

Effects of Rainwater Harvesting Projects on Household Welfare: A Case Study of Thika East Sub-County, Kiambu, Kenya

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Abstract

One of the determinants of household welfare is the availability of water for use in domestic and farm production. Harvesting rainwater is thought to provide an alternative source of water in the prevailing situations where rainfall is unreliable in both distribution and amounts. Though rainwater harvesting (RWH) projects have been adopted by some homes in the society, little is known about the role they play on household welfare. This study therefore, endeavours to assess the contribution and significance of these projects on the household's well-being, hence its main objective.

Though several factors contribute to the welfare of a household, this study focuses on; household's time usage in collecting water, level of crop yields, level of livestock yields and the aspect of gender roles in water collection within households as influenced by RWH projects.

The study area is Thika East sub-county where the sampled households are drawn. This study utilizes ex-post impact evaluation model as cited by World Bank (2004) which makes it possible to deduce effects on those who have benefited from the projects against those who have not. Data collection is by way of survey technique. The technique makes it possible to collect comparable information for a relatively large number of people in particular target groups and compare the different groups at a given point in time (World Bank 2004).

A sample of 140 respondents is considered, out of which 70 have adopted RWH projects while the rest have not. The respondents within the study area are randomly selected and stratified into two groups; those who have benefited and those who have not. Instruments for data collection include questionnaires, observation, household interviews and key informant

interviews. Before data collection, a pilot test was conducted by subjecting some potential respondents to the process of data collection intended for use to ascertain that the responses answer the research questions. Data collected was subjected to multivariate analysis to come up with processed data that can be interpreted and that meets the study objectives. MANOVA was used to test the strength of interrelationships between the multiple dependent variables.

1.1 Background information

Access to safe and reliable water supplies for domestic, livestock, agricultural and commercial use has been one of the main goals of national development. The seventh goal of the UN's Millennium Development Goals (MDGs) targets to halve the number of people living without sustainable access to water and basic sanitation by 2015; this has facilitated efforts into improving methods of water supply and sanitation especially in rural areas where 70 percent of the population still have no access to improved water based sanitation (UN MDG 2008 report).

Water scarcity and quality problems are of particular concern in the tropical regions of the world especially in less developed countries. In these regions there is often a connection between poor water resources and poverty, (Aroka, 2010). Aroka, further states that a great number of people in the tropics rely on scarce and low-quality water sources, a problem that escalates from individual level to household and national scales and which inhibits development and affects human welfare. The negative effects are reflected in many aspects of human life: health, education, agricultural yields, food security, technical development, and the general economy.

Different studies indicate that this situation is expected to even worsen in future due to changing conditions. Tripathi and Pandey, (2005) writes that the water demand for domestic, industrial, hydropower, agriculture, recreational and environmental uses is expected to increase with increasing population. In addition, climate change due to rising global temperatures is predicted to exacerbate rainfall variability (Pandey et al.2003) through extreme drought and flooding.

There is synergy and close interdependence between drought, environment and agriculture. Effects of drought cuts across the development spheres of a nation not just on the socioeconomic aspects but goes further in accelerating ecological damage, land degradation and desertification, habitat and ecosystem degradation hence loss of biodiversity (UNEP/GOK, 2000) a major impediment to sustainable development. Furthermore, water scarcity especially for domestic purposes compromises the role of women in food production since major portions of available time is spent in looking for water.

The strain of an increasing water demand is certain to create a further burden on already compromised water resources within many developing regions (Pandey et al. 2003). This is enough alarm on the future of water quantity and quality particularly in developing countries considering that water is a key driver in food security and development. The growing crisis over water has thus focused attention on ways to make use of rainfall and runoff, (Ngigi, 2003), making rainwater harvesting projects to be widely considered as a possible relieve to the impending situation.

