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Research Paper

Analysis of TechnicalEfficiency and its Determinants amongIrrigatedWatermelonFarmers belonging to Ogun-Osun River Basin Development Authority inOyo state

A.M Yaqoob, B.T Omonona and M.A Salau
[1]*(Department of Agricultural Economics, University of Ibadan, Nigeria)*
[2]*(Department of Agricultural Economics, University of Ibadan, Nigeria)*
[3]*(Department of Agricultural Extension and Management, The Oke-Ogun Polytechnic, Saki)*
Corresponding Author: A.M Yaqoob

ABSTRACT: *Theagricultural production system in Nigeria is predominantly ran-fed and accounts for about two-third of crop production. However, its production system is largely uncompetitive in major crops including watermelon. Previous studieshave adopted stochastic frontier approach in measuring technical efficiency,while the focus of few studies that appliedthe non-parametric procedure wasnot on watermelon. Hence, this study analyzed the technical efficiencyand its determinantsamong irrigated watermelon farmers belonging to Ogun-Osun River Basin authorityin Saki East Local Government area of Oyo State. The primary data used for this study were based on direct interview survey of 45 farming households that are members of Water-User Association (WUA) in Ogun-Osun River Basin irrigation scheme in the 2019-2020 production cycle. An input oriented Data Envelopment Analysis (DEA) was used to estimate technical efficiency scores. TheTobit regression analysis wasused to explain the variation in the efficiency scores. The resultsfrom the study show that the average overall technical efficiency scores of censored watermelon farms was 0.33 and ranges from 0.03 to1.00 implying that watermelon farmers could reduce their inputs including waterby 67% and still produce the same level of output. The resultsfrom the second stage analysis of Tobit regression show that farm size and household size negatively influenced technical efficiency, while the farmer's age, years of formal education and frequency of contacts with extension workers showed positively influenced technical efficiency. Based on the findings from the study, farmers in Ogun-Osun irrigation scheme particularly should be regularly trained for enhanced capacity building and productivity. In addition, they should optimize their labour resources by engaging their household members in farm activities for improved farm productivity.*

Keywords: Technical Efficiency, Data EnvelopmentAnalysis, Water users, Ogun-Osun, Irrigation,

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I. INTRODUCTION

The agricultural production system in Nigeria is predominantly rain-fed covering 80% of the cultivated land and accounts for about two-thirds of crop production (IWMI, 2007 and UNESCO, 2014). However, the Nigerian Agriculture is largely uncompetitive in major crops (World Bank, 2014).Statistics show that Nigeria imports about 6.7% and 63.5% of annual demand for staple food consumption of maize and rice respectively(FMWR, 2014).This leads tosituation of foreign exchange depletion and associated increase in price of food items. With increasing need for food production due to upsurge in the population pressure, land and water resources are the two critical and scarce resources for agricultural production activities and globally these resources are depleting (CPWF 2007).In 2013, the United Nations reported that the projected increase in world population growth rate which suggests higher food demand in the future with a direct consequence on agricultural water use, compounds the challenges of water scarcity. In addition, as a result of the increased water scarcity and drought due to climate change, extensive water use for irrigation is expected to occur in the context of increasing competition between agriculture and other sectors of the economy (Jimenez *et al.*, 2014).

Land and water are essential inputs for growing biofuels in large quantities. Consequently, imminent trade-off is expected as a result of the competition for these two resources in the production of food crops and bio-fuel (Nhatumbo and Salomao, 2010). Expansion of crop production for biofuels confers greater pressure on fresh water use, with a consequent worsening scenario of water stress especially among the most 'grabbed' countries including Nigeria (Gerbens and Hoekstra, 2011).Report of water use assessment for agricultural production in the top 24 'grabbed' countries (Rulli *et al.,* 2013) showed that most 'grabbed' countries including Nigeria are located in physical or economic water stress areas. In developing countries, studies have shown positive association between irrigation and agricultural productivity, income, food security and poverty alleviation (FAO, 2003; de Fraiture and Giordano, 2014). The foregoing suggests that water use management is a critical factor in any effort to increase theefficiency and productivity of watermelonparticularly in the Southern part of Nigeria.

