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Estimation of Irrigation Water Requirement Using Cropwat 8.0 and Climwat Software in Case of Modjo , East Shewa, ETHIOPIA

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Abstract: ***Irrigation management plays a significant role in effectively and efficiently using the available water sources to meet the variation of cropping patterns. For the sake of facilitating the management practice, experimental data based on the irrigation management model can be applied to estimate the crop water requirement and increasing the ability of irrigation management. water demand has been increasing fastly as result an increment of the number of population and some improvement of the living standard of people, which makes the water shortage to be a serious problem. The main objective of paper is to apply the CROPWAT 8 irrigation water management model for the determination of crop water requirement. This irrigation water model for Windows is a computer software program for the analysis of the detail of crop water requirements and irrigation requirements on the basis of the input dated such as crop, soil and climate data***

Keywords: CROPWAT 8, FAO

1. Introduction

Irrigation management plays a significant role in effectively and efficiently using the available water sources to meet the variation of cropping patterns. For the sake of facilitating the management practice, experimental data based on the irrigation management model can be applied to estimate the crop water requirement and increasing the ability of irrigation management. [1]water demand has been increasing fastly as result an increment of the number of population and some improvement of the living standard of people, which makes the water shortage to be a serious problem. According to different studies, irrigation uses 80% available water resource; however, only 30% of water is efficiently used by crops, and the rest is depleted and infiltrated to the land. This consumed water not only leads to a great waste, but also causes water logging and salinization that adversely affecting the productivity of most irrigated land of the area. On the other side, the farmers have no good plan for irrigation—they just traditionally wait for rain and only irrigate their crops when an extreme drought has occurred. They actually do not know how much crop yield can be improved through irrigation, when and how much water is needed to irrigate their crops

2. Objective

To apply the CROPWAT 8 irrigation water management model for the determination of crop water requirement.

3. Material and Methods

CROPWAT irrigation management model is a decision support tool investigated by food and agricultural organization called FAO .This irrigation water model for Windows is a computer software program for the analysis of the detail of crop water requirements and irrigation requirements on the basis of the input dated such as crop, soil and climate data. In addition, the program it has a capacity that show the irrigation schedule of variety crops and the Analysis of scheme water supply for different crop and land. CROPWAT 8.0 is can be used for the evaluation farmer irrigation practice and evaluating the efficiency of crop under both irrigation and rain condition .CROPWAT 8.0 can also be used to evaluate farmers' irrigation practices and to estimate crop performance under both rained and irrigated conditions

3.1 Crop water requirement

Crop water requirement is the amount of water which is needed by crop or plant in order to replace the water which is lost by evapotranspiration. this evapotranspiration may depend on different factor such as climatic or metrological, topography ,soil ,types of crop and others are the main factor which affecting the depth of water which is needed by the crop for the sake of growth .

Input data

Climate or reference evapo transpiration Eto it includes minimum temperature, maximum tempreture, humidity, wind, sun, radiation and evapotranspiration

Climatic data	crop water requirement
Rain data	scheduling
Soil data	crop pattern
Crop data	scheme

4. Result and Discussion

Climate

Climate is the main factor that affect the crop water requirement of the crop climatic factor include temperature (minimum and maximum tempreture), humidity, wind, sun, radiation and reference evapotranspiration. The average of those climatic factor in modjo district are 13 and 27.5 degree Celsius minimum and maximum tempreture

respectively,70% of humidity,145km/day speed of wind ,7.8 hr of sun ,20.5MJ/m^2/day radiation of sun and 4.27mm/day of reference evapotranspiration.

