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Grey Water Reuse To Enhance Home Kitchen Garden Production

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Abstract – Climate variability and shortage of water for irrigation are the factors that affect crop production and yield components, grey water reuse for irrigation have been suggested to be used especially in dry period to meet crop water requirement.

Research focused on grey water collection, filtration using sand filter and analysis for irrigation in rural household. Laboratory Test have been used to prove available nutrients element for crop; N, P, K and harmful elements for crops Cl and Na. The Water acidity also have been analysed before and after filtration by measuring Electrical conductivity; Ec and pH. It has been done to ensure the capability of sand filter for irrigation water quality.

Laboratory results for raw water shown that the maximum total Nitrogen, N available for concentrated grey water was 0.07%, Average Phosphorus; P (ppm) was 9.83 and Potassium; K(meq/100g) was 0.66. Harmful element, maximum concentration identified for Na (meq/100g) was 1.30 and Cl (ppm) was 1190.0. About acidity, maximum pH was 9.0 and Ec (ds/cm) 1.67.

Gravity filtration system made by wire-mesh, gravel, sand and charcoal have been used to reduce turbidity and pathogen elements. After filtering raw water pH, Ec, Na and Cl change to 5.9, 0.65, 1.29 and 507.5 respectively. Analyse conducted for ten households, stated that sand filter is able to treat grey water for irrigation water quality on household level as average of harmful element for crop; Na and Cl are 0.279, 222.6 respectively. Grand mean of Ec and pH are expected to be 0.64 and 6.0 respectively that cannot lead to the soil salinity and fall in the acceptable ranges.

Using this filter, it allows to get the clean water, particularly in increasing the pH, reducing the turbidity, eliminating odors and reducing bacteria to allow the filtered water to be used in irrigation of kitchen garden. To increase the sanitary of our homes and getting water for irrigating kitchen garden, the sand filter is a good recommendation especially in zones with scarce water in dry season.

Keywords – ***Grey Water, Nutrients, Sand Filter, Soil Salinity, Quality.***

I. INTRODUCTION

1.1. General introduction

The decline in annual rainfall, coupled with the growing demand for water in agricultural fields, triggered a new crisis in today's world. Thus, the focus is on finding solutions to new water resources. Taking a look at the normal daily life, most of the households' effluents can be ranked into a less-polluted category, called greywater. Excluding human dejects, greywater comprises the outflow from washing machines, dishwashers and bathtubs. It is considered an effluent with a more economic treatment, because it contains less microbial pollution. Hence, this work revises the effects of greywater irrigation on the quality of crops, and provides a comprehensive study of the effects of greywater on the quality of soil. Furthermore, a comprehensive discussion is carried out to evaluate the energy consumption of facilities for both greywater and wastewater treatment to provide water used in irrigation. It also addresses current methodologies for treating greywater and evaluates the effects of crops irrigation with treated and untreated greywater, indicating the type of treatment chosen depending on the type of crop to be irrigated [**1**].

Greywater is the wastewater generated from bathrooms, kitchens and laundries. Kitchen greywater is heavily polluted with food particles, cooking oils, grease, detergents, and other cleaning products such as dishwashing powders. The detergents and cleaning products may be alkaline and contain chemicals that are harmful to soil structure, plants and groundwater [18].

Greywater contains phosphorus and nitrogen-containing compounds such as nitrates and ammonia arising from the use of detergents such as washing powder, shampoo, and other personal care products as stated by Rodda et al. (2011). These nutrients might be beneficial for plants and could potentially reduce the use of commercial fertilizers.

According to IJTIMES-2018, Sand filters with active charcoal carbon are most effective at removing chlorine, particles such as sediment, volatile organic compounds (VOCs), taste and odor from water. Project dealt with grey water collection, filtration using sand filter and analysis for irrigation in rural household level [17].

In rural community, the disposal of household wastewater arising from activities such as bathing, washing clothes and washing dishes (greywater) is commonly disposed of to the ground in the vicinity of the dwelling which can lead to the domestic pollution, health hazards and mosquito breeding. Climate variability and shortage of water for irrigation to meet crop water requirement affect crop production and food security in general. Grey water reuse for irrigation have been suggested to be used especially in dry period. This project deal with grey water collection, filtration using sand filter and analysis for irrigation in rural household level.

Greywater recycling not only reduces water requirements of a building but can also significantly reduce the volume of effluents being sent to the sewer or septic system. Therefore, it is economic and vital, especially for residents of water-scarce regions [10].

Nowadays, the water crisis is an upcoming phenomenon that threatens countries all over the world. Various parts of the world are suffering from a shortage of water resources. Regions such as the Middle East, Australia, and southwest of United States are possible regions confronting drought. A study of the daily life of a typical citizen, in urban areas of developed countries, shows that the water consumption can vary from 15–55 L up to 90–120 L per day per capita [11]. Providing such amounts of water from first-hand resources requires not only a great effort, but also a lot of energy [12].

