SUSTAINABLE UTILIZATION OF GREYWATER FOR TERRACE GARDENING IN URBAN AREAS

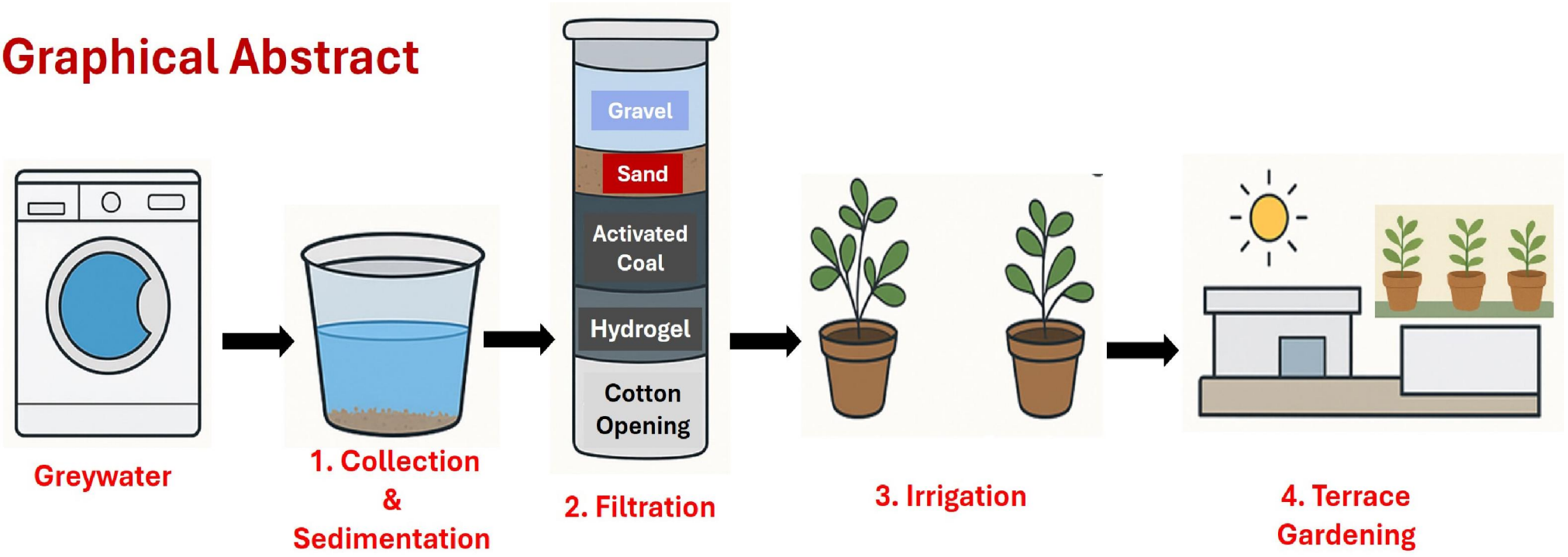
NSF-SCH-2025-111

NATIONAL SCIENCE FAIR RESEARCH PLAN

LEVEL : JUNIOR LEVEL

CATEGORY : PHYSICAL SCIENCE

Graphical Abstract



Sustainable Solution

Greywater–constituting about 50–70% of household wastewater – represents an underutilized resource that can replace fresh water for irrigation purposes if treated appropriately.

RESEARCH PROBLEM

Freshwater scarcity limits the feasibility of terrace gardening in urban areas, and greywater is an underutilized resource with potential risks and benefits.

HYPOTHESIS

It is hypothesised that filtered greywater can be safely and effectively used for terrace gardening.

