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Study on Water Requirement of Selected Crops under Tarikere Command Area using CROPWAT

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Abstract

A study was carried out to determine the crop water requirement of few selected crops for the command area in Tarikere taluk in Karnataka state, India. The crops include areca nut, coconut, and cotton, banana for two seasons, sweet pepper, onion, potato, rice, pulses, mango, and cotton, sugarcane and millet (ragi). Crop water requirement for each crop was determined by using 30-year climatic data in CROPWAT. Reference crop evapotranspiration (ET_0) was determined using the FAO Penman Monteith method. For all the crops considered, three decades: decades I, II, and III and seven crop growth stages: nursery, nursery/land preparation, land preparation, initial stage, development stage, mid-season and late season stage were considered. The study shows that reference evapotranspiration (ET_0) varies from 2.5 to 3.36 mm/day for the area under study. The gross water requirement was 342.42 mm/year with an application efficiency of 70% and hence the entire crop area of 4466 ha requires 16 MCM. Thus the dam can conveniently supply the water required for irrigation in the area.

Keywords: Crop water requirement; Peak water requirement; Reference evapotranspiration; Crop evapotranspiration; Climatic data

Introduction

Water is important for plant for its growth as well as for food production. There is a competition between municipal, industrial and agriculture users for the water available in reservoirs. Estimating irrigation water requirements is prerequisite for water project planning and management [1]. The primary objective of irrigation is to apply water to soil to meet crop evapotranspiration (ETA) requirement when rainfall is insufficient to raise crops till harvesting. Hess defined crop water requirements as the total water needed for evapotranspiration, from planting to harvest for a given crop in a specific climate regime, when adequate soil water is maintained by rainfall and/or irrigation so that it does not limit plant growth and crop yield [2].

Net irrigation water requirements (NIWR) in a specific scheme for a given year are thus the sum of individual crop water requirements (CWR) calculated for each irrigated crop. Multiple cropping (several cropping periods per year) is thus automatically taken into account by separately computing crop water requirements for each cropping period. By dividing the area of the scheme (S. in ha), a value for irrigation water requirements is obtained and can be expressed in mm or in m^3/ha (1 mm = 10 m^3/ha). FAO, Smith et al. and Smith reported that CROPWAT is meant as a practical tool to help agro meteorologists, agronomists and irrigation engineers to carry out estimation for evapotranspiration and crop water use studies, and more specifically the design and management of irrigation schemes [3]. Recommendations for improved irrigation practices, the planning of irrigation schedules under varying water supply conditions, and the assessment of production under rain-fed conditions or deficit irrigation can be derived from this. Broner and Schneekloth opined that water requirements of crops depend mainly on environmental conditions. Different crops have different water use requirements, under the same weather conditions [4].

Crops will transpire water at the maximum rate when the soil water is at field capacity. Broner found that knowing seasonal crop water requirements is crucial for planning your mixed crop planting especially during drought years [4]. Adequate data on irrigation water requirements of most crops is not available in developing nations of the world. This is one of the reasons why for the failure of large scale irrigation projects in most developing countries of the world. The objective of this study was to determine crop water requirements of arecanut, coconut, cotton, and banana for two seasons, sweet pepper, onion, potato, rice, pulses, cotton, mango, sugarcane and millet (ragi).

Study area

Tarikere is situated about 40 km south of Chikkamagaluru on the Bangalore-Honnavar road, and 45 km from Chikkamagaluru city. Tarikere is located at latitude of 13.72°N and longitude of 75.82°E at an average elevation of 698 m with annual average rainfall of 963 mm. The south west monsoon starts normally from 1st week of June and peak precipitation will occur during September.

Bhadra Dam located around 50 km from Tarikere; (Bhadra Reservoir) has been the life-saving water source for irrigating over 4,466 hectares of land spread over villages around Tarikere (Figure 1).

Stages of growth

For the present study three decades and seven stages of plant growth were used, the decades include I, II and III while the crop growth stages include nursery, nursery/land preparation, land preparation, initial stage, development stage, mid-season stage and late season stage.

