HYDROK™
Water Engineering Solutions

An Introduction to the GROW Grey/ 'Green' Water Recycling System, and the GROW HYBRID in collaboration with Indian Institution for Technology (M)

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The concept of GROW began from 2 ideas:

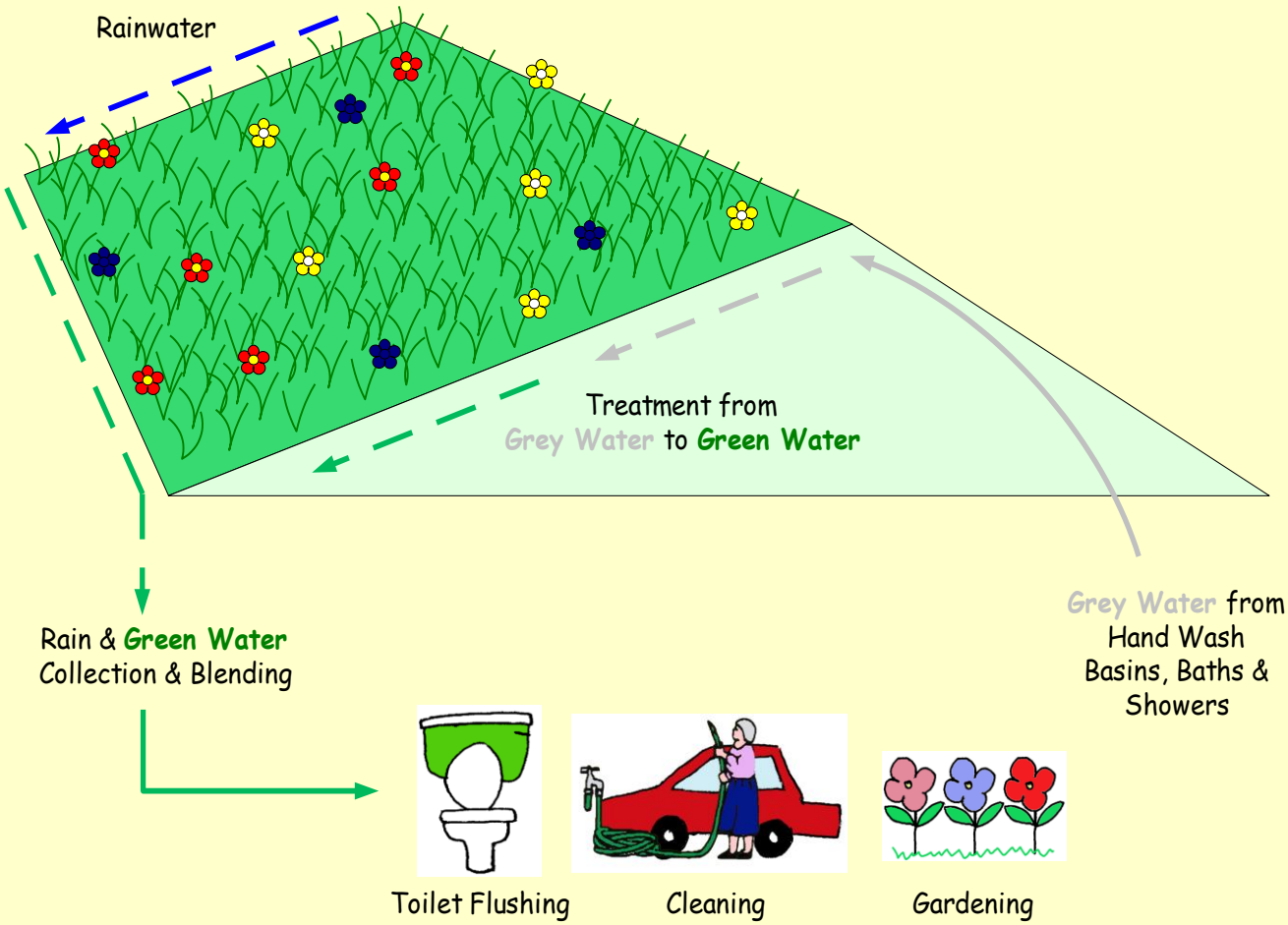
1) That **it is wasteful to use valuable, treated drinking water for certain purposes** eg: agriculture, industry and, in many countries, domestic use where flush toilets are the normal means of sanitation

2) That 'Green Roofs' (planted) on buildings are found to have a significant effect on climate mitigation in urban areas, both insulating buildings from heat in summer and cold in winter.

GROW and GROW HYBRID are designed to serve small communities both urban or rural.

GROW is of an adequate size to serve eg a block of flats or around 30 – 40 people

GROW HYBRID can be constructed to any size (up scaled). The demonstration model will serve a community of around 500 persons.



Water for a Green City

The reuse of ‘grey’ water (water used once for personal washing or clothes) again, but for a lower ‘grade use’, both saves water, and energy.

This form of water conservation and reuse is nothing new, but it requires:

