academicJournals

Vol. 7(10), pp. 344-352, October, 2015
DOI: 10.5897/JDAE2015.0676
Article Number: 6B595D055348
ISSN 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Economic Determinants of the Performance of Public Irrigation Schemes in Kenya

E. Ngenoh[1]*, L. K. Kirui[2], B. K. Mutai[1], M. C. Maina[1] and W. Koech[1]

[1]Department of Agricultural Economics and Agribusiness Management, Egerton University, P.O. Box 536 Egerton, Kenya.
[2]Kenya Institute for Public Policy Research and Analysis, P.O. Box 56445-00200, Nairobi, Kenya.

Received 21 July, 2015; Accepted 12 August, 2015

The study aimed at establishing the determinants of public irrigation scheme performance in Kenya and give policy recommendations using panel fixed effect regression model. The results indicated that, the size of land under irrigation had a significant (at 1%) and positive effect on the performance of public irrigation scheme. Similarly, per acre operations and maintenance cost that was collected in the scheme had a significant (at 10%) and positive effect on the performance of public irrigation schemes; however, the amount of donor funding to the scheme had a significant (at 10%) and negative effect on the performance of public irrigation schemes. Consequently, performance can be improved if farmers are treated as clients, shareholders or as co-managers of irrigation scheme rather than just beneficiaries. Therefore, this study recommends the enhancement of policies and institutional changes at the public scheme level, along with increased government investments on irrigation infrastructure rehabilitation and development.

Key words: Co-management, donor funding, government investment, public irrigation scheme, panel fixed effect regression model, Kenya.

INTRODUCTION

Ensuring adequate and access to nutritious food for the growing population is a major concern globally. According to Mati (2011) and Valipour (2015), irrigation has a role to reduce poverty in the world through improvement of production, enhancement of employment opportunities and stabilization of income and consumption using access to reliable water, and finally by its role in nutritional status, health, societal equity and environment. Over the years, empirical evidence have shown that irrigation increases yield of most crops by between 100 and 400% and it is expected that, in the next 30 years, 70% of the grain production will be from irrigated land in the world (FAO, 2009). A study by Valipour (2014) indicated that 46% of the cultivated areas in the world are not suitable for rain-fed agriculture because of climate changes and other meteorological conditions. Therefore, this needs to be thought carefully in order not to put too much attention to only commercial enterprises and goals but to also apply the experts' comments to the irrigation systems for any crop to achieve sustainable agricultural

*Correspondent author. E-mail: ken.ngenoh@gmail.com. Tel: +254 721 538 378.

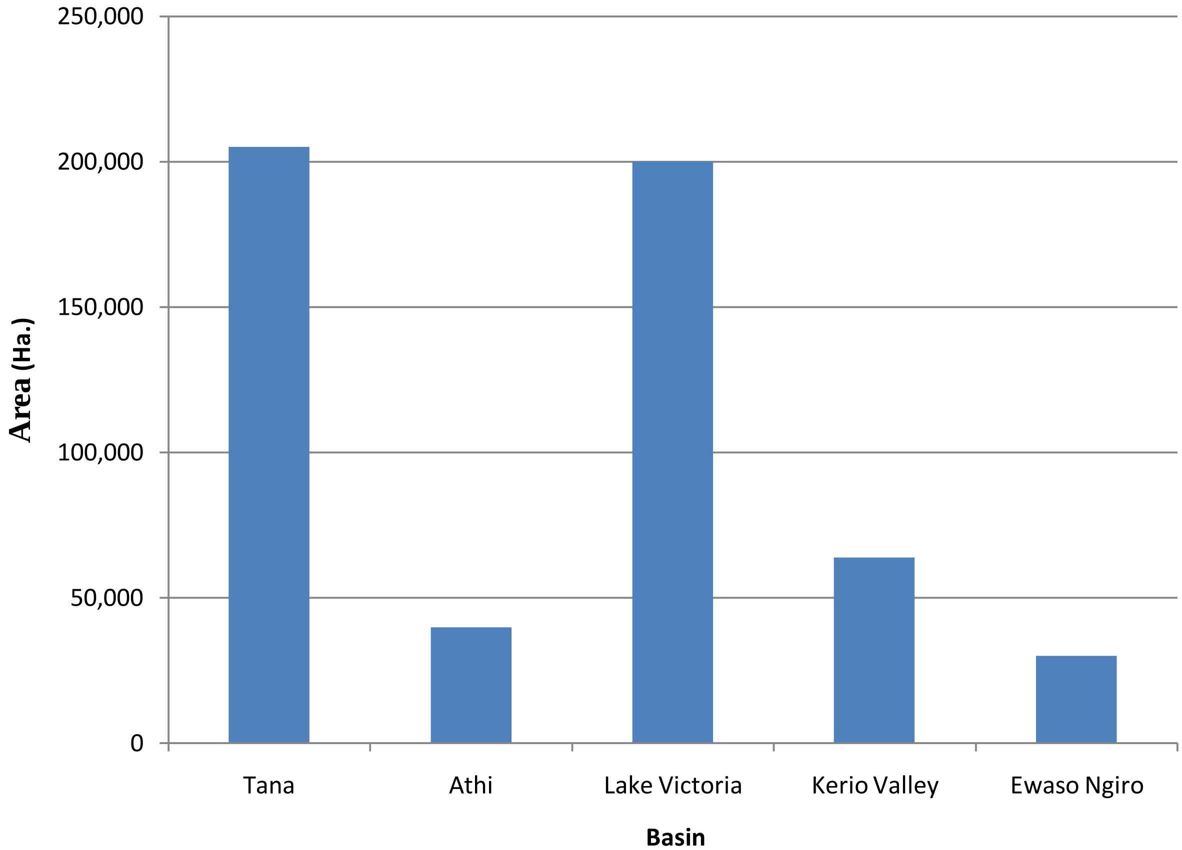

Figure 1. Irrigation potential in the Kenyan river basins. Source: National Irrigation Board (NIB) (2012).

production activities (Valipour et al., 2015; Valipour, 2015). Many studies have identified a positive link between irrigation and other development-related sectors such as population, energy, food, and environment, and the interactions among them require reckoning, as they together will determine future food security and poverty reduction (Ngigi, 2002; Inocencio et al., 2007; Franks et al., 2008; Khan et al., 2009; Mati, 2011; Burney et al., 2013).

