MODULE 9

TECHNOLOGIES FOR WATER CONSERVATION & MANAGEMENT

The topics covered in this module are:

- Need
- What can be done
- Technologies & practices

OBJECTIVE (S) OF THE MODULE

The trainer informs the following module objectives to participants:

- Explain the need for practicing water conservation and management.
- Discuss the approaches to be used.
- Brief about the available technologies and their application.

NEED

When rain falls on the Earth, that water flows across or under the ground and begins The uneven distribution of rainfall has often threatened human welfare, livelihood and economic development. The growing scarcity of water is due to the rapid growth of population, rising demand for food and cash crops, increasing urbanisation and rising standard of living. All these have increased the acuteness of the problem of water scarcity in future.

For efficient water conservation and management, the following points are to be kept in mind:

1. To aware people about the necessity of water and its conservation.
2. To involve people in all the activities of water management.
3. To make people aware that treated water should not be used in gardening, washing toilets and wash basins and so on.
4. Drying up of underground aquifers should be prevented.
5. Water-bodies should be kept pollution-free.
6. Different measures for specific area should be adopted for efficient water management, and active cooperation of the local people should also be sought in every measure. In spite of the fact that irrigation facilities in the country have improved considerably since independence, two-third of the cropped area is still rained. Increased use of tube wells and wells in recent years has lowered the water table and has caused depletion of underground water resources.

Watershed is a physiographic unit that can be used conveniently for integrated development or small natural unit areas. It is the basin of a tributary. It is developed taking into consideration the land capability and the local needs of the people.

WHAT CAN BE DONE

SUPPLY SIDE AUGMENTATION

Completion of storage dam

Interlinking of rivers

Recycling of used water

Desalination of sea water

Groundwater recharging (& suitable structures)

Rainwater harvesting

Stream flow harvesting

Conservation and restoration of wetlands

DEMAND SIDE IMPROVEMENT

Avoid wastage in various water uses

Use of recycled water for non-portable uses

Crop diversification and precision farming

Reduction in conveyance losses and pilferage in urban water supply systems (30 - 40 %)

Reduction in surface losses

Use of technologies for efficiency improvement

Water auditing (metering & pricing)

Regulation of water withdrawal

Awareness and sensitization

TECHNOLOGIES & PRACTICES

SYSTEM OF RICE INTENSIFICATION (SRI)

The System of Rice Intensification (SRI) is a methodology aimed at increasing the yield of rice produced in farming.

SRI is a combination of several practices those include changes in nursery management, time of transplanting, water and weed management. Its different way of cultivating rice crop though the fundamental practices remain more or less same like in the conventional method; it just emphasizes altering of certain agronomic practices of the conventional way of rice cultivation. All these new practices are together known as System of Rice Intensification (SRI). SRI is not a fixed package of technical specifications, but a system of production with four main components, viz., soil fertility management, planting method, weed control and water (irrigation) management. Several field practices have been developed around these components. Of them, the key cultural practices followed in most cases are:

Preparing High-quality Land

SRI requires careful leveling and raking, with drainage facilitated by 30 cm wide channels at two-meter intervals across the field.

Preferring Compost or Farmyard Manure to Synthetic Fertilizers

It is better to use organic nutrients, as they are better at promoting the abundance and diversity of microorganisms, starting with beneficial bacteria and fungi in the soil. This will promote proper microbial activity, thereby improving production.

Cultivation Using SRI Technique

Developing Nutrient-rich and Un-flooded Nurseries

The seedbeds have to be nutrient-rich and established as close to the main field as possible. This will enable quicker and easier transportation between the nurseries and the fields, minimizing both transport time and costs so that the seedlings are efficiently transplanted.

Using Young Seedlings for Early Transplantation

This has to take place when the seedlings are just 8 to 12 days old, soon after they have two leaves, and at least before the 15th day after sowing.

Ensuring Wider Spacing between Seedlings

The seedlings should be planted at precise spacing, usually 25 X 25 cm^2, about 16 plants per square meter. Rice plant roots and canopies grow better if spaced widely, rather than densely.

Transplanting the Seedlings Singly

The seedlings must be transplanted singly with their roots intact, while the seed sac is still attached. They must not be plunged too deep into the soil, but placed at 1-2 cm on the ground at the appropriate point on the planting grid.

Frequent Inter-cultivation with Weeder

A manual weeder is to be operated perpendicularly in both directions in between the hills within 10 to 12 days of transplantation, and at intervals of 10-12 days afterwards. This operation not only controls the weeds but churns the soil which causes a lot of changes in the soil which favours better growth of the crop.