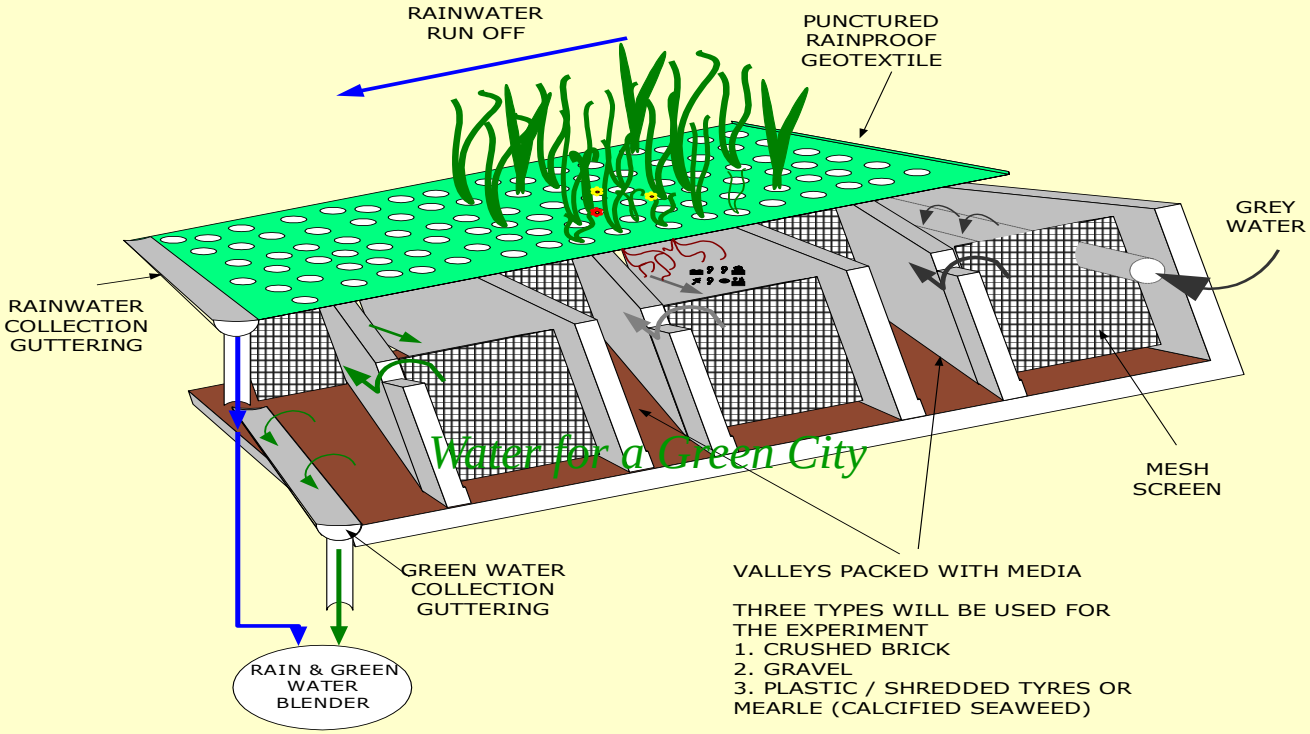
- Some simple, energy-free technology to clean the water
- Some local storage for both the collected grey water and for the cleaned ‘green’ water before it is reused

So, what is GROW?

GROW is a **‘mini-reedbed’ linear filtration system**, which uses both a physical filtrate (gravel or similar) and a biological agent (aquatic plants) to cleanse the ‘grey’ water.

The system mirrors a natural reedbed system usually associated with water courses, and is really an ‘engineered wetland’.

In order to economise on space, the GROW linear layout has been divided into a series of parallel lengths, in troughs forming a ‘staircase’ down which the water flows by gravity.



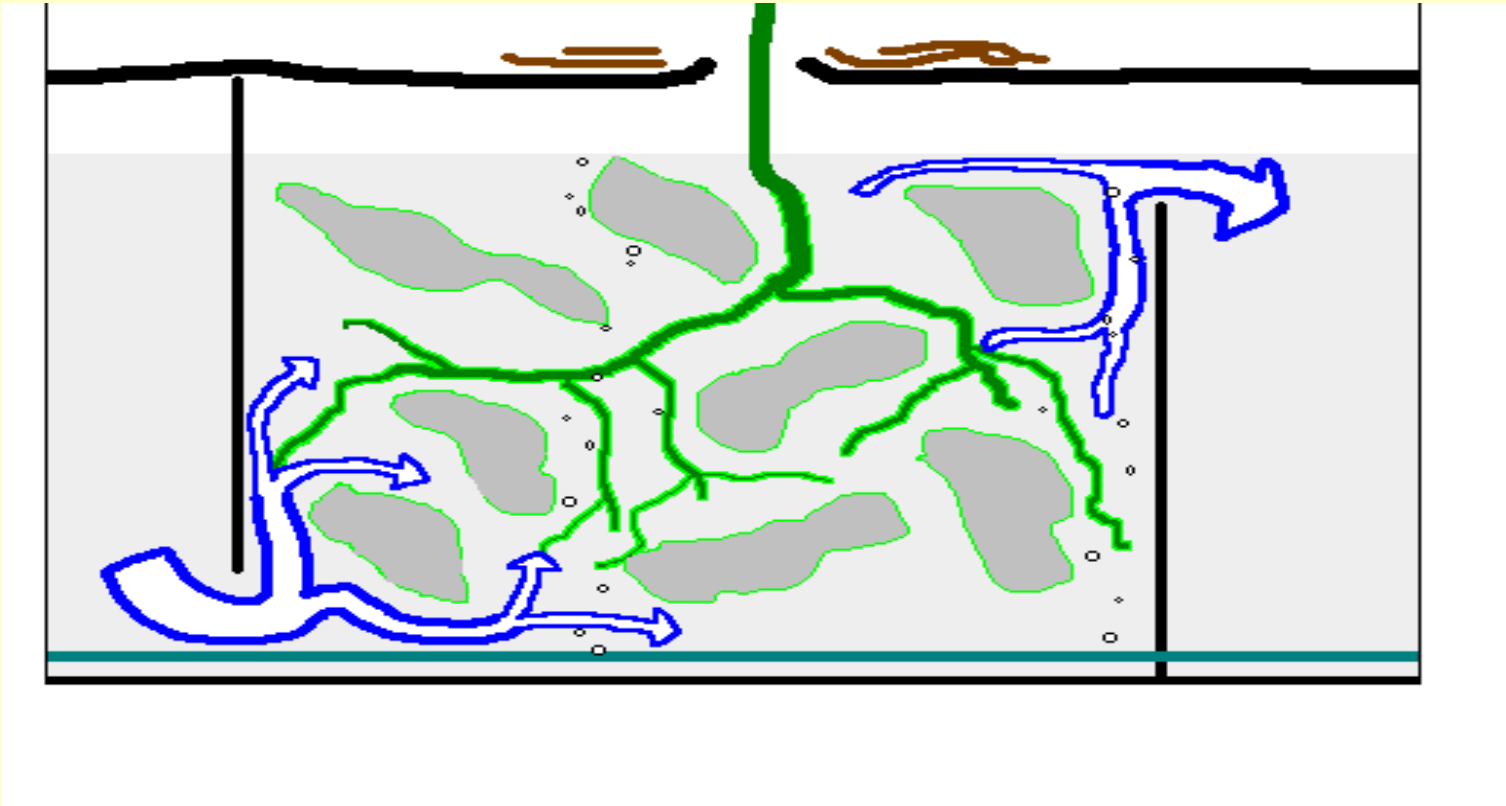
Cross Section of Green Roof Water Recycling System