Kenya's population has been growing exponentially over the past 10 years reaching 38.6 million in 2009, up from the 28.7 million recorded in 1999. Therefore, the country is facing an uphill task of securing adequate food supply through various strategies of increasing agricultural production capacity to match the population growth. Although agriculture is the backbone of the economy accounting to about 25% of the country's GDP, the scope for increasing production through expansion of arable agricultural land is severely constrained by over-reliance on rain-fed agriculture.

At current levels of population growth, the slower expansion in irrigated areas is resulting in an unprecedented amount of irrigated land decline (Figure 2). This has been exacerbated by increased construction costs, falling real prices for irrigated crops, a growing awareness of environmental and social costs and poor irrigation performance at the farm and project levels (Svendsen et al., 2009; Azad and Ancev, 2010; Valipour, 2014; Valipour et al., 2015). In addition, the environmental efficiencies of irrigated enterprises vary considerably across different agricultural water management regions (Azad and Ancev, 2010; Valipour, 2013). Based on the irrigation potential in Kenya (Figure 1), the development of the irrigation sector is among the long-term initiatives towards the achievement of a 10% annual economic growth envisioned in Vision 2030. Despite heavy initial investments, huge costs relating to land preparation, and the different kinds of machinery, irrigation in Kenya has not realized its full potential. Currently only 114600 ha (20% of total irrigation potential) have been put under irrigation where the development of irrigation potential has been categorized into three types that includes; large private commercial farms (40%), government-managed schemes (18%), and smallholder individual and group schemes (42%) in Kenya (GoK, 2010).

Kenya's main irrigated crops are rice, maize, sugarcane, vegetables, bananas, citrus, coffee, tea, cotton and flowers, some of which require large-scale production for economies of scale to be realized.

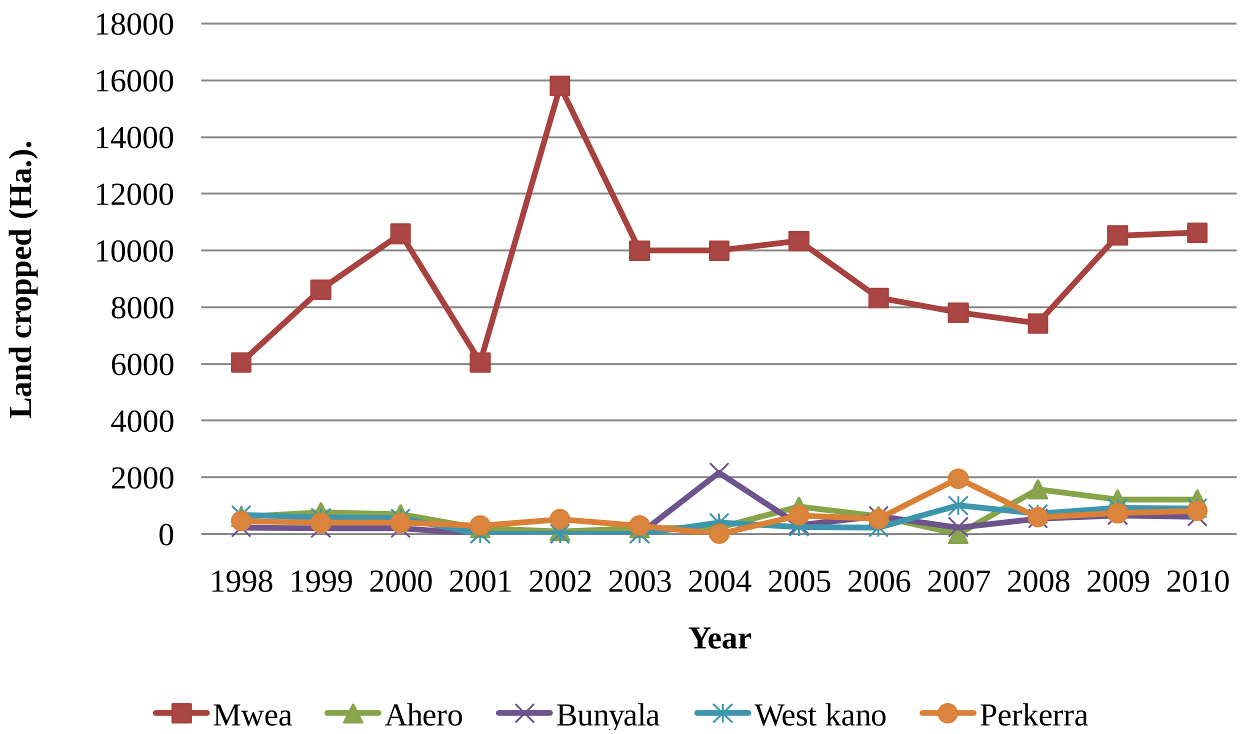

Figure 2. Land cropped status in public irrigation schemes.Source: NIB (2012).

