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Integration and implementation of rainwater harvesting technologies in development programs, planning and budgeting in Matungulu Sub-County, Machakos County, Kenya

[1*]MUYUKANI W P, [1]MUTHAMA N J, [1]MUTUNE M J

[1]Department of Earth and Climate Sciences, University of Nairobi.
***Corresponding Author**: pwekesa@uonbi.ac.ke

Abstract

The constitution of Kenya 2010 placed the supply of water and services related to sanitation as a devolved function of County Governments. The clear delineation of roles between the County and National Governments have not significantly improved access to potable and clean water to households. Thirty-six percent of Kenya's population in Arid and Semi-Arid Lands (ASAL) still have to walk many kilometers in search for water for animal and human utilization There has been introduction of new rainwater harvesting technologies (RHT) that can alleviate the water scarcity, however little progress has been made on improvement of access to clean water in ASAL areas. There is, therefore, need to investigate the initiatives by the County Government of Machakos to integrate and implement water harvesting technologies in its development programs, planning and budgeting among households. Structured questionnaires were utilized to fetch primary data on integration and implementation of rainwater harvesting technologies which were then analyzed. Data was presented using tables, Charts and bar graphs to provide clarity of the findings. Calculation of arithmetic mean, standard deviation, Analysis of variance and regression analysis was done in order to deduce clear understanding of the findings. Documentary evidence was used to establish the programs and initiatives put in place by the County Government. The findings suggested that the County Government had put in place mechanisms to integrate RHTs in its development agenda however, the cost remained the biggest impediment to integration. A regression analysis showed that the Integration of RHT had a positive and significant effect on household livelihoods (β= 0.755, t=22.351, p=0.000<0.05). The study recommends that the County Government of Machakos develop programs to support integration of RHTs including providing subsidies, training, engaging development partners to finance rainwater harvesting and providing technical support.

Keywords: *Governance mechanisms; rainwater harvesting technologies; water resource; water technologies*

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Introduction

Storm water collection is valued not merely as water 'savings' for urban areas but also as a way of water production in the household, generating new ways of decision making and social power. In the United States of America, policies have been developed to regulate micro-level harvesting of rainwater. These policies were ideally developed to suit single-household homes, and they make provisions for regulatory frameworks for design and installation of rainwater harvesting systems (Meehan and Moore 2014).

In some states, regulations have been developed that encourage large scale harvesting methods at industrial level and large-scale developments. These systems generally encompass storm water and rainwater harvesting into structural designs which can be able to store thousands of litres of water. The cost of installing these systems are however, prohibitive and widespread use seems impossible unless there is a deliberate attempt to develop regulations and incentives to encourage their use (Bruns and Meinzen-Dick, 2005). Rebates have been used by different administrations in Arizona, California, for instance with different types of rebates being applied from time to time (Meehan and Moore, 2014).

Individual households, groups or government institutions with very limited cross border implementation implement most rainwater harvesting activities or incorporation into governmental policy programs on a national or local government level. To ensure larger scale implementation, it is important to integrate rainwater-harvesting technologies in policies and governmental programs, formulating sector guidelines and implementation tools and sharing experiences and practices (Ward et al., 2009).

Governmental and non-governmental projects still exhibit the top-down development approach which still ignores the input of the local community. This is important in ensuring sustainability by taking into consideration the needs of the community as well as creating societal ownership. There is also a focus on developing urban and peri-urban areas and ignoring the rural community, especially areas experiencing difficulties in accessing water. However, this is set to change with more and more governments adopting the right to water declaration, therefore fostering equity in water access (Kahinda and Taigbenu, 2011).

In Ethiopia, the government-initiated rainwater harvesting technologies as part of its programme to provide alternative source of water for its citizens and also soil conservation. The programs included rainwater harvesting activities such as building of ponds, small dams and terraces in driest areas in Tigray, Wello and Hararghe regions. Non-governmental organizations were involved in these initiatives through the Integrated Rural Development Projects (IRDPs) several regions of the country. NGOs participated in interventions such as conservation of rainwater and rainwater harvesting for household and agricultural purposes (Seyoum, 2003).

Governments around the world often focus on piped and groundwater to supply water as per of its programs and often avoid rainwater harvesting leaving it for NGOs and individual households as the implementers (Nyanchaga, 2007). Mumma, (2007) opines that is a genuine concern that if rainwater-harvesting technologies are not integrated into government programs and policies, it will be difficult to mobilize resources for their successful implementation and their adoption will remain scattered. Mumma (2007) further points out that need for and use of rainwater harvesting technologies will influence the intervention measures depending on the prevailing environmental conditions in any geographical location. There is greater success if governments design policies that facilitate rainwater-harvesting technologies without stifling their innovation and demand and communities will readily adopt and implement them in order to improve reach to clean and safe water for domestic and other uses (Evans, 2002).

