From Waste to Plate: Empowering a Peri-Urban Community with Circular Bioeconomy in Sri Lanka

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The project was undertaken by

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Executive summary

This project aimed to empower peri-urban households in a peri-urban region in the Western Province of Sri Lanka—Kaduwela Municipal Council (KMC) region to foster a circular bioeconomy and enhance livelihoods through improved waste segregation, home composting, and home gardening. The project intervention was implemented in collaboration with KMC, community leaders, and agricultural instructors. The intervention targeted 30 households along the KMC's waste collection route, selected based on low waste segregation levels and high volumes of organic waste.

The selected households were provided with training in waste segregation, composting techniques, and home gardening practices. They were also given compost bins and vegetable seeds suited to the area. Baseline and follow-up monitoring over six months was undertaken by visiting each participant's household.

The project's capacity-building interventions, which included training on waste segregation, composting, and home gardening, significantly enhanced participants' awareness, motivation, and practical skills. Feedback from household members indicated that the waste segregation training positively influenced their habits and attitudes toward waste segregation practices. Composting training enhanced participants' knowledge and skills, leading to increased adoption of home composting practices. Home gardening training, which included directions on managing pests and diseases, was well-received, with participants expressing satisfaction and confidence in applying the techniques learned.

Monitoring visits revealed a significant shift toward sustainable waste management, showing measurable improvements in household waste management, particularly in multi-category segregation and adoption of composting. All households began using compost bins and used the compost in their home gardens.

Households demonstrated reasonable initial progress in using compost bins to process kitchen and garden waste. Although a slight decline was noted during the second visit, targeted support and practical remedies helped address challenges, leading to improved composting practices by the third visit.

Following the provision of compost bins, seeds, and training, participants made good progress in home gardening. Over three monitoring visits, steady improvement was observed despite challenges such as prolonged rainfall, pests and diseases, and poor quality of seeds.

According to participants, home gardens contributed to food and nutritional security, enabling households to supplement diets with home-grown produce and reduce dependency on high-priced vegetables from the market.

Since the project covered only a very small number of residences along the waste collection route, it did not produce a noticeable influence on KMC waste collection volumes. However, household data revealed a notable reduction in biodegradable waste entering the municipal waste stream.

The intervention demonstrated strong potential for replication and upscaling, with key outcomes including:

- Reduction of organic waste burden on municipal systems
- Enhanced household resilience and food security
- Increased awareness and behavioural change in sustainable waste and local food production practices
- Empowerment of low-income peri-urban communities through low-cost, eco-friendly solutions to achieve a household-level circular bioeconomy

The project intervention demonstrated significant potential for empowering peri-urban households to advance a bio-circular economy through proper waste segregation, home composting and home gardening for strengthening household nutrition and food security while alleviating the waste management burden of municipal councils and local authorities.

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Introduction

Background

Ensuring household food security is a paramount concern across developing nations, with Sri Lanka being no exception, especially in the context of the country's current economic crisis. The poverty rate surged from 13% in 2021 to 26% in 2023% (World Bank 2023). Access to adequate and nutritious food is essential for the well-being and development of individuals and communities. In the context of sustainable development, achieving household food security is crucial, as it forms the cornerstone for economic stability, social cohesion, and environmental sustainability. Without reliable access to nutritious food, households face heightened vulnerability to poverty, malnutrition, and health challenges. Thus, fostering household food security is not only a humanitarian imperative but also a fundamental pillar for the sustainable advancement of developing countries like Sri Lanka (Prokic et al., 2022; Alonso-Munoz et al., 2022).

In recent decades, Sri Lanka has faced a pressing issue with waste collection and disposal, exacerbated by rising waste generation and the absence of comprehensive, adequately funded waste management infrastructure. This has led to the widespread practice of open dumping and burning of discarded materials with serious environmental and social implications. In Sri Lanka, municipalities and other local authorities must deal with increasing waste generation by households owing to urbanization and increased income. Around 7,500 tons of waste is generated per day in Sri Lanka, and a person generates an average of 0.4 to 1.0 kg of waste per day in the country (UNESCAP, 2018). Interestingly, more than 60% of the municipal solid waste (MSW) generated in Sri Lanka is organic and thus biodegradable, with a high potential for recycling as an agricultural input.

Given that all synthetic fertilizer is imported, placing a significant burden on already constrained foreign exchange reserves, recycling resources emerges as a viable option from a sustainability perspective. By repurposing and reutilizing resources, countries can optimize their limited supplies and minimize waste. Moreover, with careful planning and implementation, resource recycling processes can be integrated into strategies to enhance household food security, especially in urban and peri-urban areas where the majority of waste is generated (Malaiarasan and Dobriyal, 2023; Yıldırım and Yoğun, 2023).

The concept of a circular bioeconomy provides a comprehensive framework for addressing the intertwined challenges of resource limitation, sustainability, and food security in developing countries like Sri Lanka. By emphasizing the reuse, recycling, and repurposing of biological

resources, circular bioeconomy offers a pathway towards sustainable development (Mak et al., 2019). Through initiatives such as composting household organic waste to use in home gardening, communities can harness locally available resources to produce nutritious food, thereby reducing dependence on external inputs and minimizing waste generation (Lopez and Chifari, 2018).

This project aims to bring tangible benefits not only in terms of building household food security and contributing to the triple bottom line but also for the municipal council that deals with waste collection and needs to strengthen its practice and engagement with citizens, now and into the future with increased demand to manage and treat household waste. This project intervention in the Kaduwela Municipal Council (KMC) area is expected to benefit other municipal councils and local authorities, especially those based in peri-urban areas with a similar background.

Scope and objectives

This project intervention aims to empower peri-urban households in fostering circular bio economies and improving their livelihoods through enhanced understanding of waste segregation practices, improved composting practices and home gardening techniques. By supporting peri-urban home gardening initiatives, the interventions seek to strengthen household nutrition and food security while alleviating the waste management burden of municipal councils and local authorities.

Short-term objectives

To promote households to recycle kitchen waste (composting) in the selected peri-urban area (KMC).

To promote home gardening using outputs of recycled kitchen and garden waste as inputs in a selected peri-urban area (KMC).

Long-term objectives

Practical application of household circular bioeconomy in a selected peri-urban area in Sri Lanka by demonstrating real-world examples for achieving household food security through organic waste-derived agricultural inputs.

Methodology

A mixed-method experimental research approach will be adopted along with an action research study design. The research duration will span over 6 months.

