2007-08

Field Training Report

Report submitted to-

Superintending Engineer & Administrator

Command Arad Development Authority,

Nagpur

(10/12/2007-19/01/2008)

अधीक्षक अभियंता व प्रशासक, लाभ क्षेत्र विकास प्राधिकरण, नागपुर
कार्यकारी अभियंता, लघु पाटबंधारे विभाग, नागपुर
उप–विभागीय अभियंता, पाटबंधारे उप–विभाग, नागपुर

Superintending Engineer and Administrator,
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सरळ सेवा भरतीने सहाय्यक कार्यकारी अभियंता या पदावर नियुक्ती दिलेल्या अधिकाऱ्यांसाठी क्षेत्रीय प्रशिक्षण कार्यक्रम, जलसंपदा विभाग

Field Training for Direct Recruits as Assistant Executive Engineer of Water Resource Department.

कालावधी: १०डिसेंबर २००७–१९ जानेवारी २००८ (६ आठवडे)
Duration: 10 December 2007-19 January 2008 96 weeks)

“क्षेत्रीय प्रशिक्षण अहवाल”

“FIELD TRAINING REPORT”

सादरकर्ता–
Submitted by-

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Executive Summary

Maharashtra Engineering Training Academy (META), Nashik organized training program for direct recruits - Assistant Executive Engineer of Water Resource Department (WRD), in accordance with Maharashtra Engineering Service Examination-2004. As per schedule of training program, group of Assistant Executive Engineer's was directed to undergo field training under the guidance of **Shri Ambadekar Saheb,** Superintending Engineer and Administrator, Command Area Development Authority, Nagpur to learn about the Irrigation Management and maintenance of completed projects.

As per his direction, we joined Executive Engineer, Shri. Raut Saheb, Minor Irrigation division, Nagpur. On 10th December 2007, we joined Irrigation Subdivision under the guidance of Shri. Wanode saheb after receiving orders from division office.

During our training session, we visited several projects including- Pench Project, Wunna project etc. We observed the water distribution procedure, water measurement devices, maintenance of dam and canal and administrative procedure.

This report includes the details of training program at Command Area Development Authority, Nagpur. It also contains the study and observations performed by me. It was nice experience since I could realize the importance of CADA. I learned valuable information regarding various Operation and maintenance of projects and collected reference materials and hand books from the sub-division office.

Acknowledgement

I take this opportunity to express my gratitude to those whose active help and support make this report possible in the present form.

First of all, I express my sincere gratitude to **Shri. Ambadekar Saheb**, Superintending Engineer and Administrator, CADA, and **Shri. Anil Raut Saheb**, Executive Engineer, CADA, Nagpur for insisting in me the drive to work hard and for inculcating in me the discipline to think clearly.

It is the endless guidance and constant encouragement of **Shri. Vanode Saheb**, Sub-Divisional Engineer, Irrigation Subdivision**,** and I would like to express my heartfelt gratitude to him for providing us necessary technical information along with field visits. He shared his valuable experiences with us and it was the most enjoyable part of training.

My special thanks to Sectional engineer- **Shri. R.A. Tillu** Saheb, for his active help and valuable guidance during site visit of Wunna River Project.

I am also indebted to Sectional Engineer **Shri. Jayant Garkar** Saheb for providing in-depth knowledge about 'Modified-Penmann Method' and **Shri. N.G. Oke** Saheb for memorable visit of the famous "Pench Project"

Definitely the knowledge, I received during this training session was a lifetime experience and it will serve as a foundation for my career.

Last, but not least, I wish to express my gratitude towards my parents- Shivaji and Rohini, my grandparents- Rangnath and Sitabai, my uncle Raosaheb and aunty Radhika who sacrificed a lot to give me a good education.

- Pravin Kolhe BE (Civil), MTech (IITK)
(Assistant Executive Engineer)

Content

Chapter 1 Need for Irrigation

1.1 Introduction

Irrigation is an artificial application of water to the soil for the following purposes

- Irrigation is needed for normal growth and yield of the plant.
- It is needed for metabolic processes of the plant.
- To reduce the soil temperature.
- For easy germination of the seeds from the soil.
- Irrigation water acts as a medium for transport of nutrients and photosynthesis in the plant system.
- To provide crop insurance against short duration drought.
- To washout dilute salts in the soil.
- To reduce the hazard of soil piping.
- To soften tillage pans.

1.2 Development of Irrigation In Maharashtra

Practice of irrigation has been in existence since time immemorial. Large and small surface tanks have been used for irrigation since ancient times. Lifting of water or diverting the same from small streams and rivers was also pursued in the olden age. In the Western Maharashtra, the first large scale irrigation work was constructed in the year 1870 on Krishna river near Karad known as Khodshi Weir and Krishna Canal system. The storage work was completed on the Mutha River in the year 1875 known as Khadakwaala storage reservoir. Thereafter, the storage works at Bhatghar, Chankapur, Darna, Bhandardara were constructed in the British Regime. In the Vidarbha area small tanks were taken up near Ramtek, Ghorajhari, Asola-Mendha and Naleshwar. In the Marathwada area no such tanks worth mentioning were constructed. However since 1954, good impetus for the construction of irrigation works was given and quite a number of schemes got completed.

1.3 Irrigation Acts

The state of Maharashtra consists of following there regions-

1. **Western Maharashtra**
2. **Vidarbha Region**
3. **Marathwada region**

The regions of Vidarbha and Marathwada have merged into the then Bombay State in the year 1956. There was not much irrigation practiced in the region of Marathwada before the merger of the state. Even then, **Hydrabad Irrigation Act** was prevalent in that region till the **Maharashtra Irrigation Act, 1976** was passed and made uniformly applicable to all the states from

1st January 1977. In the case of Vidarbha region, quite an appreciable irrigation was being practiced on the old tank like Ramtek, Ghorazari etc. Generally crop pattern followed was of Paddy and there used to be long term sanctions for Paddy besides sanctions on demand by the irrigators. In this region, **C.P. Irrigation Act** was prevalent till the Maharashtra irrigation Act was passed and made uniformly applicable to all state from 1st January 1977. In the case of Western Maharashtra, Irrigation has been in existence for over 100 years. Old Bombay Irrigation Act of 1879 and the rules framed by thereunder namely '**Bombay canal Rules of 1934'** continued to operate till the new act was passed.

1.4 Quantum of Water Required by Plants

1. Water requirement of a crop is the quantity of water needed for normal growth, development and yield and may be supplied by precipitation or by irrigation or by both. Water is needed mainly to meet the demands of evaporation (E), transpiration (T) and metabolic needs of the plants. The water requirement of any crop is dependent upon,
2. Crop factors like variety, growth stage, duration, plant population and growing season.
3. Soil factors like texture, structure, depth, and topography.
4. Climatic factors like temperature, relative humidity and wind velocity.
5. Crop management practices like tillage, fertilization, weeding etc.,

1.5 Quantum of Water Requirement (mm) of Different Crops

The interval between each rotation and the total number of watering required by crops, right from its sowing to its maturity has to be regulated depending up on the availability of water. So the engineer of a management work has to be quite conversant with the water requirement of different crops in the different seasons.

Crop	Water Requirement (mm)	Crop	Water Requirement (mm)
Rice	900 - 2500	**Sunflower**	350 - 500
Wheat	450 - 650	**Castor**	500
Sorghum	450 - 650	**Bean**	300-500
Maize	500 - 800	**Cabbage**	380-500
Sugarcane	1500 - 2500	**Banana**	1200-2200
Groundnut	500 - 700	**Citrus**	900-1200
Cotton	700 - 1300	**Grape**	500-1200
Soybean	450 - 700	**Pineapple**	700-1000
Tobacco	400 - 600	**Ragi**	400-450
Tomato	600 - 800	**Gingelly**	350-400
Potato	500 - 700	**Chillies**	500
Onion	350 - 550		

1.6 Stages of Crop When Irrigation is Required

- During the growth span, the plant passes through various phases and the stages of growth. The growth rhythm of plant is slow during some stages and fast during some other stages. Accordingly plant demands variable supply of water.
- The growth period of irrigated dry (ID) crops can generally be divided into 3 phases namely - vegetative, reproductive and ripening phases.

- Each of these phases has different stages.
  - **Vegetative phase:** The early vegetative phase consists of crop establishment or initial stage during the first 2 - 3 weeks after sowing. This is followed by crop development stage which last for 2 - 6 weeks in different crops.
  - **Reproductive or flowering phase:** The reproductive or flowering phase comprises the period from initiation of buds to 75 % flowering. This period in most of the seasonal ID crops last for 2 - 3 weeks and in two seasonal crops and perennial crops for 4 - 6 weeks or more.
  - **Ripening phase** the end product is formed. The flowering and yield formation period together is known as mid-season stage. During the last part of the ripening phase the crops undergo yellowing and drying to mature. This period is called maturity stage or late season stage and it last for 2 - 4 weeks in most crops. The entire reproductive phase is highly sensitive growth period when the growth rhythm is fast. Therefore the soil water stress should be avoided during this period. Active vegetative phase and yield formation stage are moderate in sensitivity while initial establishment and maturity stages are least sensitive to water stress.
- Some crops like Cotton, Groundnut and pulses even prefer stress during early vegetative growth to suppress excessive vegetative growth. In many crops the initial establishment and flowering stages are highly sensitive to excess water conditions resulting in poor performance of the root system and also shedding of flowers, in addition to lodging at maturity in some crops.

