilizers and pesticides, resulting in healthier crops and a lower environmental impact. The capacity for year-round production allows urban gardeners to cultivate a variety of crops continuously, independent of seasonal changes. Hydroponics facilitates the successful cultivation of a diverse range of vegetables and herbs, such as lettuce, tomatoes, cucumbers, and peppers, as well as ornamental plants like roses. This enhances dietary options and aesthetic appeal for city dwellers, providing them with fresh produce and beautiful gardens in urban settings. However, urban home gardening using hydroponics does face challenges. The initial financial investment required to set up hydroponic systems can be higher than traditional gardening methods. Furthermore, these systems often depend on artificial lighting and automated watering systems, leading to increased energy consumption. Not all plants are suitable for hydroponic growth, which can limit crop variety (More Agricultural Technology Resources, 2021).

To address these challenges, the study aims to explore how hydroponics can enhance urban home gardens. By identifying existing urban gardening methods and examining barriers to implementation, insights can be gained on how hydroponic systems can be tailored to meet urban needs. Promoting hydroponics as a viable solution could significantly improve food security and sustainability in cities. (Incites Food, 2024).

Hydroponics offers a promising approach to urban agriculture by addressing critical issues such as space constraints and water scarcity while promoting sustainable practices. As cities continue to expand, integrating hydroponic systems into urban home gardens could enhance access to fresh produce and reduce environmental impacts. The potential benefits underscore the importance of ongoing research and development in this innovative agricultural method as a means to foster resilient urban food systems.

This study mainly aims to identify the challenges of urban home gardens and examine the potential of Hydroponic systems. The sub-objectives to achieve the main aim were; identifying urban home gardening methods, identifying the challenges in implementing urban home gardens and proposing the hydroponic method for urban home gardens.

2. Methods and materials

The study area encompasses a substantial region comprising 34 Grama Niladhari Divisions, with the research conducted within a specified time frame. Primary data were gathered through questionnaires, structured open-ended interviews, and direct observations. According to data provided by the Colombo Divisional Secretariat, the distribution of questionnaires was limited to households engaged in home gardening within the Colombo Divisional Secretariat Divisions. However, due to the limited prevalence of home gardening activities among households during the study period, a snowball sampling technique was employed to ensure an adequate sample size for questionnaire distribution and completion. Additional data were obtained through structured open-ended interviews. The researcher conducted extensive fieldwork, which included administering questionnaires, conducting interviews, and making direct observations. Additionally, structured interviews were carried out with households to gather further information, complementing the questionnaire data.

Direct observations provided data on the size of the areas used for home gardening, the types of crops cultivated, the methods of cultivation, the materials employed, and the challenges encountered during the gardening process. Based on a report from the Divisional Secretariat, 14 Grama Niladhari Divisions practicing home gardening were purposively selected from a total of 34 divisions. These divisions, under the jurisdiction of the Colombo Divisional Secretariat, were identified as suitable for various forms of home gardening, including rooftop gardens, backyard gardens, balcony gardens, courtyard gardens, terrace gardens, and hanging gardens.

A total of 50 questionnaires were distributed exclusively to households engaged in home gardening within the selected 14 Grama Niladhari Divisions. In cases where identifying such households was challenging, the snowball sampling method was employed to ensure adequate distribution. Since the data collected through the questionnaires supported only quantitative analysis, structured interviews were conducted with the same 50 households to gather qualitative data. The questionnaire was designed to explore the types of crops cultivated in urban home gardens and to identify the challenges associated with urban home gardening within the 34 Grama Niladhari Divisions of the Colombo Divisional Secretariat. It included a combination of closed, open-ended, and multiple-choice questions. Quantitative data obtained from the questionnaires were analyzed using basic statistical methods with the assistance of the MS Excel.

In contrast, qualitative data collected from open-ended questionnaire responses, interviews, and direct observations were analyzed thematically using a descriptive qualitative analysis approach.

