

Module

3

Irrigation Engineering  
Principles

# Lesson 1

## India's Irrigation Needs and Strategies for Development

## Instructional Objectives

On completion of this lesson, the student shall come to know about the following:

1. How can the development in irrigation be sustainable
2. What are the basic requirements of irrigation and how can they be managed
3. What are irrigation schemes and how are they classified
4. What has the nation planned about irrigation
5. What are Command Area development and participatory Irrigation Management
6. How can water be managed for irrigation
7. What should be the rationale for pricing irrigation water
8. How has irrigation progressed through ages in India

### 3.1.0 Introduction

It is known fact that India has a very large population and different studies show that it will continue to rise at least till 2050 A.D. The United Nations publication “Sustaining Water - An Update”, published in 1994 indicates that the population of India by that time could vary between 1349 million (low projection) and 1980 million (high projection), with a medium projected figure as 1640 million. At present the country’s food grain availability is around 523 grams per capita per day (though it varies significantly with the economic level). In China and USA, the corresponding figures are 980 grams and 2850 grams respectively. Assuming a population figure of 1800 million by 2050A.D, and a small rise in per capita consumption of food grain at about 650 grams, the annual requirement of the country would be around 430 million tonnes. The present productivity of irrigated land is about 2.5 tonnes/hectare and less than 0.5 tonnes/hectare for rainfed lands. Assuming that these levels can go up to 3.5 and 1.0 T/ha respectively by 2050 AD (which should be the urgent needs that has to be addressed to by the water resource engineer), it is imperative that the irrigation potential of at least 130 million hectare is created for food crop alone and 160 million hectare for all crops to be able to meet the demands of the country by 2050 AD.

Since the land and water resource of any country is not going to change much over the years, the water resource planners have to make cautious decisions on optimizing the available resources for maximum benefit. In the next section, we look into the options available and the decisions that may be taken.

### 3.1.1 Sustainable development in Irrigation

For the survival of the country, there is an urgent need to implement and plan irrigation strategies for now, and in future, as the population continues to grow. But that should not be at the cost of degradation of the present available resources of land and water, which means the natural resources that we have, should more or less remain the same

after 50 or 100 years and beyond. This concept is termed “**sustainable**”, which was not much of a problem earlier when compared to the resources the demand was less. But now it is reversed and for devising any planning strategy the constraints have to be kept in mind. As an example, the utilization of ground water may be cited. In many regions of India, there has been alarming withdrawal of ground water for meeting demands of irrigation and drinking water demand than that which can be naturally recharged. This has led to rise of further problems like arsenic and fluoride contamination. Since ground water recharge by natural means takes a long time, perhaps years and even decades, there is little hope of regaining the depleted table near future.

Next we look into the options available to the irrigation engineer for development of irrigation facilities within the constraints.

### 3.1.2 Future directions

The question that is to be resolved is this: Are we capable of producing the required amount of food grain for the country? Apart from spreading the network of irrigation system further into the country, there is an urgent need on research- for better seeds, better water management and distribution practices, low cost fertilizer etc., Nevertheless, the possible options available to water resource engineer to meet the future irrigation and food requirement may, therefore, include evaporation control and reduction and losses during conveyance of water through channels, recycling of water, inter basin transfer, desalination of sea-water in coastal areas, rainfall by cloud seeding, improved technology, etc. Loss of top soil due to erosion in one of the forms of degradation which can be contained on a limited scale but problems of salinity, alkalinity, water logging, etc. reduce the productivity. The future lies in considering and bringing under cultivation additional area and considering intensified production on existing good agricultural land and water resource system optimization.

### 3.1.3 Constraints of land and water

The total geographical area of land in India is about 329 million hectare (M-ha), which is 2.45% of the global land area. The total arable land, according to an estimate made by the Food and Agricultural Organization (FAO), made available through the web-site **Aquastat**, is about 165.3 M-ha which is about 50.2 % of the total geographical area (the average world figure is 10.2%). The web-site that may be checked for this and relevant data is that of FAO:

**<http://www.fao.org/ag/aql/aqlw/aquastat/countries/india/index.stm>**

India possesses 4% of the total average annual run off in the rivers of the world. The per capita water availability of natural run off is at least 1100 cubic meters/yr. The utilizable surface water potential of India has been estimated to be 1869 cubic kms.but

the amount of water that can actually be put to beneficial use is much less due to severe limitations imposed by physiographic, topographic, interstate issues and the present technology to harness water resources economically. The recent estimates made by the Central Water Commission indicate that the water resources utilizable through surface structures is about 690 cubic kms only (about 36% of the total ground water is another important source of water).

Ground water is another important source of water. The quantum of water that can be extracted economically from the ground water aquifers every year is generally known as ground water potential. The preliminary estimates made by the Central Ground Water Board indicate that the utilizable ground water is about 432 cubic km. thus the total utilizable water resource is estimated to 1122 cubic km. It must be remembered that this amount of water is unequally spread over the entire length and breadth of the country.

Of the total 329 M-ha of land, it is estimated that only 266 M-ha possess potential for production. Of this, 143 M-ha is agricultural land. It is estimated that 85 M-ha of land suffers from varying degrees of soil degradation. Of the remaining 123 M-ha, 40 M-ha is completely unproductive. The balance 83 M-ha is classified as forest land, of which over half is denuded to various degrees.

It is alarming to note that the percapita availability of land is half of what it used to be same 35 years ago. This would further reduce as our country's population continues to grow. At present 141 M-ha of land is being used for cultivation purposes. Between 1970-71 and 1987-88 the average net sown area has been 140.4 M-ha. The need for production of food, fodder, fibre, fuel in the crop growing areas have to compete with the growing space required for urbanization. The factors of land degradation, like water logging, salinity, alkalinity and erosion of soils on account of inadequate planning and inefficient management of water resources projects will severely constrain the growth of net sown area in the future.

### 3.1.4 Benefits of irrigation

With the introduction of irrigation, there have been many advantages, as compared to the total dependence on rainfall. These may be enumerated as under:

- 1. Increase in crop yield:** the production of almost all types of crops can be increased by providing the right amount of water at the right time, depending on its shape of growth. Such a controlled supply of water is possible only through irrigation.
- 2. Protection from famine:** the availability of irrigation facilities in any region ensures protection against failure of crops or famine due to drought. In regions without irrigation, farmers have to depend only on rains for growing crops and since the rains may not provide enough rainfall required for crop growing every year, the farmers are always faced with a risk.

