Evaluation of Economic Efficiency of Smallholder Orange Farmers in Machakos County, Kenya

Corresponding Author: Tom Maithya Wambua[1]
Email Addres:integratedacademicconsultant@gmail.com

info@ku.ac.ke

Contact:0711551403

Website www.ku.ac.ke

Postal addres :43844-00100
Post address 2: +0711551403-00100

Bett Kiprotich Eric[2]
Chair Department of Agricultural Economics
Email address: bett. eric@ku.ac.ke
Contact: +254722263348
School: Agriculture and Enterprise Development

Institution: Kenyatta university
Address:43844-00100, Nairobi, Kenya
Prof. Bernard K. Njehia[3]
Senior Lecturer Department: of Agricultural Economics

School: Agriculture and Enterprise Development

Institution: Kenyatta university
Email address: njehia.bernard@ku.ac.ke
Contact: +254722488337

Address:43844-00100, Nairobi, Kenya

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Abstract

Orange is one of the world's main fruit trees with global availability, popularity and importance in contributing toward livelihoods transformation and improvement. This study attempts to estimate technical, allocative and economic efficiency levels and the influence of social economic and institutional factors on the levels of efficiency among the sampled 169 smallholder orange farmers within Machakos County in Kenya. This research finding established that, mean technical, allocative an economic efficiency among orange farmers were 60.94%, 79.59% and 48.50% respectively. Economic efficiency was strongly influenced by age, farming experience, irrigation, credit and cost of inputs. In order to enhance economic efficiency based on the analysis, the study proposed; encouragement and promotion of youth to take up orange farming, mobilization and organization of non-member farmers to form or join groups to gain to easier access to extension and credit, development of credit facilities tailored made to meet farmers', needs, development of irrigation infrastructure for all year-round production and inputs prize stabilization mechanism through subsidies and vouchers.

Keywords*:* Technical efficiency, allocative efficiency, economic efficiency, data envelop analysis Kenya, Machakos county, orange production

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1.0 Introduction

Sub-Saharan agrarian economies face a challenge of promoting sustainable and economically efficient production practices within small holder agriculture. This has been triggered by the projected increase in population and matching it with the increased demand for food and nutrition concerns amidst the negative climate change effects.

Background of the Study

In Kenya, Orange makes up approximately 3.97 per cent of the overall worth of fruits. There has been an upsurge pertaining the land producing oranges, for instance in 2016, land under production had augmented by 23 per cent, capacities 5 per cent besides value 11 per cent. Nevertheless, productivity has been declining with time for example in 2017 it had diminished from 12 tonnes per Hectare to 10 tonnes per Hectare (AFA, 2017).

The chief orange varieties consist of; Valencia along with Washington Navel. Orange fruit poses huge demand due to its widespread usage along with benefits. Orange production is significant in promoting food as well as nutrition security. As soon as small-scale growers vend their extra harvest in market, they receive a revenue that aids them achieve their monetary requirements therefore improving the standards of living, consequently, orange farming pose a vital role in economics.

The current research investigated orange farmers' economic efficiency within Machakos county aiming at providing empirical prove towards maximization of output along with the minimization of wastages to promote sustainable orange growing.

Objectives

This study aimed at assessing smallholder orange growers' economic efficiency within Machakos County for the purpose of enhancing productivity through the optimization of existing capitals while decreasing expenses. The specific objectives are to identify socio-economic traits, to determine technical, allocative and economic efficiency and to find out factors affecting economic efficiency among smallholder orange farmers. The following null hypothesis will be tested:

H_0 : Smallholder orange farmers are not technically, allocatively and economically efficient.
H_0 : Socio-economic traits do not significantly influence economic efficiency.

2.0 Literature review

Economic efficiency

Farrell (1957) designed uncomplicated measure for firm efficiency that started efficiency evaluation. Economic efficiency (EE) denotes farm's capability of producing preprogrammed output level on the lowermost conceivable expenses of certain technological level (Bravo-Ureta *et al,* 1997). Technical efficiency (TE) denotes farm's capability to generate peak output utilizing minimum inputs, while allocative efficiency (AE) denotes the farm's capability to produce a particular output quantity using most affordable input proportion. Farrell's method, in contrast, has been extensively utilized for years, with numerous revisions besides improvements. Further, Farrell indicated that the product of TE besides AE measures overall economic efficiency (EE). The three measures are linked thus: EE = TE × AE. Farrell's method, in contrast, has been extensively utilized for years, with numerous revisions besides improvements.