Irrigation infrastructure has been funded in targeted areas in a bid to improve food production and rural economies. Currently, the Kenyan government has been running the operations of the major five public irrigation schemes (Figure 2) in different parts of the country through the National Irrigation Board (NIB). Generally, irrigation activities demands costly continuous operations in terms of supply of water and adequate maintenance of the water distribution and drainage channels. The government, the private sector, and development partners have funded most of the irrigation structures since it is difficult for smallholders themselves to build such structures (PMU-Kenya, 2004). World Bank (2007) indicated that irrigation projects consume many scarce resources through both recurrent and development expenditure and adversely affect developing countries, whose capacity to set up irrigation infrastructure is limited. Ngigi (2002) and Kibe (2007) revealed that, the development of irrigation despite the high costs involved is one of the largest potential for addressing the challenge of the declining agricultural productivity with an up surging population in Kenya. In addition, availability of water also plays a vital role on the performance of an irrigation scheme and indirectly influences the cost of the project. Furthermore Saleth et al. (2003); Hussain and Wijerathna (2004); Hussain et al. (2006), and Inocencio et al. (2007) concluded that, those irrigation schemes located in areas with more water available have a tendency of being smaller in size and it reduces poverty both directly and indirectly. Direct impacts are realized through labour and land augmentation effect that ultimately translates to improved performance, employment, income and consumption, while the indirect impact is realized through enhanced local economy and improved welfare at macro level. On the contrary, Fan et al. (2000) and Jin et al. (2002) revealed a negative and/or weak relationship between irrigation and agricultural productivity. This leads to a negative or no impact on food security, household income and poverty reduction at large; hence the direct effect of irrigation could be undermined by other factors, which could have been observed at scheme level. Fan *et al.* (2000), Gomanee et al. (2003), and Mosley et al. (2004) found out that, higher government expenditure on agriculture, housing and amenities (water, sanitation and social security) had a negative and statistically significant impact on poverty. This is mainly by shifting the distribution of income in a pro-poor direction, since the level of aggregate income was held constant in their regressions.

Recently, emphasis has been on the importance of sustaining and improving the performance of existing irrigation schemes in parallel with area expansion and development of new irrigation (World Bank, 2006). In Kenya, like in many other African countries, irrigation expansion has been hindered by poor performance of the existing public irrigation schemes (Ngigi, 2002; Thairu, 2010). In addition, the performance of public irrigation scheme is way off the mark realizing only 40% of the target production levels and 28% of the expected revenues (Karina and Mwaniki, 2011). Paradoxically, there are successful irrigation undertakings especially among the private commercial large-scale agricultural irrigated farms such as Dalamare, Delmonte, Kakuzi, etc. Given the intensive investment, the already existing public irrigation schemes in the country should be operating efficiently and effectively so as to meet the rising food demands. However, it is not clear what factors play key role in the performance of public irrigation schemes in Kenya. Against this backdrop, this study seeks to establish the factors that influence performance of public irrigation schemes in order to shed some light on the areas requiring policy interventions. Furthermore, it would complement the debate on public irrigation scheme performance, and provide a basis for reformulation of strategies that are geared towards the country’s self-sufficiency in food production and food security.

Irrigation performance is the level at which resources such as water, land, and labour can be effectively utilized for the production of maximum output levels. In addition, irrigation performance assessment is the regular observation of irrigation performance parameters with the objective of acquiring important information on the use of resources within an irrigation scheme, and allows irrigation managers to make well informed decisions in terms of resource management (Bos et al., 2005; Khan et al., 2009; Mati, 2011; Valipour, 2014). Irrigation performance assessment can be used to satisfy different set objectives on different irrigation schemes but the procedure will vary depending on the system and purpose of assessment. Despite the fact that there is still no one standard way of measuring irrigation performance, most analysts suggest at least two basic domains for the purpose of irrigation or water delivery and agricultural productivity. While the former is associated with the immediate service output and determined most frequently through the performance criteria of adequacy, equity and reliability of water supplied, the latter is considered more outcome-based and can be judged against such parameters as farmers’ crop yields, cropping intensities and most recently water productivity. Other studies suggest that such a limited set of indicators should also include measures determining the maintenance status of irrigation infrastructure as well as more user-based socio-economic impact measures (Murray-Rust and Snellen, 1993; Bos et al., 2005). Molden et al. (2010) pointed out that for an increase in irrigation scheme performance, it will require strategies that are based on existing biophysical and socio-economic factors. Frequent evaluation of irrigated areas have become more important in diagnosing and improving the performance of irrigation schemes in order to achieve optimal productivity in the context of increasing food demand, open global markets and competition for limited freshwater resources (Burt et al., 1997; Molden et al. 1998; Clemmens, 2006). Such assessments should analyze the productive and hydrological impacts of internal irrigation processes to assist agents involved in crop production, water management and agricultural policy to improve the performance of irrigated schemes (Perry et al., 2009; Molden et al., 2010).

The categories of the determinants of irrigation performance has been described by Malano and Burton (2001), Molden et al. (1998) in Molden et al. (2010) and it includes those factors such as land, labour, water, cost of scheme operation and maintenance as well as the value of production that analyze the inputs into and outputs from irrigation scheme. They further developed a set of irrigation performance indicators for describing performance at scheme level that includes output per cropped area, output per unit command area, output per unit irrigation supply, output per unit water consumed, achieved production factor, and potential production factor among others. In addition, Ntsonto (2005) concluded that there is need to include financial and environmental indicators since they concentrate on the costs and returns, in monetary value and they include cost recovery ratio; maintenance cost to revenue ratio, total cost of management, operation and maintenance per irrigation scheme and revenue collection performance. While on the other hand, the environmental indicators concentrate on sustainability of irrigation scheme performance, pollution of both land and water as well as the effects of irrigation on the surroundings (Greaves, 2007; Yokwe, 2009).