Project site and participant selection

The Kaduwela Municipal Council (KMC) is a suburb of the Colombo District in Sri Lanka's Western Province, where the capital city of Sri Lanka is based. The Western Province produces about 3732 tons of municipal solid waste (MSW) each day, which ultimately accounts for over 60% of Sri Lanka's waste, 48% of which is from households. The KMC comprises 57 local administrative divisions known as Grama Niladhari (GN) divisions. It has a land area of 87.7 km^2 and a population of 264,451 (2018). KMC is divided into three divisions with KMC suboffices, namely Kaduwela, Battaramulla and Athurugiriya (Figure 1). Among the three divisions, Kaduwela is considered a peri-urban area with many low-income households. Therefore, the project was based in the Kaduwela division's waste collection zone.

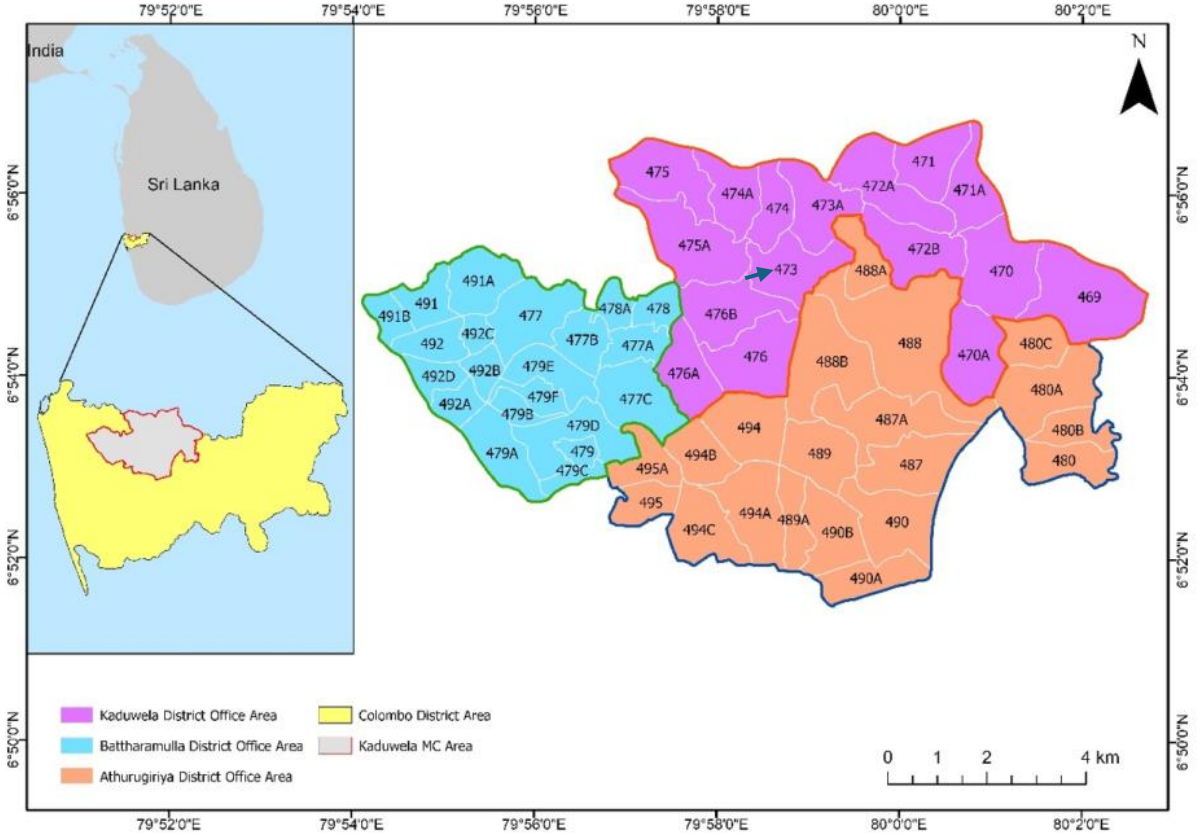

Figure 1 Project location

Source: IWMI

Waste management in Kaduwela Municipal Council

KMC collects approximately 60–70 tons of waste daily, of which around 35 tons consists of biodegradable (organic) waste. This organic portion is utilized for producing organic fertilizer, feeding animals, and generating electricity, while the remaining waste is sent to landfills. However, KMC faces several challenges in managing this process, including flooding, plastic contamination, issues with compost quality, limited demand for compost, and a shortage of skilled labour (Jayathilake et al, 2020).

Sampling and data collection

Participant selection process

The participants for the project were selected from a list of households along the KMC's waste collection route, where waste segregation was poor and volumes of organic waste were high. The following criteria were used to select 30 participants through a home visit and scoping survey with the help of KMC and community leaders.

- The household's willingness to participate in both home gardening and composting activities.
- The household's commitment to allocate time for composting and home gardening
- The household's availability for training on waste segregation, composting and home gardening.
- Presence of active community leaders in the area.

The selected households were provided with training on waste segregation, home composting and home gardening, along with materials such as compost bins and vegetable seeds suitable for the area recommended by the Department of Agriculture. Selected households were instructed to measure their kitchen waste quantities used for composting and disposed of in the KMC waste stream. Additionally, they were asked to keep records of home garden harvests and household consumption.

Plate 1 Seeds distributed to participants

A baseline survey was conducted to understand the situation before the project intervention. Progress monitoring was conducted on three occasions over six months. Additionally, qualitative data were collected from participants regarding the contribution of home gardening to household food security and livelihoods.

Data was continuously collected from 23 participants, as some participants did not contribute to the project due to personal circumstances.

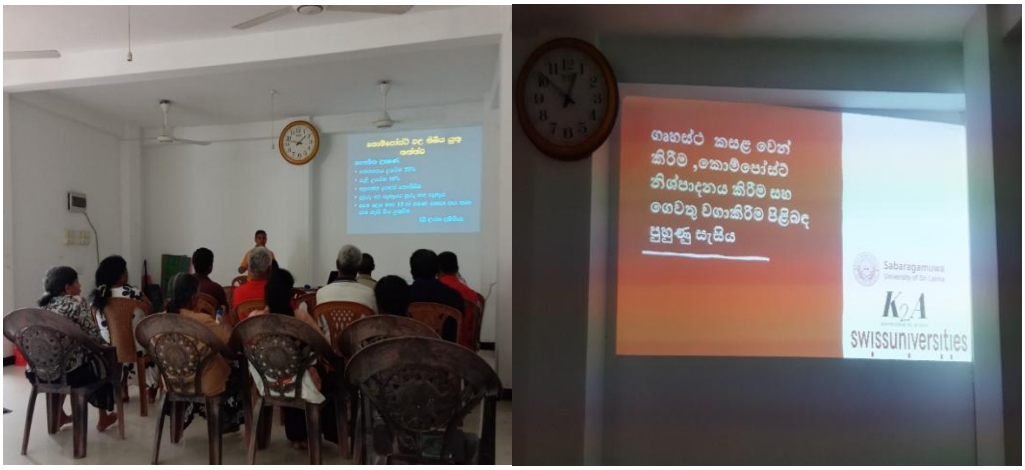

Plate 2 Some participants at a training session

Data analysis

Descriptive analysis was performed where relevant, comparing baseline with post-implementation monitoring visits. Results were interpreted to identify the effectiveness of kitchen waste recycling/composting and home gardening in promoting household food security and waste management.

