# CHAPTER 13

## WATER RESOURCES AND TYPES OF IRRIGATION

# WATER RESOURCES IN INDIA

## Surface water

- It is unevenly distributed.
- It is available to us in form of rivers, lakes, tanks, ponds, and other water bodies.
- Rivers are the most important source of surface water in India. Example: Indus, Ganga, Godavari, Narmada.

## Groundwater

- Rainwater percolates in the ground through joints and cracks in the rocks and is known as groundwater.
- The distribution of groundwater is uneven and mostly depends on the structure of rocks, surface configuration and amount of rainfall.

Example: The Northern Plains of India has high levels of ground water than that of

## Lagoons and backwaters

- These are generally found along the coastline.
- They generally have brackish water
- It is used for fishing, and irrigating certain varieties of paddy crops,coconuts, etc.

## WATER DEMAND AND UTILISATION

India is basically an agricultural country where nearly two-third of the total population depends upon agriculture. Thus, to increase the agricultural output, the irrigation has been given high priority in Five Year Plan and multipurpose projects like ***Bhakra Nangal*** , ***Hirakud*** , ***Damodar Valley*** , ***Nagarjuna Sagar*** , etc. has been taken up.

## EMERGING WATER PROBLEMS :

### DETERIORATION OF WATER QUALITY.

There are several problems regarding the water resources. The main problems of water resources are its availability, use, quality and management.Water quality refers to purity of water, or water without unwanted foreign substances. Water gets polluted by foreign matters such as micro-organisms, chemicals,industrial and other wastes. Such matters deteriorate the quality of water and render it unfit for human use. Quality of water suffers from its large scale pollution almost throughout the country. Most of the rivers are carrying polluted water. These wastes are both, solids as well as insoluble form. Cities and towns generate a lot of sewage. Most of this sewage is dumpedinto water courses without any treatment rendering the natural water coursedownstream unfit for drinking and even for bathing. Large scale pollution of rivers is turning them into septic drains posing serious threat to the health of millions of people.

# CONSERVATION OF WATER RESOURCES

Conservation of water resources has become very essential due to its short supply,increasing demand, large scale pollution and its uneven distribution in time and space.Following three steps are necessary for conservation of water resources.

(1) Developing water-saving technologies and methods.k

(2) Preventing pollution of water.

(3) Encouraging watershed development, rainwater harvesting, water recycling andreuse, and conjunctive use of water for sustaining water supply in long run.

## Prevention of water pollution.

Both surface and groundwater are polluted in most parts of the country. The **Central Pollution Control Board (CPCB)** in collaboration with **State Pollution Control Boards** has been monitoring water quality of national aquatic resources at 507 stations. According to their investigations, organic and bacterial contamination are the major caused of pollution of river waters. The Yamuna river is the most polluted river inthe country between Delhi and Etawah. Other severally polluted rivers are-theSabarmati at Ahmedabad, the Gomti at Lucknow.

Similarly, groundwater is also polluted primarly *due to high concentrations of heavy/toxic metals, fluoride and nitrates at different parts of the country.* The government made several legislative provisions for preventing water pollution. Some such provision are **Water (Prevention and Control of Pollution) Act 1974, and Environment Protection Act, 1986**. Unfortunately these provisions have not been implemented effectively. Consequently the 251 polluting industries were located on the banks of rivers and lakes in 1997. The **Water Cess Act, 1977** was passed with the primary aim to reduce pollution. This has also made little impact.

## Recycle and Reuse of Water

Availability of freshwater can be improved by recycling and reusing water.

- The water of inferior quality( which are claimed as wastewaters), can be used in industries for cooling and fire fighting.
- In urban areas, water after bathing, washing utensils, and vehicles can be used for gardening.

There are vast possibilities of replenishing water through recycling.

# Watershed Management

Watershed is a geographic area that drains to a common point, which makes it ideal for planning units for the conservation of soil and water. It may comprise one or several villages; contain both arable and non-arable lands, various categories of landholding and farmers. The watershed approach enables holistic development of agricultural and allied activities, such as horticulture, agroforestry and, silviculture (forests).The Central and State Governments, as well as some non-government organisations, are working on watershed development programmes. One such programme is **Haryali** which is sponsored by the Central Government. Its primary aim is to help the rural people in conserving water for drinking, irrigation, fisheries and afforestation.

