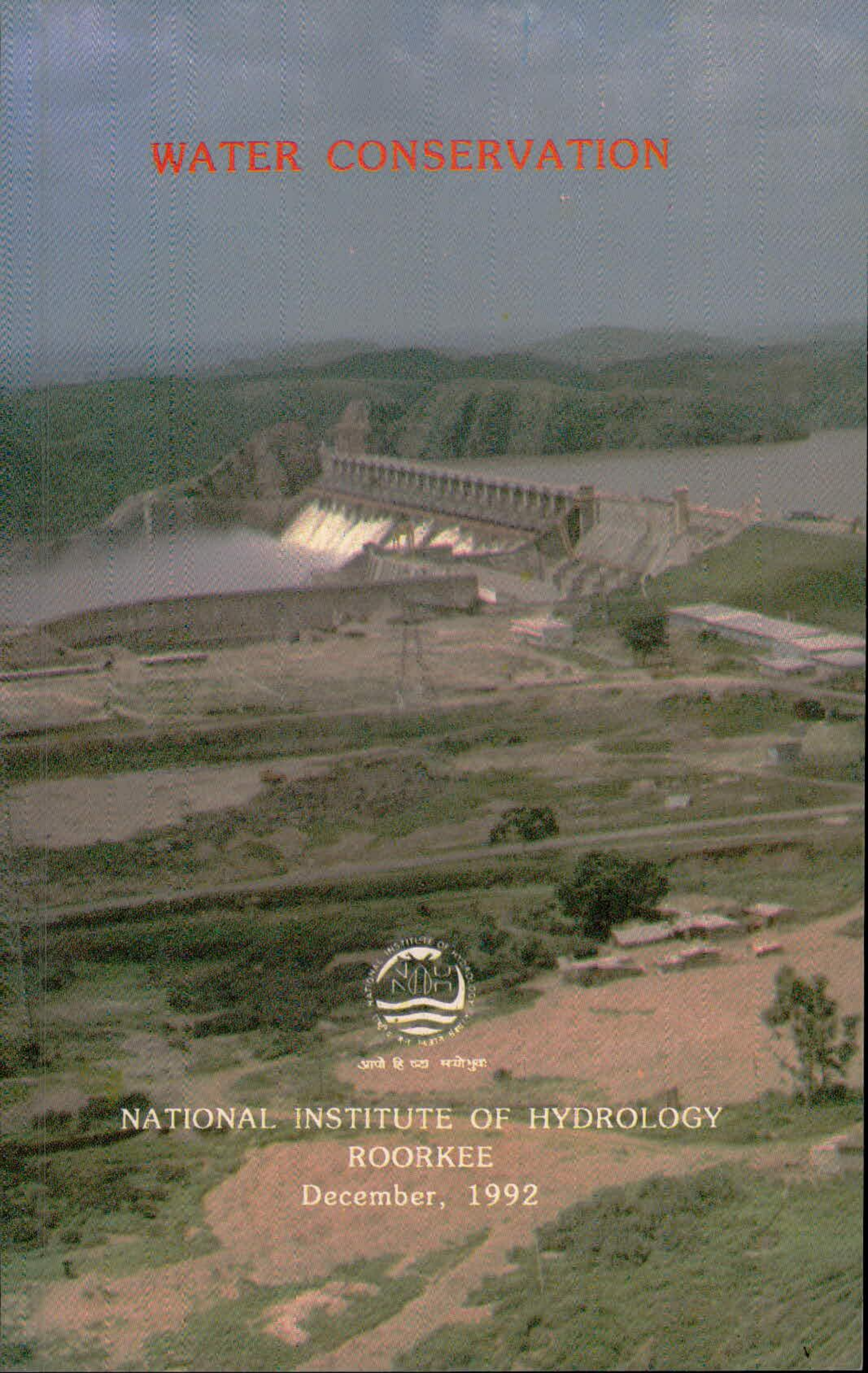
WATER CONSERVATION



आपो हि ष्ठा मयोभुवः

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1.0 INTRODUCTION

India is a rich country in natural resources. A substantial progress has been made in development and management of water resources since independence in the country. The pace of development in the country has led to the exploitation of the water resources in leaps and bounds, resulting in over-use of surface supplies and over exploitation of groundwater. One has to realize the need and importance of conservation of water. Conservation and management of water resources was advocated even in ancient times when there was not much pressure on this resource. This is evident from the following verse as quoted from the Atharva Veda:

> आपो यद् वस्तपस्तेन तं प्रतितपत यो ।
> स्मान् द्वेष्टि यं वयं द्विष्म: ।।
>
> ***Atharva Veda II, 23.1***

i.e. water of river, well, pond etc., if used and managed efficiently will reduce the intensity of drought and water scarcity. Some such strategies of water conservation/ management are described in this pamphlet. Water is used in everything people do; for irrigation, for industry, for power generation, for navigation, drinking, cooling, waste disposal and recreation. The demand for water is continually growing globally at an accelerated pace. The demands for water in various sectors including domestic use, irrigation, energy and industry etc. during year 1990 and projections for year 2000 & 2025 are given table - I. The total quantum of water available on the average may be enough to meet all our demands put together. But its availability is highly irregular. It is not available in places where we want it, at times when we want it and in quantities in which we want it - hence the need for conservation.

Conservation is defined as preservation against loss of waste. Technically conservation of water implies the same meaning in a much wider perspective. Briefly stated it means putting the water resources of the country for the best beneficial use with all the technologies at our command. In other words, surface water running down to sea should be stored to the maximum extent, evaporation and other losses minimised and benefits spread with the sole criteria of maximum benefit to maximum number having due regard to the priorities like drinking, irrigation, industrial use, navigation etc. Water conservation basically aims at matching demand and supply. The strategies for water conservation may be either demand oriented or supply oriented. The strategies may vary depending upon the field of water use-domestic, irrigation or industrial. Some of the supply oriented strategies such as creation of storages, long distance transfer and control of water loss through evaporation are generally common to all the fields of water use, whereas the others may be applicable only to specific field.

TABLE - I DEMANDS FOR VARIOUS SECTORS

Purpose	Demand (km3) in the year		
	1990	2000	2025
Domestic Use	25	33	52
Irrigation	460	630	770
Energy	19	27	71
Industrial use	15	30	120
Others	33	30	37
Total	**552**	**750**	**1050**
-Surface Water	**362**	**500**	**700**
-Ground Water	**190**	**250**	**350**

(Source: Theme Paper on Water Conservation, CWC, 1991)

2.0 CONVENTIONAL MEASURES

2.1 Surface Storages

Storage of water by construction of various water resources projects has been one of the oldest measures of water conservation. A reference from Vrahat Sanhita (550 A.D.) as quoted below describes utility of ponds for effective storage of water.

> पाली प्रागणरायताम्बु सुचिरं धत्ते न याम्योन्त्तरा ।
> कल्लौलैरव दारमेति मरूता सा प्रायश: प्रेरितै: ।।
> तां चेदिच्छति सारदारूमिरपा सम्पातमावांरयेत,
> पाषाणदिभिरेव वा प्रतिचयं क्षुण्णं द्विपा वादिभि ।
>
> ***Vrahat Sanhita, 54.118***

i.e. a pond laid East to West retains water for a long time while one from North to South is spoilt invariably by the waves raised by the winds. To render it stable the walls have to be lined with timber or with stone and the adjoining soil strengthened by stamping and trampling of elephants, horses etc.

> ककुभवगम्रप्लक्षकदम्बै: सनिचुलजम्बूवेतसनीपै: ।
> कुरबकतालाशोकमधूकैर्वकुलविमिश्रेश्चावृततीराम ।।
>
> ***Vrahat Sanhita, 54.119***

i.e. The banks must be shaded by Kakubha, Vata, Amra, Plaksa, Kadamba, Nicula, Jambu, Vetasa, Nipa. Kuravaka, Tala, Ashoka, Madhuka and Bakula Trees.

The scope of storage varies from region to region depending upon water availability, topographic conditions etc. Besides, cost of construction has gone fairly high. On an average the cost of creating irrigation potential by building dams and canals is as much as Rs. 40000 to Rs. 50000 per hectare. The environmental impacts of such storages also need to be examined for developing an environmentally balanced strategy.

2.2 Groundwater Exploitation

Use of groundwater has been practiced from ancient times. Following verses as quoted from Vrahat Sanhita (550 A.D.) will make this aspect clear:

> एकेव बर्षेन रसेन चाम्भश्च्युतं नमस्तों वसुधाविशेषात ।
> नानारसत्वं वहुवर्षतां च गने परीक्ष्यं क्षितितुल्यमेव ।।
>
> ***Varhat Sanhita, 54.2***

i.e. water which falls from the sky originally has the same colour and same taste, but assumes different colour and taste after coming down on the surface of the earth and after percolation.

