The Reuse of Filtered Greywater for Indigenous Plant Irrigation

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Abstract:

Globally, greywater is an often-under-utilised resource, despite there being increasing levels of water stress and scarcity. Arundel School has a greywater collection system that sources its greywater from the on-site boarding facilities and kitchen. As the water has no further use after collection, the research focused on filtering the greywater and analysing the growth of selected indigenous plants watered by it. The pilot, off-site, small-scale filtration system was constructed from readily available local materials, including different textured sand for the filtration purpose. By filtering the greywater, a neglected resource was utilised, contributing to a reduction in water usage while promoting the growth of indigenous vegetables, which can be harvested and consumed, and plants that can be transplanted to beautify public spaces in the surrounding community. The project is envisaged to be upscaled to School level and make use of the vastly available greywater for plant irrigation.

Keywords:

- greywater
- filtration
- drip-irrigation
- plants

Purpose of the Investigation:

As the pressure on freshwater resources grows in demand worldwide, it has become increasingly important to implement measures that aim to reduce, reuse and recycle the finite resource [1, 2]. One such prominent and well-documented method is using filtered greywater for various purposes. “Recognizing greywater as a relevant secondary source of water and nutrients represents an important chance for the sustainable management of water resources.” [3]

While greywater is often perceived as “dirty,” it is a safe and beneficial source of water that aids in reducing freshwater usage [2-4]. Greywater is estimated to represent 50-70% of domestic wastewater [5-7]. Thus, using greywater filtration systems can save households 35-40% on their annual water bill while reducing the amount of water sent to wastewater treatment facilities and thus reducing sewage loads, energy costs, and environmental impacts [7-12].

Previous studies have found that treated greywater is a viable water source for plant irrigation at a household level which has increasingly been accepted and implemented worldwide through ongoing technological advancements [13-18]. It can be used for activities such as watering gardens, flushing toilets, agriculture, and car washing, to name a few [19-21].

As such, while also considering that agriculture irrigation accounts for 70% of water usage worldwide [5-7], the research aimed to assess the effectiveness of treated greywater in the growth of selected indigenous Zimbabwean plants. This pilot research is aimed to be upscaled to make use of the greywater available at Arundel School, which has additional greywater generation from its boarding facilities, alongside an established greywater harvesting system.

Method of Investigation:

The greywater filtration system was set up in a Harare-based backyard garden of one of the project researchers for ease of access and security. The researchers designed a basic, small-scale filtration system using the following locally sourced materials:

- 2 x 2L containers
- 1m x 1m Nylon Filter Mesh Cloth
- 1kg wheat straws
- 100g ¾ stones
- 100g granulated concrete
- 100g river sand
- 500g of cotton wool

The basic filtration system used the first 2L containers, as shown in *Figure 1,* to house the filtering material, which was layered from course to fine material (*Figure 2* illustrates the differently textured stones utilised in the research). This created Stage 1 of the greywater filtration process.

Figure 1: Stage 1 of the Basic Greywater Filtration System

Figure 2: Different Stone Textures Used in the Filter in Stage 1

Greywater was collected from two piped outlets: a kitchen sink and a washing machine. A 20L collection tank was connected to these pipes, and the greywater herein was used in Stage 2 of the filtration process.

3L of water was manually extracted from the collection tank and poured into Stage 1 of the greywater filtration system *(Figure 1)*. This process allowed the different textured layers to remove any suspended material from the kitchen greywater and clumps from the washing machine greywater. This water was then directed into a temporary collecting jar.

The partially filtered greywater would then be poured into Stage 2 *(Figure 4)* of the filtering process. During this process, a makeshift funnel housed the cotton wool, wheat straw and nylon mesh fabric (Figure 3) was used to remove any sand particles or other small solid material that may have been carried over from Stage 1. The Stage 2, final filtration containers used are shown in *Figure 4.* The now fully filtered greywater water would then be emptied into the watering can, ready for irrigation.

