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# Analytical Study of Reuse of Treated Grey Water in Hydroponic Farming

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**ABSTRACT:** Due to Industrialization, Urbanization, Increased Population and High Standard of Living the water pollution is increasing due to which the water scarcity is getting very high day by day.

Around which about 2.6-2.7 billion peoples in the world are facing water shortage each and every year. To resolve this problem up to some greater the reuse and recycling of the grey water can be done which can fulfil the many water demands and can avoid the water shortage.

In this paper we have tried the use of constructed wetland as a low cost technology for the grey water treatment and the reuse of treated grey water for Hydroponic Farming. In Constructed Wetland the materials like Soil, Sand, Aggregates, Coco-peat, is used for the construction of wetland and the technique of the deep water culture for hydroponic farming and the Spinach plant and coco-peat as a supporting media for plant is used.

**KEYWORDS:** Constructed wetland, Deep water Technique, Grey Water Management, Hydroponic Farming, Reuse and Recycle

## I. INTRODUCTION

Now a days due to Exponential Growth of the Population, Industrialization, and Urbanization the demand for the use of fresh water consumption is also increasing and the water pollution is getting very high day by day due to which many natural problems are generating and one of them is water scarcity.

The grey water management is the best method to prevent from water scarcity in which the reuse and recycle of the grey water can be done which can be very beneficial for natural resources as the use of potable water will be less and the load on the waste water treatment plants will also become less.

The reuse of grey water can prove to be the one of the best solution as about 50-80% of waste water is in the form of grey water which is generated from households, and according to CPHEO Manual (1993[2]) the per capita demand for an average Indian Household System, where sewerage system is present accounts to 135LPCD out of which 70-90L is generated as the grey water.

So for the treatment of the grey water there are various Low Cost Technologies such as Filtration tank, Stabilization tank, Sand filter, Wetlands, Constructed(Artificial) Wetlands, etc. among which the Constructed Wetland as (Root Zone Technique) proves to be one of the so well engineered system which uses natural system for the grey water treatment, after the treatment this treated grey water can be used for various purposes such as landscape irrigation, gardening, cleaning, fire extinguishing, flushing etc.

The treatment of grey water depends on the contaminants present in the waste water, and most of the contaminants present in grey water are the beneficial nutrients for the plants. According to the study it has been observed that the nitrate and phosphate are present in the grey water which are rich in nutrient for plants growth, so according to that the reuse of treated grey water for irrigation can give better results. So in this study we have reused the treated grey water for the hydroponic farming.

The Hydroponic Farming is the advanced type of farming in which the plants only grow on nutrient rich water and without the use of soil. It has been studied that the plants only require nutrients for their growth either from the soil or without the soil. In hydroponic system the nutrients are given to the plants directly from the roots which are dipped in nutrient rich water.

## II. DEFINATIONS

**1) Grey Water:** It is the domestic waste water generated from Baths, wash basin, washing machine, & kitchen sink etc. The grey water does not include the waste water from toilets, W/C's etc.(i.e. Grey water is free from faecal matter), According to which it has been studied that the grey water can be recycled and reused for various purposes such as cleaning, gardening, irrigation, flushing, etc.

**2) Constructed Wetland:** Constructed Wetland is also called as Artificial Wetland as it used to treat the waste water. The Constructed Wetland uses the natural vegetation's such as soil, sand, aggregates, plants etc. for the treatment of the wastewater. In the earlier period the wetlands were only used for the treatment of the storm water and for ground water recharging, but nowadays this are constructed for reusing the treated waste water for many purposes to prevent water shortage.