In the United Kingdom, the government has established several policies in order to promote use of rainwater harvesting technologies. There is however a lack of proper implementation mechanism especially where legislation limits action by inadequate support mechanisms (Ward et al., 2009).

The Kenya vision 2030 economic development blueprint recognizes the importance of water in economic and social development. It highlights the need for conservation of water resources and implementation of new water harvesting methods such as rain water and underground water to ensure water sanitation and access to all citizens in both rural and urban areas (Koehler, 2016). The strategies put forward include introducing of specific strategies to improve water management, storage and harvesting capability, improvement of hydro-meteorological data gathering network, and construction of dams and sanitation facilities across the country (Mwenzwa and Misati, 2014). These strategies however do not specify the strategies to improve small scale household water harvesting and conservation.

The constitution of Kenya 2010 placed provision of water utilities as a decentralized function of county governments. It is therefore the responsibility of County governments to implement water sanitation programs in their areas of jurisdiction (Constitution of Kenya, 2010). The National government retained the responsibility of managing international waters and water resources (K'Akumu, 2007). The constitution of Kenya (2010) mandates the county governments to implement water and sanitation programmes as one of the devolved functions previously handled by the National Government. This has enhanced access to clean water and sanitation to citizens.

Some form of regulation had been in place for management of water resources since the establishment of civilization (Bunclark and Lankford, 2011). In India, the advent of colonial rule signaled the transformation of legal frameworks and some of which involved the management of natural resources. The legal transformation included legal frameworks touching on local property rights in land and water and the role of local authorities in management of natural resources. These legislations also to some extent affected Rainwater Harvesting. The current national policy on rainwater harvesting in India is based on colonial policies. It fails to shift from project-oriented approach to water resources. The policy is meant for major national and regional projects and clearly ignores the small-scale household rainwater harvesting (Vani, 2005).

By the year 2000, the Kenyan government tasked the water sector with providing access to clean and reliable water to improve access to clean water from 43% of the population in the year 1990. All water resources were managed through a centralized government institution, which was grossly inefficient due to lack of funding and acute lack of water infrastructure (K'Akumu, 2007). The challenges associated with bad governance in the water sector led to the formulation of water Act 2002 to streamline the sector. This was influenced by international trends spearheaded by Global Water Partnership (GWP) and strengthened by the Millennium Development Goals (2000), which aimed at improving access to safe drinking water by half by 2015 (United Nations, 2017). In order to achieve its target of providing water to the population, the Government of Kenya adopted the 1999 "National Policy on Water Resources Management and Development" (NPWRMD), which proposed decentralization of the water sector as a means of improving access to water by rural communities (Nyanchaga, 2007).

In order to operationalize the functions of county governments especially in water sector, the Water Act 2016 was legislated and enacted to specify how the counties will implement new structures (Koehler, 2016). Article 142 (2) of the Water ACT 2016, highlights rain water harvesting and household water storage as one of the most important avenues for improving household water availability. Sustainable Development Goal number six also focuses on capacity building in water and sanitation, water harvesting technologies, desalination, water efficiency, recycling as well as reuse technologies. The basis of all these processes is to ensure water availability to all if not majority of the world population. The water Act 2002 provided for separation of roles and responsibilities resulting in restructuring the water sector in compliance with international trends. It led to the formation of regional Water Service Boards and water service providers to address water related issues and decentralized water management to local autonomous institutions (Mumma, 2007).

The clear delineation of roles between the county and national governments have not significantly improved access to potable and clean water to households. 36% of Kenya's population in ASAL areas still have to walk for several kilometers in search of water (Republic of Kenya, 2015).

In Matungulu, Machakos County, the Matungulu Water Supply Project was funded by Kenya Italy Department Development Programme at a cost of Ksh. 107 million (Machakos County Integrated Development Plan (MCIDP), 2015), serving a population of 28,000 people. The main objective of this project is to try and appraise the extent to which Machakos County Government implements and integrates RWHTs in its programs, planning and budgeting among households in Matungulu Sub-County, Kenya.

Considering the social dilemma theory, which focuses on management of all resources or any given resource through decisions, whether the decisions reflect the giving or taking of resources. The theory points out that decision makers face a range of challenges in which personal and common interest conflict - normally called social dilemmas. Even though governments, corporations and other organizations are involved in resource management, individuals also are faced with their own challenges in management of resources (Gifford, 2006).