MATERIALS AND METHODS

Study area and data

The study was conducted in all the five main public irrigations schemes in Kenya (Mwea, Perkerra, West Kano, Bunyala, and Ahero) that are being managed by National Irrigation Board (NIB) and have been in operation since 1998. Panel data for the period 1998 to 2010 that were obtained from Kenya National Bureau of Statistics (KNBS), and National irrigation board (NIB) under Ministry of water and irrigation were used. It was conceptualized that public irrigation scheme performance is influenced both directly and indirectly by the size of the scheme, operations and management (recurrent expenditure), infrastructure and equipments (development expenditure), and the amount of donor funding in form of grants and technical assistance as well as scheme attributes.

The model

Panel data analysis have been used widely in recent empirical studies that seeks to address various challenges on economic development and policy analysis (Bos et al., 2005; Inocencio et al., 2007; Hsiao, 2007; Githuku, 2010; Thairu, 2010; Biwott, 2011). This is because it provides a rich environment for the development of estimation techniques and theoretical results. Furthermore, panel data have the strength of accommodating more observations hence increases the degrees of freedom. In addition, it reduces the problem of co-linearity of regressors and modeling flexibility of behavior differences within and between countries and/or groups or institutions (Hsiao, 2007; Biwott, 2011). However, it has a setback of having a cumbersome collection of long-term primary data particularly on the selected variables. Panel data has fixed effect model (FEM), random effects model (REM), and instrumental variables (IV). Nevertheless, REM and IV were not used in the study because there was no dummy variables and selection biasness in the data that were used hence ruling out the problem of heterogeneity. A standard panel FEM specification is written as;

$$Y_{it} = \beta_1 + \sum_{j=2}^{k} \beta_j X_{jit} + \sum_{p=1}^{s} Y_p Z_{pi} + \delta_t + \varepsilon_{it} \quad (1)$$

Where Y_{it} is the dependent variable, the X_j are observed explanatory variables, and the Z_p are unobserved explanatory variables. The index *i* refers to the unit of observation, *t* refers to the time period, and *j* and *p* are used to differentiate between different observed and unobserved explanatory variables. ε_{it} is a disturbance term assumed to satisfy the usual regression model conditions. A trend term *t* has been introduced to allow for a shift of the intercept over time. The X_j variables are the explanatory variables of interest, while the Z_p variables are responsible for unobserved heterogeneity and as such constitute a nuisance component of the model. Because the *Zp* variables are unobserved and FEM takes care of that, there is no means of obtaining information about the component $\sum_{p=1}^{s} Y_p Z_{pi}$ of the model and it is convenient to rewrite equation 1 as;

$$Y_{it} = \beta_1 + \sum_{j=2}^{k} \beta_j X_{jit} + \alpha_i + \delta_t + \varepsilon_{it} \quad (2)$$

Where $\alpha_i = \sum_{p=1}^{s} Y_p Z_{pi}$ and it represents the joint impact of the Z_{pi} on Y_i. Therefore, it was convenient in this study to refer to the unit of observation as an irrigation scheme, and to the α_i as the irrigation scheme-specific unobserved effects. In addition, the model assumes that the disturbance is the sum of three terms: a "scheme fixed effect" that is different for each irrigation scheme but does not vary over time; a "time fixed effect" that is different each year but does not vary across schemes; and a random effect.

This study preferred the agricultural productivity as the best indicator of public irrigation scheme performance. Irrigation scheme performance has been cited to be determined by scheme size, number of plots in the scheme, farmers contribution to investment cost, new constructions costs, mode of O&M for systems, irrigated crops, and regional effects (Bos et al., 2005; Inocencio et al., 2007; Thairu, 2010). It is therefore out of the above reviewed literature that this study will analyze the determinants public irrigation scheme performance in line with the recommendations of Bos et al. (2005) and Thairu (2010). They conclude that, the performance indicator will be based on crop yields or scheme productivity, which will be determined by land size, irrigation scheme operations and management (O&M) collection rate, investment cost, and number of plots in the scheme.

Since panel data were used, the study performed a Durbin-Wu-Hausman (DWH) test in order to determine whether the estimates of the coefficients, taken as a group, are significantly different in the two regressions (fixed or random) and select the one to be adopted using the two methods. In the first case the data was strongly balanced and the results of the DWH test (Prob>chi^2 = 0.0077) suggests that fixed effect exist between the schemes hence the panel Fixed Effect Model (FEM) were adopted since its results were efficient and consistent. Further, the panel fixed effect regression model is highly acclaimed for its simplicity and empirical robustness, and its ability to provide a solution to the problem of bias caused by unobserved heterogeneity, a common problem in the fitting of models with cross sectional data sets. Empirical literature has revealed that panel fixed effect regression model approach is a popular tool and has been used widely by researchers in analyzing the indicators of several irrigation scheme performance. Based on the reviewed literature, this study assumed that five variables affect the performance of public irrigation schemes in Kenya. This includes development and recurrent expenditure, donor funding, rate at which operation and maintenance (O&M) money is collected at scheme level, and the size of the irrigation scheme.