Watermelon (*Citrullus lanatus*) belongs to the family Cucurbitaceae (Schippers, 2000). It is one of the most widely cultivated crops in the world with global production reaching about 89.9 million metric tons(FAO, 2003). Its origin has been traced to both the Kalahari and Sahara deserts in Africa and Middle East(Jarret *et al.*, 1996).China, Turkey, Iran, Brazil, United States, Egypt and Russian Federation are the major producers of watermelon (FAO, 2010). The crop is widely distributed as a garden crop. However, its cultivation as a commercial vegetable is confined to the drier savanna region of Nigeria (Annons, 2006). It is a horticultural crop (Toth *et al*., 2007) that provides a high return and has relatively low water requirement, compared to other crops. It is a good source of vitamins A and C in form of disease fighting beta-carotene. (Wang *et al.,* 2004). Watermelon, which is a traditional food plant in Africa with low calorie (Gyulai *et al.,* 2011), has the potential to improve nutrition, boost food security, foster rural development and support sustainable land cares (NRC, 2008).Watermelon is also known to contain Potassium which is believed to help in the control of blood pressure and prevents stroke and other numerous health challenges. However, the increasing demand for this vegetable fruit does not match its supply particularly in the Southern part of Nigeria largely due to high rainfall covering many months of the year (Musmade and Desai, 2001). Reports showed that countries in Sub-Saharan Africa including Nigeria have failed to exploit the potential benefits of irrigation, as its level of development is the lowest among the developing regions (de Fraiture & Wichelns, 2010). Farmers in the developing countries fail to exploit full potential of production technology and are unable toefficiently allocate resources suggesting that the performance of irrigated farming in developing countries including Nigeriaissub-optimal.

Literature has been inundated with empirical studies (Agbo *et al.*, 2013; Otunaiya and Adedeji, 2014; Amare *et al.,* 2016 and Bishwagit *et al.,* 2017) on technical efficiency (or inefficiency) and its determinants amongsmallholders' irrigated watermelon farmers using the Stochastic Frontier Approach. Shettima *et al.* (2015)analyzed the technical efficiency of irrigated vegetable production in Borno State, Nigeria using the Frontier Approach. AlthoughSpeelman *et al.* (2015) and Tolga *et al.* (2009) analyzedtechnical efficiency using data envelopment analysis (DEA),watermelon was not the focus of their studies. The foregoing showsa gap in knowledge that this study intends to fill using the input-oriented efficiency measure of Data Envelopment Analysis to analyze the technical efficiency among irrigated watermelon farmers in Ogun-Osun public irrigation scheme. The outcome of this study is expected to inform policy making decision on the performance of public irrigation scheme towards achieving the objective of water management for optimum production.

II. MATERIALS AND METHODS

Data collection: The primary data were used in this study collected from a census survey of smallholder farmers in public irrigation scheme. The scheme comprises of fourty-five members of Water UsersAssociation under Ogun-Osun River Basin Development Authority situated in Sepeteri, Saki East Local Government area of Oyo state. Semi structured questionnaire with oral interview was used to collect data from the respondents. Secondary data was obtained from various articles, publications, journals and official website of Ogun-Osun River Basin Development Authority. One output and six inputs were used in the DEA model. The only output was the watermelon yield per farmer. The inputs were land (ha), cost of chemical, cost of fertilizer, cost of water used, cost of seed and labor used (man hr. /farm) in watermelon production from land preparation through harvest. After calculating DEA scores, Tobit model was used to determine sources of efficiency/inefficiencies. The explanatory variables used to explain the efficiency/inefficiency of studied farms were farm size, farmers' age, household's size, farmer's years of formal education and frequency of extension contacts. Technical efficiency scores were computed using DEA/Stata programme.