The theory also proposes that factors that are not human related but relevant can still affect the harvesting of any of these resources in their original form before transformation. These factors include the resource scarcity, ease of extraction, the quantity and quality of the resource and even the elusiveness of the resource. Natural resources can decline over time, sometimes caused by human or non-human activities and this influence the utilization and protection for future or current use (Gifford, 2006).
The proponent of this model notes that individuals and households utilize available resources along a continuum, which ranges from household, group, or environmental interest to individual-interest. Such individuals thus face social dilemmas on how these interests' conflict with each other (Gifford, 2008). This model, therefore, explains the influences or impacts that decision making have on the strategies used to make a decision or decisions about some phenomenon. Different outcomes are therefore, available for the decision maker in terms of satisfaction, anger or regret and the environment on the other hand on whether a resource should be depleted or sustained (Gifford, 2008).

The decisions made by a group, a household head, a community or a County Government is thus likely to influence the type of rain water harvesting technology to be used in any given area. Some decisions might be made with some insights of the technology chosen while others might be out of ignorance. The two levels of decisions might in turn influence or determine whether a resource was conserved or depleted, utilized well or misused, recycled or reused.

Materials and methods

The study area

The research was carried out in Matungulu Sub-County, Machakos County. It borders Nairobi, Kiambu, Embu, Kitui, Makueni, Kajiado, Murang'a and Kirinyaga (MCIDP, 2015). Machakos County comprises eight (8) constituencies also referred to as Sub- Counties including Machakos Town, Masinga, Kangundo, Yatta, Mavoko, Matungulu, Kathiani, and Mwala Sub-Counties (MCIDP), 2015) (Figure 1).

Matungulu is a semi –arid area with few hilly terrains (MCIDP, 2015). The sub-county has an annual precipitation of between 500 mm and 1300 mm making the rainfall patterns unreliable. The short rains are experienced in October and December and long rains from March to May with temperatures varying between 18˚C and 29˚C throughout the year. The total population of Matungulu Sub-County is 199,211 people, with 64,257 Households. It covers an area of 577.5 square kilometers with a population density is 215 persons per square kilometer dominated by the Akamba people (MCIDP, 2015).

Sampling procedure

The sample was calculated using Fisher's formulae, from a population of 64,247 households

$$n = \frac{Z^2 Pq}{d^2}$$

where (n) referred to the sample size (where the population being targeted was more than 10,000), (Z) was the standard normal deviation at the desired confidence level (Z level is 1.96 at 95% significance level), (p) is equal to 50 per cent, (q) is 1 – p while(d) is statistical significance level (0.05).

Systematic sampling was then done using probability sampling technique to select farm households from each of the two sub-locations. This sampling method was chosen since it had an advantage of giving all elements in any given population an equal opportunity of being included in the sample. Documentary evidence was also sourced to investigate strategies and programs placed by the county government in integration of rainwater harvesting technologies.

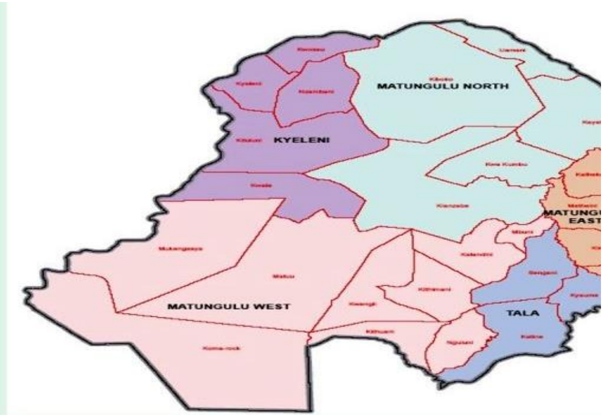

Figure 1. Map of Matungulu Sub-County
Source: IEBC

Data analysis

Descriptive statistics were used in data analysis through the use of the Statistical Package for Social Sciences (SPSS version 22 software). The arithmetic mean, standard deviation, percentages, frequencies were calculated as well as Analysis of Variance and regression analysis done.

Primary and secondary data was used. Structured questionnaires were used to collect primary data which included, integration of rainwater harvesting technologies in the community, financing rainwater harvesting technologies, and county government incentives.

Secondary data were obtained from statistical reports, government documents like the Machakos County Integrated Development Plan, 2015, Population and Housing Census documents, Ministry of Agriculture Annual Reports and Food and Agricultural Organization (FAO) publications. These data were used to complement the primary data and to confirm the study findings.

The analyzed data were then presented in tables and figures.

