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Water requirements of some selected crops in Kampe dam irrigation project

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Abstract

A study was carried out to determine the crop water requirement of some selected crops for the area around Kampe (Omi) Dam Irrigation Project. These crops include rice, maize, tomato, vegetable amaranth, pepper, onion and cabbage. Crop water requirement for each of the crops was determined by using 25-year climatic data in CROPWAT. Reference crop evapotranspiration (ET_o) 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. Crops were planted during the 2007 Rainy Season and the crop coefficient for each was determined. The study shows that for the area under study, reference evapotranspiration (ET_o) varied from 3.4 to 4.8 mm/day. Crop evapotranspiration (ET_c) and crop water requirement for paddy rice varied from 0.28 to 4.18 mm/day and 2.0 to 102.4 mm/day, for maize from 1.82 to 4.88 and 1.3 to 45.6 mm/day, for tomato from 8.7 to 52.8 and 0.0 to 45.2 mm/day, for vegetable from 3.07 to 4.74 and from 7.4 to 45.6 mm/day, for pepper 3.13 to 4.8 and from 15.1 to 40.7 mm/day, for onion from 1.80 to 38.4 mm/day, and for cabbage from 28.2 to 40.9 mm/day respectively. The peak water requirement was 0.63 l/s/ha or 5.4 mm/day with an application efficiency of 65%. Irrigation water requirement was estimated as about 61.2 MCM while the actual water diverted was 131 MCM. The reservoir capacity was 220 MCM. Thus the dam can conveniently supply the water required for irrigation in the area.

Keywords: Crop water requirement, peak water requirement, total crop water requirement, reference evapotranspiration, crop evapotranspiration and climatic data.

Abbreviations: l/s/ha_Litres/second/hectare, MCM_Million cubic meter (10^6 m^3), mm/day, ET_A_Crop evapotranspiration (mm), CWR_Crop water requirement, NIWR_Net irrigation water requirement,ET_o_Reference crop evapotranspiration

Introduction

Water is important for plant growth and food production. There is competition between municipal, industry users and agriculture for the finite amount of available water, estimating irrigation water requirements accurately is important for water project planning and management (Michael, 1999). The primary objective of irrigation is to apply water to maintain crop evapotranspiration (ET_A) when precipitation is insufficient. The finite total amount of available water is crucial for the economy, health and welfare of a very large part of the developing world. Hess (2005) 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. FAO (2005) defined crop water requirement (CWR) for a given crop as:

$$CWR_i = \sum_{t=0}^{T} \left(kc_{i_t} \cdot ET_{o_t} - P_{eff_t} \right) \quad (1)\ \text{Unit: mm}$$

where kc_i is the crop coefficient of the given crop i during the growth stage t and where T is the final growth stage. Each crop has its own water requirements. Net irrigation water requirements (NIWR) in a specific scheme for a given year are thus the sum of individual crop water requirements (CWR_i) calculated for each irrigated crop i. 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 by 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 (1992), Smith et al. (1991) and Smith (1992) reported that CROPWAT is meant as a practical tool to help agro-meteorologists, agronomists and irrigation engineers to carry out standard calculations for evapotranspiration and crop water use studies, and more specifically the design and management of irrigation schemes. It allows the development of recommendations for improved irrigation practices, the planning of irrigation schedules under varying water supply conditions, and the assessment of production under rainfed conditions or deficit irrigation. Broner and Schneekloth (2003) reported that water requirements of crops depend mainly on environmental conditions. Plants use water for cooling purposes and the driving force of this process is prevailing weather conditions. Different crops have different water use requirements, under the same weather conditions.

Table 1. Soil Properties in experiment region

Properties	Value
Soil Type	Lithosols, Cambisols, Luvisols, Eroded soils, Alluvial soils and Arenosols
Soil Texture	Coarse
Ph	5.3 to 7.0
Cation Exchange Capacity(Surface Horizons, meq/100g)	1.44 to 16.07
Cation Exchange Capacity (Sub-surface Horizons, meq/100g)	1.61 to 24.18