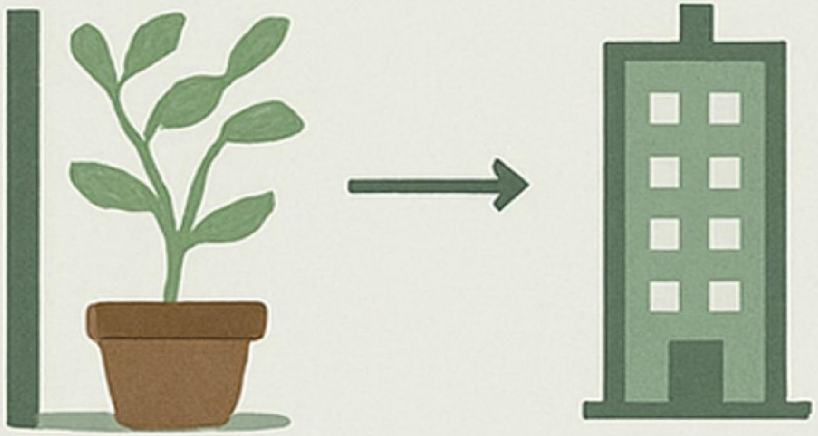
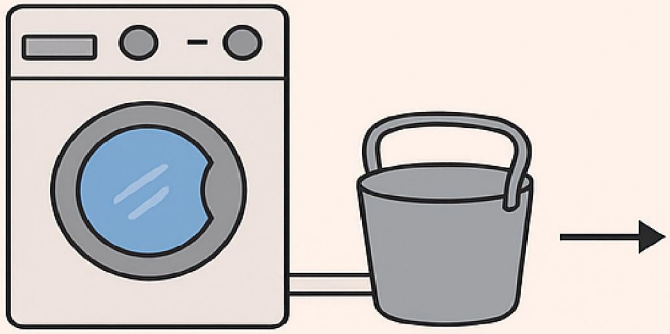
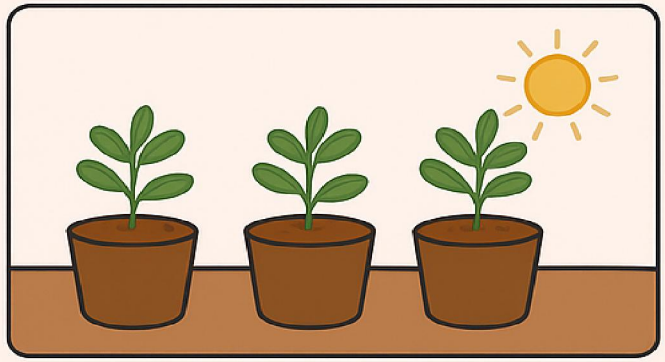


Fig. 1. Hypothesis of Proposed Research

Experimental Setup



Washing Greywater



Plant Species

Fenugreek (*Trigonella foenum-graecum*)

Sowing and Irrigation

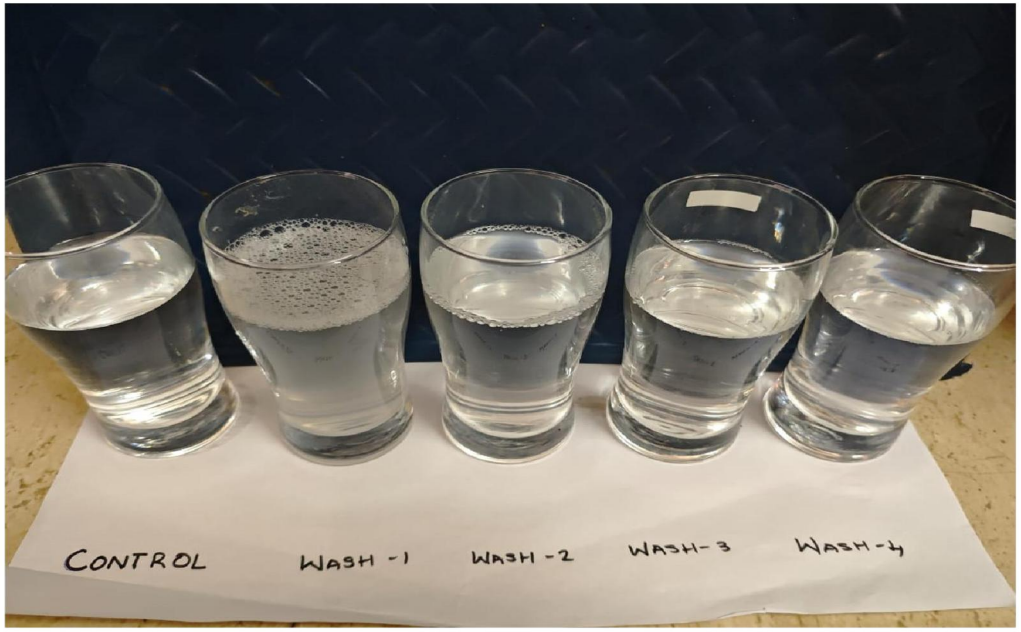
Compost, Sand — Sow Seeds — Freshwater — Fresh water — Filtered Greywater

Irrigation Schedule

50 mL/day

Data Collection Parameters

- Plant Growth • Heart Count
- Water Quality Analysis



Methodology & Procedure

Experimental Design:

I). **Collection and Filtration of Greywater**

a. Greywater will be collected from laundry rinse water.

b. A three-stage filtration system (gravel–sand–activated charcoal) will be constructed.