Construction of stand for GROW at Cranfield University

Construction of GROW rig at Cranfield University May 2004 – showing troughs filled with gravel

GROW Rig at Cranfield University, July 2004

- GROW (as illustrated in this presentation) is designed to process around 1.25m^3 /day of ‘grey water’ to ‘green water’ with a hydraulic residence time of around 18 hours.
- Weight is designed to be kept as low as possible for rooftop installation.
- For a larger community, units of 4/5 troughs each may be connected in parallel to give greater capacity.



Section showing water movement through full depth of filtration medium combining positive features of both horizontal and vertical flow filters.

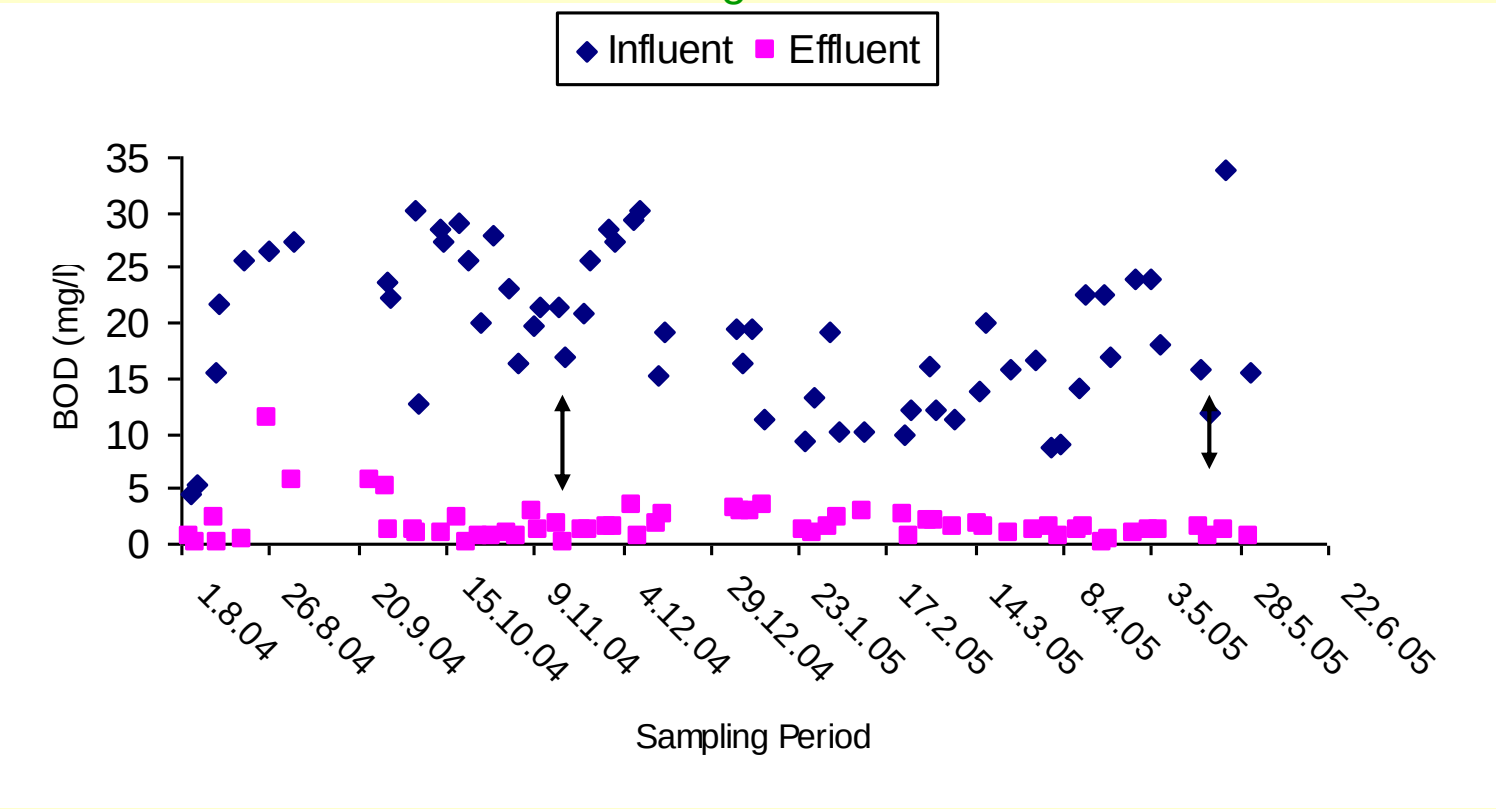
This is the key to the system.

