CHAPTER-1

INTRODUCTION
1.0. INTRODUCTION

1.1 General Account.

A little more than half of the world's population (56.90%) lives in Asia and 1/4th of the Asian's (26.5%) reside in India. India is the second largest country in Asia. In terms of population and area the population is above more than 650 million and the area is about 3277752 sq. km. There are about 576000 villages in India with more than 80% of the countries population living in these villages. Further more, about 70% of them depend upon agricultural sector. The rural sector accounts for more than 45% of the gross national products. In our country, there is, at present a gross shown area of 173.9 million hectares, the gross irrigated area to the gross shown area constitutes 27.8%. This reveals the pattern and peculiarities of Indian rural sector and this requires more attention for balanced economic development of the country.

Before 1950, food shortages were frequent in India. The poor state of Indian agriculture was high lighted by the famous Bengal famine of 1942, which took a heavy toll of human and cattle life. However, after independence top priority was accorded to the agricultural sector which caused miraculous developments in Indian agriculture.

The agricultural sector requires a number of resources and input for the development. The development of agricultural world also necessitate, the development of those areas which would strength and
easy agricultural operations. The development of allied operation also need to be improved upon. Among the various resources used in agriculture, water is the main component. According to an estimates of the available ground water, only 50% has been exploited. Although a number of attempt has been made in these area, but still 50% of the ground water is unutilized and waste. This has a great effect upon the irrigated area of the total irrigated area, about 30% is covered by ground water and rest 70% needs to be thought over. There are a total cultivated area amounting to 152 million hectares, of this 45 million hectare are under irrigation. These data and informations, thus, indicates that a proper attention should be given to the water management in agricultural sector. This way the proper utilization of water not only improved the agricultural production but also provide the reasonable output to agriculturist of the country as a whole.

In agricultural sector water management means to provide proper irrigation facilities to the agricultural land present irrigation is one of the most important and crucial inputs in the process of agricultural development. Not only today but it has been practiced from very ancient time. In our country mention of irrigation work is made in the Vedas, Purana's and other epics. Recognizing the importance of this key input the irrigation potential of the country has been sought to be improved through the development of major, medium and minor irrigation projects. Since independence about 1127 major and medium irrigation projects were taken up which have been completed and 17 more are nearing to completion. The total irrigated area in our country was about 2.26 crores
hectares in 1950-51 which increased to about 12 crores hectares at the end of 2004-05. Out of which about 5 crores hectares is through major and medium projects and about 7 crores hectares through minor irrigation schemes. Thus, irrigation potential of the country has increase near about five times since the inception of the planning.

The British rulers in India did not evolve a clearcut and definite policy on the utilisation of India's water resources before 1947. During the Second World War, India had to suffer serious food shortage, ultimately resulting in the Bengal famine. The partition of the country worsened the food situation and grow-more-food and self-sufficiency in food became the most important short-term objectives of the Government at that time. At the same time, rapid industrial development launched soon after 1951 necessitated two things: the increased production of agricultural raw materials on the one side and the generation of electricity on the other. To these were added a third dimension, viz, flood control. For centuries, Damodar, Kosi and other rivers were the courage of the people living in the eastern states and accordingly, flood control was added as an important objective of management of water resources.

Thus, India's water policy since Independence or more specifically, since 1950-51, consisted of the construction of huge dams and reservoirs, distribution canals, etc., all of which were designated as major and medium irrigation works. Some were also known as multi-purpose projects, since they were designed to generate electric power, provide irrigation water to agriculture and drinking water to cities and control floods.
The Government launched a new agricultural strategy in 1962 in the form of intensive agricultural district programme (IADP) and high-yielding varieties programme (HYVP), water was a measure component of this programme. It was to support the new agricultural strategy, that the Government encouraged intensive utilization of ground water resources in the form of tubewell irrigation and surface wells. This form of irrigation was called minor irrigation. Even though the Government encouraged minor irrigation, it did not formulate any positive policies to prevent worthless and uncontrolled exploitation of ground water resources and/or for their regeneration.