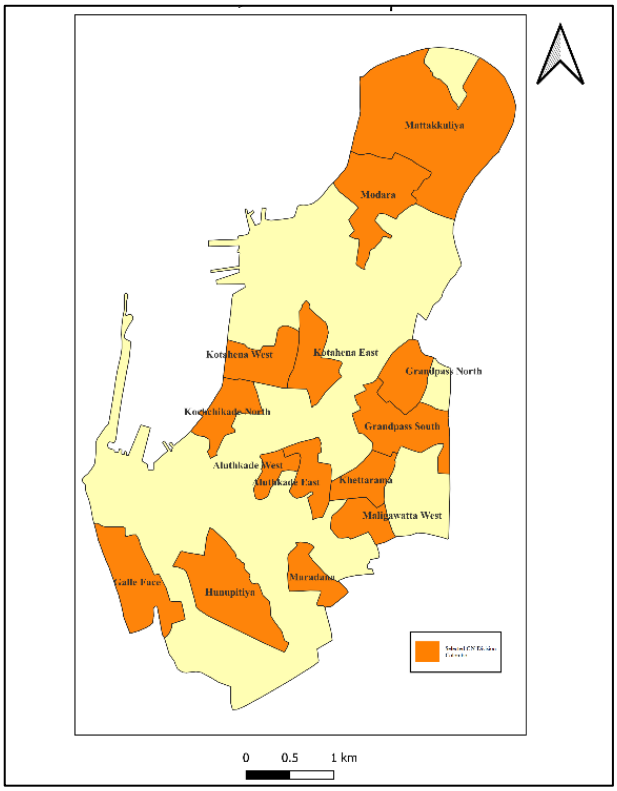

Figure 1: Study area Source: Divisional Secretariat Division; Prepared by the researcher via Arc GIS 10.8

3. Results and discussion

Home Gardening Practices and Crop types

Various home gardening practices are adopted within households in the Colombo Divisional Secretariat tailored to differing housing conditions. Figure 2 illustrates key characteristics of these homestead types.

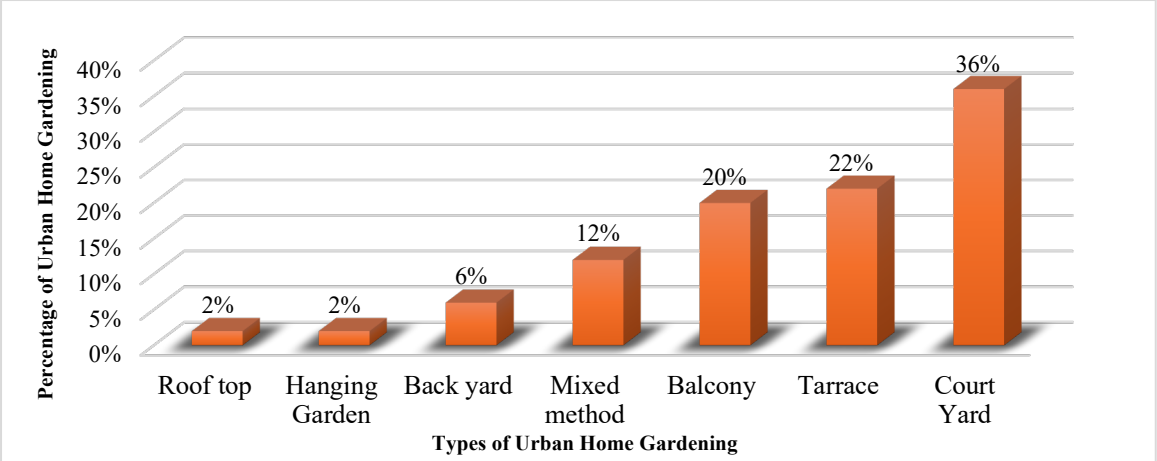

Figure 2: Types of Gardening

Based on Figure 2, 36% of households engage in yard gardening, while 22% adopt rooftop gardening. A smaller percentage, 2%, utilize hanging and terrace gardens. Additionally, some households practice mixed gardening methods, adapting to space constraints by combining rooftop, balcony, courtyard, backyard, and hanging garden techniques for cultivation. Here, space availability significantly influences the methods of home gardening.