3. **Cultivation of superior crops:** with assured supply of water for irrigation, farmers may think of cultivating superior variety of crops or even other crops which yield high return. Production of these crops in rain-fed areas is not possible because even with the slight unavailability of timely water, these crops would die and all the money invested would be wasted.
4. **Elimination of mixed cropping:** in rain-fed areas, farmers have a tendency to cultivate more than one type of crop in the same field such that even if one dies without the required amount of water, at least he would get the yield of the other. However, this reduces the overall production of the field. With assured water by irrigation, the farmer would go for only a single variety of crop in one field at anytime, which would increase the yield.
5. **Economic development:** with assured irrigation, the farmers get higher returns by way of crop production throughout the year, the government in turn, benefits from the tax collected from the farmers in base of the irrigation facilities extended.
6. **Hydro power generation:** usually, in canal system of irrigation, there are drops or differences in elevation of canal bed level at certain places. Although the drop may not be very high, this difference in elevation can be used successfully to generate electricity. Such small hydro electric generation projects, using **bulb-turbines** have been established in many canals, like Ganga canal, Sarada canal, Yamuna canal etc.
7. **Domestic and industrial water supply:** some water from the irrigation canals may be utilized for domestic and industrial water supply for nearby areas. Compared to the irrigation water need, the water requirement for domestic and industrial uses is rather small and does not affect the total flow much. For example, the town of Siliguri in the Darjeeling district of West Bengal, supplies its residents with the water from Teesta Mahananda link canal.

### 3.1.5 Classification of irrigation schemes

Irrigation projects in India are classified into three categories –major medium & minor according to the area cultivated the classification criteria is as follows:-

- 1) **Major irrigation projects:** projects which have a **culturable command area** (CCA) of more than 10,000 ha but more than 2,000 ha utilize mostly surface water resources.
- 2) **Medium irrigation projects:** projects which have CCA less than 10,000 ha. But more than 2,000 ha utilizes mostly surface water resources.
- 3) **Minor irrigation projects:** projects with CCA less than or equal to 2,000 ha. utilizes both ground water and local surface water resources. Ground water

development is primarily done through individual and cooperative effort of farmers with the help of institutional finance and their own savings. Surface water minor irrigation schemes are generally funded from the public sector only. The ultimate irrigation potential from minor irrigation schemes have been assessed as 75.84 million ha of which partly would be ground water based (58.46 million ha) and covers about two thirds. By the end of the ninth plan, the total potential created by minor irrigation was 60.41 million ha.

The ultimate irrigation potential of the country from major and medium irrigation projects has been assessed as about 64 M-ha. By the end of the ninth plan period, the total potential created from major and medium projects was about 35 M-ha.

### 3.1.6 Major and medium irrigation projects vis-à-vis minor irrigation projects

While formulating strategies for irrigation development the water resources planner should realize the benefits of each type of project based on the local conditions. For example, it may not always be possible to benefit remote areas using major/medium projects. At these places minor irrigation schemes would be most suitable. Further, land holding may be divided in such a way that minor irrigation becomes inevitable. However, major and medium projects wherever possible is to be constructed to reduce the overall cost of development of irrigation potential.

According to the third minor irrigation census carried out in 2000-01, there are about 5.56 lakh **tanks** in the country, with the most occurring in the following states

1. West Bengal: 21.2 percent of all the tanks in the country
2. Andhra Pradesh: 13.6
3. Maharashtra: 12.5
4. Chhattisgarh: 7.7
5. Madhya Pradesh: 7.2
6. Tamilnadu: 7.0
7. Karnataka: 5.0

This data has been gathered from the web-site of the Ministry of Water Resources, Government of India: <http://www.wrmin.nic.in/>.

Due to non use of these 15 percent tanks nearly 1 M-ha of Irrigation potential is lost. Another, around 2 M-ha of potential is lost due to under utilisation of tanks in use. Loss of potential due to non use is more pronounced in Meghalaya, Rajasthan and Arunachal Pradesh (above 30%), whereas loss of potential due to under utilisation is more than 50 percent in case of Gujarat, Nagaland, Rajasthan, A&N Island and Dadar and Nagar Haveli.

It also appears that the maintenance of the tanks has been neglected in many parts of the country and their capacity has been reduced due to siltation. It has been estimated that about 1.7 M-ha of net area has been lost under tank irrigation due to drying up of tanks and encroachment of foreshore area. Some advantages of minor irrigation should also be kept in mind. These are: small investments, simpler components, labour intensive, quick maturing and most importantly it is farmer friendly.

On the other hand, it is seen that of the assessed 64 M-ha of irrigation potential that may be created through major and medium projects, only about 35 M-ha have so far been created. Hence a lot of scope for development in this sector is remaining. These may be realized through comprehensive schemes including storage, diversion and distribution structures. Some of these schemes could even be multi-purpose thus serving other aspects like flood control and hydro power.

### 3.1.7 Outlook of the national water policy

Our country had adapted a national water policy in the year 1987 which was revised in 2002. The policy document lays down the fact that planning and development of water resources should be governed by the national perspective. Here we quote the aspects related to irrigation from the policy.

1. Irrigation planning either in an individual project or in a watershed as a whole should take into account the irrigability of land, cost-effective irrigation options possible from all available sources of water and appropriate irrigation techniques for optimizing water use efficiency. Irrigation intensity should be such as to extend the benefits of irrigation to as large a number of farm families as possible, keeping in view the need to maximize production.
2. There should be a close integration of water use and land use policies.
3. Water allocation in an irrigation system should be done with due regard to equity and social justice. Disparities in the availability of water between head-reach and tail end farms and between large and small farms should be obviated by adoption of a rotational water distribution system and supply on a volumetric basis subject to certain ceilings and rational pricing.
4. Concerted efforts should be made to ensure that the irrigation potential created is fully utilised. For this purpose, the command area development approach should be adopted in all irrigation projects.
5. Irrigation being the largest consumer of fresh water, the aim should be to get optimal productivity per unit of water. Scientific management farm practices and sprinkler and drip system of irrigation should be adopted wherever feasible.
6. Reclamation of water-logged/saline affected land by scientific and cost effective methods should form a part of command area development programme.

### 3.1.8 Command Area Development Programme (CADP)

This scheme, sponsored by the central government was launched in 1974-75 with the objective of bridging the gap between irrigation potential created and that utilized for ensuring efficient utilization of created irrigation potential and increasing the agricultural productivity from irrigated lands on a sustainable basis. The programme envisages integrating various activities relating to irrigated agriculture through a multi-disciplinary team under an area development authority in a coordinated manner. The existing components of the CADP are as follows:-

1. On farm development works, that is, development of field channels and field drains within the command of each **outlet**, land leveling on an outlet command basis; reclamation of **water logged** areas; enforcement of a proper system of rotational water supply (like the **warabandi**) and fair distribution of water to individual fields; realignment of field boundaries, wherever necessary (where possible, consolidation of holding are also combined) supply of all inputs and service including credit; strengthening of extension services; and encouraging farmers for participatory irrigation management.
2. Selection and introduction of suitable cropping patterns.
3. Development of ground water to supplement surface irrigation (conjunctive use under minor irrigation sector)
4. Development and maintenance of the main and intermediate drainage system.
5. Modernization, maintenance and efficient operation of the irrigation system up to the outlet of one cusec ( $1\text{ft}^3/\text{sec}$ ) capacity.

