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PRACTICABILITY OF TUBE WELLS FOR DRY SEASON FARMING IN THE FADAMA, GUINEA SAVANNAH AREA, NIGERIA

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ABSTRACT

Eighteen (18) tube wells were assessed for quantity of water and discharge rate. Soil and water samples were also analyzed for quality and suitability. Crop water requirements and potential evapotranspiration rate for wheat and vegetables were also calculated for. This shows that the months with greatest need for irrigation were November, December, January and February. These four months are also the period where the canal at Edozhigi dries up. The water requirement for the four months ranges from 8.28 x 10^{-4} m^3/s to 1.23 x 10^{-3} m^3/s. on site testing of the tube wells using a 5.5hp water pump showed that the various tube wells had a discharge rate ranging from 2l/s (2 x $10^{-3}m^3/s$) to 5 l/s (5 x $10^{-3}m^3/s$). The quantitative test showed that the discharge rate of the tube wells were sufficient for 56 hectares as against the proposed 45 hectares of fadama farmland during the peak period of demand.

Keywords: Tube Wells, Water Requirement, Fadama, Irrigation, Evapotranspiration

INTRODUCTION

Water is the greatest gift of our world. It conservation for better utilization is very essential. Irrigation is a pre-requisite for agriculture in dry climate (Northern Nigeria) or where natural rainfall does not meet plant water requirements during all or part of the year. River Basin Development Authorities were established with the responsibilities of developing infrastructure for irrigation, increasing agricultural production and under taking rural development. Today the activities of these River Basin Development Authorities across Nigeria have being streamlined to only water related activities. In the early 1990s, a programme supported by the World Bank to develop small-scale farmer based privatized irrigation system in fadama areas for wheat and vegetables cultivation during the dry season was implemented by the Government through the Agricultural Development Projects (ADP). Fadama are low-laying and undrelaid by extensive acquifers which are hydraulically connected to river systems and thus largely rechargeable (Tyem, 1994). The technologies adopted for irrigation development in these lands included water lifting from streams or rivers with the help of small or large pumps depending on the size of the land to be irrigated. Construction of ponds and wells and small earthen dams and installation of wash bore or shallow tube wells were undertaken as part of the development programme. Most of these systems were managed by the beneficiary farmers. The valley bottom irrigation systems for rice cultivation are prevalent in the central zone of Nigeria (Prachanda 1992). Evapotranspiration is the term used for evapouration of moisture from the earth's surface including lakes and streams and the vegetation that may cover the land. Consumptive use refers to the evapouration and transpiration from vegetation covered land only, frequently in respect of horticulture and agriculture and associated irrigation requirements. Consumptive use refers to water that is actually used while evapotranspiration formulae give potential water use. There are various methods of estimating actual and potential evapotranspiration; this includes the energy budget method, use of lysimeter and empirical formulae (Subramanya 2006). A model that is easy to apply and requires a minimum of commonly available meteorological parameters to be preferred over a more complex and sophisticated model with comparable accuracy of prediction. A modified form of Blaney-Morin evapotranspiration model is proposed here of satisfying these requirements since the weakness of Blaney-Cridle model for Nigeria has been identified as sole dependence on temperature as varaialble and since the Blaney-Morin model includes relative humidity parameter that varies over a wide range in Nigeria both in time and space (Duru 1984). To account for the effect of crop characteristics on crop water requirement, crop coefficient (K_c)are presented to relate ET_o to crop evapotranspiration (ET_{crop}). The K_c value relates evapotranspiration of a disease-free crop grown in large fields under optimum soil water and fertility conditions and achieving full production potential under the given growing environment (Micheal and Ojah 2006). Factors affecting the value of the crop coefficient (K_c) are mainly the crop characteristics, crop planting or growing data, rate of crop development, length of growing season and climatic conditions. The crops for which the K_c is to be considered for are wheat, tomatoes and potatoes. Edozhigi is located in Bida Local Government Area of Niger State. It is located on latitude 5^0 7' East and longitude 8^0 10' North. The area of study is located along the tributary of River

