Introduction

CHAPTER 1

INTRODUCTION

This chapter covers the importance, distribution, and deficiency of water. Requirement of water management in irrigation, and prevailing methods for finding out crop water requirements are highlighted. Necessity of further research in the available methods of crop water requirements is also discussed.

1.1 Water is a prime natural resource, basic human need and a precious national asset. Available water must, therefore, be optimally harnessed and used most beneficialy under appropriate priorities of use. As world population rapidly increases and irrigated agriculture expands to provide more food and as economic development is being pressed forward, the demand for more water is inevitable.

1.2 At present food production is about 185 million tonnes per year for total population of 700 million of our country. It is necessary for the country to increase the food production to 225 million tonnes per year by turn of the century to achieve self sufficiency. It is a hard task and needs concerted efforts. According to the latest statistics available for the land use pattern of Gujarat State, out of a total geographical area of 19.6 million hectares (Mha), C.C.A. available is 12.45 Mha, i.e. the cropped area is 63.7% of the geographical area. The ultimate irrigation potential of the Gujarat State, from surface water resources and ground water resources has been estimated as 6.5 Mha. Thus the state's potential after full development of irrigation resources is anticipated as 6.5 Mha against C.C.A of 12.5 Mha which will form 52% of the cropped area.

1.3 An estimate of ICAR shows that crop production is about 50 to 100% higher in irrigated land in comparison with that in un-irrigated lands in the same locality. Today 2/3 of the food production is from the irrigated area which is 1/3 of the total cultivated area of the country and 1/3 of the food production is from the balance 2/3 un-irrigated land.

1.4 The prime source of water is precipitation, which is generally confined to 3-4 months in a year. Its distribution over the country is highly erratic, viz 100 mm in West Rajasthan to over 11000 mm at Cherapunji in Meghalaya. On the top of all these unfavorable features, annual variation of rainfall is also highly uneven. The areas receiving less rainfall have a very high coefficient of variation. Assessed surface water resources of India are around 1850 km^3 (1500 M acre-ft.) which is about 3 % of the world's surface water resources, whereas the country's population is about 16 % of world population. Present consumption of water is around 310 km^3 (250 M acre-ft.). Thus only 16.7% of surface water is being used while the rest flows down into the sea.

1.5 Unfortunately for the people of Gujarat, drought is a recurring phenomenon. During the last 28 years the state has faced ten severe droughts. If water which is like air, one of the basic requirements for survival and also for development of economy is not made available in the areas like Saurashtra, Kachchh and North Gujarat region, future of these areas is indeed bleak. Is there any way out? The answer is yes.

1.6 The main sources of water in the state are surface water and ground water. There are 17 river basins in Gujarat region and 71 river basin in Saurashtra region and 97 river basins in Kachchh region . Considering the actual allocation of water from the inter state rivers like the Narmada, the Sabarmati, the Mahi and the Tapi, the available total surface water resources of the state have been estimated at 40.7 milliard cum (33 Maft) including 11.1 milliard cum (9 Maft) of Narmada water. The lack of reservoir sites due to flat terrain and non-availability of suitable foundations have been principle handicaps in harnessing the entire available surface water resources of the state. Because of this, only 26.5 milliard cum (21.46 Maft) including Narmada water can be harnessed for irrigation. Total ground water recharge in the state is estimated at 8.86 milliard cum (7.15 Maft). After completion of Narmada Project, there will be additional 3.1 milliard cum (2.5 Maft) of annual ground water recharge available in the state. Thus in the ultimate stage the total gross utilisation would be about 38.5 milliard cum (31.1 Maft) through surface and ground water and corresponding ultimate irrigation potential created would be about 6.5 Mha. Looking to the low irrigation potential and small water resources of the state, it is to be kept in mind that utilisable water resources if used conventionally will be exhausted and there may remain no additional water for harnessing. Also with all round development activity and planned use of resources , the cropping pattern is undergoing a gradual yet perceptible change. The use of fertilizers and water has made it possible for the farmers to grow two crops where one was raised a few years back. In addition there has developed an urge to take commercial crops and vegetable production. However all this change underlines the need for economical and judicious use of water. Hence it is necessary to see that water must be used economically, judiciously and efficiently by adopting new and modern methods of irrigation and latest methods of determination of water requirement of crops and proper water management practices.

1.7 The evaporation and transpiration from vegetation is coustomarily clubbed together and is known as evapotranspiration (ET). ET plays a dominant role in the estimate of the optimal supply of the irrigation water to farm lands. The ET estimates are used in determining seasonal crop water requirement and serve as an aid in the management of rservoirs, streams and ground water. The estimates are also used as one of the inputs in irrigation system design and to determine seasonwise consumptive use requirements of crops. It helps in matching cropping pattern and area cropped vis-a-vis the available water resources. The ET value are definitely needed in the overall planning of the command development of large scale irrigation projects. It can also be used in the hydrologic water balance studies for the catchment area.