Brief description of Ogun-Osun River Basin Development Authority: River Sepeteri is one of the tributaries of River Ogun. It is one of theproject sites of Ogun-Osun River Basin Development Authority (O-ORBDA) in the Southwestern Nigeria.The Authority is one of the twelve (12) River Basin Development Authorities established between 1973 and 1984 in Nigeria. It has jurisdiction over the area between Nigeria's border with the Republic of Benin to the West and Sasa River to the East. The area which covers the whole of present day Osun, Oyo, Ogun and Lagos state, has an estimated land area of 66,264 square kilometers. It is drained by two main rivers- Ogun and Osun and a number of tributaries and smaller rivers which include Sasa, Ona, Ibu, Ofiki, Yewa, Igbo-Ijaye and Sepeteri. The headquarters of the authority is located on a 236ha estate along Adabata road, off Ibadan-Abeokuta high way, Abeokuta in Ogun state. It has three area offices located at Oshogbo (Osun state), Ibadan (Oyo state) and Ikeja (Lagos state) as well as a liaison office at Gwarinpa in Abuja.Although O-ORBDA does not engage in direct agricultural production, farming operations are carried out directly by participating farmers who were members of water user association in the farmer-based irrigation project established by the Authority. The scheme is instituted with a view to optimizing both ground and surface water for food production. Under the scheme, group of farmers is settled as irrigated farm plot owners who pay subsidized rates for water releases, tractorization and other inputs supplied to them by the Authority (Ogun Osun River Basin Development Authority, 2013).

Analytical Techniques: Descriptive and inferential statistics as well as non-parametric measure of technical efficiencywere used to analyze the primary data collected at the farm level in order to achieve the objectives of the study. The descriptive statistics that was used in this study included the main measure of central tendency-Mean and Standard deviation.The inferential statistics and non-parametric efficiency measure were Tobit regression and Data Envelopment Analysis (DEA) respectively.

Efficiency measures: The performance of a farm can be evaluated based on different efficiency measures, namely technical, allocative and economic efficiency. This study is limited to the calculation of technical efficiencies. Following Farell (1957), technical efficiency is defined as the ability of a farm to produce the maximum feasible output from a given bundle of inputs or to use minimum feasible amounts of inputs to produce a given level of output. These two definitions of technical efficiency lead to what is respectively known as the 'output-oriented' and the 'input-oriented' efficiency measure (Coelli *et al.,* 2002; Dhungana *et al.,* 2004; Rodríguez Diaz *et al.,* 2004a; Rodríguez Díaz *et al.*, 2004b). Input-oriented models were chosen in this study because the objective of this study was not to increase production, but to use different resources more efficiently (Rodríguez Diaz *et al.*, 2004a). Technical efficiency itself can be further decomposed into two components: scale efficiency and pure technical efficiency. The former relates to the most efficient scale of operation in the sense of maximizing average productivity. Pure technical efficiency, however, is obtained when separating the scale effect from the technical efficiency. Thus, the efficiency scores obtained in the first stage were used as dependent variable in the second stage of the analysis.