Plate 3 On-site training and progress monitoring

Results and Discussion

Demographics of participants

The participant average household size ranged between 2 to 6, with an average of 4.2 members, with a household head with an average age of 52 years. The gender distribution within the household was 51%, 49% male and female respectively. The participant households in the project were predominantly female, with only 25% of participants being male. The participants are mainly from low-income groups. They generate 5 to 8 kgs of kitchen waste per week. The land extent, including their dwelling, is less than 20 perches.

Baseline status about waste segregation, composting and home gardening

The selected households before the project intervention had some experience with waste segregation, home composting and home gardening (Figure 2). About half of the participants had done home composting in their gardens using traditional compost piles. The home gardening experience was reported by the majority, especially because they have engaged in home gardening during the COVID-19 pandemic period. However, the majority of them have not regularly done compositing or home gardening.

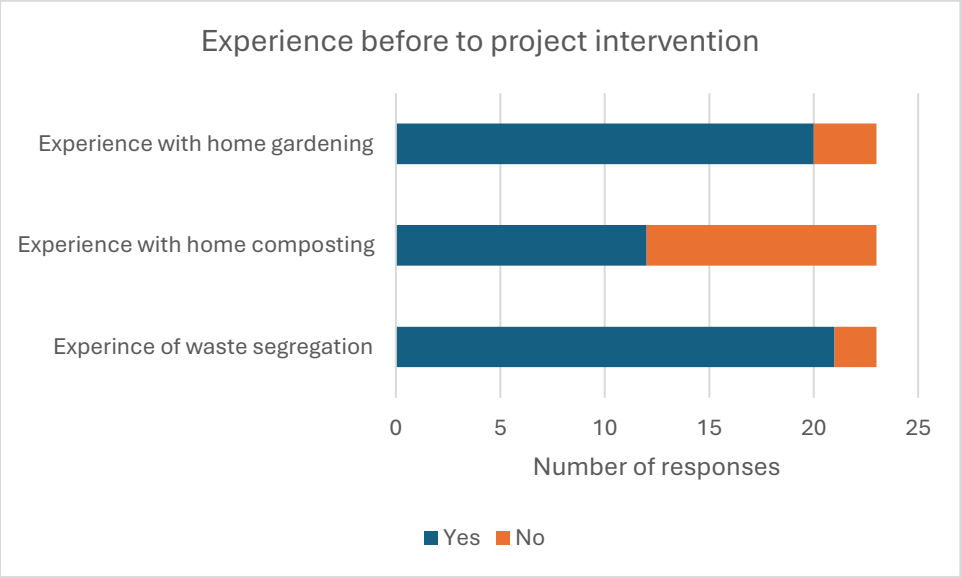

Figure 2 Experience with waste segregation, composting and home gardening before the project

Waste segregation practices

The subsequent monitoring visits to households revealed improvements in waste segregation following the awareness sessions conducted. Most households initially separated waste into

only organic and other types, a growing number began practicing multi-category segregation by the third visit (Figure 3). This reflects enhanced engagement and awareness of participants in waste segregation, likely influenced by project interventions and awareness creation.

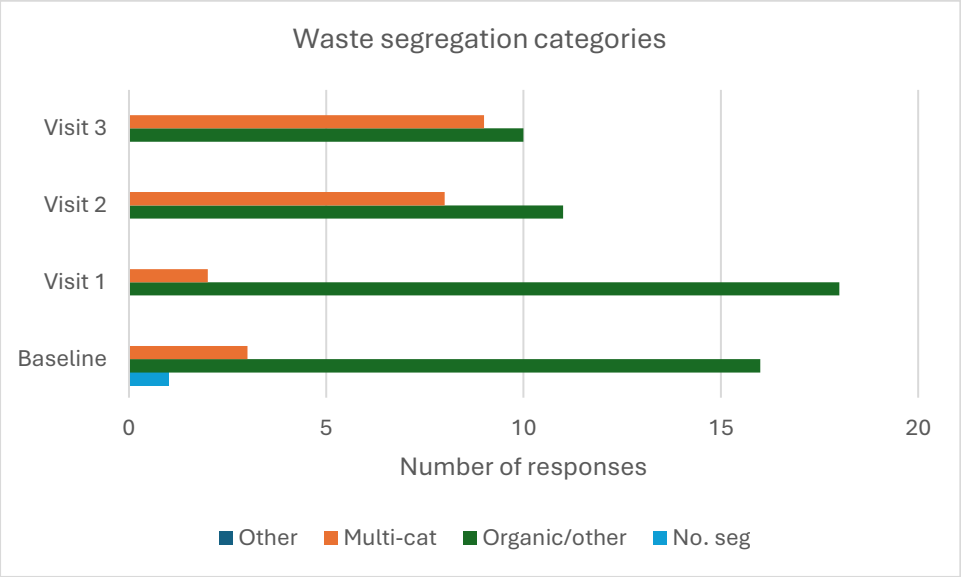

Figure 3 Waste segregation categories

The majority before the project intervention (baseline) used waste bins, but none of them used compost bins until they were given to them by the project. A notable change observed is the use of the compost bins by all the participating households. Waste bin use remained constant, indicating composting was considered a complementary practice rather than replacing traditional waste disposal methods. Mostly, they continued to use the waste bins for non-biodegradable waste. In addition, those who did not use a waste bin had the opportunity to use the compost bin for biodegradable waste after the intervention. This reflects an encouraging move toward sustainable waste management at the household level due to the project intervention.