1.7 Sources of Irrigation

1.7.1 Canals:

The practice of equating a hectare of canal irrigation area with a hectare of area served by ground water is not appropriate. A striking analysis carried out in four states, Punjab, Andhra Pradesh, Haryana and Tamil Nadu has shown that the yield of food grains under well irrigation is very much higher compared to the yield under canal irrigation. The reason for this difference in yield between sources of water supply is not so far to seek. The farmer who depends on canal irrigation is at the mercy of a system over which he has no control.

The utility of irrigation is judged by the cropping intensity. In most parts of the country, the cropping intensity is 200 % in the tube well (or) dug well irrigated land as against 100 % or less in canal irrigated land. About 18 % of the tail end area in canal commands of South India are particularly vulnerable for erratic and insufficient supply of water, not only because of losses to the extent of 50 % due to seepage, percolation and evaporation in transit from the storage reservoir to the farmers field but also because farmers in the upper reaches of the systems often succeed in cornering more than their due entitlement of water.

1.7.2 Wells

A well is a hydraulic hole to the water strata. Water in the well stands at a height equal to the static water level. There are different types of wells namely open well, tube well, artesian well, and bore well.

a. **Open Wells**

   The dug out wells up to water bearing strata of the aquifer are open wells. They derive water from the formation hole to the ground surface. The large diameter of the open wells permits the storage of water.

b. **Tube Wells**

   These are sunk by inserting pipes below ground surface and passing through different geological formations of water bearing and non-water bearing strata.

c. **Artesian Wells**

   Due to pressure, water from well comes to the ground without pumping are generally known as artesian wells.

d. **Bore Wells**

   When ground water availability is at deeper layers exceeding 16 to 20 m with hard strata, bore wells are suggested.

1.7.3 Tanks

Large tanks irrigating more than 2000 ha are classified under medium irrigation source. Small water reservoirs behind earthen dams are tanks. Though the primary purpose of tank is for irrigating crops, it also provides drinking water for humans and cattle in the villages. Monsoon rains fall erratically and confined only to a few months in the year.

Irrigation tanks serve to store and regulate water for crop production. In drought prone areas, tanks are considered to be a useful life saving sources. But day by day the area irrigated by tanks decreases due to neglect of maintenance of tanks, environmental degradation, cultivation of foreshore areas and cultivation of tank beds.

1.7.4 Filter Points

These are shallow tube wells consisting of a well and a short length of casing pipe. Filter points are generally bored in deltaic regions where aquifer

formation are of coarse sand and gravel and are very near to the surface. In coastal sands open dug wells are to be lined with concrete rings which are costly and also the availability of water is dependent on seepage water and season.
To tap this water filter pipes (slotted filter pipes or PVC pipes with a conical bottom point) is driven inside the soil to a depth of about 9 to 15 m and water is lifted by means of ordinary pump set from this filter point.

1.7.5 Rainfall

Rainfall is dependent in different degrees, on the South-West monsoon, North-East monsoon, on shallow cyclonic depressions and disturbances and on violent local storms. India receives most of its rainfall from the South - West monsoon originating in the Indian Ocean. About 75 % of the rainfall is received in four months i.e., June to September. Unequal geographical distribution, unequal seasonal distribution and frequent departures from the normal rainfall characterize the rainfall of this country.

South - West Monsoon Rainfall received during the months of June - July is critical and the fate of the Kharif crop depends very largely on distribution and amount of rain during these two months. South-West monsoon is responsible for 75-80% or more of the total annual rainfall in the country.

North - East Monsoon during October - November cyclonic storms form in the Bay of Bengal and when they strike coastal Andhra Pradesh or Coromandel Coast they bring heavy rain to these areas. About 11 % of the total rainfall in the country is received during this season.

1.8 Methods of Irrigation

1.8.1 Flood Irrigation

Flooding method of irrigation is exclusive for lowland rice though it is used for some other crops also. Water is allowed from the channel into the field without much control on either side of the flow. It covers the entire field and moves almost unguided.

The ideal size of each plot or basin is 0.1 to 0.2 ha for economizing water. Uneven distribution and low water application efficiency are the common drawbacks of this method.

1.8.2 Basin Irrigation

Basin method is almost similar to check - basin method except that in the check-basin method entire field is irrigated while in basin method only the basin around the trees is irrigated.

This method is suitable for fruit crops. Basins are generally round in shape, occasionally square in shape. The basins are small when the trees are young and their size is increased with age of the trees. Basins are connected by an irrigation channel.

1.8.3 Check-Basin Method

Check-basin method of irrigation is the most common method among surface methods of irrigation. In this method the field is divided into small plots surrounded by small bunds on all the four sides.

Water from head channel is supplied to the filed channels one after the other. Each field channel supplies water to two rows of check basins and water is applied to one basin after another. This method is adopted when the field is quite large and is not easy to level the entire field. In such situations, the field is divided into small strips and each strip into several plots by putting bunds and these plots are called check basins.

The advantage of this method is that the water can be applied uniformly and effectively. It is suitable for close growing crops like groundnut, wheat, finger millet, pearl millet, paragrass etc.,. The disadvantages are more labour is required; more land is wasted under channels and bunds. Intercultivation is not possible due to bunds.

1.8.4 Border Strip Method

The field is divided into number of stripes by forming bunds of around 15 cm height. These parallel earth ridges are called borders, and are formed to guide a sheet of flowing water across a field.

The area between two borders is the border strip. Length of the strip ranges from 30 to 300 m and width from 3 to 15 m. However, the most common sizes are 60 to 90 m in length and 6 to 12 m in width.

The size of border strips depends on stream size, soil structure and slope of the land. The borders are laid out along the general slope or on the contour. Water from the channel is allowed into each strip at a time. This method is suitable for close growing crops and medium to heavy textured soils, but not suitable for sandy soils.

1.8.5 Drip Irrigation

It is defined as the precise, slow application of water in the form of discrete or continuous or tiny streams of miniature sprays through mechanical devices called emitters or applicators located at selected points along water delivery lines.

It is also called trickle irrigation. Drip irrigation is adopted extensively in areas of acute water scarcity and especially for crops such as

Coconut, Grape, Banana, Ber, Citrus, Sugarcane, Cotton, Maize, Tomato, Brinjal and plantation crops.

The advantages of drip irrigation are,

- No fertilizer nutrient loss due to localized application.
- High water distribution efficiency.
- Levelling of the field not necessary.
- Only root zone is saturated.
- Moisture always at field capacity in the root zone.
- Soil factor plays less important role in frequency of irrigation.
- No soil erosion.
- Highly uniform distribution of water i.e., controlled by each nozzle.
- Low labour cost.
- Variation in supply can be regulated by regulating the valves and drippers.
- Fertigation can be adopted with drip irrigation.
- The disadvantages of drip irrigation is expensive i.e., initial cost is more in installing drip method.

1.8.6 Sprinkler Irrigation

Sprinkler irrigation system conveys water from the source through pipes under pressure to the field and distributes over the field in the form of spray of 'rain like' droplets. It is also known as over head irrigation.

Different types of sprinkler systems namely portable, semi-portable, semi-permanent and permanent are in vogue. But due to increased labour costs and energy costs, different types of sprinklers are developed.

Centre-pivot system is largest sprinkler system with a single machine can irrigate up to 100 ha. A centre - pivot sprinkler consists of a series of sprinklers mounted on a lateral pipe, 50 - 800 m long, mounted or carried by a row of five or more mobile towers.

One end of the lateral is fixed on a pivot pad. The unit rotates around a centre pivot where water is pumped into the pipe, and water is distributed through sprinkler fitted on lateral. The limitations of this system are,

10 - 20 % of area is not irrigated at the corners of square or rectangular plot.

High energy requirement and Huge cost of the equipment.

Now lateral - move systems are developed to overcome the draw backs in centre-pivot system for irrigating square or rectangular plots. This irrigation system consists of lateral - move systems which move up and down the field.

Sprinkler irrigation can be advantageously chosen in the following situations-

- When the soil is too shallow eliminating the possibility of leveling of lands.
- When the land is too steep (> 1% slope).
- When light (< 5 cm) and frequent irrigations are to be given.
- When soils are very sandy (rapidly permeable coarse textured soils) and

- When supplemental irrigation is to be given to dry land crops during prolonged dry spells, without any land preparation.

Disadvantages

- o High winds (> 12 km/hr) cause improper distribution of water.
- o Evaporation losses are high from sprinkler irrigation especially under high temperature and low relative humidity conditions.
- o The initial cost is high,
- o Some sort of knowledge is needed for successful operation of sprinkler system.

1.9 Problems of Under Irrigation

- Under irrigation causes reduction in photosynthesis due to reduction in photosynthetic rate, chlorophyll content and leaf area.
- Due to under irrigation, water deficit occurs, as a result stomata are closed, so that reduction in transpiration takes place.
- Translocation of assimilates is also affected by water stress.
- Respiration rate decreases with increased moisture stress.
- Due to under irrigation enzymatic activity decreases. So that accumulation of sugars and amino acids takes place due to breakdown of carbohydrates and proteins.
- Due to under irrigation hormonal balance is altered.
- Due to under irrigation reduction in fixation, uptake and assimilation of nitrogen takes place.