In the formulation of its policy regarding utilisation and management of water resources, the Government did not consider the role and significance of traditional sources of water, viz. pond and tanks, small rivers, and watersheds. Their importance as sources of drinking water, means of irrigation, usefulness for controlling and moderating floods, use for inland fisheries, etc.-all these were ignored by the planners and policy makers.

A serious blunder our planners have committed and continue to commit is their reliance on big irrigation dams as a means of raising agricultural production. These gigantic dams costing hundreds and thousands of crores of rupees-because of poor planning, and bad execution-have brought much less benefits than were anticipated and have caused positive harm to people and the environment. They have already displaced millions of people mostly tribals, who are the poorest
and the most powerless in the country. They have drowned thousands of hectares of rich forests. Even though, one of the professed objectives of large dams is he prevention and control of floods, this objective is rarely achieved.

The most serious and damning condemnation of our reliance on big dams has come from, no less a person than Mr. Rajiv Gandhi, a former Prime Minister of India, who addressed the State Irrigation Ministers in 1986. “The situation today is that since 1951, 256 big surface irrigation projects have been initiated. Only 65 out of these have been completed. 181 are still under construction. This is not a happy state of affairs. We need some definite thrust from the projects that we started after 1970. Perhaps we can safely say that almost no benefit has come to the people from these projects. For 16 years we have poured money out. The people have got nothing back, no irrigation, no water, no increase in production, no help in their daily life. By pouring money out to a few contractors or a few thekedars and labourers to build canals and may be public works departments to construct the dam, we are not really doing our people a favour.” This blunt and damning criticism—coming not from an anti-dam activist but from the Prime Minister of the country—had absolutely no effect either on the planners or on the bureaucrats who continue to waste crores of rupees on huge multi-purpose river-valley projects.

The planner’s obsession with large irrigation projects has led to the neglect of tanks which at one time used to be the traditional and the most common form of irrigation in many parts of the country. Through
poor maintenance, tanks were allowed to fall into disuse because of siltation. To the planners and to our bureaucrats, tanks have always meant small technology and their upkeep and maintenance called for people’s participation and co-operation.

It is now generally realised that tanks are important for good water management and are substitutes for canal irrigation in medium rainfall areas. They help to reduce and moderate floods, recharge wells and provide drainage in high rainfall periods. They are beneficial wherever crop failures are common or where the rains recede early. The Second Irrigation Commission stated clearly: “Dug wells and tanks are, by and large, the most important source of irrigation in the drought areas.” Dr. Bhumbla, a former Commissioner of Agriculture, Government of India, states: “There is absolutely no doubt that if stress is laid on management of rainwater by storing the excess run-off, the average production of rice can be raised to 120 million tonnes and that of wheat to 70 million tonnes within the next 5 to 10 years.”

Ground Water resources. Ground water and its proper use assume great significance for a country such as India which faces continuous threat of drought and famines and “the big thirst” in less than 20 years from now. Unfortunately there is no accurate survey of ground water resources in the country but, according to one guesstimate, India’s ground water resources would be about 3,700 million hectare metres, or about 10 times the annual precipitation. The annual exploitable potential is put at 45 million hectare metres but only around 13 million hectare metres.
are being exploited at present. With the introduction of the new agricultural strategy in the early 1960's there has been increasing use of tube-wells. In 1961, only 1 percent of net irrigated land received tubewell irrigation but by 1990-91 about 30 percent of the net irrigated land got the benefit of tubewell irrigation. Actually, it is the ground water irrigation and not large dams and canals which is the basis of India’s green revolution.

Ruthless exploitation of ground water has also serious consequences. Since ground water withdrawal is greater than the recharge, the ground water table is declining rapidly. This problem is assuming serious proportions in many states especially in Maharashtra where there has been a major shift in cultivation from rainfed coarse grains to water-intensive sugarcane. Over-exploitation of groundwater can also lead to the intrusion of saline water, making the water unfit for drinking or irrigation.

There is another danger to ground water resources. In recent years, certain cases of dangerous pollution of groundwater have been reported from different parts of the country, e.g., pollution of groundwater by the effluents of tanneries in Tamil Nadu, by the textile printing and dyeing units in Kerala and Gujarat and so on. While pollution of rivers and lakes is easily detectable, pollution of ground water is rather difficult to detect and to rectify.