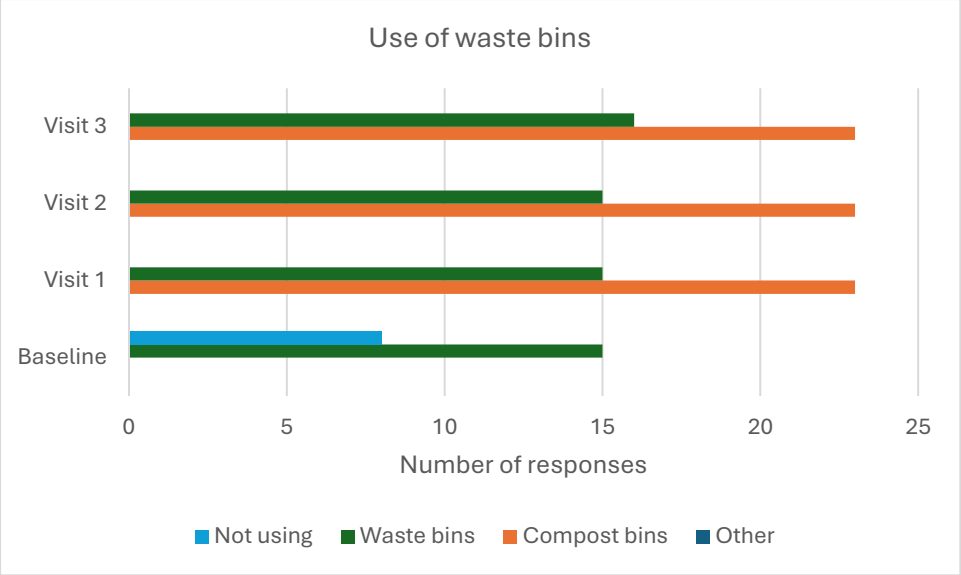

Figure 4 Use of waste bins

The biodegradable waste includes both kitchen waste and garden waste. It is evident from Figure 4 that a significant shift toward sustainable waste management, specifically home composting, has occurred over time. Households used the compost bin to store the biodegradable waste, especially kitchen and garden waste, for composting. Disposal in garden pits and open burning did not happen. The most significant outcomes were the reduction of waste entering the KMC waste stream and the contribution of home garden produce to household food security and nutrition.

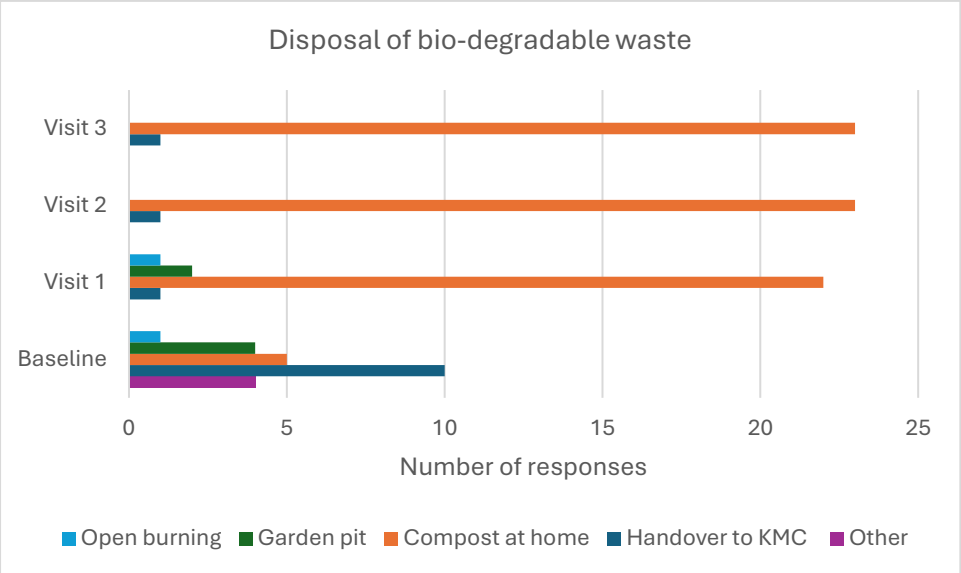

Figure 5 Disposal of biodegradable waste

Impact of training on waste segregation, composting and home gardening

The waste segregation training sessions conducted as part of the project intervention have influenced their awareness, waste segregation habits and motivation, as illustrated by the feedback of the household members who participated in the training (Figure 6). The most significant impact of the training was on raising awareness of waste segregation, followed by the influence on habits and motivation.

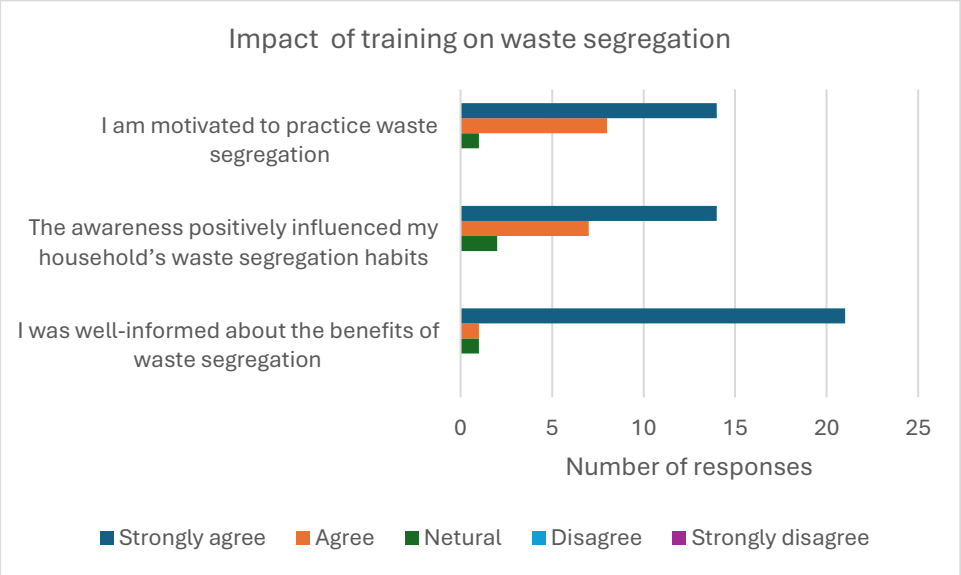

Figure 6 Impact of training on waste segregation

The composting training was conducted both at the community centre and at the household level. The training sessions influenced participants' awareness, composting skills, and motivation to undertake composting. More than 80% of those who participated in the training had a positive perception about the training and its usefulness to enhance their knowledge and skills in composing.

