Assessment of Supplemental Irrigation in Enhancing the Economic Viability of Yam Production in Nigeria

Oladipo I. O.

The Federal Polytechnic Department of Agricultural and Bioenvironmental Engineering PMB 5351 Ado Ekiti Nigeria.

Abstract:

This paper reports the investigation of yam cultivation under supplemental irrigation in Nigeria. Three levels of drip irrigation water application volumes 0.5, 1.0 and 1.5 litre/stand were used while the control experiment was left for rainfed. Biological growth, such as stem and branch elongation, leaf formation, canopy temperature (canopy density) were measured. The size and weight of the harvested tubers were taken. The cumulative monetary return for all yam tubers obtained from the irrigated plots was N370 per kg while that of rainfed yam was N30.3 per kg. The ANOVA results for the correlation of the irrigated yam with that of rainfed gave a lower P-Value to the F critical values for the biological growth parameters and the size of yam tuber harvested for all the treatments. However the economic return was highly significant at 0.1 level of confidence. The data was used to develop a Market Price-Time Model which was used to determine that the actual economic return of yam could only be attained up to first week of July. Beyond this point direct involvement of the farmer in the sales of yam has a negative effect on the economic return of yam cultivation business. The paper recommends that commercial yam cultivation should involve irrigation practice and engagement of marketing hand when the Critical Marketing Point (CMP) is unavoidably encountered.

Keywords: Yam cultivation, drip irrigation, climate change, desertification, rainfed

Introduction:

Yam (Dioscorea species) comprised over 600 species (Ike and Odjuvweserdie, 2006). The widely cultivated among these diverse species include white yam (Dioscora rotundata), yellow yam (D. alata) and water yam (D. esculanta). Other species that are of less popularity are trifoliate yam (D. dumenerum) and D. bulbifera (Ebewore et al., 2013). Yam is produced almost in all the humid tropical regions of the world (Ebewore et al., 2013; Wikipedia, 2013 and Abdu Wahid et al., 2010). This is evidenced by the top twenty chart of World's yam producing countries namely; Nigeria, Ghana, Ivory Coast, Benin, Togo, Burkina Faso, Cameroun Chard, Ethiopia, Central Africa Republic, Gabon, and Democratic Republic of Congo all in Africa, while Cuba, Colombia, Haiti, Brazil, Jamaica and Venezuela in Latin America. The list also included countries located in Eastern Asia like Japan, Malaysia and the Philippines (Ike and Odjuvwederdie, 2006). West Africa accounted for up to 95 per cent of the total world yam production and out of this, Nigeria alone contributes over 72 per cent (Ike and Odjuvwederdie, 2006; Wikipedia, 2013). Yam should Have been able to thrive in most parts of the tropical condition but for the limitation of water supply (Ike and Odjuvwederdie, 2006; Abdu Wahid et al,. 2011). Anywhere the average daily temperature can be between 30 – 34 ^{o}C, and rainfall amount is up to 2700 mm/year and cover up to 132 days, yam will perform well (Ebewore et al,. 2013; Abdu Wahid et al., 2011; World Bank 2013). This condition explains why yam production is almost restricted to the Southern parts with a little extension to the Sudan Savannah vegetation belt of Nigeria and the rain forest regions of West Africa sub region.

Yam is cultivated mostly manually in West Africa. Planting usually starts in late September-Early December. The yam seed remain dormant in heaps throughout the span of the dry season which on many occasions can prolong until early April. Sprouting and growth is very slow and even discouraged because of inadequate water supply to sustain plant growth (IITA, 2010; Root Crop Digest, 2013). However, it was discovered that yam can sprout and grow without hindrance immediately it is planted. So the entire period of yam dormancy on the field amounted to waste of valuable time. In the tradition yam cultivation system, this time waste is inevitable (Abdu Wahid et al., 2011; Adeniyi, 2012; Tetteh and Saakwa 2010). A survey and analysis of the various factors associated with yam production in Nigeria was carried out. This was to identify the constraints militating against achieving optimal profit/economic return to yam farmers in Nigeria. The report listed many factors including infrastructure, social, economic, market forces, political influences and many others (Ebewore, 2013). No mention was made of climatic condition, climate change; water supply in particular and market time factors, which according to Abdu Wahid et al., (2011); Tettteh and Saakwa (2010); Farming Business, (2012) will to a larger extent determine the survival of yam production and the economic wellbeing of yam farmers in the near future. A close observation of yam market trend in the last decade revealed that yam produce that got to the market in the first 15 days of the harvest period enjoys high price, good patronage and very low marketing time. Every week thereafter, the price of yam will almost slice by 30 per cent while marketing time will increase by about 45 per cent (Business Day 2012; FAO, 2011).