To conclude: India is one of the wettest countries of the world but it is not able to hold all the water it receives. Because of deforestation and denudation, a large portion of the monsoon water disappears into the
sea as surface run-off. Community resources such as ponds, tanks and rivers are misused and continuously neglected. Rivers are increasingly getting polluted as urban and industrial wastes are dumped into them. India’s water policy has concentrated on gigantic river system and reservoirs and despite huge investments on them, their productivity continues to be low. They have not helped in controlling or moderating floods. Nor are they cost effective, or ecologically desirable.

Ground water table has gone down dramatically in more intensely cropped areas, clearly indicating the need to increase recharges or to regulate pumping. In some areas, there is serious pollution danger to groundwater due to industrial wastes.

The UPA Government has started a pilot project for repair, renovation and restoration of water bodies directly linked to agriculture during the last two years of the Tenth Plan (vi., 2005-07). The pilot project will include work on repair of related structures such as check dams, weirs, bunds and water conveyance systems. The objectives of pilot projects on water bodies are:

(a) to restore and augment storage capacity of water bodies, and

(b) to recover and extend their lost irrigation potential.

1.2 Irrigation.

Irrigation is an artificial application of water to the soil. It is used to assist in the growing of agricultural crops, manitenance of landscapes
and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against forest, suppressing weed growing in grain fields and helping in preventing soil consolidation. In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dryland farming. Irrigation systems are also used for dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a given area.

Irrigation is also a term used in medical/dental fields to refer to flushing and washing out anything with water or another liquid.

1.3. Types of irrigation.

Various types of irrigation techniques differ in how the water obtained from the source is distributed within the field. In general, the goal is to supply the entire field uniformly with water, so that each plant has the amount of water it needs, neither too much nor too little. The modern methods are efficient enough to achieve this goal.

1.3.1 Surface irrigation.

In surface irrigation systems, water moves over and across the land by simple gravity flow in order to wet it and to infiltrate into the soil. Surface irrigation can be subdivided into furrow, borderstrip or basin irrigation. It is often called flood irrigation when the irrigation results in flooding or near of the cultivated land. Historically, this has been the
most common method of irrigating agricultural land.

Where water levels from the irrigation source permit, the levels are controlled by dikes, usually plugged by soil. This is often seen in terraced rice fields (rice paddies), where the method is used to flood or control the level of water in each distinct field. In some cases, the water is pumped or lifted by human or animal power to the level of the land.

1.3.2. Localized irrigation

Localized irrigation is a system where water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied as a small discharge to each plant or adjacent to it. Drip irrigation, spray or micro-sprinkler irrigation and bubbler irrigation belong to this category of irrigation methods.

1.3.3. Drip irrigation.

Drip irrigation, also known as trickle irrigation, functions as its name suggests. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water efficient method of irrigation, if managed properly, since evaporation and runoff are minimized. In modern agriculture, drip irrigation is often combined with plastic mulch, further reducing evaporation, and is also the means of delivery of fertilizer. The process is known as fertilization.

Deep percolation, where water moves below the root zone, can occur if a drip system is operated for too long of a duration or if the delivery rate is too high. Drip irrigation methods range from very high-
tech and comprised to low-tech and labor-intensive. Lower water pressures are usually needed than for most other types of systems, with the exception of low energy centre pivot systems and surface irrigation systems, and the system can be designed for uniformity throughout a field or for precise water delivery to individual plants in a landscape containing a mix of plant species. Although it is difficult to regulate pressure on steep slopes, pressure compensating emitters are available, so the field does not have to be level. High-tech solutions involve precisely calibrated emitters located along lines of tubing that extend from a computerized set of valves. Both pressure regulation and filtration to remove particles are important. The tubes are usually black (or buried under soil or mulch) to prevent the growth of algae and to protect the polythene from degradation due to ultraviolet light. But drip irrigation can also be as low-tech as a porous clay vessel sunk into the soil and occasionally filled from a hose or bucket. Subsurface drip irrigation has been used successfully on lawns, but it is more (or aesthetically pleasing) for lawns and golf courses. In the past one of the main disadvantages of the subsurface drip irrigation (SDI) systems, when used for turf, was the fact of havint to install the plastic lines very close to each other in the ground, therefore disrupting the turfgrass area. Recent technology developments on drip installers like the drip installer at New Mexico State University Arrow Head Center, places the line underground and covers the silt leaving no soil exposed.
1.3.4. Sprinkler irrigation.