Rainwater harvesting projects are simple and low cost water supply techniques that involve the capturing and storing of rainwater from roofs and ground catchments for domestic, agricultural, industrial and environmental purposes. Though harvesting of rainwater and runoff has been practised for centuries in different parts of the world, the practice has received little attention until relatively recently, (Ngigi, 2003). The current upsurge of interest derives from a growing recognition that human life is threatened in many places either

because the quantity of water available is insufficient to meet expanding needs or because the quantity of available water is detrimental to health. Most of Kenya has two rainy seasons, the long rains runs from March to May and the short rains from October to December, meaning half of the year, these regions goes without rains. This situation is made worse with the existence of few permanent rivers crossing the country and scattered seasonal streams that flow only during the wet season and remain dry for the rest of the year thus outspread water scarcity.

One promising technology to abate water scarcity and flooding is through harvesting rainwater. The variability of rainfall has triggered a myriad of rainwater harvesting schemes which have sprouted in recent years, both in Kenya and in other water-stressed nations with the aim to abate drought and the water shortages, (Aroka, 2010). Different types of rainwater harvesting management systems have been implemented throughout Kenya as a strategy to secure water resources in rural areas (Kenya Rainwater Association, 2010).

Despite all these efforts, the effects of rain water harvesting projects on household welfare, food security and sustainable development have not been assessed and documented. Some of the studies have revealed the role of rainwater in alleviating hunger; however, little has been done to assess the level of adoption of this projects and resulting effects on sustainable human welfare. The lack of tangible evidence on the significance of rainwater harvesting projects in human welfare and sustainable development could possibly be the reason why there have been little efforts from the government and the line ministries in setting up guiding policies on these projects.

1.2 Statement of the problem

Over the years, various rainwater harvesting projects have been proposed, tested and adopted across eastern and southern Africa with different types of rainwater harvesting management systems gaining some recognition in the region as a strategy to secure water resources in rural areas (Kenya Rainwater Association, 2010). Additionally, potential benefits of rainwater harvesting for rural communities has been cited in many reports (Gould 1995, Mugerwa 2007, Enfora 2009, Relma 2009). However, less study has been done to determine the effects of these projects on human welfare at the household level.

RWH projects have not received enough attention to warrant widespread adoption and implementation more specifically on complimentary research in order to arrive at a holistic view of these projects. It's alarming that currently, most RWH projects are planned on ad-hoc basis without much knowledge and scientific information. Muturi, (1992) reviewed the curricula and content of agro-forestry training courses offered through workshops, field days for farmers and extension workers. Although soil and water conservation was included in some of the courses, rainwater harvesting was lacking.

In a separate study, Abebe (1997) assessed the status of education in six colleges in eastern Africa; degree, diploma and certificate courses on water and soil management. Surprisingly, all the courses covered soil erosion and conservation well, but not all included topics on RWH. Furthermore, rainwater use by crops and natural vegetation is in many cases by-passed in integrated water resource management (IWRM), which primarily focus on stream flow or groundwater resources.

A key barrier to the adoption of RWH projects is lack of scientific information— both technical and otherwise. The actual planning of the RWH projects requires detailed surveys and consideration of other socio-economic factors, such as competing water requirements, financial constraints, politics and culture, (RELMA, 2007) and more importantly the significant effects on household welfare.

A study by UNEP/SEI (2009), points out clearly that the biggest challenge with using rainwater harvesting in many countries is that it is not included in water policies and in investment plans. In the other hand RELMA, (2007) asserts that, in a region where rainwater harvesting is not widespread, information is vital to create awareness, influence policy and encourage adoption of various technologies. Governments, the public, donors, and development agencies have often neglected challenges in water governance. Some of these challenges are related to policies, access to water resources, participation and water information. This therefore presents a research opportunity to help come up with data that would help bridge the gap and present informative findings on RWH projects as well as build a base for future research on this technology.