Empirically, taking the above factors into consideration, the panel fixed effect regression model in this study follows the works of Bos et al. (2005), Inocencio et al. (2007), Hsiao (2007), and Thairu (2010) where the model assume a lagged form and is specified as:

$$I_{it}^{p} = \beta_1 + \beta_2 R_{it-1} + \beta_3 D_{it-1} + \beta_4 DF_{it-1} + \beta_5 IS_{it-1} + \beta_6 OMR_{it-1} + \varepsilon_{it-1} \quad (3)$$

Where: $I_{it}^{p} =$ Irrigation scheme performance level in yields per area cropped; R_{it-1} = operations and management of the irrigation scheme proxied by recurrent expenditure to the scheme; D_{it-1} = Irrigation equipments and infrastructure proxied by development expenditure; $DF_{it-1} =$ Grants and technical assistance costs proxied by donor funding/investment; IS_{it-1} = Irrigation scheme total land size in operation in acres; OMR_{it-1} = Rate of O&M collection in the scheme in Kenya shillings, and $\varepsilon_{it-1} =$ Regression disturbance term

RESULTS AND DISCUSSION

Descriptive statistics

Irrigation productivity is the ratio of output (physical, economical or social) to the size of land cropped in producing the output. It is a measure of the economic or biophysical gain from the use of a unit of irrigated land in crop production and is expressed in productive crop units of kg/acre (Thairu 2010). The results of the trends of public irrigation schemes productivity in Kenya are presented in Figure 3. It showed that the general productivity of public irrigation schemes in Kenya has been fluctuating in various schemes during the period of 1998 to 2010. Most of the public irrigation schemes productivity started to show positive trends in 2003 when the strategy for revitalizing agriculture (SRA) 2004-2014, together with the Maputo declaration of increasing the agricultural sector budgetary allocation to 10% was being implemented in the country. Furthermore, Mwea irrigation scheme had benefited during this time from the counterpart funding which saw the Japanese and Kenyan government investing KShs 3 billion.

The introduction of the Economic Stimulus programmes (ESP) in 2008/2009 boosted the productivity of all the public irrigation schemes in Kenya. In addition, the positive productivity trends during this periods was attributed to the stable and growing economy during this period as well as the implementation of the Agriculture Sector Development Strategy (ASDS, 2009-2020) and the first medium term plan for the country blueprint Vision

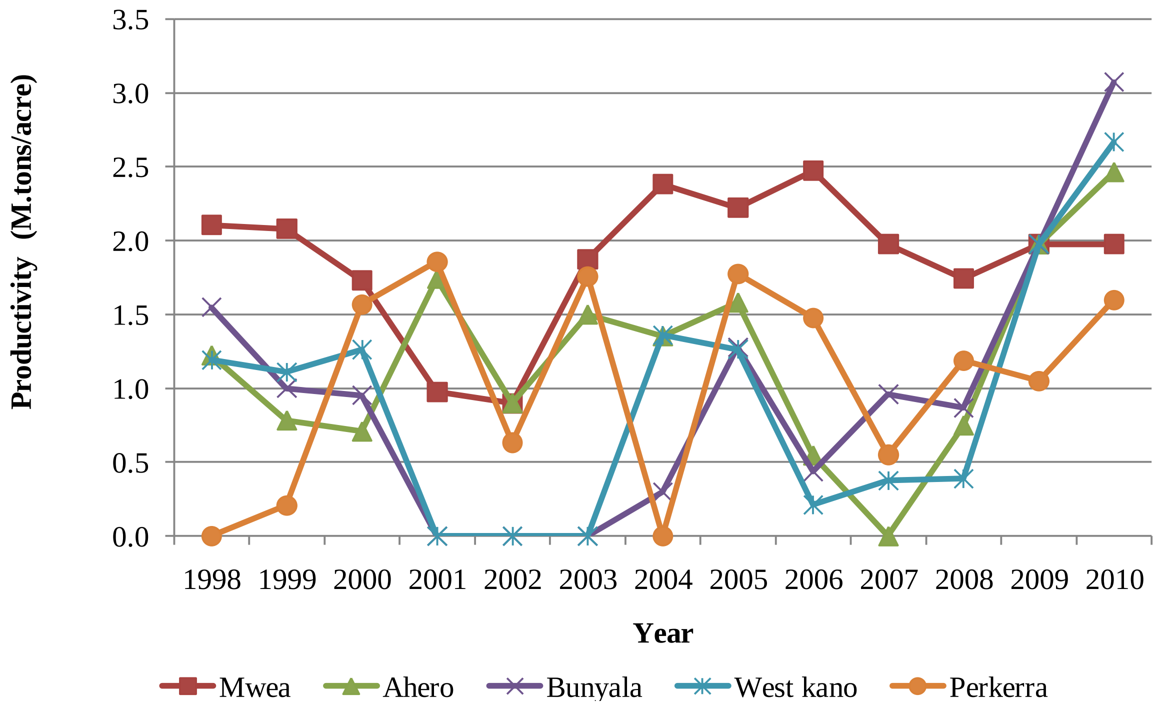

Figure 3. Trends of public irrigation schemes productivity in Kenya.

2030. This was aimed at increasing agricultural productivity, expanding irrigated agriculture, commercializing agriculture, and improving governance in the agriculture sector. This result concurs with the findings of Gulati *et al.* (2005) and Meizen-Dick and Rosegrant (2005), who concluded that poor irrigation scheme productivity is directly related with the decline in irrigation investments and low rates of economic return on the irrigation projects.