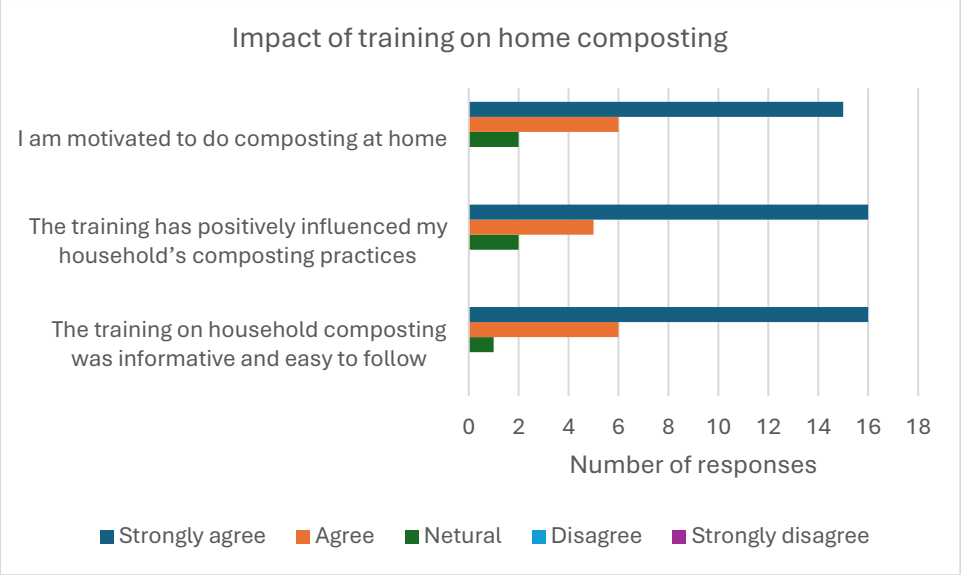

Figure 7 Impact of training on home composting

The home garden trainings were conducted both at the community centre and during regular visits to monitor progress. The participants expressed satisfaction with the training as they appreciated the enhancement of skills in home gardening, especially the knowledge given on coping with pests and diseases (Figure 8).

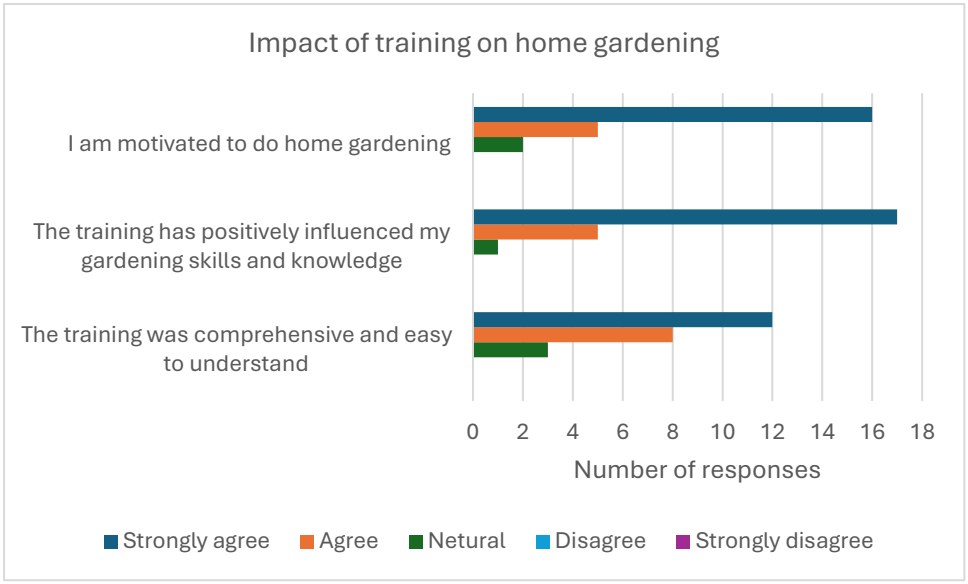

Figure 8 Impact of training on home gardening

Progress of composting and home gardening

Progress with composting

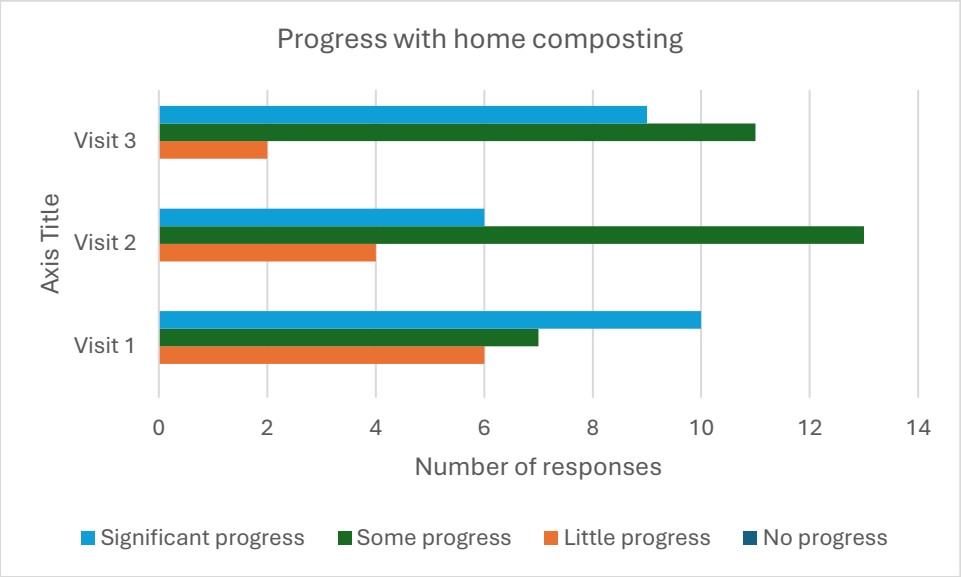

Figure 9 Progress with home composting

Reasonable progress was observed during the first visit in the utilization of the compost bins to process compost from kitchen and garden waste. However, a slight decline was observed during the second visit. Efforts were made to encourage households in terms of proposing remedies for the challenges faced in the composting process, which helped to improve the situation as observed in the third visit (Figure 9). A similar pattern of behaviour of the participants was observed concerning their engagement in the composing process (Figure 10).

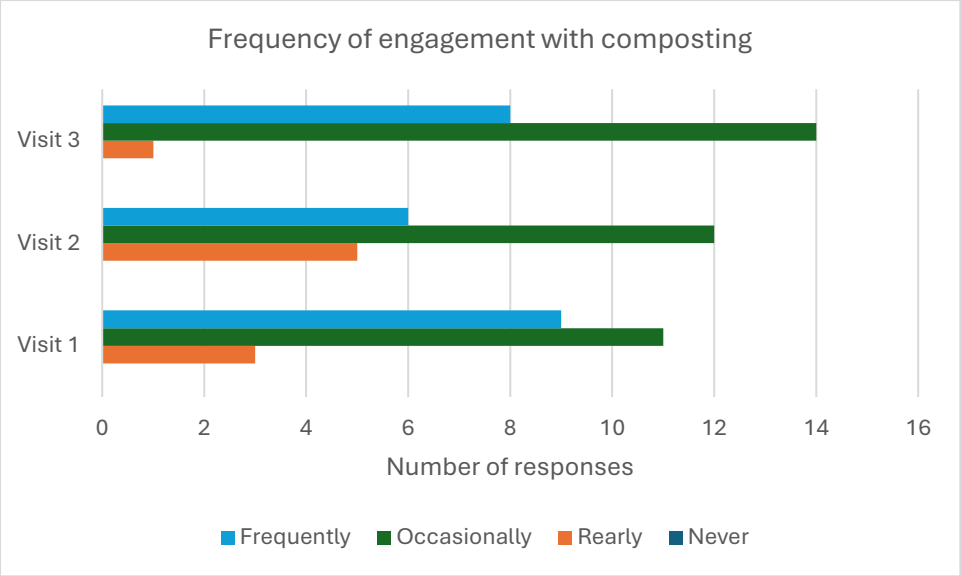

Figure 10 Frequency of engagement with home composting

The participant reported a high level of commitment to continuing with the composting activities throughout monitoring visits, as depicted in Figure 11. Some participants reported challenges in using kitchen waste as it attracted house flies, rats, and the odour emanated from the compost bin. Remedies were suggested to overcome these issues, like maintaining proper moisture levels, using charcoal, and properly covering the compost bins.