Managing water carefully so that the plants' root zones moisten, but are not continuously submerged

SRI requires the root zone to be kept moist, not submerged. Water applications can be intermittent, leaving plant roots with sufficiency, rather than surfeit of water. Rice grown under SRI has larger root system, profuse and strong tillers with big panicles and well-filled spikelets with higher grain weight. The rice plants develop about 30 - 80 tillers and the yields are reported to be higher. The secret behind this is that rice plants do best when young seedlings are transplanted carefully at wider spacing; their roots grow larger on soil that is kept well aerated with abundant and diverse soil microorganisms.

RAINWATER HARVESTING (RWH)

The term rainwater harvesting is being frequently used these days, however, the concept of water harvesting is not new for India. Water harvesting techniques had been evolved and developed centuries ago.

Ground water resource gets naturally recharged through percolation. But due to indiscriminate development and rapid urbainzation, exposed surface for soil has been reduced drastically with resultant reduction in percolation of rainwater, thereby depleting ground water resource. Rainwater harvesting is the process of augmenting the natural filtration of rainwater in to the underground formation by some artificial methods. "Conscious collection and storage of rainwater to cater to demands of water, for drinking, domestic purpose & irrigation is termed as Rainwater Harvesting."

How to harvest rainwater:

Broadly there are two ways of harvesting rainwater:

(i) Surface runoff harvesting

(ii) Roof top rainwater harvesting

Surface runoff harvesting:

In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

Roof top rainwater harvesting (RTRWH):

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system. This method is less expensive and very effective and if implemented properly helps in augmenting the ground water level of the area.

Components of the roof top rainwater harvesting system

The system mainly constitutes of following sub components:

- Catchment
- Transportation
- First flush
- Filter

Catchment

The surface that receives rainfall directly is the catchment of rainwater harvesting system. It may be terrace, courtyard, or paved or unpaved open ground. The terrace may be flat RCC/stone roof or sloping roof. Therefore the catchment is the area, which actually contributes rainwater to the harvesting system.

Transportation

Rainwater from rooftop should be carried through down take water pipes or drains to storage/harvesting system. Water pipes should be UV resistant (ISI HDPE/PVC pipes) of required capacity. Water from sloping roofs could be caught through gutters and down take pipe. At terraces, mouth of the each drain should have wire mesh to restrict floating material.

First Flush

First flush is a device used to flush off the water received in first shower. The first shower of rains needs to be flushed-off to avoid contaminating storable/rechargeable water by the probable contaminants of the atmosphere and the catchment roof. It will also help in cleaning of silt and other material deposited on roof during dry seasons Provisions of first rain separator should be made at outlet of each drainpipe.

Filter

There is always some skepticism regarding Roof Top Rainwater Harvesting since doubts are raised that rainwater may contaminate groundwater. There is remote possibility of this fear coming true if proper filter mechanism is not adopted. Secondly all care must be taken to see that underground sewer drains are not punctured and no leakage is taking place in close vicinity. Filters are used fro treatment of water to effectively remove turbidity, colour and microorganisms. After first flushing of rainfall, water should pass through filters. There are different types of filters in practice, but basic function is to purify water.

Sand Gravel Filter

These are commonly used filters, constructed by brick masonry and filleted by pebbles, gravel, and sand as shown in the figure. Each layer should be separated by wire mesh.

Charcoal Filter

Charcoal filter can be made in-situ or in a drum. Pebbles, gravel, sand and charcoal as shown in the figure should fill the drum or chamber. Each layer should be separated by wire mesh. Thin layer of charcoal is used to absorb odour if any.

PVC- Pipe filter

This filter can be made by PVC pipe of 1 to 1.20 m length; Diameter of pipe depends on the area of roof. Six inches dia. pipe is enough for a 1500 sq.ft. roof and 8 inches dia. pipe should be used for roofs more then 1500 sq.ft. Pipe is divided into three compartments by wire mesh. Each component should be filled with gravel and sand alternatively as shown in the figure. A layer of charcoal could also be inserted between two layers. Both ends of filter should have reduce of required size to connect inlet and outlet. This filter could be placed horizontally or vertically in the system.

Sponge Filter

It is a simple filter made from PVC drum having a layer of sponge in the middle of drum. It is the easiest and cheapest form filter, suitable for residential units.

METHODS OF ROOF TOP RAINWATER HARVESTING

Storage of Direct use

In this method rain water collected from the roof of the building is diverted to a storage tank. The storage tank has to be designed according to the water requirements, rainfall and catchment availability. Each drainpipe should have mesh filter at mouth and first flush device followed by filtration system before connecting to the storage tank. It is advisable that each tank should have excess water over flow system.