II). **Experimental Setup**

a. Location: Terrace garden with uniform sunlight exposure.

b. Plant species: Fenugreek (*Trigonella foenum-graecum*) will be selected.

c. Pots: 2 L plastic grow bags with standardized soil mixture (soil:compost:sand = 2:1:1).

d. Groups:

Control Group: Irrigated with freshwater.

ii. **Experimental Group**

Irrigation

Irrigation Schedule

e. Plants will be watered with equal volumes (50 mL per pot, every day).

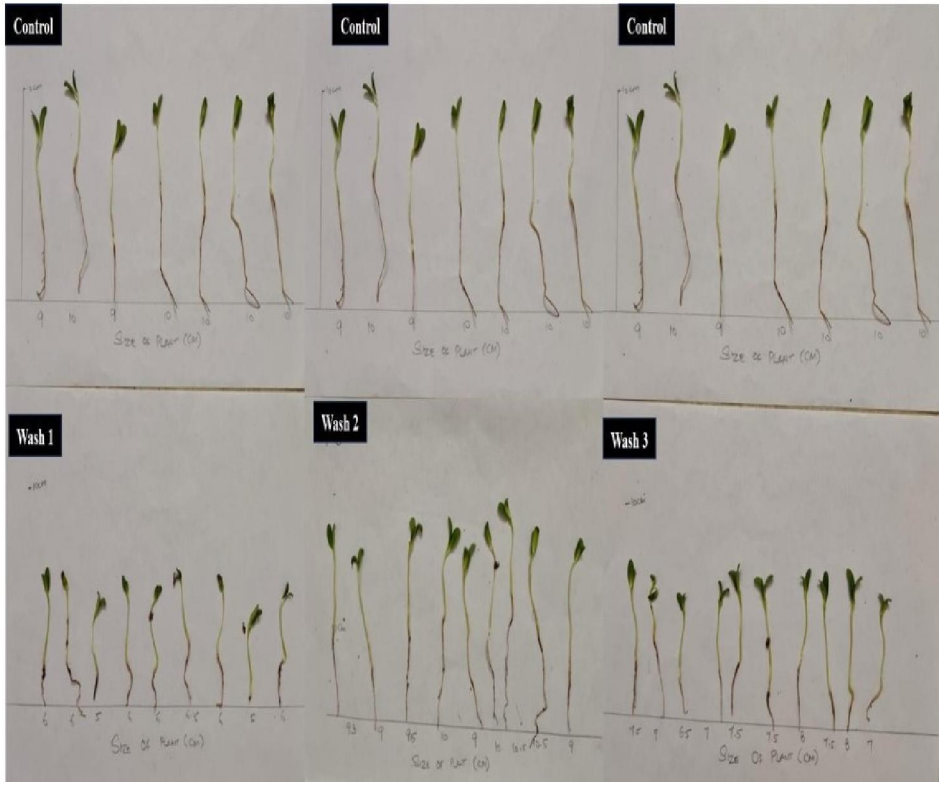
Data Collection Parameters

f. **Plant Growth:** Height (cm) and leaf count.

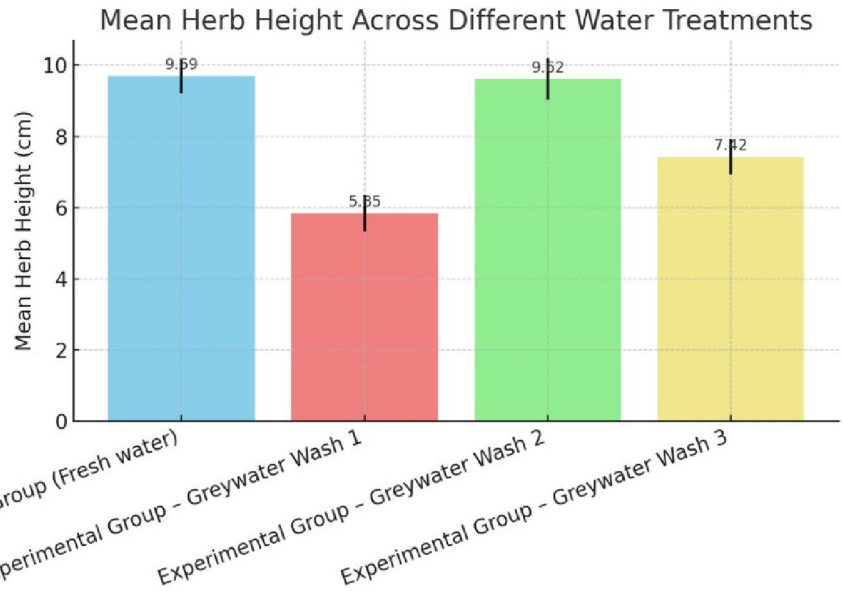
g. **Water Quality Analysis:** pH, turbidity, and TDS