For an overall appreciation of an entire irrigation project it is essential that the objectives of the CAD be kept in mind by the water resources engineer.

### 3.1.9 Participatory irrigation management (PIM)

Any irrigation project cannot be successful unless it is linked to the stakeholders, that is, the farmers themselves. In fact, people's participation in renovation and maintenance of field channels was the established practice during the pre independence days. However, the bureaucracy encroached on this function in the post independence period and a realization has dawned that without the participation of farmers, the full potential of an irrigation scheme may not be realized. Though a water resources engineer is not directly involved in such a scheme, it is nevertheless wise to appreciate the motive behind PIM and keep that in mind while designing an irrigation system.

The national water policy stresses the participatory approach in water resources management. It has been recognized that participation of the beneficiaries would help greatly for the optimal upkeep of irrigation system and utilization of irrigation water. The participation of farmers in the management of irrigation would give responsibility for operation and maintenance and collection of water rates from the areas under the jurisdiction of the water user's association of concerned hydraulic level. Under the command area development programme (CADP), presently a provision exists for a one-time functional grant to farmer's associations at the rate of Rs. 500 per hectare of which Rs. 225 per hectare is provided by the central government and state government each, and Rs. 50 per hectare is contributed by the farmer's associations.

It may be mentioned that so far, that is by year 2004, the state governments of Andhra Pradesh, Goa, Karnataka, Tamilnadu, Rajasthan and Madhya Pradesh have enacted legislations for the establishment of the water user's associations.

The sustainability and success of PIM depends on mutual accountability between the water user's association and the irrigation department of the concerned state, attitudinal change in the bureaucracy, autonomy for the water user's associations, multifunctional nature of the water user's association and the choice of appropriate model for PIM with appropriate legal and institutional framework. If the farmers have to take over and manage the system, then the system must be rectified by the irrigation department to a minimum standard to carry the design discharge before it is handed over to the water user's association. The success of the PIM is also linked to the introduction of rotational water supply and water charges with rationalized establishment costs. Unlined field channels need to be manually constructed in a 'V' shape which is considered stable and efficient for carrying water.

### 3.1.10 Management of water for irrigation

Of the two resources –land and water, management of the former is largely in the domain of agricultural engineers. Management of water, on the other hand, is mostly the purview of the water resources engineer who has to decide the following:

- How much water is available at a point of a surface water source, like a river (based on hydrological studies)
- How much ground water is available for utilization in irrigation system without adversely lowering the ground water table?
- For the surface water source, is there a need for construction of a reservoir for storing the monsoon runoff to be used in the lean seasons?
- What kind of diversion system can be constructed across the river for diverting part of the river flow into a system of canal network for irrigating the fields?

- How efficient a canal network system may be designed such that there is minimum loss of water and maximum agricultural production?
- How can excess water of an irrigated agricultural fields be removed which would otherwise cause water logging of the fields?

In order to find proper solution to these and other related issues, the water resources engineer should be aware of a number of components essential for proper management of water in an irrigation system. These are:-

- 1. Watershed development:** since the water flowing into a river is from a watershed, it is essential that the movement of water over ground has to be delayed. This would ensure that the rain water falling within the catchment recharges the ground water, which in turn replenishes the water inflow to the reservoir even during the lean season. Small check dams constructed across small streams within the catchment can help to delay the surface water movement in the watershed and recharge the ground water. Measures for the water shed development also includes afforestation within the catchment area which is helpful in preventing the valuable top-soil from getting eroded and thus is helpful also in preventing siltation of reservoirs. Other soil conservation methods like regrassing and grass land cultivation process, galley plugging, nullah bunding, contour bunding etc. also come under watershed development.
- 2. Water management:** surface water reservoirs are common in irrigation systems and these are designed and operated to cater to crop water requirement throughout the year. It is essential, therefore, to check loss of water in reservoir due to
  - Evaporation from the water surface
  - Seepage from the base
  - Reduction of storage capacity due to sedimentation
- 3. Water management in conveyance system:** In India the water loss due to evaporation, seepage and mismanagement in the conveyance channels (for canals and its distributaries) is exceptionally high-nearly 60%. Some countries like Israel have reduced this loss tremendously by taking several measures like lining of water courses, lining not only reduces seepage, but also minimizes weed infestation and reduces overall maintenance cost though the initial cost of providing lining could be high depending on the material selected.
- 4. On farm water management:** Though this work essentially is tackled by agricultural engineers, the water resources engineers must also be aware of the problem so that a proper integrated management strategy for conveyance-delivery-distribution of irrigation water is achieved. It has been observed from field that the water delivered from the canal system to the agricultural fields are utilized better in the head reaches and by the time it reaches the tail end, its quantity reduces. Often, there are land holding belonging to different farmers along the route of the water course and there is a tendency of excess withdrawal by the farmers at the upper reaches. In order to

tackle this kind of mismanagement a proper water distribution roster has to be implemented with the help of farmers' cooperatives or water user's associations. At times farmers are of the opinion that more the water applied more would be the crop production which is generally not true beyond a certain optimum water application rate. Education of farmers in this regard would also ensure better on-farm water management.

- 5. Choice of irrigation method:** Though irrigation has been practiced in India from about the time of the Harappa civilization, scientific irrigation based on time variant crop water need within the constraints of water and land availability is rather recent. It is important to select the right kind of irrigation method to suit the particular crop and soil. For example, following is a short list of available methods corresponding to the kind of crop.

Method of irrigation	Suitable for crops
Border strip method	Wheat, Leafy vegetables, Fodders
Furrow method	Cotton, Sugarcane, Potatoes
Basin method	Orchard trees

Other methods like sprinkler and drip irrigation systems are adapted where water is scarce and priority for its conservation is more than the consideration for cost. Although most advanced countries are adopting these measures, they have not picked up as much in India mainly due to financial constraints. However, as time passes and land and water resources get scarce, it would be essential to adopt these practices in India, too.

- 6. Choice of cropping pattern:** Scientific choice of cropping pattern should be evolved on the basis of water availability, soil type, and regional agro-climate conditions. Crop varieties which give equivalent yield with less water requirement and take less time to mature should be popularized. Scientific contribution in the form of double or multiple cropping can be achieved if the sowing of crops such as paddy, groundnut, arhar etc. is advanced, if necessary, by raising the nurseries with the help of ground-water. Selection of crops planting sequence per unit weight of water applied.

- 7. Scheduling of irrigation water:** Traditional farmers engaged in crop production are aware of some kind of scheduling of water to the crops, but their knowledge is based mostly on intuition and traditional wisdom rather than on any scientific basis. Modern scientific study on crop growth has shown that a correlation can be established between the climatic parameters, crop water requirement and the moisture stored in the soil especially in the root zone. It has now been established by scientific

research that the application of irrigation should be such that the available water in the soil above the **permanent wilting point** is fully utilized by the crop before requiring application of water to replenish the depleted moisture in the soil. Since any canal would be delivering water at the same time to different fields growing different crops, the demand of the various fields have to be calculated at any point of time or a certain period of time(days, weeks),and the water distributed accordingly through the canal network.