Theoretical framework

Producers under microeconomic theory for farm production use several inputs in generating outputs. Targeting mainly to enhance output as well as profits under existing inputs restriction along with market expenses. Under production theory, economic efficiency is used in evaluating producer performance (Mussa, 2011).

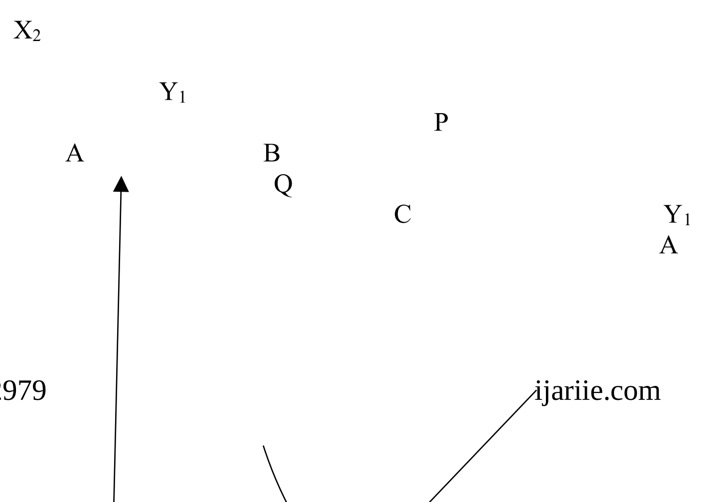

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Figure2.1: Economic efficiency X_1
(Source Farrell,1957)

Position P signifies technically ineffective as it is within the isoquant of output level Y1; considering best practice frontier, lesser inputs quantities X1 as well as X2 might be used in generating alike output. Position B signifies technically efficiency as it is on the isoquant of output Y1, nevertheless since it is not on the cost line A, it is not allocatively efficient. Point C denotes economic efficiency point; this is technically as well as allocatively efficient.

From Figure, T.E., A.E., along with E.E. can be signified as well as computed through the following distances;

T.E. = OQ/OP

A.E = OQ/OR

E.E. = T.E. x A.E.

= (OQ/OP) x (OQ/OR)

= OR/OP

Empirical literature review

SFA along with DEA are significant tools in quantifying efficiency in the presence of ineptitude influences on production. A comparison of DEA and SFA shows that unlike SFA which assumes existence of maximum quantities of outputs which can be generated from an amalgamation of inputs, DEA is a construction of observed data. Mutoko (2008) examined maize growers' economic efficiency within North Western Kenya to determine the factors influencing maize production efficiency by means of SFA.

Based on this research's results, sampled maize growers possessed technical efficiency of 64 per cent, 75 per cent allocative efficiency along with 49 percent economic efficiency. Influences established to impact economic effectiveness consist of; family size, out of farm revenue, education, soil fertility management, extension interactions along with market access.

By means of stochastic frontier model, Kibaara and Kavoi (2012) assessed Kenyan small scale maize growers` technical efficiency and farms was revealed to vary from 8 to 98%. Variables that reduced technical efficiency were; credit, tractors usage during land preparation, certified seeds, farmer's age as well as education.

Ng'eno *et al.*, (2011) established technical effectiveness amongst the bulrush millet farmers within Bomet, Bureti as well as Kericho districts of Kenya utilizing SFA. The hypothesis that there is no technical inefficiency influences and that explanatory variables had no impact on efficiency was strongly rejected in the three counties information. This inefficiency is associated with insufficient usage of inputs popular amongst small scale bulrush millet growers.

Mulwa *et al*., (2009) utilized DEA in identifying ineptitudes for maize production within Western Kenya. Results indicated that, maize farmers had 20 to 30 out of a hundred technical inefficiency and about 50 out of a hundred allocative ineptitude. Allocative efficiency appeared to be more restricting compare to technical efficiency, consistent with this research. Variables influencing maize production economic efficiency within Kenya including; farmers' education level, off farm doings along with interaction with extension amenities.