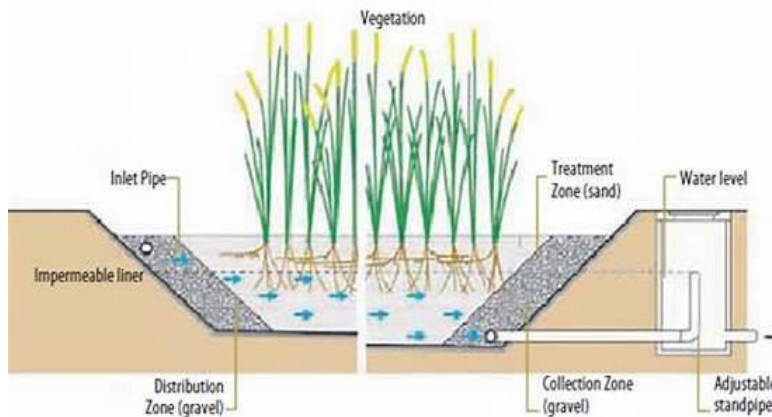


Fig 1 Constructed Wetland (wordpress.com)

**3) Sub-Surface Flow:** This flow occurs in the constructed wetland from the plants roots and requires less area for the treatment, Sub-Surface flow is classified in Horizontal and Vertical Flow. In Horizontal Flow the water travels horizontally by gravity and in Vertical Flow the water travels vertically through plants layers and gets out. In Sub-Surface flow the Vertical Flow is considered as most effective and less area consuming than horizontal flow.

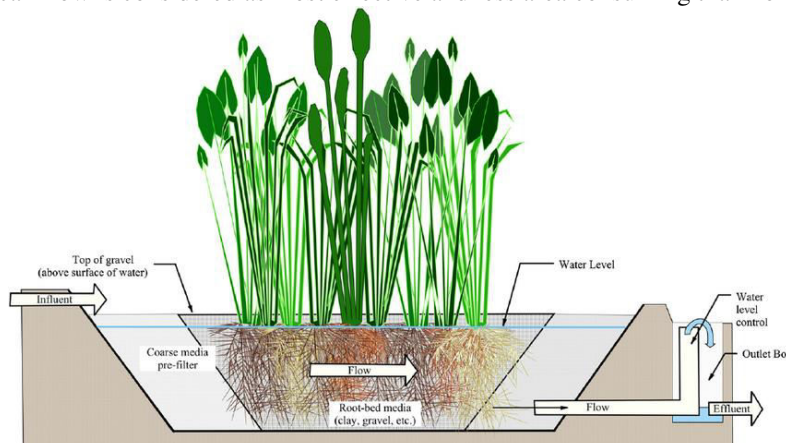


Fig 2 Sub-Surface Flow (Researchgate.com)

**4) Hydroponic Farming:** It is the advanced type of farming in which the plants only grow on nutrient rich water without use of soil. In this the plants roots are dipped in the nutrient rich water and all the nutrients are delivered directly from roots. In Hydroponic Farming the plants get everything at right proportion and at right time. In this the plants do not waste their energy for the growth of the root system but utilize that energy for their growth.





Fig 3 Hydroponic Farming

**5) Deep Water Culture:** It is the most popular method of Hydroponic Farming. It is also called as floating or raft method, in this the plants are kept in the steady water and the roots are dipped in the nutrient rich water with continuous oxygen supply. In this the plants are planted in the net cups and expanded clay or coco peat is used in net cups as supporting media for the plants.

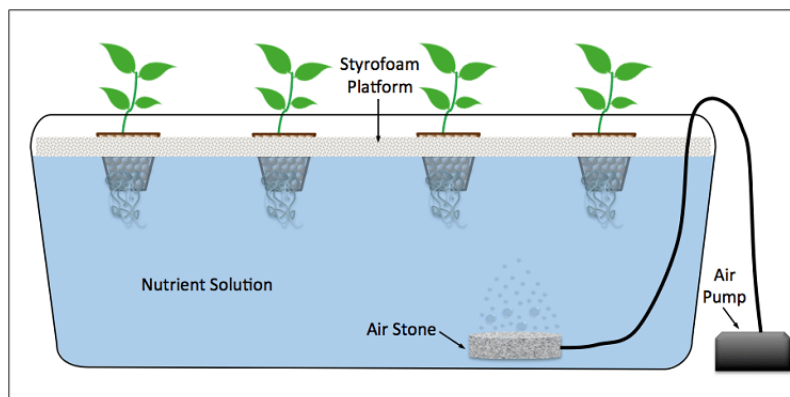


Fig 4 Deep Water Culture([www.hydroblossom.co](http://www.hydroblossom.co))