8. **Development of land drainage:** Due to improper application of water and inadequate facilities for drainage of excess water from irrigated lands, large tracks of land near irrigated areas have been affected with water logging and excess salt concentration in soils. Adequate drainage measures like surface and subsurface drainage systems, vertical drainage, bio-drainage etc. should be developed as an integral part of the irrigation system.
9. **Command area development:** We have already seen that the government has initiated the command area development programme (CADP) which would ensure efficient water utilization and integrated area developments in the irrigation command.
10. **Canal automation:** At present, the water entering the canal network through the **headworks** as well as the water getting distributed into the various branches and finally reaching the fields through the outlets are controlled manually. However, if these operations are carried out through automated electro-mechanical systems which can communicate to a central computer, then the whole process can be made more efficient. This would also help to save water and provide optimal utilization of the availability water.

### 3.1.11 Classification of irrigation schemes

The classification of the irrigation systems can also be based on the way the water is applied to the agricultural land as:

1. **Flow irrigation system:** where the irrigation water is conveyed by growing to the irrigated land. This may again be classified into the following.
  - **Direct irrigation:** Where the irrigation water is obtained directly from the river, without any intermediate storage. This type of irrigation is possible by constructing a weir or a barrage across a river to raise the level of the river water and thus divert some portion of the river flow through an adjacent canal, where the flow takes place by gravity.
  - **Reservoir/tank/storage irrigation:** The irrigation water is obtained from a river, where storage has been created by construction an obstruction across the river, like a dam. This ensures that even when there is no inflow into the

river from the catchment, there is enough stored water which can continue to irrigate fields through a system of canals.

- 2. Lift irrigation system:** Where the irrigation water is available at a level lower than that of the land to be irrigated and hence the water is lifted up by pumps or by other mechanical devices for lifting water and conveyed to the agricultural land through channels flowing under gravity.

Classification of irrigation systems may also be made on the basis of duration of the applied water, like:

- 1. Inundation/flooding type irrigation system:** In which large quantities of water flowing in a river during floods is allowed to inundate the land to be cultivated, thereby saturating the soil. The excess water is then drained off and the land is used for cultivation. This type of irrigation uses the flood water of rivers and therefore is limited to a certain time of the year. It is also common in the areas near river deltas, where the slope of the river and land is small. Unfortunately, many of the rivers, which were earlier used for flood inundation along their banks, have been embanked in the past century and thus this practice of irrigation has dwindled.
- 2. Perennial irrigation system:** In which irrigation water is supplied according to the crop water requirement at regular intervals, throughout the life cycle of the crop. The water for such irrigation may be obtained from rivers or from wells. Hence, the source may be either surface or ground water and the application of water may be by flow or lift irrigation systems.

### 3.1.12 Pricing of water

This is more of a management issue than a technical one. After all, the water being supplied for irrigation has a production cost (including operation cost and maintenance cost) which has to be met from either the beneficiary or as subsidy from the government. Since water is a state subject (as the matter included in entry 17 of list 11 that is, the state list of the Constitution of India), every state independently fixes the rates of water that it charges from the beneficiaries, the remaining being provided from state exchequer.

There are wide variations in water rate structures across states and the rate per unit volume of water consumed varies greatly with the crop being produced. The rates charged in some states for irrigation vary even for different projects depending on the mode of irrigation. The rates, at present, also vary widely for the same crop in the same state depending on irrigation season, type of system, etc.

As such, right now, there is no uniform set principles in fixing the water rates and a wide variety of principles for pricing are followed for the different states, such as:

- recovery cost of water
- capacity of irrigators to pay based on gross earning or net benefit of irrigation
- water requirement of crops
- sources of water supply and assurance
- classification of land linked with land revenue system

In some states water cess, betterment levy, etc. are also charged. Hence, there is an urgent need of the water resources planners to work out a uniform principle of pricing irrigation water throughout the country, taking into account all the variables and constraints.

### 3.1.13 Procedure for setting up a major/medium irrigation project scheme in India

The central design organization of each state desiring to set up an irrigation project shall have to prepare a detailed project report of the proposed irrigation scheme based on the document "Guidelines for Submission, Appraisal and Clearance of Irrigation and Multipurpose Projects" brought out by the Central Water Commission. This report has to be sent to the project appraisal organization of the Central Water Commission for the clearance with a note certifying the following:

1. All necessary surveys and investigations for planning of the project and establishing its economic feasibility have been carried out according to the guidelines mentioned above.
2. 10% or 5000 ha (whichever is minimum) of the command area of the proposed project has been investigated in details in three patches of land representing terrain conditions in the command for estimation of the conveyance system up to the last farm outlets.
3. 10% of the canal structures have been investigated in full detail.
4. Detailed hydrological, geological, construction material investigations have been carried out for all major structures, that is, dams, weirs (or barrages, as the case may be), main canal, branch canal up to distributaries carrying a discharge of 10 cumecs.
5. Soil survey of the command area has been carried out as per IS 5510-1969.
6. Necessary designs for the various components of the project have been done in accordance with the guidelines and relevant Indian standards.
7. Necessary studies for utilization of ground water have been done with special regard to the problem of water logging and suitable provisions have been made for conjunctive use of ground water and drainage arrangements.

8. The cropping pattern has been adopted in consultation with the state agriculture department and is based on soil surveys of the command keeping in view the national policy in respect of encouraging crops for producing oil seeds and pulses.

9. The cost estimates and economic evaluations were carried out as per guidelines issued by the Central Water Commission.

It may be noted that similar report has to be made even for multipurpose projects having irrigation as a component. Apart from the above techno-economic studies carried out by the state central design organization, the project report should be examined by the state-level project appraisal/technical advisory committee comprising representatives of irrigation, agriculture, fisheries, forests, soil conservation, ground water, revenue and finance departments and state environmental management authority.

It may be noted that a project of the magnitude of a major or medium irrigation scheme has wide impacts. Hence, the techno-economic feasibility report should also be supplemented with “Environmental Impact Assessment Report” and “Relief and Rehabilitation Plan”. The latter touches the issue of the plans for appropriate compensation to the affected persons due to the construction of the projects.

The project proposal submitted to the Central Water Commission shall be circulated amongst the members of the advisory committee of the ministry of water resources for scrutiny. Once the project is found acceptable it shall be recommended for investment clearance to the planning commission and inclusion in the five year plan/annual plan.

### 3.1.14 Plan development

Since the commencement of the first five year plan in 1951, the developmental schemes of India have been planned in a systematic programme. Under this scheme, each state of the union of India has seen development in the field of irrigation development. A brief description of the development in each state so far, has been indicated in the following paragraphs.