An exploration by Mengui (2019) explored smallholder Irish potato growers' technical efficiency within Santa Subdivision, Cameroon utilizing DEA. This exploration`s findings established that gains from enhancing technical efficiency exist within all farm-particular variables, along with environmental in addition to institutional variables. The research established that, farmers age, experience, usage of manure, along with extension amenities were considered as the most significant technical efficiency determinants.

3.0 Methodology

The Study Area

This study took place within Kenya's Machakos county, specifically within Mwala along with Machakos sub-counties. The yearly rainfall varies from 500 to 1300 millimeters; besides it is bimodal. All through the year, the temperature varies between 18 to 29 degrees Celsius. Agriculture is the main source of income within Machakos County, employing around 73 per cent of the overall population making up approximately 70 per cent of household revenue.

Sample size

Computation of the orange growers' numbers to take part in this research was achieved through Cochran's sampling method.

$$n = \frac{Z^2pq}{e^2}$$

whereby n denotes sample size, Z^2 denotes chosen confidence level, at 95% z is 1.96, e^2 denotes chosen precision level, e = 0.029270, p denotes estimated portion of a feature existing within a population and q is 1-p (Cochran, 1977). Formula usage along with its Calculations:

$$\frac{1.96^2\,((2645/80220)\,(1-2645/80220))}{0.029270^2} = 169.34 \approx 169$$

A total number of 169 farmers were sampled.

Data collection

Primary data collection was conducted using structured as well as piloted questionnaires that were given out to orange growers within Mwala along with Machakos sub-counties in Machakos County helped by trained enumerators. Information gathered encompassed socio-economic variables for orange growers within Machakos county. The data was compiled, cleaned and analyzed using SPSS and Ms Excel.

Empirical Framework: Data Envelopment Analysis and Cost function

Data Envelopment Analysis

Technical efficiency was calculated as shown below (Cooper *et al*., 2004).

$$Max \sum_{k=1}^{s} V_k Y_k \quad \text{---(i)}$$

$$Max \frac{\sum_{k=1}^{s} V_k Y_k}{\sum_{j=1} U_j X_{jp}} \quad \text{---(ii)}$$

$$s.t. \frac{Max \sum_{k=1}^{s} V_k Y_{ki}}{Max \sum_{j=1}^{m} U_k X_k} \quad \text{---(iii)}$$

$$V_k\,, \quad U_j \geq o \quad \forall k,j$$

Whereby *k*= 1 to *s*; *j*= 1 to *m*; *i*= 1 to *n, Vk* = Output *k* weight, *Vk* = Output *k* weight, *Uj* = Input *j* weight, Yki=output yielded by farm i, Xji = input j used by farm i

Cost function

Cost minimization economic efficiency method denotes proportion of least cost farm will confront when working at optimum resource use, Wi'Xi* along with the established charge Wi'X.

$$E.E. = \frac{W'_i X^*_i}{W'_i X'_i} \quad \text{--- (iv)}$$

$$A.E. = \frac{E.E.}{T.E} \quad \text{--- (v)}$$

Tobit model

Efficiency scores produced by DEA were regressed counter to socio-economic features through two-limit Tobit regression model to determine their impact. In examining the third objective, socio-economic variables were regressed on efficiency estimations for farms utilizing two- limit Tobit regression model.

$Y^*_i = \gamma_0 + \sum \gamma_i X_i + \mu_i$ ---(vi)
$Y_i = 1$, if $Y_i^* \geq 1$ ---(vii)
$Y_i = Y^*_i$, if $0 < Y_i^* < 1$ ---(viii)
$Y_i = 0$, *if* $Y_i^* \leq 0$ ---(ix)

Whereby;
Y denoted efficiency score , γ0 denoted constant efficient score , γi denoted parameter estimations, Xi denoted independent variables, i signified the ith farm, Yi denoted inefficiency scores , Yi denoted latent variable, μi denoted random error term, that is, (μi ~NI (0,δ 2)).

This research`s Tobit model was as demonstrated below;

$Y = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \gamma_4 X_4 + \gamma_5 X_5 + \gamma_6 X_6 + \gamma_7 X_7 + \gamma_8 X_8 + \mu i$

Whereby;

Y denotes orange yield, X_1 denotes gender, X_2 denotes age, X_3 denotes education, X_4 denotes experience, X_5 denotes extension, X_6 denotes farm size, X_7 denotes group membership and X_8 denotes credit access.