The study hypothesis was tested using linear regression model stated below:

$$y = a + \beta_1 + X_1 + e$$

Whereby:

y = Impact on House Household Livelihoods

a = Constant

β_1 = Beta coefficient

X_1= Compute score Barriers and Enablers

X_2= Compute score Water Harvesting Technologies

X_3= Compute score Integration of RHT in County Development Agenda

e = error term

$$Y_1 = a_1 + \beta_1 X_1 + e_1$$
$$Y_2 = a_2 + \beta_2 X_2 + e_2$$
$$Y_3 = a_3 + \beta_3 X_3 + e_3$$

Correlation Analysis

The correlation coefficient is a statistical measure of the strength of the relationship between the relative movements of two variables (Akhilesh and Westfall, 2020). Correlation analysis in this study was to show the strength of relationships between the independent and dependent variable. A high correlation meant that two or more variables had a strong relationship with each other, while a weak correlation meant that the variables were hardly related.

Pearson Correlation coefficient was used to determine the relationship between integration of RHT in county development agenda and impact on household livelihoods.

Table 6. Model Coefficients of Integration of RHT in County Development Agenda and Impact on Household Livelihoods

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
	(Constant)	1.706	0.112		15.221	0.000
1	Integration of RHT in County Development Agenda	0.611	0.027	0.755	22.351	0.000

a. Dependent Variable: Impact on Household Livelihoods

Regression Analysis

This technique was used in this study to find out whether the independent variables influenced the dependent variable. Regressions help uncover areas in operations that can be optimized by highlighting trends and relationships between factors (Dana Liberty, 2020). The standardized regression - beta weights (ß) - was used to assess the independent effect of each variable in the regression equation on the dependent variable. The regression model aided in describing how the mean of the dependent variable changes with the changing condition.

Results

This section presents the results of the study whose main objective was to interrogate the extent to which Machakos County Government implements and integrates water harvesting technologies in its programs, planning and budgeting in Matungulu Sub-County, Kenya.

RWHTs Integrated in the Community

The respondents were asked how the rainwater harvesting technologies were integrated in the community and the results were as displayed in Figure 2.

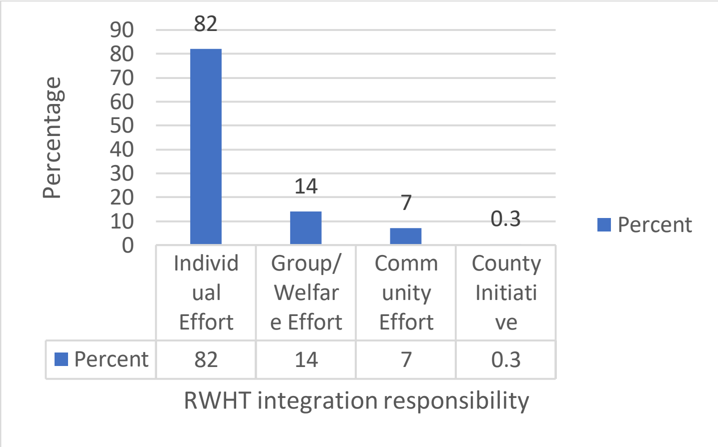

Figure 2. RWHTs integration in the community

Majority of the respondents at 82% indicated that rainwater harvesting technologies integration was an individual effort while 14% of the respondents attributed this to group/welfare effort. 7% and 0.3% of the respondents said it was community effort and the county initiative respectively.

Main source of capital to purchase rain Water harvesting method

The respondents were asked "what was the main source of income to purchase or construct the rainwater harvesting method and the results were shown as below in figure 3"? The study findings in figure 3 revealed that majority of the respondents at 88% showed that the head of household was the main source of income to purchase the rainwater harvesting technologies while 6% of the respondents said it was the community. Five percent of the respondents said it was done by the self-help group while only 2% of the respondents was done by the county government.