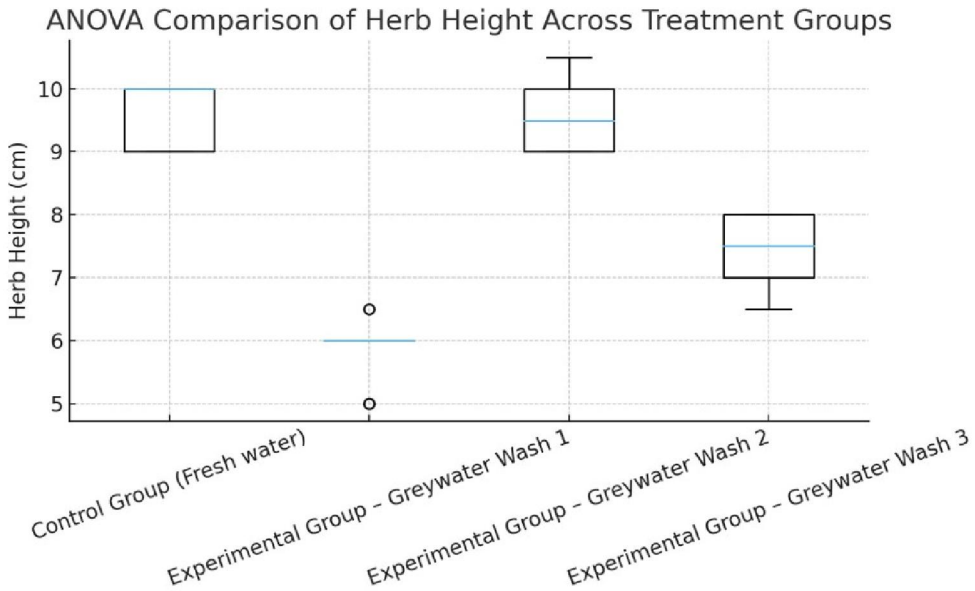
Plant Growth - RESULTS

Group	Herb Height (cm)												
Herb number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Control Group (Fresh water)	9	10	9	10	10	10	10	10	9	9	10	10	10
Experimental Group – Greywater Wash 1	6	6	5	6	6	6.5	6	5	6	5	6	6	6.5
Experimental Group – Greywater Wash 2	9	9	9.5	10	9	10	10.5	10.5	9	10	10	9	9.5
Experimental Group – Greywater Wash 3	7.5	7	6.5	7	7.5	7.5	8	7.5	8	7	8	8	7



Plant Growth





Discussion:

- The Control Group (Fresh Water) and Greywater Wash 2 groups show higher mean herb heights, indicating better growth performance (Table 1).
- The Greywater Wash 1 group shows the lowest herb height, suggesting possible inhibitory effects of the first wash greywater on plant growth.
- Greywater Wash 3 shows moderate growth, indicating partial tolerance or improved water quality after multiple washes.

The ANOVA test confirms that water quality significantly influences herb height. Reusing greywater may be feasible only after adequate treatment or dilution, as untreated wash water (first wash) negatively impacts plant growth compared to fresh water.

Plant Growth Parameters

Group	Plant Height (cm, Mean ± SD)	Leaf Count	Days to 50 % Germination	Fresh Leaf Yield (g)
Control Group (Fresh Water)	9.69 ± 0.48	2	4	6
Experimental Group – Greywater Wash 1	5.96 ± 0.48	2	7	9
Experimental Group – Greywater Wash 2	9.72 ± 0.52	2	5	7
Experimental Group – Greywater Wash 3	7.42 ± 0.45	2	5	7

Discussion

The results demonstrate that water quality strongly influences plant height and early growth characteristics.