1.10 Problems of Excess Irrigation

- Excess irrigation causes several changes in the soil and plant resulting in reduced growth and in some cases death of plants.
- Germinating seeds are sensitive to water logging since they are totally dependent on the surrounding soil space for oxygen supply.
- Yield of cereals depressed if the excess irrigation given at panicle development stage. iv. Excess water causes injury to the plant due to low oxygen supply to the root system and accumulation of toxic substances in soil and plant.
- Wilting of tobacco takes place when bright sunshine occurs after a prolonged wet spell.
- Leaching of nitrates and gentrification occurs resulting in nitrogen deficiency.

- . Shoot elongation, senescence, abscission and production of adventitious roots takes place as a result of continuous excess irrigation.
- Respiration in the roots change from aerobic to anaerobic with the result, toxic substances accumulates in roots and damages the root system.
- Permeability of roots decreased due to shortage of O2. It results in decreases water and nutrient uptake.

1.11 Losses of Water

- Generally water is last through leaching, drainage, evapotranspiration and runoff.
- The following disadvantages will be observed due to water loss,
- Soil becomes very hard.
- The germination percentage will be decreased.
- · The nutrients in the soil leach or evaporate.
- The root growth retards, so that plant becomes stunted as a result yields become reduced.
- Stomata become closed, so that the transpiration process caused as a result accumulation of gases or metabolic wastes increases, leads to death of the plant.
- · The soil micro organism activity decreases.

1.12 Water Use Efficiency

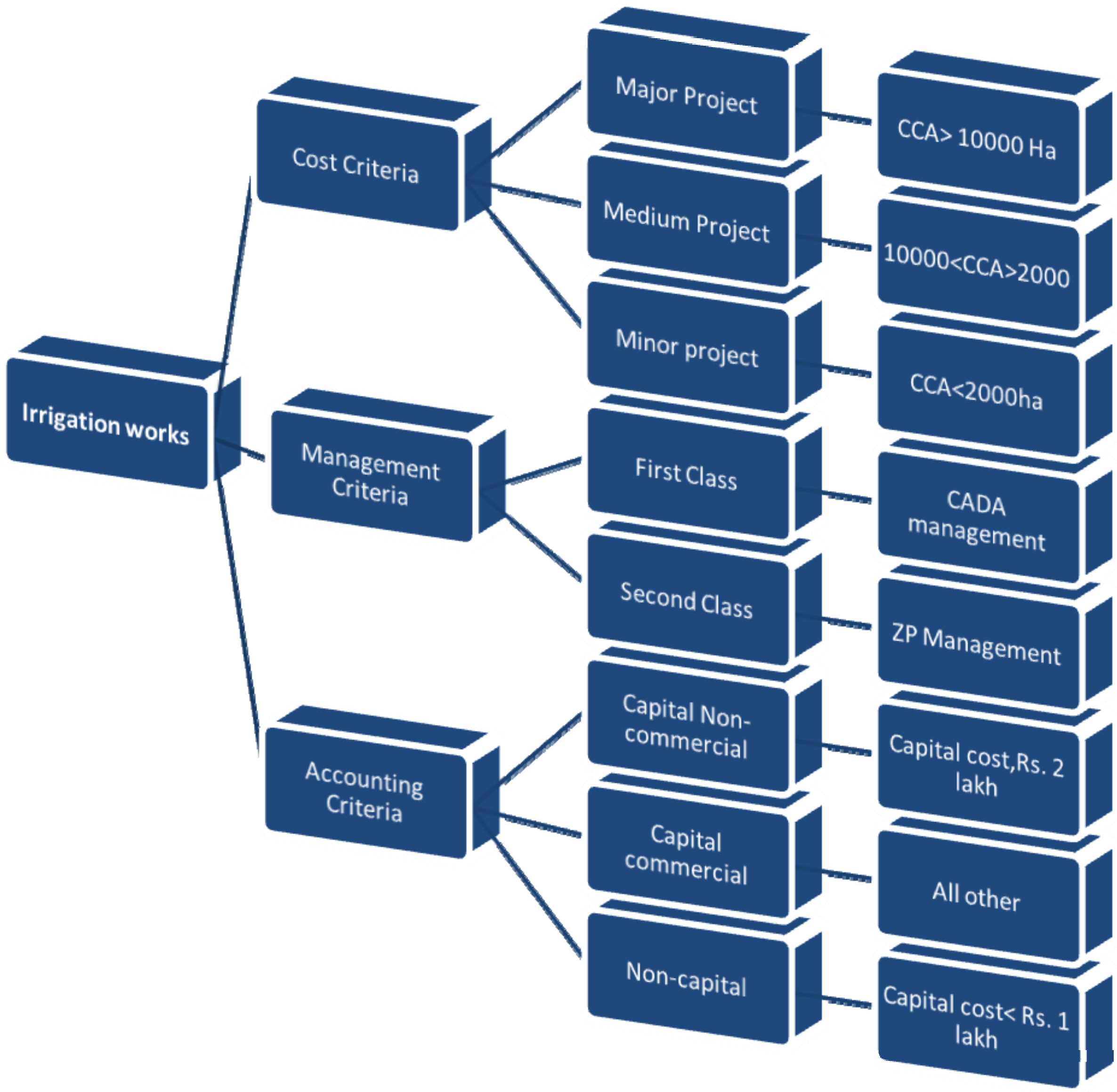
- Water use efficiency is the yield of marketable crop produced per unit of water used in evapotranspiration.
- WUE = Y/ET
- Water use efficiency is also known as crop water use efficiency or consumptive water use efficiency (Ecm) if the water used for metabolic purpose of the crop (G) and is included with ET.
- ECU = Y/G+ET
- If yield is proportional to ET, water-use efficiency has to be a constant but it is not so. Actually, Y and ET are influenced independently or differently by crop management practices, while ET is mainly dependent on climate and soil moisture. Fertilization and other cultural practices for high crop yields usually increase WUE. The factors affecting WUE are nature of the plant, agronomic practices, climate, ET, irrigation, fertilization and plant population.

- There are considerable differences between plant species to produce a unit dry matter per unit amount of water used resulting in widely varying values of water use efficiency. The water use efficiency for few crops is listed below.

Crop	Water requirement (mm)	Grain yield (kg/ha)	WUE (kg/ha mm)
Rice	2000	6000	3.0
Sorghum	500	4500	9.0
Pearlmillet	500	4000	8.0
Maize	625	5000	8.0
Groundnut	506	4680	9.2
Wheat	280	3534	12.6
Fingermillet	310	4137	13.4

Chapter 2 Irrigation Management

2.1 Classification of Irrigation works



2.2 Sanction of Irrigation demand

On completion of irrigation schemes, as cultivators are new to the canal irrigation, water supply to crop is allowed after giving sanction to the water applications of the cultivators. The Form of water application is known as-

Vidarbha Region : Form G
Western Maharashtra region : Form No. VII

This water supply is called as **'Demand'.** Form No. VII is application form on which water supply is sanctioned for a crop from its sowing to its maturity. Thus in the case of Kharif or Rabi seasonal crops, the water supply is allowed is for the entire year. In the case of sugarcane crop when the crop is standing beyond a period of full year, the additional sanction is also given separately for the period of over and above the year on Form VII.

Long Term sanction of water is practiced when cultivators become conversant with the above mentioned procedure of calling Water Demand forms (Form VII or G), then there is no need of such forms. So to avoid un-necessary the paper work, long term sanction of water is followed and it is again known by following names in these two regions.

Vidarbha Region : Agreement
Western Maharashtra region : Block System
Marathwada region : Form No. VII

2.3 Irrigation Management in Vidarbha Region-Old irrigation tanks

In the Vidarbha region water supply to irrigated crops is at present allowed by **field to field method** of irrigation, in which water is supplied from one field to another and not by water courses and individual outlets.
The irrigation demand is mostly for the Rice crop, and the tanks are constructed at Chanda, Bhandara and Nagpur districts. The water application for this request is called **Form G** and the supply system is known as **Demand System.** As the time passes, the cultivators get conversant with the procedure and they enter into long-term commitment with Water Resources Department, and this is known as **Agreement System.**
In 'Agreement System' if and when the permanent holder occupying not less than 2/3rd of the irrigable land or 95 percent of the total number of permanent holders of the irrigable land in village Mahal (part of the village) chak (Command of an outlet) apply for the water supply to the crop (mostly rice) an agreement is executed for a period of years for the supply irrigation

water at a fixed rate on a canal system. The rate at which the water supply is made under the agreement is called as **'Agreement Rate'.**

*The agreement may be made in **Form A of A-1,** depending upon the conditions as described in Form-A, **Part-I, Item 3** or Form A-1 **Part III Item 3 and 4.** Supplementary agreements are made in the **form 'B'** for the cultivators who desire to enter into the agreement at a later date. The agreement comes in force after the inquiry is made by the Irrigation Inspector or Canal deputy Collector and declaration of his finding made under Form C .*

In the new irrigation works which have been taken for construction by Government of Maharashtra are designed to received the water supply through distributaries and individual outlets, similar to that of Western Maharashtra.