Model results

The model results (Table 1) indicates that, the total size of irrigation scheme, amount of donor funding to scheme, and the per acre rate at which O&M were collected were significant at 1, 10 and 10% respectively. This therefore conforms to prior expectations. The result further indicates that, total irrigation scheme size was significant with positive effects on the performance of the irrigation scheme in Kenya. This implies that, increase in the scheme land size, increases the probability of the scheme to perform better in its activities and hence maximum output levels. The findings of this study concur with the findings of Huang et al. (2005); Clemmens (2006), and Kibe et al. (2007) who concluded that as the scale of operation increases, farmers tend to benefit from the economies of scale of operations. In addition, those farmers who own large tracks of land tend in the irrigation schemes to easily access credit facilities in financial institutions, which in turn helps them, meet other farm inputs and hence better performance in their operations. Furthermore, the larger the public irrigation scheme size, the higher the economic returns as confirmed by the finding of Jones (1995) that “big projects just do better than small projects.”

According to Inocencio et al. (2007), irrigation scheme size is a critical determinant of cost and its significant impact on economic returns could be through impact on irrigation cost and economies of scale effect. Larger irrigation schemes are supposed to attract better managers, and managing and implementing agencies like NIB may have more incentive to be cost-efficient given the relatively higher profile and greater public attention. The strong economies of scale in public irrigation schemes suggest the importance of the scarce inputs such as land while, on the other hand, it has been argued that scale of operation appears to be less important in determining the performance of the irrigation scheme than how it is managed (Meinzen-Dick and Rosegrant, 2005). Therefore, the result of this study indicates that, as far as the scale of public irrigation scheme is concerned, it is definitely the case that “large is good”. However, it requires a caution based on the availability of irrigation water and management. Further, the rate at which farmers are being charged by NIB for the O&M services cost is significant at 10% level with positive effects on performance implying that it increases the probability of achieving more output or yields from public irrigation scheme. Majority of the schemes have

Table 1. Summary of the determinants of public irrigation scheme performance.

Variables	Coefficient	Standard error	P-value
Scheme land cropped size	0.4353651	0.1035223	0.000*
Management cost	0.0272844	0.1824122	0.882
Development cost	-0.0082568	0.1881861	0.965
Donor funds	-0.0629516	0.0328501	0.061**
Rate of O&M collection	0.1156603	0.0671855	0.091**
Constant term	-0.525307	1.000779	0.602
Diagnostic statistics			
Corr (u_i, xb)	0.0808		
Sigma_u	0.36588		
Sigma_e	1.54394		
Rho	0.05317		
Number of observations	65		
Number of groups	5		
F(5,55)	5.58		
Prob> chi2	0.0003		

*** ($p<0.01$); ** ($p<0.05$); * ($p<0.10$).

been varying there O&M cost rate depending on the type of crop grown and the region of production. The result further shows that increasing this rate by one unit will lead to an increase in the performance of public irrigation scheme by 11.5% as shown by the coefficient. This implies that O&M cost collection rate have a direct effect on the performance since, when increased, farmers tend to improve on their efficiency in order to maintain and/or increased their profits, which would have otherwise be indirectly affected negatively. This result concurs with the findings of Inocencio et al. (2007) and Molden et al. (2010) who concluded that, where farmers contribute to irrigation development, irrigation schemes perform better than those without farmers' contribution.

The government as a part of a strategy to encourage a more participatory approach has promoted farmers' contribution to irrigation schemes. This was aimed at achieving a greater sense of ownership among the beneficiaries of irrigation scheme, and results in more sustainable scheme operations while reducing the financial burden of the NIB. The result in this study confirms the earlier findings, and supports a policy that encourages farmers to contribute to the O&M cost, on the grounds that it serves as an incentive to using the funds more effectively for farmers' needs and priorities. However, poor performance in most of the public irrigation scheme can be attributed to poor irrigation management by NIB, due to lack of accountability and incentive to deliver quality service and water supply. This is confirmed by Gulati et al. (2005) and Clemmens et al. (2008) who concluded that poor irrigation performance is exacerbated by the absence of link between irrigation quality, revenues generated from irrigation service fees and staff incentives. The existence of well established and operational WUAs has also been associated with better maintenance of systems and more efficient water deliveries which in turn has led to higher yields and better economic performance of irrigation schemes (Shah et al., 2002; Gulati et al., 2005; Raju and Gulati 2005).

The amount of donor funding to an irrigation scheme has been indicated by the result to be significant at 10% level with negative effects on the performance of public irrigation scheme. This implies that, as the amount of donor finding increases in the scheme the probability of farmers meeting the target of their operations decreases within the irrigation scheme. This could be because farmers tend to relax their effort in terms of effectiveness and efficiency since most of the donor funds are not refundable and they always target specific purpose in a particular scheme which has no effect on their profits. In addition, donor funds comes in form of grants and technical assistant which are always aimed at capital investment and/or irrigation development that takes longer period of time to be in operation. The results concurs with the findings of Svendsen et al. (2009) and World bank (2008) where they indicated that, donors are providing relatively limited resources to the agriculture sector in developing countries, based on its comparative advantage, specialization and track records. Furthermore, most of the development partners have recently diverted their attention to smallholder-irrigated agriculture hence leaving the public irrigation scheme (large) to be run entirely by the government.

Conclusion

The result of the study based on the available data on public irrigation schemes in Kenya used in this paper indicates that most of the public irrigation schemes productivity was boosted by the implementation of the strategy for revitalizing agriculture (SRA) 2004-2014 and the Maputo declaration of increasing the agricultural sector budgetary allocation to 10 percent from 2003. In addition, stable and growing economy as well as the implementation of the Agriculture Sector Development Strategy (ASDS, 2009-2020) and the first medium term plan for Vision 2030 also shows positive contribution to public irrigation productivity in Kenya. The result further indicates that, total irrigation scheme size, amount of donor funding to the scheme, and O&M rate per unit of irrigated land was significant with positive, negative, and positive effects respectively on the performance of the irrigation scheme in Kenya. However, the availability of water supplies is a serious constrain in many of the Kenyan rivers. In addition, while some of these irrigation schemes perform poorly, many perform reasonably well, and therefore could be a positive component of particular links proposed under the ASDS of 2009-2020. Hence, the additional interventions of such links are likely to detract from the performance of specific public irrigation schemes, and therefore require careful scrutiny.

