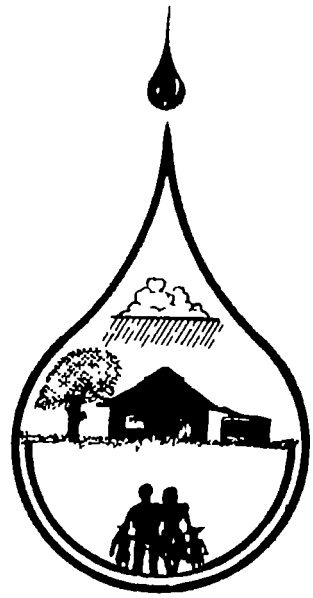
RAIN WATER HARVESTING IN KENYA

Social Economic Issues

Research Report



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It is with pleasure that we extend our thanks to the Swedish International Development Agency for providing the financial support for this study. Special thanks goes to Dr. Wamani for his contribution in the preparation of the research proposal.

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LIST OF ACRONYMS

ESA	External Support Agency
AEZ	Agro-ecological zones
ASAL	Arid and Semi-arid lands
ITCZ	Inter-tropical Convergence Zone
SIDA	Swedish International Development Agency
UNICEF	United Nations Children's Fund
IDRC	International Development Research Centre
CIDA	Canadian International Development Agency
GTZ	Gesellschft Fur Technische Zusamernarbeit
DANIDA	Danish Development Agency
FINIDA	Finland Development Agency
WB/UNDP	World Bank/ United Nations Development Programme
NGO	Non-Governmental Organizations
KENGO	Kenya Energy Non-Governmental Organisation
MCM	Million Cubic Meters
CSD	Child survival Development
DHMT	District Health Management Team
GRDP	Gross Regional Domestic Product

FORWARD

This report stems from the common recognition by development agencies in Kenya and particularly in water sector that an assessment of how widespread rainwater harvesting is in Kenya would be useful information to planners and water engineers.

Therefore the purpose of this study is to assess how wide spread Rain Water Harvesting practice is. And also make conclusions and recommendations which would facilitate co-ordination and integration of Rain Water Utilization into social economic development.

The technologies discussed in this report should not be seen as substitutes to the conventional systems but rather as supplement to the standard large-scale water supply and management methods.

In order to obtain facts about how widespread RWH is in Kenya and the related socio-economic issues, this study was designed:

(a) To hold discussions and to review documents of various GOK, NGO and donor communities regarding this subject.

(b) To administer standard questionnaires to two selected locations in Kenya. The locations were selected to represent small scale farmers living as subsistence farmers in small land holding and the other one was selected to represent pastoralist living on herding in group ranch land tenure system.

Roda pwani area of Nakuru District represented subsistence farmers as the Mukogodo Division of Laikipia District represented pastoralist lifestyle.

The research methodology was designed to collect facts and information on various actors and communities in Kenya as base for testing the hypothesis that Rainwater Harvesting practice is widespread in Kenya.

John Mbugua
The Principal Investigator

EXECUTIVE SUMMARY

Kenya's population in 1992 was estimated at about 24 million and is growing at the rate of 3.6% per annum. The growth rate is one of the fastest in the world. In Kenya, this population is influencing prospects for economic growth and the living standards of its people.

Water is an essential ingredient in virtually every human endeavor. For example, it is important in achieving food security, producing the material goods that raise living standards and preserving the integrity of natural systems upon which life itself depends.

Dependable water supplies continue to diminish and therefore feeding growing populations, sustaining economic progress and improving living standards will depend on using existing water supplies more efficiently, and using rainwater to supplement the conventional systems will be a logical option.

There is a growing competition for limited water sources, heightened environmental awareness and costly capital. Therefore new water policies and strategies are needed. Continuing to bank on new large water projects and failing to take steps towards a water efficient economy is risky.

This study revealed that RWH was particularly useful in the following circumstances:

1. Where other sources are too distant or costly or where wells are impractical because of geology or costs.

2. Where other sources provided unsafe drinking water e.g. polluted rivers and other unprotected sources.

3. Where water supply schemes provided unreliable services due to a number of causes for example, poor maintenance, organisation, operations and management or where the demand exceeded supply.

The study also revealed that rainwater harvesting (utilization) is well suited to supplying water to small scattered villages, schools, livestock and even wildlife.

However rainwater harvesting technologies usually have initially high capital costs. This is because the storage, catchment and sometimes treatment structures are expensive. In order to facilitate RWH projects several approaches were identified during this study.

(a) Subsidy by external support agency.

(b) Rural credit scheme designed to suit the target groups' social economic constraints.

(c) Social mobilization campaign to promote more awareness in order to foster more contribution by beneficiaries to the RWH project.

(d) Choice of technology is such that the option selected demand management skills materials and financial resources locally available.

Decision makers at the national level, district levels and those leading various projects are engineers, schooled through national and international universities which pursued conventional systems of water supply. Low-cost and simple solutions are not often recognised as providing equally reliable and dependable solutions.

This is because these engineers are not sufficiently familiar with the choices, available to them or are not as yet convinced of the economic or financial impact these technologies have in alleviating poverty and improving the health and well being of the poor.

Conclusion

The study has revealed that in spite of the limited official government recognition and support, rainwater harvesting is practiced extensively in Kenya. It is practiced at individual and even institutional levels. Technologies vary in complexity and cost and there is no standard approach or standard designs.

The technology has however received support from NGOs who have attracted funding from bilateral and multilateral agencies operating in Kenya. Government support is limited but the Ministry of Health, environmental health division and soil and water conservation section of the Ministry of Agriculture have supported rainwater for drinking and runoff control and management respectively. Both programmes are funded by SIDA.

Other related social economic issues identified during this study are discussed in this report under the headings, policy, technology, sustainability and poverty.

Recommendation

1. Rainwater harvesting (utilization) should be based on delivering sustainable services to the communities particularly the scattered and poor communities that live in fragile environments and resource poor areas of the ASAL. It should be noted however that sustaining services to this often neglected and isolated group is difficult and success will only be possible with a long term commitment to a broad framework for sector development in which financial, institutional and other non-technological issues play an important role.

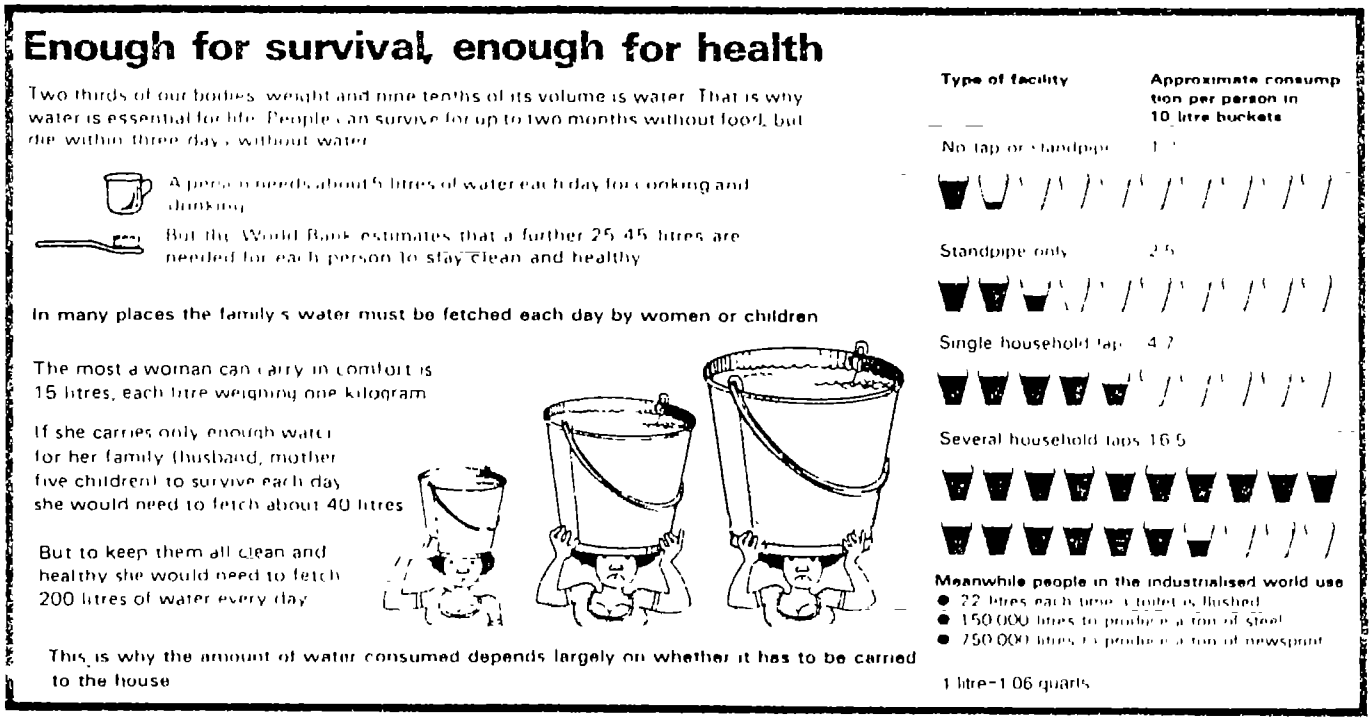


Fig. 1. A woman's role as transporter is linked to her role as the primary provider of the household basic needs of food, water and fuel.

2. Both ground and surface water resources have their origin from the rainfall. These resources represent only a small percentage of the original evaporation and transpiration losses that take place. Rain water harvesting and utilization therefore provides an approach that uses water before excessive pollution and losses takes place.

3. Cisterns are structures built to store considerable amount of water. Thus from the viewpoint of public safety a new building code regulations should be included for cistern structures and for covers to prevent accidents in the cistern.

4. Cisterns should be part of housing projects just as solar heaters are being installed as part of housing project (e.g. BuruBuru in Nairobi) to conserve energy, rainwater harvesting, water conservation and water reuse should also be considered as important factors in housing development.

5. Some countries are using water conservation tax credits. Kenya could consider such steps whereby consumers will use water most economically and promote rainwater as a supplementally source.

1. INTRODUCTION AND BACKGROUND INFORMATION

1.1. Location

The republic of Kenya is located within the eastern side of the African continent. It is bordered on the Southeast by the Indian Ocean. It shares international boundaries with former East African community neighbors, the republic of Uganda in the west, the united republic of Tanzania in the south and is also bordered by Ethiopia in the North, republic of Sudan in the Northwest and republic of Somalia in the east.

Kenya covers an area of about 592,000 km^2 with water surface of some 11,230 km^2 (2%).

Kenya is divided into 8 provinces and forty-one (41) districts units for administrative purposes.

The latitudinal location of Kenya is along the equator. Kenya has a varying surface configuration ranging from sea level to heights over 5,500 m above sea level. This combination creates a physical environment that varies from almost equatorial characteristics to polarial one in the highlands. (see Fig.2)

1.2. Climate

Rainwater is dependent upon availability of rainfall which in turn depends on climate.

In Kenya, the main factors which control the climate are latitude, altitude, topography, character of prevailing winds and the distance from the sea or from any sizeable water body. The pressure belts are also important.

Kenya strides across the equator and has a geographical diversity. The climate conditions are controlled therefore by its location and the wind system of Inter-Tropical Convergence Zone (ITCZ).
Kenya is dominated particularly by the following three (3) distinct air masses.

1. From about April until about August the southeast monsoon persists more or less with the same consistency. The monsoon brings the source of the main rains in Kenya from the Indian Ocean.

2. From July to October, the Congo airstream brings unstable and convectional storms and dominates the western parts of Kenya.

3. During the months from November to March very dry winds from the Sahara desert which is called the harmattan dominate the western part of the country. In the eastern

parts of the country the Northeast brings some rains to the coastal lands.

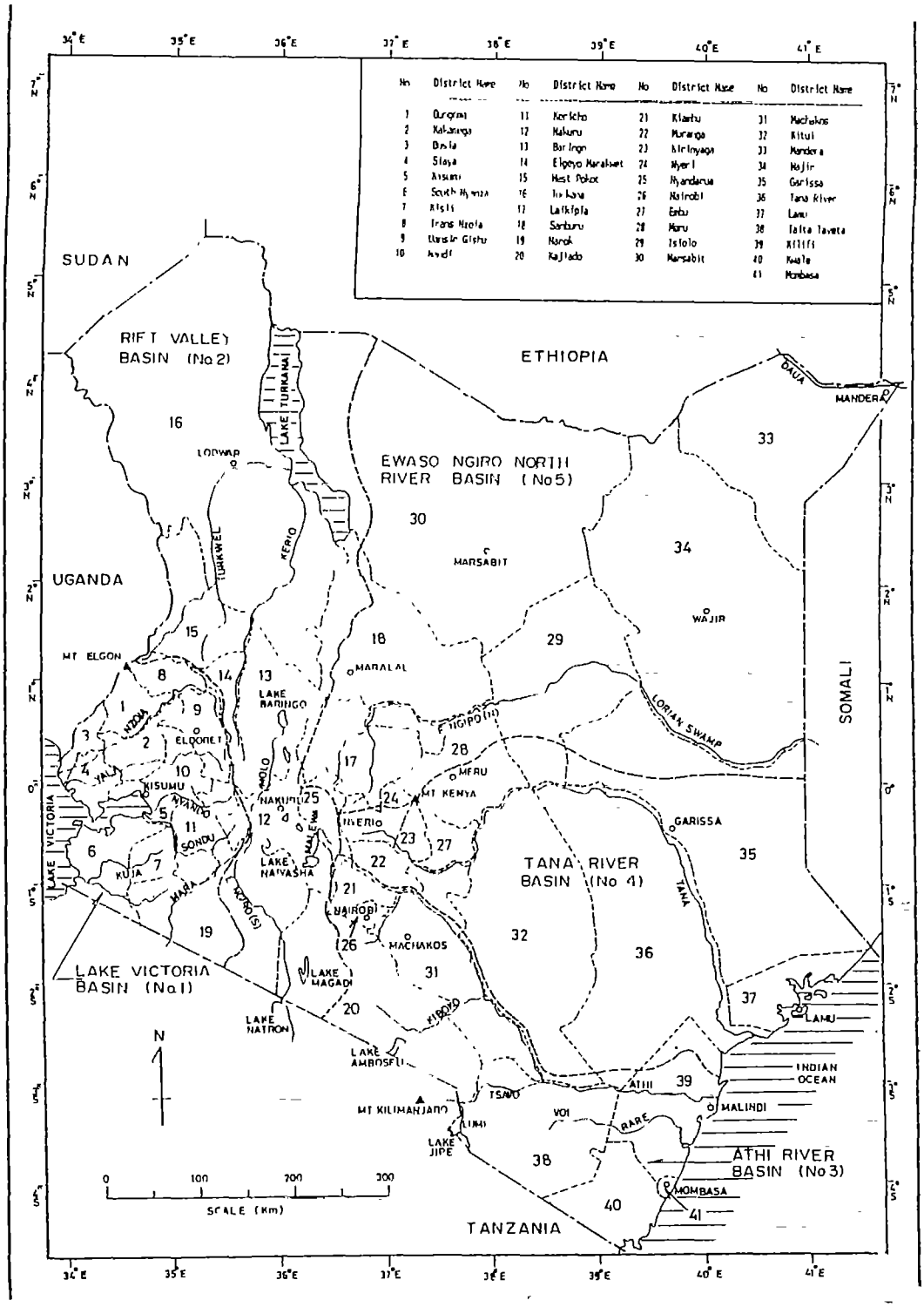


Fig. 2. The major river basins of Kenya and principal rivers.

In western and central parts of the country especially in Lake Victoria basin, there is no distinct dry season but with double maximum on April and August. The coastal areas shows a remarkable single maximum in May. The annual mean rainfall was estimated at 621 mm in Kenya. See Fig. 3 and 4.

1.3. Geology

Water availability and water quality depend on the geology and geography of the area. And therefore because use and promotion of rainwater is influenced by availability of other alternatives like groundwater, geology become of interest to rainwater promoters.

1.4. Vegetation and surface cover

The range of climatic conditions is reflected in six (6) ecological zones.

1. The alpine moorlands and grassland zone at high altitude above forest line.

2. The humid to dry sub-humid climate belt suitable for forestry and intensive agriculture.

3. The humid to dry sub-humid climate belt suitable for agriculture, where soils and topography permit.

4. The semi-arid zone (rangelands with marginal agricultural potential and potentially productive land).

5. The arid zone (rangelands of low potential with a very dry form of bushed grassland).

The arid and semi-arid lands (ASAL) areas cover 83% of the land areas of Kenya. These areas are distributed among 22 districts. The ASAL occupy 439,000 km^2. The lands support 3-4 million people 15-20% of the Kenyan population and approximately 50% of the national livestock herd. These area contributes 3% to the annual agricultural output and 7% to commercial production. A major portion of the nations wildlife resources also occur in ASAL Districts. This study out of 21 Districts visited only 5 are outside ASAL classification.

1.5. Population

Kenya's population in 1992 was estimated at about 23.7 million and is growing at the rate of 3.6% persons per annum.

In Kenya, there are on average 28 persons per square kilometre. Though about 80% of the population live in areas totalling about 20% of the land mass. Kenya's population is concentrated around three clusters. Along Indian Ocean around Lake Victoria and in areas extending from Nairobi, north of Mt. Kenya and northeast to the Nyambene Hills. In these areas rural densities vary from 100-200 persons per square kilometre.

Age and gender structure

59% of Kenyans are less than 20 years of age. By contrast, the most productive group of the population, those aged 20 to 50 years constitute only 36% of the population according to situational analysis GOK/UNICEF 1992. While 18% of the population are children under 5 (3.8 million) while 20% (4.3 million) are women of child bearing age (15 - 49 years old).

The rate of population growth influences development trends and is a key factor in Kenya. It influences country's prospects for economic growth and the living standards of its people. Rapid population growth has the following implications to development today in Kenya.

(a) More food is needed.

(b) More jobs.

(c) More education facilities.

(d) Expanded public services.

It is therefore inevitable that Kenya must pursue population policies which ensure a balance between population growth and socio-economic development.

1.6. Scope of this study

The study deals with the most aspects of rainwater harvesting and rainwater utilization for various socio-economic development. However the study is confined to micro-catchment scale of roof catchment, artificial catchments and land surfaces of about 200 m long slopes. The large scale macro-catchment of river basins is however not covered.

Quality aspects of water is however not covered although the rainwater schemes in the field were evaluated against adequacy and reliability, quality of water collected, quantity and ownership of the facilities.

Engineering of the building materials was not analysed although performance was of interest to the team. Finally structural analysis was not done but once again structural performance was of interest to the study team.