Available water resource will be seriously hampered by combined effects of climate change factors as time progresses (Tetteh and Saakwa, 2010; World bank, 2010; Oladipo and Adewumi, 2013; Sagoe, 2006). Rainfall will become more unpredictable, extreme conditions of heat, dryness, wetness, storms, wind and evaporation will become rampant, extensive and more severe (World Bank, 2010; Vanguard, 2004). Melting permafrost and polar ice will cause ocean level to rise thereby resulting to coastal and estuaries inundation, submergence of low islands, intrusion of salt into the deltas and fresh water in the river discharge points. This and many other problems will force the yam cultivation zone to retreat into the hinterlands (Adeniyi, 2012; Tetteh and Saakwa, 2010; Farming Business 2012; Oladipo and Adewumi, 2013). While at the northern boundary, desertification, sand dune migration, excessive evaporation, heat and prolonged dryness will force the yam cultivation belt to shrink or at least put a limit to northward expansion (Oladipo and Adewumi, 2013).

To increase the sustainability of yam cultivation in the Southern part Nigeria therefore, there must be a serious consideration for supplemental irrigation that is not just to supply the needed water but also ensure optimal water use and maximize crop yield per water drop. It was upon this premise that this research was conceptualized and conducted.

Materials and Methods

Materials:

The materials used for this research were improvised drip irrigation system adapted to suite the cultivation pattern of yam farm in South Western Nigeria. 0.5 Ha farmland, water pump, overhead storage tank and Infrared thermometer. Other materials used were yam sets, fertilizer herbicides and tillage implement.

Method:

The research was carried out at the student demonstration field of the Department of Agricultural and Bio-environmental Engineering of Federal Polytechnic Ado Ekiti in Nigeria. The farmland was tilled into ten (10) rows of ten (10) heaps each. Two rows were dedicated to irrigation water application of 0.5, 1.0 and 1.5 liter/plant stand while two rows were treated as rainfed (control) plots. The average land area occupied by each heap was 1.0 m^2. The yam set were weighed and trimmed to 0.5 kg each. They were left in the open air store until they began to sprout. Thereafter they were transferred to the filed for planting. They were staked individually and mulched to reduce excessive heat and evaporation. The irrigation facility was installed and the two rows were subjected to different volumes of water application treatments using randomized complete block design (RCBD). Wetting was carried out at three days interval throughout the entire period of growth of the crop. Biological growth viz: length of stem with branches computed with Total Plant Height (TPL) model given by [4] as

$$(TPL = n_1 \times (L_1 + n_2 \times L_2 + n_3 \times L_3) \quad \ldots\ldots (1)$$

Where:

nx = no of branches of the x^{th} order on the $(x-1)^{th}$ branching order.

Lx = length of x^{th} plant order

Leave area:

No of leaves in different treatments at maximum growth (5 matured leaves randomly taken per plant at different stages of growth and measured using graphical method. (Leaf Area (A) = L x B (m^2)

Total leaf Area (TLA) = $A_{average}$ x no of leaves

canopy temperature, leave density and weight of harvested tuber were noted. Also, the market price of 200 kg and the time taken to sell the produce were recorded. The weighted market Return (WMR) was computed by dividing market price by the time it took to sell the produce. The experiment was carried out in three consecutive years i.e. 2010, 2011 and 2012. The data collected were subjected to statistical ANOVA using MS excel 2007 version software.