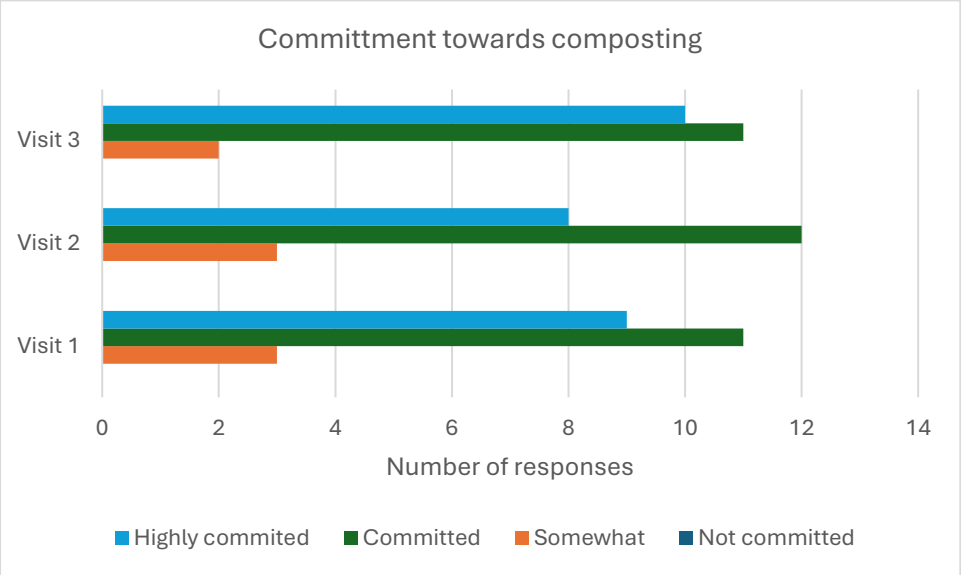

Figure 11 Commitment towards composting

Plate 4 Compost from the bins

Challenges in home composting

A majority of respondents highlighted issues of the presence of rats, which are attracted to improperly managed compost bins, especially those that contain kitchen waste. Due to this issue, some participants got discouraged from adding kitchen waste to the compost bins. Another commonly mentioned issue was the presence of maggots and flies. Odour and leachate were also highlighted as concerns. From a nutrient perspective, participants highlighted the need to use synthetic fertilizer to supplement the compost due to low nutrient levels in the home-made compost.

Progress with home gardening

Satisfactory progress was observed with home gardening after providing compost bins, seeds, and training (Figure 12). Most of the participant households had previous experience in home gardening, although they had not regularly done home gardening. Over the three visits, reasonable progress was observed despite challenges such as heavy rain over a prolonged period, pests and diseases and attacks from pest animals like monkeys, porcupines, and giant squirrels.