4.0 Results and Discussion

Demographic and socio-economic characteristics
According to this study in Machakos county, 66% of the households are male led while 34% of the households are female headed. This called for government intervention to promote equality in land ownership between men and women. From the sampled household heads, 14% did not have any formal schooling,15% had achieved primary education, 26% had secondary education, 36% had tertiary education while 9% were university graduates. On average the County has fair access to education implying better levels of uptake and adoption of new farming technologies and implementation of extension services.
The average age of 46 years indicated that farmers are youthful and have good managerial ability of the farm operations (Makombe et al., 2011). Average household size was 4 members. The members could provide readily available labour for the orange farming activities. Farming average experience was 16 years meaning that farmers had a wealth of practical skills, practices and experience in cultivation the orange fruit. Mutoko (2007) in the study for economic efficiency of smallholders' farmers considered the farming experience variable and found average farmers age to be 17 years. Longer experience was expected to increase efficiency although it may become less applicable to the new technologies as well as limitations.
The average land size set aside for orange farming was 1.6 ha. This was relatively sizeable considering that most farmers were small holders. For sustainable production, irrigation is a perfect way of complementing the rains. The results shows that only 17 farmers representing 10% were carrying out irrigation which is very low meaning that sustainable orange production is at greater risk.
Results show that 42% of the famers had access the extension services while 58% did not have access to the extension services. Presently extension officer against farm household proportion within Kenya is 1: 1093, contrary to the FAO recommendation of 1:400 (Manfre, C., & Nordehn, C., 2006). This show showed that extension access was low but fair compared to national averages.
The study shows that 41% of the farmers had access to credit while 59% did not access credit. Credit is needed for timely access to farm inputs and technology adoption given that productivity and efficiency is sensitive to timely inputs application and utilization and a delay can lead to losses.
From the interviewed farmers the average distances the averages to extension service provider and market are 22 and 17 Km respectively. For small holders when distances are longer this has an impact of reducing access to extension and also discourage access to inputs and also delivery of produce to markets.

The average loan amount farmers could access was Kes. 25,171.43. This is relatively low given that the average cost of production is Kes. 24,750 also competing family needs and that farmers do not ideally apply the acquired fund to farming only. This was an indication that credit offering in the market is not farmer friendly and there is gap.
On average farmers were making profits but they were not optimizing on the profits. It was worth noting that access to inputs and allocation was poor with fungicides, labour and pesticides topping the list as the most expensive inputs in orange production.
The results from the interview farmers showed the ranked problems and challenges in order of their priority were; Inadequate rainfall, pests and diseases, high of inputs and soil fertility.
The average productivity of orange farmers in Machakos county is 4.2t/ha. This confirms the findings that production of farmers is between 4-10t/ha. However, according to Kilalo (2009) the potential is 50t/ha. Therefore, productivity is still low in Machakos county.

The distribution of technical, allocative and economic efficiency

Class	Economic efficiency		Technical Efficiency		Allocative Efficiency	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0 - 0.1	0	0	162	95.86	0	0
0.11 - 0.2	0	0	0	0	3	1.78
0.21 - 0.3	8	4.73	8	4.73	1	0.59
0.31 - 0.4	19	11.24	19	11.24	2	1.18
0.41 - 0.5	36	21.3	36	21.3	1	0.59
0.51 - 0.6	34	20.12	34	20.12	0	0
0.61 - 0.7	23	13.61	23	13.61	0	0
0.71- 0.8	15	8.88	15	8.88	0	0
0.81-0.9	11	6.51	11	6.51	0	0
0.91- 1	23	13.61	23	13.61	0	0
Mean		0.4850		0.6094		0.7959
Std. deviation		0.016235		0.016235		0.00435
Minimum		0.23		0.23		0
Maximum		1		1		0.45

From the results, the mean technical efficiency, allocative efficiency and overall economic efficiencies was 60.94%, 79.59% and 48.50%. This meant that there was a gap and there was probability for the increment of economic efficiency by 51.5 percent.