Kaduna on the left bank of its flood plain in Niger State of Nigeria. It has two water sources, the rivers Kupanko and Ejiko which are perennial streams. Mostly, at the end of May and at the beginning of June, the rivers show arises followed by a peak in September and subsequent decline there after. Since the area is underlined by the Nupe sandstones, there is a minimal variation in water flow. The seasonal flows become more attenuated owing to the direct runoff after rainfall and consequent inflow of groundwater to the rivers throughout the season. The geology of the area is that of the Nupe group of the Niger embankment which consists of flat lying, poorly exposed course to fine elastics and icon stones known from bore holes and from mesa sections. The area falls under the Bida sandstone unit. The sediments are multicoloured, varying from brown and yellow to green and white. The unit commonly underlies the plains in the Bida area and is generally exposed in the lower part mesas hopes (Adeleye and Dessauvagie 1994). The objectives of this study are to ensure/ascertain the practicability/use of tube wells for dry season farming and to ensure that there is a higher and increased crop production in the area.

MATERIALS AND METHODS

A total of eighteen (18) tube wells were sampled during this study. Standard laborartory reagents and apparatus were used to anaylsis the water and soil samplescollected from the field. The methods and procedures of the analysis were determined using the procedure described by the American Public Health Association (APHA, 1995). Secondary information about the climate of the area was collected from the Bida metrological station. The climatic data were used to determine the period of the year when irrigation can be extensively practiced and also to determine the crop water requirements of some of the crops grown in the area. Irrigation water use and management requires estimates of rates of crop water use and measurements of available water supply. The physical, atmospheric and environmental components such as radiation, air temperature, humidity and wind speed help to determine the rate of water transportation and evapouration. Several methods have been developed to estimate crop water use in relation to these physical variables. The temperature of the air considered was that at the level of the crop canopy and for the purpose of irrigation planning and management. The daily minimum (T_{min}) and maximum (T_{max}) temperature were considered and the mean average (T_{mean}) were taken. It is represented below as

$$T_{mean} = \frac{T_{min} + T_{max}}{2} \qquad (1)$$

Evapotranspiration is determined using the Blaney-Morin Nigeria model which is expressed as

$$Et_p = r_f (0.45T + 8)^{(520 - R^{131})/100} \qquad (2)$$

Where Et_p is given as potential evapotranspiration (mm/day), R is the mean relative humidity (%), r_f is the ratio of maximum possible radiation to annual maximum and T is the mean daily temperature (^{0}C) (Duru, 1984).

RESULTS AND DISCUSSION

The results of obtained for the crop water requirements were obtained using Blaney-Morin Nigeria empirical formula. The reslt shows that the potential evapotranspiration for the months with the greatest need for irrigation were November, December, January and February while March, April, May and October require less quantity of water. Therefore we can base our assumptions on these four months being the months the tube wells are most needed as even the canals which are also used for irrigation at Edozhigi dry up. The water requirements for the first four months were 8.28 X 10^{-4} m^3/s, 1.15 x10^{-3} m^3 /s, 2.64 x 10^{-4} m^3 /s and 1.23 X 10^{-3} m^3/s. On site testing of the tube wells using a 5.5hp water pump showed that the various tube wells have a discharge rate ranging from 2L/s (2 X 10^{-3} m^3/s) to 5L/s (5 X 10^{-3}/s). Though the tube wells have the same diameter and drilled depth, the variation observed may be due to varying geological formation and the hydrogeology of the area. On comparing the discharge rate of the tube wells and the irrigation water requirements, the tube wells can give sufficient quantity of water of 2 X 10^{-3} m^3/s to meet the demand of 1.23 X 10^{-3} m^3/s per hectare which is highest water demand rate of the month of February. The eighteen (18) tube wells located at Edozhigi area had a total discharge rate of 6.9 X 10^{-2} m^3/s which is enough to supply 56 hectares of the fadama farm land during the peak period of demand. It was observed that the potential evapotranspiration was highest during the months of February with 8.61 mm/day which is the peak period of

the dry season and the lost was in the months of August which is the peak period of rainfall around the area. A gradual increase of the Et_p could be seen from the month of August to February and from the month of March a drop in the Et_p was observed.