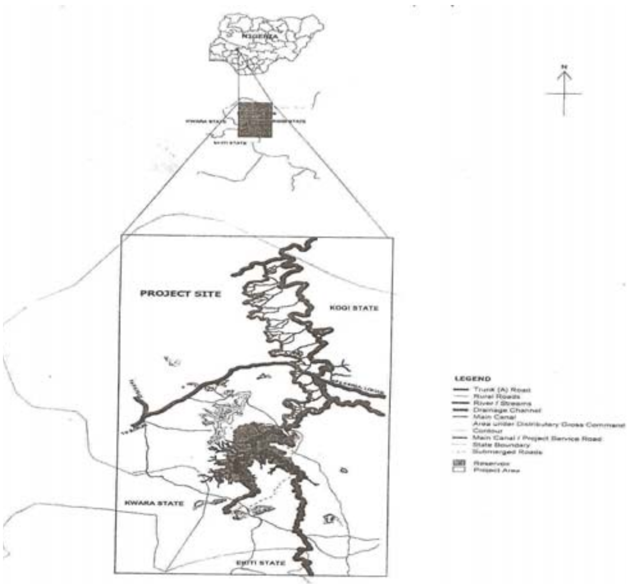

Fig 1. Location Map of Kampe (Omi) Dam Irrigation Project

Crops will transpire water at the maximum rate when the soil water is at field capacity. Broner (2003) reported that knowing seasonal crop water requirements is crucial for planning your crop planting mixture especially during drought years. 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 paddy rice, maize, tomato, grain amaranth, pepper, onion and cabbage

Materials and methods

Study area

Kampe (Omi) Dam Irrigation Project (KODIP) (Fig 1) is located in Yagba West Local Government Area of Kogi State, Nigeria. It is about 146 km from Ilorin the capital of Kwara State. It lies between longitudes 6^0 37' and 6^0 42' E of Greenwich and latitudes 8^0 34' and 8^0 38'N of the Equator. The project was first conceived in 1979 while the construction works started in 1983. It involved the construction of 42 metre-dam with a water reservoir capacity of about 250 million cubic metres. The irrigation network consists of 39 km length of main canal and about 300 km length of feeder canals and complimentary drainage lines. The dam will be capable of irrigating about 4100 hectares when all the phases are completed. Phase 1 of the now completed comprises the main dam, spillway, headwork, and 16 km out of the 39 km length of the main canal commanding 2000 hectares of irrigable land. This phase allows for agricultural production of maize, vegetables, sorghum, and rice all the year round.

Stages of growth

Three decades and seven distinct stages of plant growth were used in determining water requirement of the crop. 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 and late season stage.

Estimation of water requirement

Crop water requirement was determined from the inter-relationships of the ET, soil type, bulk density of the soil, field capacity and permanent wilting point of the soil and the effective root zone of okra plant at the project site. The crop ET (ET_C) was estimated by FAO Penman-Monteith equation (FAO, 1998) Hatfield and Fuchs (1992) and Smith et al., 1991)

$$ET_O = ET_c = K_C (ET_O) \quad (2)$$

where the reference crop ET (mm/day) is as defined in eqn (3) below as:

$$ET_O = 0.408\Delta(R_n\text{-}G) + \gamma[900/(T + 273)]\, u_2 (e_a - e_d)/\Delta + \gamma(1 + 0.34u_2), \quad (3)$$

where ET_o = 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 m height [°C], u_2 = wind speed at 2 m height [ms^{-1}], e_s = saturation vapour pressure [kPa], e_a = actual vapour pressure [kPa], e_s - e_a = saturation vapour pressure deficit [kPa], D = slope vapour pressure curve [kPa °C^{-1}], g =psychrometric constant [kPa°C^{-1}]. Irrigation frequency was calculated using the relationship discussed by Michael (1999) Irrigation frequency (days) = Field capacity of Soil – Moisture content before irrigation / Daily consumptive use,

$f_i = d_g / C_u$ (4) , where f_i = irrigation frequency (days), d_g = gross depth of application (mm), and C_U = daily consumptive use (mm/day). The CROPWAT programme (version 5.7) developed for the FAO Penman-Monteith method (FAO, 2005) was utilized for estimating the crop water requirement of each of the seven crops studied. To ensure the integrity of computations, the weather measurements were made at 2 m (or converted to that height) above an extensive surface of green grass, shading the ground. The climatic data used for the calculations were obtained from a meteorological station located at Lokoja.