In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high-pressure sprinklers or guns. A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed risers in often referred to as a solid set irrigation system. Higher pressure sprinklers that rotate are called rotors and are driven by a ball drive, gear drive, or impact mechanism. Rotors can be designed to rotate in a full or partial circle. Guns are similar to rotors, except that they generally operate at very high pressures of 40 to 130 lbf/in² (275 to 900 kPa) and flows of 50 to 1200 US gal/min (3 to 76 L/s), usually with nozzle diameters in the range of 0.5 to 1.9 inches (10 to 50 mm). Guns are used not only for irrigation, but also for industrial applications such as dust suppression and logging.

Sprinklers can also be mounted on moving platforms connected to the water source by a hose. Automatically moving wheeled systems known as travelling sprinklers may irrigate areas such as small farms, sports fields, parks, pastures and cemeteries unattended. Most of these utilize a length of polyethylene tubing wound on a steel drum. As the tubing is wound on the drum powered by the irrigation water or a small gas engine, the sprinkler is pulled across the field. When the sprinkler arrives back at the reel the system shuts off. This type of system is known to most people as a ‘waterreel’ traveling irrigation sprinkler and they are used extensively for dust suppression, irrigation, and land application of wastewater. Other travelers use a flat rubber hose that is dragged along behind
while the sprinkler platform is pulled by a cable. These cable-type travelers are definitely old technology and their use is limited in today's modern irrigation projects.

**1.3.5. Center pivot irrigation.**

Center pivot irrigation is a form of sprinkler irrigation consisting of several segments of pipe (usually galvanized steel or aluminum) joined together and supported by trusses, mounted on wheeled towers with sprinklers positioned along its length. The system moves in a circular pattern and is fed with water from the pivot point at the center of the arc. These systems are found and used in all parts of the nation and allow irrigation of all types of terrain. Newer irrigations have drops as shown in the image that follows.

Most center pivot systems now have drops hanging from a u-shaped pipe attached at the top of the pipe with sprinkler heads that are positioned a few feet (at most) above the crop, thus limiting evaporative losses. Drops can also be used with drag hoses or bubblers that deposit the water directly on the ground between crops. Crops are often planted in a circle to conform to the center pivot. This type of system is known as LEPA (Low Energy Precision Application). Originally, most center pivots were water powered. These were replaced by hydraulic systems (T-L Irrigation) and electric motor driven systems (Reinke, Valley, Zimmatic). Many modern sprinklers features GPS devices.

**1.3.6. Lateral move (side roll, wheel line) irrigation.**

A series of pipes, each with a wheel of about 1.5 m diameter
permanently affixed to its midpoint and sprinklers along its length, are coupled together at one edge of a field. Water is supplied at one end using a large hose. After sufficient water has been applied, the hose is removed and the remaining assembly rotated either by hand or with a purpose-built mechanism, so that the sprinklers move 10 m across the field. The hose is reconnected. The process is repeated until the opposite edge of the field is reached. This system is less expensive to install than a center pivot, but much more labor intensive to operate, and it is limited in the amount of water it can carry. Most systems utilize 4 to 5-inch (130 mm) diameter aluminium pipe. One feature of a lateral move system is that it consists of sections that can be easily disconnected. They are most often used for small or oddly shaped fields, such as those found in hilly or mountainous regions, or in regions where labor is inexpensive.

1.3.7. Sub-irrigation.

Subirrigation also sometimes called seepage irrigation has been used for many years in field crops in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants root zone. Often those systems are located on permanent grasslands in lowlands or river valleys and combined with drainage infrastructure. A system of pumping stations, canals, weirs and gates allow it to increase or decrease the water level in a network of ditches and thereby control the water table.