1.7. Significance of the study

The study was to cover the socio-economic issues of rainwater harvesting in Kenya. Methodology was so designed to visit and evaluate facts and information on various actors and communities in Kenya as basis for testing the hypothesis that Rainwater harvesting practices are widespread in Kenya.

In addition, the study was expected to reveal socio-economic issues that affect the spread of this technologies. From various

conclusions and recommendations, it will be possible to suggest strategies most suitable to be adopted by government for future policy guidelines, donor communities and other NGOs who are active in this area.

2. DATA COLLECTION

2.1. Target population and sample selection

Three main line Ministries, involved in water were visited i.e. Ministry of Water, Agriculture and health. Bilateral and Multilateral agencies visited included SIDA, UNICEF, IDRC, CIDA, GTZ, DANIDA, FINIDA and WB/UNDP projects.

Several NGOs visited during the study included religious NGOs, local and International NGOs such as AMREF, KENGO and ACTION-AID. The above actors gave useful information about their interest and levels of funding of rainwater harvesting projects. However in order to collect facts about socio-economic and cultural issues two groups were selected.

1. Group one was selected to represent smallholder subsistence farmers with individual holding tenure system. This was Roda Pwani of Nakuru District.

2. Group two was selected to represent pastoralist herders with group ranching holding tenure system. This was Mukogodo location of Laikipia District.

2.2. Collection of data

In order to collect data for this study survey method was chosen due to its wide applicability as a data collection method in social sciences. Secondly the method has the advantage in that, it requires a relatively short time and is inexpensive (36). The survey comprises of an administration of a structured interview to proportions of members of the selected groups as well as the external support agencies operational in the area. These proportions depended on the size of the respective group. The role of the members in the group and the organisation structure of the group activity.

2.2.1. Data collection instruments

The research instruments were developed in consultation with the technical experts of the external support agency operational in the area of study. There were four interview schedules that were administered.

1. General interview schedules for families with rainwater tanks (socio-economic issues).

2. Interview with community group leaders.

3. Interview on Rainwater technologies with group leaders and ESA staff in the areas of catchment collection and storage water tank, altitude and awareness.

4. Interview on socio-cultural issues with groups.

5. Interview with water technicians in the field.

2.2.2. Data collection procedure

The researcher with the help of research assistants carried out the interview throughout the area of study. The responses from the questions were recorded for further analyses. To ensure the availability of the required respondents, letters were sent to the respective chiefs of the area, spelling out the time of the visit and who would be seen.

3. DATA ANALYSIS

3.1. Water Resources in Kenya

Four major river catchment (Rift Valley, Tana, Athi and Ewaso Ngiro North) convey surface water to the ASAL areas. These rivers rise in the central highlands and are subjected to wide seasonal and inter-annual variations in discharge and silt content as cultivation and deforestation increases in the upper reaches. A large majority of ASAL water courses are ephemeral, existing only briefly after rainfall and do not provide a reliable source of supply unless trapped in either natural or artificial pans or dams or diverted to storage tanks (58).

Information on groundwater resources in 83% of Kenya (ie. ASAL regions) is limited. What is clear is that water drawn from shallow wells varies greatly in both quantity and quality from place to place and between seasons and years. These sources are less reliable as they depend on the vagaries of rainfall and river flood regimes.

The principal hope for improving the water supply to the ASAL areas is through water harvesting conservation and saving. However techniques that are simple, low cost and effective must be distributed through extension to the wider area of the country especially semi-arid lands.

It is therefore extremely essential to understand the areas rainfall pattern distribution and intensity. This information will help planners and engineers to develop structures that are suited to the occurrence and circulation of the rainfall. For example this information will help to propose the optimum catchment and storage needed to meet water needs for a family in a given dry spell.

Figure 3 shows variations of monthly rainfall while Figure 4 shows variation of monthly rainfall at representative rainfall gauging stations in Kenya. These two figures produced from the study documents of the National Water Master Plan by JICA 1992 give very useful details which would help planners and engineers in developing rainwater harvesting programmes.

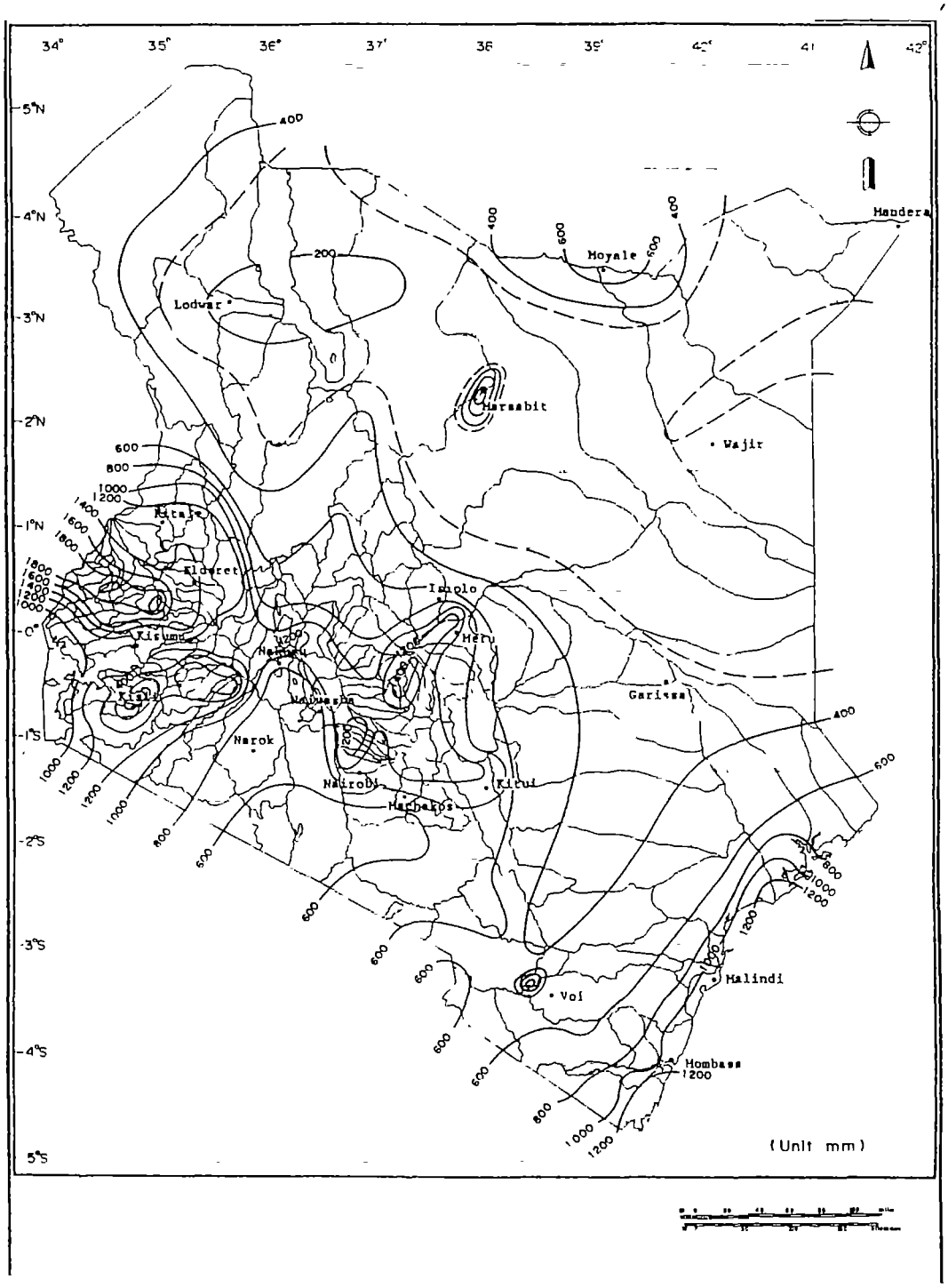


Fig. 3. Annual rainfall depth

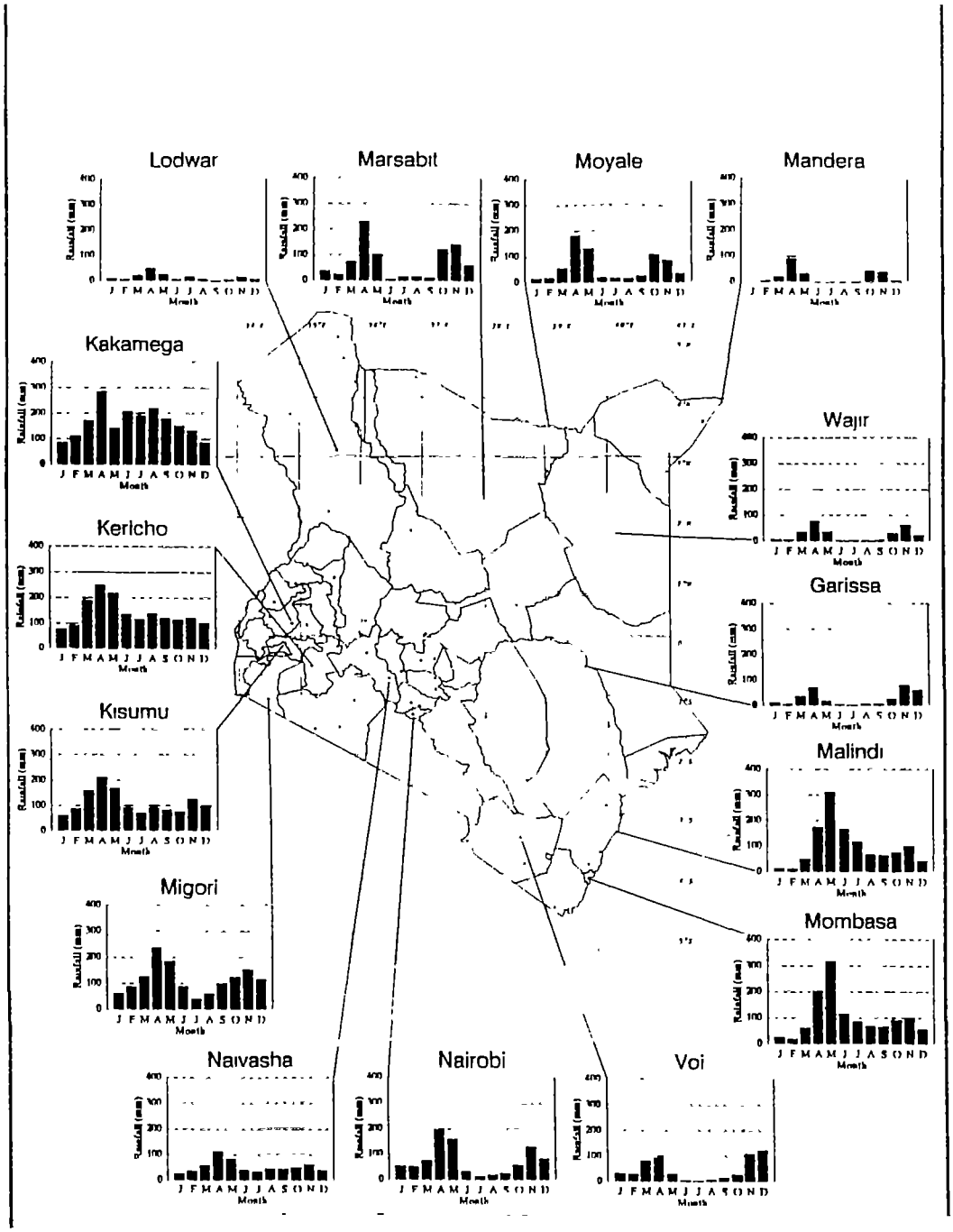


Fig. 4. Variation of monthly rainfall depth at representative rainfall gauging stations.3.2. The broad rainfall regions of Kenya

1. **The Indian Ocean coastal region**

Here January to March is usually dry with the long rains falling between the end of March to May, rainfall decreases from June to August. Short rains occurs in October and November late December through to late February are generally dry and hot.

2. **The east, northeast, southeast and central region**

Two distinct rainy seasons occur in this region from March to May (long-rains) and from October to December (short rains). June to September are generally dry months. The short rains often fail but also frequently contain the most intense rainfall.

3. **The western Rift Valley and Lake Victoria basin region**

These region effectively has no dry season. Rainfall is usually generally higher from March to September but some rain falls throughout the year especially in the highlands. At lower attitudes April and May tend to be the wettest months.

Design of rainwater harvesting (utilization) will therefore vary with regions and depend on rainfall occurrence distribution etc.

Details of distribution of rainfall in Kenya is as shown in Table 1.

Table 1.

Mean annual rainfall (mm)	Land area km^2	% total
> 1000	64,070	11.2
800 - 1000	32,960	5.8
700 - 800	24,260	4.3
500 - 700	73,140	12.8
300 - 500	270,410	47.4
< 300	105,730	18.4

Source: IGADD (1990)

The above table indicates that over 2/3 of the country receives less than 500 mm of rain per year and 79% has less than 700 mm annually. Only 11% of the country has more than 1000 mm per year.

When evaporation factor is added to the above scarce rainfall, then it becomes obvious that Kenya's future will depend on wise planning. Such planning will put to the maximum use of little rainfall, by controlling runoff and evaporation, practicing more water saving and conservation.

Mean evaporation from free water surfaces in Kenya ranges from 1250-3120 mm per annum. Mean monthly figure range from 85 - 260 mm. Few areas in Kenya have evaporation rates below 100 mm/ month. It is therefore extremely important that the limited water resources are carefully planned as a finite resource with economic value that is critical to socio-economic progress.

In order to appreciate need for change of altitude among the water sector planners and engineers, the national water demand for various water needs urban, rural, industry, livestock and irrigation is given below.

3.3. **Water demand in Kenya**

As projected in the water master plan study (JICA, 1992),but first
a socio-economic conditions in Kenya.

Table 2.

Item	1990	2000	2010
Population (thousand)			
Revised projection	22,749	30,712	40,305
Urban	3,965	7,933	12,698
Rural	18,784	22,779	27,607
GDP at 1989 constant prices			
Total amount (US$ million)	7188	12,807	18,922
per capita US$	341	450	507

Source: National Water Master Plan (JICA 1992)

Table 3.

Projection of water requirement			
Item	1990	2000	2010
a. Domestic & industrial water x $100m^3$/day			
Urban	537	1169	1906
Rural	532	749	1162
Industry	219	378	494
Per capita (L/day)	58	75	88
b. Irrigation x 1000 m^3/day	1448	-	4254
c. Livestock x 1000 m^3/day	326	427	621
Total including wild life and fisheries	3144	-	8434
mcm/year	1148	-	3096

Source: National Water Master Plan (JICA 1992)

3.4. Potential water sources

Table 4.

(a) Surface water	19,590 mcm	Including all perennial rivers
(b) Groundwater Total	619 mcm	
Boreholes	193 mcm	
Shallow wells	426 mcm	
Total	20,209 mcm	

By the year 2010 water demand will be only 15%of water potential.
Source: National Water Master Plan JICA (1992)

Rainwater Contribution to Rural Water Supply

Of the entire rural centres of respective locations, the major rural centres will be covered by a piped grid water supply system and the other rural centres by a point supply system. However some rural centres cannot help being supplied by rainwater harvesting facility such as roof catchment rock catchment according to water master plan (JICA 1992) See table below.

Table 5

3.5. **Rural water supply**

Source Development	Water exploitation m^3/day	%	No. of facilities
Surface water	669,399	57.9	-
Bore hole	118,945	10.3	8,936 holes
Shallow well	115,618	10.0	33,513 holes
Roof catchment	133,806	11.6	3940,778 households
Small dam	39,698	3.4	665 No.
Sub-surface dam	2,123	0.2	396
Sand dam	1,896	0.2	365
Rock catchment	2,001	0.2	278
Existing pipeline	71,675	6.2	-

Source: National Water Master Plan (JICA 1992)

3.6. **Livestock water supply sources**

Water for livestock is proposed to be supplied from surface water, groundwater or rainwater harvesting. The water is provided at water source points in principle. Water exploitation by type of source is planned to be as summarized below.

Table 6.

Source development	Water exploitation m^3/day	%	No. of facilities
Surface water	231,091	42.0	-
Bore hole	143,085	26.0	4,253 holes
Shallow well	150,824	27.4	27,008
Small dam	14,435	2.6	688
Subsurface dam	3,414	0.6	512
Sand dam	4,194	0.8	595
Existing pipeline	2,962	0.6	-
Total	550,015	100%	

Source: National Water Master Plan (JICA 1992)

3.7. **Financial implication**

The total costs of water resources development are enumerated below. These development plans are established to meet basic human needs for domestic potable water and of livestock farming.

Table 7.

Development sector	US$ million	K million
1. Domestic/Industrial w/s		
(a) Urban water supply	5,644	8,185
(b) Rural water supply	5,520	8,003
TOTAL	11,164	16,188
2. Livestock Water Dev.		
(a) Source Dev.	628	911
(b) Provision of water points in nomadic, pasturage area (every 25km)	73	106

Source: National Water Master Plan. JICA 1992.

The above table which is taken from the recently launched National Water Master Plan (JICA, 1992) does indicate the economic burden provision of water will have on the already poor economy.

3.8. Background Information on Roda Pwani sample area

Location, climate and occupation

The Rhoda Pwani community is situated about 15km west of Nakuru town in Kenya. People were settled there in 1974. These smallholder are occupied in mixed farming on plots of 1 ha or less. Pwani is in agro-ecological zone (AEZ) receiving 700-850 mm rainfall annually. They grow maize (the preferred crop though not the most suitable). Maize crop fails once in every three years. Most people in Pwani Roda have livestock (usually one or two cows for milk). But as grazing land decreases due to food production, stock numbers are decreasing. Cash is derived from other sources which may include charcoal burning and sale of unskilled labor in nearby Nakuru town.

Development

In 1987 CPK Diocese of Nakuru initiated an integrated development programme. The community was involved through a participatory rural appraisal (PRA) also called Baseline survey. The survey identified 5 major problems but water was top priority. The other needs were, schools, health, food and roads.

Through a process of discussions and dialogue rainwater harvesting was identified as the best option as other options had been tried with only a limited success. Those options tried were a community dam and a bore hole.

Before CPK entry the source of water was a bore hole 4 km away and due to poor management it broke down most of the time. When the bore hole is out of order Pwani people travelled to town 15 km away. The other option was selling labor in exchange of water in a nearby farm and at the end of 6 hrs labor one would then earn 20 litres of water.

A local politician helped to have a bore hole drilled in Pwani but was not successful. However the politicians used the bore hole to influence votes during civic and parliamentary elections. This delaying tactics caused people of Pwani a lot of time and suffering.