Table 1: Climate characteristics

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	Hours	MJ/m²/day	mm/day
January	11.3	26.8	69	164	8	19.5	3.95
February	12.1	28.4	73	173	8.4	21.2	4.37
March	14	29.5	66	181	8.4	22.3	4.96
April	14.6	30.2	70	130	8.4	22.4	4.81
May	14.4	30.2	69	130	8.1	21.4	4.66
June	14.8	29.7	67	121	7.6	20.2	4.46
July	13.5	27.8	77	121	6.8	19.2	4.01
August	13.8	25.2	77	95	6.7	19.4	3.79
September	13.3	25.9	76	78	6.7	19.5	3.79
October	12.4	26	63	173	8.2	21.1	4.45
November	11.5	26	66	181	9	21	4.31
December	10.5	22.2	65	199	8.1	19.1	3.71
Average	13	27.3	70	145	7.8	20.5	4.27

Effective rainfall

It is the part of total annual rainfall which is useful directly and indirectly for meeting the crop water requirement in production of crop at the site where it is fall. This effective rainfall may vary depending on the soil type, characteristic of rainfall, topography ,ground water characteristics and management practice. For the case modjo district the total amount of effective rainfall is 693mm per annual.

Table 2: Characteristics of rainfall

	Rain (mm)	Eff rain (mm)
January	11	10.8
February	32	30.4
March	46	42.6
April	62	55.8
May	51	46.8
June	88	75.6
July	236	146.9
August	230	145.4
September	119	96.3
October	21	20.3
November	17	16.5
December	6	5.9
Total	919	693.4