Sub-irrigation is also used in commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed upwards,
and the excess collected for recycling. Typically, a solution of water and nutrients floods a container or flows through a trough for as short period of time, 10-20 minutes, and is then pumped back into a holding tank for reuse. Sub-irrigation in greenhouses requires fairly sophisticated, expensive equipment and management. Advantages are water and nutrient conservation, and labor-saving through lowered system maintenance and automation. It is similar in principle and action to subsurface drip irrigation.

1.3.8. Manual irrigation using buckets or watering cans

These systems have low requirements for infrastructure and technical equipment but need high labor inputs. Irrigation using watering cans is to be found for example in peri-urban agriculture around large cities in some African countries.

1.3.9. Automatic, non-electric irrigation using buckets and ropes

Besides the common manual watering by bucket, an automated, natural version of this also exist. Using plain polyester ropes combined with a prepared ground mixture can be used to water plants from a vessel filled with water.

The ground mixture would need to be made depending on the plant itself, yet would mostly consist of black potting soil, vermiculite and perlite. This system would (with certain crops) allow to save expenses as it does not consume any electricity and only little water (unlike sprinklers, water timers, ...). However, it may only be used with certain crops (probably mostly larger crops that donot need to humid environment, perhaps e.g. paprikas).
1.3.10. Irrigation using water condensed from humid air

In countries where at night, humid air sweeps the countryside, water can be obtained from the humid air by condensation into cold surfaces. This is for example practiced in the vineyards at Lanzarote using stones to condense water or with various fog collectors based on canvas or foil sheets.

1.4. Sources of irrigation water.

Sources of irrigation water can be groundwater extracted from springs or by using wells, surface water withdrawn from rivers, lakes or reservoirs or non-conventional sources like treated wastewater, desalinated water or drainage water. A special form of irrigation using surface water is spate irrigation, also called floodwater harvesting. In case of a flood (spate) water is diverted to normally dry river beds (wadis) using a network of dams, gates and channels and spread over large areas. The moisture stored in the soil will be used thereafter to grow crops. Spate irrigation areas are in particular located in semi-arid or arid, mountainous regions. While floodwater harvesting belongs to the accepted irrigation methods, rainwater harvesting is usually not considered as a form of irrigation. Rainwater harvesting is the collection of runoff water from roofs or unused land and the concentration of this. Some of Ancient India's water systems were pulled by oxen.

1.5. How an in-ground irrigation system works.

Most commercial and residential irrigation systems are 'in ground' systems, which means that everything is buried in the ground. With the
pipes, sprinklers, emitters (drippers) and irrigation valves being hidden, it makes for a cleaner, more presentable landscape without garden hoses or other items having to be moved around manually. This does, however, create some drawbacks in the maintenance of a completely buried system.

1.5.1. Water source and piping.

The beginning of a sprinkler system is water source. This is usually a tap into an existing (city) water line or a pump that pulls water out of a well or a pond. The water travels through pipes from the water source through the valves to the sprinklers and emitters. The pipes from the water source up to the irrigation valves are called 'mainlines' and the lines from the valves to the emitters or sprinklers are called 'lateral lines'. Most piping used in irrigation systems today are HDPE and MDPE or PVC or PEX plastic pressure pipes due to their ease of installation and resistance to corrosion. After the water source, the water usually travels through a check valve. This prevents water in the irrigation lines from being back into the containing the clean water supply. Ideally a pressure control valve is also installed to regulate water pressure and help prevent excessive pressure from harming the system.

1.5.2. Controllers, zones, and valves.

Most irrigation systems are divided into zones. A zone is a single irrigation valve and one or a group of drippers or sprinklers that are connected by pipes or tubes. Irrigation systems are divided into zones because there is usually not enough pressure and available flow to run sprinklers for an entire yard or sports field at once. Each zone has a
solenoid valve on it that it controlled via wire by an irrigation controller. The irrigation controller is either a mechanical (now the 'dinosaur' type) or electrical device that signals a zone to turn on at a specific time and keeps it on for a specified amount of time. "Smart Controller" is a recent term used to describe a controller that is capable of adjusting the watering time by itself in response to current environmental conditions. The smart controller determines current conditions by means of historic weather data for the local area, a soil moisture sensors (water potential or water content), rain sensor, or in more sophisticated systems satellite feed weather station, or a combination of these.