Data Envelopment Analysis (DEA): Data envelopment analysis (DEA) is a mathematical and linear programming technique which is used to measure the relative efficiency of decision making units (DMUs) with multiple inputs and multiple outputs. DEA is one of several techniques that can be used to calculate a best practice production frontier (Helfand andLevine 2004).Although,the stochastic frontier approach is mostly used to measure technical efficiency, data envelopment analysis has some advantages over the parametric approach to efficiency measurement. Firstly, because it is nonparametric, it does not require assumptions concerning the functional form for the frontier technology or the distribution of the inefficiency term. Secondly, the approach permits the construction of a surface over the data, which allows a relative comparison of the best production method with the others in terms of a performance index. Furthermore, using DEA, efficiency measures are not significantly affected by small sample size as long as the number of inputs variables is relatively fewer,compared to sample size.The measure of technical efficiency that Farrell (1957) introduced is an input oriented measure—by how much inputs could be reduced, while maintaining the existing level of output. The alternative way in which to consider technical efficiency is an output oriented measure—by how much could output be increased, while using a given level of inputs. This approach to measuring technical efficiency yields a relative measure as itassesses the efficiency of a farm relative to all other farms in the sample. Farrell argued that this is more appropriate because it compares a farm's performance with the best actually achieved rather than with some unattainable ideal (Fraser and Cordina, 1999). Technical efficiency considers optimal combination of inputs to achieve a given level of output (an input-orientation) or the optimal output that can be produced given a set of inputs (an output orientation).This study is focused on input oriented models, because it assesses the ability of decision-making units to consume the minimum feasible inputs, given the level of outputs that can be obtained. Moreover, the choice of this orientation is also supported when considering the degree of farmers' control over their resources. Farmers have more control over their inputs than outputs.

According to Coelli *et al.* (1998), the constant return to scale (CRS) DEA model is only appropriate when all firms are operating at optimal scale. Imperfect competition or constraints on finance may cause a firm not to operate at optimal scale. For this reason, an input-oriented variable return to scale (VRS) DEA model is used to calculate technical efficiency in this study. Although, DEA is deterministic and sensitive to measurement errors and other noise in the data, studies have shown that results from both methods - stochastic frontier and data envelopment analysis are highly correlated (Thiam *et al.*, 2001; Aleue and Zeller, 2005).By allowing for variable return to scale, our measure of technical efficiency can be split into pure technical efficiency and scale efficiency. An input oriented VRS-DEA model is given below for N farms, each producing M output by using k different inputs (Coelli *et al.*, 1998):For thei_{th} farm, inputs and output data are represented by the column vectors X_i and Y_i respectively. The KxN input matrix, X_i and the MxN output matrix, Y represents data for all N farms in the sample. The DEA model to calculate technical efficiency (TE) is represented by the equation below:

$$Min_{\theta\lambda}\theta,$$

Subject to $-y_i + Y\lambda \geq 0$ …………………………………. (1)

θx_i -$X\lambda \geq 0$

$$N1'\lambda = 1$$

$\lambda \geq 0$

Where θ is a scalar, $N1$ is a $Nx1$ vector of ones, and λ is a $Nx1$ vector of constants. This is solved once for each farm, where the value of θ obtained is the technical efficiency score for the i_{th} farm which lie between zero and one with a value of 1 indicating a point on the frontier and thus technically efficient. According to the Farrell (1957), the linear programming problem needs to be solved N times and a value of θ is provided for each farm in the sample.Because the VRS-DEAmodel is more flexible and envelops the data in a tighter way than the CRS DEA, the VRS DEA efficiency score is equal to or greater than the CRS score. Using the relationship between VRS and CRS DEA scores, the scale efficiency (SE) score for a farm is computed (Dhungana *et al.*, 2004) as:

$$SE_i = \frac{TE_{i\ CRS}}{TE_{i\ VRS}} \quad \text{…………………………………………..... (2)}$$

Where SE= 1 indicates a scale efficient farm that isoperating at a point on CRS, a value SE<1 indicatesscale inefficiency.

Tobit Model: After calculating the efficiency measures, the next step was to identify the determinants of efficiency. The DEA efficiency measures obtained in the first stage were used as dependent variables in the second stage involving the analysis ofTobit model. It expresses the relationship between the efficiency measures and its suspected correlates (Binam *et al.,* 2003; Chavas *et al.,* 2005 and Barnes, 2006). Tobit model is used because the efficiency parameters vary between 0-1 and they are censored variables. These models are also known as truncated or censored regression models (the model is truncated if the observations outside a specified range are totallylost and censored if one can at least observe the exogenous variables) where expected errors do not equal zero. The maximum likelihood estimation technique was used to estimate the parameters of the model because the ordinary least squares (OLS) estimation technique gives a biased parameter estimate since OLS assumes a normal and homoscedastic distribution of the disturbance and the dependent variable (Amemiya, 1984).The standard Tobit model can be defined as follows:

$$y_i^* = x_i^t \beta + u_i \quad \text{…………………………………………………......... (3)}$$

Where i = 1, 2… n.