> चिन्हमपि चार्धपुरूषे मण्डूक: पाण्डुरोश मृत पीता ।
> पुत्भेदकश्च तस्मन् प्राषाणो भवति तोयमध: ।।
>
> ***Varhat Sanhita, 54.7***

i.e. on digging if we will get yellow frog at a depth of half Purusha, then yellow soil, then rocks, certainly then we will get ample amount of water beneath.

3.0 RAINWATR HARVESTING

3.1 Surface Water Conservation

Rainwater harvesting techniques have been used for agriculture in several parts of the world since ancient times. The infrequent rain, if haversted over a large area, can yield considerable amoung of water. The examples of ancient rainwater harvesting involve water and moisture control at a very simple level. It often consits of rows of rocks placed along the contour of slopes. Contour terraces (also known as linear boarders) have been found in use in various parts of world. These are constructed by placing long rows of stones spaced at intervals along the contour of a slope. Runoff captured behind these barriers also allow for the retention of soil, thereby serving as an erosion control measure on gentle slopes. Most contour terraces are located on slopes of less than 25 percent. The field width varies with slope of land. For gentle slopes (1-5%), field width can be of the order of 5-6.5 m while for steeper slopes (10-25 %) it has to be of the order of 2.5 m. (UNEP, 1983). Corrugated galvanised iron roofs have been used to harvest rainwater in many humid and sub-humid regions. For cost effective system, the roofs can be made of tiles which can be produced on a self help basis (Fig 1). The runoff from roof tops is collected in different kinds of storage tanks which can be above or below ground. This kind of water harvesting system is specially suited for areas having rainfall of considerable intensity spread over the large part of the year, e.g. the Himalayan areas, North-Eastern states, Andaman Nicobar islands and Southern parts of Kerala & Tamilnadu. In Meghalaya, the total cost of a roof harvesting system designed for a norm of 10 lit per person per day for 90 days critical dry period for 8 persons household was Rs. 1189 per capita. (Min. of Agril, 1990). In areas where rainfall is scanty and for shroter duration, it is worth attempting the techniques which will induce surface runoff which can be stored for use. Some of these techniques are Surface clearing, Vegetation management, chemical treatment,surface binding treatment, rigid surface covering and fiexible surface covering etc.

3.2 Groundwater Conservation

Groundwater in storage should not be ignored as a long range depletable resource whose development could have major benefits as emergency supplies in water scarce areas. In order to maintain the groundwater resource indefinitely, a hydrologic equilibrium must exist between all water entering and leaving the basin. The techniques of maintaining this equilibrium are discussed in following sections :

3.2.1 Artificial recharge

In water scarce areas, due to low and erratic distribution of rainfall and the consequent increased dependence on groundwater,

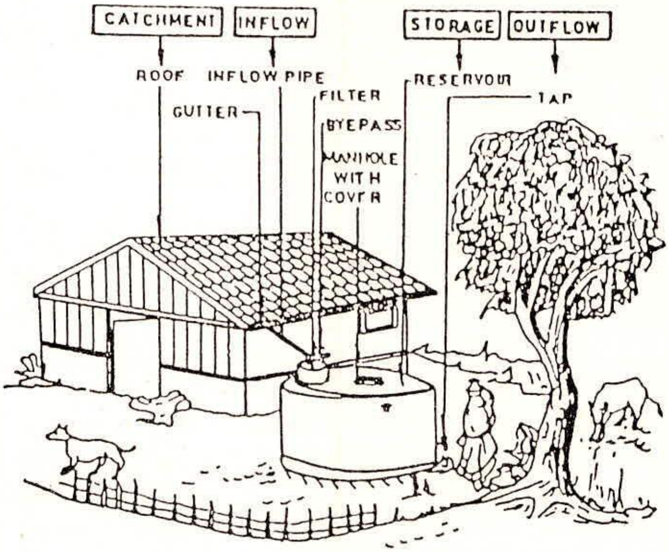

FIG. 1 : RAIN WATER COLLECTION THROUGH ROOFS

the water-table declines quickly. As the main source of groundwater recharge is rainfall, in its absence the only alternative to replenish the groundwater is by artificial means.