After agreeing on rainwater option another process of selecting the best design, utilizing local skills, funding and materials was identified. The pwani tank is a square masonry tank 13 m^3. The area has many stone quarries and square shaped tank was found simple to construct.

A group of 72 was formed in 1988 and built 13m^3 at the rate of 2 per month. This was followed by many other groups and this area has over 60 groups with over two thousand (2000) tanks, 1992 December.

The area was identified and standard questionnaires were administered.

The areas covered about 500 km^2 with population as per 1989 projected at 1990 as 62,500 and 10,000 households. The area covers part of Njoro location and Mau Narok Lare and Kihingo. (see figure 5)

Roda Pwani Community spent their income as shown below.

Table 8.

Item-groups	% age to total expenditure
1. Food drink and tobacco	66.2
2. Clothing and footwear	3.6
3. Fuel, energy	10.5
4. Household and personal equipment and goods	8.2
5. Transport & communications	0.3
6. Health and medical care	4.4
7. Education	2.8
8. Recreation and other services	0.1
Total consumption expenditure	96.2
Non consumption expenditure	3.8
Total expenditure	100%

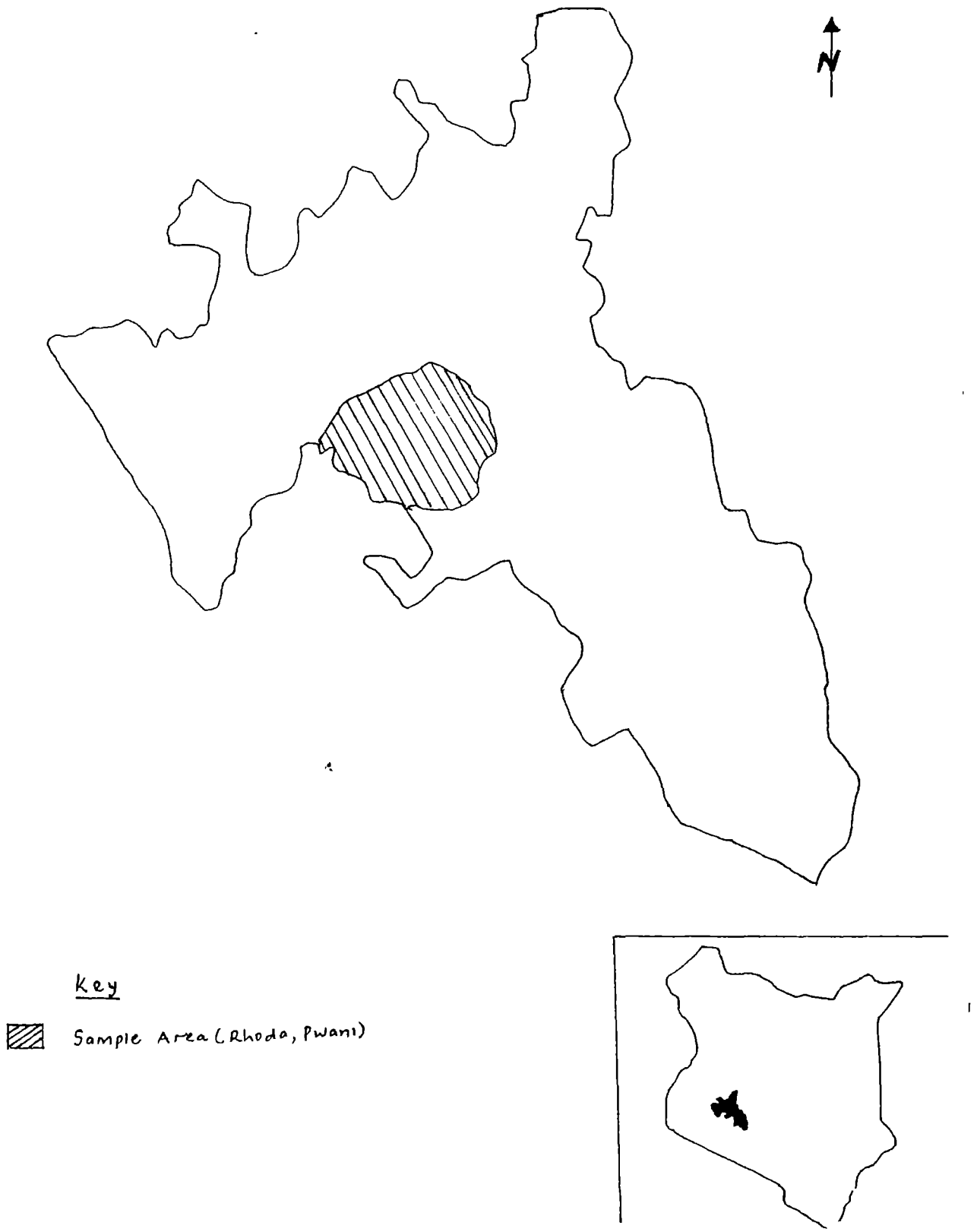


Fig. 5. A map of Nakuru District

(Source: The study of National Water Master Plan. Jan 1992, JICA) 3.9.

3.9. **Mukogodo Location**

Background information

Despite remoteness of Mukogodo Division, a literature review and visits to the area revealed the following.

- The division covers roughly 1,100 km2 in the northeastern edge of Laikipia District. Based on 1979 census its population was 14,000 although 1986 and 1984 droughts have seen a population decrease in this area.

- The division is administered from a small division centre in Doldol some 55km from the district capital Nanyuki.

- Other than two main shopping centres of Doldol and Kimanjo, only 5 other shops operated intermittently in this division, in 1988.

- Doldol is served by unreliable taxis (2-3 in no) and Public transport to other areas of Mukogodo is not available. Central Mukogodo is drained by Sinyai and Kipsing rivers. The main vegetation cover is a more or less open acacia savanna. In the west, it is less steep with gently undulating hills covered with acacia and open grasslands descending towards Ewaso Nyiro and Ndare rivers constituting its eastern and western boundaries. There are no perennial rivers in Mukogodo.

- Mukogodo, has mean annual rainfall which declines from southeast to northeast from 700 to 500 mm/year. Long rains occur from March to May and short rains October to November. It is convective in origin. Mukogodo Division lies outside the zone suitable for rain-fed crop production according to the zoning done within the Kenya AEZ system. Its crop production must be supported with additional water from sources other than surface waters.

Published information on the population, history and economy of Mukogodo is extremely limited, the major information being that contained in Herren's thesis for Doctor of Philosophy in Ethnology.

Mukogodo Division is one of the results of the Kenya land commission which proposed establishment of a native reserve in northern Laikipia. This reserve was created for a sizeable Maasai speaking population left behind on the Laikipia plateau after the northern Maasai had been deported from the area. in the ill-famed moves of 1914, to make room for white settlers.

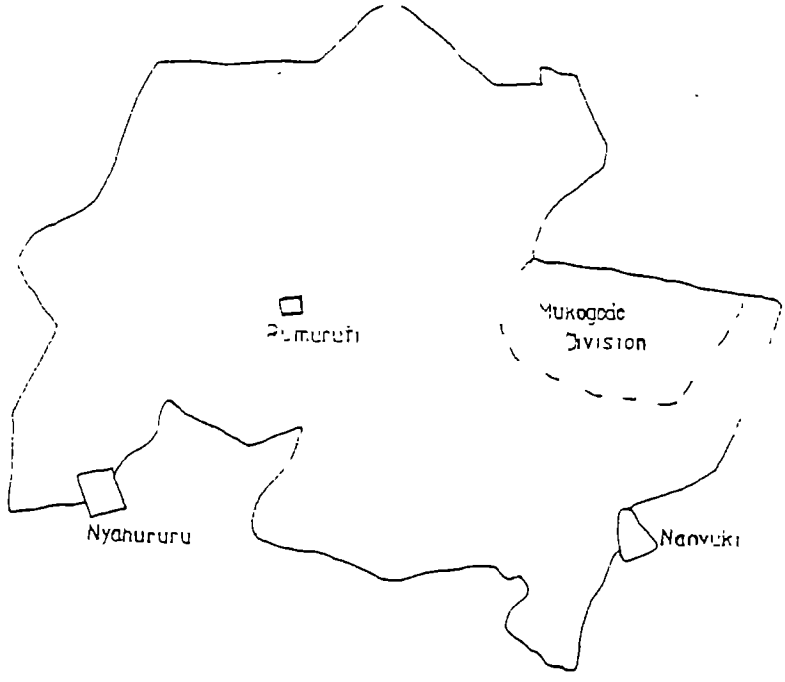


Fig 6: Location map for Mukogodo (source: Urs Herren)

3.10. **Asal regions**

By definition the ASALs are dry and hot with a rainfall to evapotranspiration ratio of less than 0.5 i.e. evaporation exceeds rainfall by at least a factor two (2). This is the key factor limiting vegetation growth and thereby agriculture, livestock and wildlife production in ASAL regions (59).

Rainfall expectancy in ASAL areas by Agro-ecological zone

Table 9.

Zone	Average rainfall mm/ year	50% probability		
		1st season	2nd season	% E^r_o
VII very dry	200 - 300	-	-	15
VI arid	300 - 500	100 - 200	50 - 150	15 - 25
V semi arid	550 - 700	150 - 300	150 - 300	25 - 40
IV semi humid	700 - 850	250 - 350	250 - 300	40 - 50

Source: IGADD (1990)

Despite the low rainfall in ASAL soil erosion and land degradation is a serious problem in some localities within ASAL Districts. Locally severe degradation is recognised as being particularly serious in west Pokot, Baringo and whole of North Eastern Province (59).

In these areas gully and sheet erosion and surface sealing are common. Severe rain induced erosion is also occurring on the hilly pastures in Machakos and Kitui. In general the worst soil conservation problems occur on sloping land in marginal rainfall areas where land use is intensive, i.e. especially in zone IV and around smallholder settlements schemes (Rhoda pwani).

3.11. National Water Master Plan

Kenya government through the Japanese cooperation has recently released a National Water Master Plan. This is a major contribution to the water sector in this country. Although the master plan comes before the eagerly awaited National water policy, the document is a big step in the right direction.

The national water master plan has given emphasis to the use of rainwater, though it has tended to limit its potential in the arid and semi-arid areas. The report has not indicated use of rainwater in urban areas and in high rainfall areas of Kenya. For example, western and central regions will tend to rely on surface water and rainwater has insignificant contribution according to this plan. One major assumption also in the report is that rural water supply relying on rainwater option will use roof catchment and only in small cases natural surfaces such as rock catchment shall be used.

Also given more emphasis is use of other low cost and simple technical options like shallow wells hand-dug or hand augured and this option is the main one proposed to provide source of water for livestock in low rainfall areas. In this arrangement, there occurs one assumption that in an area both shallow well and rainwater choices will be available. This study has however revealed that where the water table was high shallow wells were common and rainwater was less preferred unless quality, taste or colour rendered the well water unacceptable e.g. around the lake region.

This understanding tends to suggest that Rainwater Harvesting in an area where it is the most suitable option may be developed not only roof catchment for rural water supply but also groundwater catchment with ground tank or dams for livestock water demand. This brings into play another factor raised in the Master Plan. The plan discourages construction of small scale dams in hot and dry ASAL Districts e.g. Garissa, Mandera and Lamu. The argument that evaporation and silting is excessive is varied only to some extent. This study concludes that a multi-technical approach to water problems should instead be promoted.

Regarding use of rainwater in urban and high rainfall areas. The plan indicates no rainwater use would be expected in all 42 urban centres and the Districts like Nyeri, Kisii, Kericho, Transzoia, Uasi Gishu, Nandi, Bungoma and Kakamega. However visit to some of this places revealed extensive practice and use of rainwater. Reasons for this widespread use of RWH is that rural water schemes had fallen into disrepair or quality of the water was bad and therefore for drinking purposes people turned to the relatively clean water from their roofs and left the surface source (Rivers) for non consumption use.

However the Master plan has revealed the great potential of rainwater harvesting in this country. The challenge is distribution of this techniques to those needing it most in the rural and urban areas.

3.12. National Water Policy

During the study several issues of policy nature surfaced, they included concerns on how much water is used where, when and by whom.

Visits to the various line ministries, parastatals NGOs and other donor communities showed that there is need for a national water policy, to direct and guide use and distribution of this decreasing commodity, so important to sustain human livelihood endeavors.

The hundreds of actors in the water sector in this country needs a policy framework that will establish and strengthen institutional capacities at national, districts and local levels. Some notable constraints both legislative and regulatory have to be dealt with if effective cooperation, collaboration and coordination of various agencies will be productive in promoting rainwater utilization in Kenya.

At the District level, there were however a number of committees responsible for development. Almost all of them have the DC as Chairman and DDO as Secretary. This two officials are not elected but appointed by Government. The other officials are government appointed and this is probably the greatest weakness of the District focus for rural development. These officials should be elected by district development committees.

The committee were DDC, DEC, DPU, DEC District NGO steering committee and District Health Management Team (DHMT).

Various actors were identified in the field and the table below shows the agency and Districts in Kenya they are operating.

Table 10: Examples of agencies involved in the water sector in Kenya

Organization	Agency/Programme	Place
1. SIDA of Rift and Eastern	Environmental Health	22 districts Valley
2. DUTCH	ASAL programmes	4 districts in Kya
3. WB/UNDP	i) Pastoralist water ii) Drought recovery	Turkana Laikipia Marsabit, Tana River Baringo, Mandera,
4. EEC		Kisii
5. IFAD	ASAL programmes	Mombasa, Kwale
6. UNICEF	CSD	Baringo, Kitui
7. Care Kenya	Water	Western province
8. DANIDA	ASAL programme	Kitui
9. GTZ	KIWASAP	Kilifi
10. Belgium	NCCK/GoK	Laikipia
11. Red Cross	Primary Health Care	Nakuru
12. Aga Khan	PHC	Kisumu
13. World Vision	Relief Emergency	Marsabit, Nakuru
14. Catholic Church	Development department	Many parts of Kenya.
15. Anglican Church	Christian Community Services	Eldoret, Machakos, Nakuru etc
16. KWAHO	Water programmes	Coast province.

During this study a number of documents were found which further indicated that there has been increased awareness on the potential of rainwater and there has been also widespread use of these technologies. The documents were:

1. 1992 GoK.

   Guidelines for the design, construction and rehabilitation of small dams and pans in Kenya. Kenya-Belgium Water Development Programme, Nairobi Kenya.

2. 1990 Lee. at al ...

Water harvesting in five African countries occasional paper 14 IRC International Water and Sanitation Centre, The Hague, Netherlands.

3. 1992 IRCASA.

Proceedings of the Second National Conference on Rainwater Catchment Systems in Kenya 30th August - 4th Sept. 1992.

4. 1991 IRCASA.

Proceedings of the First National Conference on Rainwater Catchment Systems in Kenya May 28 - 29 1991.

5. 1993 IRCASA.

Proceedings of the Sixth International Conference on Rainwater Catchment Systems held in Kenya 1 - 6 August, 1993.

6. 1992 Adrian at al ...

A development dialogue: Rainwater harvesting in Turkana IT Publications. London U.K.

7. 1987 Oxfam

Rainwater catchment ferrocement tanks workshop report Feb 17th - 30th 1987 in Kenya by World Neighbors and Oxfarm.

8. 1990 Erik.

RWH in semi arid Africa manual series 1-6.

9. UNICEF technology support section standing ferrocement water tank $10m^3$, $20m^3$, $30m^3$, $40m^3$ and $50m^3$.

3.13. Groups formation

Throughout this study promotion of rainwater through community groups was found to be the best institutional arrangement. This approach gave the communities maximum opportunities to participate in developing their delivery systems.

Some common issues regarding the groups are summarised in the Table below. Table 11 and 12.

Table 11. Important issues about group formations

Area	Rainfall mm annual ave.	Average no.of members per group	Out of Total no. of groups	Ave monthly contributions in(ksh)	Size of tank	Reliability of the system on ave.%	Other sources in the area
1 Molo	>1000	37.1	10	224	$20m^3$	85	Springs
2 Ngarua	700	16 4	80	51	$13m_3, 90m_3$	5	Dams
3 Olkalao	1000	30	26	158	$18m^3$	95	Springs (b/h)
4 Subukia	800	30.1	22	150	$10m^3$	70	River (b/h)
5. Roda/pwani	800	38.6	46	120	$13m^3$	78	B/h
6 Gilgil	600	41	23	130	$13m^3$	60	piped (b/h)

The above six regions including the sample area Roda/Pwani were visited and standard questions were administered and the information was summarised. Except Molo with over 1000 mm rainfall the rest receive only minimal. The families sizes and mode of water use determine amount of water use. The column reliability was included to find out what % age of time in the year the tank run dry and consumers sought other alternative sources. In Molo the RWH provided dependable supply up to 85% and 15% of the time other resources were sought. Roda Pwani was 78% dependent upon RWH. This concludes that RWH should be seen as a supplement not substitute other sources.

3.14. Groups contributions

Table 12. Contribution important issues

	Ave. Contrib' per month	GRDP per month per family of(6)	% contribut ion per month	Cost of tank 1990	36 months contribut ion as % of total cost of the tank.
Molo	224	2700	8%	25,000	32
Ngarua	51	1270	4%	10,000	18
Olkalao	158	3550	4%	15,000	38
Subukia	150	2700	5%	12,000	45
Roda Pwani	120	2700	6%	7,000	68
Gilgil	130	2700	5%	10,000	47

Gross regional domestic product (GRDP)

GRDP by district was not available from existing data. However GRDP is essential information to plan for a water supply project. The above figures are based on figures as quoted from the master plan and converted to income per family per month of 6 members. Usually the GRDP is usually not accurate assessment of true income. However it provides useful information of income of the rural people per district.

The above table gives 36 months of a family giving towards a tank project. In turn GRDP is converted to shillings per month per a family of 6. It is clear then that at even 5% giving for 3 yrs the tank cost is only about 40%. This means a RWH project must be planned with social economic issues incorporated in the planning.

3.15. Ways of coping with cost constraints

However attractive and appropriate rainwater harvesting is its initial cost remains a critical constraint.

The study team came across a number of ways used in the field to cope with this constraint.

(a) The community without external help practiced rainwater harvesting using various forms e.g. small domestic containers, 100 litres drums, 200 litres drums, ditches, water tanks or family dams.

(b) Communities were organised into groups by an external support agency like government Ministry of Culture and Social Services, NGOs or peoples own initiatives. In this case approach is more systematic and tanks are more standard in size. This group often receive generous

subsidies and this enables quick progress.