**6) Seeds Growing Media:** The most critical thing in Hydroponic is planting the plants as Hydroponic Farming is a soil less farming so the seeds cannot grow in Hydroponics and for growing the plants in hydroponics the seeds is required to be germinated before planting in hydroponics. For germinating the seeds the Coco-peat and Rockwool is used in this seeds are converted to plants and after 15-20 days of plants growth the plants are transferred to the net cups in Hydroponics.



Fig 5 Plants grown in Coco-Peat

#### IV. LITERATURE REVIEW

During our study on various literatures we have studied many things about Grey Water Management, Its Recycle & Reuse, Hydroponic Farming, Methods, Uses, Benefits, Design Composition, etc.

1) Lina Abu Ghunmi et al. (2011) In this literature we have studied about various grey water treatment characteristics, its reuse standards, various methods or technologies used for treatment, its energy requirement, maintenance etc. In this it has also been studied that the treated grey water can be reused for many purposes such as Irrigation, Cleaning, Flushing, Fire Extinguishing, Ground Water Recharging, etc. except for drinking. In this about the grey water treatment methods such as Cloth Filter, coarse Filter, Sand filter, soil Filter with or without plants is also been studied.

2) Constructed Wetland to Treat Wastewater- Framework and schematic Overview (2012) in this literature it has been studied that the wetland should be waterproofed to avoid the percolation of water into ground and use the water for other purpose. In this about various materials for water proofing such as Reinforced concrete, polyethylene membrane sheets, or compacted clay is been studied.

3) Hari Bhakta Sharma et al. In this literature about two different filter media is been studied for grey water treatment, one consist of gravels and sand and the other consist of the gravel, sand and soil and in both the media the canna plant was planted. In this about the treated water quality and the plants growth was observed and it has been found that the both the filter media shows almost same results but the filter consist of soil give much better result and the plants growth in the both was almost same and also it has been found that for short term or for small quantity the sand filter media can be used and for long term the soil filter media as constructed wetland is suitable.

4) D. Saranya et al.(2018) in this literature the study has been done on screening and sedimentation, as before treating the waste water in wetland the screening and sedimentation is required for prevention from clogging. For that the jute bag was used for screening and sedimentation for the removal of floating matter, oil and grease present in grey water. In this study it has been found that the use of jute bags can be beneficial.

5) Nisha Sharma et al. (2018) in this literature the study on hydroponic method as deep water culture is done in this it has been found that this method is one of the best and economical method for hydroponic as less water and less energy is required in this method and the continuous oxygen supply is required to plants roots for their growth.

6) Pavan K S et al. (2021) in this literature the study has been done on the vertical garden setup in this the vertical garden was created as a filter media for grey water treatment, in this the coco-peat and saw dust was used separately as an additional material for treatment. In this study it has been found that coco-peat gives the better results for water treatment and also acts as good growing media for plants in the wetland.

7) Kunal Thanekar et al. In this literature it has been studied that the grey water can be treated with the low cost technology (i.e. constructed wetland) which is constructed with soil, coco peat, sand, aggregates and plants and the

treated grey water can be reused in the hydroponic farming. In this study it has been found that the hydroponic farming can be done on the treated grey water.

## V. METHODOLOGY

1) Site Visit: We have visited at Hydrofresh Organics at Manewada Nagpur, here Mr. Rahul Langde Guided us about Hydroponic Farming he explained many things such as methods of Hydroponics, Plants which can grow, materials used and many more.