Figure 3: Types of Urban Home gardening

In these home gardening practices, 32% of the crops are vegetables, 26% are green leaves, 28% are fruits, 9% are medicinal plants, and 4% are other types of plants. Among vegetables, tomatoes make up 40%; among fruits, mango and guava represent 11.4%; within green leaves, spinach accounts for 26.4%; in medicinal plants, *Karpuravalli* (Indian Borage) comprises 32.56%; and among other plants, coconut trees are the most cultivated at 46%.

Challenges faced by households in practicing urban home gardening and corresponding alternative solutions.

Based on data collected in the study area, households engaged in home gardening face various challenges and adopt alternative solutions to address them.

When referring to extreme weather conditions, according to the sectorial impact details developed by the Sri Lanka Ministry of Environment, the Grama Niladhari divisions under the Colombo Divisional Secretariat have been identified as the most vulnerable areas to flooding, based on residential and urban development.

The Mattakkuliya Grama Niladhari division, located near the main outflow of the Kelani River, is categorized as a flood-prone area (Hewawasam & Matsui, 2020).

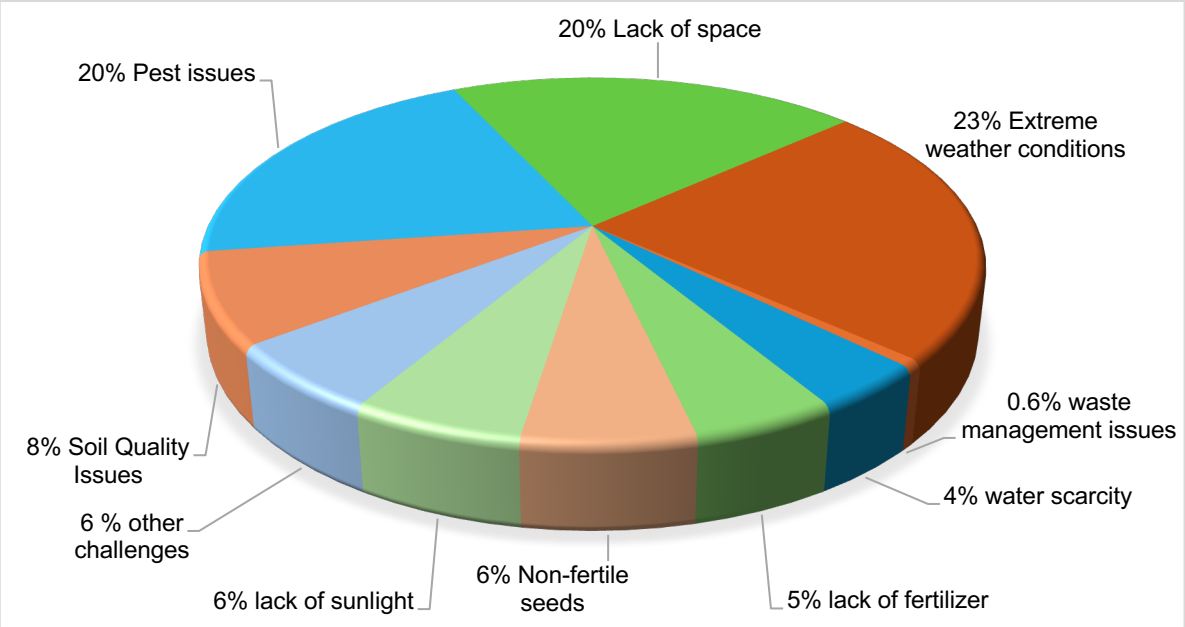

Figure 4: Problems faced by the household gardeners

As a result, during the monsoon seasons in the study area, crops are adversely affected by flooding. Furthermore, due to limited opportunities for water drainage after rainfall, water stagnation occurs, leading to the destruction of crops. As the study area is urbanized, the impact of urban heat islands is significant. Consequently, crops experience wilting, scorching, and decay. Moreover, individuals engaged in rooftop gardening are particularly vulnerable as they are directly exposed to solar heat, resulting in increased damage to their crops. As the Colombo Municipal Council is an urbanized area, there are only multi-story residences, row houses, garden homes, and apartment buildings. As a result, there is a lack of available space for home gardening.