2.4 Irrigation Management in Western Maharashtra

In the Western Maharashtra Region the following types of blocks are in force-

- Sugarcane Blcok 'A' Type (1:4 cane blcok)
- Sugarcane Blcok 'B' Type (1:3 cane blcok)
- Fruit Block
- Garden Block (1/3:1/3:1/3)
- Garden and Seasonal Block (0.5:0.5)
- Three Seasonal Block
- Two Seasonal Block
- Rabi Block

2.5 Irrigation Management in Marathwada Region

In the Marathwada Region above block system is yet to be introduced on canal system and the water supply is permitted on Form No. VII. However, on Purna Canal System which has command area in the Parbhani and Nanded districts, the following special types of blocks are proposed-

- Sugarcane Blcok
- Rice Block
- Other perennial block- Fruit and grass block
- Long staple cotton block
- Turmeric block(0.5:0.5)
- Rabi Block

2.6 Procedure for receiving water application

Cultivator registers his demand in 'Application Register'

'Application Register' is maintained at Sectional Office, Sub-Division and Division

Sectional Officer with scrutinize the applications and passed to SDE

SDE will recommend the applicatiosn to Division office with remark as 'Sanctioned/Rejected'

Eligible applications are sactioned by EE and passes issued to irrigator.

All these sactions are entered in register- "Block Register"

These Block Registers are signed by Canal Officer as a token of record.

Sactioned irrigatior have to apply for water on issue of such notice.

Irrigator has to attach 7/12 form and reference to the preveous sanctions, if any.

2.7 Panchanama

For efficient and smooth running of irrigation system and able to administer day-to-day control the water supply, the there is a need of levy of certain punishment in case of unauthorized use of water or irrigation system.
Following are the broad aspects giving guidelines for control of irrigation management-

1. Water supply ONLY to sanctioned cultivators
2. Tail-to-Head irrigation system
3. Preparation of *Shejpali Patrak*
4. No obstruction to flow
5. Not more than one irrigation in one rotation

If it is observed that above rules are not followed then penal action is taken against the person, confirming the rules made under Maharashtra Irrigation Act.

Types of unauthorized irrigations-

1. Technical Panchanama
2. Bigar Pali
3. Gairkayada Panchanama
4. Double Watering
5. Waste of water
6. Purely unauthorized irrigation

2.8 Irrigation revenue-Water rates

Major, medium and minor irrigation projects are constructed and maintained by Government. Water is supplied to the cultivators on the basis of their demand received through water water applications invited by the management staff, by time-to-time. Government, therefore, has to deploy the services of Revenue Establishment for smooth running of the canal system and efficient water supply to the cultivators. It is therefore very necessary that the expenditure incurred by Government on the running and maintenance of the irrigation works is met with the irrigation revenue. Government has therefore to levy a water tax on the supply of water to-

a. Irrigators
b. Industries and domestic consumers

Water rates will depend on-

1. The total recoveries on the account of the water rate should NOT be less than actual cost incurred.
2. Water rate for crop should be equal to equitable and should be related to the ability of the crop to bear it.

3. Water rate should be so pitched so not to leave any irrigation potential unutilized on account of either the system of charging rates or the level of particular rates in fixing the crop rate following considerations are taken into account-
    a. Cost of irrigated water required by the crop
    b. Average gross income of crop.

2.9 Betterment Levy

Due to advent of irrigation systems values of land under their command increases. In order to meet rising cost of irrigation projects as well as to raise the capital for the new irrigation schemes, Government has to tap various sources. As irrigators derive benefit of increased value of their land, it is justifiable that Government should share some part of the unearned increment to irrigators. It was therefore, thought to impose betterment levy on the lands coming under the command of irrigation system.

2.10 Percentage check on crops

On the basis of water supply sanctioned to different crops water rates are leviable and before the crop s harvested, cultivated area must be measured in a field book known as '**Tippan Book**'
In order to exercise appropriate check on the work of the measures, irrigation officer have to give prescribed percentage check as under-

Officer	Percentage check on crops
Executive Engineer	1% of the area on canal
Sub-Divisional Engineer	2% of the area in each section
Sectional Officer	7% of the area in each village

Chapter 3 Preliminary Irrigation Programme

3.5 Yearly Water Planning on storage reservoirs

In the northern part of India viz., in Uttar Pradesh and Punjab, the canals are fed continuously from the run of the river and plentiful of water is available to the irrigations. Similarly, in the southern state there is no restriction on the quantity of water drawn in the canal as the entire area is practically under one crop. However, in the Maharashtra state there is positive need for the regulation of the quantity of water to be supplied to the crops in the command; because all the variety of crops are grown by the cultivators and the quantum of water available, proportionate to the demand is just adequate, advance water planning has to be done for the entire Irrigation Year.

3.6 Preliminary Irrigation Programme

On *07th January 2007,* we discussed the Irrigation Program with **Shri. Vanode Saheb, SDE**, and he explained basic assumption while formulating the irrigation program, which is - the cropping pattern as envisaged at the time of formulation of the irrigation project is such that all water available in the storage is fully utilized before the next replenishment is received. However, if the catchment area is not assured with reliable rainfall then a certain quantum of water is allowed to be stored as carry-over and carried to be next year. This “Carry Over” enables the engineer to tide over the deficit water storage situation in a bad year and to supply water at least to perennial crops and honour the standing commitments.
In case of medium projects, while dealing with the storage capacity, the irrigation in Kharif season is allowed water supply to the extent of 20 percent of the total Kharif requirements from storage while remaining Kharif requirement is planned to utilize the water from the overflow or from the run-off the river as the case may be.
In order to fix up the programme of utilization it is necessary to know the irrigation year and the season thereunder.
*Dependable yield for **major** and **medium** project : 75 percent*
*Dependable yield for **minor** project : 50~60 percent*

The Irrigation Year is reckoned from 1st July to 30th June next year.

Kharif Season

- 1 July-14 Oct

Rabi Season

- 15 Oct-28 Feb

Hot weather

- 1 Mar-30 June

The PIP has to be very realistic and based on the probable demands of the cultivators in the command. The planning has therefore, to be such that all the available water in the storage as on 15th Oct is fully utilized by the end of the Irrigation year. It is also customary to prepare a supplementary irrigation programme by January every year so as to account for the actual utilization of the water during the past 3 to 3.5 months and to revise the forecast of the utilization of the balance of water completely during ensuring hot weather season.

Chapter 4. Water Requirement of crops

4.1 Introduction

This chapter explains the concepts of and the differences between reference crop evapotranspiration (ETo) and crop evapotranspiration under standard conditions (ETc) and various management and environmental conditions (ETc adj). It also examines the factors that affect evapotranspiration, the units in which it is normally expressed and the way in which it can be determined.

4.2 Factors affecting Water requirement of crops

The interactive discussion with **Shri. Vanode saheb** results in in-depth knowledge gaining phenomenon. The role of 'Management-engineer' is very crucial while dealing with the water requirement of crops, since it involves several factors as mentioned below-

Factors pertaining to Climatology-

- Rainfall, intensity and distribution
- Temperature
- Wind
- Evaporation
- Humidity

Factors pertaining to Soil and topography-

- Type and texture of soil
- Fertility
- slope of ground
- Water table

Factors pertaining to Cultivation

- Irrigation method
- Drainage condition
- Extent of irrigation beds

Factors pertaining to Water supply

- Adequate supply of water during growth period
- Method of supply of water.

4.3 Methods of supply of irrigation water.

There are following two methods water supply of water for irrigation-

1. Water Supply on area basis
2. Water Supply on Volumetric basis.

It is important to note that presently under MWSIP[1] scheme, it is proposed to supply irrigation water on volumetric basis to the WUA[2]

[1] Maharashtra Water Sector Improvement Project
[2] Water User Associations

4.4 Evapotranspiration process

The combination of two separate processes whereby water is lost on the one hand from the soil surface by evaporation and on the other hand from the crop by transpiration is referred to as evapotranspiration (ET).

Evaporation

Evaporation is the process whereby liquid water is converted to water vapor (vaporization) and removed from the evaporating surface (vapor removal). Water evaporates from a variety of surfaces, such as lakes, rivers, pavements, soils and wet vegetation.

Energy is required to change the state of the molecules of water from liquid to vapor. Direct solar radiation and, to a lesser extent, the ambient temperature of the air provide this energy. The driving force to remove water vapor from the evaporating surface is the difference between the water vapor pressure at the evaporating surface and that of the surrounding atmosphere. As evaporation proceeds, the surrounding air becomes gradually saturated and the process will slow down and might stop if the wet air is not transferred to the atmosphere. The replacement of the saturated air with drier air depends greatly on wind speed. Hence, solar radiation, air temperature, air humidity and wind speed are climatological parameters to consider when assessing the evaporation process.