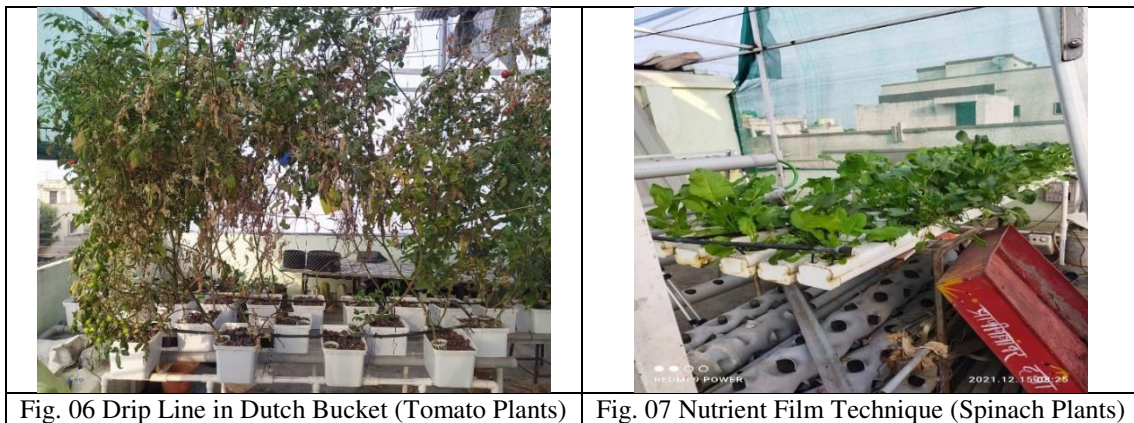


Fig. 06 Drip Line in Dutch Bucket (Tomato Plants)

Fig. 07 Nutrient Film Technique (Spinach Plants)

This are the actual site visit photos where we have visited and in this the deep water culture and drip line in Dutch Bucket method is used.

2) Model Making: On the basis of our study we have made a model of treatment of grey water by Constructed wetland and Reusing treated water into Hydroponic Farming.

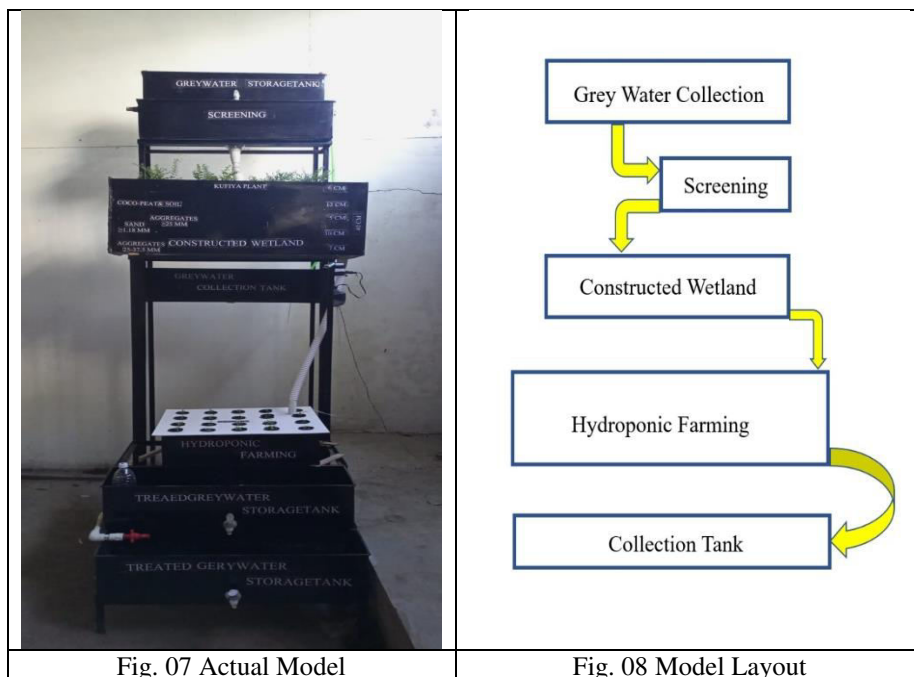


Fig. 07 Actual Model

Fig. 08 Model Layout

- In The Screening Section the layer of jute bags for the removal for floating and the suspended impurities which can cause clogging in the Constructed Wetland is used.
- The Constructed Wetland is constructed with the materials like Coco-peat, Soil, Sand, & Aggregates.