$y_i = y_i^*$ if $y_i^* < 0$

$y_i = 0$, otherwise and u_i is identically and independently distributed with zero mean and constant variance.

$x_i^t$and β are vectors of explanatory variables and unknown parameters respectively.y_i^* is a latent variable and y_i is the DEA score (Amemiya, 1984).Following Tolga *et al.* (2009) and Speelman *et al.*(2017), the following explanatory variables as specified in the tobit model included farmers' age, household size, cultivated area, frequency of extension contacts, and years of formal education.

III. RESULTS AND DISCUSSION

Table 1 presents the summary of the continuous variables used in Data Envelopment Analysis (DEA) of technical efficiency scores. The results show that the average yield of Watermelon per hectare was 1690.87kg, while the average yield per farm was 2298.67kg. The average farm size of the respondents (Water user) in Ogun-Oshun public irrigation scheme was 1.42 hectares. Of all the inputs used in production of watermelon, water users spent more on water than any other input ranging from N12500 to N100000 with an average of N42255. Furthermore, the average amount spent on fertilizer, seed and pesticide by the irrigated watermelon farmers in Ogun-Oshun public irrigation were N16144.44, N13520 and N5662.22 respectively.

Table 1 Summary Statistics of the Output and InputsVariablesUsed in Efficiency Analysis

Variables	Unit	Mean	SD	Minimum	Maximum
Output	kg/ha	1690.87	1060.39	306	4309.5
	Kg/farm	2298.67	1605.4	306	6936
Inputs					
Land	ha	1.42	0.965	1	7
Fertilizer	Naira	16144.44	11257.97	1750	64000
Labour	man/hr.	272.16	108.50	60	614
Expenses on seed	Naira	13520	5682.49	7000	33000
Expenses on water	Naira	42255	20650.95	12500	100,000
Expenses on pesticide	Naira	5662.22	6624.28	1800	45000

Source: Author's computation from field survey, 2019

Table 2.Summary Statistics of variables used in Efficiency Model

Variables	Mean	SD	Minimum	Maximum
Farm size	1.42	0.965	1	7
Age	48.80	9.80	28	70
Formal education (years)	10.80	4.96	0	16
Household size	7.00	3.697	1	18
Frequency of ext. contacts	2.80	3.035	0	12

Source: Author's computation from field survey, 2019

Table 2 shows the summary statistics of the variables used in the inefficiency model. The results show that the mean age of irrigated farmers in the study area was 48.80 years. This implies that Watermelon farmers in Ogun-Osun public irrigation scheme were within the active labour force. The high level of literacy among the respondents with an average of 10.88years of formal education was likely to influence their efficiency in terms of adoption of innovation and improved technologies.The results from the table also show that irrigated watermelon farmers had an average household size of 7 members.Therelatively-large household size among the respondents impliesavailability of adequate family labour among the respondents and it is an important factor in efficiency consideration because the endowment of family labour is expected to reduce the cost of production and consequently increase technical efficiency. However, the frequency of contacts with extension workers among the irrigated Watermelon farmers in Ogun-Osun irrigation scheme was relatively poor with an average of 2 contacts in a year. The poor number of contact with extension agents implies inefficiency among the farmers. This is because the ability of the respondents to access modern and improved production technologies as well as market information regarding the prices of inputs and outputs might be restricted.