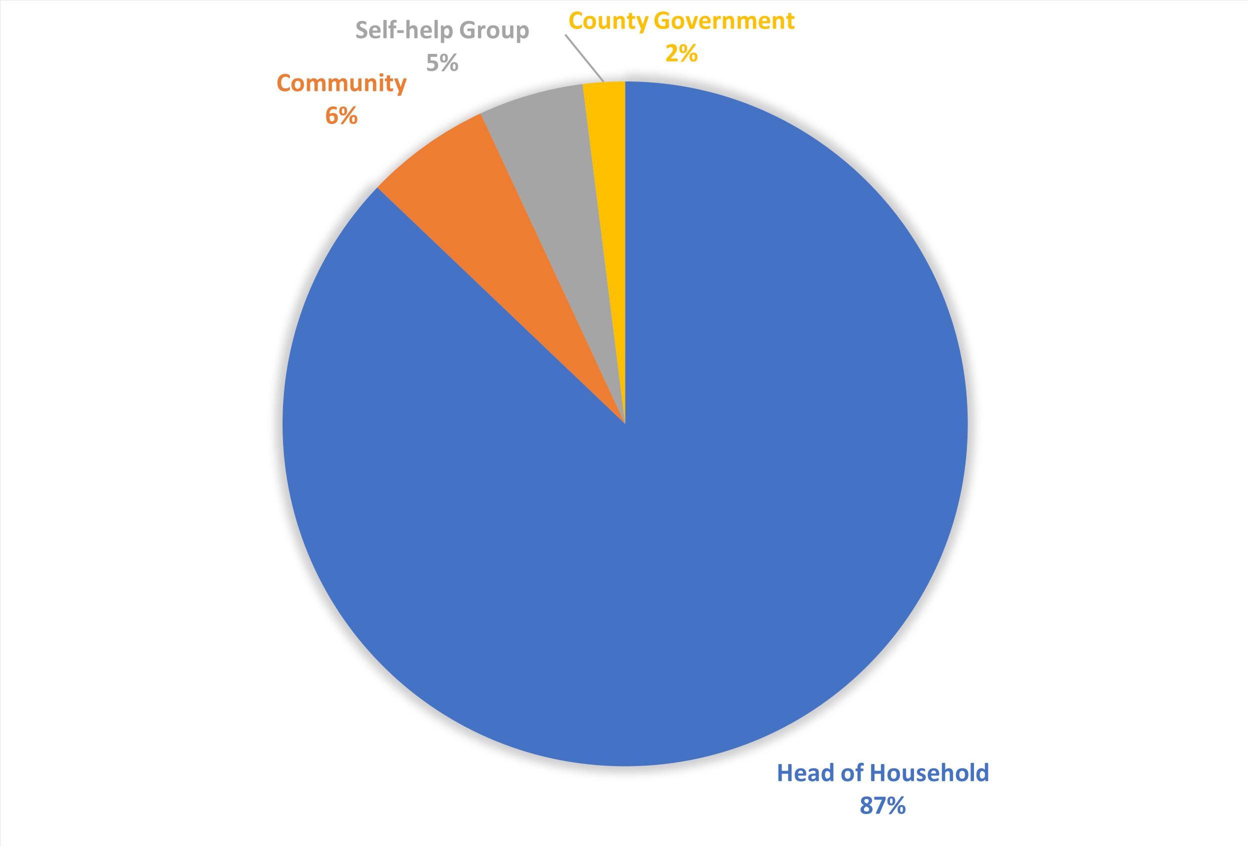

Figure 3. Source of capital to purchase rainwater harvesting technologies

County Government Empowerment on Any Rain Water Technologies

The findings indicate that the County government has initiated programs to empower residents on the adoption and use of rainwater harvesting technologies. This was confirmed by a positive response rate of 95% of the respondents (Table 1). This was a great significance of support accorded to the community from the county government.

Table 1. Empowerment by the County Government

Empowerment	Frequency	Percent
Yes	361	95
No	18	5
Total	**379**	**100**

County government initiatives for integration of rainwater harvesting technologies

The study identified several initiatives by the county government to promote adoption of rainwater harvesting technologies. These are represented in figure 4. The study results indicated that more than half of the respondents with a mean of 4.44 and a standard deviation of 0.916 agreed that the county government of Machakos provided training to farmers as an incentive, which promoted water-harvesting technologies. This was followed by a mean of 4.35 and a standard deviation of 1.037 of the respondents who said excavation of water pans and dams for community use was also given as an incentive. Again, a mean of 3.92 and a standard deviation of 0.670 of the respondents agreed that funding of groups to implement water-harvesting technologies was also given by the county government as an incentive. In addition, means of 3.77 and 3.72 with standard deviations of 0.727 and 0.915 of the respondents agreed awareness creation and provision of plastic water tanks to households were given by the county government respectively.

Overall, a composite mean of 4.04 and a standard deviation of 0.699 of the respondents agreed that the above incentives from the county government of Machakos significantly encouraged water harvesting technologies.