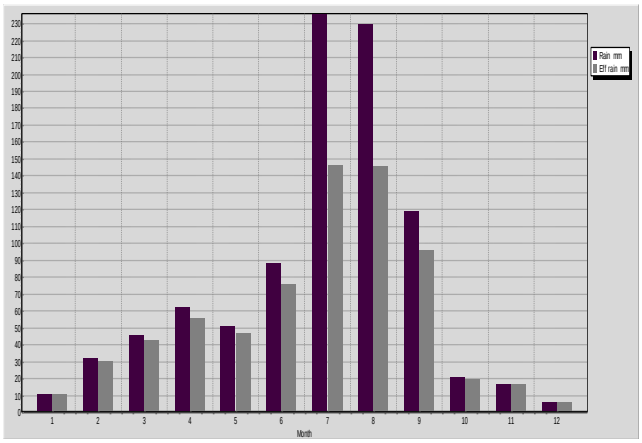


Figure 1: Effective Rainfall Vs Time 1

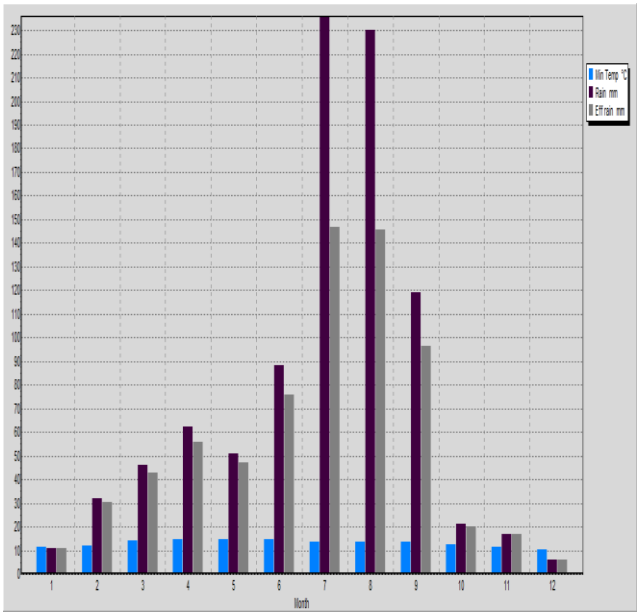


Figure 2: Minimum temperature, rain, effective rain vs time

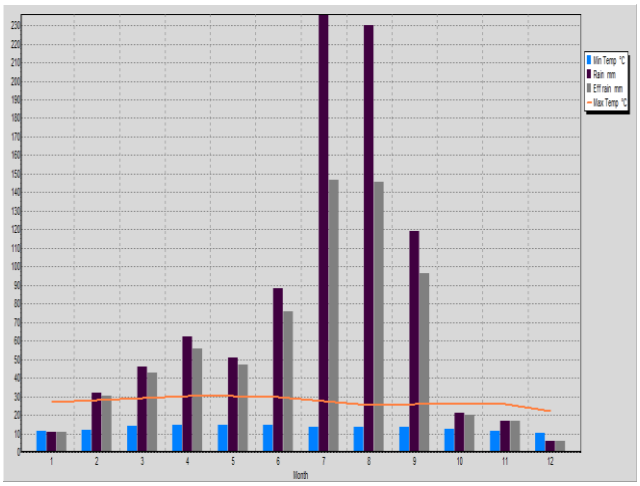


Figure 3:.Max temperature, minimum tempreture, rain, effective rain vs time

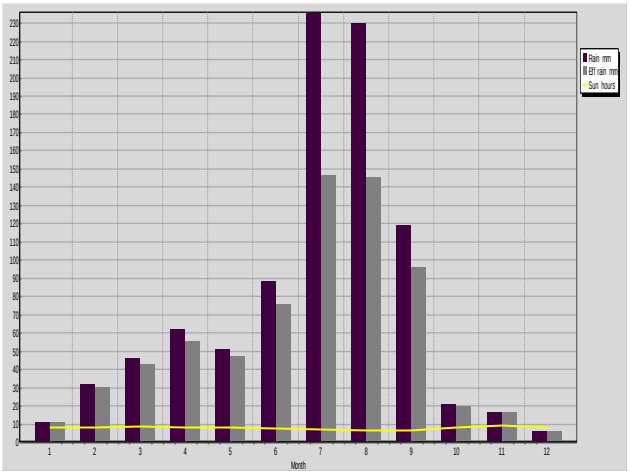


Figure 6: Sun, rain, effective rain vs time

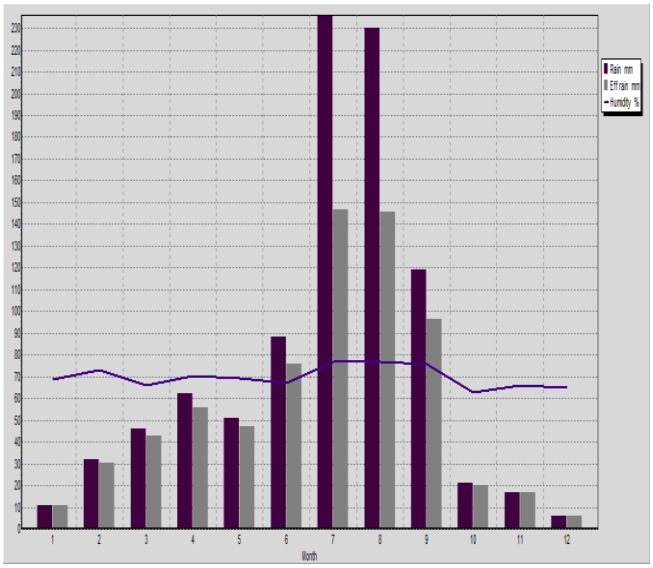


Figure 4: Humidity, rain, effective rain vs time

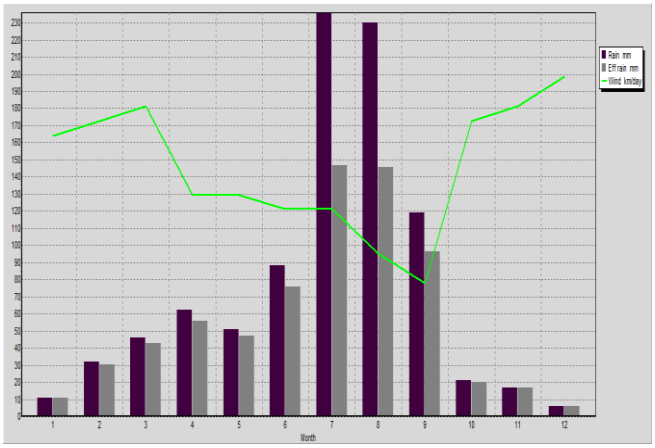


Figure 5: Wind, rain, effective rain vs time

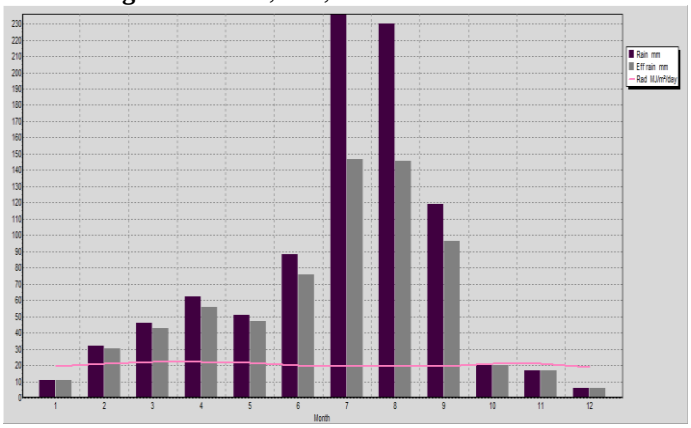


Figure 7: Radiation, rain, effective rain vs time

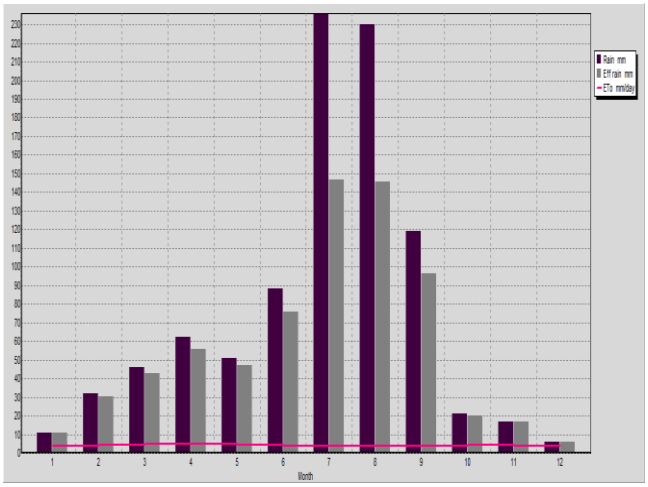


Figure 8: Eto, rain, effective rain vs time

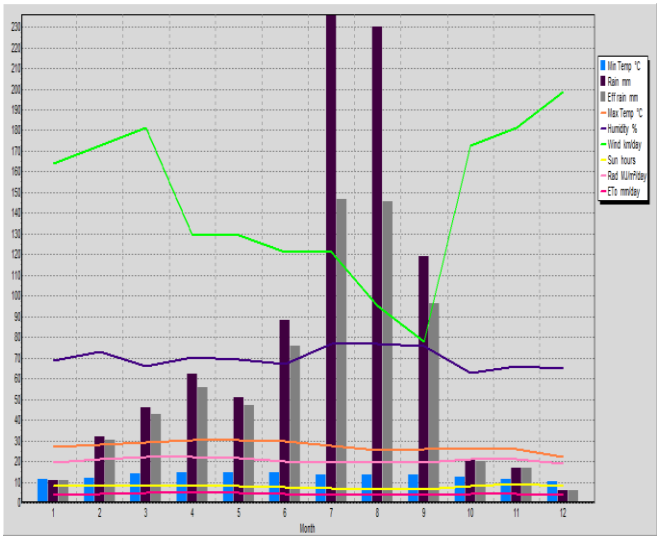


Figure 9: Min temp,sun ,wind,radi,Eto,max temp,rain,effective rain vs time

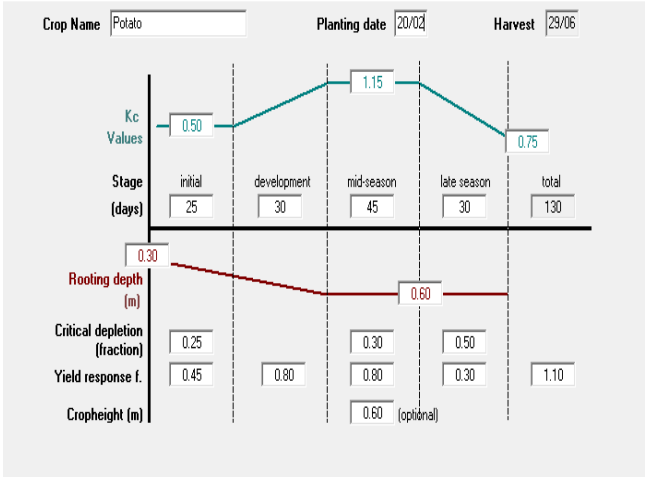