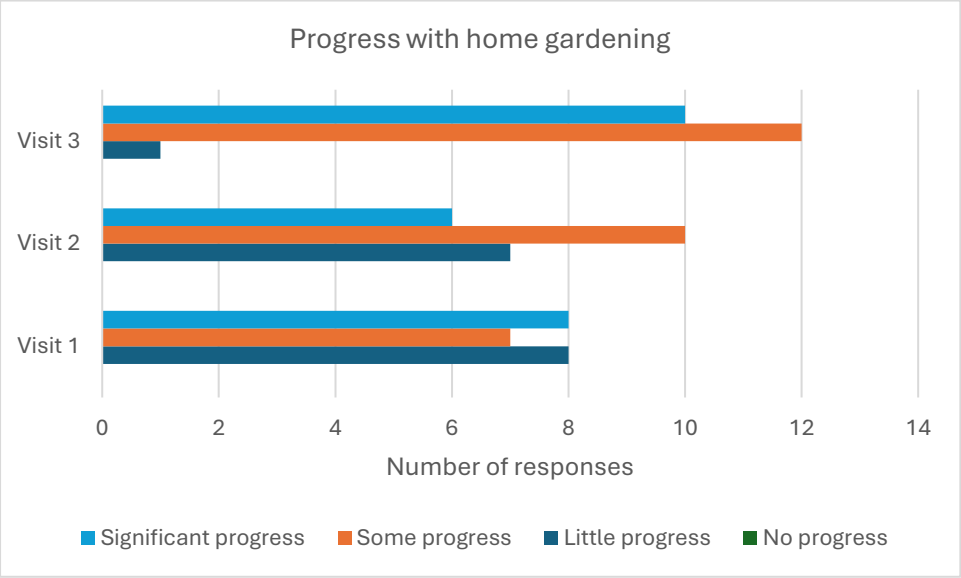

Figure 12 Progress with home gardening

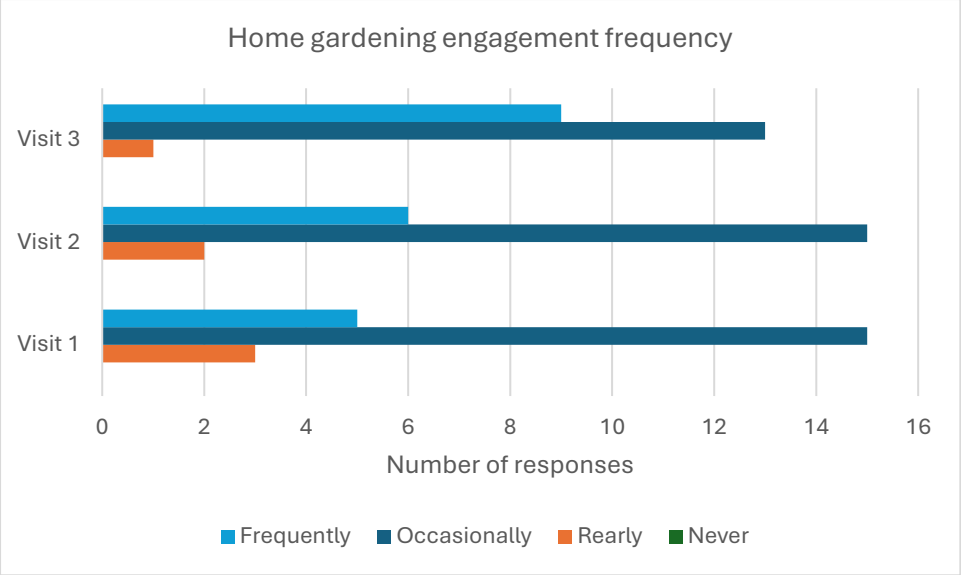

Figure 13 Home gardening engagement frequency

The engagement and commitment to home gardening also show improvement over the three visits. The second monitoring visit revealed reduced interest in actively involving oneself in home gardening. To motivate farmers, they were advised on managing pests and diseases using traditional methods (leaflets were prepared and distributed to participants). Most farmers avoided using agrochemicals to cope with pests and diseases and instead preferred traditional methods to manage pests and diseases. This helped to improve engagement and commitment to home gardening (Figures 13 & 14).

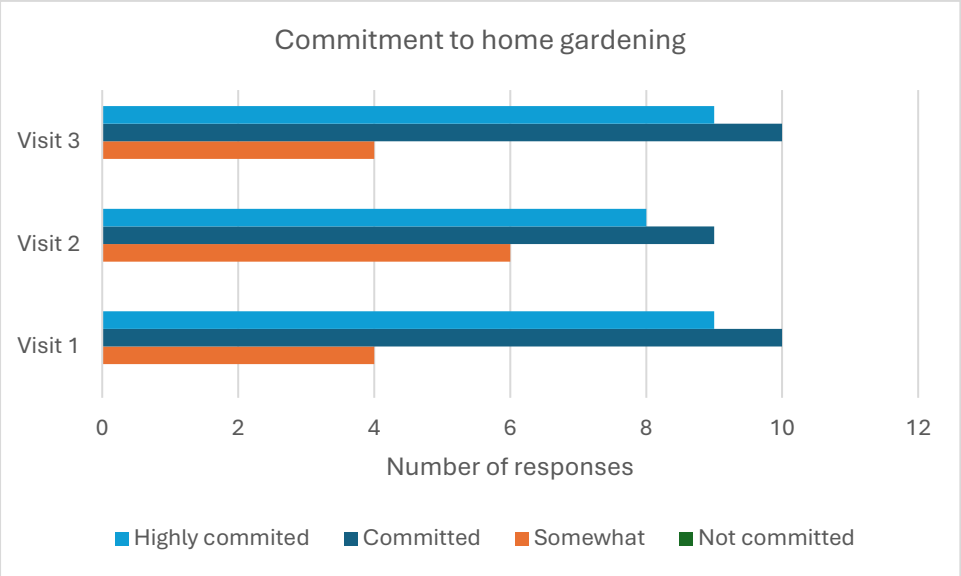

Figure 14 Commitment to home gardening

Plate 5 Okra and chilli plants

Challenges encountered in home gardening

The most frequently cited challenge is the issue of pests and plant diseases. This is a widespread problem with managing common garden threats such as insects, fungi, and other pathogens that negatively impact plant health and yield. This is compounded by interference from large pests, including monkeys, porcupines, and giant squirrels, which cause additional damage to home garden crops.

Another issue highlighted was the poor quality of seeds and the exorbitant seed costs. Many households reported poor seed germination. Some households reported that the low nutrient content of home-processed compost made it necessary to supplement with inorganic fertilizer, which added an extra cost which they found difficult to accommodate within their household budget.

Space availability is another limitation noted by several respondents. Limited space in peri-urban settings restricts the plot size and diversity of crops that can be grown, impacting both productivity and satisfaction derived from home gardening.

Interaction with external stakeholders

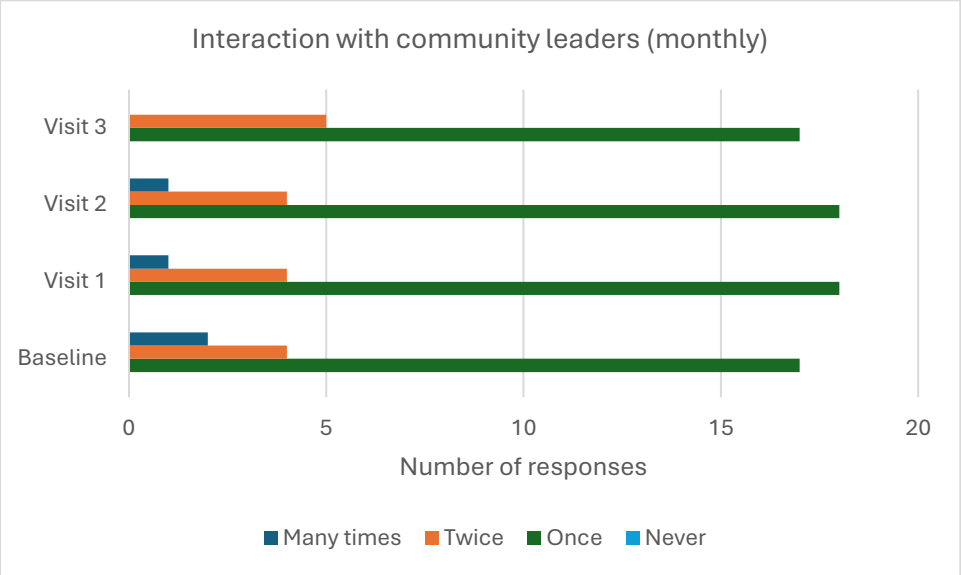

Figure 15 Interaction with community leaders

Since the project intervention was based in an area where community leaders were already active, the results show that initial contact with community leaders (at least once) remained high and consistent, and repeated engagement slightly increased over time (Figure 15). This suggests that the project intervention enhanced interaction with community leaders.