Table 1: Calculated Et_p from January to December 2000.

Months	Blaney-Morin Nigeria Parameters			
	R(%)	r_f	T(^{0}C)	Et_p(mm/day)
January	32	0.08058	28	7.09
February	33	0.09544	27	8.61
March	38	0.09351	31.7	8.38
April	59	0.09284	31.4	6.39
May	66	0.08480	29.7	5.04
June	72	0.07936	27.9	4.06
July	77	0.06648	26.7	2.98
August	78	0.06398	26.3	2.78
September	77	0.07658	26.6	3.43
October	70	0.08674	28.4	4.66
November	50	0.09589	28.5	7.01
Decemebr	43	0.08379	28.1	6.61

The results of the water analysis are shown in Table 2. The pH value is 7.24 which is slightly alkaline but is within the advisory limit of water sources for irrigation of between 7.0 and 8.5 (WHO, 2001). Thus, it will not be of any hazard to the crops in that area but will further determine the type of crop to be grown. The value of electrical conductivity (Ec) was 4.5 $X10^{-5}$ ms/cm means that if the present level of cropping intensity is maintained, it will take time before any salt problem is likely to be encountered. On comparing the value of SAR of 6.00 PPm to its standards which ranges from 0-10PPm, it shows that the irrigated water can be used for plants that are highly sensitive to sodium which means that wheat, potatoes and tomatoes can be conviently grown in this area. An average value of the power of hydrogen of the soil sample of the site was 6.51 which is slightly acidic. Though most plant and soil micro-organisms thrive best in the soils with a pH of between 6 and 7.5, plant species and varieties differ in degree to which they tolerate pH. All crops grown within this area thrive very well with the pH of the soils. The average value of electrical conductivity was 4 X 10^{-5} ms/cm which indicates that the soil is free from salts which may be attributed to the good drainage system in place. The Cation Exchange Capacity (CEC) is fertility indicator. Table 3 shows the exchangeable cations is restricted to those of Ca, Mg, K and Na. The result indicates good values of CEC which is an indication of good fertility.

CONCLUSION

The study shows that the quality and quantity of water produced by the tube wells can meet the demand of the irrigation scheme since the tube wells can sufficiently irrigate 56 hectares of farmland as against the proposed 45 hectares of farmland by the Government through the Agricultural Development Project (ADP). The soil sample test also showed that Edozihigi is a very fertile land; therefore agricultural activities should be utilized to the fullest. This will ensure increased crop production and economy of the farmers.

Table 2: Under ground water sample analysis of Edozhigi farmland.

Trace Elements														
Zn	Fe	Mn	Cu	Bo	S	Al	PH	EC	Na^+	K^+	Ca^{2+}	Mg^{2+}	NH_4^+	SAR
PPm	PPm	PPm	PPm	PPm	PPm	PPm	Hs/cm	(ms/cm	PPm	PPm	PPm	PPm	PPm	PPm
0.012	0.17	-	0.028	-	-	-	7.24	$4.5 X 10^{-5}$	21.5	16.0	10.0	10.0	0.01	6.00

Table 3: Soil analysis of Edozhigi agricultural farmland

						Exchange Cations					Trace Elements				
Sample No	PH	OC %	OM %	N %	P PPm	Na Meq	K Meq	Ca Meq	Mg Meq	CEC Meq	Zn PPm	Fe PPm	Co PPm	Bo PPm	Ec ms/cm
1	6.43	1.2	2.07	0.02	9.81	32.93	0.97	90.0	30.0	153.90	0.01	0.02	0.022	-	$4 x 10^{-5}$
2	6.58	0.9	1.56	0.02	8.40	38.60	0.92	84.0	40.0	165.52	0.02	0.02	0.23	-	$4 x 10^{-5}$

Source: NSADP 2000

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