(c) This category usually involves the elites with access to loan or credit facilities like teachers and civil servants. This people only seek professional help and employ qualified technicians to build the systems. This option if combined with (b) above, so that the groups are organized to receive loans to finance water tank development and other income generating activities (IGA) the results would be much better.

This emphasizes the need for an integrated approach to Rainwater Projects so that both technical and non-technical limitations are evaluated and considered in the planning.

During the study the following institutional arrangements were identified. They were different and their impact in delivering sustainable services were assessed.

1. Community alone
2. Community plus an external support agency e.g. NGO
3. Community, NGO and Government
4. Community and Government
5. Government alone

How the projects are initiated and implemented made a great difference. But where community alone was involved success rate was small but degree of awareness was high. 5th case is of government alone who construct and then hand over to the community. This registered speedy progress with no future unless the government provided the infrastructural support to maintain the facilities.

The best combination was however where government community and other actors cooperated and worked together. Good leadership attracted donations from the various actors and internally generated funds to support their rainwater projects.

3.16. **Consumer prices**

Inflation rate has been rising in recent years and in 1990 the rate abruptly jumped because of the Gulf war. While elections in 1992 and donor community with holding balance of payment due to economic problems, all combined have had serious impact on consumer prices.

Construction materials were decontrolled and prices of cement, sand and reinforcements went high. These affected affordability of rainwater tanks to a great extent.

As indicated by this table below prices of consumer commodities went up and buying power of the farmer was greatly affected. Rhoda pwani community price increases were as shown below.

Table 13. Price increases over the years

	'80	'82	'84	'86	'88	'90	92	93
Cement 50 kg	79/=					120	185	400
Nails per kg		6/50	9/50	81/50	11/50	22/50	35/=	80
Petrol per litre			4/33	5/50	8/33	14/27		28/=
Sugar		5/50	7/20		8/15	12/40		40kg
Wheat flour 2kg	9/00	9/70	14/50	17/50		27/00	37/50	63/=
Maize 2 kg			7/80	9/85		13/00	14/50	22/=
Gutters	25		32	38		42	68	230

3.17. **Cost effectiveness of various cisterns**

During the process of technology choice total cost of the rainwater harvesting system is discussed and identified. Total cost items are indicated as per the appendix 6:5. The items are broken down under hardware items (cement reinforcements pipes etc) under gutters (gutters, down pipes, brackets etc.). Then local materials (sand, ballast, hardcore stones transport). Then labor (skilled and unskilled). The last item is under miscellaneous to cover overheads, water for construction transport, timber.

Various tanks and their cost per gallon as found in the field during this study are given below.

Table 14. Costs of various tanks technologies

Type of technology	% Community involvement	Various Tank Technologies		
		Cost per gallon	Total capacity	Area of tech
1. Underground tanks	48%	1/45	90 m^3 (20,000 gal)	Laikipia June 1993
2 Masonry tanks	19%	9/35	18 m^3 (4,000 gal)	Nyandarua June 1993
3 Ferrocement tanks	19%	9/70	18 m^3 (4,000 gal)	Laikipia June 1993
4 Water jar	30%	6/65	2.5 m^3 (500 gal)	Laikipia June 1993
5 Masonry tank	-	2/80	5,000 gal (23m^3)	Molo June 1993
6. Masonry tanks	-	4/35	3,300 gal (14 m^3)	Laikipia Jan 1992
7 Square tanks masonry	-	1/80	3,300 gal (14 m^3)	Nakuru Jan 1992
8. GOK Isiolo water jar	-	18/-	660 gal (3m^3)	Isiolo Sep 1992
9 GOK water jar	-	13/-	660 (3m^3)	Kajiado Sep 1992
10. GOK water jar	-	21/-	660 (3m^3)	Embu Sep 1992
11. GOK water jar	-	16/-	660 (3m^3)	Kitui Sep. 1992
12. NGO water jar	-	5/30	300 gal	Laikipia June 1993
13. Ferrocement	-	4/-	1,500 gal	Laikipia June 1993

4. FINDINGS

4.1. Policy

4.1.1. General

It is by now very evident that freshwater has become a constraint to economic growth and food production in Kenya.

Yet in Kenya like many other nations little is known about how much water is used where, when and by whom.

4.1.2. Competing uses

When analysts speak of the demand for water they typically refer to water's use as a commodity: as a factor of production in Agriculture, industry or household activities. Yet water in rivers, lakes, streams and estuaries also is home to countless fish and plants. Therefore there is need to protect these natural functions of water when plans to develop water schemes is being considered.

4.1.3. Consequences of mismanagement

There is mounting pressures on water resources and resulting pollution is evident in many ways. Other concerns include the depletion of groundwater supplies, falling water tables and damages to ecological systems. Failure to heed these signs of stress, and to place water use on a sustainable footing, threatens the viability of both the resource base itself and the economic systems that depend on it (60).

4.1.4. Augmenting dependable supplies

When natural water supplies become inadequate to meet a region's demands, water planners and engineers historically have responded by building dams to capture and store runoff that would otherwise flow through the water cycle unused and by diverting rivers to redistribute water from areas of lesser to greater need. However there are a number of environmental and financial constraints that limit these conventional systems. Rainwater has become a useful option and its inclusion on small and large scale applications requires legislative, political and financial support.

4.1.5. Conserving water

As affordable options to augment dependable water supplies diminish, the key to feeding the Kenyan growing population, sustaining economic progress and improving living standards, will be learning to use existing supplies more efficiently. Using less water to grow food and flushing toilets. Collecting and using rainwater increases the water available for other uses. For example use of rainwater for other needs means decreasing demand, on conventional systems, cutting cost and sustaining economic systems which would be grounded without conventional

systems.

4.1.6. Priorities

Much of the waste and inefficiency in todays use of water results from policies that promote false feeling that water is in abundance.

Kenyans don't pay the true cost of the water they use. In future consumers would pay more as market fosters conservation and a reallocation of water supplies to their highest valued uses. The extent to which a market drive reallocation should take place is partially a political decision, since it would alter a region's basic character and social fabric but by economic criteria it is an efficient option.

However e.g. in Kenya where cost per hectare of ' building a new irrigation systems often exceeds per capita gross national product, pricing water at its full cost may not always be feasible. Water is often supplied for free or is heavily subsidized because it is so vital to food production. Yet most experts agree that the inefficient operation and poor maintenance of irrigation systems is largely due to farmers perceptions that they have no responsibility for this. This attitude is no different in case of water supply for domestic and livestock needs.

Existing laws and methods for allocating water supplies are often heavily biased towards those wanting to withdraw water and against those desiring that it may remain in place. Where demands are already at the limits of the available supply, regulations may be necessary to put water use on a sustainable footing. Strategies geared towards balancing the water budget are lacking in most areas of falling water tables e.g. along coastal areas of Mombasa or shrinking surface supplies in this country e.g. sources for Nairobi.

In an era of growing competition for limited water sources, heightened environmental awareness, scarce and costly capital, new water strategies are needed. Continuing to bank on new large water projects and failing to take steps towards a water - efficient economy is risky because this would lead to decreased food production slowed economic growth and more drinking water rationing.

4.1.7. Water act

In Kenya an act of parliament to make better provision for the conservation, control, apportionment and use of the water resources in Kenya, exists as commenced on 7th May 1952. In 1972 there was a revision to the act.

There has been so many changes however of political, social and economic nature that there is now need for more integrated and holistic approach to water and land resource management. Kenya

needs policies that would promote a new vision of integration so that other policies like population, land, environmental, food security, etc. are all harmonized to promote the new thinking.

4.1.8. National water policy

Pressure has mounted on the need for a national water policy from various donors and NGOs. The responsible ministry is said to be working on some draft not made public yet. It is our hope that the policy is developed with the full participation of the public.

4.1.9. The national water master plan

A national water master plan, released recently has been a great contribution to the water sector. It is hoped that as the districts undertake their own district level plans, more localized details will improve the master plan and more actors will have opportunities to contribute.

Conclusions

There is a lot of fragmentation of water sector along ministries such as Health, Water, Agriculture, Natural Resources, Energy etc. Donors too have tended to fund the fragmented bits thereby increasing the negative impact of fragmentation.

Recommendations

Kenya government through its relevant ministries and department will need to develop a national water policy, a new relevant water act and other related guidelines on use and support to the water sector.

Policy should define role of government as policy, legislative, control, standardization while implementation is left to consumer and private sectors.

Policy should recognize and promote use of low-cost options (water harvesting and other point source, etc).

4.2.0. **Poverty**

4.2.1. **General**

It is usually difficult to describe what poverty is. But world development report 1980 32) has described absolute poverty as that condition of life so characterised by malnutrition illiteracy and disease as to be beneath any reasonable definition of human decency.

Poverty has human factors and natural factors. But human factors are by far the most serious causes. People described as absolutely poor have a daily struggle to access food, clean water education and health care. This category of people live in confusion and hopelessness. Their mobilization to take part in a process of overcoming poverty and social injustice calls for a careful planning of the intervention. Such intervention should aim at a movement towards self-reliance through an empowerment of the poor with skills knowledge and other infrastructural support.

Fig. 7. Hungry & Hopeless.

4.2.2. **Poverty affected participation**

In Kenya today, food security, basic health care, water, education and housing have become too costly for the public budget to provide. Political and institutional arrangements in Kenya have failed to supply raw materials to meet the needs of the poor. This is partly due to the enormous strain on the public purse by debt servicing.

This state of affair has come about generally due to constraints in management, Leadership and policies. As a result Kenya could not accommodate and cope with the global economic trends like the Arab-Israel war 1973 (Sharp-rise in oil), 1979 when oil price rose again, global recession of 1980 - 1982.

However 1976 - 1989 Kenya entered a period of structural adjustments and there was improvement in GDP. But between 1990 and 1992 Kenya's G.D.P. fell from 5.8 in 1990 to 2.2% in 1991 and 2% in 1992.

These has resulted in serious poverty hunger and diseases among the disadvantaged rural subsistence farmers and pastoralist while the urban poor were also not spared.

It is therefore clear that the country's economic performance will influence peoples capacity to actively participate in development of basic needs, for example rainwater harvesting.

4.2.3. Poverty levels in Kenya

Kenya compared to many other countries is resource-poor. There are no minerals, precious stones or petroleum. Moreover use of modern technologies is limited. Without mining or manufacture base, Kenya is forced to rely heavily on agriculture for its economic production. Unfortunately 83% of Kenya is arid and semi-arid and so of very limited agricultural value with the existing technologies. (61).

Majority of residents of Mukogodo division are part of the 85% of the pastoralist households living below the poverty line (August 1992, Ksh.3,000 per year income levels) in Kenya, while majority Roda/pwani residents are among the 30% of small scale rural farmers in Kenya living below poverty line.

Generally about 20% of all rural households in Kenya are now landless or near landless and of these, about 15% are absolutely poor. Finally about 47% of the urban population in Kenya now lives in very low income neighborhoods and of these, some 3-4% are absolutely poor. Most of these poor households are headed by females. (61).

These category of people will need a broad based approach which is holistic in nature. If they will be expected to participate actively in development.

Conclusions

Increased costs of living and collapse of several public services e.g. health care systems, slow inflow of funds into the country, mismanagement of the little resources, unequitable distribution of those resources and opportunities in Kenya has lead to the following implications to rainwater groups.

a). Several groups formed to construct rainwater facilities have collapsed.

b). Several groups have adjusted their monthly contribution to a small amount and as costs of materials have gone up, the resulting reality is that now it takes 6 months or more to build one facility previously done in a month.

c). Improvement of social justice and relationships among villages because of the joint project is lost with collapse of the groups.

d). Communities once on a road of self reliance and independence now retreat back into passive recipients of handouts and as they struggle for survival they resort to charcoal burning, local brewing, prostitution and other anti-social activities.

2. Rainwater harvesting technology has high initial capital costs but negligible recurrent costs. The amount needed vary from one form of technology to another but whatever the choice there is high capital investment needed.

3. Poor marketing of livestock products in pastoral areas, plus cultural belief that discourage sale of large herds at the end of the rainy season has left this people poor and unable to fund rainwater systems.

4 Among many groups who have done rainwater harvesting activities there is (a) marked increase of better stewardship of resources (b) the projects have enhanced skills, knowledge, innovative capabilities and self-confidence of participating communities (c) the projects have fostered more community solidarity and caring by sharing the benefits of the project with poorer households.

5. If the target groups knowledge of the environment and traditional productive practices could be harnessed this could contribute greatly towards a new development approach based on integrating and preservation of Kenya's fragile ecological systems with the need to improve economic opportunities and living standard.

Recommendations

1. Credit facilities should be incorporated in the intervention package. Together with this the groups involved in rainwater projects should be assisted to start small scale income generating activities (IGA) which would raise income levels to finance tank construction or earn money to pay the loan. Such projects were identified during the study to include:

Table 15

Sector	Activity
Manufacturing	Carpentry/masonry any other income generating activity
Textiles	Tailoring, knitting
Trade	Selling cabbage and vegetables, second hand clothes, small retail shops (consumer, agricultural), small market shops
Service	Food kiosks, shoe repairers, water vendors

The above IGA activities applies to small holders subsistence farmers while people in pastoral communities will need IGAs that are relevant to them and their localities e.g.

Trade
- Buy and sell animal products like skin, meat, milk and live animals and honey business.
- Selling handcraft and;
- Selling and buying useful plant materials e.g. cum arabica in Mukogodo.

2. Effort should be given to finding low cost and cheap storage facilities. As identified the tank is the single most expensive structure in the rainwater catchment system, other components like gutters, however need attention too. Therefore finding a more affordable building material will go along way in removing the economic barrier to the spread of RWH.

3. While standardization is good in many ways it tends to suppress innovation that can reduce costs of delivery systems to the millions not reached with water supply and sanitation services in Kenya. Therefore a joint effort of the policy makers and consumers should be enhanced to produce low cost storage and catchment systems among the target communities.

4.3.0. Technology

4.3.1. General

Water may be abstracted naturally from the hydrologic cycle at various points. Technology chosen should however be appropriate where appropriate refers to that intervention being acceptable to the local people, affordable to the target group and sustainable through local resources. If such choice is accurate, it creates self-reliance confidence and self determination. And these are important qualities where technology is introduced as a catalyst for social economic growth.

4.3.2. Rainwater harvesting techniques

Though rain falls infrequently in arid lands, it comprises considerable amount of water. For example a 10 mm of rain equals to 100 m^3 of water per ha. Harvesting this rainwater can provide water for regions where their sources are too distant or too costly.

Ancient desert dwellers harvested rains by redirecting the water running downhill slopes into fields or cisterns. Techniques suitable for harvesting and putting to productive use these water is the main challenge. Rainwater harvesting is possible in areas with as little as 50 - 80 mm average annual rainfall (41). Rainfall runoff can be collected from an untouched natural catchment into ponds or depressions where the collected runoff is used for livestock or growing fodder or food.

Modern technologies for obtaining and using water are concerned chiefly with the exploitation of rivers systems and the development of ground water by means of wells and boreholes. The river flows and groundwater only counts for 40% of total rainwater received in the catchment as the rest 60% is lost through evaporation from soil or pools marshes and lakes and by evapotranspiration from leaves of growing plants. In some of the world's driest areas rivers account for as little as 4% of precipitation (62).

Engineers in Kenya have concentrated their efforts on the major rivers and considering the number of dams they could build on them. But for the vastly greater areas of the ASAL which are outside big river systems they have nothing else to offer except boreholes which might be impractical because of unfavorable geology or excessive drilling costs.

If rivers represent only a small portion of annual precipitation as mentioned above, the area outside big river systems would benefit by collecting rainwater immediately it falls and before large evaporation losses occurs.

4.3.3. **Defining rainwater collection**

The principle of collecting and using precipitation from a small catchment area is often referred to as "Rainwater harvesting". The term derives from a more general name "water harvesting" first used in Australia by H.J. Geddes to denote "the collection and storage of any farm waters eg. runoff flow for irrigation. In this original meaning the term rainwater harvesting included stream flow in creeks and gullies not just rainwater at the point where it falls.

Other definitions include water arising from all kinds of precipitation, snow, due or mist not just rainfall. Therefore putting to use precipitation for the purpose of economic development is generally the concern of this report. However being in Kenya where other than rainfall other forms of precipitation are rare the term Rainwater harvesting and sometimes, the term rainwater utilization is preferred as it in-co-operates every useful use precipitation is put to e.g. into cisterns, dams, water holes, re-vegetation or gully healing, groundwater recharge and environmental protection.

However there is varying levels of rainwater utilization so that there is micro-catchment and macro-catchment scales. This report is confined to micro-catchment scales covering runoff from roofs, artificial surfaces at ground levels and land surfaces with slopes of average 200 meters long. Macro catchment scale, looking at river basins is outside the scope of this study.

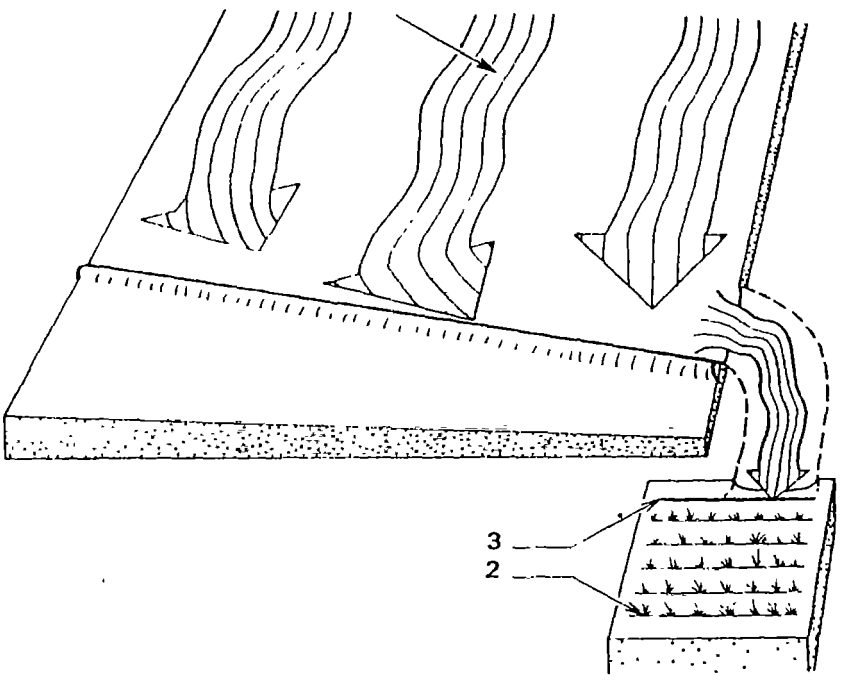


Fig. 8. Principle of RWH. (Source 62.)