Results

Soil properties

Six soil types are available in the seven sites studied, namely Lithosols, Cambisols, Luvisols, eroded soils, Alluvial soils and Arenosols (Table 1). The soils in the area are predomin-

Table 2. Reference Crop Evapotranspiration

Country: Nigeria Coordinates: 7.48 N.L.			Meteorological Station: Lokoja 6.44 E.L.			Period : 25 Years Altitude: 476m	
Month	Max Temp (^{0} C)	Min Temp (^{0} C)	Humidity (%)	Wind (km/day)	Sunshine Hours	Solar Radiation (r_f) ($MJ/m^2/day$)	ET_o (mm/day)
January	35.5	20.2	63	86	7.8	19.2	4.3
February	35.6	23.1	62	60	8.1	20.9	4.5
March	36.0	24.8	63	60	7.4	20.9	4.8
April	34.2	24.5	64	60	6.6	19.6	4.5
May	32.8	23.6	70	60	6.8	19.4	4.3
June	31.1	22.7	74	60	5.9	17.6	3.8
July	30.3	22.6	75	60	4.8	16.2	3.5
August	29.8	22.3	76	60	4.0	15.4	3.4
September	30.2	22.3	77	60	4.9	16.9	3.6
October	31.5	22.5	75	60	6.4	18.5	3.9
November	33.1	20.7	69	60	8.0	19.8	4.1
December	33.5	20.1	66	84	8.1	19.2	4.2
Year	25	22.5	77	64	6.6	18.6	48.9

where ET_o = Reference Crop Evapotranspiration computed using the FAO Penman-Monteith Method

Table 3. Evapotranspiration and Irrigation Requirement for Paddy Rice

Station: Lokoja .						Date of Transplant: 5 June 2007 Crop : Paddy Rice		
Month	Decade	Stage	Crop Coeff. (k_c)	ET_{crop} (mm/day)	ET_{crop} (mm/dec)	Effective Rain (mm/dec)	IR (mm/day)	IR (mm/dec)
May	1	N	1.20	0.28	0.84	0.9	1.09	5.5
May	2	N/L	1.19	0.84	8.4	6.2	5.67	56.7
May	3	LP	1.15	2.61	26.1	21.3	10.24	102.4
June	1	L/A	1.11	3.92	39.2	35.2	7.11	71.1
June	2	A	1.10	4.18	41.8	40.7	3.11	31.1
June	3	A/B	1.10	4.05	40.5	40.9	2.97	29.7
July	1	B	1.08	3.90	39.0	41.1	2.79	27.9
July	2	B	1.07	3.73	37.3	41.3	2.60	26.0
July	3	B/C	1.05	3.65	36.5	41.4	2.51	25.1
Aug	1	C	1.05	3.61	36.1	41.6	2.45	24.5
Aug	2	C	1.05	3.57	35.7	41.7	2.40	24.0
Aug	3	C	1.05	3.64	36.4	43.3	2.31	23.1
Sept	1	C/D	1.03	3.64	36.4	45.7	1.82	18.2
Sept	2	D	0.97	3.48	34.8	47.7	0.84	8.4
Sept	3	D	0.88	3.27	32.7	43.8	0.20	2.0
Oct	1	D	0.80	3.04	30.4	20.6	1.39	6.9
Total					502.1	553.4		482.6

where N = Nursery, N/L = Nursery/Land Preparation, LP = Land Preparation, A = Initial Stage, A/B = Initial/Development Stage, B = Development Stage, B/C = Development Stage/Mid-Season Stage, C = Mid-Season Stage, C/D = Mid-Season/Late Season Stage, IR = Irrigation Requirement (mm/day), IR = Irrigation Requirement (mm/dec), K_c = Crop Coefficient and ET_{crop} = Crop Evapotranspiration (mm/day) and ET_{crop} = Crop Evapotranspiration (mm/dec).

antly coarse textured, ranging from loamy to sandy loam in the surface horizons and from sandy loam to clay in the sub-surface horizon. The soil pH ranges from 5.3 to 7.0, showing the soil is predominantly acidic. The Cation Exchange Capacity was generally low from 1.44 to 16.07 meq/100g of soil material in the surface horizons and 1.61 to 24.18 meq/100g at the sub-surface horizons, which means that the soils available have low potentials for retaining plant nutrients.

Reference crop evapotranspiration

The results obtained when a 25-year period was used with the FAO-Penman Monteith method to determine the reference crop evapotranspiration (ET_O) for the area under study show that ET_O varied from a minimum value of 3.4mm/day in August to the highest value of 4.8 mm/day in March (Table 2). The results show that ET_O was lowest during the peak of the rainy season to highest during the peak of the dry season.