Figure 10: Potato stage and rooting depth with respect to time

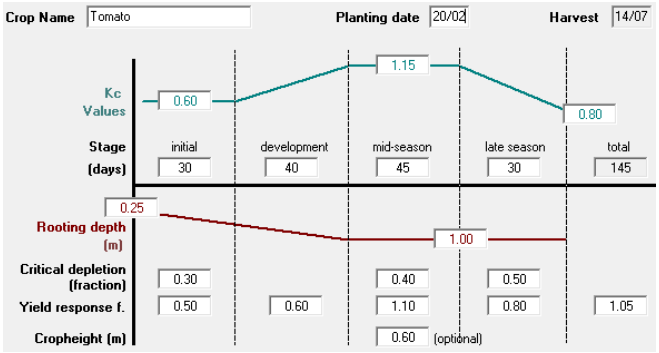


Figure 11: Tomato stage and rooting depth with respect to time

From above figure for the tomato crops in the district of modjo kc values is 0.6 at initial stage and 1.5 at mid season .the total day required for the growth of tomatos crop is takes 145 days that means at initial stage growth it takes 30days at development stage it takes 40 days ,at mid season stage 45 and at late season 30 days .the rooting depth is one of the factor that determined crop and soil type and it is varies from 0.25m to 1.0m and crop height is 0.6m.however for the potato crop the kc values ranges from 0.5 to 1.15 and during the harvest date it should be 0.75.in case of the growth stage of potato it take 130 days from initial to harvest date therefore croping potato is takes 10 days less than planting tomato.

Soil