2.0 LITERATURE REVIEW

2.2 Theoretical review and Conceptual framework

Interest on rainwater harvesting projects are gaining popularity in recent years as researchers, scholars, private practitioners and development partners sought more effective ways of abating the twin issue of droughts and floods. Recent studies suggest that in Africa and globally, soil storage enhancement and small-scale runoff harvesting can make a useful contribution to agricultural productivity under current and future climates (Rockstrom et al. 2009; Vohland and Boubacar 2009; Wisser et al. 2010). RWH projects can productively utilize the direct rain and the runoff, which are currently underutilized and left to cause flooding, land erosion, displacement and demolition of infrastructure in the downstream. These interventions promote economic growth and help alleviate poverty by reducing risk and making water available when and where it is needed (Braune and Xu, 2010). The technologies employed are cheaper, decentralized and participatory and benefit communities in rural and urban areas.

In theory, household water harvesting can be done mainly through the effort of an individual with the use of readily available catchments and storage facilities. Use of stored rainwater could supplement natural rainfall and make farming families less vulnerable to drought and therefore less dependent on outside help in harder times (Takele, 2006). Water harvesting tanks and ponds at the village or household level are proposed as a practical and effective alternative to improve the lives of rural people at little cost and with minimal outside inputs. The technology yields numerous social and economic benefits, and contributes to poverty alleviation and sustainable development (RELMA, 2005).

The drought has had serious social and economic implications. About 75 percent of Kenyans are farmers whose lives are threatened by starvation and malnutrition. Some empirical studies suggest that irrigation has shown some positive impacts in increasing agricultural productivity and thereby increase the income of farm households, who participate in the irrigation schemes (FAO, 1993). Improving domestic water supply with rainwater harvesting projects also saves women and children from the tedious work of fetching water from distant water sources.

Availing water through RWH projects, therefore, saves children from the duties of fetching water hence time to attend school. Also, by resolving the family water problems and creating proper income, women become empowered and escape from poverty, thus enabling them to play a strategic role in not only household livelihood but also on sustainable development . RWH projects in many cases not only increases human well-being and ecosystem services, but also act as ways of improving equity, gender balance and strengthens social capital in a community.

A study by Nasr (1999) on the Bedouin tribe of Egypt showed that rainwater harvesting if systematically implemented not only helps in producing crops in areas where it otherwise wouldn't have been possible, but also helps in reducing or halting environmental degradation.

Conceptual framework



Figure 2.2 Schematic representation of the relationships between the independent and dependent variable.

2.3 Critique of the existing literature

Existing literature on RWH projects are so diverse and at some point give conflicting views in some topics, one such example is on adoption progress. Ngigi, (2003) says that it's encouraging that governments in GHA are starting to identify RWH as a viable technology for alleviating persistent food insecurity and water scarcity in the region and hence gaining popularity, however, a study by AfDB (2006) surprisingly found out that, although, the policies are being developed and formulated with recognition of RWH as an element, there is still in the administration, among technical staff both centrally and locally in ministries and local authorities a sentiment that RWH technique is technically backward and really belonging to the initiative of NGOs and private households.

There is no universal view on the biophysical environments suitable for the implementation of such projects; whereas some studies alludes that such projects are intended for Arid and Semi arid regions some however indicates that they are meant for all agro-ecological zones. Boers and Ben-Asher (1982) defines rainwater harvesting as a method for inducing, collecting, storing and conserving local surface runoff for agriculture in arid and semi-arid regions. UNEP (2006) on the other hand, defines RWH as a technology that is flexible and adaptable to a very wide variety of conditions, being used in the richest and the poorest societies on our planet, and in the wettest and the driest regions of the world. This contradiction may have contributed to the perception that RWH is a practice for Arid and semi arid lands (ASAL), hence its slow pace of adoption across different agro-ecological zones.

There is still some contradiction on the contribution of RWH projects on health. RWH projects are touted to contribute significantly on improvement of household health as confirmed by some studies citing improved health of the population through better drinking water quality generated by provision of harvested rainwater. However, some studies point out some of the negative effects associated to them. The concern is that the rush to develop water harvesting projects and storage for climate change adaptation may increase the risk for already vulnerable people, in some cases more than cancelling out the benefits of greater water availability (Boelee, 2012).

This is evident on studies of schistosomiasis in Burkina Faso and malaria in Ethiopia associated with rainwater harvesting and water storage projects.