Crop water requirement

Results show that for paddy rice, crop evapotranspiration (ET_c) and crop water requirement for varied from 0.28 to 4.18 mm/day and 2.0 to 102.4 respectively (Table 3). For maize, crop evapotranspiration (ET_c) and crop water requirement varied from 1.82 to 4.88 and from 1.3 to 45.6 mm/day respectively (Table 4). For tomato, crop evapotranspiration (ET_c) and crop water requirement for varied from 8.7 to 52.8 and from 0.0 to 45.2 mm/day respectively (Table 5). For grain amaranth, crop evapotranspiration (ET_c) and crop water requirement varied from 3.07 to 4.74 and from 7.4 to 45.6 mm/day respectively (Table 6). For pepper, crop evapotranspiration (ET_c) and crop water requirement varied

Table 4. Evapotranspiration and Irrigation Requirement for Maize

Station: Lokoja Date of Transplant: 5 June 2007 Crop : Maize

Month	Decade	Stage	Crop Coeff. (k_c)	ET_{crop} (mm/day)	ET_{crop} (mm/dec)	Effective Rain (mm/dec)	IR (mm/day)	IR (mm/dec)
Nov	1	A	0.45	1.82	5.4	4.1	0.44	1.3
Nov	2	A	0.45	1.84	18.4	1.7	1.68	16.8
Nov	3	A	0.45	1.86	18.6	1.3	1.73	17.3
Dec	1	A/B	0.52	2.18	21.8	1.0	2.08	20.8
Dec	2	B	0.69	2.90	29.0	0.7	2.84	28.4
Dec	3	B	0.88	3.71	37.1	1.0	3.61	36.1
Jan	1	B/C	1.04	4.42	44.2	1.3	4.28	42.8
Jan	2	C	1.10	4.73	47.3	1.7	4.56	45.6
Jan	3	C	1.10	4.80	48.0	2.6	4.55	45.5
Feb	1	C	1.10	4.88	48.8	3.4	4.53	45.3
Feb	2	C/D	1.07	4.83	48.3	4.3	4.39	43.9
Feb	3	D	0.95	4.39	43.9	7.4	3.64	36.4
Mar	1	D	0.77	3.62	36.2	10.6	2.58	25.8
Mar	2	D	0.59	2.82	19.7	9.6	1.45	10.1
Total					466.8	50.7		416.1

where A, A/B, B, B/C, C, C/D, D, k_c and ET_{crop} are as defined in Tables 1 and 2

Table 5. Evapotranspiration and Irrigation Requirement for Tomato

Station: Lokoja Date of Transplant: 5 June 2007 Crop Tomato

Month	Decade	Stage	Crop Coeff. (k_c)	ET_{crop} (mm/day)	ET_{crop} (mm/dec)	Effective Rain (mm/dec)	IR (mm/day)	IR (mm/dec)
Nov	3	A	0.70	2.89	8.7	0.4	2.76	8.3
Dec	1	A	0.70	2.92	29.2	1.0	2.82	28.2
Dec	2	A	0.70	2.94	29.4	0.7	2.87	28.7
Dec	3	A/B	0.72	3.03	30.3	1.0	2.93	29.3
Jan	1	B	0.78	3.33	33.3	1.3	3.19	31.9
Jan	2	B	0.88	3.78	37.8	1.7	3.62	36.2
Jan	3	B	0.98	4.28	42.8	2.6	4.02	40.2
Feb	1	B/C	1.07	4.72	47.2	3.4	4.38	43.8
Feb	2	C	1.10	4.95	49.5	4.3	4.52	45.2
Feb	3	C	1.10	5.06	50.6	7.4	4.32	43.2
Mar	1	C	1.10	5.17	51.7	10.6	4.11	41.1
Mar	2	C	1.10	5.28	52.8	13.7	3.91	39.1
Mar	3	C/D	1.03	4.86	48.6	18.6	3.00	30.0
Apr	1	D	0.88	4.06	40.6	23.4	1.72	17.2
Apr	2	D	0.72	3.23	32.3	28.3	0.39	3.9
Apr	3	D	0.55	2.44	4.9	6.3	0.00	0.0
Total					589.6	124.7		466.3

where A, A/B, B, B/C, C, C/D, D, k_c and ET_{crop} are as defined in Tables 1 and 2.