Maintenance of reeds required from time to time

The filtrate also requires annual maintenance

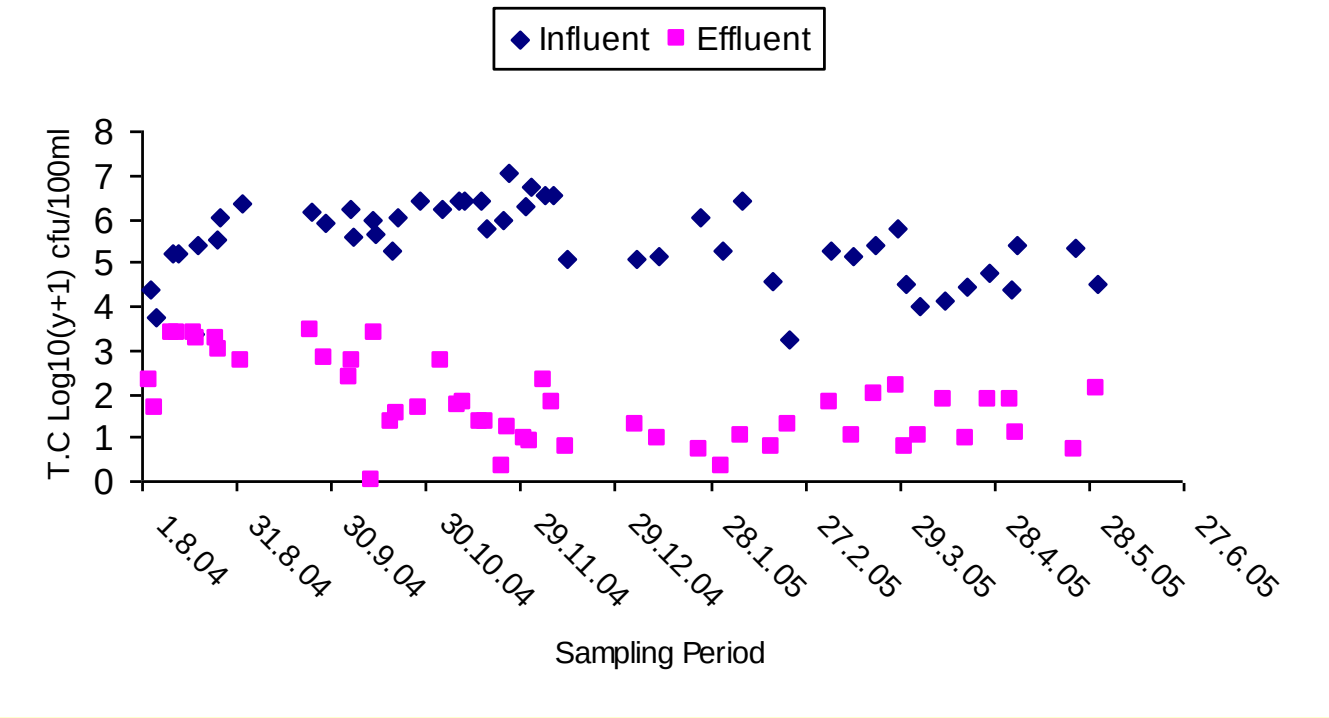
- At Cranfield UK, GROW was connected to a live supply of ‘grey’ water from the students’ accommodation
- **Results** 2004 – 6 indicated that GROW was 90% + effective in removal of:
  BOD_5, TSS, and Total Coliform for ‘weak’ to ‘medium’ strength ‘grey water’.
- GROW achieved a significant improvement in DO_2

BOD_5



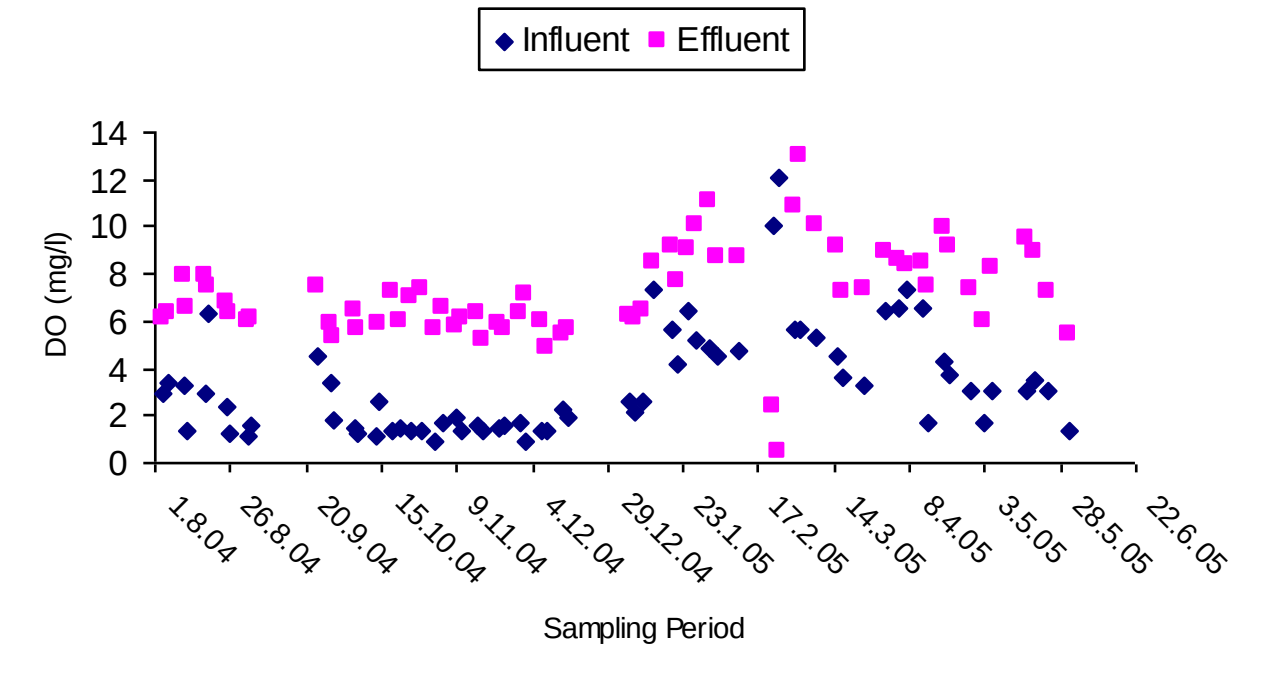
Samples from Canfield GROW Rig taken and analysed by R..Frazer Williams

Indicator microorganisms: Total Coliforms



Samples from Cranfield GROW Rig taken and analysed by R.Frazer Williams

Dissolved Oxygen



Samples from Cranfield GROW Rig taken and analysed by R.Frazer Williams

- ‘Green Water’

  The main objective for the GROW system is to produce ‘Green Water’ which can be used for a range of applications including toilets, agriculture and public area cleansing.