*Neeru-Meeru*( Water and You) in Andhra Pradesh and *Arvary Pani* in Alwar district of Rajasthan) are two major programs of water harvesting. Tamil Nadu is one state which made it mandatory to have water harvesting in the houses.

# Rainwater Harvesting

Rain water harvesting is a technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff).

OBJECTIVES OF RAINWATER HARVESTING

1. meet the ever increasing demand for water,
2. reduce the run-off which chokes drains,
3. avoid the flooding of roads,
4. augment the groundwater storage and raise the water table,
5. reduce groundwater pollution,
6. improve the quality of groundwater.

# National water policy

This policy has stipulated water allocation priorities in definite order which is drinking water,imgation, hydro-electric generation, industrial and other miscellaneous uses. It also emphasised onnew approaches to water management. Its key features are as under:

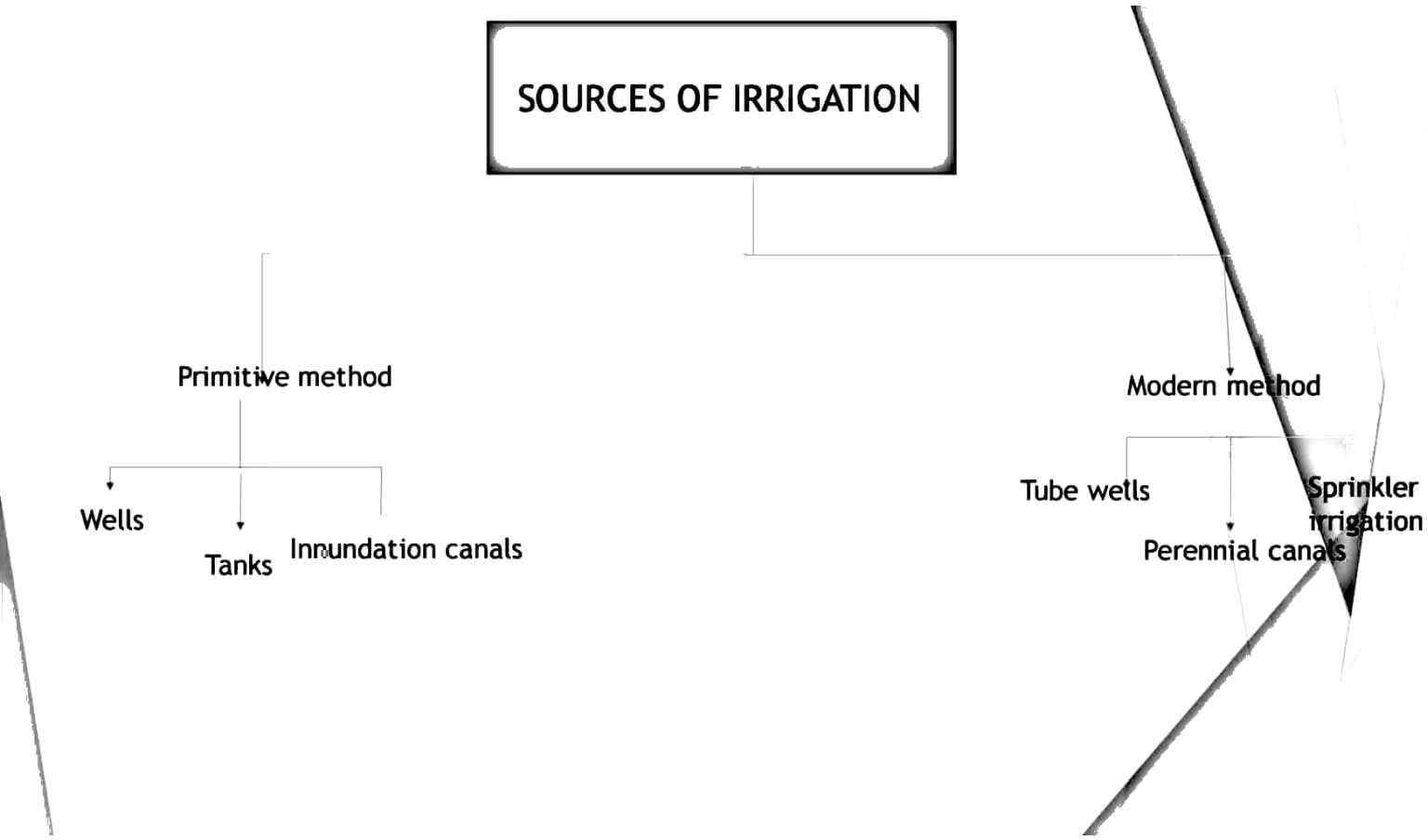
- irrigation and multi-purpose projects should invariably include drinking water component,wherever there is no alternative source of drinking water.
- Providing drinking water to all human beings and animals should be the first priority.
- Measures should be taken to limit and regulate the exploitation of groundwater.
- Both surface and groundwater should be regularly monitored for quality. A phased programmeshould be undertaken for improving water quality.