#### **Andhra Pradesh:**

At the beginning of plan development there were about 56 major and medium projects in addition to several minor projects in the state. Irrigation potential of about 2.4 M-ha was created through these projects which was about one-fourth of the ultimate irrigation potential of the state. About one hundred major and medium projects were undertaken during plan development. These along with a large number of minor irrigation projects created an additional potential of about 4M-ha thus raising the irrigation potential created to about two-thirds of ultimate potential of 9.2 M-ha. This has resulted in bringing a net area of 4.3 M-ha under irrigation out of 11 M-ha of net sown area in the state. The important projects taken up in the last 50 years include large projects like

Nagarjuna Sagar, Sriram Sagar and Srisailem in addition to projects like Tungabhadra high level canal, Somasila etc.

### **Arunachal Pradesh:**

Situated in the hilly region of the North east, irrigation potential of the state is as low as 0.16 M-ha. There was hardly any irrigation projects have been undertaken which have created an irrigation potential of 82,000 ha, which accounts for about half of the ultimate potential. A net area of about 36,000 ha out of the net sown area of 149000 ha has been brought under irrigation by these projects.

### **Assam:**

Before the commencement of plan development, irrigation development in the state was limited to minor projects utilizing surface and ground water which provided an irrigation potential of 0.23 M-ha under plan development about 20 major and medium irrigation projects and a large number of minor irrigation projects were undertaken resulting in creation of an irrigation potential of 0.85 M-ha which is about one-third of the ultimate irrigation potential 2.67 M-ha for the state. A net area of 0.57 M-ha has been brought under irrigation through these projects. Important taken up during the period include Bodikerai, Dhansiri, Koilong etc.

### **Bihar:**

Irrigation development in the pre-plan period included four major and medium projects in addition to several minor irrigation projects. These projects accounted for an irrigation potential of 1.4 M-ha. About 105 major and medium irrigation projects in addition to a large number of minor irrigation projects were undertaken during plan development, resulting in creation of additional irrigational potential of about 7V. Two-third of the ultimate irrigation potential of 12.4 M-ha for the state has thus been created so far. An area of 3.3 M-ha out of net sown area of 7.7 M-ha in the state has been brought under irrigation from these projects. Important projects undertaken during the plan period include Gandak, Kosi barrage and Eastern canal, Rajpur canal, Sone high level canal, Subernarekha, North Koel reservoir etc.

### **Goa:**

Pre-plan irrigation development in Goa was limited to construction of a few minor projects. During plan development, four major and medium irrigation projects and a number of minor irrigation projects were undertaken. These projects have created an irrigation potential of 35000 ha, which accounts for about 43 percent of the ultimate irrigation potential of 82000 ha for the state. A net area of 23000 ha of the sown area of 131000 ha available to the state has been brought under irrigation. The important projects undertaken during the period include Salauli and Anjunem.

### **Gujarat:**

Two major projects and a number of minor irrigation projects were undertaken in the state during the pre-plan period which created an irrigation potential of 0.46 M-ha.

About 130 major and medium irrigation projects were undertaken during plan development and these projects have created an irrigation potential of 3.4 M-ha. Thus 74 percent of the ultimate irrigation potential of 4.75 M-ha for the state has been created. An area of 2.64 M-ha out of net sown area of 9.3 M-ha has been brought under irrigation under the above projects. Important projects taken up in the state include Ukai, Kakrapur, Mahi etc. The giant project of Sardar Sarovar is one of the projects presently ongoing in the state.

### **Harayana:**

The major project of Western Yamuna canal was constructed in the state during pre-plan period. Irrigation potential created in the pre-plan period was about 0.72 M-ha. About 10 major projects were taken up during the plan period in addition to a number of tubewells and other minor irrigation projects. The total irrigation potential created by projects so far undertaken amounts to 3.7 M-ha which accounts for about 80 percent of the ultimate irrigation potential for the state. Out of the net sown area of 3.6 M-ha, an area of 2.6 M-ha has been brought under irrigation. Important projects undertaken during the plan period include inter-state projects like Bhakra-Nangal, Sutlej-Yamuna link canal etc.

### **Himachal Pradesh:**

Irrigation development in the hilly state of Himachal Pradesh was restricted to minor projects in the preplan period. During the plan development, 5 major and medium projects and a number of minor projects were undertaken in the state. Sofar, these projects have created a total irrigation potential of 0.16 M-ha and have brought an area of 99,000 ha under irrigation out of the net sown area of 5,83,000 ha in the state. Important projects undertaken in the State include Balh valley, Shahanahar etc.

### **Jammu & Kashmir:**

Pre-plan irrigation development in the state included seven major and medium projects in addition to minor irrigation schemes. These projects accounted for creation of an irrigation potential of 0.33 M-ha. During the plan development, about 20 major and medium irrigation projects and a number of minor projects were undertaken in the state. With the addition of about 0.22 M-ha from these projects the irrigation potential, so far, created has risen to 0.55 M-ha which is about 70 percent of the ultimate irrigation potential of 0.8 M-ha. Net area brought under irrigation is 0.3 M-ha. Important projects undertaken during plan period include Kathua Canal, Ravi-Tawi Lift, Karwal etc.

### **Karnataka:**

Pre-plan irrigation development in the state included 11 major and medium projects, in addition to a large number of minor projects. These projects created an irrigation potential of 0.75 M-ha. During plan period about 54 major and medium irrigation projects and a number of minor irrigation projects were undertaken. These projects have raised the irrigation potential created in the state to 0.32 M-ha which is about 70 percent of the ultimate irrigation potential of the state. Net area brought under irrigation

is 2.1 M-ha Important projects undertaken during the plan period include Ghataprabha, Malaprabha, Tungabhadra, Upper Krishna stage-I, Kabini, Harangi, Hemavati etc.

### **Kerala:**

Irrigation development in the state in the pre-plan period was limited to minor irrigation which had created a potential of 2,25,000 ha. During plan development, about 22 major and medium irrigation projects were undertaken which have raised the irrigation potential created to about 1.2 M-ha thus achieving 70 percent of the ultimate potential of 2.1 M-ha for the state. Net area brought under irrigation is 0.33 M-ha. Important projects taken up during plan development include Malampuzha, Chalakudi, Periyar Valley, Kallada etc.

### **Madhya Pradesh:**

A little over 1 M-ha of irrigation potential was created in the state in the pre-plan period through the construction of about 20 major and medium and a number of minor projects. During the period of plan development about 160 major and medium projects were undertaken along with minor irrigation schemes. With this, the irrigation potential created has gone upto over 5 M-ha which is about half of the ultimate potential of 10.2 M-ha. About 4.8 M-ha of land has been brought under irrigation through these projects. Important projects undertaken during the period include Chambal, Barna, Tawa, mahanadi Reservoir, Hasdeo-Bango, Bargi, Upper Wainganga etc.