Excess water could be diverted to recharge system. Water from storage tank can be used for secondary purposes such as washing and gardening etc. This is the most cost effective way of rainwater harvesting. The main advantage of collecting and using the rainwater during rainy season is not only to save water from conventional sources, but also to save energy incurred on transportation and distribution of water at the doorstep. This also conserve groundwater, if it is being extracted to meet the demand when rains are on.

Recharging ground water aquifers

Ground water aquifers can be recharged by various kinds of structures to ensure percolation of rainwater in the ground instead of draining away from the surface.

Commonly used recharging methods are:-

- Recharging of bore wells
- Recharging of dug wells.
- Recharge pits
- Recharge Trenches
- Soak ways or Recharge Shafts
- Percolation Tanks

Recharging of bore wells

Rainwater collected from rooftop of the building is diverted through drainpipes to settlement or filtration tank. After settlement filtered water is diverted to bore wells to recharge deep aquifers. Abandoned bore wells can also be used for recharge.

Optimum capacity of settlement tank/filtration tank can be designed on the basis of area of catchement, intensity of rainfall and recharge rate as discussed in design parameters. While recharging, entry of floating matter and silt should be restricted because it may clog the recharge structure. "first one or two shower should be flushed out through rain separator to avoid contamination. This is very important, and all care should be taken to ensure that this has been done."

Recharge Pits

Recharge pits are small pits of any shape rectangular, square or circular, contracted with brick or stone masonry wall with weep hole at regular intervals. to of pit can be covered with perforated covers. Bottom of pit should be filled with filter media.

The capacity of the pit can be designed on the basis of catchment area, rainfall intensity and recharge rate of soil. Usually the dimensions of the pit may be of 1 to 2 m width and 2 to 3 m deep depending on the depth of pervious strata. These pits are suitable for recharging of shallow aquifers, and small houses.

Soak away or Recharge Shafts

Soak away or recharge shafts are provided where upper layer of soil is alluvial or less pervious. These are bored hole of 30 cm dia. up to 10 to 15 m deep, depending on depth of pervious layer. Bore should be lined with slotted/perforated PVC/MS pipe to prevent collapse of the vertical sides. At the top of soak away required size sump is constructed to retain runoff before the filters through soak away. Sump should be filled with filter media.

Recharging of dug wells

Dug well can be used as recharge structure. Rainwater from the rooftop is diverted to dug wells after passing it through filtration bed. Cleaning and desalting of dug well should be done regularly to enhance the recharge rate. The filtration method suggested for bore well recharging could be used.

Recharge Trenches

Recharge trench in provided where upper impervious layer of soil is shallow. It is a trench excavated on the ground and refilled with porous media like pebbles, boulder or brickbats. it is usually made for harvesting the surface runoff. Bore wells can also be provided inside the trench as recharge shafts to enhance percolation. The length of the trench is decided as per the amount of runoff expected. This method is suitable for small houses, playgrounds, parks and roadside drains. The recharge trench can be of size 0.50 to 1.0 m wide and 1.0 to 1.5 m deep.

Percolation tanks

Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation to recharge the ground water. These can be built in big campuses where land is available and topography is suitable.

Surface run-off and roof top water can be diverted to this tank. Water accumulating in the tank percolates in the solid to augment the ground water. The stored water can be used directly for gardening and raw use. Percolation tanks should be built in gardens, open spaces and roadside green belts of urban area.

AIR-TO-WATER

In this technology, water vapor in the air is condensed by cooling the air below its dew point, exposing the air to desiccants, or pressurizing the air. An atmospheric water generator (AWG), is a device that extracts water from humid ambient air. AWGs are useful where pure drinking water is difficult or impossible to obtain, because there is almost always a small amount of water in the air. The two primary techniques in use are cooling and desiccants.

The extraction of atmospheric water may not be completely free of cost, because significant input of energy is required to drive some AWG processes, sometimes called "trading oil for water". Certain traditional AWG methods are completely passive, relying on natural temperature changes, and requiring no external energy source. Research has also developed AWG technologies to produce useful yields of water at a reduced (but non-zero) energy cost.

Some Highlights

- This technology utilizes air humidity, filters to remove pollutants
- First machine installed in Jalimundi village (AP), for 600 people
- Supplied by Air Water Corporation, with support of Water Maker (Pvt) Ltd
- Dutch 'Rainmaker' is a system with a wind turbine, which drives a heat pump where the air is cooled & condensation takes place

Groundwater Remediation

In this technology, water vapor in the air is condensed by cooling the air below its dew point. Groundwater remediation is the process that is used to remove pollution from groundwater. Groundwater is water present below the ground surface that saturates the pore space in the subsurface.