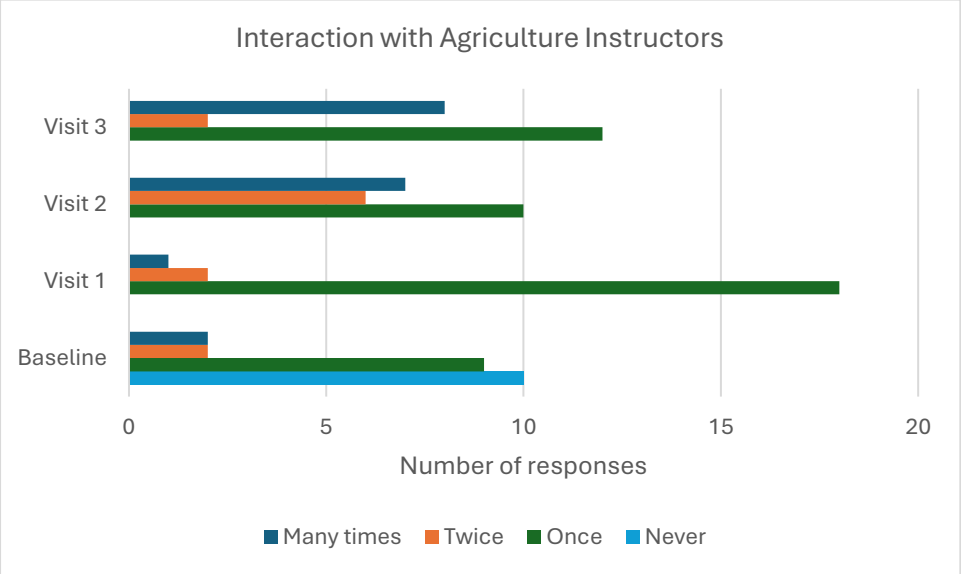

Figure 16 Interaction with Agriculture Instructors

The monitoring visits (Figure 16) revealed a positive trend in engagement with agriculture instructors over time. Initially only few participants interacted with agriculture instructors, but

as the project progressed, more participants began engaging with agriculture instructors repeatedly. This implies a growing interest in home gardening.

Impact of the project intervention on waste disposal to KMC waste stream

The amount of waste, especially biodegradable waste, entering the waste stream has reduced significantly (Figure 17). Since the sample size was relatively small, the waste collectors (KMC) did not observe a tangible reduction in the waste collected from the waste route where the participants were residing. This outcome suggests a potential impact of a large-scale intervention promoting composting and home gardening to reduce biodegradable waste entering the KMC waste stream.

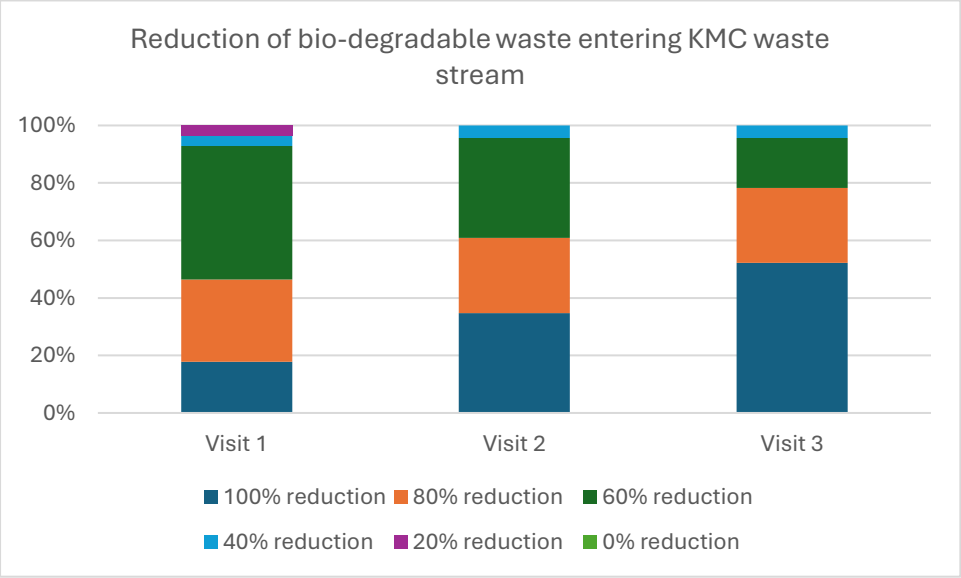

Figure 17 Reduction of biodegradable waste entering the KMC waste stream

Innovative practices in home gardens

Several creative and resourceful practices were observed among trained home gardeners, showcasing their adaptation of low-cost and sustainable methods. Resourceful gardening practices were observed in the creative reuse of materials for container gardening. Many gardeners have repurposed old tyres, plastic bottles, and plastic buckets, transforming them into containers for growing plants. This form of upcycling not only reduces plastic waste but also showcases the community's commitment to environmentally friendly and cost-effective gardening solutions.

A few participants have moved a step further by adopting vermicomposting, an advanced composting technique that uses earthworms to accelerate the decomposition process and improve compost quality. The use of vermicompost demonstrates a deeper understanding of organic waste management. In addition, some participants used poultry manure to enhance the nutritive value of the compost. This indicates a practical understanding of nutrient recycling and highlights efforts to improve soil health through locally available organic materials.

Contribution to household food security

Many home gardeners expressed satisfaction in being able to supplement their diets with produce from their gardens, helping them to increase their vegetable intake. By growing even a small portion of their food, these households were able to both enhance their nutritional well-being and resilience to market instability. Low-income segments in the peri-urban region struggle to meet the recommended daily vegetable intake due to high costs and frequent price fluctuations in the market. While the ideal daily intake of vegetables in Sri Lanka is around 225-300 g per day, actual consumption remains significantly lower, averaging only about 60 g per day. This shortfall is largely driven by the inability of low-income households to afford adequate quantities of vegetables required for a balanced diet. In this context, home gardening emerges as a practical and empowering solution.

Limitations

The unusually high rainfall during the project period hindered implementation, as some participants reported damage to their home garden crops. As a result, a few participants could not be considered for monitoring purposes. Although the proposal included the use of Black Soldier Flies (BSF) for composting and planned training on BSF composting, this component was not implemented due to difficulties in sourcing BSF eggs and some resistance from participants due to religious reasons.

Conclusions

The project intervention involved capacity building on waste segregation, home composting and home gardening. The participating households were also provided with compost bins and vegetable seeds suitable for home gardening. The activities were observed over six months, and they were continuously supported to overcome challenges in composting and home gardening. Significant outcomes and lessons learned from the project intervention included the following.

- A measurable reduction in biodegradable waste entering the municipal waste stream.
- Enhanced household food and nutritional security through the production of home-grown vegetables.
- Recognition of the importance of sustained encouragement and support to promote a bio-circular economy.
- The active involvement of community leaders proved essential in motivating household participation.
- Regular training and knowledge-sharing sessions on composting and home gardening are crucial to maintaining momentum and improving outcomes.
- Support in the form of inputs such as high-quality seeds, compost bins, potting materials, and essential tools should be provided to enable the continuity and scaling up of home gardening efforts.
- Participants should have ongoing access to agricultural expertise to resolve issues that arise during composting and gardening activities.
- Timely and up-to-date information on composting and home gardening practices should be readily accessible to all participating households.

The project intervention demonstrated significant potential for empowering peri-urban households to advance a bio-circular economy through proper waste segregation, home composting and home gardening to strengthen household nutrition and food security while alleviating the burden on municipal councils and local authorities in waste management.

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