Soil is one of the factor that affect the growth of the plant or crop according to FAO the soil type around modjo disrict is included und er medium or loam soil.therefore the total available soil moisture (FC-WP)IS 290mm/meter,40mm/day maximum rain water infiltration rate ,900cm maximum rooting depth and 290mm/meter of initial available soil moisture.

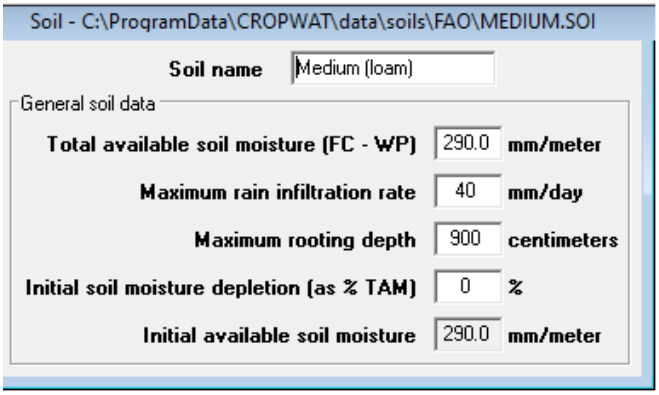
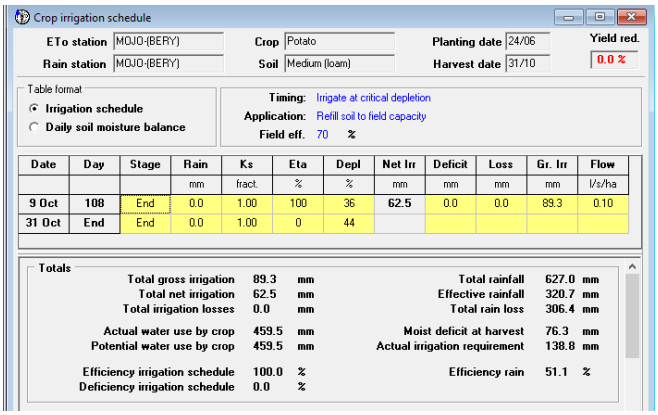


Figure 1: Soil type s and characteristic of soil

Irrigation scheduling

Irrigation scheduling is the process which used to determine the correct frequency and duration of water taking by irrigation system manager .irrigation scheduling is useful in reducing the farmer cost of water and labor, reducing the salinity and reducing water logging .from our studies (table 3) during the month of April and may the irrigation requirement of crop are maximum compared to rest of the month and this show that rainfall on those month is less.