Where the evaporating surface is the soil surface, the degree of shading of the crop canopy and the amount of water available at the evaporating surface are other factors that affect the evaporation process. Frequent rains, irrigation and water transported upwards in a soil from a shallow water table wet the soil surface. Where the soil is able to supply water fast enough to satisfy the evaporation demand, the evaporation from the soil is determined only by the meteorological conditions. However, where the interval between rains and irrigation becomes large and the ability of the soil to conduct moisture to pear the surface is small, the water content in the topsoil drops and the soil surface dries out. Under these circumstances the limited availability of water exerts a controlling influence on soil evaporation. In the absence of any supply of water to the soil surface, evaporation decreases rapidly and may cease almost completely within a few days.

Transpiration

Transpiration consists of the vaporization of liquid water contained in plant tissues and the vapour removal to the atmosphere. Crops predominately lose their water through stomata. These are small openings on the plant leaf through which gases and water vapour pass (Figure 1). The water, together with some nutrients, is taken up by the roots and transported through the plant. The vaporization occurs within the leaf, namely in the intercellular spaces, and the vapour exchange with the atmosphere is controlled by the stomatal aperture. Nearly all water taken up is lost by transpiration and only a tiny fraction is used within the plant.

Transpiration, like direct evaporation, depends on the energy supply, vapour pressure gradient and wind. Hence, radiation, air temperature, air humidity and wind terms should be considered when assessing transpiration. The soil water content and the ability of the soil to conduct water to the roots also determine the transpiration rate, as do water logging and soil water salinity. The transpiration rate is also influenced by crop characteristics, environmental aspects and cultivation practices. Different kinds of plants may have different transpiration rates. Not only the type of crop, but also the crop development, environment and management should be considered when assessing transpiration.

Evapotranspiration (ET)

Evaporation and transpiration occur simultaneously and there is no easy way of distinguishing between the two processes. Apart from the water availability in the topsoil, the evaporation from a cropped soil is mainly determined by the fraction of the solar radiation reaching the soil surface. This fraction decreases over the growing period as the crop develops and the crop canopy shades more and more of the ground area. When the crop is small, water is predominately lost by soil evaporation, but once the crop is well developed and completely covers the soil, transpiration becomes the main process. In Figure 2 the partitioning of evapotranspiration into evaporation and transpiration is plotted in correspondence to leaf area per unit surface of soil below it. At sowing nearly 100% of ET comes from evaporation, while at full crop cover more than 90% of ET comes from transpiration.

4.5 Units

The evapotranspiration rate is normally expressed in millimeters (mm) per unit time. The rate expresses the amount of water lost from a cropped surface in units of water depth. The time unit can be an hour, day, decade, month or even an entire growing period or year. As one hectare has a surface of 10000 m^2 and 1 mm is equal to 0.001 m, a loss of 1 mm of water corresponds to a loss of 10 m^3 of water per hectare. In other words, 1 mm day^{-1} is equivalent to 10 m^3 ha^{-1} day^{-l}. Water depths can also be expressed in terms of energy received per unit area. The energy refers to the energy or heat required to vaporize free water. This energy, known as the latent heat of vaporization (l), is a function of the water temperature. For example, at 20°C, l is about 2.45 MJ kg^{-1}. In other words, 2.45 MJ are needed to vaporize 1 kg or 0.001 m^3 of water. Hence, an energy input of 2.45 MJ per m^2 is able to vaporize 0.001 m or 1 mm of water, and therefore 1 mm of water is equivalent to 2.45 MJ m^{-2}. The evapotranspiration rate expressed in units of MJ m^{-2} day^{-1} is represented by l ET, the latent heat flux. **Table 1** summarizes the units used to express the evapotranspiration rate and the conversion factors.

TABLE 1. Conversion factors for evapotranspiration

	depth	**volume per unit area**		**energy per unit area**[1]
	mm day^{-1}	**m^3 ha^{-1} day^{-1}**	**l s^{-1} ha^{-1}**	MJ M^{-2} DAY^{-1}
1 mm day^{-1}	1	10	0.116	2.45
1 m^3 ha^{-1} day^{-1}	0.1	1	0.012	0.245
1 l s^{-1} ha^{-1}	8.640	86.40	1	21.17
1 MJ m^{-2} day^{-1}	0.408	4.082	0.047	1

4.6 Factors affecting evapotranspiration

Weather parameters, crop characteristics, management and environmental aspects are factors affecting evaporation and transpiration. The related ET concepts presented in Figure 3 are discussed in the section on evapotranspiration concepts.

Weather parameters

The principal weather parameters affecting evapotranspiration are radiation, air temperature, humidity and wind speed. Several procedures have been developed to assess the evaporation rate from these parameters. The evaporation power of the atmosphere is expressed by the reference crop

[1] For water with a density of 1000 kg m^{-3} and at 20°C.

evapotranspiration (ETo). The reference crop evapotranspiration represents the evapotranspiration from a standardized vegetated surface. The ETo is described in detail later in this Chapter and in Chapters 2 and 4.
Crop factors

The crop type, variety and development stage should be considered when assessing the evapotranspiration from crops grown in large, well-managed fields. Differences in resistance to transpiration, crop height, crop roughness, reflection, ground cover and crop rooting characteristics result in different ET levels in different types of crops under identical environmental conditions. Crop evapotranspiration under standard conditions (ETc) refers to the evaporating demand from crops that are grown in large fields under optimum soil water, excellent management and environmental conditions, and achieve full production under the given climatic conditions.
Management and environmental conditions

Factors such as soil salinity, poor land fertility, limited application of fertilizers, the presence of hard or impenetrable soil horizons, the absence of control of diseases and pests and poor soil management may limit the crop development and reduce the evapotranspiration. Other factors to be considered when assessing ET are ground cover, plant density and the soil water content. The effect of soil water content on ET is conditioned primarily by the magnitude of the water deficit and the type of soil. On the other hand, too much water will result in water logging which might damage the root and limit root water uptake by inhibiting respiration.

When assessing the ET rate, additional consideration should be given to the range of management practices that act on the climatic and crop factors affecting the ET process. Cultivation practices and the type of irrigation method can alter the microclimate, affect the crop characteristics or affect the wetting of the soil and crop surface. A windbreak reduces wind velocities and decreases the ET rate of the field directly beyond the barrier. The effect can be significant especially in windy, warm and dry conditions although evapotranspiration from the trees themselves may offset any reduction in the field. Soil evaporation in a young orchard, where trees are widely spaced, can be reduced by using a well-designed drip or trickle irrigation system. The drippers apply water directly to the soil near trees, thereby leaving the major part of the soil surface dry, and limiting the evaporation losses. The use of mulches, especially when the crop is small, is another way of substantially reducing soil evaporation. Anti-transpirants, such as stomata-closing, film-forming or reflecting material, reduce the water losses from the crop and hence the transpiration rate.