3.1 Research design

This study utilizes ex-post impact evaluation model as cited by World Bank (2004) which makes it possible to deduce effects on those who have adopted the projects against those who have not. A mix of quantitative and qualitative approaches is ideal because it provides the quantifiable impacts of the intervention as well as an explanation of the processes and

relationships that yielded such outcomes (Shiferaw et.al, 2005). This integration helps to increase the validity and reliability of impact assessment by describing rural conditions and the effects of rainwater harvesting projects as holistically as possible within the scope of this study.

The research study was conducted in Thika East Sub-county-Kiambu, Kenya. The sub-county has been plagued before with annual droughts that has subjected the residence to water deprivation. Out of the 20,441 households in the sub-county, the proportion of those who have benefited from RWH projects against those who haven't is not known. This study considered 140 respondents from the population. The sample size was then stratified into two equal groups of 70 respondents each. This required purposive sampling technique to acquire respondents of required characteristic in each group; those who have access to RWH projects and those who don't.

Data collection was by way of a survey conducted in households within Thika East. The instruments employed included; Questionnaires, observation, household interviews and key informant interviews.

4.0 RESULTS AND DISCUSSION

4.1 Response rate

Prior to the sampling design and techniques discussed in Chapter Three, a total of 140 respondents were targeted in the study, however, 4 questionnaires didn't meet the standards for analysis and were discarded. The remaining 136 were subjected to analysis, this represents 97.14% response rate.

4.4.2 Effects of RWH Projects on Crop yields

Field observations show contrasting effects of heavy rainfall in the region, whereas some harvest and store water for use, others leave it to flow as runoff causing damages on farm structures and crops. Figure 4.3 is a clear depiction on this. The picture shows macadamia crops destroyed by floods during a heavy rainfall (un-harvested rainwater) and adjacent picture of a dam with stored water for dry season use (Harvested rainwater).



Figure 4.1 A contrast on un-harvested rain water (flooding) and harvested rain water (Dam)

From the research results, most households derived their food from own farms 72.46% and 65.67% with others buying from the local markets 24.64% and 26.87% and surprisingly some rely on aids and donations from different organs 2.90% and 7.46% for 'beneficiary' and 'non-beneficiary' groups respectively (Table 4.2). Those interviewed and admitted to rely on aids and donations revealed that the aids and donations came from the churches, community and some times from the government under relief food programme.

Table 4.1 Source of Food in the Household

Food source	Beneficiaries	Non-Beneficiaries
	Frequency (%)	Frequency (%)
Own farm	72.46	65.67
Market	24.64	26.87
Aid/Donation	2.90	7.46
Total	100	100

Questions were posed to the respondents to help understand whether there were any significant differences on the number of crop seasons per year on the beneficiaries against the non-beneficiaries. The main food crops grown by households are maize and beans and coincidentally the two formed the main staple food for the households. The respondents indicated that 61.45% and 67.81% manage one season annually, 38.55% and 32.19% twice for beneficiaries and non beneficiaries respectively. No group managed three seasons, Table 4.3.

Table 4.2 Seasons of Main Food Crop per Year

Seasons	Beneficiaries	Non-Beneficiaries
	%Frequency	%Frequency
Once	61.45	67.81

Twice	38.55	32.19
Thrice	0.00	0.00
Total	100	100

The researcher investigated further the main determinants influencing crop seasons in the district; the majority felt it was the availability of rains with such high responses of 95.65% and 98.51 % for beneficiaries and non beneficiaries respectively. Others still felt it was partly because of availability of inputs 47.83% and 49.25% and still others felt it was because of the availability of family labour and would confessed preferring to do planting during school holidays, 42.03% and 46.27% in that order (Table 4.4).

Table 4.3 Determinants of the Number of Crop Seasons per Year

Determinant	Beneficiaries	Non-Beneficiaries
	Frequency (%)	Frequency (%)
Rains	95.65	98.51
Inputs	47.83	49.25
Family labour	42.03	46.27

From the variety of crops grown by the sampled population, the researcher selected four of the most preferred crops in the households and the annual output of each. From maize and bananas there were no significant differences on average household production between beneficiaries and non-beneficiaries, 1.29% and 1.19% respectively. Whereas from beans and cabbages there were significant differences of 50.67% and 61.00% on the two categories of households, (Table 4.5).