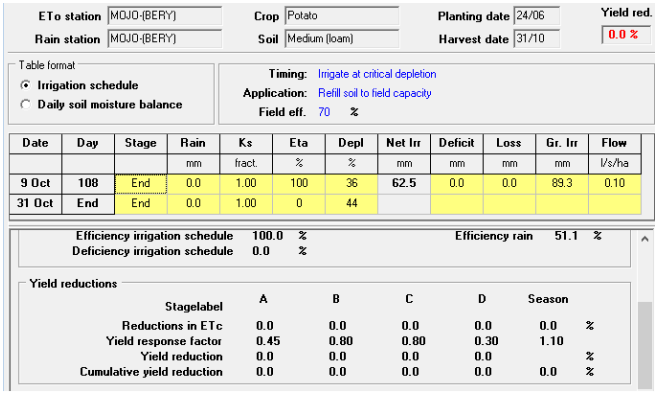


Table 3: irrigation scheduling

Month	Decade	Stage	Kc	ETc	ETc	Effrain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Feb	2	Init	0.5	2.19	2.2	1	2.2
Feb	3	Init	0.5	2.28	18.3	11.7	6.6
Mar	1	Init	0.5	2.38	23.8	12.8	11
Mar	2	Deve	0.52	2.59	25.9	14.2	11.7
Mar	3	Deve	0.72	3.52	38.8	15.7	23.1
Apr	1	Deve	0.95	4.6	46	17.8	28.2
Apr	2	Mid	1.13	5.44	54.4	19.6	34.8
Apr	3	Mid	1.15	5.49	54.9	18.3	36.6
May	1	Mid	1.15	5.44	54.4	15.4	38.9
May	2	Mid	1.15	5.38	53.8	13.9	40
May	3	Late	1.15	5.3	58.3	17.6	40.6
Jun	1	Late	1.07	4.83	48.3	20.7	27.6
Jun	2	Late	0.93	4.15	41.5	23.2	18.3
Jun	3	Late	0.8	3.45	31.1	28.6	0
					551.5	230.6	319.5