Nonetheless, greater farmer participation in public irrigation O&M in terms of enhancing irrigation performance in Kenya would have positive impact. Therefore, this study recommends for a policy that encourages farmers to contribute to the O&M cost through the formation of a well established and operational WUAs. Moreover, its success would require NIB to treat farmers as clients, shareholders or as co-managers of irrigation scheme rather than just beneficiaries so as to enhance their roles in irrigation scheme O&M fee collection and management. However, while the results of the study provide support for such a policy, the inherent difficulties and challenges in making participatory initiatives should not be underestimated. This is because building capacities and stronger farmers' groups in form of WUAs require a lot of time and resources, which the Government and donors should invest in for public irrigations to be sustainable. Therefore, public investments could focus only on improving and expanding the irrigation infrastructure needed if no special social plan exists, and encourage private operation of the irrigation systems instead of developing and operating additional under-performing irrigation projects. Generally, based on the findings, this study affirms that policy and institutional changes, along with increased government investments in irrigation, and infrastructure, have markedly influenced growth in production and productivity of the irrigation schemes.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGEMENT

The author acknowledges the financial support for the study to the Kenya Institute for Public Policy Research and Analysis (KIPPRA) through the young professional training programme. In addition, They would also like to appreciate the Productive sector division at KIPPRA for the much-accorded support while undergoing the training. They also claimed responsibility for any errors of omission or commission.

REFERENCES

Biwott PK (2011). International Trade Liberalization and Economic Growth: The Role of Regulatory Policies. Kenya Institute for Public Policy Research and Analysis (KIPPRA) DP/125/2011.

Bos MG, Burton MA, Molden DJ (2005). Irrigation and Drainage Performance Assessment: Practical Guidelines. CABI Publishing, London, UK.

Burney JA, Naylor RL, Postel SL (2013). The case for distributed irrigation as a development priority in sub-Saharan Africa. Proc. Natl. Acad. Sci. USA. 110:12513-12517. doi:10.1073/ pnas.1203597110

Burt CM, Clemmens AJ, Strelkoff TS, Solomon KH, Bliesner RD, Hardy LA, Howell TA, Eisenhauer DE (1997). Irrigation performance measures: efficiency and uniformity. J. Irrig. Drain. Eng. 123(6):423-442.

Clemmens AJ (2006). Improving irrigated agriculture performance through an understanding of the water delivery process. J. Irrig. Drain. Eng. 55(3):223-234.

Clemmens AJ, Allen RG, Burt CM (2008). Technical concepts related to conservation of irrigation and rainwater in agricultural systems. Water Resour. 44:16.

Fan S, Zhang L, Zhang X (2000). Growth and Poverty in Rural China: The Role of Public Investments. Environment and Production Technology Division, International Food Policy Research Institute: EPTD Discussion Paper No.66.

Food and Agriculture Organization (FAO), (2009). Copping with changing climate: consideration for adoption and mitigation in agriculture.

Franks T, Garces-Restrepo C, Putuhena F, Franks T, Garcés-Restrepo C, Putuhena F (2008). Developing capacity for agricultural water management: current practice and future directions. Irrig. Drain. 57:255-267.

Githuku S (2010). Effects of Regional Trade Arrangements on Kenya's Export Flows.Kenya Institute for Public Policy Research and Analysis (KIPPRA) DP/113/2010.

Gomanee K, Morrissey O, Mosley P, Verschoor A (2003). Aid, Pro-poor Government Spending and Welfare. CREDIT Research Paper 3. Nottingham: University of Nottingham, CREDIT.

Greaves KR (2007). Quantifying and Benchmarking Irrigation Scheme Performance with Water balances and Performance Indicators. Unpublished Master's Thesis of University of KwaZulu-Natal.

Gulati A, Meinzen-Dick R, Raju KV (2005). Institutional reforms in Indian irrigation. New Delhi: Sage Publications.

Hsiao (2007). "Panel Data Analysis- Advantages and Challenges", Institute of Economic Policy/ Research (IEPR) Working paper, No. 06/49, pp. 1-22.

Huang Q, Dawe D, Rozelle S, Huang J, Wang J (2005). Irrigation, Poverty and Inequality in Rural China. Aust. J. Agric. Resour. Econ. 49:159-175.

Hussain I, Wijerathna D (2004). Irrigation and Income-Poverty Alleviation: A Comparative Analysis of Irrigation Systems in Developing Asia. International Water Management Institute (IWMI).

Hussain M, Hussain Z, Ashfaq M (2006). Impact of Small Scale Irrigation Schemes on Poverty Alleviation in Marginal Areas of Punjab, Pakistan. Int. Res. J. Fin. Econ. 6:6.