In India, studies on artificial recharge have been taken up in the states of Gujarat, Maharashtra, Andhra Pradesh, Madhya Pradesh, Tamilnadu and Kerala. A report of Ministry of Agriculture (1990) indicates that the cost of artificial recharge schemes for domestic water supply works out to be Rs. 0.75-5.0 per head per year which is reasonable espeically in water scarcity areas. Various techniques have been developed to recharge ground water artificially..Water spreading over the ground surface is done to increase area and length of time for water to remain in contact with soil to allow the maximum possible quantity of water to enter into the soil mass. This is most commonly used technique of artificial recharge. The artificial recharge by recharge wells which admits water from surface to fresh water aquifers has also proved effective. The effectiveness of the method depends on the site condition and physical characteristics of soil profile. The selection of recharging site involves consideration of following factors:

- Availability of land and topography.
- Hydrological Condition.
- Possible Sources of water for recharge.
- Operation and maintenance problems.
- Economics Considerations.

3.2.2 Percolation tanks

In many parts of India such as Maharashtra, Andhra Pradesh, Karnataka and Rajasthan, percolation tanks have been constructed across the water courses for artificial recharge. Rao (1979) has reported that in a study carried out in central Maharashtra, the average area of influence of a percolation tank was 1.5 km^2, the average groundwater level rise was 2.5 m and the annual artifical recharge to groundwater from each tank was 15 ha.m. Percolation ponds in steep slopes may be very useful in improving the groundwater table and recharge potential of wells. Results of some studies have established that a chain of percolation tanks may play a vital role in reduction of carbon-di-oxide level in the atmosphere. There is a lot of scope for understanding the concept of percolation pond and its impact on the environment.

Some of the results of the studies on percolation ponds in Tamilnadu are highlighted below:

* It prevents depletion of water table at the existing level by continuous recharging. Maximum distance up to which the influence of percolation ponds in recharging ground water is computed as 1300m, over a width of 1000m.

* The ground water recharge from the percolation ponds is substantial. The net groundwater recharge is about 91.4% of the stored volume in the pond.

* Water level increase in wells situated in the influence zone of the percolation pond range from 3.5 to 12.4 m.

Systematic studies to evaluate zone of influence of percolation tanks and effectiveness in rechanging groundwater are required to be done.

3.2.3 Sub-Surface Dam

Two-third of the Indian sub-continent have hard crystalline rock formation and its groundwater storing and transmitting capacity primarily depends on the fractures and joints of the rocks. Groundwater sanctuary in hard rock areas can be developed by impounding the flow of water by constructing dyke across the flow direction of groundwater. A sub-surface dam across a valley will convert it groundwater sancturaries, water from there can be drawn in the hour of need. Material like clay, bricks and concrete can be used to construct the dykes depending upon the local conditions. Sub-surface dykes of 1 to 4 metres height were found effective in augmenting the ground water resources, particularly in hard rock areas underlain by fractured aquifers.

3.3 Control of Evaporation from Water Bodies

The loss of water from storage structures like reservoirs, irrigation tanks etc. through the process of evaporation causes reduction in storage meant for making water supply as smooth as possible for various usage. A number of approaches/techniques have been developed to reduce evaporation from water bodies. Some of these are:

* Locating reservoirs at high altitudes
* Keeping the lower area/volume ratio of water body
* Minimising exposed surface through reservoir regulation

* Constructing artificial aquifers
* Application of monomolecular film
* Reducing energy available for evaporation
* Installing wind breaks

3.4 Reducing Demand of Water

Water demand may be reduced in agriculture by changes in crops and cropping practices and in industry by changes in technology or product.

3.4.1 Reducing evapotranspiration

Evapotranspiration losses can be reduced by reducing evaporation from soil surface and transpiration by plants. In water scarce areas, where in general low humidity conditions prevail, considerable amount of water is lost by evaporation from soil surfaces. This loss can be prevented by placing water-tight moisture barriers or water retardant mulches on the soil surface. Non-porous materials such as paper, asphalt, latex oil, plastic film or metal foil can also be used for reducing evaporation from soil surface. Conservation of soil moisture is greatly improved by gravel mulches, even by a thick layer of 5-10 mm. Paper and plastic mulches can also be used on the soil surface to reduce evaporation.

Tranpiration losses of plants can be reduced by (i) reducing air movement over a crop by wind breaks (rows of taller plants), (ii) evolving varieties that transpire less, (iii) destroying unwanted plants or unproductive leaves, (iv) enclosing the crops with a structure so that transpired water can be collected and reused, and (v) using chemicals. Anti-transpirants reduce the transpiration by closing stomata, forming a film over stomata and cooling the leaf by reflecting the solar energy.