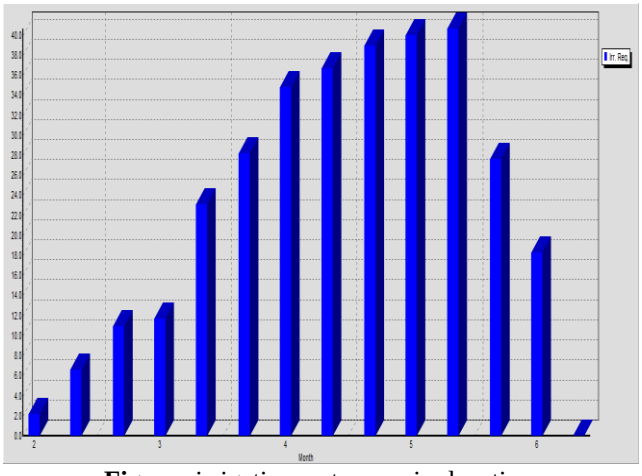


Figure: irrigation water required vs time

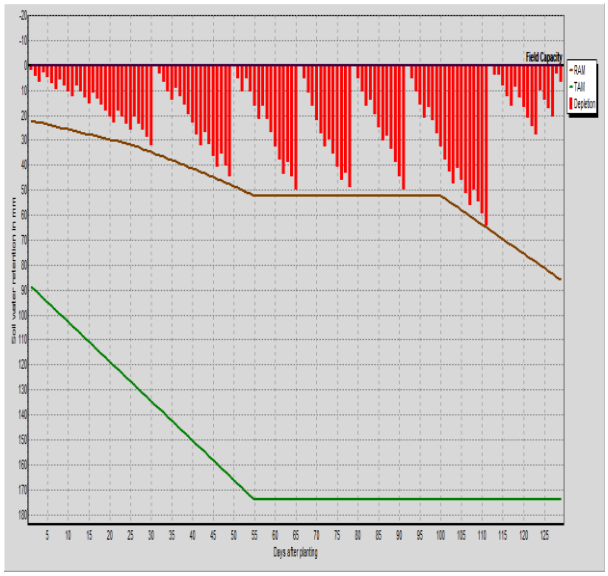


Figure: Readily available moisture, total available moisture and depletion vs with day after planting

Cropping pattern

It is the process of proportioning of area under variety of crops at different time .under this studies the coverage area of both potato and tomato crops are 100% that means 50% of total area is covered with tomato and 50% are covered with potato under different time.

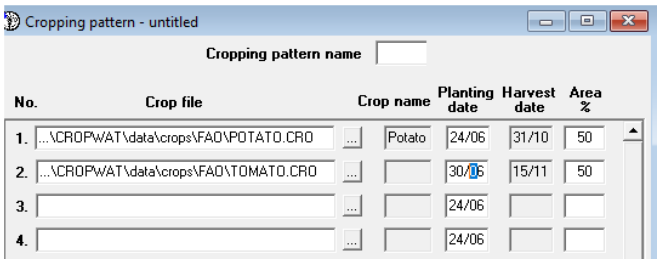
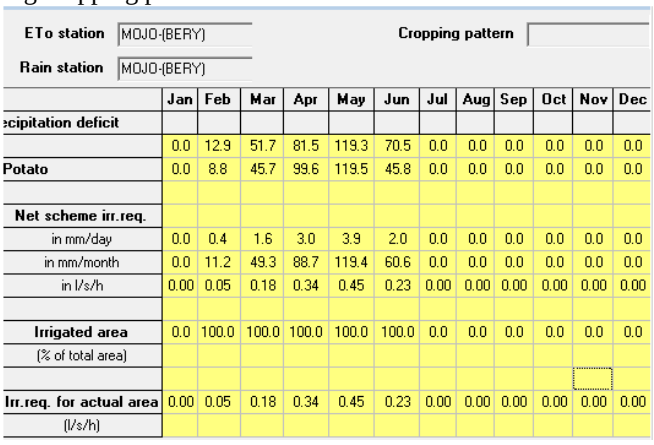


Fig cropping pattern



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ecipitation deficit												
	0.0	12.9	51.7	81.5	119.3	70.5	0.0	0.0	0.0	0.0	0.0	0.0
Potato	0.0	8.8	45.7	99.6	119.5	45.8	0.0	0.0	0.0	0.0	0.0	0.0
Net scheme irr.req.												
in mm/day	0.0	0.4	1.6	3.0	3.9	2.0	0.0	0.0	0.0	0.0	0.0	0.0
in mm/month	0.0	11.2	49.3	88.7	119.4	60.6	0.0	0.0	0.0	0.0	0.0	0.0
in l/s/h	0.00	0.05	0.18	0.34	0.45	0.23	0.00	0.00	0.00	0.00	0.00	0.00
Irrigated area	0.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
(% of total area)												
Irr.req. for actual area	0.00	0.05	0.18	0.34	0.45	0.23	0.00	0.00	0.00	0.00	0.00	0.00
(l/s/h)												

5. Conclusion

Irrigation management plays a significant role in effectively and efficiently using the available water sources to meet the variation of cropping patterns. The main target of this paper is to apply the CROPWAT 8 irrigation water management model for the determination of crop water requirement. This model used to know climatic condition, rainfall, soil type, crop water requirement, crop pattern and schedule of irrigation and scheme of irrigation.

Finally in this study results shows as the way of knowing the irrigation water requirement based CROPWAT 8.0 model it is most useful and effective if there is no availably or shortage of data .

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