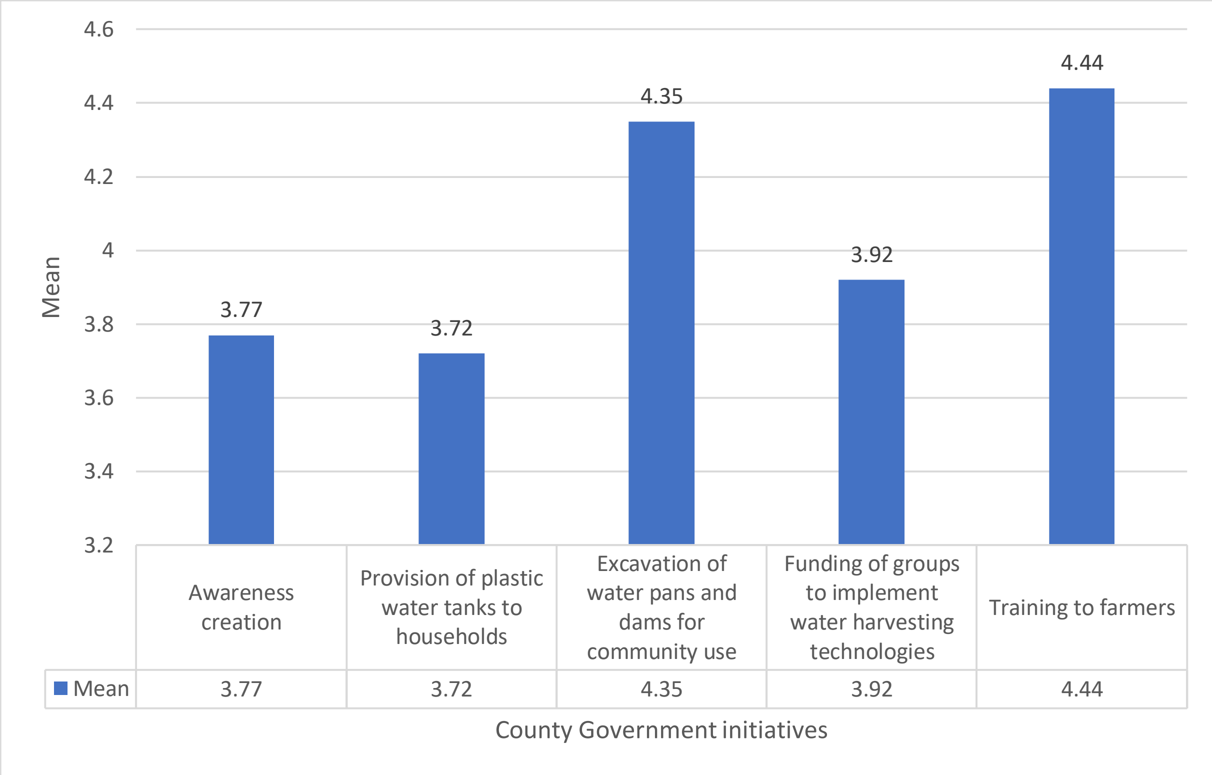

Figure 4. County Government initiatives to integrate rainwater harvesting technologies

Suggestions for promotion and adoption of rainwater harvesting technologies

The respondents were requested to suggest ways in which County Government would promote adoption of rainwater harvesting technologies. The findings indicate that that majority of the respondents at 96% said that subsidized on water storage tanks by the County Government could encourage them harvest water while 94% of the respondents suggested getting assistance in water treatment. 91% of the respondents said community empowerment through training will be ideal. Furthermore, 88% each of the respondents suggested on subsidize of roofing materials and creation of markets for the farm produces would be a great boost for rainwater harvesting. Lastly, 85% of the respondents suggested that coming up with better ways of storing and conserving water could be of great support (Figure 5).

Inferential Statistics

The study further carried out inferential statistics using correlation and regression analyses for purposes of quantifying the strength of the linear relationship between variables.

Correlation Analysis for Water Harvesting Technologies and Impact on Household Livelihoods

Pearson Correlation coefficient was used to determine the relationship between water harvesting technologies and impact on household livelihoods as shown in table 2.

Table 2. Correlation Analysis for WHT and Impact on Household Livelihood

Variable		**Performance**
	Pearson Correlation	0.703**
Water Harvesting Technologies	Sig. (2-tailed)	0.000
	N	379

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation matrix displayed in table 4.40 above revealed that there was a positive strong and significant correlation between water harvesting technologies and impact on household livelihoods which implied that a unit increase in water harvesting technologies increases impact on household livelihoods by 0.703 in Machakos County.

Figure 5. Suggestions for promotion and adoption of rainwater harvesting technologies

Correlation Analysis for Integration of RHT in County Development Agenda and Impact on Household Livelihoods

As displayed in table 3, the correlation matrix displayed revealed that there was a positive strong and significant correlation between integration of RHT in county development agenda and impact on household livelihoods. This implied that a unit increase in integration of RHT in county development agenda increases impact on household livelihoods by 0.755 in Machakos County.