# IRRIGATION IN INDIA

The process of supplying water to crops by artificial means such as canals, wells, tube-wells, tanks, etc. from the sources of water such as rivers, tanks, ponds or underground water is called irrigation.

## NEEDS FOR IRRIGATION

- Uneven Spatial Distribution of Rainfall.
- Uneven Temporal Distribution of Rainfall.
- High Rainfall Variability.
- Uncertainty of Rainfall.
- Nature of crops.
- High yielding crops.
- Long growing period.
- Increase in productivity.



# Well irrigation.

A well is hole dug in the ground to obtain subsoil water. The well irrigation is used in India where sufficient, sweet groundwater is available. This includes a large part of the Great plain, the deltaic regions of the Mahanadi, the Godavari ,etc. The largest concentration is found in three states of Uttar Pradesh, Rajasthan and Madhya Pradesh.

ADVANTAGES

- Well is simplest and cheapest source of irrigation and the poor Indian farmer can easily afford it.
- Well is an independent source of irrigation and can be used as and when the necessity arises. Canal irrigation, on the other hand, is controlled by other agencies and cannot be used at will.
- Excessive irrigation by canal leads to the problem of *reh* which is not the casewith well irrigation.
- There is a limit to the extent of canal irrigation while a well can be dug at any convenient place.

DISADVANTAGES

- Only limited area can be irrigation. Normally, a well can irrigate 1 to 2 hectares of land.
- The well may dry up and may be rendered useless for irrigation if excessive water is taken out of it.
- In the event of a drought, the groundwater level falls and enough water is not available in the well when it is needed the most. Some of the wells go completely dry and become unfit for irrigation.
- Well irrigation is not possible in areas of the brackish groundwater.

# Tank irrigation.

A tank consist of water storage which has been developed by constructing a small bund of earth or stones built across a stream.The tank irrigation is popular in the peninsular plateau area of India where Andhra Pradesh, Telangana and Tamil Nadu are the leading states.Andhra Some tank irrigation is done in some other states like Maharashtra, Rajasthan, Jharkhand,Bihar, Bundelkhand area of Uttar Pradesh, West Bengal, Odisha and Kerala.The tank irrigation is practised mainly in the peninsular India due to the following reasons.The undulating relief and hard rocks make it difficult to dig canals and wells.

Most of the rivers of this region are seasonal and dry up in summer season.Therefore, they cannot supply water to canals throughout the year. There are several streams which become torrential during rainy season. The only way to make best use of this water is to impound it by constructing bunds and building tanks. Otherwise this water goes waste to the sea.The scattered nature of population and agricultural fields also favours tank irrigation.

**ADVANTAGES**

1. Most of the tanks are natural and do not involve heavy cost for their construction.Even an individual farmer can have his own tank.
2. Tanks are generally constructed on rocky bed and have longer life span. In many tanks, fishing is also carried on. This supplements both the food resources and income of the farmer.

**DISADVANTAGES**

1. Many tanks dry up in dry season.
2. Silting of the tank bed is a serious problem.
3. Much water is evaporated.

## Innundation canals

These canals are taken out from the rivers without any regulating system like wires etc. at their head. Such canals provide irrigation mainly in the rainy season when the river is in flood and there is excess water. When the rainy season is over, the flood in the river subsides, the level of water falls below the level of the canal head and the canal dries up. Some canals taken off from the Satluj in Punjab are of this type. Since irrigation from this type of canals is uncertain, they have been converted into perennial canals.