### **Maharashtra:**

Irrigation development in pre-plan period in Maharashtra was also over 1 M-ha achieved through the construction of about 21 major and medium irrigation projects along with a number of minor irrigation projects. During plan development, over 250 major and medium projects and a large number of minor projects were added which raised the irrigation potential created to about 4.9 M-ha, which is about two-third of the ultimate potential of 7.3 M-ha. Out of the net sown area of 18 M-ha available to the state, 2.5 M-ha has been brought under irrigation. The important projects undertaken during the period of the plan development included Jayakwadi, Pench, Bhima, Mula, Purna, Khadakwasla, Upper Penganga etc.

### **Manipur:**

An irrigation potential of about 5,000 M-ha was created in the state during pre-plan period through minor irrigation projects. During plan development, six major and medium projects and a number of minor irrigation projects were added which has raised the irrigation potential to 0.14 M-ha which is about 60 percent of the ultimate potential of 0.24 M-ha. A net area of 65,000 ha has been brought under irrigation through these projects. One of the important irrigation projects taken up is the Loktak lift.

### **Meghalaya:**

Minor irrigation projects are source of irrigation in this hilly state. A potential of 7,000 ha developed in the pre-plan period was enhanced to about 53,000 ha by taking up more

minor irrigation projects. The state has little scope of taking up major and medium projects. A net area of about 45,000 ha has, so far, been provided with irrigation.

### **Mizoram:**

There was hardly any irrigation development in the state in the pre-plan period. The terrain is not suitable for taking up major and medium projects. In the period of plan development, an irrigation potential of 13,000 ha was created through minor irrigation projects, thereby bringing a net area of about 8,000 ha under irrigation. The ultimate irrigation potential of the state is about 70,000 ha, which is one of the lowest of all states.

### **Nagaland:**

Nagaland too has a low irrigation potential of about 90,000 ha out of which about 5,000 ha was created in the pre-plan period through minor irrigation schemes. This has been raised to about 68,000 ha (about three-fourth of the ultimate) by taking up minor irrigation projects. The net area provided with irrigation is of the order of 60,000 ha.

### **Orissa:**

Pre-plan development in the state amounted to 0.46 M-ha through 5 major and medium and a large number of minor irrigation projects. During the period of plan development, 55 major and medium projects and a host of minor irrigation projects were undertaken in the state bringing up the irrigation potential created to about 3 M-ha which is more than half the ultimate irrigation potential of 5.9 M-ha for the state. A net area of 2 M-ha has been brought under irrigation through these projects. Important projects taken up during the project include Hirakud, Mahanadi Birupa Barrage, upper Kolab etc. Schemes like inter-state Subernarekha project and upper Indravati are presently in progress.

### **Punjab:**

Punjab was one of the states where significant development in irrigation was made during pre-plan period. An irrigation potential of about 0.21 M-ha was created in the state through construction of 5 major and a number of minor lift irrigation projects. During the period of plan development 10 major and medium and a large number of minor projects were undertaken which has raised the irrigation potential of 6.5 M-ha. A net area of about 3.9 M-ha has been brought under irrigation in the state out of net sown area of 4.2 M-ha. Important major and medium projects undertaken in the state include inter-state Bhakra Nangal, Sutlej-Yamuna Link Canal, Beas etc.

### **Rajasthan:**

Out of the ultimate irrigation potential of 5.15 M-ha for the state, a potential of 1.5 M-ha was developed during the pre-plan period through the construction of one major and 42 medium irrigation projects in addition to several minor projects. About 67 major and medium projects and a large number of minor projects were undertaken during the plan period which has raised the irrigation potential created to about 4.8 M-ha which is more than 90 percent of ultimate irrigation potential of the state. Net area brought under

irrigation is 3.9 M-ha out of net sown area of 16.4 M-ha. Important projects undertaken during plan development include inter-state Chambal project, Bhakra Nangal, Beas, Indira Nahar, Mahi Bajaj Sagar etc.

### **Sikkim:**

There was hardly any irrigation development in Sikkim at the time when plan development started in India. After Sikkim joined as a part of India, plan development was extended to the state in the seventies and an irrigation potential of about 25,000 ha is likely to be developed by the end of 1996-97 through minor irrigation projects.

### **Tamil Nadu:**

The state of Tamil Nadu was one of the forerunners in development of irrigation during the British period. An irrigation potential projects of 2.4 M-ha was developed through 24 major and medium irrigation projects and a large number of minor irrigation projects during the pre-plan period. About 1.3 M-ha of irrigation potential was added during plan development through addition of 24 major and medium projects and a number of minor irrigation projects. Out of the ultimate irrigation potential of 3.9 M-ha, over 3.7 M-ha (about 95 percent) has so far been created. Out of the net sown of 5.6 M-ha, net area brought under irrigation is 2.7 M-ha. Important projects undertaken during the period include Cauvery Delta, Lower Bhavani, Parambikulam Aliyar etc.

### **Tripura:**

Irrigation development in the pre-plan period in Tripura was mainly through minor irrigation. Potential of 10,000 ha was created during the pre-plan period. With the addition of 3 medium and several minor irrigation projects during plan development, the irrigation potential, so far, developed has risen to over 100,000 ha which is nearly half of the ultimate potential of 215,000 ha. About 16,000 ha of sown area have been brought under irrigation. One of the important projects taken up in the state is Gumti.

### **Uttar Pradesh:**

With vast development in the Ganga valley an irrigation potential of 5.4 M-ha was created in the state during the pre-plan period, through 15 major schemes and a host of minor schemes. During plan development over 90 major and medium projects and a very large number of minor irrigation projects were undertaken in the plan period thereby raising the potential created to about 30 M-ha against the originally assessed ultimate potential of about 26 M-ha. Three-fourth of this development (22.7 M-ha) is attributed to minor irrigation projects- largely ground water works. About 11.3 M-ha of area out of net sown area of 17.3 M-ha has been brought under irrigation through these projects. Important projects undertaken during the period include Ramganga, Sarda Sahayak, Saryu Nahar, Gandak, Madhya Ganga Canal, Tehri etc.

### **West Bengal:**

Pre-plan irrigation development in West Bengal saw the implementation of major projects in addition to a large number of minor projects which resulted in creation of an

irrigation potential of about 0.94 M-ha. During plan period, about 13 major and medium and large number of minor schemes were added which have raised the irrigation potential of 6.1 M-ha. A net area of 1.9 M-ha has been brought under irrigation through these projects out of net sown area of 5.3 M-ha. Important projects undertaken during the period include DVC Barrage and canal system, Mayurakshi, Kangsabati etc.

Since the above information has been based on the available data from Central Water Commission, and Ministry of Water Resources, Government of India for the last decade, the smaller states carved out later have not been included and the data represents that for the undivided state.