Inocencio A, Kikuchi M, Tonasaki M, Maruyama A, Merrey D, Sally H, de Jong I (2007). Cost and performance of irrigation projects: A

comparison of Sub-Saharan Africa and other developing regions. Research Report 109
Jin S, Huang J, Hu R, Rozelle S (2002). The Creation and Spread of Technology and Total Factor Productivity in China's Agriculture. Am. J. Agric. Econ. 84:916-930
Jones WI (1995). The World Bank and irrigation. A World Bank Operational Evaluation Study. Washington, DC.
Karina FZ, Mwaniki AW (2011). Irrigation Agriculture in Kenya. Impact of the Economic Stimulus Programme and Long-term Prospects for Food Security in an Era of Climate Change. Heinrich BöllStiftung East and Horn of Africa.
Khan S, Hanjra MA, Mu J (2009). Water management and crop production for food security in China: a review. Agric Water Manage. 96:349-360.
Kibe SN, Kaluli W, Home P, Gathenya M (2007). Integrated water resources management for crop production and domestic water supply in Kaiti watershed, Eastern Kenya. Msc. thesis. Biomechanical and Environmental Engineering department, Jomo Kenyatta Universty of agriculture and Technology, Nairobi, Kenya.
Malano H, Burton M (2001).Guidelines for Benchmarking Performance in the Irrigation and Drainage Sector. IPTRID and FAO, Rome, Italy.
Mati BM (2011). Optimizing agricultural water management for the green revolution in Africa. In: Bationo A, Waswa B, Okeyo JM, Maina F, Kihara JM, editors. Innovations as key to the green revolution in Africa. Dordrechet: Springer, pp. 83-94. ISBN 978-90-481-2541-8.
Meinzen-Dick R, Rosegrant M (2005). Chapter 10: Emerging water issues in South Asia. In Economic reforms and food security. (eds) S. C. Babu and A. Gulati. pp. 213-229. New York: Haworth Press, Inc.
Molden D, Oweis T, Steduto P, Bindraban P, Hanjra MA, Kijne J (2010). Improving agricultural water productivity: between optimism and caution. J. Agric. Water Manag. 97(4):528-534.
Molden DJ, Sakthivadivel R, Christopher J, Perry CJ, de Fraiture C (1998). Indicators for Comparing Performance of Irrigated Agricultural Systems Research Report 20. IWMI Publications, Colombo, Sri Lanka.
Mosley P, Hudson J, Verschoor A (2004). 'Aid, Poverty Reduction and the "New Conditionality"'. Econ. J. 114, June: F217–F243.
Murray–Rust H, Snellen B (1993). Irrigation system performance assessment and diagnosis. International Irrigation Management Institute Publications. Colombo, Sri Lanka.
National Irrigation Board (NIB) (2012). National Irrigation Boards Strategic Plan of 2008-2012.
Ngigi S (2002). Review of Irrigation development in Kenya. In Sally H, Abernethy CL (eds). Proceedings of private irrigation in sub Saharan Africa. IWMI, FAO, ACP-EU.
Ntsonto NE (2005). Economic performance of Smallholder Schemes: a case study of Zanyokwe, Eastern Cape, South Africa. Unpublished MSc Thesis, University of Pretoria.
Perry CJ, Steduto P, Allen RG, Burt CM (2009). Increasing productivity in irrigated agriculture: Agronomic constraints and hydrological realities. J. Agric. Water Manage. 96(11):1517-1524.
PMU-KENYA (Project Management Unit Kenya), (2004). Improving the performance of irrigation in Africa (IPIA): Report on analysis of a baseline survey on the performance of 10 pilot schemes in Kenya, Nairobi.
Raju KV, Gulati A (2005). Chapter 11: Pricing, subsidies, and institutional reforms in Indian irrigation. In Economic reforms and food security. (eds) S. C. Babu and A. Gulati. pp. 231-255. New York: Haworth Press, Inc.
Republic of Kenya (GoK), (2010). Agriculture Sector Development Strategy, 2010- 2020. Government printers. Nairobi.
Saleth RM, Namara RE, Samad M (2003). Dynamics of Irrigation-Poverty Linkage in Rural India: Analytical Framework and Empirical Analysis. Water Policy 5:459-473.
Shah T, van Koppen B, Merrey D, de Lange M, Samad M (2002). Institutional Alternatives in African Smallholder Irrigation: Lessons from International Experience with Irrigation Management Transfer Research Report 60. IWMI Publications, Colombo, Sri Lanka.
Svendsen M, Ewing M, Msangi S (2009). Measuring Irrigation Performance in Africa. International Food Policy research Institute Discussion Paper 00894. Washington DC, USA.
Thairu NK (2010). Agricultural production and Irrigation Management. The case of irrigated rice production in Kenya. Unpublished Master's Thesis at international institute for social sciences, Netherlands.
Valipour M (2013) Necessity of Irrigated and Rainfed Agriculture in the World. Irrigat Drainage Sys Eng S9: e001. doi:10.4172/2168-9768.S9-e001.
Valipour M (2014). Land use policy and agricultural water management of the previous half of century in Africa. Appl. Water Sci. DOI 10.1007/s13201-014-0199-1.
Valipour M (2015). Future of agricultural water management in Africa. Arch. Agron. Soil Sci. 61(7):907-927.
Valipour M, Ziatabar Ahmadi M, Raeini-Sarjaz M, Gholami Sefidkouhi MA, Shahnazari A, Fazlola R, Darzi-Naftchali A (2015). Agricultural water management in the world during past half century. Arch. Agron. Soil Sci. 61(5):657-678.
World Bank, (2006). Reengaging in Agricultural Water Management: Challenges and Options. Washington, DC.
World Bank, (2007). Investment in Agricultural Water for Poverty Reduction and Economic Growth in Sub-Saharan Africa. Synthesis Report of the collaborative program of AfDB, FAO, IFAD, IWMI, and the World Bank. Washington, DC.
World Bank, (2008). The Challenge of Hunger in Africa: A Call to Action. World Bank, Washington D.C..
Yokwe S (2009). Water productivity in smallholder irrigation schemes in South Africa. Agric. Water Manage. J. 96(2009):1223-1228.