Table 4.4 Annual crop yields per household

Average Annual Crop yields/household	Beneficiaries		Non-Beneficiaries		% Difference
	Annual production (Kgs/acre)	Annual production (Kgs/acre)	Annual production (Kgs/acre)	Annual production (Kgs/acre)	
Maize	549	542	542	542	1.29
Bananas	3050	3014	3014	3014	1.19
Beans	678	678	450	450	50.67
Cabbages	7245	7245	4500	4500	61.00

Discussion

Most residents of Thika East Sub-county depend on their own farm for food production, Table 4.2. The food production is a factor influenced by different variables, of particular importance is the number of crop seasons annually and crop production per season. In Table 4.3, it was found out that majority of residents, 61.45% and 67.81%, managed only one crop season

annually, 38.55% and 32.19% managed two seasons while none managed thrice for beneficiary and non-beneficiary households respectively. The researcher was interested to know the factors that influence crop seasons, majority of households indicated rains as the main determinant, 95.65% and 98.51 for beneficiaries and non-beneficiaries. Availing water through RWH projects would increase the number of crop seasons annually and in turn increase annual production per household.

There was an enormous significance on the influence of RWH projects on garden crops (beans and cabbages) where the beneficiaries had greater output from the crops than non-beneficiaries due to the availability of water, Table 4.5. As a result, the RWH beneficiaries were found to have more stable food inflow than the non-beneficiaries which is attributed to the availability of water from RWH projects. This in turn sets apart the two groups on food security status. However, there was no significant difference on the output from field crops (maize and bananas) on the two categories of households, probably because those who utilize RWH projects haven't extended the harvested water to the crop fields as irrigation measures. Most residents; 97.06% of the sampled households have rainfall as the main determinant on their crop seasonality, Table 4.4. This demonstrates how rainfall thwarts the region's crop production and thus unequivocally the main limiting factor. A supply of water through RWH projects can increase the seasons to 3 for short season crops which in turn have multiplier effect on the output and consequently the household income.

Drought was established as the main hindrance to stable food production within households which was found to be caused by inadequate total rainfall, erratic rainfall distribution, long dry spells and delayed onset and/or early cessation of rains. This calls for an in-depth exploration on alternative water sources to alleviate the imminent crisis and hence RWH is a strategic and viable alternative.

The findings concurred with that of Hatibu *et al*, 2006, who deduced that; water shortages have profound consequences on small-holder farmer welfare, and are a major obstacle to reducing poverty levels. Takele, (2006) also buttressed the findings in concluding that the use of stored rainwater could supplement natural rainfall and make farming families less vulnerable to drought and therefore less dependent on outside help in harder times. Some empirical studies further suggest that irrigation has shown some positive impacts in increasing agricultural productivity and thereby increase the income of farm households, who participate in the irrigation schemes (FAO, 1993).

In Thika East, it was clear the beneficiaries who utilized on kitchen gardens had embraced diversification of garden crops and would have more crop output than their counterparts.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

This presents the summary of the findings of the study with key highlights on the effects of RWH projects on crop yields within households both in terms of seasons and production per season, conclusions drawn from the research work and recommendations made.

5.1.1 Effects of RWH Projects on Crop yields

The adoption of RWH projects continues to gain and may eventually appear in every household within the sub-county. In the eyes of the majority households, harvesting, storing and reusing rainwater not only cuts down on utility bills and saves on treated unreliable municipal water for drinking and for domestic chores but it also helps reduce storm water runoff into farms cutting down on pollution and erosion. Thus households and farm owners

that utilize RWH projects contribute to the conservation of local resources in a cost-effective approach as they get water for both household chores and domestic enterprises like livestock keeping and kitchen gardens.