Socio economic and institutional factors influencing technical, allocative and economic efficiency
This study sought to determine factors influencing technical, allocative and economic efficiency of orange farmers within Machakos county. The two limit Tobit regression analysis was done between efficiency scores in addition to chosen socio economic as well as institutional factors. The findings are herein presented in table below.

Variables	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio

Age	-0.000868	-0.310294	0.001921	0.625407	0.001244	0.606587
Household size	-0.007637	-0.451861	-0.006764	-0.364604	-0.012533	-1.011686
Education	0.000852	0.053224	-0.011292	-0.642864	-0.003906	-0.333035
Farming exp.	0.001301	0.419844	0.000793	0.233170	0.000763	0.335898
Land under	0.042391	0.704446	-0.224880	-3.404335	0.142693	3.234999
Fertilizer	0.013489	0.252497	-0.047272	-0.806111	-0.007878	-0.201190
Agrochem.	-0.052375	-1.017737	-0.061806	-1.094091	-0.077897	-2.065073
Labour	0.044374	0.853375	-0.127139	-2.227408	-0.038174	-1.001565
Irrigation	-0.055942	-0.865765	-0.015849	-0.223440	0.005268	0.111231
Group	0.072309	1.573547	0.123964	2.457518	-0.027926	- 0.829086
Dist. extension	-0.002724	-0.698213	-0.001006	-0.234817	- 0.002695	- 0.942508
Dist. market	0.000280	0.071056	0.005674	1.309915	-0.003075	-1.063063
Credit (Kes.)	0.000001	0.836555	0.000001	0.871169	0.000001	-1.701881

Regression estimates of factors influencing technical efficiency

Education, farming experience, land size, labour, distance market group membership and credit posed a positive influence to technical efficiency whereas age, household size, agrochemicals, irrigation, distance to extension service providers had a negative influence on technical efficiency.
Education had a positive impact on technical efficiency. This concurred to the Abdulai and Huffman (2000) study on rice producers in Ghana who established a positive relationship but contrary with findings of Kibaara (2005) which showed a negative influence. This meant that those with a higher education level understood and applied new technologies.

Household size posed a negative effect on technical efficiency. This study`s results were contrary to Wakili (2012) exploration for sorghum producers in Nigeria that household size increased labour and therefore improving technical efficiency.
Land size posed positive impact on technical efficiency. This was similar to finding by Mburu et al (2014) which indicated that large scale farmsteads posed higher technical efficiency compared to small scale farmsteads. Signifying that upsurge in farm size for the small holder orange farmers would increase technical efficiency. This is because the farmers reap from the economies of scale.
Fertilizer applied had positive impact to the technical efficiency. This was expected to increase technical efficiency as a technology aimed at improving soil fertility. The influence was similar with that of fertilizer on maize yield in a study by Mutoko (2007) in North Western Kenya.
Agrochemicals use which was anticipated to increase technical efficiency in contrast posed a negative effect. The influence was congruent to that of Nwahia *et al*., (2020) where it was reported that 1% increase in herbicide used in rice production would cause rice output to decrease by 0.02 percent. This means that the quantities applied and timing of the application were not well matched with crop needs to have a positive effect because of financial and liquidity constraint among the orange farmers or it could be as a result of fake chemical being sold to the farmers.

Credit access exhibited a positive effect to technical efficiency. Results were similar to findings of an exploration by Mochebelele and Winter-Nelson (2000) in Lesotho. This is because it solves liquidity challenges, giving the farmers ability to access inputs timelier and adopt technologies which have a positive effect to technical efficiency.

Regression estimates for factors influencing allocative efficiency
Age, farming experience, distance to market, Group membership and credit had a positive sign implying that they increased allocative efficiency while education, household size, farm size, agrochemicals, fertilizer, irrigation and distance to extension service providers had a negative sign.
Household size influenced the allocative efficiency negatively meaning a larger household size decreased allocative efficiency. The results concur with findings from Tijjani and Bakari (2014) for rice farmers in Nigeria.
Age and Farming experience showed a positive sign implying that increased years of farming experience in orange farming provided knowledge, skills and practices which farmers utilized to make better decisions in inputs use, and this therefore improved their allocative efficiency. However, for age it was expected to reach a turning point downwards for aged farmers as the physical energy to work and manage farmers decreased with age. This would

necessitate handing over of farms and the gained farming experience and best practice by the older farmers to the youthful farmers. The finding agrees with Ogundari *et al*., (2007).