There are alternatives that can be used instead. As an instance, treatment and reuse of wastewater in each household can be considered as a local solution to the emerging problems of water supply needed to irrigate crops.

Rwanda has recently subscribed to the Global Compact to end hunger and malnutrition by 2025 and has also joined the Scaling Up Nutrition (SUN) movement. Climate variability and shortage of water for irrigation to meet crop water requirement affect crop production and food security in general. Grey water reuse for irrigation has been suggested to be used especially in dry period.

The discussed solution has already been used by ten selected households in Ruhango district. However, there are significant concerns about the safety of reusing wastewater for irrigation, including the possibility of contamination of soil and plants and the impacts on human health. Studies have shown that the microbial population of untreated wastewater is very diverse. Diseases such as food-borne illness are thought to have direct connection with pathogens presented in the irrigation water. The hypotheses of this research are:

- The household water used satisfy the home garden irrigation water requirement.
- The quality of treated grey water was improved by the sand filter.
- The use of treated grey water in irrigation increase home garden production in dry period.

Decentral recycling of greywater offers a notable economic potential to reduce environmental pollution and hygiene risk and thereby increase the availability of non-potable water uses (irrigation, cleaning, toilet flush) and alleviate the freshwater demand.

In line with the *Sustainable Cities and Communities: Clean Water and Sanitation,* the recycling of greywater is a core component in sustainable water management to upgrade slums and improve the access to basic services for all (UN 2016). For that, the treatment and reuse of wastewater in each household can be considered as a local solution to the emerging problems of water supply needed to irrigate crops.

II. Materials And Methods

2.1. Description and location of the study area

The study area is located in Rwanda, Ruhango district, Ruhango Sector, Munini cell, Bisambu village.

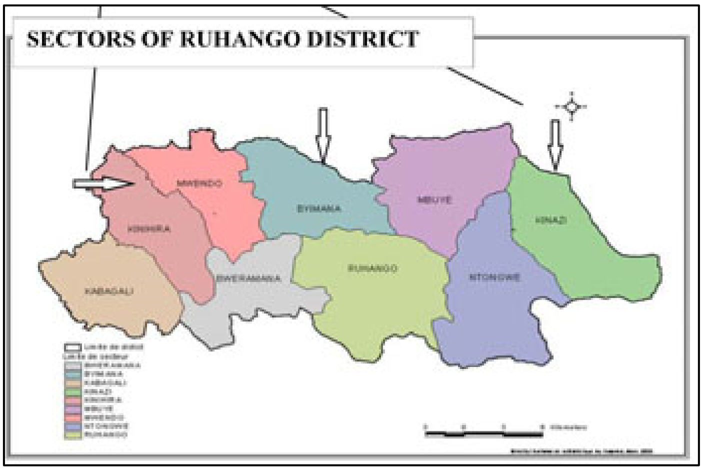

Figure 1: Map of Ruhango district

2.2. Population and Study sample

Observation and interview have been used to know the amount of water use per day, detergents and type of soaps they use in dish washing and bathing.

2.3. Household selection criteria for sand filter installation

- Having an active kitchen garden located at a lower level allowing the water to reach there by gravity.
- Having at least household water use of 80 litres.

Among the visited households, only 10 households have been selected then the grey water samples were collected, filtered, tested and analysed.

From the laboratory, the content plant nutrients (N, P, K) and harmful elements (Na and Cl) available in the grey water that can affect soil and/or plant have been tested.

2.4. Variables:

Water pH, Electrical Conductivity

N, P, K, Cl and Na in grey water before and after treatment,

2.5. Filtration system layout

Structure of filter

The main materials of filter are:

- ❖ Small basin Bucket
- ❖ Basin
- ❖ Supports in timber

- Big basin bucket

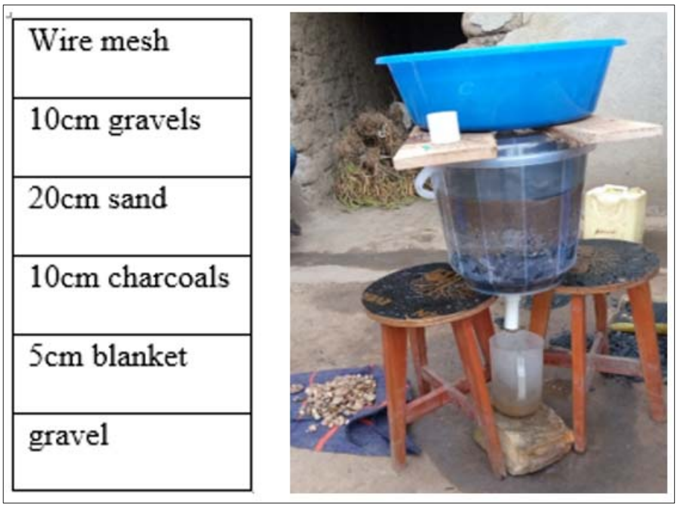

Figure 2: Dimensions of sand filter

The filter is made of bucket of 20liters, where the filtration materials are stored, the water is poured into the basin which is considered as supply source, the big bucket of 60 litres was provided for storing the filtered water. The sand is a passing of a mesh which has an opening of 1sqmm. The timber was used as supports.