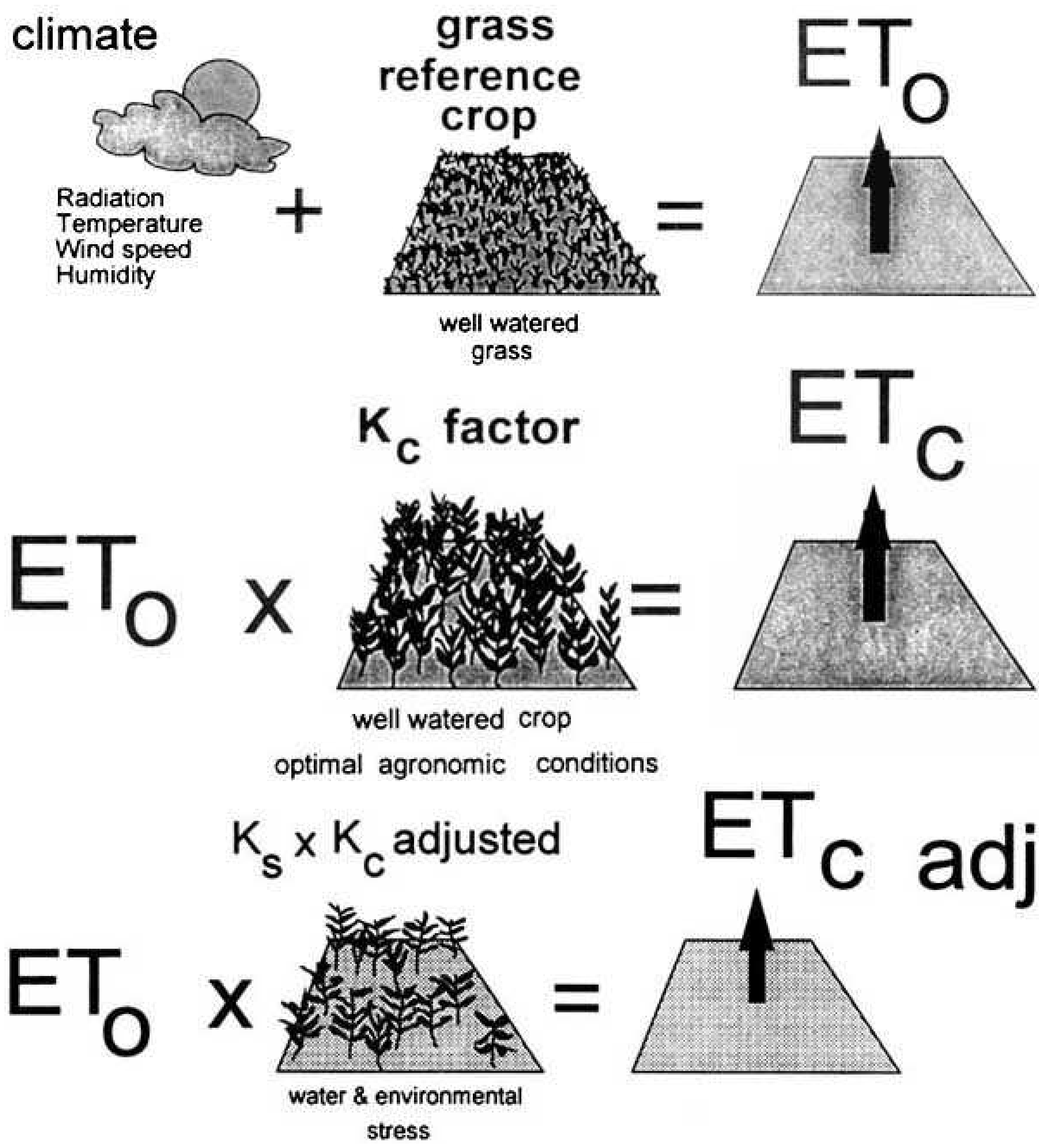


FIGURE 4. Reference (ETo), crop evapotranspiration under standard (ETc) and non-standard conditions (ETc adj)

4.7 Evapotranspiration concepts

Distinctions are made (Figure 4) between reference crop evapotranspiration (ETo), crop evapotranspiration under standard conditions (ETc) and crop evapotranspiration under non-standard conditions (ETc adj). ETo is a climatic parameter expressing the evaporation power of the atmosphere. ETc refers to the evapotranspiration from excellently managed, large, well-watered fields that achieve full production under the given climatic conditions. Due to sub-optimal crop management and environmental constraints that affect crop growth and limit evapotranspiration, ETc under non-standard conditions generally requires a correction.

Reference crop evapotranspiration (ETo)

The evapotranspiration rate from a reference surface, not short of water, is called the reference crop evapotranspiration or reference evapotranspiration and is denoted as ETo. The reference surface is a hypothetical grass reference crop with specific characteristics. The use of other denominations such as potential ET is strongly discouraged due to ambiguities in their definitions.

The concept of the reference evapotranspiration was introduced to study the evaporative demand of the atmosphere independently of crop type, crop development and management practices. As water is abundantly available at the reference evapotranspiring surface, soil factors do not affect ET. Relating ET to a specific surface provides a reference to which ET from other surfaces can be related. It obviates the need to define a separate ET level for each crop and stage of growth. ETo values measured or calculated at different locations or in different seasons are comparable as they refer to the ET from the same reference surface.

The only factors affecting ETo are climatic parameters. Consequently, ETo is a climatic parameter and can be computed from weather data. ETo expresses the evaporating power of the atmosphere at a specific location and time of the year and does not consider the crop characteristics and soil factors. The FAO Penman-Monteith method is recommended as the sole method for determining ETo. The method has been selected because it closely approximates grass ETo at the location evaluated, is physically based, and explicitly incorporates both physiological and aerodynamic parameters. Moreover, procedures have been developed for estimating missing climatic parameters.

Typical ranges for ETo values for different agroclimatic regions are given in Table 2. These values are intended to familiarize inexperienced users with typical ranges, and are not intended for direct application. The calculation of the reference crop evapotranspiration is discussed in Part A of this handbook (Box 1).

Crop evapotranspiration under standard conditions (ETc)

The crop evapotranspiration under standard conditions, denoted as ETc, is the evapotranspiration from disease-free, well-fertilized crops, grown in large fields, under optimum soil water conditions, and achieving full production under the given climatic conditions.
The amount of water required to compensate the evapotranspiration loss from the cropped field is defined as crop water requirement. Although the values for crop evapotranspiration and crop water requirement are identical, crop water requirement refers to the amount of water that needs to be supplied, while crop evapotranspiration refers to the amount of water that is lost through evapotranspiration. The irrigation water requirement basically represents the difference between the crop water requirement and effective precipitation. The irrigation water requirement also includes additional water for leaching of salts and to compensate for non-uniformity of water application. Calculation of the irrigation water requirement is not covered in this publication, but will be the topic of a future Irrigation and Drainage Paper.

Crop evapotranspiration can be calculated from climatic data and by integrating directly the crop resistance, albedo and air resistance factors in the Penman-Monteith approach. As there is still a considerable lack of information for different crops, the Penman-Monteith method is used for the estimation of the standard reference crop to determine its evapotranspiration rate, i.e., ETo. Experimentally determined ratios of ETc/ETo, called crop coefficients (Kc), are used to relate ETc to ETo or ETc = Kc ETo.

Differences in leaf anatomy, stomatal characteristics, aerodynamic properties and even albedo cause the crop evapotranspiration to differ from the reference crop evapotranspiration under the same climatic conditions. Due to variations in the crop characteristics throughout its growing season, Kc for a given crop changes from sowing till harvest. The calculation of crop evapotranspiration under standard conditions (ETc) is discussed in Part B of this handbook (Box 2).
Crop evapotranspiration under non-standard conditions (ETc adj)

The crop evapotranspiration under non-standard conditions (ETc adj) is the evapotranspiration from crops grown under management and environmental conditions that differ from the standard conditions. When cultivating crops in fields, the real crop evapotranspiration may deviate from ETc due to nonoptimal conditions such as the presence of pests and diseases, soil salinity, low soil fertility, water shortage or waterlogging. This may result in scanty plant growth, low plant density and may reduce the evapotranspiration rate below ETc.

The crop evapotranspiration under non-standard conditions is calculated by using a water stress coefficient Ks and/or by adjusting Kc for all kinds of other stresses and environmental constraints on crop evapotranspiration. The adjustment to ETc for water stress, management and environmental constraints is discussed in Part C of this handbook (Box 3).

4.8 Determining evapotranspiration

ET measurement

Evapotranspiration is not easy to measure. Specific devices and accurate measurements of various physical parameters or the soil water balance in lysimeters are required to determine evapotranspiration. The methods are often expensive, demanding in terms of accuracy of measurement and can only be fully exploited by well-trained research personnel. Although the methods are inappropriate for routine measurements, they remain important for the evaluation of ET estimates obtained by more indirect methods.
Energy balance and microclimatological methods

Evaporation of water requires relatively large amounts of energy, either in the form of sensible heat or radiant energy. Therefore the evapotranspiration process is governed by energy exchange at the vegetation surface and is limited by the amount of energy available. Because of this limitation, it is possible to predict the evapotranspiration rate by applying the principle of energy conservation. The energy arriving at the surface must equal the energy leaving the surface for the same time period.

All fluxes of energy should be considered when deriving an energy balance equation. The equation for an evaporating surface can be written as:

Rn - G - l ET - H = 0 (1)

where Rn is the net radiation, H the sensible heat, G the soil heat flux and l ET the latent heat flux. The various terms can be either positive or negative. Positive Rn supplies energy to the surface and positive G, l ET and H remove energy from the surface (Figure 5).

In Equation 1 only vertical fluxes are considered and the net rate at which energy is being transferred horizontally, by advection, is ignored. Therefore the equation is to be applied to large, extensive surfaces of homogeneous vegetation only. The equation is restricted to the four components: Rn, l ET, H and G. Other energy terms, such as heat stored or released in the plant, or the energy used in metabolic activities, are not considered These terms account for only a small fraction of the daily net radiation and can be considered negligible when compared with the other four components.

The latent heat flux (l ET) representing the evapotranspiration fraction can be derived from the energy balance equation if all other components are known. Net radiation (Rn) and soil heat fluxes (G) can be measured or estimated from climatic parameters. Measurements of the sensible heat (H) are however complex and cannot be easily obtained. H requires accurate measurement of temperature gradients above the surface.

Another method of estimating evapotranspiration is the mass transfer method. This approach considers the vertical movement of small parcels of air (eddies) above a large homogeneous surface. The eddies transport material (water vapour) and energy (heat, momentum) from and towards the evaporating surface. By assuming steady state conditions and that the eddy transfer coefficients for water vapour are proportional to those for heat and momentum, the evapotranspiration rate can be computed from the vertical gradients of air temperature and water vapour via the Bowen ratio. Other direct measurement methods use gradients of wind speed and water vapour. These methods and other methods such as eddy covariance, require accurate measurement of vapour pressure, and air temperature or wind speed at different levels above the surface. Therefore, their application is restricted to primarily research situations.

Soil water balance

Evapotranspiration can also be determined by measuring the various components of the soil water balance. The method consists of assessing the incoming and outgoing water flux into the crop root zone over some time period (Figure 6). Irrigation (I) and rainfall (P) add water to the root zone. Part of I and P might be lost by surface runoff (RO) and by deep percolation (DP) that will eventually recharge the water table. Water might also be transported upward by capillary rise (CR) from a shallow water table towards the root zone or even transferred horizontally by subsurface flow in (SFin) or out of (SFout) the root zone. In many situations, however, except under conditions with large slopes, SFin and SFout are minor and can be ignored.