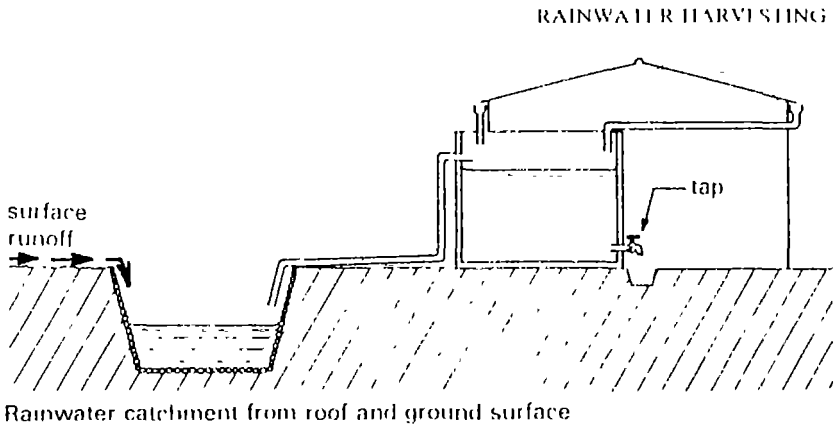


Fig. 9. (Source 62)

4.3.4. Storage facilities

There are various types of tanks available. Generally these tanks can be grouped into three main categories according to the building materials used:

1. cement and concrete tanks
2. steel tanks
3. plastic and fiberglass tanks

Plastic and fiberglass tanks are not common in rural areas as they are expensive, they are however common in urban areas. Ordinary steel tanks (mabati tanks) are very common in Kenya but due to inadequate maintenance they have 3 - 5 years life span but potentially they could last even 10 years. Recently when a tank rusts and leaking starts at the bottom and the tank is put out of use, the tank is turned upside down and rusted bottom becomes the top. Another modification which is possible in many rural centres is converting steel tank into a ferrocement tank using the steel body as a reinforcement with only chicken wire being added.

However under the steel tank category is the pressed steel tanks which are common in government institutions. They are rarely in individual homes as they are expensive. Cement and concrete tanks include water jars of various sizes and shapes, ferrocement cylindrical tanks of various sizes, brick, rubble stone, masonry tanks, these are most common as they use local skills and materials.
Recently concrete rings have become popular too and are being promoted.

Sometimes in the 80s use of sun dried blocks stabilized with grass was promoted however after about 10 years 100% of those built in Gilgil, Nakuru have all collapsed.

Use of cement stabilised and pressed soil blocks were introduced but these materials despite vigorous promotion by Nairobi university was not widely tried because of the need for pressing machine.

Use of gala tanks was also introduced in the 80s but after 10 years they have failed to stand the test and like the sun dried adope blocks they are no longer popular.

Lastly throughout the areas visited about 50% of homes had thatched roofs which many people belief could not produce safe water and use of domestic filters is not known. A number of programmes instead of promoting roof catchment among this category of people they instead promoted ground catchment with ground water tanks. Ground catchment with or without catchment improved and channels well done to collect and channel clean water which is less turbid was introduced by C.P.K. Laikipia Project. Groundwater catchment provided large quantities of water that is less attractive due to high turbidity and may have taste or odor depending on quality of the catchment.

This water is however very useful to livestock and kitchen gardens.

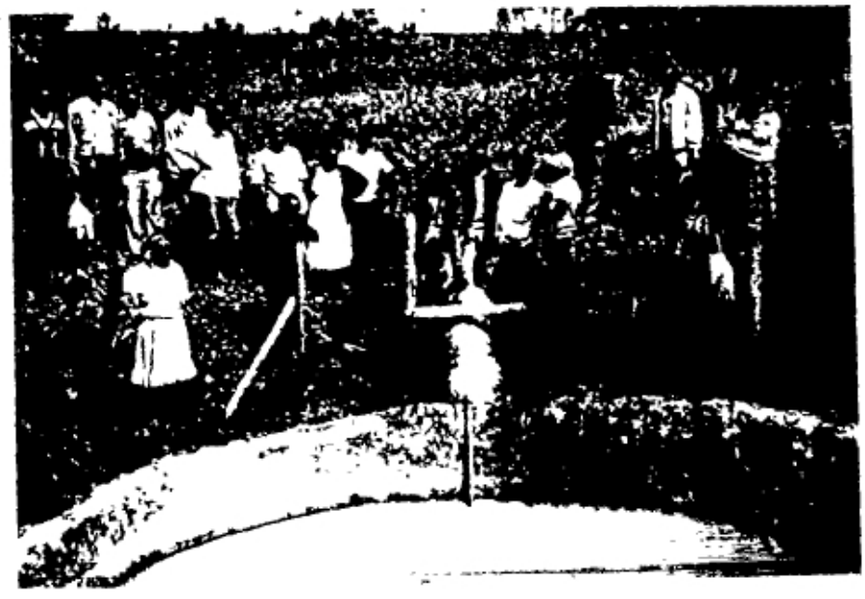
The Laikipia rainwater harvesting has developed a package which has the following features:

1. Ground catchment and ground tanks (livestock and kitchen gardens).
2. A house improvement with a water jar for drinking purposes.
3. Runoff farming (where runoff is managed and controlled to avoid soil erosion and to put the water to farming.
4. Sanitation and vector control.
5. Health education (especially hygiene).

A few points of interest discovered in the field included techniques that decreased silt load that was carried into the ground tanks. The channel was grassed or planted with Nappier grass (fodder) or crops like sorghum, finger millet etc. In addition near the tank one or two silt traps are dug. These silt trap collected the soil often very rich with nutrients. This is removed and used to improve soil fertility as water in the ground tank is left less turbid.

Water in the ground tank has several benefits among which are livestock, kitchen garden watering and other non consumptive use.

See the sketch.



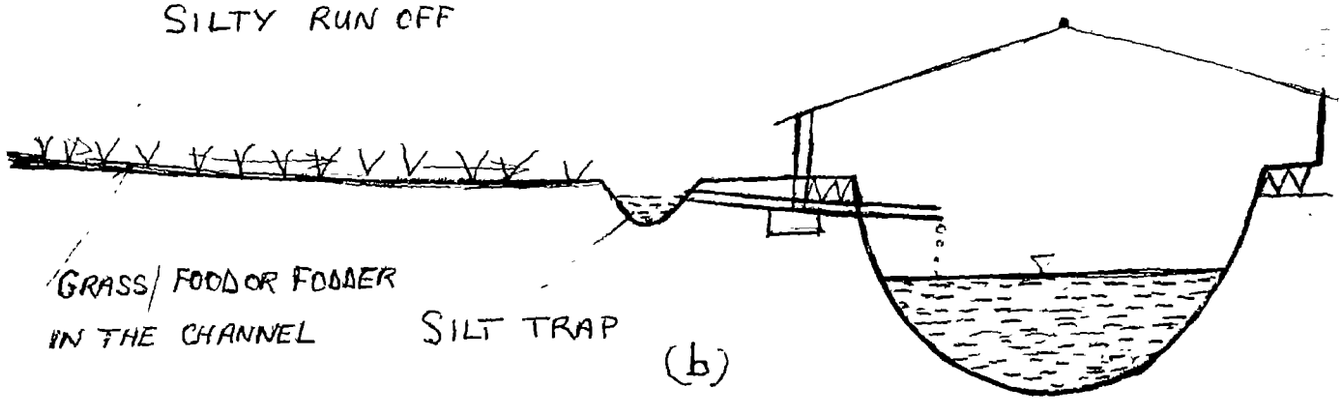


Fig. 10. (a and b) Ground water catchment and ground tank.

In general water harvesting techniques found in Kenya include rock catchment, sub-surface dams, sand dams, ground and road catchments. Roof catchments, triangular micro-catchments, semi-

circular bunds and trapezoidal bunds.

In Isiolo District the C.P.K. Kirinyaga Diocese promoted semi-circular and trapezoidal bunds to control runoff and in turn grow crops. See figures below. Rock catchment is also common especially in Kitui, Laikipia and Machakos and Embu Districts. Machakos and Kitui Districts are also famous of sand storage dams. Skills in developing the system is well known by the consumers who build the wall in stages of 2 ft. (50 cm) every season. This systems removes silt and leaves behind sand with high storage properties. Locating the masonry wall is also accurately done so that its location ensures stability and leaking is minimal. See the figure 14.

Among the pastoralist with dome shaped cow dung roofs a makeshift of a few iron sheets and a water jar or petroleum container provided water during the rains for limited drinking use. However to our amazement during this study in Kajiado Isiolo and Turkana the use of this water was so efficiently used that just a quarter litre was enough to wash the face in the morning and using a wet piece of cloth a litre would be enough to wash the body. See figure 15.

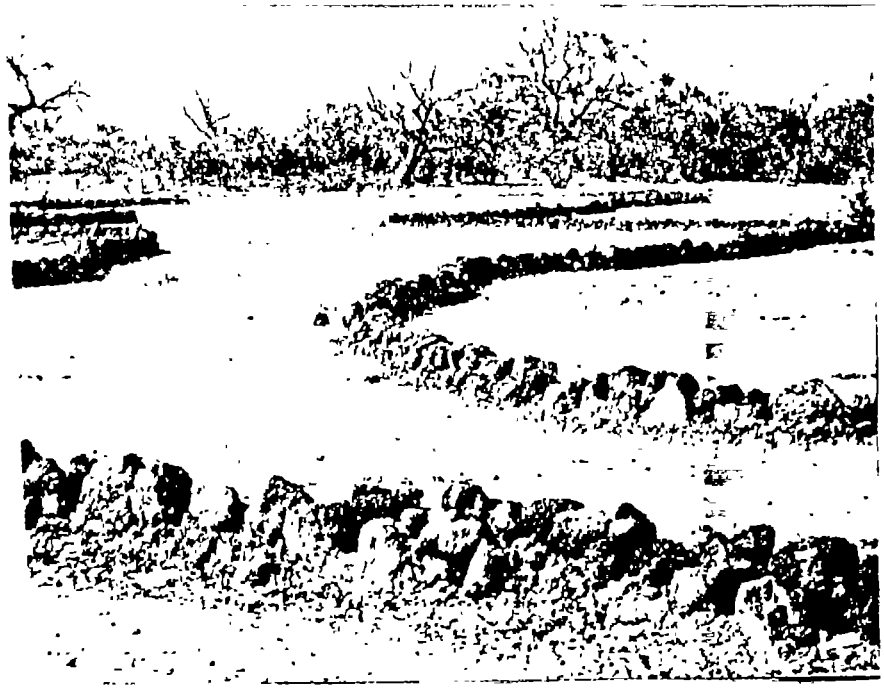


Fig. 11. Run-off Harvesting using stones.

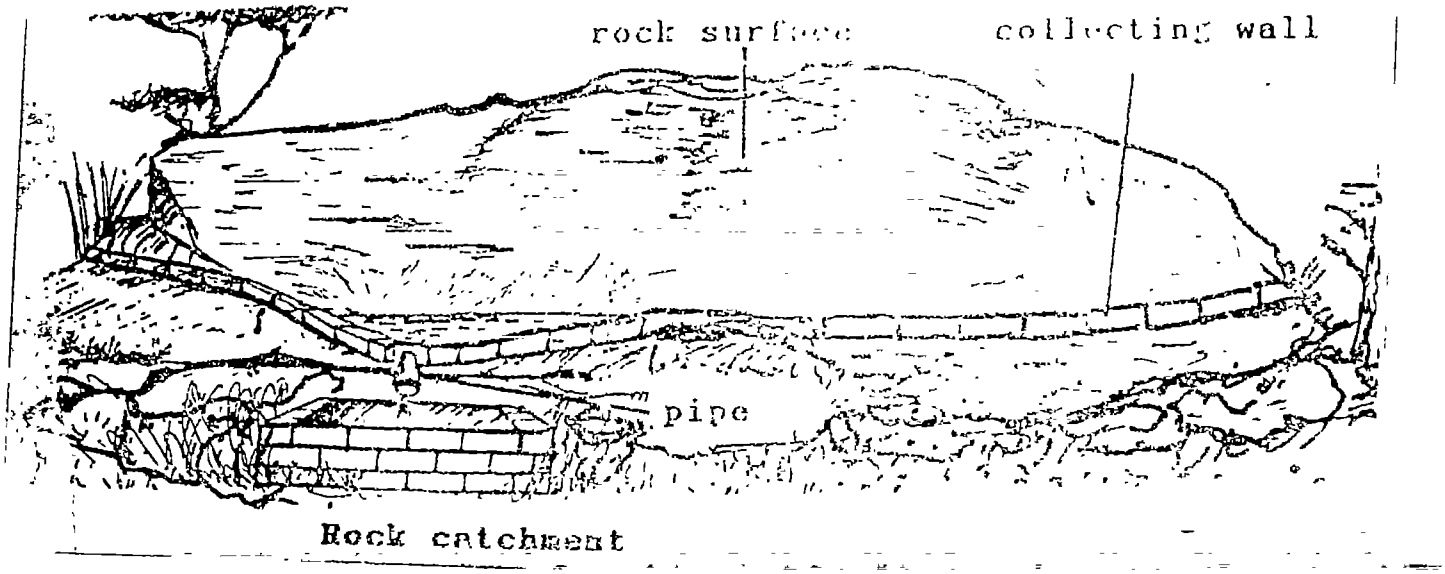


Fig. 12. Rock Catchment (Mbugua 1991)

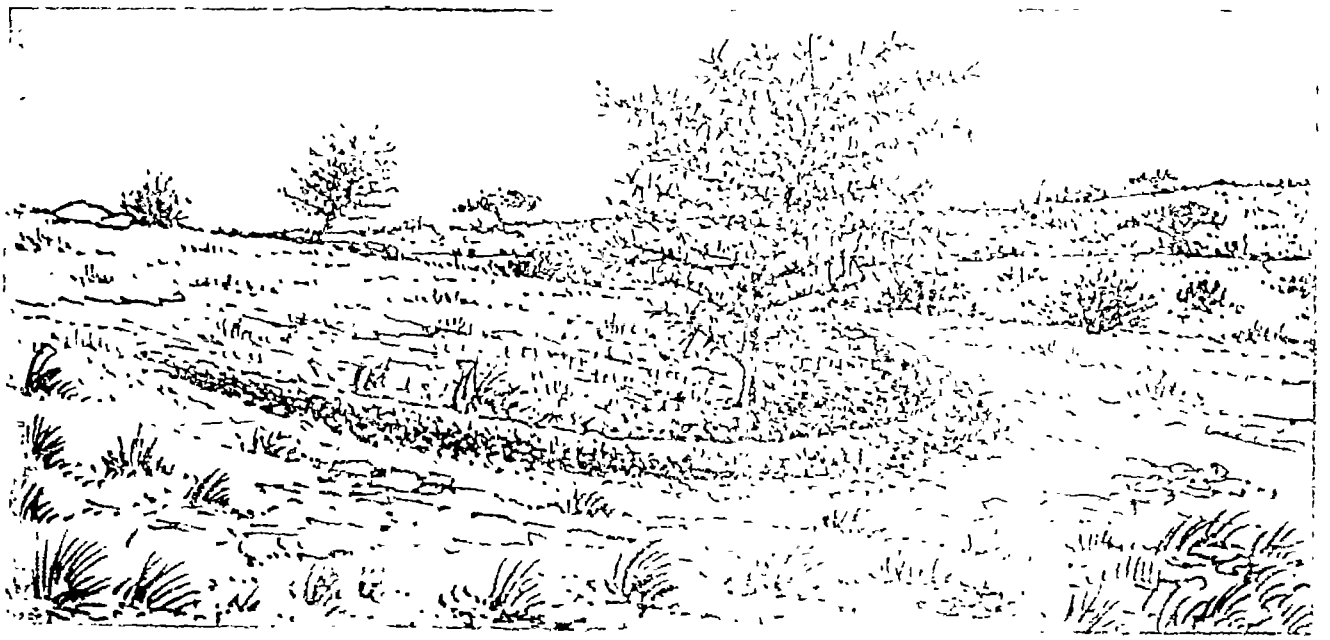


Fig. 13. Run-off Harvesting (Mbugua 1991)

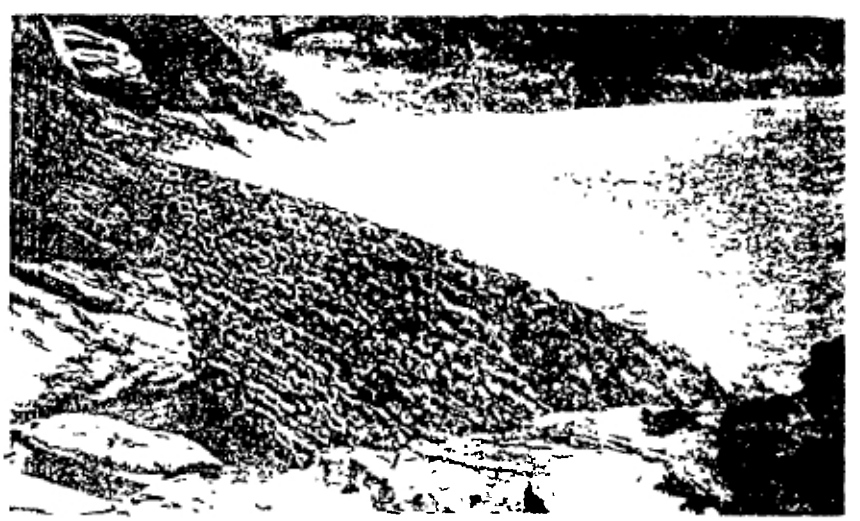


Fig. 14. Sand dam in Machakos District.