Figure 3: Filtration Wheat Straw(L) and Mesh Cloth (R)

Figure 4: Stage 2 of the Basic Greywater Filtration System

This entire filtration process took approximately 1 hour to complete. It filtered the raw greywater shown in *Figure 5* to Stage 1, as shown in *Figure 6*, and then to the final output from Stage 2, as illustrated by samples A and B in *Figure 7* and *Figure 8*, respectively.

Figure 5: Greywater Before Filtration Sample A and Sample B

Figure 6: Greywater After Stage 1 Filtration

Figure 7: Greywater After Stage 2 Filtration Sample A

Figure 8: Greywater After Stage 2 Filtration Sample B

Plantation and Irrigation the Indigenous Seedlings:

A species of indigenous vegetable seedlings, readily available and grown for consumption, was used. Locally they are known as Rape *(Brassica napus)* *(Figure 9*).

The vegetable seedlings were planted in two separate rows: one for greywater irrigation and the second for borehole water irrigation. The latter served as the control.

Figure 9: Rape Seedlings Irrigated with Greywater (R) and Borehole Water (L)

Each row contained 4-5 plants with enough spacing between each one (30cm) to allow for maximum nutrient absorption from the soil and direct sunlight access without the leaf growth obstructing one another.

The control plants were purposefully placed under the same conditions as the greywater plants to provide insight into how the seedlings would grow, with the only difference being the type of water for irrigation.

To avoid any water contamination, two labelled watering cans; one for the control borehole water and another for the filtered greywater. All the seedlings were manually irrigated once a day between 17:00hrs - 17:30hrs to reduce water loss through evapotranspiration. Halfway through the research, a drip irrigation system was implemented, and watered the seedlings in the same manner as before. Each row of seedlings received 3L of water during the watering process.

Results:

The greywater was treated to a clarity acceptable to the researchers for irrigation purposes. The results tracked plant growth over a seven-week (49-day) period and considered leaf size growth as the part of the plant that would be consumed.

The study found that although the control and the filtered greywater irrigated Rape plants were planted simultaneously, some minor, noticeable differences were experienced throughout their growth. After 14 days, the filtered greywater irrigated Rape plants were slightly smaller than the control Rape plants. A similar trend was observed for two weeks- these slight growth differences are shown in *(Figure 10)*.

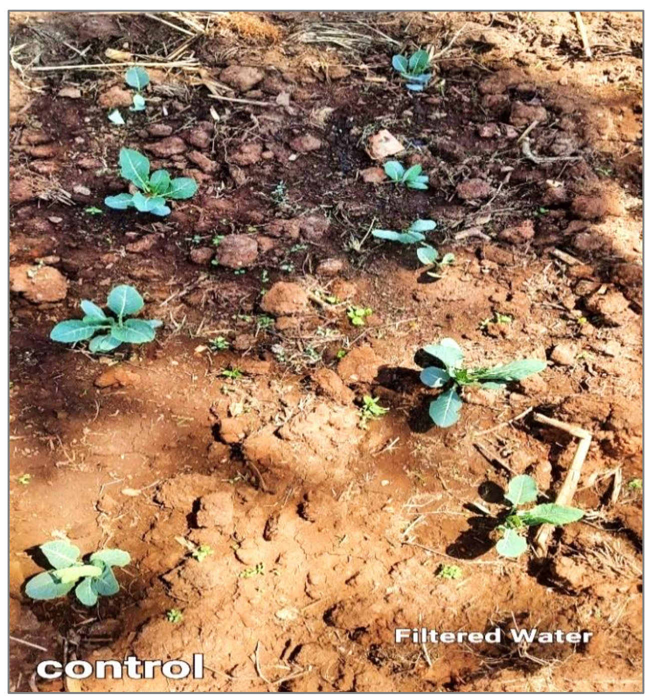

Figure 10: Rape Seedlings 14 Days After Planting- Greywater (R) and Borehole-Water (L)