Soil evaporation and crop transpiration deplete water from the root zone. If all fluxes other than evapotranspiration (ET) can be assessed, the evapotranspiration can be deduced from the change in soil water content (D SW) over the time period:

ET = I + P - RO - DP + CR ± D SF ± D SW (2)

Some fluxes such as subsurface flow, deep percolation and capillary rise from a water table are difficult to assess and short time periods cannot be considered. The soil water balance method can usually only give ET estimates over long time periods of the order of week-long or ten-day periods.

Lysimeters

By isolating the crop root zone from its environment and controlling the processes that are difficult to measure, the different terms in the soil water balance equation can be determined with greater accuracy. This is done in lysimeters where the crop grows in isolated tanks filled with either disturbed or undisturbed soil. In precision weighing lysimeters, where the water loss is directly measured by the change of mass, evapotranspiration can be obtained with an accuracy of a few hundredths of a millimetre, and small time periods such as an hour can be considered. In non-weighing lysimeters the evapotranspiration for a given time period is determined by deducting the drainage water, collected at the bottom of the lysimeters, from the total water input.

A requirement of lysimeters is that the vegetation both inside and immediately outside of the lysimeter be perfectly matched (same height and leaf area index). This requirement has historically not been closely adhered to in a majority of lysimeter studies and has resulted in severely erroneous and unrepresentative ETc and Kc data.

As lysimeters are difficult and expensive to construct and as their operation and maintenance require special care, their use is limited to specific research purposes.
ET computed from meteorological data

Owing to the difficulty of obtaining accurate field measurements, ET is commonly computed from weather data. A large number of empirical or semi-empirical equations have been developed for assessing crop or reference crop evapotranspiration from meteorological data. Some of the methods are only valid under specific climatic and agronomic conditions and cannot be applied under conditions different from those under which they were originally developed.

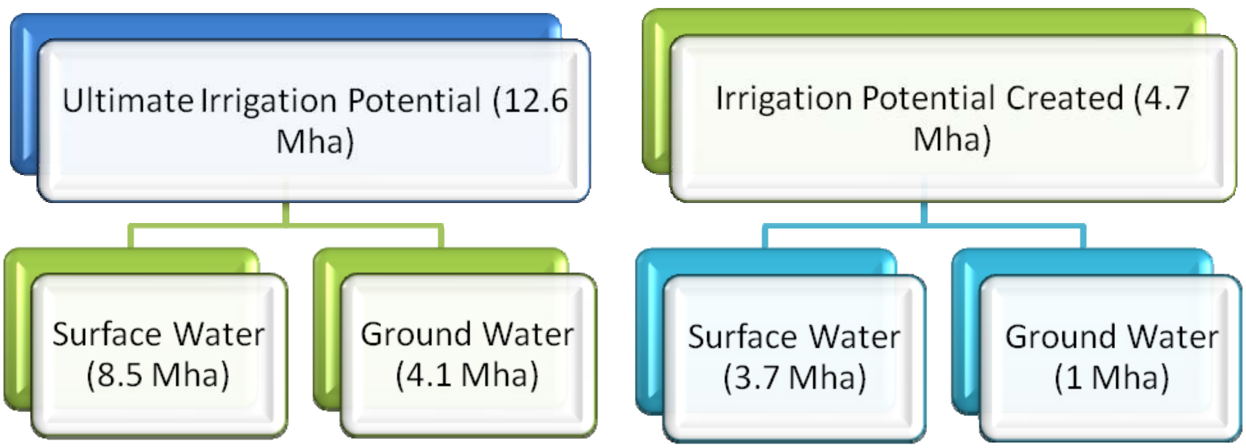
Numerous researchers have analysed the performance of the various calculation methods for different locations. As a result of an Expert Consultation held in May 1990, the FAO Penman-Monteith method is now recommended as the standard method for the definition and computation of the reference evapotranspiration, ETo. The ET from crop surfaces under standard conditions is determined by crop coefficients (Kc) that relate ETc to ETo. The ET from crop surfaces under non-standard conditions is adjusted by a water stress coefficient (Ks) and/or by modifying the crop coefficient.

ET estimated from pan evaporation

Evaporation from an open water surface provides an index of the integrated effect of radiation, air temperature, air humidity and wind on evapotranspiration. However, differences in the water and cropped surface produce significant differences in the water loss from an open water surface and the crop. The pan has proved its practical value and has been used successfully to estimate reference evapotranspiration by observing the evaporation loss from a water surface and applying empirical coefficients to relate pan evaporation to ETo. The procedure is outlined in Chapter 3.

Chapter 6. MSWIP

6.1 Irrigation Potential of Maharashtra



6.2 Objective and scope of MWSIP

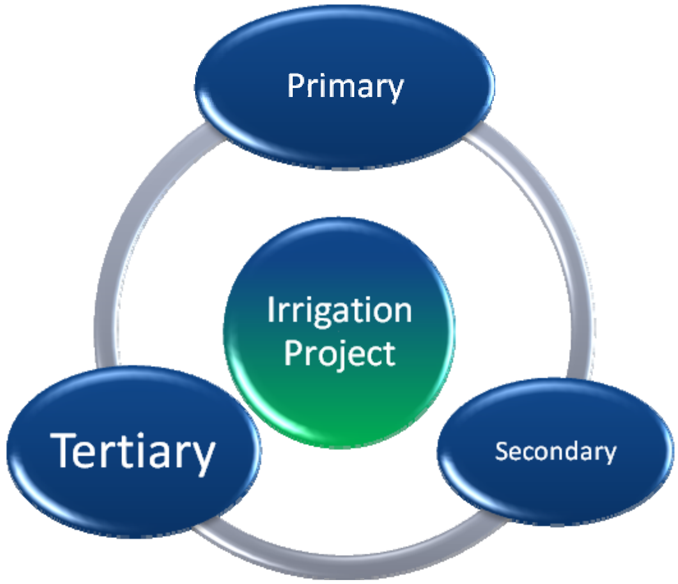
Objective:

1. Strengthen the state's capacity for multi-sectoral planning, development, and sustainable management of the water resources; and
2. Improve irrigation service delivery on sustainable basis, to increase productivity of irrigated agriculture and contribute to rural poverty reduction.

Scope:

The MWSIP envisages the rehabilitation and monetization of the existing irrigation systems. No new projects are proposed to be covered by this project.

6.3 Irrigation Project stakeholders



Project stakeholders are indentified as-

1. Primary Stakeholders
    a. Farmers accessibility to canal system: Head/Middle/Tail reach
    b. Farmers income level: Rich/Middle level/Poor
    c. Women
    d. Tribal
    e. Landless labour
    f. Water User Associations (WUA)
    g. Panchayat Members
    h. Affected peoples
2. Secondary Stakeholders
    a. Implementing agency: WRD
    b. NGO's
    c. SHG's
3. Tertiary Stakeholders
    a. Implementing agency: WRD
        i. NGO's
        ii. SHG's
        iii. Other subsector water users such as-
        iv. Agricultural Department
        v. Revenue Department
        vi. Rural Development Department
        vii. Rural Water Supply and Sanitation Department

6.4 Future challenges

1. About 40% primary stakeholders are NOT educated even up to SSC
2. Performance of WUA's needs improvement
3. Unsynchronized interaction between Service providers and beneficiaries.
4. Inadequate awareness at grass root towards the policies of GoM in water sector.
5. Lack of business sense in managing water as economic commodity.
6. O&M cost is high compared to revenue collected.

6.5 New Interventions of MWSIP

1. Establishment and administration of water entitlement among water using subsectors;
2. Management of bulk supplies of water to various sub-sectors;
3. Volumetric pricing of water; and
4. Establishment of the Maharashtra' Water Resources Regulatory Authority (MWRRA) for administration and management of water sector.

6.6 Revised policies and measures adopted by GoM to improve efficiency

Revised Policies

1. State Water Policy, 2003;
2. Maharashtra Water Resources Regulatory Authority Act, 2003;
3. Maharashtra Management of Irrigation Systems by Farmers (MMISF) Act, 2004

Measures-

1. Transforming IDCs into RBA;
2. Raising canal water charges to cover full O&M cost, progressively increasing at the rate of 15% annually;
3. Initiate restructuring of ID, including downsizing.

6.7 Proposed components of MWSIP

1. Institutional Restructuring & Capacity Building
2. Increase Irrigation Water Service Delivery & management
3. Improving Knowledge Base of Water Sector
4. Project Management & Monitoring

Participatory Irrigation Management

1. Traditionally the responsibilities for canal O&M was with WRD
2. But the system has suffered from –
3. Inadequacy of funds for O&M,
4. Non-recovery of irrigation cess from the beneficiaries
5. Since needs of the users in the command areas are different, it lead to unequal water distribution and hence, caused social conflict.
6. This could be addressed by greater involvement of the beneficiaries in the distribution of water supplies and canal O&M.
7. The Participatory Irrigation Management (PIM) system is a arrangement for the involvement of stakeholders in the O&M of the irrigation system.
8. WRD would act as technical consultant and facilitator to the WUAs and Project Committees
9. The PIM system is an extension of the Panchayat Raj system, which empowers the users to manage their own affairs according to their requirements.
10. The schemes rehabilitated under the MWSIP would, therefore, be operated under the PIM model.