- In the UK there is no official standard to date for a ‘Green Water’ quality, but AWS/ Albion Water have been suppliers of such water for a number of years.

- Therefore, in order to protect customers, we have set ourselves a reasonable and attainable water quality standard. This is in some criteria higher than guidance set for EU, Germany and USEPA

‘Green Water’ has the following characteristics:

- conforms to criteria for tertiary treatment:
  typically:<10mg/l BOD
  <10mg/l Suspended Solids
  < 5mg/l Ammonia
- pathogen free (at least <10cfu/100ml)
- should be clearly identified as a separate supply, not for human ingestion, by the use of a green tinged vegetable dye at a specified dilution (1:20,000)
-

- In 2012 AWS/ HYDROK was invited to take part in a joint research project sponsored by the EU and the Indian Institute of Technology (M):
- ‘Supporting, Replicating and Up-scaling of Sustainable Waste Water Reuse Technologies for India’ (SARASWATI)

- AWS/ Hydrok and IITM have four main objectives:
- To test the GROW system under tropical conditions using indigenous plants
- To test the GROW system using different, locally available physical filtration media
- To test that the system is sufficiently robust to provide reused water over a extended period of time
- To create an up-scaled version known as GROW HYBRID (See in a minute)

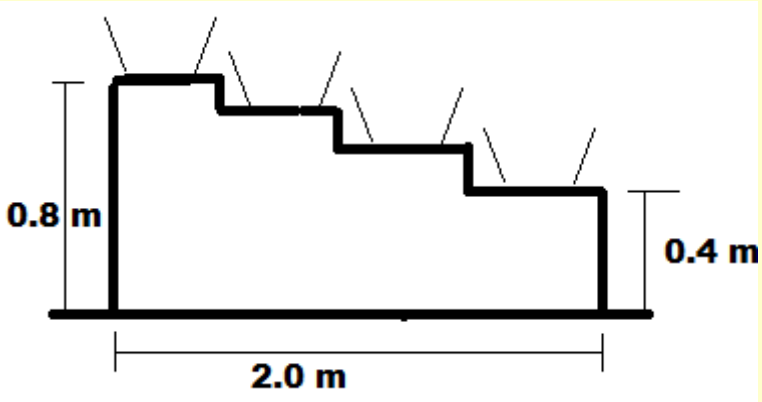
GROW system

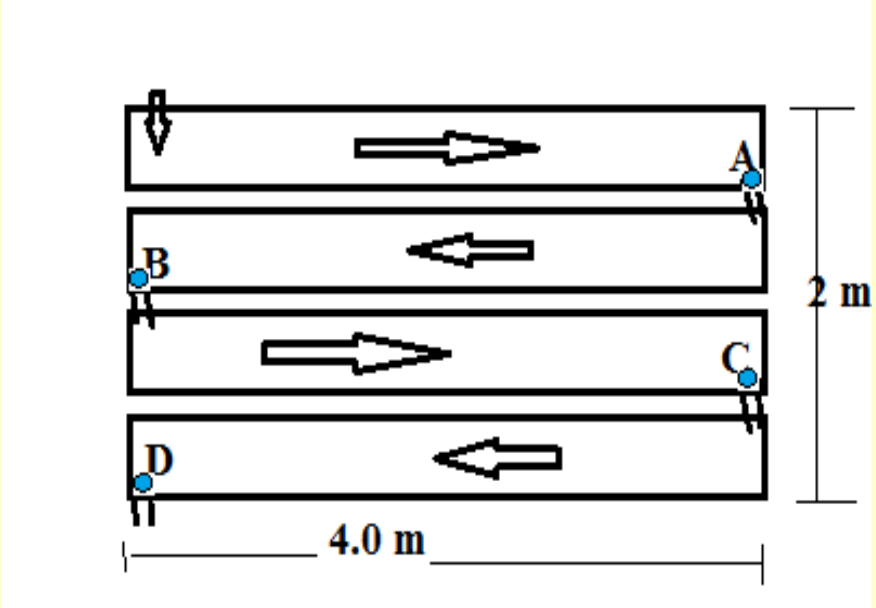
Location – IIT Madras, Krishna Hostel

GROW – Green water recycling system, UK patented technology

Dimensions of GROW troughs – 4 m (L) x 2 m (W)

Mild Steel scaffolding are made to support the troughs





GROW at Indian Institute for Technology 2013
Planting Day!

GROW system contd…

- Planted in GROW system are 8 species of indigenous aquatic plants:
  - *Canna indica, Canna flaccid, Canna lily – hybrid, Cardamine pratensis, Plectranthus amboinicus, Crossandra infundibuliformis, Phragmities australis, Solanum trilobatum*

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Trough (trapezoidal profile) of size (400 mm (upper width) 230 mm (lower width) x 150 mm deep)

- Materials filled in the bed are gravel and crushed brick bats of equal proportion (2:1)

Plants becoming established

Plants have been decimated...