# Tube wells

A tube well is a deeper well (generally over 15 metres deep) from which water is lifted with the help of a pumping set operated by an electric motor or a diesel engine. Obviously, a tube-well cannot be constructed everywhere and requires some geographical conditions favouring its installation.

The main factors of building tube wells are:

- There should be sufficient quantity of ground water because a tube-well generally irrigates 2 hectares per day against 0.2 hectares per day irrigated by an ordinary well.
- The water level sshould be nearly 15 metres. If the water table is more than 50 metres deep the cost of pumping out water from the tube-well becomes uneconomic.
- There should be a regular supply of cheap electricity or diesel so that water from the tube-well can be taken out at the hour of need.
- The soil in the immediate neighbourhood of the tube-well should be fertile so that there is a demand for irrigation and the cost involved in the construction and operation of the tube-well can be recovered by the increased farm production.

Uttar Pradesh, Rajasthan,Madhya Pradesh, Punjab, Gujrat, Bihar, etc. are some of the states which practices Tube-well irrigation.

# Advantages and disadvantages of Tube-well irrigation.

T dvantages of Tube-well Irrigation

1. A tube-well can irrigate about ten times more area than an ordinary well.
2. It is operated by an electric motor or by a diesel engine and water can be easily lifted from greater depths.
3. It is the most suitable source of irrigation in areas where canal irrigation is not available.
4. A tube-well is an independent source of irrigation and can be used by the farmer whenever the crops need water.
5. Several chemicals are mixed with tube-well water. Such chemicals add to the fertility of the soil.

Disadvantages of Tube-well Irrigation

1. Although it can irrigate much larger area than an ordinary well ; yet a tube-well can irrigate only a limited area which much less than the area irrigated by canals.
2. The farmer has to spend money regularly on electricity or diesel.
3. This source of irrigation is not fit for areas of brackish ground water.
4. A tube-well can draw much larger quantity of water. Thus the ground water level goes down and large scale depletion of ground water takes place. The ground water level has already gone critically down in several areas of Punjab and Haryana where rice culture, requiring larger quantities of water, has become popular during the last few years.
5. In the event of a drought the ground water level falls critically below therequired level and the water is not available when it is needed the most.

## CANALS

Canals can be an effective source of irrigation in areas of low level relief, deep fertile soils, perrenial source of water and extensive command area. Therefore, the main concentration of canal irrigation is in the northern plain of India, especially the area comprising Punjab, Haryana and Uttar Pradesh. The digging of canals in rocky and uneven areas is difficult and uneconomic. Thus the canals are practically absent from the Peninsular plateau area. However, the coastal and the delta regions in South India do have some canals for irrigation.

# Uttar Pradesh

Canals constitute an important source of irrigation in Uttar Pradesh. The state is drained by perennial rivers originating in the snow covered Himalayan ranges and is blessed with fertile soils. But the amount of rainfall, especially in western parts of the state, is not sufficient for sustained agricultural growth. Therefore, a large number of canals have been constructed to provide regular supply of sufficient water to the crops.Uttar Pradesh about 2,756 thousand hectares under canal irrigation which is 18.05 per cent of the total canal irrigated area of country. Over one-fourth of the net irrigated area of the state is irrigated by canals. Following are the main can

**1.UPPER GANGA CANAL :** This Canal takes off from the Ganga at Kankhal (Haridwar) Uttaranchal. The construction of this canal commenced in 1842 and completed in 1854. The main c is 342 km long while the length of its distributaries is about 6,200km. During the first 32 km of its course, between Haridwar and Roorkee, it passes through a broken country so that at some places taken over the rivers and at othersbelow the rivers. It irrigates about 7 lakh hectares of land in th upper part of the Ganga-Yamuna Doab. Districts of Saharanpur, Meerut, Ghaziabad, Bulandshahar Aligarh, Mathura, Etah, Kanpur, Mainpuri, Farrukhabad and Fatehpur get benefit fromthis canal. I branches are Devbandh Anupshahar, Motta and Hathnras. It is joined with the Lower Ganga Canal Mainpuri and the water in this canar is considerably increased. Further beyound, these two cana separately.