Conclusion

The training session at Command Area Development Authority, Nagpur was the most enjoyable session for me. We joined Irrigation Sub-Division on 10th Dec 2007 under the guidance of Shri. Vanode Saheb and interacted with him along with the staff of sub-division and division office. Training session ended on 19th January 2008 and this report includes the summary of the training.

We visited several sites under the jurisdiction of Irrigation Sub-division and it includes- Wunna Project which is situated near village. Another exciting visit is Pench Project, which is one of the ambitious project in the Vidarbha region.

It was nice experience for me since I could realize the importance of management work. The success of the project heavily depend on the management. I learned valuable information regarding Water requirement of crops, Preliminary Irrigation Programme (PIP), procedure of water supply and recovery and collected reference materials and hand books from the sub-division office.

At last, I am thankful to Superintending Engineer- Shri. Ambadekar Saheb, Executive Engineer- Shri. Raut Saheb, SDE- Shri. Vanode Saheb, Shri. Tillu Saheb all the staff of sub-division for providing me an opportunity to enjoy the thrill of Managment and providing all the necessary documents and related procedure.

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Appendix I: Glossary of Irrigation Terms Applicable to Irrigation System in Maharashtra

1. A ***canal*** is the main channel of irrigation scheme for which as a rule no direct irrigation takes place.
2. A ***branch canal*** is a channel taking off from the main canal, which has the same function as the main canal, viz., carrying water to distribution.
3. **Distributary-**
    a. A **Major Distributary** is a cannel taking off from the main canal or a branch canal and its main function is to supply water to minor distributaries and outlets.
    b. A **Minor Distributory** is a channel taking off from a major distributor and supplying water to outlets.
4. An **Outlet** is a regulating device through which water is supplied to water course. They are numbered serially from head to tail of the distributory of minor and where two outlets face each other the one on the right bank has the lower number.
5. A **minor** is a branch of distributroy and has the same function as a disributory. A minor is given the name of the village mainly served by it.
6. A **Water Course** is a channel taking off from a Government channel and irrigation fields.
7. A **Ghat-fed canal** is a canal fed from a storage which derives its supply from unfailing monsoon rain in the ghat.
8. A **Tank-fed canal** is a canal fed from a storage which obtains an unreliable supply from a non-ghat catchment.
9. A **perennial canal** is a canal that receives supply of water throughout the year.
10. A **non-perennial canal** is a canal that normally doesn’t receives supply of water throughout the year.
11. A **Balance of Balancing Tank** is a subsidiary reservoir for storing excess river-water which is utilized during period of short supply.
12. A **Tail Tank** is a reservoir supplied with water from a canal whenever in excess of canal requirement, having its own command and usually situated near the tail of canal.

13. A **Pick-up weir** is a masonry weir constructed across the river at the head of works of a canal to raise the level of water sufficiently high for it to flow into the canal.
14. A **Bhandara or Dharan or Nalla Pick-up** Weir is a weir across a nalla to diver water into a channel for irrigation.
15. **Rotation** is defined as n interval at which water is supplied to the sanctioned crops.
16. A Module is a device for ensuring a constant discharge of water passing from one channel into another, irrespective of the water level in each, within certain specified limit.
17. A **Semi-module** is a device, the discharge through which varies according to the head of the water in the parent channel, but is unaffected by the downstream fluctuation.[1]
18. A **Meter** is a device for measuring quantities of water passed or rate of flow.
19. **Base** is the period on which a 'Duty' is calculated. There were three basses in common use in the Deccan.

Old Base Periods		
Rabi	15 Oct-14 Feb	1 cusec for 123 days
		10.627 Mcft
		246 acre-feet
Hot weather	15 Feb-14 June	1 cusec for 120 days
		10.308 Mcft
		240 acre-feet
Mansoon	15 june-14 Oct	1 cusec for 122 days
		10.541 Mcft
		244 acre-feet
New Base Periods		
Rabi	15 Oct-28 Feb	0.0283 cusec for 137 days
		334981.44 M^3
		(11.8368 Mcft)
Hot weather	1 Mar-30 June	0.0283 cusec for 122 days
		298304.64 M^3
		(10.38528 Mcft)
Mansoon	1 July-14 Oct	0.0283 cusec for 106 days
		259182.72 M^3
		(9.1584 Mcft)

[1] The term 'rateable' may be applied either to modules or semi-modules and means 'that can be rated or set'. A semi-module is said to be proportional when it draws off a supply directly proportional to the discharge flowing in the parent canal.

20. **Daily Discharge** (in Cumecs/in Cusecs) is the total flow (in cubic metre/cubic feet) in a day divided by number of seconds in 24 hours (86,400).
21. **Discharge** at any section, normal to flow is the quantity of water passing that section in unit time.
22. **Supply** is water which enters a canal head less water escaped into nallas or tail tanks.
23. **Mean Supply** is the sum of the 'daily discharge' utilized (i.e., less escapade) divided by the number of days of 'base' period.
24. **Mean Discharge** is the sum of the daily discharges of any 'base' period divided by number of days.[1]
25. **Open Discharge** is the number of 'day cusecs' passed into a channel divided by the number of days the channel was open or in other words the 'mean discharge' for days in flow.
26. **Day Cusec** is a unit of quantity of water equal to 86,400 cubic feet and equivalent to 1 cusec flowing for 24 hours.
    a. **A Cusec** is the unit of discharge and means a discharge of one cubic feet per second.
    b. **A Cumec** is the unit of discharge and means a discharge of one cubic meter per second.
27. **Acre foot** is the quantity of water equivalent to one feet depth on one acre.
28. **Capacity** is the full supply discharge of a canal.
29. **Capacity Factor** is the ration of mean supply to capacity.
30. **Rabi capacity factor** is the ratio of mean supply of rabi season to 'capacity'[2]
31. **Full Supply Co-efficient:** The number of Ha/Acres irrigable per cumecs/cusec of capacity of a canal at its head.[3]
32. **Time Factor** of a canal is the ratio of the number of days the channel is in flow to the 'base'. The most convenient 'base' for this calculation is the normal ten day rotation period. If in a ten day period the channel flows for 4 days and nights and 6 days only and not at night, the time factor is 7/10.
33. **Gross area** is the total area included within the farthest limit up to which the canal water is proposed to be supplied.

[1] If the whole discharge is utilized mean supply and mean discharge are the same.

[2] 50 percent to 60 percent for Deccan canals

[3] The controlling factor in the design of canal is the 'rabi' full supply coefficient. This varies in the Deccan according to type of crops to be grown being as low as 50 for cane, and as high as 120 for rabi crops only. The record year on th eNira gave 92 and 80 is a fair figure for ordinary proportions of crops on perennial canals.

34. **Gross Command Area** is the area arrived at after deducting from the gross area, such areas within irrigation limits as are not commanded by the Project.
35. **Actual Command Area** is the area on which water will flow from complete canal system as constructed or likely to be constructed.
36. **Culturable Command Area** is the portion of 'gross commanded area' which is culturable.
37. **Actual Irrigable Area** is the portion of the 'actual command' which is suitable for irrigation.
38. **Area Irrigated** is the area on which water is supplied.
39. **Area Assessed** is the area on which assessment is charged.
40. **Intensity** is the percentage of the 'area irrigated' bears to the 'actual irrigable command'
41. **Block** means the whole area of certain specified land to which the block system is applied.
42. **Block condition** means the special conditions prescribing, regulating or restricting the irrigated cultivation which may be carried on within a block.
43. **Block Period** means a period for which a supply of water is sanctioned under the block system
44. **Block Rate** means a fixed uniform, annual rate levied for the supply of water to the block.
45. **Block System** means a system under which supply of water is provided for carrying an irrigated cultivation under certain conditions throughout a block for a period of years.

Appendix II: Different application forms used

Form	Purpose
Form No. I	Two Seasonal Blocks
Form No. IA	New-Two seasonal Blocks
Form No. IB	Rabi Bloacks
Form No. II	Sugarcane blocks
Form No. IV	Fruit Block
Form No. V	Garden Block
Form No. VA	Garden and Seasonal block
Form No. VI	Additional water for overlap/Post/Seasonal/pre-seasonal watering
Form No. VII	Seasonal Crop
Form No. VVI-A	Demand of water on Pazar, nallas and streams
Form No. I-K	Three seasonal block
Form No. V-B	Garden Blocks (1/5,1/3,1/3)
Form AA-1	Irrigation agreement for fixed years
Form B	Supplementary agreement
Form C	Declaration of finding
Form G	Water Application
Form D-1 (PWD XVII D 119)	*Paracha* (Agreement of Irrigation area)
PWD 449	Water requirement application
PWD XVII-D-172	
PWD 216	Water level and water loss weekly sheet

Site Visits and Photo Gallery

Visit to Wunna Project

Canal of Wunna Project just before HWF

Pench Project

With Shri. R.A. Tillu and Shri. N.G.Oke at Pench Project

RBC of Pench project

Left Bank Outlet of Pench Proect

Hydraulic Wave Flume for measuring discharge of LBC of Pench Project