Table 3. Correlation Analysis for Integration of RHT in CDA and Impact on Household

Variable		Performance
Integration of RHT in County Development Agenda	Pearson Correlation	0.755**
	Sig. (2-tailed)	0.000
	N	379

**. Correlation is significant at the 0.01 level (2-tailed).

Regression Analysis for Machakos County Government Programs, Planning and Budgeting and Impact on Household Livelihoods

Simple linear regression model was used to test the hypothesis to achieve the requirements of the objective.

Table 4. Model Summary for Integration of RHT in County Development Agenda and Impact on Household Livelihoods

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.755[a]	0.570	0.569	0.372

a. Predictors: (Constant), Integration of RHT in County Development Agenda

The results in table 4 showed the model explanatory power between Integration of RHT in County Development Agenda and the impact on household livelihoods determined by the 'R square'. This established that 57.0% of the changes in the impact on household livelihoods can be explained by Integration of RHT in County Development Agenda while the remaining percentage of the impact on household livelihoods at 42.3% can be explained by other factors excluded from the model.

Table 5. Analysis of Variance of Integration of RHT in County Development Agenda and Impact on Household Livelihoods

ANOVA[b]

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	69.101	1	69.101	499.577	0.000[a]
	Residual	52.146	377	0.138		
	Total	121.247	378			

a. Predictors: (Constant), Integration of RHT in County Development Agenda
b. Dependent Variable: Impact on Household Livelihoods.

The ANOVA results above showed an F Value of 499.577 reflecting a significant level of .000[a] meaning the test statistic is significant at that level. This revealed that Integration of RHT in County Development Agenda had a significant impact on household livelihoods at 95% confidence level.

The results indicated that Integration of RHT in County Development Agenda had a positive and statistically significant influence on the impact on household livelihoods ($\beta = 0.755$, $t=22.351$, $p=0.000<0.05$). This further implied that a unit change in Integration of RHT in County Development Agenda holding other factors constant increases impact on household livelihoods by 0.755 units.

Based on the research findings achieved, the null hypothesis which stated that Machakos County Government programs, planning and budgeting do not significantly influence the effects of rainwater harvesting technologies among households was rejected. Therefore, using the statistical findings, the regression model can be substituted as: $y = 1.706 + 0.755X_3$.

Discussion

The study findings indicated that majority of the respondents with a mean of 4.44 and a standard deviation of 0.916 agreed that the county government of Machakos provided training to farmers as an incentive which encouraged water harvesting technologies while a mean of 4.35 and a standard deviation of 1.037 of the respondents said that excavation of water pans and dams for community use was also provided as an incentive. On the other hand, a mean of 3.92 and a standard deviation of 0.670 of the respondents agreed that funding of groups to implement water harvesting technologies was likewise given by the county government as an incentive. In addition, means of 3.77 and 3.72 with standard deviations of 0.727 and 0.915 of the respondents agreed that awareness creation and provision of plastic water tanks to households were given by the county government respectively. These study results support the findings of Meehan & Moore (2014) who found out that in the United States of America, rebates have been adopted by administrative governments in Arizona, California, New Mexico, and Texas as earlier discussed.

Overall, a composite mean of 4.04 and a standard deviation of 0.699 of the respondents agreed that the above incentives from the county government of Machakos significantly encouraged or promoted water harvesting technologies. This was confirmed by a positive strong and significant correlation between integration of RHT in county development agenda and impact on household livelihoods.

A further regression analysis indicated that Integration of RHT in County Development Agenda had a positive and statistically significant influence on the impact on household livelihoods ($\beta = 0.755$, $t=22.351$, $p=0.000<0.05$), hence, the rejection of the null hypothesis which stated that Machakos County Government programs, planning and budgeting do not significantly influence the effects of rainwater harvesting technologies among households.

According to the Machakos County Integrated Development Plan (2015), there is an ongoing Matungulu Water Supply Project funded by Kenya Italy Department Development Programme at a cost of Ksh. 107 million which will serve a population of 28,000 people. The project scope of works includes: drilling and equipping of one borehole, construction of one grade 9 house, laying of a 5km rising main, construction of 1500m3rc tank, laying of 15km gravity main line, fabrication and erection of 250m3 and 100m3 elevated steel tanks, construction of six water kiosks. Once completed, the total production capacity will be 720m3/day (MCIDP, 2015).

In addition, there are legal frameworks on Article 142 (2) of the Water ACT 2016, which talks about rainwater harvesting and household water storage to improve household water availability. SDG 6 also focuses on capacity building in water and sanitation, water harvesting technologies, desalination, water efficiency, recycling as well as reuse technologies.