## 2.LOWER GANGA CANAL

This canal was taken from the Ganganear Narora (Bulandshahar) in1878. The length of the canal including its distributaries is about 6000 km. Its main branches are Etawah, Kanpurand Fatehpur. It irrigates about 4.6 lakh hectares in the districts of Bulandshahar, Aligarh,Farrukhabad,Aligarh, Etah, Fatehpur,Kanpur and Allahabad.

## PUNJAB

Canal irrigation accounts forover 20 per cent of the totalirrigated area in Punjab and formsthe basis of agricultural prosperityin the state. Following are some ofthe important canals of Punjab.

1.UPPER BARI DOAB CANAL :Thiscanal is taken from the Ravi riverat Madhopur near Pathankot.Construction of this canal startedin 1849 and completed in 1859. Itirrigates about 3 lakh hectares inGurdaspur and Amritsar districts.

# SIRHIND CANAL

This canalwas taken from the Satluj river atRupnagar (Ropar) in the year1886-87. The total length of thecanal along with its distributariesis 6,115 km. Its main branches arethe Patiala, Abohar, Bhatinda,Kotla and Ghaggar. It irrigates about 7 lakh hectares in Patiala, Sangrur, BhatindaLudhiana and Ferozepur districts. The Kotla and the Ghaggar branches provideirrigation to Hissar and Sirsa districts of Haryana also. In order to augment the supplyof water, the Sirhind Feeder Canal was completed in 1960. It takes off from theFerozepur Feeder at its 18th km. at Malanwala. It is 142 km long and supplies water toAbohar branch of the Sirhind Canal. This water is drawn from the Satluj and Beas riverswhich used to go unused to Pakistan. It also provides irrigation to Ferozepur, Faridkotand Muktsar districts in Punjab and to some parts of Rajasthan.

# HARYANA

Haryana depends upon canal irrigation for its agricultural prosperity to a great extent. About half of the irrgated area irrigatedna is irrigated by canals. This is the highest percentage for any state.Following are the main canals.

## 1.THE WESTERN YAMUNA CANAL.

It takes off from the right bank of the Yamuna at Tajewala.It was built by Feroze Shah Tughlak in the 19th century. The total length of the canal along with its distributaries is 3,200km. and it irrigates about 4 lakh hectares in Ambala, Karnal,Kurukshetra, Kaithal, Rohtak,Hissar and Jind districts. Its important branches are, the Delhi, the Hansi and Sirsabranch.

## BHAKRA CANAL

After irrigating Punjab areas, the Bhakra canal enters Haryana near Tohana and irrigates large parts of Hissar, Fatehabad and Sirsa districts. Its main branches Canal. Its main branches are the Fatehabad, the Ratia, the Rori, the Barwala and theTohana branch.

## ANDHRA PRADESH

Canals irrigate about 37.3 per cent of the net irrigated area of Andhra Pradesh. Here inadequate rainfall, level and fertile plain facilitate the development of canal irrigation in the state. Important canals are as follows:

**1. GODAVARI DELTA PROJECT CANALS**-The Godavari delta project comprises two-weirs-the Dolaishwaram and the Ralli. From these, right bank and delta canals have been taken out to irrigate about 4.5 lakh hectares of land. These canals were completed in 1846.

2. **KRISHNA DELTA CANALS**-The Krishna irrigation system originates from the dam built across the river near Vijayawada. It was completed in 1853. It irrigates about 4.5 lakh hectares of agricultural land. The system includes Vijayawada anicut, Sunkesula anicut and Tungabhadra canals.

**Bihar** Rainfall in several parts of Bihar is inadequate, unreliable and uncertain leading tosevere and frequent droughts. This has made canal irrigation an important part ofagricultural practice in Bihar. Canal irrigation accounts for over one-fourth of the totalirrigated area of the state.

1. **SONE CANALS.** The Eastern Some Canal was taken from the Sone river at Varun in1857. This 130 km. long canal irrigates 2.5 lakh hectares in Patna and Gaya districts.The Western Sone Canal has been taken from this river at Dehri. It provides irrigation toShahabad district.
2. **KOSI CANALS.** Two canals known as the Eastern and the Western Kosi Canal havebeen taken from the eastern and the western banks of the river respectively byconstructing a multipurpose dam near the Indo-Nepal border. These two canals have theirrigation potential of 4.5 and 3.5 lakh hectares respectively. Purnea, Muzaffarpur,Darbhanga, Champaran and Saran districts are benefited by this project. Besides, 4 lakhhectares are irrigated in Nepal.