Ground water remediation techniques span biological, chemical, and physical treatment technologies. Most ground water treatment techniques utilize a combination of technologies.

Biological treatment techniques - bioaugmentation, bioventing, biosparging, bioslurping, and phytoremediation.

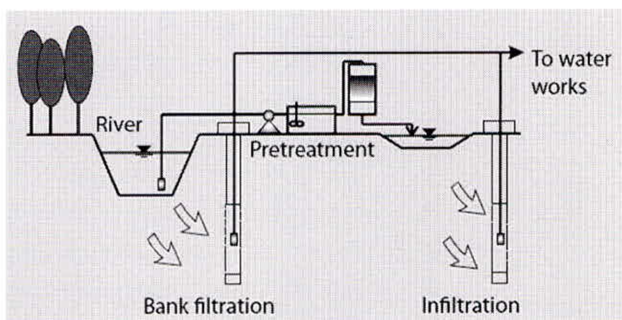
Chemical treatment techniques - ozone and oxygen gas injection, chemical precipitation, membrane separation, ion exchange, carbon absorption, aqueous chemical oxidation, and surfactant enhanced recovery.

Physical treatment techniques - but not limited to, pump and treat, air sparging, and dual phase extraction.

RIVER WATER REMEDIATION

River Bank Filtration (RBF)

Riverbank filtration (RBF) operates by extracting water from wells located near rivers (~20 to 200 m away). If engineered correctly, most of the extracted RBF water originates from the river. As this river water passes through the riverbed sediments, contaminants are removed by overlapping biological, physical, and chemical processes. Although simple in concept, the performance of an RBF system is dependent on local conditions, such as permeability of the riverbank, river level and sediment transport variability, and the type and load of



Riverbank Filtration

contamination. These RBF site conditions are typically assessed for geographically narrowly defined sites, e.g. individual cities. Our approach to RBF seeks implementation over a much larger area (watershed), by employing modern spatial data referencing methods, i.e. geographical information systems (GIS) and geographic positioning systems (GPS).

Ozone Treatment

Ozone is used to deactivate bacteria, viruses and other pathogens present in source water. It also increases the efficiency of the coagulation process and helps to reduce the concentration of metals and undesirable compounds that can form during the disinfection process.

Filtration

After separating and removing floc, the water is further treated to remove any remaining suspended particles and microorganisms. This is accomplished by filtering the water through gravel, sand and anthracite coal filters. This treatment step combines both physical and chemical processes to remove impurities.

Granular Activated Carbon (GAC) Absorption

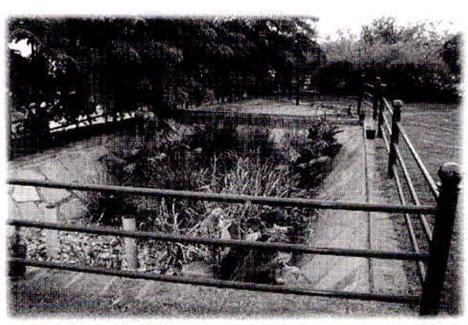
Carbon has been used as an adsorbent for centuries. Early uses of carbon were reported for water filtration and for sugar solution purification. Activated carbons ability to remove a large variety of compounds from contaminated waters has led to its increased use in the last thirty years. Recent changes in water discharge standards regarding toxic pollutants has placed additional emphasis on this technology.

Adsorption is a natural process by which molecules of a dissolved compound collect on and adhere to the surface of an adsorbent solid. Adsorption occurs when the attractive forces at the carbon surface overcome the attractive forces of the liquid.

Granular activated carbon is a particularly good adsorbent medium due to its high surface area to volume ratio. One gram of a typical commercial activated carbon will have a surface area equivalent to 1000 square meters. This high surface area permits the accumulation of a large number of contaminant molecules.

ROOT ZONE TREATMENT (Constructed Wetland)

Root Zone Systems are artificially prepared wetlands comprising of clay or plastic lined excavation and emergent vegetation growing on gravel/sand mixtures and is also known as constructed wetland. This method combines mechanical filtration, chemical precipitation and biological degradation in one step for the treatment of wastewater. A number of factors like low operating cost, less energy requirement and ease of maintenance attribute to making root zone system an attractive alternative for wastewater management.