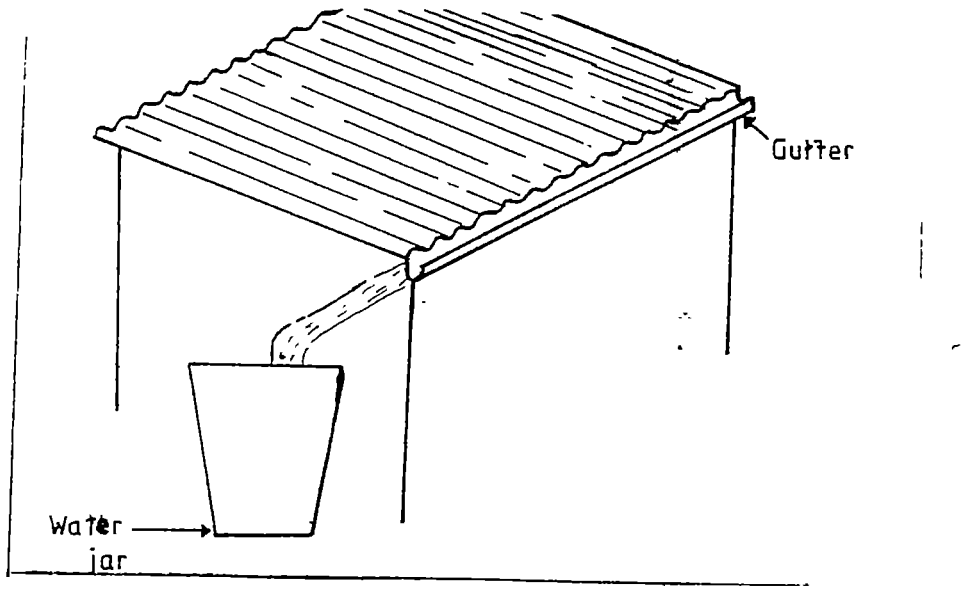


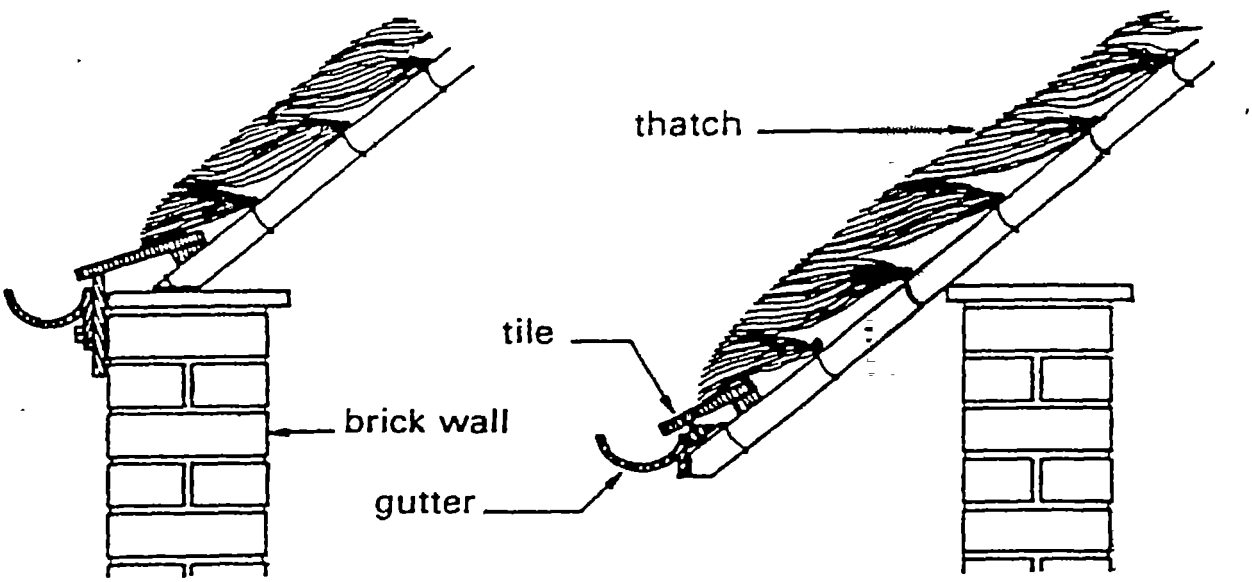
Fig. 15. A Makeshift of Rainwater Catchment System.

It is this runoff that is diverted to a ground tank through a specially designed slope that reduces silt load. This water is covered by a roof to reduce evaporation loss it also reduces pollution. Quality is not very high and household filtering system is recommended. But for non-drinking purposes this water is suitable. See Fig. 17.

4.3.5. Other special features

Amount of water received from rainfall is influenced by a number of factors such as:

1. Ridge line oriented perpendicularly to prevailing wind direction increases yield.
2. Trees and other obstacles reduce amount of water collected by roof catchment.
3. Well over 50% of potential rainwater users have thatched roofs. It is now possible to collect water from such roofs and by filtering, one obtains clean water. See sketch below

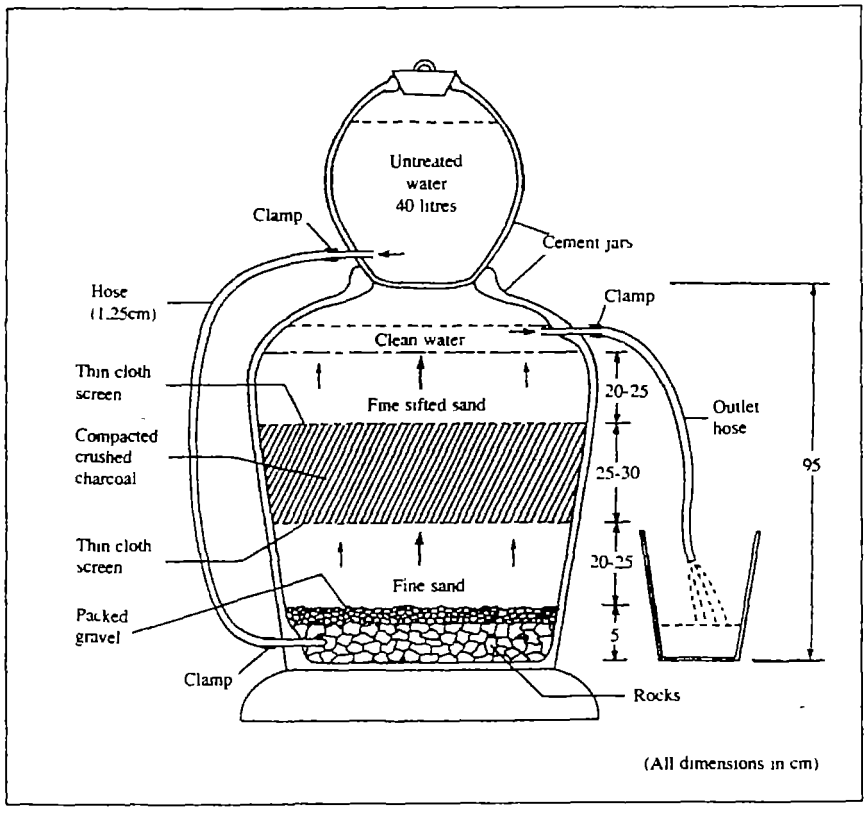


Schematic diagram of water collection off thatch

extending the rafters to produce an overhanging eave

Fig. 16 Grass Thatched Roof Catchment arrangements.

Successful water projects can charge women with confidence and relieve them of drudgery



1. The UNICEF upward-flow water filter.

Fig. 17. Domestic Water Filter.

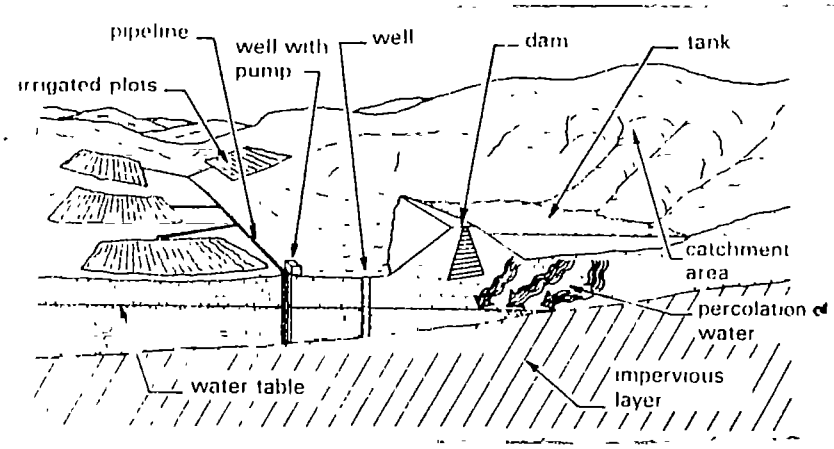


Fig. 18. Schematic View of the Operation of a Percolation Tank which retains Floodwater for use in Irrigation (source 62)

Fig. 19. Tank roofing reduces water pollution and loss due to evaporation (Photo by Mbugua 1991)

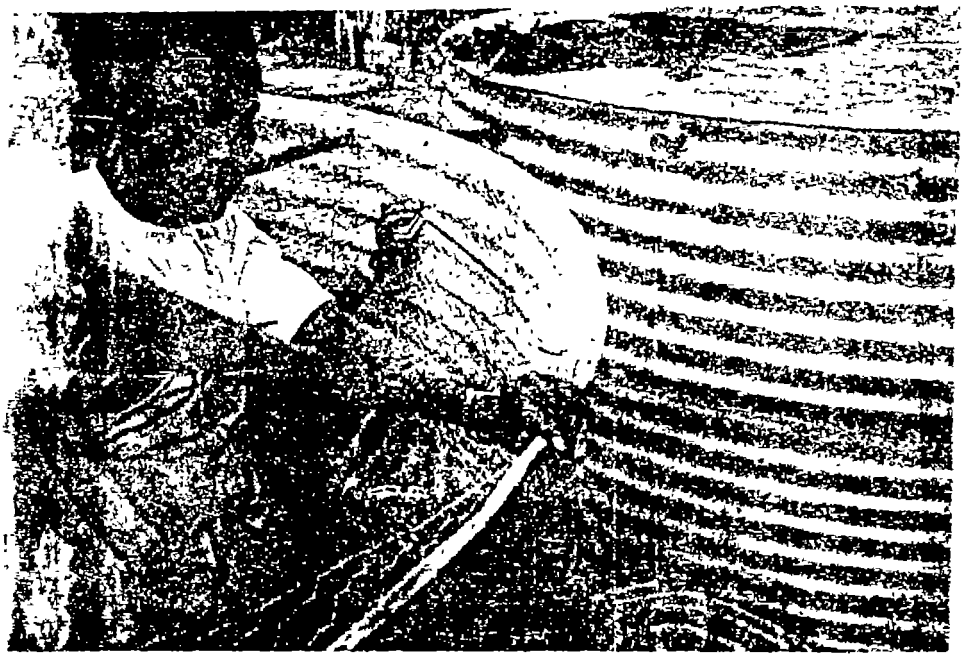


Fig. 20. Converting Iron Sheet tank into a Ferrocement tank (Photo by Erik 1991)

4.3.6. **Water jar**

Water jars are essentially ferrocement with a spherical shape and unlike the Thailand's jars those in Kenya use piece of Cloth and flexible materials (sand, goat and sheep dung, wooden shavings, and sawdust). Another interesting innovation was the Ground tank in the dry Bubisa area of Marsabit District. In Bubisa annual rainfall is 400mm on average, with one season and sometimes two. However, rainfall in distant areas produces run off that reach Bubisa and is harvested using this clever techniques. (58)

Despite increasing cost splash guards are very useful in improving collection efficiency

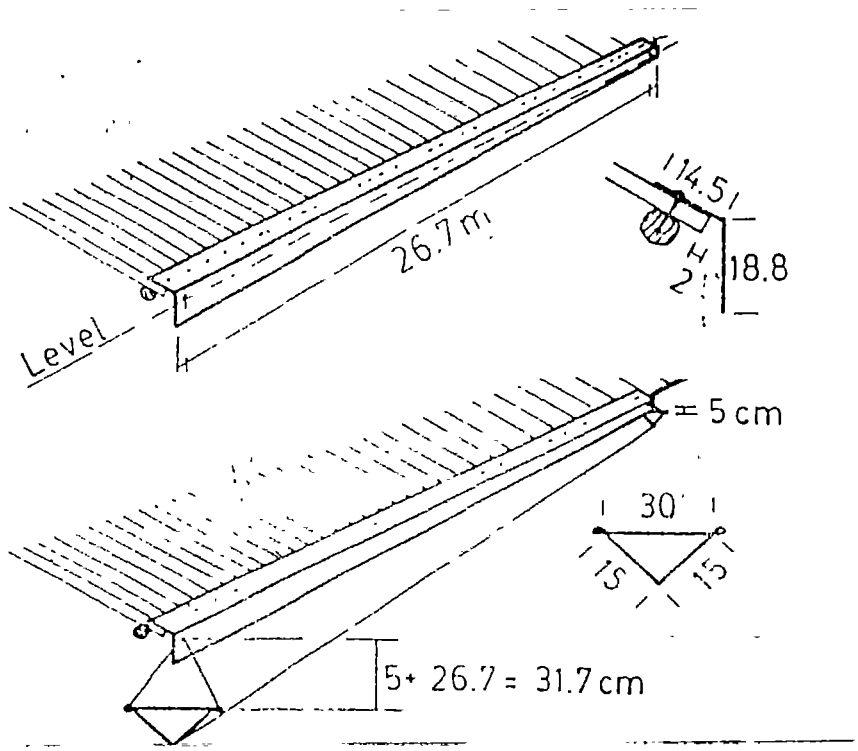
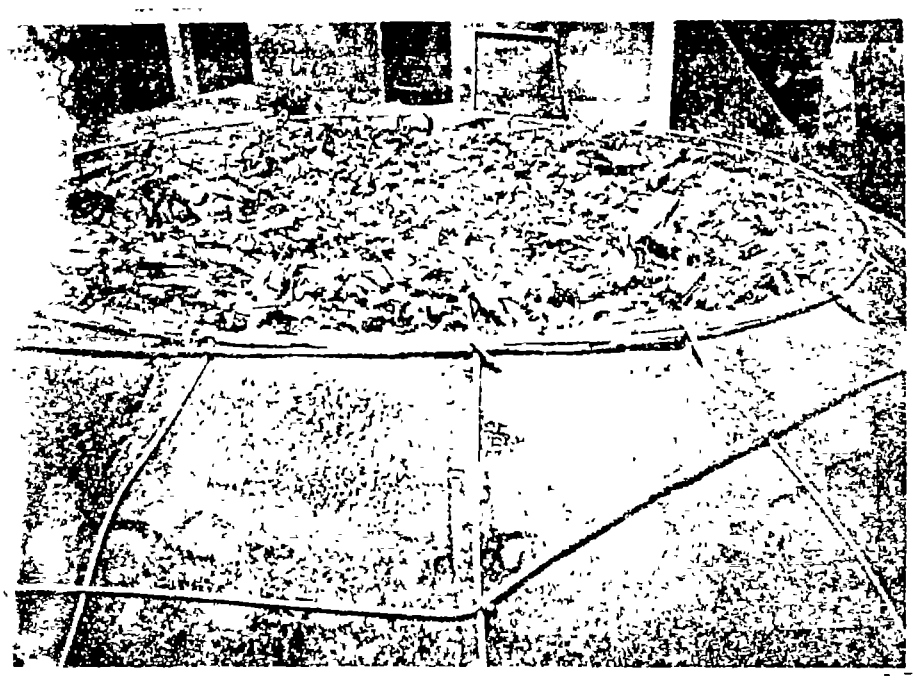


Fig. 21. Standard design of V-Shaped Gutters and Splash-guards.



Water Jar with wood shavings as filler. **Fig 22**

4.3.7. **Standardization**

In order to control quality of performance standardization is a good idea. However, this may kill innovations that could be more effective. The Government should however provide useful guidelines, coordination and should produce standards, set qualities and offer monitoring mechanism to ensure the standards are adhered to.

However, these standards,and guidelines are not available and actors are promoting their technologies and working out their standards. Examples in the Catholic Diocese of Nakuru indicated two standard sizes of 13m3. capacities.

1. Masonry with ferrocement roof
2. Ferrocement with ferrocement roof

CPK Diocese of Nakuru has 4

1.	500 gal	2.3m3 water jar
2.	3000 gal	13.6 masonry tanks
3.	3000 gal	13.6 ferrocement
4.	20,000 gal	90m3 Ground tanks

Other Government departments like Ministry of health did not have standard tanks, other NGOs like CPK Diocese of Machakos, Maseno West too did not have particular standard.
However although these organizations did not have standard sizes each organisation seemed to favor particular size e.g Catholic diocese of Machakos preferred mould tank. 13m3 while Maseno west preferred 2.4m3 ferrocement tanks.

In Roda Pwani area the following tanks were identified.
1. Sun dried adope block tanks 1,200 gal($5.5m_3$)
2. Masonry square tanks 3,000 gal($13m_3$)
3. Steel tanks(various sizes)
4. Ground tank and small family dams.

When Roda Pwani community was asked what tank shape they preferred 75% indicated masonry blocks square tanks because they were easy to build and less expensive.

From the questionnaire also Roda Pwani community were asked how the time saved and energy was used now that water is available. Many indicated they were now able to do the following

(a) There is now time to prepare children going to school in the morning.
(b) Children do homework instead of going to fetch water.
(c) The woman has more time to do kitchen garden and vegetables grown improved nutrition for household.

(d) Others said they had enough time to attend small scale business.
(e) Others said they saved money they used to buy water with.
(f) The labor sold for water is now put to farming which in

turn improves household food security.

(g) Because of working together with my neighbors our relationships has improved and appreciation of each others contributions to life.

(h) A small girl said she now could resume school discontinued to help with household activities especially water fetching.

4.3.8. Water conservation and saving

Rainwater utilization has a better result when the water is better managed, conserved and saved. Reducing evaporation is an important way to increase the supply of water. It increases reservoir capacity without new construction. In arid regions it may mean the difference between a dry reservoir and filled one. Several methods have been developed and tried in a number of places. The techniques vary from one to another in cost and complexity.
Based on stage of water conservation some of the techniques are:

A. Protection against evaporation from water bodies.

(i) Liquid chemicals eg. Aliphatic alcohols, wax
(ii) Solids blocks of light weight aggregate or floating foam-rubber sheets. (see fig.23 and 24)

B. Sand - filled reservoirs eg. sand storage dams.

This is common in Machakos and kitui District.

C. Reducing seepage losses

These are several low cost methods of making soils impervious, they include using polythene sheet, butyl lining, reinforced concrete, ferrocement, using anti-termite soils, clay soil in combination of other materials. All these are applicable in ground tanks or small family dams.

In Laikipia and some parts of Nakuru, Kitui and Machakos these methods were identified. However, community dams found common in Nyandarua, Samburu, Laikipia, Marsabit, Wajir, Garissa and Mandera are known to loose a lot of water from the surface (due to evaporation) and through seepage. However, loss due to seepage is usually caused by calcium in the soil. Calcium causes clay to aggregate forming cracks and a porous structure that lets water seep through easily. In this situation seepage can be greatly reduced by treating the soil with a sodium salt such as sodium carbonate. Throughout Kenya there is no such action being promoted. This is explained by the fact that rainwater based technologies are still done by individuals receiving limited recognition and official support by the Government.