1.8 The advance knowledge in the field of Irrigation Engineering, Agronomy and Soil Science has made the computations of crop water requirements more rational. There are number of empirical formulae in use in different countries for estimating the crop water requirements. The Food and Agricultural Organisation (FAO) of United Nations has dealt with this aspect in its publication No.24 entitled "Crop water requirements" published in 1977. In all , four different methods are discussed in this publication. Later on other research workers have also developed some empirical formulae for crop water requirements. A comparison of different methods shows that the Penman Method because of its scientific base and rationality, offers the best results with minimum possible error where measured data on temperature, humidity, wind and sunshine and radiation are available. The method is now being used for all the new irrigation projects of Gujarat and also for reviewing the water planning of the completed and on going projects.

1.9 Prediction methods for crop water requirements are used owing to the difficulty of obtaining accurate field measurements. The methods often need to be applied under climatic and agronomic conditions very different from those under which they were originally developed. Testing the accuracy of the methods under a new set of conditions is laborious, time consuming and costly, and yet crop water requirement data are frequently needed at short notice for project planning. To meet this need, guidelines are presented to calculate water requirements of crops under different climatic and agronomic conditions based on the recommendations formulated by the FAO group on crop water requirements during its meetings held in 1971-72. Evapotranspiration of reference crops (ETo) will however vary from year to year and a frequency distribution analysis of ETo for each year of climatic record is recommended. The selected ETo value for planning is thus not based on average conditions but on the likely range of conditions and on an assessment of tolerable risk of not meeting crop water demands.

1.10 The four methods presented i.e. Blaney-criddle, Radiation, Penman and Pan evaporation are modified to calculate ETo using the mean daily climatic data for 30 to 10 days periods. The Penman method suggested by FAO would offer the best results with minimum possible error of plus or minus 10% in summer and upto 20% under low evaporative conditions. The Pan method can be graded next with possible error of 15% depending on the location of the pan. The radiation method in extreme conditions involves a possible error upto 20% in summer. The Blaney-criddle method should only be applied for periods of one month or longer. In humid, windy and winter conditions an over and under prediction upto 25% has been noted. Other research workers also developed other prediction formulae for local regions based on local data. Table 1.1 shows a comparison between ETo measured and ETo estimated (ASCE 1979) for coastal and non-coastal areas for various methods. It can be seen from the Table that percentage variation for various formulae is +83% to -27% for coastal areas and +47% to -45% for noncoastal areas. Under such circumstances it is necessary to check the applicability of each method for a particular region. The calculated ETo values by various methods needs verification by correlating the results with available local data.

1.11 Looking to the complexity, accuracy and data requirement of the above mentioned prediction methods, it is necessary to analyse and compare various prediction methods for ETo for their applicability for agroclimatic zones of Saurashtra, North and Central Gujarat. It is also necessary to develop simple equations for local region which can hold good for agroclimatic zones of Saurashtra, North and Central Gujarat . Therefore in this study an attempt has been made to check the applicability of most reliableequations with available meteorological data of Gujarat. Meteorological data of five stations in Gujarat viz Dantiwada, Anand, Vadodara, Rajkot and Junagadh is used for the study. Finally based on various prediction methods an equation is developed for five sub regions and also for entire region which is easy and can be solved with minimum data.

Table 1.1

A comparision between ETo measured and ETo estimated.

$$\% = \frac{\text{Eto estimated}}{\text{Eto measured}} \times 100$$

	Coastal area	%	Non-coastal area Semi-Arid & Arid	%
1.	Christiansen RS	104	Jenson-Haise	104
2.	Turk	104	V.Baval-Businger	105
3.	Kohler	107	Penman	106
4.	Ivanov	99	Kohler	91
5.	Blaney-Criddle	96	V.Baval-Businger	117
6.	Penman	123	Olivier	94
7.	Makkink	89	Christiansen-tonge	83
8.	Stephen-Stewart	80	Stephen-Stewart	122
9.	Papadakis	89	Papadakis	87
10.	Ostromocki	116	Christiansen RS	82
11.	Van Bavel-Businger	129	Ivanov	109
12.	Thornthwaite	85	Behnke-Maxey	118
13.	Olivier	73	Turk	74
14.	Van Bavel-Businger	144	Blaney-Criddle	67
15.	Van Bavel-Businger	166	Makkink	68
16.	Behnke-Maxey	183	Van Bavel-Businger	139
17.	-		Thornwaite	55
18.	-		Ostromocki	147