3.4.2 Adjusting cropping pattern

In areas where water is a scarce resources, the crop selection should be based on their effeciency in utilizing water. Some of the plants suitable for water scarce areas can be

(i) plants having shorter growth period (ii) high yielding plants that require no increase in water supply. (iii) plants that can tolerate saline irrigation water, (iv) plants with deep and well branched roots.

3.4.3 Improving irrigation practices and Irrigation Scheduling

Usual surface irrigation methods are of little use in water scarce areas where high losses of water because of surface evaporation and percolation are experienced. Drip irrigation in which only the adjoining area of plant is irrigated could be suitable method of irrigation in water scarce areas. This method is particularly suitable for row crops, however, because of its high cost of installation and maintenance, drip irrigation is not extensively practiced. In addition to drip irrigation, other methods of irrigation like sprinkler irrigation, sub-surface irrigation could be suitable for water scarce areas. Use of gated pipes for irrigation can save seepage loss of water in field laterals. In this method, instead of laterals, gated pipes are used to carry water to the head end of the field and depending upon the requirement of water, the gates are opened. With improved practices of irrigation, it is also essential to schedule the irrigation properly in order to make proper and effective use of limited water that is available in water scarce areas. Growth stages of crops should be given due consideration in determining water requirements of crops.

3.5 Reuse of Water

After proper treatment, waste water can be used for irrigation, industry, recharging groundwater and even for municipal use. If agricultural lands are located close to the cities, municipal waste water can be easily used for irrigating the crops. Industrial waste water may also be used for irrigation purpose after proper treatment. Municipal waste water can also be used for industrial purposes after treatment. In any reuse scheme, major constituents of waste water like pathogenic bacteria and viruses, parasite eggs, salts and nitrates have to be completely removed.

3.6 Interbasin and within basin water transfer

A broad analysis of water and land resources and the population statistics of various river basins of our country reveals that the areas in the western and peninsular regions of the country have comparatively low water resources/culturable land ratio. The Northern and Eastern regions which are drained by the Ganga and the Brahmaputra, the country's two largest river systems, have substantial water resources. It is because of uneven distribution of water resources, the schemes for diverting waters from regions with surplus water to water deficits regions can be thought of. These transfers have to be properly planned keeping in mind the interests of water users in both the receiving and supplying basins.

3.7 Weather Forecasting

In view of frequent occurrences of drought in the country attention is being paid on making forecast of weather with particular reference to monsoon rains. In fact, making forecast of weather has been in practice in ancient times as is evident from the following verses of the Mayur Chitraka:

> माघे हिमं न पतति वाता वान्ति न च फाल्गुन ।
> न च धूमायितं चैचे घनेर्नभस्ततं न तु ।।
> कारकामाच न वैशाखे शुक्रे चण्डानतो न हि ।
> तदानितुच्छा वृष्टि: स्याद् प्रावृतकाले न संशय: ।।
>
> ***Mayur Chitraka***

i.e. If there is no frost in Magha, no vigorous wind in Phalguna, no clouds in Chaitra, no hailstorm in Vaisakha and no scorching heat in Jyestha, there is insufficient rain in the rainy season.

In recent years successful forecasts have been made by the Department of Science and Technology in respect of monsoon rains. Use of long term weather records and correlation between changes in certain physical features like sea surface temperature with the ensuing weather conditions are being used to forecast weather conditions.. More efforts in this directions are on.

4.0 WATER CONSERVATION IN INDUSTRIES

Only when water scarcity or its cost hurts on industry water conservation practices are thought of. Studies have been done in context of water conservation in a variety of industries to help them fix quotas for water suplies to the large water consuming industries to force them to consider conservation stretegies.

A sound water budgeting in industry can reduce the water demand to a considerable extent. Water Conservation measures in industry should include:

(i) review of alternative production process and technologies from water consumption point of view

(ii) ensuring sound plant maintenance practices and good house keeping, minimising spills and leaks; and

(iii) Optimisation of treatment to achieve maximum recycling.

The adoption of modern manufacturing technologies which inherently requires less water than older technologies it to be properly planned. In almost every industry important changes have come about in the last few years requiring less water per unit of production than before. Notable examples are to be found from major water consuming industries, such as refineries, pulp & paper, distilleries, textiles, fertilisers etc. The dry cooling tower technique is one of the water saving methods that can be attempted.