Estimation of Water Requirement

The term crop water requirement is defined as the "amount of water required to compensate the evapotranspiration loss from the cropped field". "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

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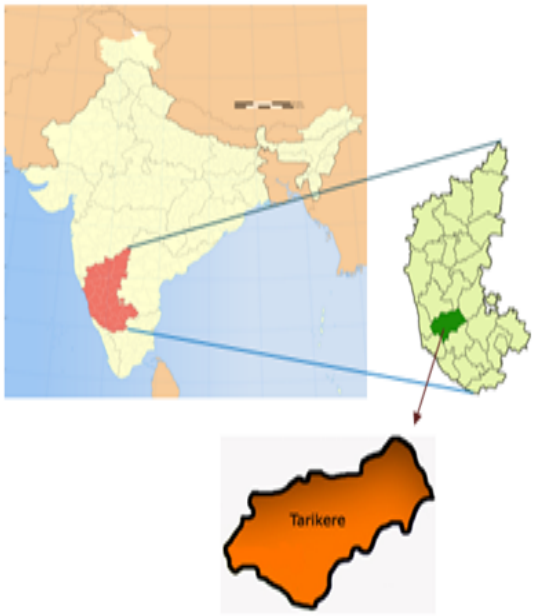

Figure 1: Location map of study area-Tarikere.

to the amount of water that is lost through evapotranspiration". The crop *ET* (ET_C) was estimated by FAO Penman-Monteith equation:

$$ET_c = K_c (ET_o) \quad (1)$$

where ET_o = Reference crop (mm/day) and it is determined by:

$$ET_o = 0.408\Delta(R_n - G) + \gamma\left[\frac{900}{T+273}\right]u_2\frac{(e_a - e_d)}{\Delta} + \gamma(1+0.34u_2) \quad (2)$$

Where,

ET_0 = Reference evapotranspiration [mm day^{-1}]

R_n = Net radiation at the crop surface [MJ m^{-2} day^{-1}]

G = Soil heat flux density [MJ m^{-2} day^{-1}]

T = Mean daily air temperature at 2 mm height [°C]

U_2 = Wind speed at 2 m height [m s^{-1}]

E = Actual vapour pressure [KP_a]

e_s-e_a = Saturation vapour pressure deficit [KP_a]

D = Slope vapour pressure curve [$KP_a C^{-1}$]

g = Psychometric constant [$KP_a C^{-1}$]

CROPWAT

The CROPWAT programme (version 5.7) developed for the FAO Penman-Monteith method was utilized for estimating the crop water requirement of the crops studied. To ensure the integrity of computations, the weather measurements were made at 2 m (or converted to that height) above the surface of green grass, shading the ground [5]. The climatic data used for the calculations were obtained from a meteorological station located at Tarikere (Tables 1-4).

Conclusion

The estimation of actual irrigation requirement of Tarikere command area was carried out as shown in Tables 1-4. The net irrigation water requirement is 292.7 mm/year (Tables 1-4). This is summation of the NIR2 values from January to December. Using an irrigation application frequency of 70%, the gross water requirement of 342.42 mm/year was obtained. Therefore the entire land area of 4466 ha requires 16 MCM. The reservoir capacity is 71.50 MCM. Thus the capacity of 71.5 MCM is sufficient to irrigate the irrigation water requirement for the entire area under the command area, which is 16 MCM. The results show that the dam can conveniently supply the water required for irrigation in the area. The results obtained from the study can be used as a guide by farmers for selecting the amount and frequency of irrigation water for the crops studied under consideration.

Country: India	**Station: Tarikere**		**Altitude: 693 m**	**Lat: 13.43°N**		**Long: 75.49° E**	
Month	Min Temp (°C)	Max Temp (°C)	Humidity (%)	Wind (Km/day)	Sun (hrs)	Rad (MJ/m^2/day)	ET_o (mm/day)
January	15	32	67	1.4	0.6	8.4	2.74
Febraury	16	34	60	1.4	0.6	9.2	3.15
March	18	37	57	1.1	0.6	10	3.33
April	21	36	66	1.1	0.6	10.4	3.24
May	21	36	68	1.1	0.5	10.3	3.26
June	20	32	72	1.7	0.3	9.9	3.19
July	20	30	74	2.8	0.2	9.8	3.36
August	20	29	76	2.8	0.2	9.8	3.15
September	19	31	73	2.2	0.4	9.8	3.18
October	20	34	73	1.4	0.5	9.2	2.91
November	18	30	70	1.1	0.5	8.4	2.5
December	16	31	66	1.4	0.5	8	2.67
Average	18.7	32.7	69	1.6	0.5	9.4	3.06

Where, ETo = Reference Crop Evapotranspiration computed using the FAO Penman-Monteith Method.