During home gardening, the impact of pests is significant (Legesse et al., 2016) and there is a lack of sufficient awareness among urban residents regarding measures to control pest damage. Specifically, pests such as rats and cats destroy crops, while birds like crows' damage flowers, and insects, including ants, cause harm. Additionally, white mold attacks are observed on leaves and stems, further affecting the crops. Those engaged in urban home gardening primarily purchase seeds from stores; however, these seeds are often found to be dry and infertile, leading to delays in crop growth and, at times, failure of the crops to grow.

As a result, they use alternative methods such as utilizing seeds from purchased vegetables, fruits, and leafy greens, as well as buying small, pre-grown plants from stores and planting them in containers or gardens. For optimal crop growth, compost is essential. However, in urban areas, opportunities to obtain organic compost and facilities to produce it are very limited. After enriching the soil with chemical compost, the soil often becomes unsuitable for reuse, leading to challenges in continuing home gardening. Water and waste disposal issues are also faced by those engaged in urban home gardening. Individuals with rooftop or balcony gardens often struggle to transport water containers to their terraces or balconies, making it difficult to properly care for their crops, which leads to wilting and decay. Additionally, the removal of organic waste generated from home gardening poses challenges.

The benefits of hydroponics are numerous: it uses approximately 95% less water than traditional soil-based gardening, allows for faster growth and higher yields, and can be conducted indoors or outdoors year-round. Hydroponics also minimizes the risk of pests and diseases typically associated with soil gardening, reducing the need for harmful pesticides. Additionally, this method enables urban gardeners to cultivate a wide variety of crops, including leafy greens, herbs, tomatoes, and cucumbers, in a controlled environment that can be tailored to their specific needs. By adopting hydroponics, households can enjoy fresh produce while maximizing limited space and resources, contributing to a more sustainable urban lifestyle.

Hydroponics and traditional home gardening represent two distinct approaches to plant cultivation, each with unique characteristics, advantages, and challenges. Both methods aim to produce healthy plants for personal consumption or aesthetic enjoyment, allowing for the growth of various vegetables, herbs, and ornamental plants. Regardless of the approach, plants require essential elements such as water, nutrients, light, and air for optimal growth, necessitating careful management of these factors to ensure healthy development. Additionally, both hydroponics and traditional gardening can employ similar techniques like pruning and monitoring for pests.

However, the differences between the two methods are significant. Hydroponics utilizes nutrient-rich water solutions instead of soil, allowing for precise control over nutrient delivery and resulting in faster growth rates often 30-50% quicker than traditional gardening. This method also conserves water, using 50% to 90% less due to its recirculating systems. Hydroponics can be implemented in smaller spaces and vertical setups, making it ideal for urban environments where land is limited.

In contrast, traditional gardening relies on soil as a growing medium, which can lead to variability in nutrient availability and requires more horizontal space.

Moreover, hydroponics generally entails higher initial setup costs due to specialized equipment but results in cleaner harvests and reduced labor intensity since it minimizes tasks like weeding. Traditional gardening is often more accessible for beginners due to its lower initial investment and simpler maintenance requirements. However, it is more susceptible to pests and diseases from the soil and is limited by seasonal changes and weather conditions (Tuhopeta, 2023).

While hydroponics offers innovative solutions suited for urban settings with limited resources and provides higher yields in controlled environments, traditional gardening remains a viable option for those seeking a simpler approach with lower startup costs. Each method has its own set of benefits and challenges that cater to different gardening preferences and circumstances.

4. Conclusion

Urban home gardening, despite facing environmental constraints, limited space, and resource availability, presents significant opportunities for sustainable living. A study of households in the Colombo Divisional Secretariat area highlights the resilience of urban gardeners who employ innovative techniques such as container gardening, vertical gardening, and hydroponics to tackle challenges like poor soil quality and pest infestations. Hydroponics stands out as an especially effective solution for urban environments, allowing for year-round cultivation of a variety of crops in a controlled, water efficient system that reduces reliance on soil and pesticides. This method not only enhances food security but also promotes environmental sustainability by minimizing water usage up to 90% less than traditional gardening methods and eliminating soil borne diseases. Overall, hydroponics contributes to a greener urban landscape, making it an attractive option for those seeking to grow their own food in limited spaces.

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