Analysis of Technical Efficiency

An input-oriented DEA model was used to estimate overall technical, pure technical and scale efficiencies of the irrigated watermelon farms in the study area as shown in the Table 3.The mean values of overall technical, pure technical and scale efficiencies were 0.33, 0.87 and 0.42 respectively. Overall technical efficiency score of watermelon farmers in the study area was 0.33.This means that, on average, watermelon farmers in the study area could reduce their inputs by 67% and still produce the same level of output. The splitting of the technical efficiency measures produced estimate of 13% pure technical inefficiency and 54% scale inefficiency (Table 3). However, farmers can increase their average technical efficiency from 0.33 to 0.87 if only they can overcome inefficiency due to inappropriate scale of production.

Table 3: DEAScores of Technical, Scale and Pure TechnicalEfficiencies forWatermelon Farmers

Mean	SD	Minimum	Maximum

Overall technical efficiency	0.33	0.21	0.03	1
Pure technical efficiency	0.87	0.22	0.35	1
Scale efficiency	0.41	0.29	0.03	1

Source: Author's Computation from Field Survey, 2019.

Table 4 presents the result of returns to scale characteristics. Of the 45 members of water users Association (WUA) in Ogun-Osun public irrigation scheme, 42 showed increasing returns to scale, 2 showed decreasing returns to scale and only one farm showed constant returns to scale.

The large number of farms with increasing return to scale implies that majority (93.3%) of the farmers were not producing at the optimum level. This indicates that a unit increase in the current input mix by these farmers will lead to more than proportionate increase in output. The results from the table also show that very few farmers (4.4%) were operating at decreasing returns to scale. This implies that any attempt by these farmers to further increase the level of the current input-mix will lead to less than proportionate increase in output. In the entire study, only one farm (2.2%) was technically efficient as it operated at optimal level of production. Any deviation from the current production practice by this farm will lead to loss in output or rise in the cost of production given the level of output. Generally, inefficiency exists as a result of either inappropriate scale or misallocation of resources. Inappropriate scale suggests that the farmers were not taking advantage of economies of scale as evident from the result of this study, whereas misallocation of resources refers to inefficient input combinations. Theresults from the study revealed that substantial inefficiency exists largely due to inappropriate scale of production (Oren an Alemdar, 2006).

Table 4:Summary Results of the Returns to Scale (RTS) among the Irrigated Watermelon Farmers

Characteristics	Frequency	%	Mean farm size (ha)	Mean output (kg/ha)
CRS	12.2		1	3094.00
DRS	2	4.4	2	1963.50
IRS	42	93.3	1.4	1644.48

Source: Author's computation from field survey, 2019.

Determinants of Technical Efficiency

In the second stage of the analysis, VRS-DEA efficiency scores were used as the dependent variable, while farmers specific factors were used as independent variables in the Tobit model. Positive coefficient implies increase in efficiency of farm operation, while a negative coefficient implies its decrease. The result of the efficiency model as presented in table 5 revealed that the overall fitness of the model as shown by the likelihood estimate of 17.16 was statistically significant at 1%. This indicates that the model adequately fits the data. The table 5 also revealed that, out of the five independent variables specified in the model, farm size was the only statistically significant variable at 1% level. The limitation in data collection resulting from the small size of the water-users in public irrigation scheme of Ogun-Osun River Basin Development Authority might be responsible for this result. However, the signs and magnitude of the coefficients as well as the estimates of marginal effects were consistent with the expectations.
Contrary to *a priori* expectation, the coefficient of farm size negatively influenced technical efficiency. The marginal effect estimate was 0.3168 and statistically significant at 1% level. This implies that an increase in farm size by one hectare decreases technical efficiency by 31.68%. This may be attributed to the fact that watermelon production is highly labour intensive and the excessive cost expended on labor may neutralize the gain in output due to increased farm size, leading to inefficiency. This finding is contrary to Biswajit, (2017), but consistent with Haji (2006).