Table 6. Evapotranspiration and Irrigation Requirement for Vegetable (Grain Amaranth)

Station: Lokoja Date of Transplant: 5 June 2007 Crop : Grain Amaranth

Month	Decade	Stage	Crop Coeff. (k_c)	ET_{crop} (mm/day)	ET_{crop} (mm/dec)	Effective Rain (mm/dec)	IR (mm/day)	IR (mm/dec)
Nov	2	A	0.75	3.07	24.6	1.3	2.91	23.3
Nov	3	A/B	0.77	3.19	31.9	1.3	3.05	30.5
Dec	1	B	0.86	3.59	35.9	1.0	3.49	34.9
Dec	2	B	1.00	4.21	42.1	0.7	4.14	41.4
Dec	3	B/C	1.09	4.60	46.0	1.0	4.50	45.0
Jan	1	C	1.10	4.69	46.9	1.3	4.56	45.6
Jan	2	C	1.10	4.73	47.3	1.7	4.56	45.6
Jan	3	C/D	1.09	4.74	47.4	2.6	4.48	44.8
Feb	1	D	1.02	4.54	45.2	3.4	4.18	41.8
Feb	2	D	0.92	4.14	8.3	0.9	3.71	7.4
Total					375.6	15.2		360.4

where A, A/B, B, B/C, C, C/D, D, k_c and ET_{crop} are as defined in Tables 1 and 2.

Table 7. ET and Irrigation Requirement for Pepper

Station: Lokoja Date of Transplant: 5 June 2007 Crop : Pepper

.

Month	Decade	Stage	Crop Coeff. (k_c)	ET_{crop} (mm/day)	ET_{crop} (mm/dec)	Effective Rain (mm/dec)	IR (mm/day)	IR (mm/dec)
Dec	1	A	0.75	3.13	15.6	0.5	3.03	15.1
Dec	2	A	0.75	3.15	31.5	0.7	3.08	30.8
Dec	3	A	0.75	3.18	31.8	1.0	3.08	30.8
Jan	1	A/B	0.77	3.28	32.8	1.3	3.14	31.4
Jan	2	B	0.82	3.53	35.3	1.7	3.37	33.7
Jan	3	B	0.89	3.90	39.0	2.6	3.64	36.4
Feb	1	B	0.96	4.28	42.8	3.4	3.93	39.3
Feb	2	C	1.00	4.50	45.0	4.3	4.07	40.7
Feb	3	C	1.00	4.60	46.0	7.4	3.86	38.6
Mar	1	C	1.00	4.70	47.0	10.6	3.64	36.4
Mar	2	D	1.00	4.80	48.0	13.7	3.43	34.3
Mar	3	D	0.96	4.52	45.2	18.6	2.67	26.7
Apr	1	D	0.89	4.08	40.8	23.4	1.74	17.4
Total					500.8	89.2		411.6

where A, A/B, B, B/C, C, C/D, D, k_c and ET_{crop} are as defined in Tables 1 and 2.

Table 8. ET and Irrigation Requirement for Onion

Station: Lokoja Date of Transplant: 5 June 2007 Crop : Onion

.

Month	Decade	Stage	Crop Coeff. (k_c)	ET_{crop} (mm/day)	ET_{crop} (mm/dec)	Effective Rain (mm/dec)	IR (mm/day)	IR (mm/dec)
Nov	3	A	0.70	2.89	14.5	0.7	2.76	13.8
Dec	1	A	0.70	2.92	29.2	1.0	2.82	28.2
Dec	2	A	0.70	2.94	29.4	0.7	2.87	28.7
Dec	3	A/B	0.72	3.03	30.3	1.0	2.93	29.3
Jan	1	B	0.76	3.25	32.5	1.3	3.12	31.2
Jan	2	B	0.83	3.55	35.5	1.7	3.38	33.8
Jan	3	B	0.89	3.88	38.8	2.6	3.62	36.2
Feb	1	B/C	0.93	4.14	41.4	3.4	3.80	38.0
Feb	2	C	0.95	4.28	42.8	4.3	3.84	38.4
Feb	3	C	0.95	4.37	43.7	7.4	3.63	36.3
Mar	1	C	0.95	4.46	44.7	10.6	3.41	34.1
Mar	2	C	0.95	4.56	45.6	13.7	3.19	31.9
Mar	3	C/D	0.93	4.39	43.9	18.6	2.53	25.3
Apr	1	D	0.88	4.06	40.6	23.4	1.72	17.2
Apr	2	D	0.82	3.68	36.8	28.3	0.84	8.4
Apr	3	D	0.75	3.33	16.6	15.7	0.18	1.8
Total					566.1	134.4		431.7

where A, A/B, B, B/C, C, C/D, D, k_c and ET_{crop} are as defined in Tables 1 and 2.

Table 9. Evapotranspiration and Irrigation Requirement for Cabbage

Station: Lokoja Date of Transplant: 5 June 2007 Crop : Cabbage

.