D. Reducing evaporation from soil surfaces

Evaporation from soil surfaces wastes large amounts of water. In arid lands where low humidity greatly encourages evaporation.

Reducing evaporation from soil surface can be an important consideration as about one fourth to one-half of the water lost from a crop is evaporated from the soil surface. (41) see Fig 25

This loss can be reduced and irrigation water saved by placing water tight moisture barriers or water retardant mulches on the soil surface.

Other benefits of this barriers include stabilization of loose soils, allow run-off agriculture, aid in landscaping and will also reduce salinity build up.

Suppressing evaporation from the soil conserves water where its effect is great, that is within the root zone of the plant. In an arid region small water savings here may be more important to crop survival than large improvements of the water supply for irrigation.

Examples of mulching methods:-

1. Plant residual is widely practiced in Kenya although in many places burning of such materials in practiced.

2. Stone mulching is not common but in Laikipia pineapple farmers were found practicing it.

3. Minimum tillage system because hard soil surface provided a better moisture barrier than the loose ploughed soil.

4. Paper and plastic mulches.

5. Latex Asphalt and oils have been applied elsewhere (No example was identified in Kenya.

6. Using more efficient methods such as Trickle Irrigation (limited to a few rich farmers in Kenya).

7. Reducing cropland percolation losses (Not a single example was identified in Kenya.

8. Reducing Transpiration (in form of pruning, weeding, and thinning, (though farmers do this unknowingly.)

9. Selecting and managing crops to use water more efficiently (eg. Bio-intensive - agriculture)

10. Using controlled environment Agriculture Green Houses (In practice in Kenya by highly specialized flower farmers)

Fig. 23 (41) Using light weight concrete slabs to reduce evaporation from water bodies.

Fig. 24 (41) Using Plastic materials to control evaporation from a Tank.

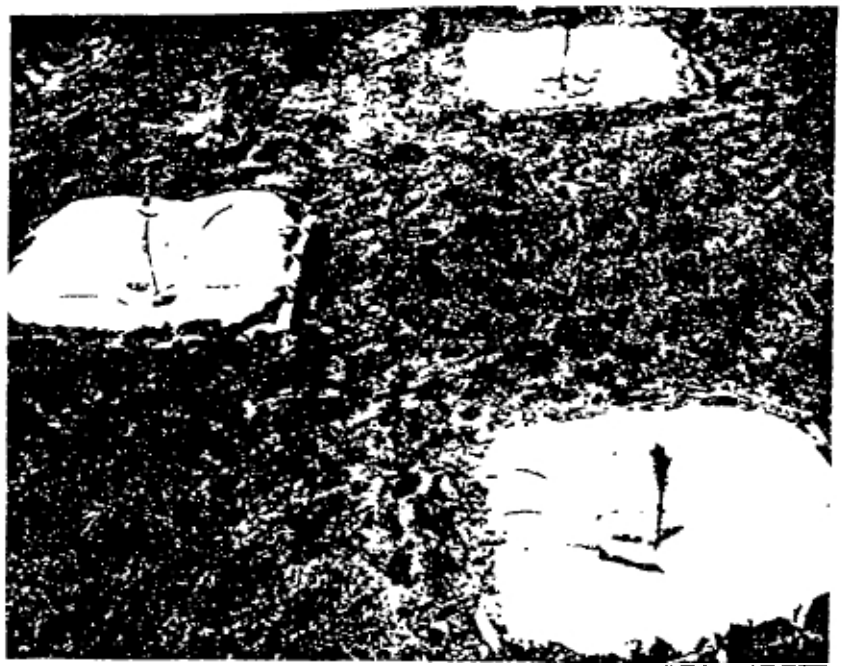


FIGURE 52 These plastic "aprons" are being evaluated to determine their ability to catch rainfall (chapter 2), reduce evaporation, suppress weeds, and promote the growth of tree seedlings in arid areas. (FAO)

Fig. 25 (41) Plastic Cover used as a mulch around a plant.

CONCLUSIONS

1. Rainwater Harvesting, water conservation and saving are rarely seen as components of water programmes during the design and planning for water schemes. As a result there is direct and indeed wastage of water at institutional and household levels.

2. Serious soil erosion by run-off water results in loss of soil fertility leading to decreased yield and therefore hunger and malnutrition among the poor rural people.

3. There is enormous water losses from water bodies like water tanks, dams etc. that are not covered (estimated between 1.2 - 3.2m per year) leads to enormous loss of water. But even from soil surface and through unproductive transpiration more water is lost.

Recommendations

1. The Government, Donor community, NGOs and the community should plan and design water programmes in an integrated approach so that efficient use, conservation, saving and protection of water is made into an integrated component but not just loose component of water schemes.

2. Soil and water conservation, water saving and protection should be approached as a watershed or water catchment integrated project so that both land and water resources are managed for the overall ecosystems protection and human resources base development.

3. All low cost and simple techniques to control loss,

wastage, seepage, evaporation, unproductive transpiration should be promoted as integrated components of the intervention watershed approach.

4.4.0. Sustainability

4.4.1. General

Clearly, strategies must be formulated that will foster the expansion of food production to feed growing populations on a sustainable manner, support the economic development of the region, increase incomes, promote the welfare of the rural people and protect the environment. Lack of adequate rainfall is the major constraint although the only source of water widely accessible and spread out is rainwater. Therefore careful planning of both water and land resources must be managed effectively. Misuse of rainwater indeed all other fresh water, poses a serious threat to sustainable development and to the protection of the environment, Human health and welfare, food security and ecosystem on which they depend are at risk unless water and land resources are managed more effectively particularly in Kenya's Asal regions.

Visits to both pastoralist in Turkana, Samburu, Marsabit, Isiolo and Kajiado and subsistence small holders in Uasin Gishu, Nakuru, Nandi, Laikipia, Kitui and Kwale Districts showed that communities will only participate in a project being introduced if it brings clearly identifiable solution to their felt needs. Projects with only indirect benefits have only little chances of success. This findings then suggests that as the external support agency plans to enter into a community he or she must plan such entry through a process which allows the local people enough opportunity to participate, understand and eventually own the introduced facilities. Such approach has been called participatory rural appraisal (PRA) or simply Baseline Survey.

Among the many groups visited in kenya it was however learnt that no baseline survey were conducted and in many instances people were mobilised to receive already designed packages. As a result rate of failure and abandonment has been high. This was most common among Government initiated projects. However, among the NGO's it was learnt considerable effort is done to invite participation of the potential consumers.

Questionnaires administered in Roda Pwani the sample area showed that projects with higher sustainability included those started through a kind of participatory rural appraisal.

In Roda Pwani 48 groups were visited and the research instruments were administered and 62% indicated that they started through some sort of Baseline Survey 29% started on Merry Go Round * and only 9% started using other process.

* This is a women project where members contribute and give the collections to members on a revolving basis.

In other areas visited though outside the sample area indicated similar tread. To ensure participation of the people a Baseline Survey is an important entry point into the community. During Baseline Survey key actors are identified roles and responsibilities shared. It is during this inception period important socio-economic factors are understood and constraints studied. Some important issues to be studied during baseline survey include the following (as taken from Roda/Pwani experience)

1. Household economies and composition
2. Land/stock ownership
3. Power and authority structures
4. Land rights and tenure systems
5. Take inventory of National and Natural resources in the target area. (Skills, materials, finances, communication and other services)

During the study period over 200 groups were met, discussions and dialogue were held based on the questionnaires. The groups in rural areas are formed sometimes for water project but the members used their money and time to meet other needs of one of their members if found helpful. This indicates rainwater promotion through groups had several other benefits of socio-economic nature. This also in turn shows that technologies like RWH do better through village groups as catalysts for social justice and sustainable development. Among the subsistence small holders the groups, in addition to water project did the following activities also

(a) Environmental health

- Health education
- Vector control and drainage
- Food storage and preservation
- Food hygiene

(b) Household food security

- Run off farming to control soil erosion and improve yield.
- Kitchen Garden
- Food storage and preservation

(c) Sanitation

- Human excreta disposal
- Compound cleanliness rubbish pit
- Drains
- Vector control

However, the degree of achievements varied with amount of support from external support Agency, leadership quality, and economic status of the target group.

4.4.2. Principles and guidelines to groups

In order to achieve the above integrated components the groups made the following rules that reflected, this integrated and holistic nature of their programmes. These are more of goals and principles that were guiding them

1. We shall follow and advance in all aspects of our lives.
2. We shall bring prosperity to our families.
3. We shall improve our house compounds to allow better ventilation, lighting and vector control.
4. We shall grow vegetables in our kitchen gardens and eat plenty and sell surplus.
5. We shall plan to keep our families small and look after our health.
6. We shall educate our children and earn enough to pay their school needs.
7. We shall always keep our children and environment clean.
8. We shall build and use pit latrines.
9. We shall drink safe water from our tanks after boiling and keeping it in a clean place.
10. We shall not inflict any injustice on anyone.
11. We shall be ready to help each other.
12. We shall restore disciplines where it has been eroded.
13. We shall introduce functional education and social activities.

These set of bye-laws indicate that rainwater harvesting promoted through group action will develop a strong institutional base for sustaining poverty alleviation efforts.

Therefore, the institutional capacity for implementing integrated water management in Kenya should be reviewed so that the new watershed based approaches with communities at the centre of action is formulated.

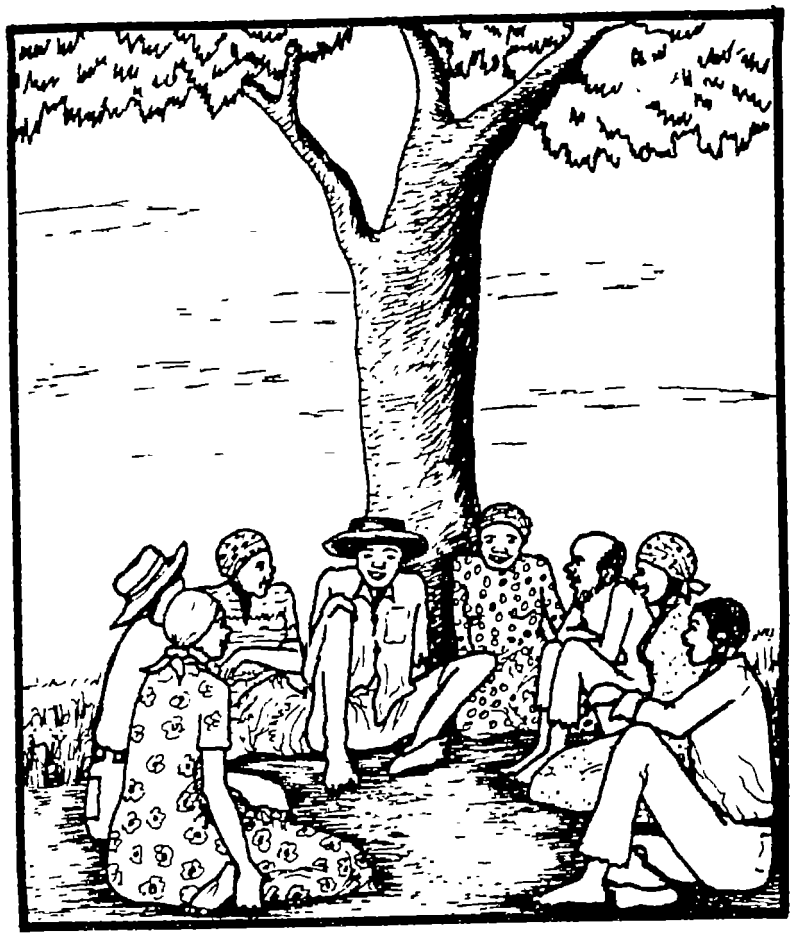


Fig. 26. Discussion and dialogue produced best result

4.4.3. Operation and Maintenance

The integrated development approach will take into account local customs, economic constraints and the adaptation of high technology to local capacities. These are key issues in spreading water supply to the millions not covered today in Kenya.

Accessibility

Another issue that was evident during the study is that accessibility is key to sustainability. The idea of ownership and control are part of the concept of accessibility. The technology like RWH system must be affordable by its recipients and it must be controllable in such a way that it may be both adopted and adapted to meet individual needs.

Maintainability

The sum of all the costs both social and economic, imposed by a given technology on its recipients, is its technological liability. The ability of the recipients to meet that liability or part there of represents their technology competence. Therefore maintainability of a technology is the match-up of the technology liability and technological competence.
Beneficiaries of rainwater harvesting technologies are mainly the

poor rural women. This group is disadvantaged due to lack of capital, employment and power. This group also suffers poor health and live far from clean water sources. Therefore, projects introduced with short term objectives which ignore capacity building cannot be expected to be sustainable by the low income category described before.

Capacity building and institutional strengthening are extremely essential for sustainability. The community must be able to resolve conflicts, identify needs and formulate projects.

All groups visited indicated that their success has been due to discipline, unity, courage and hard work. But even though weak leadership, or lack of transparency and accountability cause suspicion and conflicts that lead to group collapse.

The role of social services department or the administration was evaluated and out of 48 groups in Roda Pwani 43 indicated that they solved most of their problems among themselves and often the local Government officials were not helpful.

The following rules were responsible for discipline in groups.

1. Attendance at all meetings is a must except for accepted cause.
2. Regular contributions at fixed date & time.
3. The tank erected in your compound belongs to all members until they all own one.
4. If you pull out after a tank has been built in your compound the group will recover cost of the tank from you with assistance from local administration if necessary.
5. If you withdraw before you have had a tank constructed in your compound them you are entitled to full refund minus labor.

4.4.4. **Institutional capacity**

Many NGO's in the field exhibited a number of weaknesses. It appears most NGO's capacity is around personalities not institutions. A number of NGO's visited had problems associated with lack of clear policies, poor management and leadership. This resulted in several interpersonal conflicts , jealousies and envy. Project facilities become source of infighting like vehicles, computers and fax facilities. This leads to misuse of project facilities and corruption, transparency and accountability problems force donors to withdraw or find alternative channel for their funds.

Position among Government departments was no better and some problems of efficiency and effective use of funds was in question.

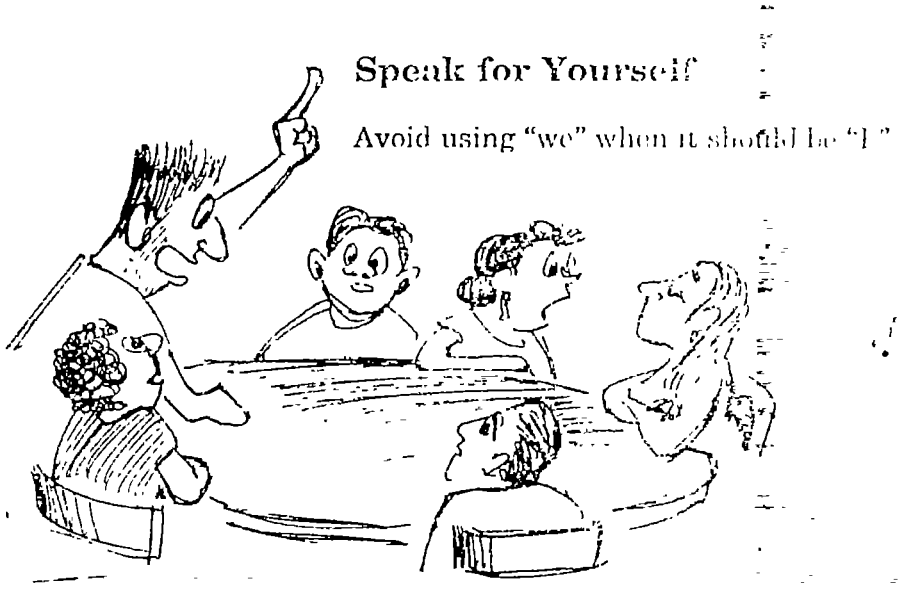


Fig. 27

4.4.5. Social Cultural Issues

People living away from highly developed urban infrastructure seems to depend upon cultures, traditions and religious beliefs, introduction of a project must involve studying and understanding the community. Any violent interference with these values may lead to rejection of the project by the target group.

Some beliefs however don't promote water supply instead inhibits progress. Such belief include

1. Tank facilities for the rich not poor.
2. Tank facility located outside the house can be poisoned.

Other concerns involve communication such that effective communication could exploit traditional and cultural systems such as music, drama, poems, dance, story telling etc.

4.4.6 Security

While at National level security and peace is a condition for development so it is at village level. Where communities are constantly at war either as cattle rustling or ethnic hostilities the end result is backwardness, dependency and hopelessness. Therefore, it becomes necessary that in project design social justice and development become integral components.
Travelling in Turkana, Isiolo, Nakuru during this study the team came across several deserted homes and destroyed tanks.
There were also many deserted homes and those still staying there have little motivation to invest in water development.

4.4.7. Gender

Throughout this study it was discovered that women were central in all affairs related to production and management of water especially at household level. Sustainability of a project has shown that popular participation of the user(consumer) is a basic requirement. Therefore full involvement and participation of women become a prerequisite for sustainability.

Implication of this strategy where women are given opportunities for full involvement are

1. Choice of technology must be such that maintenance is possible at the community level.

2. In order to attract both women and men to become actively involved then social mobilization becomes a must.
3. The user committee should include adequate women representation because usually women give higher priority to a well-functioning water systems than men.

4. Appointment of women to jobs in water project is done.

5. Promote informal sector an area where women participate in income generating activities (IGA).

However, not many Government officials both women and men are convinced that involvement of women has such great impact. Women are a principal if not the sole economic support of themselves and their children. Generally women direct their earnings to meet the needs of their families.

It cannot be emphasized enough that we must find ways to enlarge women's productive capacities and income. Yet their access to resources, such as credit, training and tools that would enable them to increase their productivity and income as small farmers or micro-entrepreneurs is still limited. To achieve the needed coverage of water and sanitation women must have access to the resources they need and the opportunity to participate at all levels.

In Kenya institutional support at right levels that would enable and empower women to take advantage of opportunities is currently missing or insufficient. The national machineries created in the wake of the UN Decade for women to guarantee participation of women in all development efforts are often understaffed and lack power and financial resources.
In Roda/pwani and indeed all groups visited during this study, out of all the 200 stable and successful groups 99% have women as leaders and the 1% men are more or less messengers because they are more flexible to send here and there. It is true women's groups are ready, able and committed to take on new tasks, but they need the skills and the know-how to take the most effective action.