Table 1: Reference crop evapotranspiration.

Crop	Planting Date	ETc(mm/dec)	Eff rain(mm/dec)	Irr. Req.(mm/dec)
Sweet pepper	01-Nov	309.2	67.7	247.6
Mango	20-Mar	1034.5	743.7	400.6
Banana(Summer)	01-Jun	786	670	407
Banana(Winter)	01-Jan	849.6	478.9	416.6
Cotton	01-Aug	428.6	389.3	178.3
Potato	01-Oct	318.7	176.5	210.9
Ragi	15-Jul	256.3	429.4	12.1
Rice	01-Jan	336.1	541.9	182.5
Pulses	10-Jun	244.1	404.6	12
Sugacane	01-Jan	1162.4	743.7	460.7
Onion	01-Nov	234.6	63.2	174.7
Coconut	01-Dec	1097.3	741.6	455
Arecanut	01-Jun	1113.5	743.7	467

Table 2: Evapotranspiration and irrigation requirement for major crops.

S.No	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Sweet pepper	86.2	83.9	14.1	0	0	0	0	0	0	0	5.4	53.3
2	Mango	73.5	57.1	57.4	37	24.7	9.4	0	0	21.6	0.2	37.7	75.2
3	Banana1	85.3	93.2	104.5	47.3	0	0	0	0	0	0	16.2	62.1
4	Banana2	85.7	86	99.1	59.9	51.7	32.2	0	0	0	0	0	0
5	Cotton	52.9	0	0	0	0	0	0	0	0	2.9	44.6	79
6	Potato	84.8	15.5	0	0	0	0	0	0	0	0	27.8	81.1
7	Grains	0	0	0	0	0	0	0	0	10.5	0	1.4	0
8	Rice	0	0	0	0	0	93.1	90	1.3	30.7	0	5.7	0
9	Pulses	0	0	0	0	0	0	1.2	0	0.3	0	0	0
10	Sugarcane	31.4	50.1	95.5	70.1	58.8	39	0	3.3	35.4	0	28.7	55
11	Onion	85.3	8	0	0	0	0	0	0	0	0	12.1	67.5
12	Coconut	80.5	80.6	89.4	37.5	31.8	13.8	0	0	10.1	0	27.7	67.1
13	Areca nut	85.3	93.2	104.5	47.3	0	0	0	0	0	0	16.2	62.1
14	NIR 1	1.5	1	1	0.6	0.4	0.8	0.5	0	0.4	0	0.5	1.2
15	NIR 2	45.2	29.4	31.5	16.6	11.6	22.8	16.3	0.4	12.8	0.1	14.8	38.2
16	NIR3	0.17	0.12	0.12	0.06	0.04	0.09	0.06	0	0.05	0	0.06	0.14
17	IA (%)	59	58	37	36	31	49	25	24	73	26	94	56
18	IR_a	0.29	0.21	0.32	0.18	0.14	0.18	0.24	0.01	0.07	0	0.06	0.25

where, NIR 1 = Net Water Requirement (mm/day), NIR 2 = Net Water Requirement (mm/month), NIR 3 = Net Water Requirement (l/s/h), IA = % of the total area that is actually irrigated, IR_a = Net Water Requirement for Actual Irrigated Area (l/s/h)

Table 3: Irrigation scheming.

Crops	ETc (mm)		Irrigation requirement (mm)
	Minimum	Maximum	
Sweet pepper	1.5	3.27	0-32.7
Mango	1.79	3.39	0-27.2
Banana1(summer)	1.6	3.72	0-35.6
Banana2(Winter)	2.8	3.39	0-33.9
Cotton	1.1	3.26	0-27.5
Potato	1.5	3.1	0-31.5
Ragi	0.99	3.06	0-8.2
Rice	0.292	2.48	0-90.3
Pulses	1.1	3.64	0-6.1
Sugarcane	1.9	4.13	0-35.5
Onion	1.84	2.9	0-31.1
Coconut	2.6	3.27	0-31.4
Arecanut	2.56	3.36	0-31.7
Total	21.572	42.97	422.7

Table 4: Minimum and maximum values of evapotranspiration and irrigation requirements for various crops.

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