Month	Decade	Stage	Crop Coeff. (k_c)	ET_{crop} (mm/day)	ET_{crop} (mm/dec)	Effective Rain (mm/dec)	IR (mm/day)	IR (mm/dec)
Dec	1	A	0.70	2.92	29.2	1.0	2.82	28.2
Dec	2	A	0.70	2.94	29.4	0.7	2.87	28.7
Dec	3	B	0.74	3.14	31.4	1.0	3.04	30.4
Jan	1	B	0.83	3.54	35.4	1.3	3.40	34.0
Jan	2	B	0.91	3.93	39.3	1.7	3.76	37.6
Jan	3	B/C	0.98	4.27	42.7	2.6	4.02	40.2
Feb	1	C	1.00	4.43	44.3	3.4	4.09	40.9
Feb	2	C	1.00	4.50	45.0	4.3	4.07	40.7
Feb	3	D	0.93	4.26	42.6	7.4	3.51	35.1
Total					339.4	23.4		315.9

where A, A/B, B, B/C, C, C/D, D, k_c and ET_{crop} are as defined in Tables 1 and 2.

Table 10. Scheme Irrigation Requirements

Crop	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Rice	0.0	0.0	0.0	0.0	5.7	4.4	2.6	2.4	1.0	0.5	0.0	0.0
Onion	3.4	3.8	3.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.9
Cabbage	3.7	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Maize	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tomato	3.6	4.4	3.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.9
Beans	4.8	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	3.0
Pepper	3.4	4.0	3.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
Grain Amaranth	4.5	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	4.0
NW1	5.4	5.1	2.5	0.6	2.3	1.8	1.1	1.0	0.4	0.2	1.0	4.3
NW2	163	152	75	17	68	53	32	29	11	6	31	130
NW3	0.63	0.59	0.29	0.06	0.26	0.20	0.12	0.11	0.04	0.02	0.12	0.50
AI	140	1333	75.0	51.7	40.0	40.0	40	40.0	40.0	13.3	40.0	140
NW	0.45	0.44	0.39	0.12	0.66	0.51	0.30	0.28	0.11	0.16	0.30	0.36
CD	13.5	13.2	12.5	10.6	9.6	8.3	8.2	8.5	9.7	10.8	12.6	13.3

where NW1 = Net Water Requirement (mm/day), NW2 = Net Water Requirement (mm/month), NW1 = Net Water Requirement (l/s/hr), AI = % of the total area that is actually irrigated, NW = Net Water Requirement for Actual Irrigated Area (mm/day), CD = Current Diversion (MC

varied from 3.13 to 4.8 and from 15.1 to 40.7 mm/day respectively (Table 7). For onion, crop evapotranspiration (ET_c) and crop water requirement for varied from from 2.89 to 4.56 and from 0.9 to 38.4 mm/day respectively (Table 8). Finally for cabbage, crop evapotranspiration (ET_c) and crop water requirement for varied from 0.7 to 7.4 and from 28.2 to 40.9 mm/day respectively (Table 9).

Scheme irrigation requirement

The estimation of actual irrigation requirement of KODIP was carried out (Table 10). The net irrigation water requirement is 767 mm/year (Table 10). This is summation of the WR_2 values from January to December. Using an irrigation application frequency of 65%, the gross water requirement of 1180 mm/year was obtained as 11800m^3/ha/year. Therefore the entire land area of 4100 ha will require 61.20 MCM and 23.88 MCM for the present 1600 ha after allowing 10 and 15% losses for main canal and distributory canals respectively. The amount of water diversion was estimated at 131 MCM (Table 10). This value was obtained by adding all water diverted from a whole year. The reservoir capacity is 220 MCM. Thus the capacity of 220MCM is sufficient to irrigate the irrigation water requirement for the entire area under the KODIP, which is 61.20 MCM. The results show that the dam can conveniently supply the water required for irrigation in the area.

Discussion

The results showed that reference and crop evapotranspiration (ET_o and ET_C) were higher for crops with longer growing season than for those with shorter ones. Also ET_o and ET_C were more during the dry season than the rainy season. FAO (2005) reported that crops grown in the dry season needs more water than those grown during the rainy season. The range of water requirement for lowland rice was particularly high because the water requirement during the peak rainy season (due to large amount of rain water) was very low while that of the peak dry season (no rainfall) was very high. Jehanger et al., (2004) reported that rice require more water than other those of other crops. Luca et al., (2003) and Broner and Schneekloth 2003) obtained values in the same range for the water requirement of maize.

Conclusion

The study shows that the dam can conveniently supply the water required for irrigation in the area used at present and also in the entire land 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.

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