Farm size negatively influenced allocatively efficient at 1% significance level. This can be elucidated by the assertion that, holding a large farm had high-cost implication which could not be met by the small holder farmers more rely more on cost minimization of the scare and limited financial resources to be efficient.

Agrochemicals, fertilizer, labour and irrigation use was established to impact allocative negatively. Labour was noted to be statistically significant at 5% level. The findings were in line with those of Mutoko (2007) in which fertilizer use affected allocative efficiency negatively. This meant that the costs were high and had a notable effect the total cost of orange production. This therefore called for intervention targeted at lowering the costs of these inputs to achieve the cost minimizing objective and therefore enhancing allocative efficiency.

Distance to extension had a negative sign. This meant that as the distance to access extension increase farmers became more allocatively inefficient. Extension plays a critical role in disseminating technical and practical information for improving decision making capacity of farmers and new technologies which increase allocative efficiency. As the distance increases it becomes difficult and challenging for the farmers to access the extension services.

Distance to market influenced allocative efficiency positively. This might be attributed to the assertion that farmers distant away from markets will have restricted input accessibility as well as output markets along with market information hence procurement fee for inputs as well as amenities will be considerably higher. However, longer distances to markets dishearten farmers from partaking in market-oriented production in addition may allot capitals improperly. Markets development as well as road infrastructure could decrease resource usage inadequacies while also increasing productivity, this is according to study by Mulu (2015).

From the results age showed a negative sign. This meant that youthful farmers were extra allocatively effective than older farmers in addition, for older farmers as age increased, they became less efficient.

Education posed a negative influence on allocative efficiency as a result of the negative sign on the coefficient. The result was contrary to Cheryl *et al*., (2003). This result meant that the less educated farmers were more allocative effective than the more educated farmers. This relationship was unexpected because theory hold that increased education improves farmers' capacity to make well informed decisions on input use therefore increasing their efficiency. This unexpected relationship can be elucidated through the assertion that, with increased education level gives households more incomes generating economic opportunities competing for attention with farming which makes household move to urban areas giving less attentions to farming.

Group membership influenced allocative efficiency positive at 5% significance level, implying that farmers who had joined groups were able to share and exchanges useful information on farming and access extension services which improve allocative efficiency. Wakili & Isa (2015) established the same positive influence.

Credit access influenced allocative efficiency positively at 1% significance level. Credit access enhanced allocative efficiency by enabling famers overcome financial constraints and access time sensitive inputs in the production process in a timely manner. Farmers who accessed credit were also noted to be more motivated in the enterprise and also allocating resources more efficiently in order to realize a return sufficient to repay the loan and have a take home margin which was similar to results of Obare, *et al*., (2010).

Regression estimates of factors influencing economic efficiency

The technical efficiency of 48.99% and allocative efficiency 80.68%, produced economic efficiency of 48.50% with R^2 of 61.76 %. This implied that the analyzed variables explained 61.76 % variation in economic efficiency and also economic inefficiencies existed and there was room the increase economic efficiency by 38.24 percent.

From the results in Table, there was room to improve on technical efficiency by 39.04% and allocative efficiency by 20.41 percent It is evident that economic inefficiencies were largely brought about by farmers not optimizing on output than minimizing costs of inputs.

The results showed that age, farming experience, credit and irrigation posed a positive influence to economic efficiency while household size, education, agrochemicals, fertilizer, labour, distance to market access and extension amenity providers posed a negative impact.

The results showed that age and farming experience went hand in hand showing a positive coefficient which meant that they influenced economic efficiency positively. These findings were parallel to those of Coelli *et al.,* (1996) who found out that, age posed positive influence on economic efficiency. Aged farmers had accumulated a wealth of experience in orange cultivation which enabled them to maximize outputs and minimizing costs than the youthful farmers. However youthful famers need to be encouraged to take up orange farming and learn by doing while exchanging knowledge with the aged famers. Aged farmers should also pass knowledge and hand over farmers gradually and smoothly to the young famers because with increased aged, economic efficiency came to a turning point downwards because they had less physical energy to work on farms. A study by Bravo-Ureta *et al*., (1997) determined a positive influence between age and young farmers whereas for old farmers the influence was negative.