As expected, the age of watermelon farmers had positive relationship with technical efficiency. Farmers' age may show both positive and negative effects on technical efficiency depending on whether or not older farmers were more experienced and receptive to new ideas and innovation that can improve their efficiency. The estimate of marginal effect shows that a year increase in age of the farmers increases their technical efficiency by 0.4%. This implies that older farmers are more experienced, receptive to new ideas and innovation and are therefore technically efficient than the relatively younger farmers. This finding is consistent with Bifarin *et al.* (2010) and Asogwa *et al*. (2011).

The years of formal education of irrigated watermelon farmers positively influences technical efficiency. The marginal effect estimate shows that a year increase in formal education of irrigated watermelon farmers increases technical efficiency by 0.2%. This finding is in consonance with Otunaiya and Adedeji, (2014). Mapemba *et al.* (2013) reported that education is a variable that enhances managerial skills of farmers and thus improve their efficiency level. In line with prior expectation, the coefficient of frequency of extension contacts positively influences technical efficiency. The marginal effect estimate shows that frequency of extension contact increases technical efficiency by 1.6%. This finding is consistent with Gideon *et al.* (2015) and Biswajit, (2017). Balal *et al.* (2009) also reported that there is no alternative to extension services as it ensures access to prompt information about the market condition as well as transfer of technology. As expected, the coefficient of household size had a negative influence on technical efficiency. The estimate of marginal effect revealed that a member increase in household size reduces technical efficiency by 2%. The possible reason for this result is that farmers under public irrigation in Ogun-Osun were not taking advantage of large household size to increase their productivities. Hence, substantial cost was incurred on hired labour for farm operations. In other words, relatively-large household tends to lower per capita income of household members resulting in delay in taking decision on critical farm operations or outright trade-off for household consumption expenditure. Ani *et al* (2003) and Biswajit, (2017) corroborates this finding.

Table 5. Tobit regression result of the determinants of technical efficiency

Variables	Coefficients	Marginal effects
Constant	1.6350 (0.9665)	- -
Farm size	-0.3172 (0.0872)*	-0.3168 (0.0875)*
Age	0.0029 (0.0155)	0.0044 (0.0152)
Years of education	0.0037 (0.0211)	0.0023 (0.0208)
Frequency of extension contacts	0.0156 (0.0348)	0.0156 (0.0348)
Household size	-0.0211 (0.0306)	-0.020 (0.0307)
LR chi^2 (6) = 17.16		
Prob. > chi^2 = 0.0087		
Pseudo R^2 = 0.3148		

Source: Author's computation from field survey, 2019.* *indicates 1% level of significance. Figures in parenthe: are coefficients of standard errors.*

IV. CONCLUSSION

The focus of this study was to analyze technical efficiency among irrigated water melon farmers belonging to Ogun_Osun public irrigation scheme.Based on descriptive, inferential statistics as well as non-parametric efficiency measure including Data Envelopment Analysis (DEA),the results revealed that watermelon farmers in Ogun-Osun irrigation scheme could benefit from the current production technology using the optimal level of inputs combination with respect to water, fertilizer, seed, pesticide and labour in the production of Watermelon., In other words, they could take the advantage of economies of scale by increasing the size of farm plot allocated in order to enjoy increased watermelon output. On the average, majority of farmers were operating below the production frontier and were therefore inefficient in terms of both technical and scale efficiency even though they had the potential to reduce their inputs by 67%, given the same level of output. Splitting the technical efficiency into pure technical and scale efficiency, the conclusion from the study was that, majority of the farmers were operating at increasing return to scale. Therefore, substantial inefficiency (54%) that occurred among the studied watermelon farmers was largely due to inappropriate scale of production. It was also found that years of formal education, frequency of extension contacts and age of the farmers were positively associated with technical efficiency. It is therefore recommended that the Ogun-Osun River Basin Development Authority should scale up strategies for enhanced capacity development in its farmers-based public irrigation scheme.

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