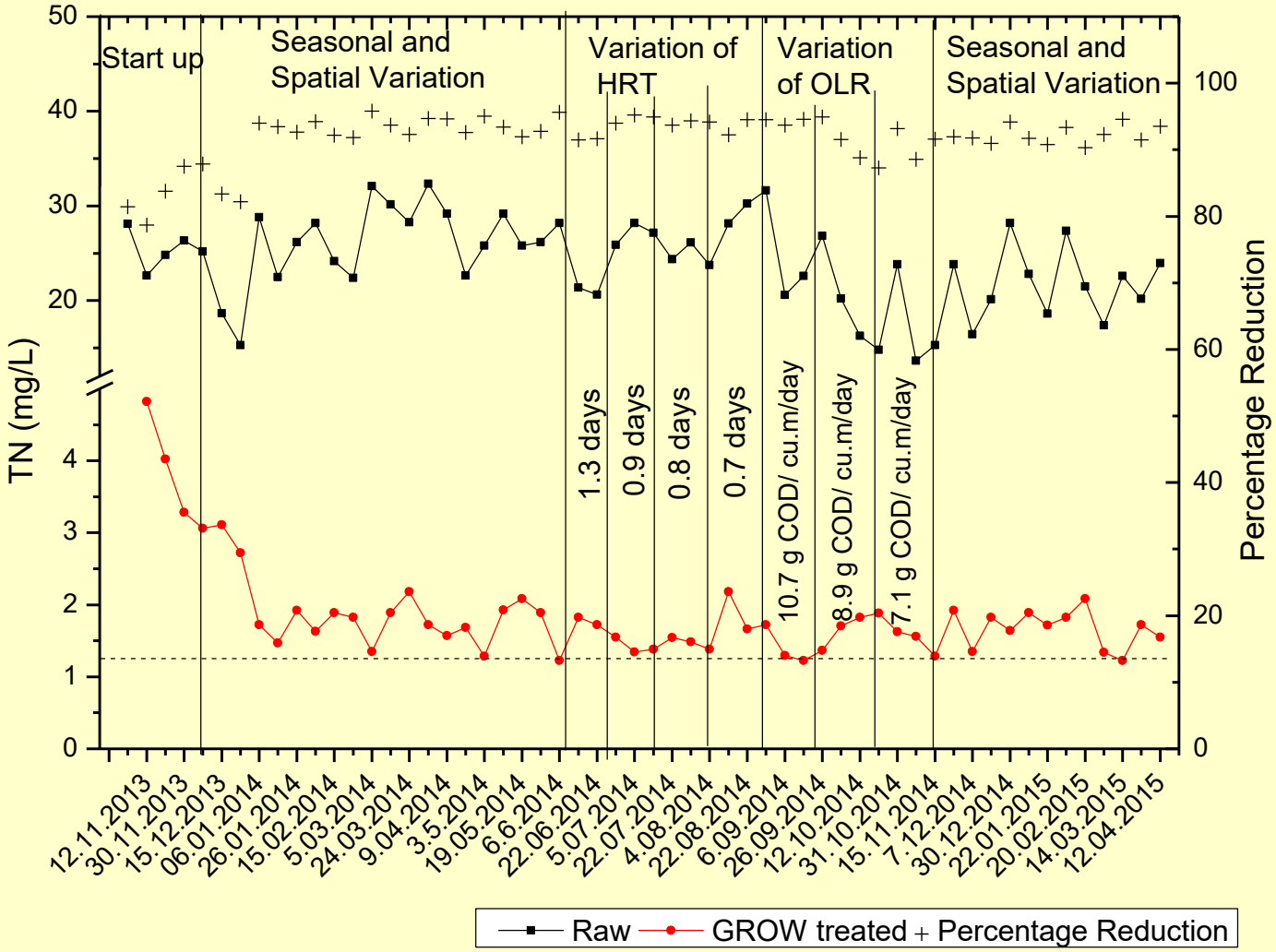
Why did we have to put GROW in a cage?

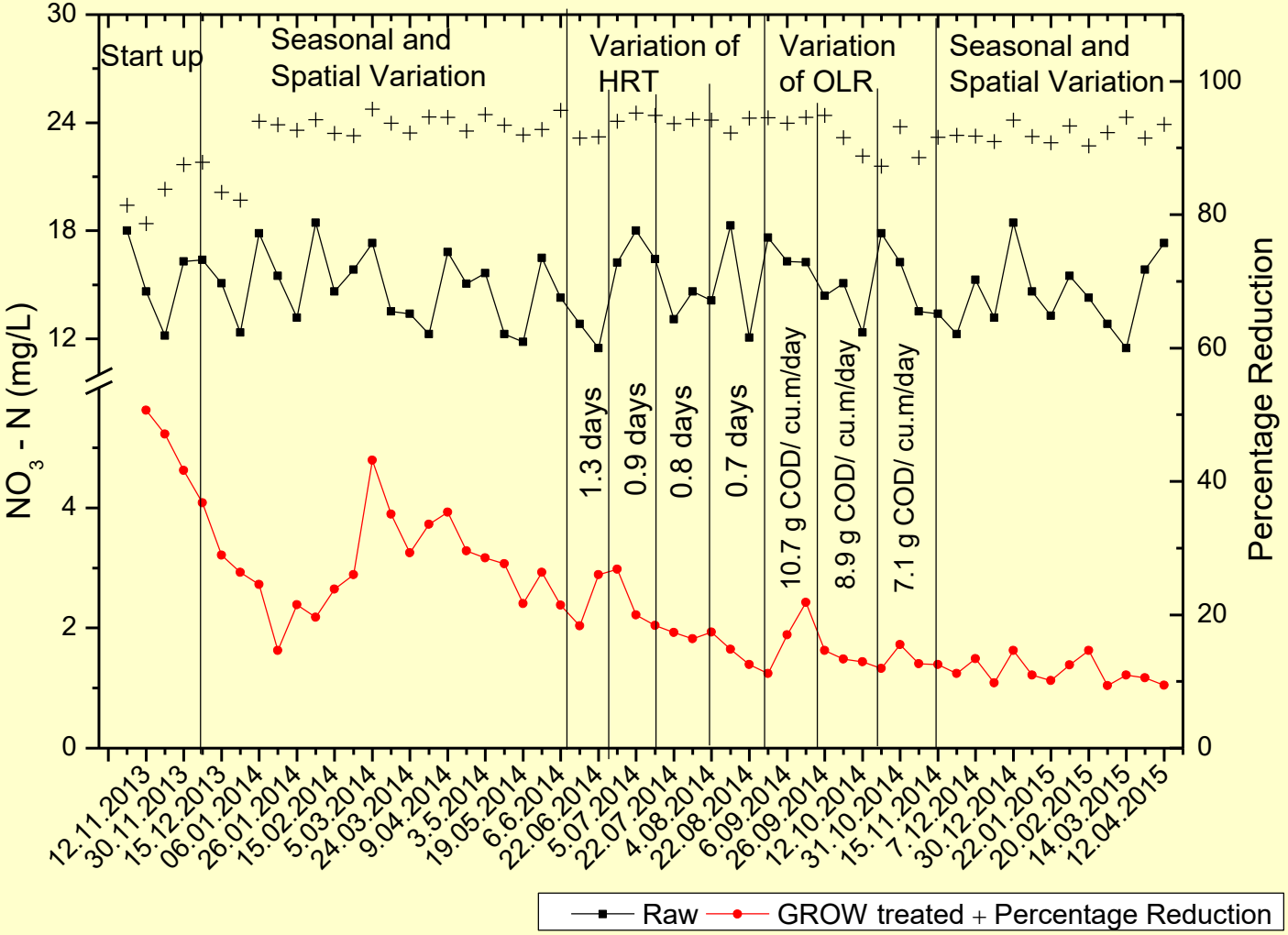
- The system was connected up to the Student Hostel housing some 200 students, and which, from a holding tank, supplied a constant flow of ‘grey’ water
- Once the GROW had been established it was fortunate that the IITM were also conducting research on ‘grey’ water and they had a spare concrete tank for our Up-scale.
- Aka GROW Hybrid.