In this we have used- 1) The 1<sup>st</sup> layer is of Mixed Coco-peat and Soil for the depth of 12cm.

2) The 2<sup>nd</sup> layer is of Aggregates of size  $\geq 25$ mm for depth of 5cm.

3) The 3<sup>rd</sup> layer is of Sand of less than 1.18mm for depth of 10cm.

4) And the last layer is of Aggregates of size 25-37.5mm for the depth of 7cm.

5) And in this Constructed Wetland we have planted Kufiya Plant (Garden Plant).

- And in the Deep Water Culture of Hydroponic farming is used in which we have planted Spinach Plants and trying to grow them on Treated Grey Water.

3) Grey Water Collection – The main task in this is Grey water Collection we have collected Grey water from the residential House.

4) Model running – The model runs in the following steps:

Step 1 The grey water is collected in the storage tank.

Step 2 Then the screening is done with the help of jute bags.

Step 3 after screening the water is transferred to the constructed wetland gravitationally.

Step 4 In constructed wetland the water gets treated in layers [1<sup>st</sup> layer is of Plants and Coco-peat & soil 2<sup>nd</sup> layer is of aggregates 3<sup>rd</sup> layer is of sand and the last layer is of aggregates.]

Step 5 After Treatment the treated water comes into hydroponic System.

Step 6 In Hydroponics the water level is maintained by the overflow valve and the excess water gets out in the storage tank.

All this Process takes place gravitationally.

## V. EXPERIMENTAL RESULTS

This are the obtained results for the Raw Grey Water, and Treated Grey Water from constructed wetland and hydroponic farming.

All the test parameters are tested and certified at the ISO lab.

Sr. No.	Test Parameters	Inlet Raw Grey Water	Outlet Treated GW Const. Wetland	Outlet Treated GW Hydroponic Farming	BIS Specifications 10500:2012 Normal Values	
					Desirable Limits	Permissible Limits
1	Physical Appearance	Hazy Black Coloured	Hazy Coloured	Hazy Coloured	-	-
2	Odour	Present	Present	Present	Agreeable	Agreeable
3	Turbidity	612.0	6.5	1.2	1.0	5.0
4	pH Value	8.28	8.13	8.41	6.5-8.5	No Relaxation
5	Chlorides	450.0	260.0	230.0	250.0	1000.0
6	Nitrates	0.0	120.97	135.60	45	No Relaxation
7	Total Hardness	732.0	500.0	436.0	200.0	600.0
8	Alkalinity	768.0	520.0	440.0	200.0	600.0
9	Total Dissolved Solids	1836.0	1198.0	1065.0	500.0	2000.0
10	Iron	1.395	0.091	0.029	0.3	No Relaxation
11	Fluorides	0.0830	1.055	1.063	1.0	1.5
12	Calcium	128.5	56.11	64.1	75.0	200.0
13	Magnesium	100.1	87.48	67.0	30.0	100.0

Table : Result Analysis

## VI. CONCLUSION

From all the research done it has found that the Grey water can be treated effectively with low maintenance and the water can be treated up to greater extent in the constructed wetland. Also it has been found that the plants can grow on the treated grey water in the hydroponic System but it has been observed that the growth of the plants is less than the





growth in the normal water used in Hydroponic. But by changing the method of hydroponic & with some greater care and maintenance the plants can give the more growth as the treated grey water also contains the nutrients which are helpful for the plants growth.

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