- Plants irrigated with fresh water and Greywater Wash 2 performed best, indicating favorable growing conditions and nutrient balance (Table 2).
- The first wash greywater (Wash 1) negatively affected height and delayed germination, suggesting that detergent residues or high salinity inhibited early development.
- Greywater Wash 3 showed intermediate performance, implying that multiple washes or partial dilution reduced harmful substances, improving its suitability for irrigation.

Physico-Chemical Properties of Water Samples

Group	pH	Total Dissolved Solids (mg/L)	Odour	Colour
Control Group (Fresh Water)	7.2	451	Odourless	Clear
Experimental Group – Greywater Wash 1	8.1	534	Surf smell	Bluish turbid
Experimental Group – Greywater Wash 2	7.4	445	Odourless	Clear
Experimental Group – Greywater Wash 3	7.3	451	Odourless	Clear

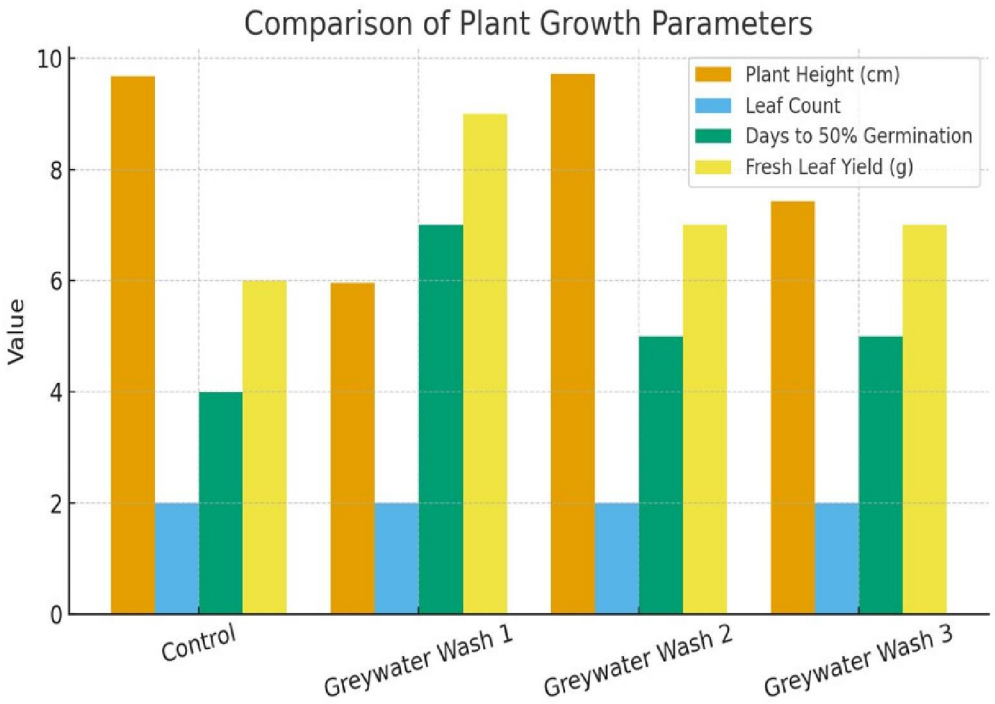
Results

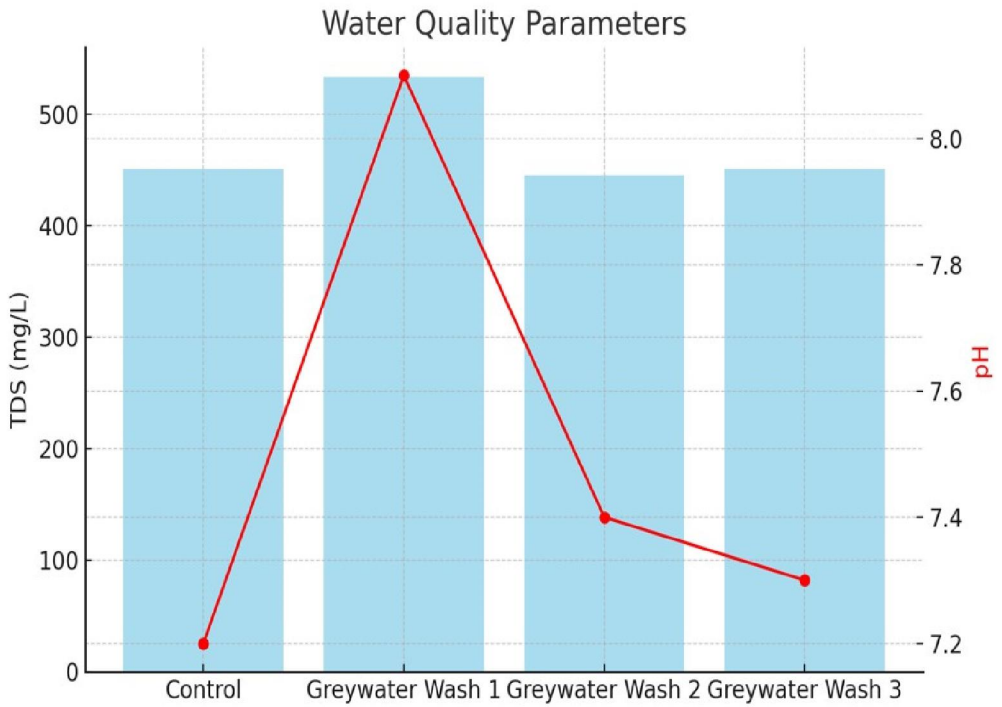
The pH and total dissolved solids (TDS) varied slightly across the water samples. The Control Group (Fresh Water) recorded a neutral pH of 7.2 and a TDS of 451 mg/L, which are within acceptable limits for irrigation.

The Greywater Wash 1 sample showed a higher pH (8.1) and elevated TDS (534 mg/L), along with a noticeable surf odour and bluish turbidity, indicating the presence of detergent residues.

In contrast, Greywater Wash 2 and Greywater Wash 3 exhibited near-neutral pH (7.3–7.4) and clear appearance, comparable to the control sample, reflecting improvement in quality with repeated washing or dilution.