Up-scaled GROW ‘Hybrid’ at Indian Institute of Technology, Madras 2013. Exactly the same principles deployed.

A veritable jungle! See GROW HYBRID in the centre.

- Additional hazards:
- Deer, snakes, monkeys and mongoose!


Start up
Seasonal and Spatial Variation
Variation of HRT
Variation of OLR
Seasonal and Spatial Variation
1.3 days
0.9 days
0.8 days
0.7 days
10.7 g COD/ cu.m/day
8.9 g COD/ cu.m/day
7.1 g COD/ cu.m/day
TN (mg/L)
Percentage Reduction
Raw
GROW treated
Percentage Reduction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Seasonal and Spatial Variation
Variation of HRT
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Seasonal and Spatial Variation
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0.9 days
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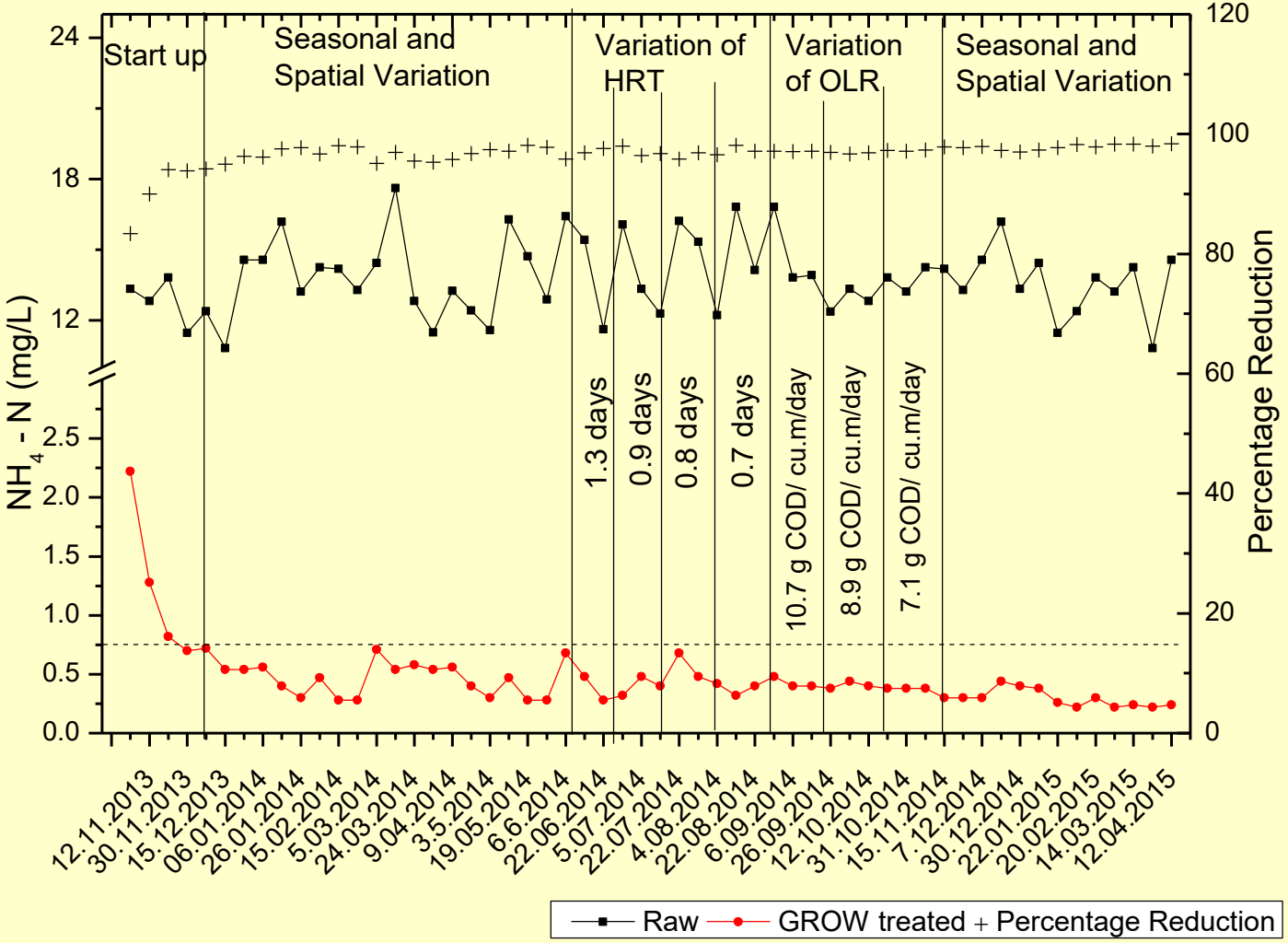
10.7 g COD/ cu.m/day
8.9 g COD/ cu.m/day
7.1 g COD/ cu.m/day
NO3 - N (mg/L)
Percentage Reduction
Raw
GROW treated + Percentage Reduction