Result and Discussion

Fig 1 presents the cumulative stem elongation growth recorded for the yam plant during the investigation. Rate of elongation were similar in all the irrigated treatments and they attained full length between 50 and 62 DAP. While the rainfed plot was delayed and therefore prolonged to 80 DAP. This delay equally pushed forward the commencement of leaf formation and accounted for the low canopy density of inferred from the canopy temperature in the rainfed plot as shown in fig 2. Total leaf area estimated were 7.2m^2, 7.6m^2 and 7.4m^2 for the 0.5l, 1.0l and 1.5l irrigated plots and 7.0m^2 for rainfed plot. These values were not significantly different from one another as the P-values obtained in the ANOVA analysis were smaller than the F critical. The only area where a difference was observed was in the time of attaining optimal point which took over 38 days in the rainfed plot. The total quantity of tuber harvested for all the plots showed no significant difference. However, the yam in rainfed plot did not attain marketable size and maturity 2nd week of July in all the three years of the research. By this period, most farmers growing their crop on rainfed had started harvesting their yam and the yam supply rose sharply in the market. Since demand for yam did not rise with the same degree as the supply, price naturally fell. Consumers had ample opportunity and diverse choices to make not just within the same market but among markets (conventional, roadside and street hawkers), time to complete sales transaction increased sharply after 4th week of June. Fig 4 describes the combination of time factor and market price of yam at any given time. The graph of money value of time met that of the sales return in 1st week of July. This point is the critical market point (CMP) where the value of Weighted Market Return (WMR) is a unit (1.0). Before this point, WMR is naturally above 1.0 and is less than 1.0 at any point after it. The farther a point is away from this critical point to the left the higher the economic return of yam production and the situation will grow worse in case of moving away to the right of the critical market point (CMP) is unavoidably encountered, it is advisable to contract the marketing of the produce to a neutral body to handle and the return could still be enjoyed particularly if the market transfer will add little or no cost to the farmer.

Table 1 presents Weighted Market Return (WMR) of Harvested Yam. The cumulative market return of 200 kg irrigated yam was ₦74,100 Amounting to ₦370.5 per kg. While that of 66.67 kg rainfed yam was ₦2020 amounting to ₦30.3 per kg. When the price of yam-set was ₦100 per kg the return of rainfed yam was economically not viable.

Conclusion:

This research revealed that the best irrigation water application volume was 1.0 litre/stand in one irrigation. It also showed that irrigation does not really results to increase in yam yield but rather break the dormancy and reduce the total time yam will take to complete its growth to maturity. It simply implies that irrigated yam will get to the market earlier than the yam cultivated under rainfed condition and as such will enjoy market patronage, command higher price and realise a greater economic return to the farmer. However, if the critical market point is unavoidably encountered, it is recommended that the marketing should be contracted to an external party with very minimal or no cost. The outcome of this research established that sales of yam at the peak of market supply is economically unviable and should be avoided if yam production is to be sustained.

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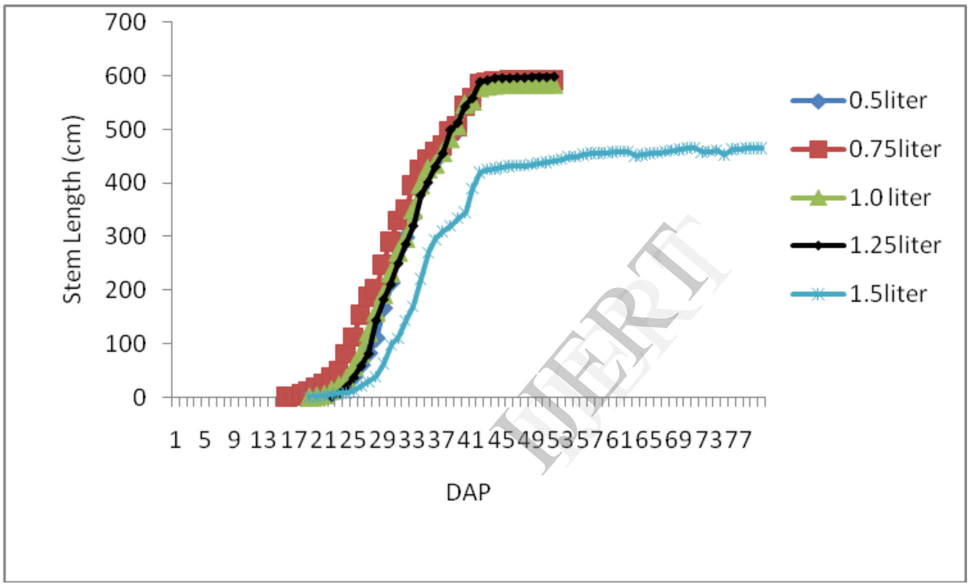