By day 21, the filtered greywater irrigated Rape caught up to the control plants in size. At 35 days after plantation, it was observed that there was barely any noticeable difference in the leaf sizes between the borehole and greywater-irrigated plants. The slight difference noticed was the difference in the shape of the leaves. The leaves of the control Rape plants were slightly longer but slightly narrower (*Figure 11*), as opposed to the slightly rounder and slightly wider shaped greywater irrigated plants (*Figure 12).*

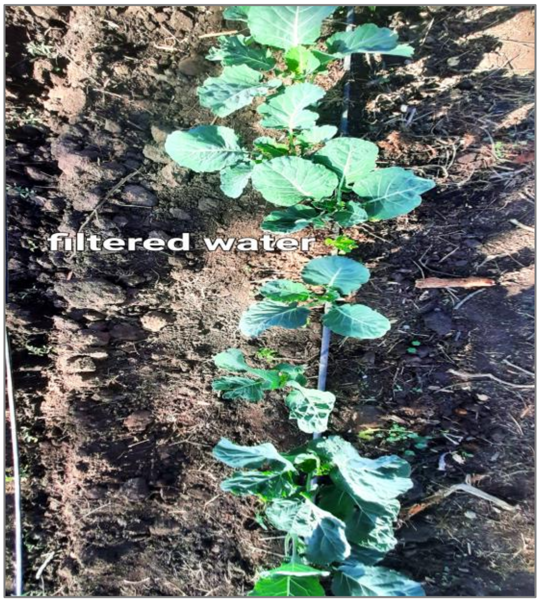

Figure 11:Rape Seedlings 35 Days After Planting -Greywater Drip- Irrigation

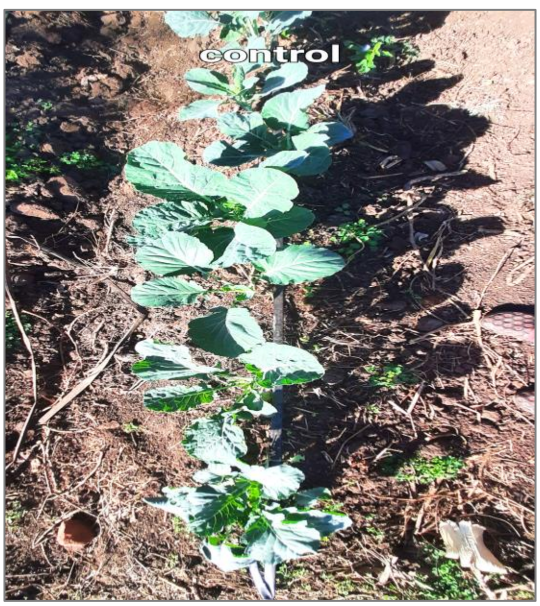

Figure 12: Rape Seedlings 35 Days After Planting -Borehole Water Drip-Irrigation

The slight differences in the leaf shape can be seen below in *Figure 13* and *Figure 14.*

Figure 13:: Rape Seedlings 49 Days After Planting -Greywater Irrigated

Figure 14: Rape Seedlings 49 Days After Planting -Greywater Irrigated

Overall, the results showed that after 49 days, under similar conditions, the greywater seedlings and the borehole water seedlings grew at similar speeds. The leaf colours and textures of the Rape seedlings were also similar. Although the greywater seedlings initially grew slower, at the end of the research, the only slight difference recorded was in shape.

Conclusion:

Implementing treated greywater into irrigation practices is growing in use and plays a crucial role in preserving freshwater. The pilot study showcased that filtered greywater has the potential to produce vegetation of the same or very similar quality as when using freshwater sources. As technology improves, there is growing potential for greywater reuse for irrigating vegetation for consumption or for irrigating aesthetic vegetation at schools in developing countries such as Zimbabwe. In the case of using greywater for irrigating plants for consumption, further research would be required to investigate if the produced vegetables were safe for human or animal consumption and how potential consumers would respond to the water source.

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