Start up
Seasonal and Spatial Variation
Variation of HRT
Variation of OLR
Seasonal and Spatial Variation
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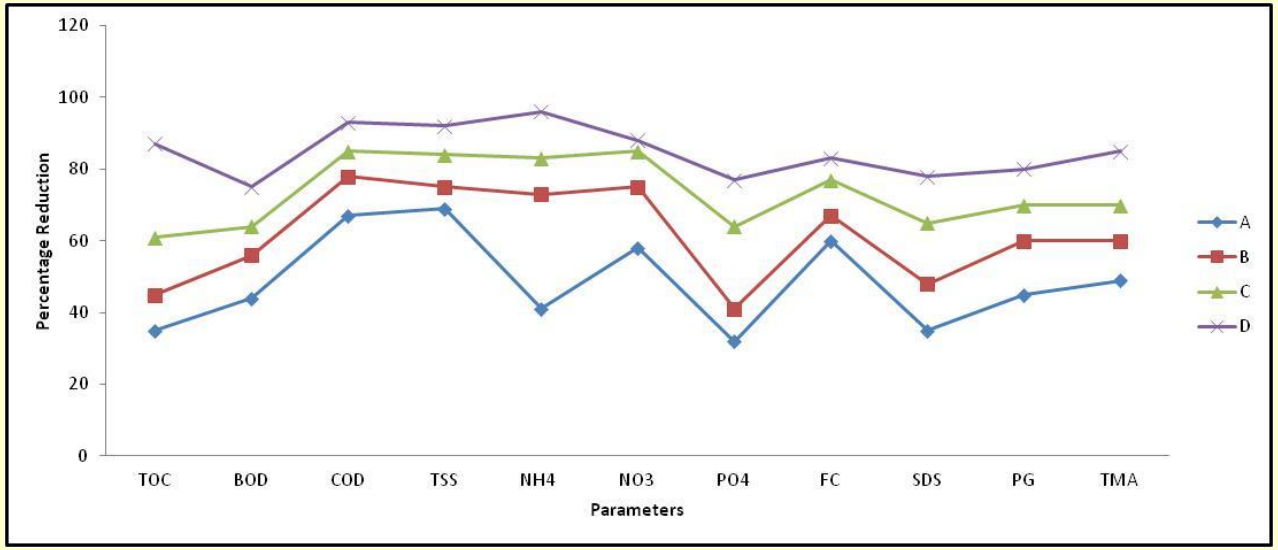
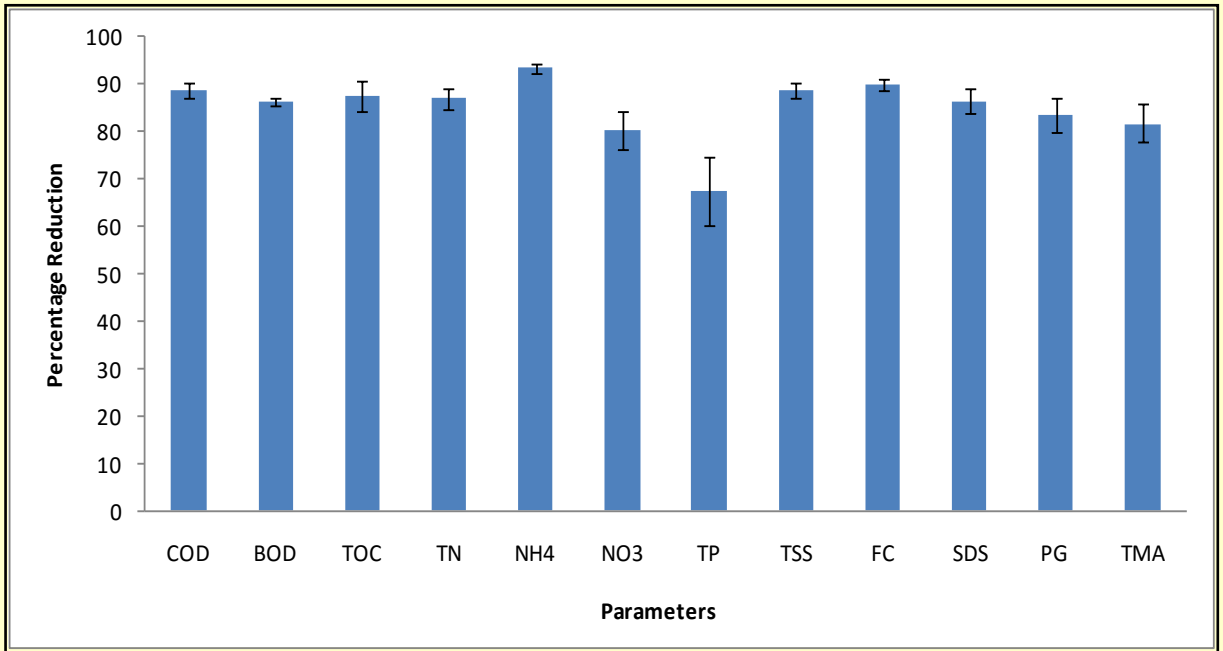
0.9 days
0.8 days
0.7 days
10.7 g COD/ cu.m/day
8.9 g COD/ cu.m/day
7.1 g COD/ cu.m/day
NH4 - N (mg/L)
Percentage Reduction
Raw
GROW treated
Percentage Reduction



Spatial Variation

A – sampling point at top of the bed (near to inlet)

D – sampling point at bottom of the bed (near to outlet)



Perform-ance after changing substrate (gravel only) and with *Canna Spp.*

- The research is on-going.
- Thus far we have found that for GROW HYBRID brick bats, roadstone and gravel make ideal filtration medium as well as a good anchorage for the plants.
- Any finer substrate clogs the pathways and reduces flow.

- The plants we are finding most effective in the climate in India:
- For GROW: Phragmites, Cannya, Batruse
- For Hybrid GROW only Phragmites were used
- With thanks to our partners at IITM, Professor Ligy Philip and Ramprasad

- We would now like to move to a practical application of GROW Hybrid for the benefit of Indian rural communities.
- Please contact me if you are interested and/ or can assist in finding a village/ community who would benefit from this simple technology.
- css@wwuk.co.uk
- Thank you.