RWH projects have combined multiple benefits of water reuse, runoff reduction and groundwater recharge which have tremendous effects on environmental conservation.

Recently, environmental conservationists have appealed for alternative means of attaining water supply in both rural and urban regions of the economies including suggesting adoption of rain water harvesting projects. There is growing recognition of the economic value of water with some households making capital investment on such projects and further distributing water to the livestock sheds and kitchen gardens. This is expected to be extended in future to the farms for irrigation purposes.

Water has been recognized as having both social and economic value and is a major catalyst for economic growth and wealth creation. Some researchers have argued that achieving the MDG target on "safe water and adequate sanitation" will take Kenya closer to achieving other MDG targets on gender equity and reduced poverty. Time and energies saved from fetching water especially by rural women is channelled to other economic activities. Further studies have shown that where gender concerns are mainstreamed in water and sanitation, there is generally improved level of service.

Additionally, provision of safe water and adequate sanitation is known to reduce water borne diseases and improve child attendance in schools and hence contributing to meeting partially if not wholly on achieving the second MDG of achieving universal primary education.

5.4 Conclusion

RWH projects are long term investments that demonstrate how effectively water and money can be conserved through out the year. Water continues to be the most important resource and rainwater harvesting is the perfect solution to aid in the conservation of potable drinking water and for other household activities. Rainwater management can productively utilize the direct rain and the runoff, which are currently underutilized and left to cause land erosion, displacement and demolition of infrastructure in the downstream.

The Thika East experience shows that despite apparent benefits, implementing rainwater harvesting projects has not been fully utilized. Along with the tangible benefits, the non-tangible benefits contribute to the overall reward of using the RWH projects. Coping strategies by non beneficiaries of RWH projects include travelling farther to fetch water, collecting water of worse quality from dry riverbeds, buying drinking water from vendors and consuming less water.

The beneficiaries of such projects testified that water quality had improved which in turn has led to an increase in water consumption as the water use expands to cover not just household chores but also for sustaining livestock and in some situation supporting household gardening. The same scenario has been seen in Botswana, where rainwater harvesting systems have nearly doubled household consumption of water (Gould, 1995).

Harvested rain water is not commonly used for irrigation among households rather the majority rely on rainfall in their farming enterprises. There are few cases where well established households have extended piping and hosepipes to the kitchen gardens and livestock sheds, which showed demonstrable good returns on investment. These are strong indicators that the implementation of RWH projects for irrigation purposes proves to be a valuable practice that should be implemented in Thika East.

It was evident that rainwater harvesting projects have the potential to buffer droughts and are relatively reliable as long as they have sufficient capacity and are properly maintained.

Current scenarios indicated that the beneficiary households would most likely return to the coping strategies if the projects fail to ensure water supplies during a dry spell.

This study concluded that though RWH projects may not satisfy the minimum demand requirement through all days of the year, it is more than able to provide an alternative water supply for the domestic household in periods of long dry spells or when primary water sources are inadequate. The few households who had big storage capacities and are thought to have invested heavily on those projects could boast of survival over long dry spells, manifesting the success stories on such projects. Thika East is a perfect example of water stressed region with a potential of revitalizing development through the adoption of RWH projects.

5.5 Recommendations

To abate problems caused by natural rainfall variations RWH projects must be constructed so as to retain water over such lengths of time as to keep households with a constant water supply. An assessment is necessary on rainfall pattern, amounts and the capacity required satisfying households in order to have reliable water harvesting projects either per household or on shared community basis.

Better still, infrastructure should be developed to escalate the RWH projects beyond meeting domestic water requirements to other more paying ventures like irrigation and other economically rewarding enterprises that improve human welfare.

The capacity and distribution efficiency of harvested rain water should be scaled up in conserving potable water, reducing irrigation costs and reducing the amount of runoff. A policy on the implementation of RWH projects should be brought in place to guide the project planning, initiation, implementation, and most importantly sustainability of such projects. This calls for the central government, counties as units of devolved government and other water support-stakeholders to champion the exploration of meeting water shortages by up scaling RWH projects.

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