# WEST BENGAL

West Bengal is a humid state where little irrigation is practiced. Only south-western part of the state needs some irrigation. The state has 37.5 per cent of its net irrigated area under canal irrigation. Important canal systems are as follows:

**1. DAMODAR PROJECT CANALS-** Under the Damodar Valley Corporation a 692 meter long and 12 meter high barrage has been built up from which two canals have been taken out. The right bank canal is 89 km long and it irrigates about 4.2 lakh hectares of land in Hugli, Asansol and Barddhaman districts. The left bank canal is 137 km long and is used for navigation.

**2. MAYURAKSHI PROJECT CANALS-** a barrage (640 meter long and 47.24 meter high) has been constructed across the Mayurakshi River, a tributary of the Hugli River, near Marsanjor (Birbhum) in 1951 from which two canals have been constructed which irrigate 2.51 lakh hectares of land in Birbhum, Murshidabad and Barddhaman districts.

# RAJASTHAN

**1. INDIRA GANDHI CANAL.** It originates from Harike barage near the confluence of the Satluj and the Beas rivers in Ferozepur district of Punjab. The plan for this canal was prepared in 1957-58 and the work on this project started on 31st March, 1958. The canal does not do any irrigation in Punjab and is known as Rajasthan Feeder. The length of the Rajasthan Feeder is 204 km. The project is being executed in two stages. Stage I envisages the construction of 204 km long feeder, 189 km of the main canal and 2,960 km long distribution system. Nearly 4.79 lakh hectares of land is provided with flow irrigation and 0.46 lakh hectares get lift irrigation. The construction work on Stage II isstill in progress. It includes construction of 256 km. long main canal and 4,800 km long distributaries. When completed this stage of the project will provide flow irrigation to 7 lakh hectares and lift irrigation to 3.12 lakh hectares. Districts of Ganganagar,Hanumangarh, Jodhpur, Bikaner and Jaisalmer will be benefited from this project.

**2. CHAMBAL PROJECT.** This is a joint venture of Rajasthan and Madhya Pradesh.Under this project, Gandhi Sagar Dam has been constructed. Canals taken off from this dam irrigate about 5.15 lakh hectares in Rajasthan and Madhya Pradesh. In the second stage, Rana Partap Dam has been constructed which provides irrigation to 1.2 lakh hectares. In the third stage Jawahar Sagar Dam will be constructed.

## ODISHA

1.HIRAKUD PROJECT CANALS-under the project a 4,801.2 meter long dam (largest in the world) has been constructed across Mahanadi near Sambalpur which impounds 8,100 million cubic meters of water. Three canals have been constructed which irrigate about 3 lakh hectares of land in Sambalpur, Puri, Bolangir and Cuttack districts.

2. MAHANADI DELTA CANALS-Canals of the Mahanadi Delta Scheme provide irrigation to about 5.49 lakh hectares of land in Cuttack and Puri distrticts. The scheme was completed in 1975.

# KARNATAKA

In Karnataka canal irrigation contributes 41.3 percent of the net irrigated area. Most of these canals have been taken out from the Krishna and Kaveri rivers. Main canals are as follows:

1. GHATAPRABHA PROJECT CANALS-This project involves three stages leading to the construction of dams across the Ghataprabha river at Dhupdal and Hidkal, 114 krri long canal along the east side, 197 km long canal along the west side and creation of irrigation facilities for 3.18 lakh hectares of agricultural land in Belgaum and Bijapur districts.

2. TUNGABHADRA PROJECT CANALS-under the project dams have been built across the Tungabhadra and Tung rivers to lay down canals which irrigate 4.97 lakh hectares of land in Bellary, Raichur, Chikmagalur and Shimoga districts.

# TAMIL NADU

Major part of Tamil Nadu enjoys rainfall during winter season while summer remains dry. This requires irrigation to make up the deficiency of rainfall. Canal irrigation is popular in deltaic and coastal areas accounting for 29 per cent of the net cropped area.