### 3.1.15 History of Irrigation Development

(This section has been adapted from the information provided in the Ministry of Water Resources, Government of India web-site: <http://wrmin.nic.in/>).

#### Earliest evidences of irrigation

The history of irrigation development in India can be traced back to prehistoric times. Vedas and ancient Indian scriptures made reference to wells, canals, tanks and dams which were beneficial to the community and their efficient operation and maintenance was the responsibility of the State. Civilization flourished on the banks of the rivers and harnessed the water for sustenance of life. According to the ancient Indian writers, the digging of a tank or well was amongst the greatest of the meritorious act of a man. Brihaspathi, an ancient writer on law and politics, states that the construction and the repair of dams is a pious work and its burden should fall on the shoulders of rich men of the land. Vishnu Purana enjoins merit to a person who patronages repairs to well, gardens and dams.

In a monsoon climate and an agrarian economy like India, irrigation has played a major role in the production process. There is evidence of the practice of irrigation since the establishment of settled agriculture during the Indus Valley Civilization (2500 BC). These irrigation technologies were in the form of small and minor works, which could be operated by small households to irrigate small patches of land and did not require co-operative effort. Nearly all these irrigation technologies still exist in India with little technological change, and continue to be used by independent households for small holdings. The lack of evidence of large irrigation works at this time signifies the absence of large surplus that could be invested in bigger schemes or, in other words, the absence of rigid and unequal property rights. While village communities and co-operation in agriculture did exist as seen in well developed townships and economy, such co-operation in the large irrigation works was not needed, as these settlements were on the fertile and well irrigated Indus basin. The spread of agricultural settlements to less fertile and irrigated area led to co-operation in irrigation development and the emergence of larger irrigation works in the form of reservoirs and small canals. While

the construction of small schemes was well within the capability of village communities, large irrigation works were to emerge only with the growth of states, empires and the intervention of the rulers. There used to emerge a close link between irrigation and the state. The king had at his disposal the power to mobilize labour which could be used for irrigation works.

In the south, perennial irrigation may have begun with construction of the Grand Anicut by the Cholas as early as second century to provide irrigation from the Cauvery river. Wherever the topography and terrain permitted, it was an old practice in the region to impound the surface drainage water in tanks or reservoirs by throwing across an earthen dam with a surplus weir, where necessary, to take off excess water, and a sluice at a suitable level to irrigate the land below. Some of the tanks got supplemental supply from stream and river channels. The entire land-scape in the central and southern India is studded with numerous irrigation tanks which have been traced back to many centuries before the beginning of the Christian era. In northern India also there are a number of small canals in the upper valleys of rivers which are very old.

### **Irrigation during Medieval Period**

In the medieval India, rapid advances also took place in the construction of inundation canals. Water was blocked by constructing bunds across streams. This raised the water level and canals were constructed to take water to the fields. These bunds were built by both the state and private sources. Ghiyasuddin Tughluq (1220-250 is credited to be the first ruler who encouraged digging canals. However, it is Fuz Tughluq (1351-86) who inspired from central Asian experience, is considered to be the greatest canal builder before the nineteenth century. Irrigation is said to be one of the major reasons for the growth and expansion of the Vijayanagar empire in southern India in the fifteenth century. It may be noted that, but for exceptional cases, most of the canal irrigation prior to the arrival of the British was of the diversionary nature. The state, through the promotion of irrigation, had sought to enhance revenue and provide patronage through rewards of fertile land and other rights to different classes. Irrigation had also increased employment opportunities and helped in the generation of surplus for the maintenance of the army and the bureaucracy. As agricultural development was the pillar of the economy, irrigation systems were paid special attention to, as irrigation was seen to be a catalyst for enhanced agricultural production. This is demonstrated by the fact that all the large, powerful and stable empires paid attention to irrigation development. It may be said that the state in irrigation was commensurate with its own interest.

### **Irrigation development under British rule**

Irrigation development under British rule began with the renovation, improvement and extension of existing works, like the ones mentioned above. When enough experience and confidence had been gained, the Government ventured on new major works, like the Upper Ganga Canal, the Upper Bari Doab Canal and Krishna and Godavari Delta Systems, which were all river-diversion works of considerable size. The period from 1836 to 1866 marked the investigation, development and completion of these four major

works. In 1867, the Government adopted the practice of accepting works, which promised a minimum net return. Thereafter, a number of projects were taken up. These included major canal works like the Sirhind, the Lower Ganga, the Agra and the Mutha Canals, and the Periyar Dam and canals. Some other major canal projects were also completed on the Indus system during this period. These included the Lower Swat, the Lower Sohag and Para, the Lower Chenab and the Sidhnai Canals, all of which went to Pakistan in 1947.

The recurrence of drought and famines during the second half of the nineteenth century necessitated the development of irrigation to give protection against the failure of crops and to reduce large scale expenditure on famine relief. As irrigation works in low rainfall tracts were not considered likely to meet the productivity test, they had to be financed from current revenues. Significant protective works were constructed during the period were the Betwa Canal, the Nira Left Bank Canal, the Gokak Canal, the Khaswad Tank and the Rushikulya Canal. Between the two types of works namely productive and protective, the former received greater attention from the Government. The gross area irrigated in British India by public works at the close of the nineteenth century was about 7.5 M-ha. Of this, 4.5 M-ha came from minor works like tanks, inundation canals etc. for which no separate capital accounts were maintained. The area irrigated by protective works was only a little more than 0.12 M-ha

### **Irrigation development at the time of independence**

The net irrigated area in the Indian sub continent, comprising the British Provinces and Princely States, at the time of independence was about 28.2 M-ha, the largest in any country of the world. The partition of the country, however, brought about sudden and drastic changes, resulting in the apportionment of the irrigated area between the two countries; net irrigated area in India and Pakistan being 19.4 and 8.8 M-ha respectively. Major canal systems, including the Sutlej and Indus systems fell to Pakistan's share. East Bengal, now Bangladesh, which comprises the fertile Ganga Brahmaputra delta region also went to Pakistan. The irrigation works which remained with India barring some of the old works in Uttar Pradesh and in the deltas of the South, were mostly of a protective nature, and meant more to ward off famine than to produce significant yields.

### **Plan development**

In the initial phase of water resources development during the plan period after independence, rapid harnessing of water resources was the prime objective. Accordingly, the State Governments were encouraged to expeditiously formulate and develop water resources projects for specific purposes like irrigation, flood control, hydro-power generation, drinking water supply, industrial and various miscellaneous uses. As a result, a large number of projects comprising dams, barrages, hydro-power structures, canal net work etc. have come up all over the country in successive Five Year Plans. A milestone in water resources development in India is creation of a huge storage capability. Because of these created storage works it has now become possible to provide assured irrigation in the command area, to ensure supply for hydro-power

and thermal power plants located at different places and to meet requirement for various other uses. Flood moderation could be effected in flood prone basins, where storage have been provided. Besides, supply of drinking water in remote places throughout the year has become possible in different parts of the country.