The ecomomics of industrial water recycling vary greatly from one site to another. In deciding how much to recycle, any industry weights the combined cost of getting water and treating it prior to dispose with those of treating waste water for reuse within the plants. In many of the industries, recycling may offset its cost by recovery of valuable materials such as nickel and chrome. As water and waste water treatment cost go up, recycling will begin to pay (CWC, 1991)

5.0 TIPS FOR WATER CONSERVATION

5.1 Residential Water Conservation

5.1.1 Indoor

Dos:

- ★ Reduce time in shower
- ★ Try soaping up with the shower off
- ★ Turn off water while brushing teeth
- ★ For shaving, fill the sink rather than using running water
- ★ Use minimum water for vegetable cooking
- ★ Close faucets while soaping clothes
- ★ Close faucets while rinsing clothes
- ★ While going outdoor, turn off the main valve for water
- ★ Develop habit of monitoring water meters

Don't

- ★ Don't use excessive water in bath
- ★ Don't use running water for releasing ice tray ahead of time from freezer
- ★ Don't use extra detergent in washing clothes
- ★ Don't use running water while hand-washing clothes

5.1.2 OUTDOOR

Dos:

- ★ Water the lawns early morning
- ★ Try to use waste water of dish washing/cloth cleaning for gardening
- ★ Monitor watering time using available information
- ★ Turn off water a little before watering time and use full water available in hose

- ★ Check leaks in hose

Don'ts:

- ★ Don't allow water to flow into a gutter
- ★ Don't wash floors with a hose. Use a broom
- ★ Don't apply water during hot and windy day
- ★ Don't leave watering pipes on driveways
- ★ Don't water the lawn frequently

5.2 PUBLIC PLACES

Dos:

- ★ Inform local bodies of leaks in water supply system
- ★ Open slowly public taps and close after using
- ★ Use as much water as required
- ★ Close running taps opened by others
- ★ Consider public water loss as personal loss
- ★ Paste water saving instructions at public places

Don'ts ·

- ★ Prevent kids playing with water
- ★ Don't povide high pressure at public taps
- ★ Don't play with public taps by multilating them
- ★ Don't use excessive water at public conveniences
- ★ Don't let water running at public toilets

5.3 AGRICULTURAL FIELDS

Dos:

- ★ Learn to compute water requirements of crops
- ★ Apply as much water as needed
- ★ Vary water application rates with growth of crop
- ★ Choose irrigation system best suiting to crops, soil and climate
- ★ Use sensors to indicate irrigation time
- ★ Recycle tail end water for irrigation
- ★ Level the land properly
- ★ Check joints, couplings properly for leaks

- ★ Provide a good maintenance to irrigation system
- ★ Use lined canals and ensure canals are free from rodent holes
- ★ Maintain records of canal flows
- ★ Use clean water with drip and sprinklers

Don'ts:

- ★ Don't over irrigate the crop
- ★ Don't irrigate randomly rather follow a proper schedule
- ★ Don't let the weeds grow and eat away water
- ★ Don't let the pipe joints/coupling leak
- ★ Don't use wild guess to fix irrigation timings
- ★ Don't breach canals
- ★ Don't consider water as a priceless resources rather think if no water then what and how ?

References

1. Atharva Veda, Bhashye by Pt. Khem Karan Das Trivedi, Sarvadeshik Arya Pratinidhi Sabha, Maharshi Dayanand Bhavan, Ramlila Maidan, New Delhi.

2. CWC, (1991), Theme paper on Water Conservation, Water Resources Day, April 1991.

3. Mayurchitaka (Nardiya) Manuscript kept at Saraswati Bhavan library of Sampuranand Sanskrit University, Varanasi, Requoted from 'Hydrology in Ancient India' Publication of National Institute of Hydrology, Roorkee,

4. Ministry of Agriculture (1990), 'Rainwater Harvesting', Govt. of India, Deptt. of Rural Development, New Delhi, India.

5. Rao, R.V. (1979), 'Drought Mitigation Measures for Drought Prone Areas in A.P., Proc. Int. Symp. on Hydrologic Aspects of Drought, Dec. 2-7, 1979, New Delhi, India.

6. UNEP (1983), 'Rain and Storm Water Harvesting in Rural Areas', Published by Tycoaly Inst., Ltd., Dublin, Ireland.

7. Vrahat Sanhita (550 A D) by Varahamihira, Edited and Bhasya by Pt. Achyutananda Jha, Chow Khemba Vidyabhavan, Varanasi, 1988.