The County Government of Machakos recognizes the need for adequate access to water and has embarked on a comprehensive water program which has the following components: water resource mapping, drilling, equipping and reticulation of boreholes, weir and dam construction, rehabilitation of existing water projects, rainwater harvesting and strengthening of governance structures for water service providers and community water projects (CIDP, 2018). Among the objectives of the County Integrated Development Plan, 2018 is to establish pro-poor subsidy programs in poor resource settings (free water) and to strengthen governance in water service providers (WSPs) for sustainable provision of water services for domestic, industrial, and agricultural purposes to ensure the conservation of environment. The findings of this study highlighted the cost of RWT as one of the barriers to adopting rainwater technologies, therefore, necessitating subsidy programs for Rain Water Harvesting technologies.

Conclusion and recommendations

There is a deliberate initiative by the county government of Machakos to integrate rainwater harvesting initiatives in its programs. However, more needs to be done to provide adequate measures to promote adoption of these technologies. There is a need to develop regulatory framework and include incentives as part of policy. The County Government also must ensure that guidelines for water treatment and use are developed to guard against an increase in waterborne diseases that may further hinder the utilization of rainwater in the county.

There is also an urgent need to include rainwater-harvesting programs in the county government budgets. Apart from this, there is a huge potential in involvement of donors and non-governmental organizations in initiatives that promote rainwater-harvesting technologies. The study noted that county government does not participate in initiatives that promote use of rainwater harvesting technologies at the household level. There is therefore an urgent need to bridge this gap by involving development partners and community-based organizations to assist the vulnerable, who cannot afford these technologies to access financial support to set up these technologies.

References

Bruns, B. R., & Meinzen-Dick, R. (2005). Frameworks for water rights: An overview of institutional options. In B. R. Bruns, C. Ringler, & R. Meinzen-Dick (Eds.), *Water rights reform: Lessons for institutional design* (pp. 3–25). Washington, DC: International Food Policy Research Institute. [Crossref], [Google Scholar]

Bunclark, L. A., & Lankford, B. A. (2011). Rainwater harvesting: A suitable poverty reduction strategy for small-scale farmers in developing countries? *Waterlines*, 312-327. http://www.un.org/sustainabledevelopment/sustainable-development-goals (accessed July 22, 2020).

K'Akumu O.A, (2007) Toward Effective Governance of Water Services in Kenya, *Water Policy* 9, no. 5: 529–43; "Effective Water Governance: Learning from the dialogues," Global Water Partnership Sweden: Elanders Novum, http://www.gwpforum.org/gwp/library/Effective_Water_Governance.pdf

Kahinda, J. M., & Taigbenu, A. E. (2011). Rainwater harvesting in South Africa: Challenges and opportunities. *Physics and Chemistry of the Earth, Parts A/B/C*, *36*(14-15), 968-976.

Koehler, J. (2018). Exploring policy perceptions and responsibility of devolved decision-making for water service delivery in Kenya's 47 county governments. *Geoforum*, *92*, 68-80.

Machakos County Integrated Development Plan, (2015). Retrieved on 28th August, 2019, from www.machakosgovernment.com

Meehan, K. M., & Moore, A. W. (2014). Downspout politics, upstream conflict: formalizing rainwater harvesting in the United States. *Water international*, *39*(4), 417-430. DOI: 10.1080/02508060.2014.921849.

Mumma A, (2007) "Kenya's New Water Law Analysis of the Implications of Kenya Water Act 2002, for the Rural Poor," in *Community-based Water Law and Water Resource Management Reform in Developing Countries*, ed. B. Van Koppen, M. Giordono, and J. Butterworth (Cambridge, MA: CAB International), 163.

Mwenzwa, E. M., & Misati, J. A. (2014). Kenya's Social Development Proposals and Challenges: Review of Kenya Vision 2030 First Medium-Term Plan, 2008-2012.

Nyanchaga E.N, (2007) "Historical Timeline on Water Governance in Kenya (1895–2002)," in *Governance in Water Sector: Comparing development in Kenya, Nepal, South Africa and Finland*, ed. Petri Juuti et al., (Tampere, Finland: Tampere University Press – ePublications,), 18–37.

Republic of Kenya, (2002)."The Water Act, 2002"

Seyoum, M. (2003). Overview of the Ethiopian rainwater harvesting association (ERHA). *Integrated water and land management research and capacity building priorities for Ethiopia*, *155*.

The National Council for Law Reporting (2010). *The Constitution of Kenya*. Nairobi.

United Nations, (2017), Sustainable Development Goals,

Vani, M. S. (2005). Political Economy of Rainwater Harvesting in India: Reflections in Central and Regional Law and Policy. *New Delhi*.

Ward, S., Butler, D., Barr, S., & Memon, F. A. (2009). A framework for supporting rainwater harvesting in the UK. *Water Science and Technology*, *60*(10), 2629-2636.