Distance to extension service providers and market access posed negative influence towards economic efficiency. This resulted from increased distance increased the transaction costs with higher costs reducing economic efficiency. These findings were concurred with those of the study by Linh (2005) for rice farmers in Vietnam. It can be explained in that some with the county being semi-arid only a few areas were suitable for orange farming with some being located far form extension service providers and market. Farmers were willing to incur the associated transaction costs because the output guaranteed a much higher return to compensate for the transaction costs and still make profit. Infrastructure development on road networks, bridges, communication and market integration would be reducing transaction costs and improve economic efficiency.
Agrochemicals use was established to impact economic efficiency negatively at 5% significance level. Agrochemical use is meant to control losses caused by pest and diseases but the prices were high. The agro chemical costs were too high that they had an effect on the total cost of orange production. Therefore, there was need for government intervention in the form of subsidies to lower the costs.
Credit access posed a positive influence on economic efficiency at 10% significance level. This meant that farmers who accessed credit were extra economic effective than those who did not access. The results concur with those reported by Goncalves *et al*., (2012) among milk producing farms in Brazil. This is because access solved liquidity challenges enabling farmers' access inputs and modern technologies timelier.

Household size as a proxy for own available family labour coefficient had a negative sign implying that increased household size reduced economic efficiency. Ajewole, and Folayan (2008) established that household size negatively influenced efficiency. This is because not all members were skilled, available and motivated to critical provide farm labour demands for orange farming.
Education posed negative influence towards economic efficiency meaning that less educated households were extra economically efficient that more educated households because as stated earlier increased education provided more opportunities for other economic activities competing with farming. These findings were in line with those of Mutoko (2007) who established that education posed negative influence towards efficiency. Interestingly farming experience was found to be more important in influencing efficiency than education level.

Irrigation practice was found to influence economic efficiency positively. Farmers practicing irrigation were able to produce oranges through the year. Only 10.65 percent of the farmers were practicing irrigation. This called for need to develop irrigation infrastructure and subsidize irrigation equipment to make adaption of irrigation by farmers more convenient
Group membership posed a negative impact on economic efficiency meaning that the groups had a weak leadership and poor management and that the activities of the groups did not provide value to members.
Sanyang (2014) reported a positive association between group membership and efficiency because it provided opportunities to access support from government, donors along with NGOs in terms of information, inputs and credit.

5.0 Conclusion

Orange production in Kenya has been on a descending trend instigating dependency on traded in oranges from outside nations. This is despite governments efforts to achieve food security and self-sufficiency in the wake of the previous global supply chains disruptions which affect access to imported goods. This study therefore explored oranges famers efficiency with a view of improving productivity.

The combined technical along with allocative efficiency 60.94% and 79.59% respectively produced mean economic efficiency level of 48.50% for the orange famers. This indicated that there was likelihood of increasing the economic performance of the farmers by 51.50% through efficient use of inputs and appropriate combination of inputs while considering their prices. The low economic efficiency was brought about more by the technical inefficiencies than allocative inefficiencies.
The study findings put forward some recommendations for consideration to boost farmers efficiency: training program and monitoring the average farmers age to maintain a balanced mixed farmers, entrepreneurship training programs to make farming competitive an economic activity of choice, increment of extension workers in the county to build capacity of the farmers in making decision and also disseminating information on new technologies and farmers should be sensitized to use cheap alternatives like farm manure, family labour, biological pest and disease control measure and also employing the integrated pest control management, development irrigation infrastructure.

Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

List of Declarations

Ethics approval and consent to participate

Ethical issues that were considered included: acquisition of informed consent from all participants, seeking the consent of all households involved in the study thus protecting the anonymity and confidentiality of respondents, guaranteeing the physical and psychological security of participants, giving room for participants to withdraw at any stage, and observing honesty.

Consent for publication

The author sought permission to publish his work with Ijariiejournal by first registering as well as following all their guidelines.

Availability of data and material

The original study data is included in this article. Further inquiries can be directed to the corresponding author.

Competing interests

The authors declare that there is no conflict of interest regarding the publication of this paper

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Authors' contributions

The authors conceived and collaboratively contributed to development of this study.

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