Comparative plant growth and Water Quality Parameters





The figure clearly demonstrates that water quality significantly influences plant growth performance. While first-wash greywater impairs growth due to chemical stress, subsequent washes (Wash 2 and Wash 3) provide nearly equivalent results to freshwater. These outcomes highlight that reused or filtered greywater can be a sustainable irrigation source for terrace gardening when managed properly.

OVERALL INSIGHT

- Later-wash greywater naturally supports better plant growth and maintains soil health when used correctly.
- A household-friendly filtration system can significantly improve greywater clarity.
- Terrace gardens can safely adopt greywater to reduce freshwater usage and promote sustainability.

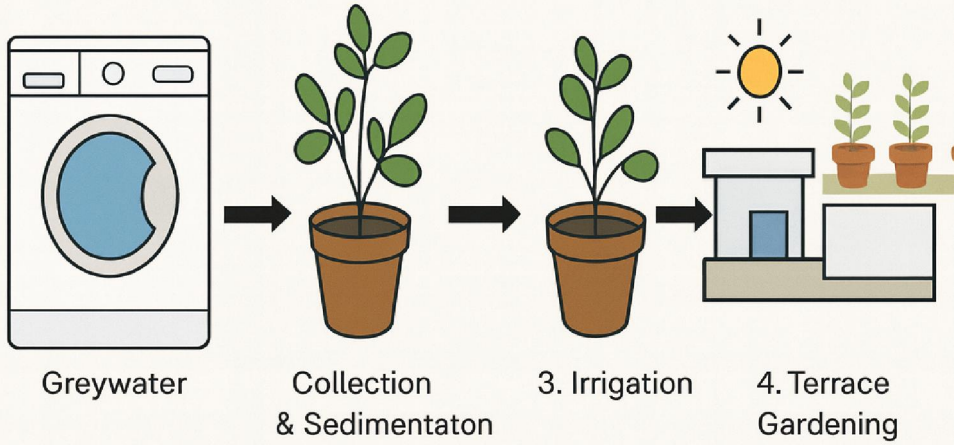
CONCLUSION

- Settled or filtered greywater does not harm plants or soil when used correctly.
- A household-friendly filtration system can significantly improve greywater clarity.

RECOMMENDATIONS

- Use later-wash greywater whenever possible.
- Allow greywater to settle for 1–2 hours before use.

Overall, the study highlights a sustainable, low-cost, and eco-friendly approach to utilizing domestic wastewater in horticultural applications.



This aligns with the United Nations Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities), by promoting responsible water use and encouraging green urban living.

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