Fig 1: Stem length (cm) with respect to time

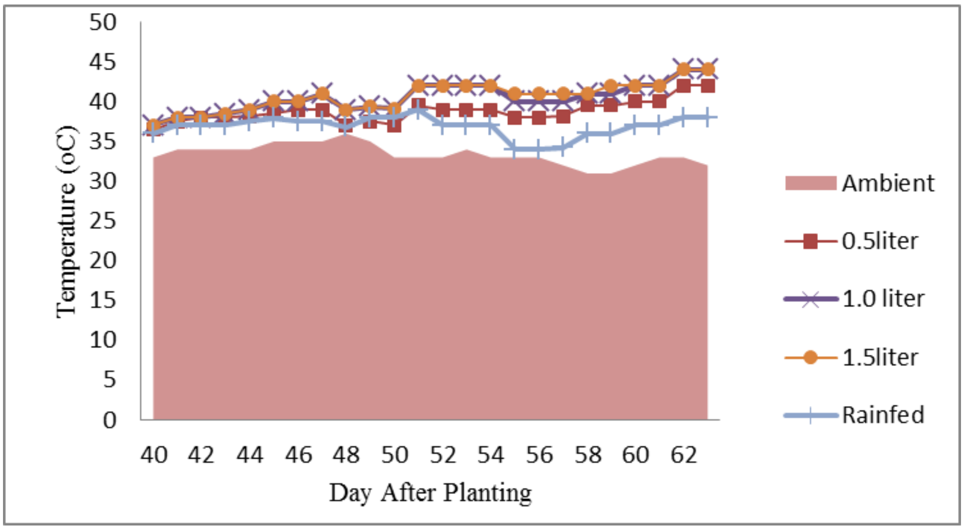

Fig. 2: Canopy Temperature (^oC) measured above ambient value

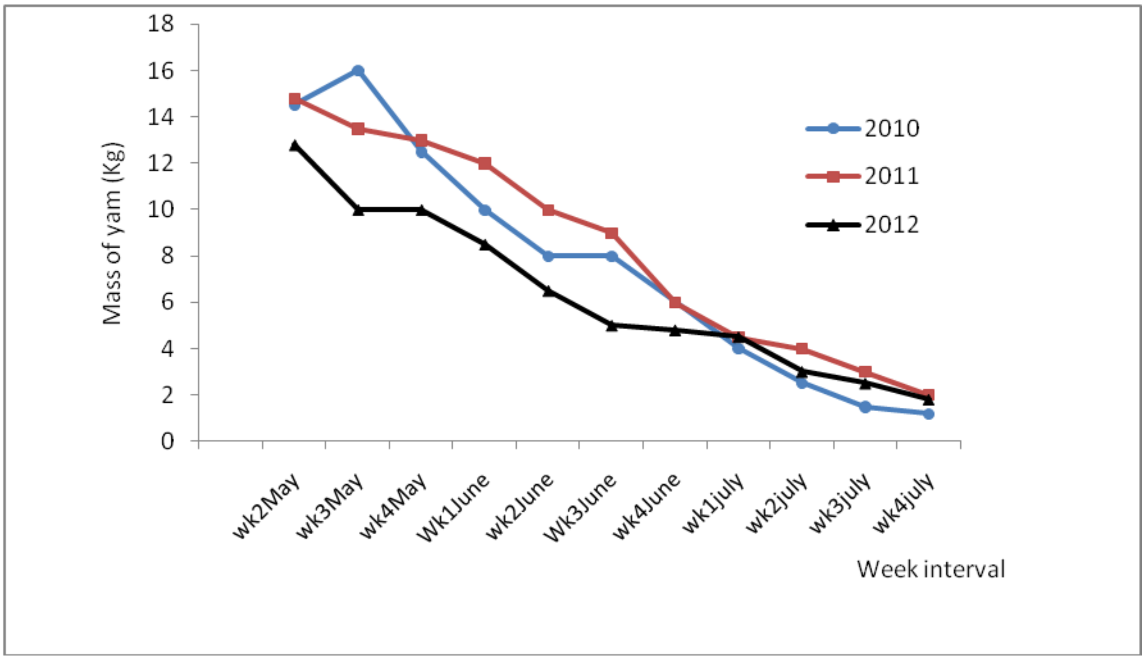

Fig 3: Sales Price of 250kg Yam for the three years (2010-2012)

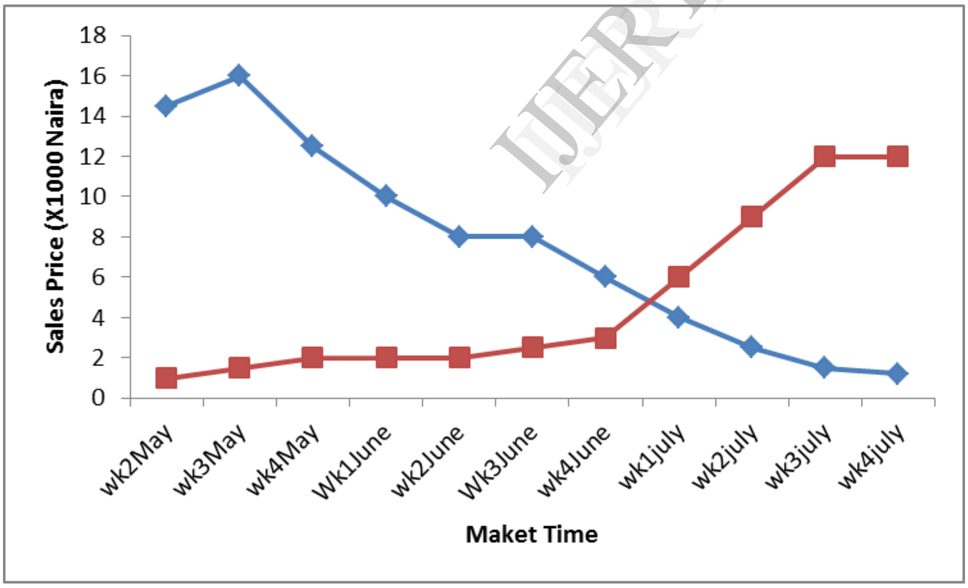

Fig 4: Graph of Yam Sales Price against the Transaction Time

Table 1: Weighted Market Return (WMR) of Harvested Yam

Period	Price (xN1000)	Money Value of Transaction time	WMR (x N1000) (col2÷col3)	Cumulative WMR of irrigated yam	Cumulative WER of rainfed yam
Wk2 May	14	0.5	28	28	Crop not yet
Wk3 May	16	0.8	20	48	ripe for sale
Wk4 May	12	1.0	12	60	,,
Wk1 June	9	2.0	4.5	64.5	,,
Wk2 June	8	2.0	4.0	68.5	,,
Wk3 June	8	2.4	3.3	71.8	,,
Wk4 June	6	2.6	2.3	74.1	Sale begins
Wk1 July	4	4	1	End of sales	1.0
Wk2 July	4	6	0.7		1.7
Wk3 July	2	12	0.17		1.87
Wk4 July	1.8	12	0.15		2.02
			Return/kg*	N370.5	N30.3

NB * Irrigated yam = 200 kg; Rainfed yam = 66.7kg 1.0 kg yam set = ₦100

Exchange rate as at July 2012: ₦150:00 to USD1:00