Root Zone Treatment

The Process:

The process in a root zone system to treat the sewage begins with passing the raw effluent (after removing grit or floating material) horizontally or vertically through a bed of soil having impervious bottom. The effluent percolates through the bed that has all the roots of the wetland plants spread very thickly, nearly 2500 types of bacteria and 10000 types of fungi, which harbor around roots get oxygen form the weak membranes of the roots and aerobically oxidize the organic matter of the effluent. The characteristics of plants of absorbing oxygen through their leaves and passing it down to roots through their stems which are hollow, is utilized as a bio-pump. Away from the roots, anaerobic digestion also takes place. The filtering action of the soil bed, the action with fungi etc. and chemical action with certain existing or added inorganic chemicals help in finally obtaining very clear and clean water. The system of plants regenerates itself as the old plants die and form useful humus. Hence, the system becomes maintenance free and can run up to 50 to 60 years without any loss of efficiency.

Advantages:

- With no use of machinery and associated maintenance, the root zone system provides for low maintenance cost and negligible attendance for operation and monitoring
- It enhances the landscape and gives the site a green appeal
- It provides natural habitat for birds and after a few years gives an appearance of a Bird's sanctuary
- It is a green zone, it does not have mosquitoes problem.
- Salinity may not be a problem for a survival or operations of reed beds
- It is recommended to combine vertical flow and then horizontal flow of sewage with a soil having impervious bottom
- In the horizontal flow system, the sewage percolates through bed and that has all roots of the wetland plants spread very thickly nearly with 2500 types of bacteria and 10,000 types of fungi and aerobically oxidized organic matter of the effluent.
- Root zone system gives a very good performance of removing 90% BOD and 63% Nitrogen.
- Phragmites australis has been found more efficient in nitrogen removal compared to Typha latifolia.

Solar Aquatics System (SAS)

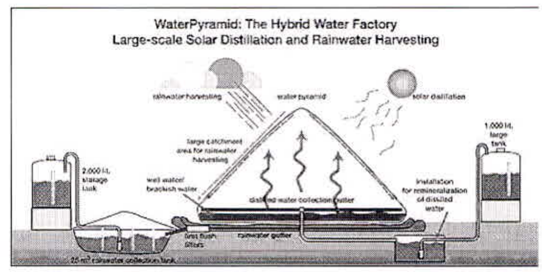
- Treatment is done by a combined action of sunlight, oxygen, bacteria, algae, plants, snails, and fish
- 4-stage treatment in a greenhouse thru a series of aerated tanks that host plants & aerobic microroganisms- replicates natural wetland processes Aeration, bioaugmentation and BOD reduction Nitrification, & first stage nitrogen and

phosphorus removal Nutrient removal, reduction of suspended solids, & nitrate uptake Pathogen reduction, filtration & denitrification

- Removal efficiencies: total suspended solids (99%), BOD (99%) and ammonia (98%)
- Treatment capacity: 22 to 4500 m^3/day
- High quality effluent (suitable for groundwater recharge)
- Potential tourism attraction (for revenue generation)

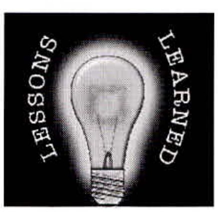
SOLAR DISTILLATION THROUGH WATER PYRAMID

- Water pyramid is foil structure, utilizing solar energy to evaporate dirty or polluted source water and to condense high quality drinking water in tropical & Island regions
- Suitable for salt water, brackish water or polluted river water
- With a total area of 200 m^2, a water pyramid can produce 400 to 800 litres of fresh water a day
- Can also be used for rainwater harvesting
- Installation cost is comparable & operational costs are ~ 1/10 to that of a RO installation
- A pilot project in Rajasthan: 30 m wide, 9 m high structure supplies 1000LPD.



Solar Aquatics System

LESSONS LEARNED



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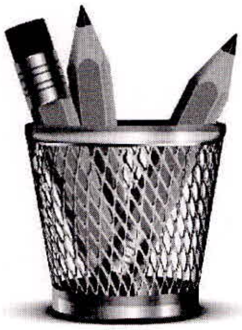
- SRI is a combination of several practices those include changes in nursery management, time of transplanting, water and weed management.
- Conscious collection and storage of rainwater to cater to demands of water, for drinking, domestic purpose & irrigation is termed as Rainwater Harvesting.
- In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building.
- In air-to-water technology, water vapor in the air is condensed by cooling the air below its dew point, exposing the air to desiccants, or pressurizing the air.
- Groundwater remediation is the process that is used to remove pollution from groundwater.

- Root Zone Systems are artificially prepared wetlands comprising of clay or plastic lined excavation and emergent vegetation growing on gravel/sand mixtures and is also known as constructed wetland.
- Solar Aquatics System (SAS) treatment is done by a combined action of sunlight, oxygen, bacteria, algae, plants, snails, and fish.

NOTES



The trainer can note down important notes below and discuss them towards the end of the training programme.