Figure 3: Complete filter constructed

The timber of 20 cm thick was buried below the surface to shorten the structure of the filter to ease its accessibility leaving the total height of 1.5 m. The structure is kept at a secured place chosen by the owner.

III. Result And Discussion

All of the tests done on the water before and after filtering were done in the Analytical Laboratory of RAB, Rubona station. The samples were collected directly from the field in the 10 households chosen. Testing was conducted to determine the conditions of the water after filtration, including the physical properties of turbidity and smell, the chemical property of pH and the E.C, harmful elements and useful elements to the crops.

Table 1: Water samples before and after filtration

No	Treatment	pH	ec(mS/Cm)	Tot N(%)	Av P(ppm)	K(meq/100g)	Na(meq/100g)	Cl(ppm)
1	T10	6.4	0.24	0.03	1.61	0.08	0.19	175.0
	T10'	7.4	0.63	0.03	1.96	0.28	0.19	192.5
2	T11	5.3	0.20	0.02	1.36	0.11	0.56	168.0
	T11'	7.2	0.05	0.01	0.23	0.03	0.04	126.0
3	T12	4.5	1.67	0.07	9.83	0.47	1.30	1190.0
	T12'	4.7	1.29	0.01	1.11	0.52	0.65	507.5
4	T13	4.6	0.75	0.05	2.46	0.20	0.56	178.5
	T13'	5.9	0.62	0.06	0.76	0.24	0.37	178.5
5	T14	3.9	1.23	0.04	4.72	0.66	0.47	402.5
	T14'	4.1	1.32	0.02	0.90	0.66	0.47	318.5
6	T15	4.6	0.43	0.01	0.90	0.17	0.28	154.0
	T15'	5.5	0.55	0.01	0.32	0.19	0.28	122.5
7	T16	3.8	0.45	0.04	3.66	0.22	0.09	308.0
	T16'	6.5	0.16	0.02	1.22	0.20	0.07	150.5
8	T17	4.0	0.60	0.03	1.59	0.38	0.19	280.0
	T17'	6.6	0.39	0.02	0.99	0.24	0.09	164.5
9	T18	5.6	0.32	0.02	3.38	0.14	0.19	119.0
	T18'	6.3	0.24	0.01	0.92	0.16	0.07	94.5
10	T19	9.0	0.72	0.04	6.22	0.17	0.65	112.0
	T19'	5.9	1.14	0.01	1.36	0.52	0.56	371.0

T: Water sample before filtration

T': Water after filtration

After filtration, the pH rises slightly to reach the neutral zone for 9 out of 10 samples. Normally, charcoal raises the pH. The only sample had a pH more than 7 after filtration fell down from 9 up to 5.6. The acceptable pH for irrigation water ranges between 6.0 to 7.5. After filtration, the pH found shows that almost 7 samples fell slightly in the recommended range, 2 sample (T12' and T14') remained in the acid range which cannot be used. This is due to the fact that the non-treated water contained more acid components even though filtration reduced the acidity but it failed to reach the acceptable range.

For EC,0-3 is acceptable with recommended less than 0.7 and slight to moderate toleration 0.7 to 3. Above 3, treatments are required. After filtration, the EC found shows that 7 samples fell in the recommended range that is less than 0.7. Other 3 samples fell under the slight toleration between 1.14 to 1.32. As for the results, the filter decreased the EC of the 6 samples of grey water.

For the useful elements in the water, it is seen that even though the reduction, N, P, K remain available in the water after the filtration.

As for harmful elements, Sodium (Na) has reduced into the acceptable range recommended that is 0-40me/l ≈ 0-4me/100g. The grey water normally contains less of Na to harm the crops when used in irrigation then after filtration, the quantity reduces eventually.

For Chlorine (Cl), the quantity has reduced to meet the irrigation acceptable range of 0-1063.5 ppm even though some non-treated samples were in the range before. But as example for T12, it was high and reduced close to its half (from 1190 to 507.5).

IV. Conclusion And Recommendation

4.1. Conclusion

The filtering of grey water for irrigation purpose controls visibly its turbidity. The large particles that may clog the irrigation systems will be removed. It optimizes its pH to meet the acceptable range (6-7.5). It keeps the available useful elements (such N, P and K) with a slight reduction. As for agriculture, the application of manure or fertilizers that contain the above elements is recommended to increase the yield. It also reduces harmful elements to meet the acceptable range. Except when unusual detergents were used, the grey water contains almost acceptable range of Cl and Na to cause tolerable harm to the crops.

Normally, using this filter will allow us to get clean water, particularly in increasing the pH, reducing the turbidity, eliminating odors and reducing bacteria to allow the filtered water to be used in irrigation of kitchen garden.

4.2. Recommendation

To increase the sanitary of our homes and getting water for irrigating kitchen garden, the sand filter is a good recommendation especially in zones with less water in dry season.

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