1. KAVERI DELTA CANALS-The Kaveri delta has the oldest and the longest (6,400 km) irrigation canal system in the state. These canals taken off from the Grand Anicut (built in 1889) irrigates about 5.15 lakh hectares of land in Thanjavur and Tiruchchirappalli districts.

2. METTUR CANAL SYSTEM-these canals taken out from the Kaveri River (Mettur dam) provide irrigation to 1.8 lakh hectares of land in Salem and Coimbatore districts

# MAHARASTRA

In Maharashtra there is dearth of major irrigation projects. Instead there are small irrigation projects. Canals contribute 20.9% of the net irrigated area of the State.

1.MUTHA CANAL PROJECT-under this project a barrage has been built across the Mutha river (in 1879) at Khadakvasla from which two canals have been taken out. The right bank canal (112 km) irrigates about 45,000 hectares of land in Pune district, while the left bank canal supplies drinking water to Pune and Kirkee.

2. GODAVARI CANALS-these canals (length 200 km) originating from a barrage built across the Godavari river irrigate about 57,000 hectares of land in Ahmadnagar and Nashik districts.

# MERIT & DEMERITS OF CANAL IRRIGATION

Merit:

- Un-irrigated wastelands can be developed by canal irrigation, which would increase the quantity of biomass in the area.
- Economic development can be expedited by avoiding dangerous droughts. Dependence on rainfall can be minimized through canal development.
- Canals are fed by rain water received by rivers, and the water is used for irrigation. Production of crops needing more water is also possible through canals. As compared to un-irrigated soils, higher productivity per hectare is also possible due to canals.
- Canal system is a permanent structure, hence only maintenance is required for getting its benefits for a long time.
- Canals are multi-purpose where apart from irrigation hydro electricity generation, navigation, drinking water supply and fishery development is also done.
- Groundwater level does not go down on account of canal irrigation, but on the contrary water level increases, which facilitates digging of wells.

Demerits:

- Many diseases are caused due to spread of mosquitoes, worms and insects on account of stationary water in canals.
- Sometimes efficient canal management results in excessive production of crops, due to which the farmers are not able to get suitable price for their product in the market.
- Due to shortage of water in inundational canals, crops are destroyed for want of water for irrigation.
- Due to excessive economic investment, it is not practicable to provide canal irrigation to all areas. Construction of canals also takes more time.

# SPRINKLER IRRIGATION

Sprinkler Irrigation is a method of applying irrigation water which is similar to rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air and irrigated entire soil surface through spray heads so that it breaks up into small water drops which fall to the ground.

Sprinklers provide efficient coverage for small to large areas and are suitable for use on all types of properties. It is also adaptable to nearly all irrigable soils since sprinklers are available in a wide range of discharge capacity.

# DANGERS OF OVERWATERING

In some parts of India, water meant for irrigation is not properly utilised. Farmers tend to flood their fields with water with an intention of getting a bumper crop. This happens especially in areas of canal irrigation where the farmer wants to get the maximum benefit from the money he has spent to use the facility of canal irrigation. In the process he indulges in over-watering the fields. Over watering leads to serious problems of soil salinity and alkalinity. Alternately, with intensification is canal irrigation water-table rises sufficiently and once the water-table is within 2 metres it is likely to act as continuous source of soluble salts in the soil profile. Soluble salts have generally accumulated at some depth in the profile but in areas where irrigation has not been well managed, surface accumulation of salts is a common feature. The chief salts in these soils include chlorides and sulphides of sodium and calcium and to a much less degree carbonates. Irrigation, instead of being an agency for creation of new agricultural development, has brought about devastation in large tracts of land in India by waterlogging and salinity. It is a creeping paralysis that has taken hold of large tracts in canal irrigated areas, which may become a galloping paralysis if not tackled, effectively, efficiently and quickly. The increasing salinity and alkalinity indicated the extension of the waterlogging (*sem*), saltincrustation (saline afflorescence) or *thur* tendencies. The sandy soils are more alkaline and loamy soils are saline-alkaline. Large areas, once fertile and productive, have become impregnated with salts locally known as *reh* or *kallar* with highly deleterious effect on cultivation. Gypsum, sand, green manuring and leaching are many amendments for kallar or thur or usar soils.