At the time of commencement of the First Five Year Plan in 1951, population of India was about 361 million and annual food grain production was 51 million tonnes which was not adequate. Import of food grains was then inevitable to cover up the shortage. Attaining self sufficiently in food was therefore given paramount importance in the plan period and in order to achieve the objective, various major, medium and minor irrigation and multi-purpose projects were formulated and implemented through successive Five Year Plans to create additional irrigation potential throughout the country. This drive compounded with green revolution in the agricultural sector, has enabled India to become marginally surplus country from a deficit one in food grains.

Thus the net irrigated area is 37 percent of net sown are and 29 percent of total cultivable area. As stated earlier, the ultimate potential due to major and medium projects has been assessed as 58 M-ha of which 60 per cent estimated to be developed.

Scenario of development of irrigation in the states during plan development is discussed in the following paragraphs.

### **Minor irrigation**

While the development of irrigation is most essential for increasing food and other agricultural production to meet the needs of the growing population, development of Minor Irrigation should receive greater attention because of the several advantages they posses like small investments, simpler components as also being labour intensive, quick maturing and mot of all farmer friendly.

Minor Irrigation development programmes in the state is being implemented by many Departments/Organisations like Agriculture, Rural Development, Irrigation, Social Welfare etc At the central level also, different departments launch schemes having Minor Irrigation component.

The Ministry of Rural Areas and Employment launched a Million Wells Schemes (WMS) in 1988-89. Till 1997-98, a total of 12,63,090 wells have been constructed under MWS with an expenditure of Rs. 4,728.17 crore. The Ministry of Rural Areas and Employment is also implementing Drought Prone Area Programme(DPAP) on watershed basis.

The Ministry of Agriculture has been instrumental in providing credit to farmers for the development of Minor Irrigation through Commercial Banks, Regional Rural Banks, Co-operatives and National Bank for Agriculture and Rural Development (NABARD).

The Minor Irrigation Division of the Ministry of Water Resources monitors the progress of development of irrigation created through Minor Irrigation Project. It implements the Centrally Sponsored Scheme Rationalisation of Minor Irrigation Statistics (RMIS) and conducts census of Minor Irrigation structures on quinquennial basis with a view to create a reliable database for the development of Minor Irrigation Sector. It also assists the State Governments in preparation of schemes for posing to external funding agencies for attracting external assistance for Minor Irrigation Schemes.

Ground Water Development is primarily done through individual and co-operative efforts of the farmers with the help of institutional finance and their own savings. Surface Water minor Irrigation Scheme i.e. surface lift schemes and surface flow schemes are generally funded from the public sector outlay. NABARD provides finance to the banks for installation of Minor Irrigation works in the States. In addition, the Land Development Banks provide bank credit to the farmers under their normal programmes also. During the year 1997-98, the total credit disbursement for minor irrigation works out of Rs. 488.65 crores. Further, many old schemes go out of use due to one reason or the other. The Irrigation Potential created and utilised through ground water as well as surface water. Minor Irrigation Schemes are not being recorded systematically in most cases as there schemes are implemented and monitored by individual farmers. Further, the norms being adopted for assessing the irrigation potential of Minor Irrigation Schemes are also not uniform. All the Ground Water and Surface Water Schemes having Cultivable Command Area (CCA) up to 2,000 hectares are included in the Minor Irrigation Sector.

### **Reservoir storage**

The storage position in 68 important reservoirs in different parts of the country is monitored by the Central Water Commission. Against the designed live capacity at full reservoir levels of 129.4 Th. Million Cubic meters (TMC) in these reservoirs the total live storage was 95.3 TMC at the end of September, 1999 and 106.3 TMC at the same point of time last year.

### **Irrigation potential**

The reassessed Ultimate Irrigation Potential (UIP) is 139.89 million hectare (M-ha ). This re-assessment has been done on the basis of the re-assessment of the potential of ground water from 40 M-ha to 64.05 M-ha and re-assessment of potential of surface minor irrigation from 15 M-ha to 17.38 M-ha Thus, there has been an increase of 26.39 M-ha in the UIP of the country, which was 113.5 M-ha Before re-assessment. At the inception of planning in India in 1951 the created irrigation potential was 22.60 M-ha The irrigation potential created upto the end of Eighth Plan has increased to 89.56 M-ha

### **Major and medium irrigation**

The Ultimate Irrigation Potential of the country from Major and Medium Irrigation projects has been assessed as 58.5 m ha. This includes projects with a culturable

command area of more than two thousand hectare. The potential created up to the end of the Seventh Plan (1985-90) was 29.92 M-ha and at the beginning of the Eighth Five Year Plan (1992-93) was 30.74 M-ha

A target 5.09 M-ha had been set for creation of additional potential during the Eighth Plan (1992-97) against which, the potential created was about 2.22 M-ha Thus, at the end of the Eighth Plan, the cumulative irrigation potential created from major and Medium irrigation was about 32.96 M-ha According to a provisional estimate, the irrigation potential through Major & Medium projects has reached the level of 34.5 M-ha By 1998-99.

### **Minor irrigation**

All ground water and surface water schemes having culturable command area (CCA) upto 2000 ha individually are classified as minor irrigation schemes. Ground water development is primarily done through individual and cooperative efforts of the farmers with the help of institutional finance and their own savings. Surface water minor irrigation schemes are generally funded from the public sector outlay.

### **3.1.16 Some important terms**

**Culturable Command Area (CCA):** The gross command area contains unfertile barren land, alkaline soil, local ponds, villages and other areas as habitation. These areas are called unculturable areas. The remaining area on which crops can be grown satisfactorily is known as cultivable command area (CCA). Culturable command area can further be divided into 2 categories

1. Culturable cultivated area: It is the area in which crop is grown at a particular time or crop season.
2. Culturable uncultivated area: It is the area in which crop is not sown in a particular season.

**Gross command area (GCA):** The total area lying between drainage boundaries which can be commanded or irrigated by a canal system.

$$G.C.A = C.C.A + UNCULTURABLE AREA$$

**Water Tanks:** These are dug areas of lands for storing excess rain water.

**Outlet:** This is a small structure which admits water from the distributing channel to a water course of field channel. Thus an outlet is a sort of head regulator for the field channel delivering water to the irrigation fields.

**Water logged area:** An agricultural land is said to be waterlogged when its productivity or fertility is affected by high water table. The depth of water-table at which it tends to make the soil water-logged and harmful to the growth and subsistence of plant life

depends upon the height of capillary fringe, which is the height to which water will rise due to capillary action. The height of capillary fringe is more for fine grained soil and less for coarse grained ones.

**Permanent wilting point:** or the wilting coefficient is that water content at which plants can no longer extract sufficient water from the soil for its growth. A plant is considered to be permanently wilted when it will not regain its turbidity even after being placed in a saturated atmosphere where little or no consumptive water use occurs.