1.5.3. Emitters & Sprinklers.

When a zone comes on, the water flows through the lateral lines and ultimately ends up at the irrigation emitter (drip) or sprinkler heads. Many sprinklers have pipe thread inlets on the bottom of them which allows a fitting and the pipe to be attached to them. The sprinklers are usually installed with the top of the head flush with the ground surface. When the water is pressurized, the head will pop up out of the ground and water the desired area until the valve closes and shuts off that zone. Once there is no more water pressure in the lateral line, the sprinklers head will retract back into the ground. Emitters are generally laid on the soil surface or buried a few inches to reduce evaporation losses.

1.6. Problems in irrigation.

Irrigation can lead to a number of problems:
1. Competition for surface water rights.

2. Depletion of underground aquifers.

3. Ground subsidence (e.g. New Orleans, Louisiana)

4. Underirrigation or irrigation giving only just enough water for the plant (e.g. in drip line irrigation) gives poor soil salinity control which leads to increased soil salinity with consequent build up of toxic salts on soil surface in areas with high evaporation. This requires either leaching to remove these salts and a method of drainage to carry the salts away. When using driplines, the leaching is best done regularly at certain intervals (with only a slight excess of water), so that the salt is flushed back under the plant’s roots.

5. Overirrigation because of poor distribution uniformity or management wastes water, chemicals and may lead to water pollution.

6. Deep drainage (from over-irrigation) may result in rising water tables which in some instances will lead to problems of irrigation salinity requiring watertable control by some form of subsurface land drainage.

7. Irrigation with saline or high-sodium water may damage soil structure owing to the formation of alkaline soil.
1.7. Importance of water for plants.

1. Water helps in germination of seeds.
2. It keeps the plant cool in summer and warm in winter.
3. Water makes the soil soft and helps the roots of plant to spread easily.
4. Water in the field is the best check for controlling insects like white ant, termites.
5. Water helps in transportation of nutrients from one part to another.
6. Water increases the activity of bacteria and other organisms in the soil which are useful.
7. Plants food exists in soil in solid form. It dissolves in water and then roots of plants are able to absorb it.

Although significant efforts have been made to develop the irrigation potential of the country through major and minor irrigation, yet there has been rather inadequate awareness of the economics of irrigation through different sources. Nodoubt various studies have been made in these areas but this area particularly still requires the deep study regarding the water management. These has been very little appreciation of the need for rational all allocation of water among different region, different crops and overtime. There is not a single study which deals the upper Ganga canal zone. Further, there has been a phenomenal growth in the number of electric motors and diesel engines in a bid to supplement canal water
supplies to take advantage of the new farm technology comprising H.Y.V.
of seeds, chemical fertilizers, pesticides, etc. The farmers have resorted
to mass adoption of electric motors and diesel engines in a bid to provide
assured irrigation to their crops. Due to lack of full control on power and
frequent breakdowns and cuts, the farmers have been maintaining diesel
engines in addition to the electric motors. In certain cases diesel engines
have been installed due to the facility of their movement from one bore
to the other. This sharp increase in tube-wells has resulted in creation
excess capacities due to the small and fragmented holdings of the farmers.
Further in certain areas, state tube-wells have been installed to provide
assured irrigation to the farmers.

Keeping in view, the water as a important resource of agricultural
input, the present study is intended to examine the different sources and
aspects of water management in all integrated manner and thus, provide
a macro perspective for formulation of rational policies for water
management in agricultural sector.

1.8. Objectives of the study.

As is clear from the above introductory discussion the agricultural
sector occupies an important role in our economic system and water is
one of the main input for agriculture. Therefore, the basic objective of
the study is to examine and analyse the various irrigation resources
available at present in rural areas and to suggest some important
measures for further improvement and also search out the new resources
for irrigation. In nutshell, the present proposed study is undertaken with
the following specific objective in the area of water management.

(1) To study the allocation of water by regions crops and overtime.

(2) To examine the economics of minor irrigation, electric motors, diesel engines & state tube-wells.

(3) To draw out policy implications and to make specific recommendations for further improvement.