In order to break the cycle of poverty, hunger and meagre

opportunities poor women need access to credit, lack of collateral often proves a major obstacle for women to increase their income. It is therefore necessary to design a rural credit scheme that provides this vital link in crossing from poverty.

Family structures are changing as male migration and weakening marriage bonds encourage the creation of the female-headed households that is today a typical family pattern. These changes are complicated by the global economic crisis, Kenya's debt and the impact of structural adjustment programs. It is therefore imperative that we revise our perceptions and understanding of what women do and incorporate this new concept of women as breadwinners into our thinking and planning of water supply and sanitation.

Fig 28. Women need respect

4.4.8. **User Hostile Designs**

Most designers of RWH structures showed no user friendly concerns. For examples:

1. The position of the tank relative to the kitchen and the dish rack is not considered when locating the tank site.

2. Orientation of the tap relative to the kitchen does not respect the user distance to be travelled.

3. Room for the bucket drawing water is usually not adequate.

4. The user sometimes has to step in mud and is exposed to dangers of slipping and infection.

5. Waste water drains are not provided and the water point areas becomes breeding ground for disease vectors.

Conclusion

1. All the 200 groups visited and in particular visit to sample areas Mukogodo and Roda pwani locations, it is very clear that working through local women groups in Kenya is the best institutional arrangement that guarantees sustainability of development efforts especially among poor urban and rural people.

2. A number of external support agencies promoting use of rainwater both NGO and government suffered organisational problems arising from

   (a) poor policies
   (b) poor leadership
   (c) poor management
   (d) lack of institutional capacity

These resulted in problems of:
   (a) accountability and
   (b) transparency

The organizations are then no longer corruption proof and programmes collapse.

3. Where RWH projects were based on handouts (Turkana District) sustainability was compromised. However a careful combination of relief and development remains a challenge among the planners.

4. The extent to which rainwater harvesting projects contributes to economic productivity and social-well being of consumers is not fully appreciated by some users and planners.

5. Institutional support that would enable and empower women to take advantage of opportunities available in social economic development is currently missing or insufficient.

6. Women's health and status will remain poor if their access to land and credit continues to be limited and if they are denied the education and training they need.

Recommendations

1. For sustainability and replication of demonstrated techniques of utilizing rainwater for various uses in urban and rural areas, realistic policies and regulations are required. These regulations and policies will be expected to mobilize domestic resources and to decentralize efforts so that the local public and private institutions will participate fully in the promotion and use of rainwater.

2. In order to offer potential consumers (users) the opportunity to participate and contribute effectively towards the project planning design and construction a baseline survey or participatory rural appraisal (PRA) should be conducted. In addition operation and maintenance ownership and control of the facilities will be guaranteed when the communities are fully involved from the very beginning.

3. Training needs and targets should be identified through careful study of progress reports, discussions and dialogue and continuous assessment of programme progress. The information obtained should be able to reveal training needs and targets. This should be followed by development of training objectives and training programmes finally implemented.

4. More support should be given to national machineries and to non-governmental organisations that focus on women.

5. Adult literacy well designed should therefore be crucial and necessary component of the intervention in order to improve the well-being of women and their families.

6. Programmes should include women component in order to provide adequate resources to improve women in development of the water schemes.

4.4.9 Limitations

The study faced a number of limitations:

(a) poor communications;
(b) political instabilities;
(c) people in pastoral areas moved from place to place in search for pasture;
(d) Several actors did not have well documented guidelines they use as was several GOK ministries.

5. APPENDIX

5.1. The Research Problem and Introduction

An adequate water supply is one of the basic needs of life. It is often lacking in developing countries particularly, in the arid and semi-arid (ASAL) parts of Africa.

The ASAL areas which are characterised by low rainfall, are coming under increasing pressure from human and animal populations. In Kenya, the Government policy has led to settlement of people in marginal areas, as for instance in Ng'arua-Laikipia District. For survival in such areas people must harvest what little rain they receive. The catchment systems to be adopted will have to be cheap, small-scale and decentralized to maximize funds available for benefit of maximum numbers of people. They would have to be constructed locally from local materials and controlled and maintained by the local people themselves, in order to avoid the need for continued and expensive infrastructural support. Small-scale irrigation systems to boost crop yield are fundamental to nutrition and health, among small-scale farmers (27).

The present levels of water supply coverage in Kenya vary widely -from as low as 14% in North Eastern Province to 20% in Central Province and 15% on average for all rural areas. At the end of 1986 the unserved population was estimated to be 14 millions (10) suggesting that serious attention must be given to alleviate this problem.

Propagation of rainwater harvesting in Kenya may be one way of alleviating this problem. Although, rainwater harvesting is an ancient technology, well known in India, Sudan, Egypt and Middle East, very little research on the potential for run-off water in farming systems, has been done. In sub-saharan Africa, where severe drought and food shortage are frequent (12), water harvesting is still to be seen as a possible solution to these problems. Although most Governments and Non-Government Organizations (NGO), have tried to encourage it, financially and technically, the rate of construction of improved water supply systems is still slower than the target set under the International Drinking Water Supply and Sanitation Decade (1981-1990).

Also many of the schemes already completed are not operating. Various reasons can be given for this e.g. lack of sufficient funding and trained personnel to operate and maintain water and sanitation systems (Nation, p. 14 14th June, 1993: and 6). It has been suggested that for lasting impact on the urgent needs of the community, water supply strategies must be based on sustainable programmes, taking into account the pace at which resource constraints can be overcome (21). A successful community water supply programme involves a combination of hardware and software technology, and institutional and organizational support elements, matched so that, each community can afford at least the costs of operating and maintaining the

water supply and have the skills, spare parts, materials, and tools required to sustain it. Technology choice, must match available community resources, for the up-keep of the system. Various water projects in Kenya have employed borrowed water harvesting technologies, without reference to a study on the most appropriate technology.

While this background may help us to understand the problem, there is still urgent need to carry out a study on what may be influencing the success such endeavors. No study has been conducted to evaluate how those who have succeeded in establishing a rainwater harvesting system, have utilized the water, in farming, domestic and livestock activities of the family (32). A similar observation has been made in relation to much-needed research into low-cost community water supply and sanitation technologies to demonstrate availability of appropriate technology to match the favored strategy of full community management of completed systems (32). The key requirement for an appropriate solution is that, it should be selected to match local circumstances, with particular attention to the human material, their socio-cultural environment and financial resources available for the operation and maintenance. The type of technology chosen should meet the requirements of the community reliably and economically for many years under local conditions and should not be something that is copied directly from a different situation. It has been shown (32, p.93) that, the targets of the International Drinking Water Supply and Sanitation Decade cannot be achieved unless there is a re-orientation away from expensive methods towards appropriate low cost techniques.

The most suitable water supply system is developed with the involvement of the local people, by creating a sense of participation and ownership within the target group (45). Efforts to introduce rainwater harvesting technology to the Turkana people in Kenya, were not fully realized due to lack of understanding of the social structure within which the technology was to be implemented and maintained, and lack of communication between the experts and the Turkana people on the type of technology they presented vis-a-vis the traditional methods of the Turkana people (10). The need for research before significant decisions are made, to enhance the understanding of the people's traditions and attitudes needs to be emphasized as does economic capability and the level of acceptability of the new forms of technologies. Such base-line data would lead to the improvement of water facilities while making them affordable with minimal maintenance costs (47).

Kenya, as one of the U.N member states, pledged to abide by the objectives of the International Drinking Water Supply and Sanitation Decade (1981-1990), so far, only a few areas have benefitted from such efforts. What needs to be investigated is why some areas have benefitted while others have not. The situation has been aggravated by lack of funds, frequent and unchecked settlement in the former ranching areas of European settlers, lack of qualified personnel to start and man water-

projects, poor operation of established water-projects and inappropriate introduction to rainwater harvesting technology.

Inevitably educational researchers, water engineers, community development officials, and others concerned with the health and agricultural production of the rural and urban populations, must engage in a series of investigations of why rainwater harvesting has not succeeded as expected, to assist government planners and community development officials in alleviating water problems in Kenya. Such investigations should help to review recent lessons, experiences and challenges in developing rainwater harvesting systems, and act as base-line data for use in future efforts involving this technology. It is imperative that an assessment of the socio-economic impact of rainwater harvesting on Kenya in general is carried out.

This information is essential in the identification of new strategies for greater local participation and crystallization of ideas related to rainwater harvesting systems, as well as conceptualization of rainwater harvesting projects by local people.

5.1.2. Statement of the Problem

Despite, various attempts by the Government, NGO's or the Rural Co-operative problems of water, sanitation and agricultural production in Kenya, are far from being solved. No studies have been done to point at the direction to be taken in order to resolve these problems. Absence of attempts to resolve these problems or to study the factors that have hindered the introduction and implementation of the various water harvesting technologies have yet to be investigated. Lack of agreement among the community development officials on the most appropriate rainwater harvesting strategies, and the ways that these would be implemented and responded to at the village-level, requires a survey to be carried out.

This research examined existing rainwater harvesting practices and factors that have hindered the acceptance and implementation of rainwater harvesting technologies. The study also explores cultural, economic, social and psychological barriers that impede the promotion of these technologies, reasons for the success of on-going water harvesting projects, and their effect on agricultural production, health and sanitation status in rural and urban Kenya.

5.1.3. Specific Objectives of the Study

This study

1. Examined rainwater harvesting practices and their relationship
   to rainfall patterns in the study area.
2. Determined - with respect to the existing water harvesting

technologies - the beliefs, perceptions, and attitudes of people in the study area.

3. Analyzed the socio-cultural structure of the people and its influence on the acceptability and use of water harvesting technologies not indigenous to the area.
4. Explored how rainwater harvesting systems have re-developed in the area, i.e either at house-hold or community level.
5. Determined the stage at which introduction of rainwater harvesting technology is most vulnerable, and factors associated with this.
6. Established the "state of the art" of the rainwater harvesting in Kenya as documented by various organizations eg NGOs, Governments, Bilateral and multilateral agencies.
7. Established the most common RWH technologies and estimated how widespread the technology is in Kenya.

5.1.4. Research Questions

To collect information that will assist in the realization of the above objectives, the following questions were raised:

I. Questions about Rain-Water Harvesting Practices and their Socio-Economic Impact

- Is there adequate rainfall to justify the construction of rainwater harvesting systems?
- Which are the most popular rainwater harvesting systems in Kenya?
- What are the catchment modes used e.g. roof, road, rock etc.
- If roofing is used, which are the most adequate and appropriate roofing surfaces to meet domestic needs?
- If tanks are used what size of tank is most appropriate.
- What health problems result from the use of harvested water?
- What tank construction technologies are used in the project area?
- How have existing rainwater harvesting practices influenced the economic status of households in Kenya?

II. Questions about development of Rainwater harvesting systems:

- Are rainwater harvesting systems privately or communally developed?
- What is the composition of community water groups and what factors influence the formation of these groups?
- What factors influence performance of the rainwater harvesting group, and at what stage is the group's effort most vulnerable?
- What role do External Support Agencies (ESAs) play in enhancing efforts of the rainwater harvesting target group?

III. Questions on the Socio-Cultural background of the People

- How do beliefs and attitudes of the people affect introduction and acceptability of non-indigenous water harvesting technologies?

- What are the beliefs, perceptions and attitudes with respect to the existing rainwater harvesting technologies?

5.2. Review of Related Literature

5.2.1. General

Little has been documented on the status of rainwater harvesting in Kenya. Available literature is also not properly referenced. This is probably due to the nature of work on rainwater harvesting which has tended to be localized, and results of which only appear in small papers and practical pamphlets that only circulate among the people a particular project. Lack of co-ordinated information has resulted in considerable duplication of work among the water harvesting groups.

In this review, rainwater harvesting refers to small-scale collection of rainwater from roofs, primarily for domestic water supply. Other systems may involve many hectares of collection area in the form of roads, sealed pavements and ground-runoff catchments to provide water for livestock and irrigation, as in Bermuda (51), (54), Yugoslavia (23), Hawaii (16, p.2), (22), (25), (26) and elsewhere (42). This review is primarily concerned with; (1) water supply alternatives for Kenyan communities; (2) rainwater quality and Health aspects; (3) Design and construction and (4) lessons and challenges facing development of rainwater harvesting systems.

5.2.2. Water supply alternatives for rural Kenyan communities

After independence in 1963, majority of the rural communities in Central Kenya moved into the former white farms and ranches, to look for land. Uncontrolled immigration led to settlement areas that were not adequately supplied with water systems. Attempts by the government to alleviate water problems were unsuccessful due to limited resources, uncontrolled settlement of people, and inefficient management of available water resources. Rainwater harvesting became a viable alternative, aimed at meeting a demand for a given quantity of water at a minimum cost, maximum hydrologic reliability, maximum quality, and minimal sensitivity to organizational or administrative failure. Among the limited number of studies involving rainwater harvesting in Kenya, ie (17), (43), (44), (53), (8), few are concerned with the issues raised above.

There is a clear need to study and evaluate the performance of various water projects in rural Kenya, to identify challenges facing development of rainwater harvesting systems in Kenya.

5.2.3. Design and Construction

Although, the design and construction of all components are reviewed in (11), (23), (24), (28), (34), (37) and (57); the

hydrology in (17), (33), (39), (41), (46), (48), (49), (51), (52), and (58): roofs in (5), (7), (14), (19), (20), (15), (29), (30), (34), (35) and (38), (55), no study has been done to identify the technologies being applied by rainwater harvesters in Kenya. There is an obvious need to carry out a survey, to assess these technologies in terms of affordability and maintenance. The Abidjan seminar of 1986, called for governments in developing countries to emphasize affordable and sustainable rainwater harvesting systems by adopting low-cost technologies appropriate to each country. However, efforts made to this end in Kenya, have not been documented.

5.2.4. Development of rainwater harvesting systems: Lessons and challenges

Rainwater harvesting as a water source has an increasingly bright future in Kenya. Little interest in studying this technology in Kenya, and isolation of the limited information available from studies on similar endeavors, in other parts of Africa and elsewhere have greatly hindered application of this technology in Kenya.

Renewed emphasis is now being put on this topic by researchers, governments and NGO's and it is now clear that rainwater harvesting is a unique area of applied science involving a wide range of fields, e.g. hydrology, design, construction, water treatment, environment and economics. Future developments in rainwater harvesting must involve collaborative efforts by experts to resolve water problems from a multi-variate standpoint. Lessons about the viability of runoff farming to improve crop production and economic performance of rural households; improvement of sanitation, general livelihood of rural people and environmental protection, have yet to be learnt. A study attempting to reveal the lessons from the current water harvesting practices and challenges thereof, is long overdue, to assist the government and NGO's in formulating their water harvesting related policies. Such lessons would also allay the anxiety of the desperate peasant farmers in our arid and semi-arid rural Kenya.

In summary, the literature review shows that studies on various aspects of rainwater harvesting in Kenya are few and inadequate, with no serious indication that findings from these have been transferred to the policy level in order to make an impact on prospects for runoff farming and improved sanitation practices. Furthermore, little documentation exists about evaluations carried out by donor agencies or NGO's that may have funded projects on water harvesting in rural Kenya. What is available are budgets of the proposed projects and accounting of the expended monies. This study will aim to fill this information gap and study some of the salient issues cited above.

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5.4. Rainwater Questionnaire

A. Interviews with families with rainwater tanks.

Socio-Economic conditions

1. Particulars
   Family name
   Sub-location ..... Location .....
   District ..... Province .....

2. Interview status/age
   ( ) Father/husband ( ) Wife
   ( ) Others (specify) .....

3. Education
   ( ) None ( ) Primary ( ) Secondary ( ) Higher

4. Number of person's currently in the household.

.....

5. i) Is the land owned individually or communally?
   ii) What is the approximate size ..... (1 acre = 0.405 ha)

6. What are the land owned individually or communally?

7. What benefits are derived from the activities?
   ( ) Milk ..... gallons ..... family use/day .....
   ( ) Selling animals ..... Monthly/yearly specify .....
   ( ) Crops: Maize in cobs ..... bags/year
   Pyrethrum ..... kg/week or month
   Others (specify) ..... kg/month/year.

8. What are the problems encountered in production/rearing or crops and animals from planting to marketing respectively?
   ii) If the source money is inadequate; what is your other source of income?

9. How has the rainwater harvesting tank affected production and standards of living on your farm/household?

10. i) How did you manage to have a tank?
    ii) What major obstacles do you overcome in completing it?
    iii) Now that you have water at reach how do you spend time formally spent in fetching water?

11. What are the sources of water supply on your farm? (Ranking from one most used.) (Use for this code 1-6).
    ( ) Dams
    ( ) Rivers
    ( ) Wells/boreholes

( ) Springs
( ) Tank water from roofs
( ) Tank water from fields/roads

B. Interviews with community group leaders

This interview is intended for leaders of various groups involved mainly in rainwater harvesting.

1. Name of group .....
   Location ..... Sub-location.....
   Province .....

2. Numbers of members .....

3. How did the group start?

4. Was there a criteria used in drawing the group members?
   ( ) Gender issues ( ) Age.....
   ( ) Income class
   ( ) Others (specify) .....

5. What criteria did the group use in choosing its committee members?

6. i) What challenges have faced in realizing the objectives seen by the group?
   ii) What rules have you set to govern the group to ensure smoothing running?

7. i) Where do you get advice in case of problems arising within the group?
   ( )Chief( ) C.D.A( ) Party leaders
   ( )others (specify) .....
   ii) How effective are they is solving problems?

8. How many households are female-headed among your members?

9. What is the groups monthly contribution and how do you deal with defaulters?

10. Which community organizations educated you on rainwater harvesting and sanitation.
    ( )Church groups: which are .....
    ( ) Agricultural officers ( ) other (specify) .....

11. i) Has the group received any assistance?
    ( ) yes( ) no
    ii) From who?Kind of assistance?
    ( ) Church (specify) ..... ( ) Money .....
    ( ) Government ..... ( ) Materials .....
    ( ) International ..... ( ) Others

(specify)
( ) NGO (Specify) .....

12. In your views have the community really appreciated the technologies available on rainwater harvesting!

C. Rainwater harvesting technology:
i) Catchment, collection and storage

This section mainly intended for the groups and can be assisted by technicians working in the communities.

1. Interview status
( ) Group leader ..... Position .....
( ) Group member ..... ( ) Technician

2.Which type of tank (s) do you have/aware of.
( ) Ferrocement (Cement and B.R.C - no.....
( ) Masonry blocks (cut stones) no. .....
( ) Adobe block (mud) ..... no. .....
( ) Underground water tank ..... no. .....
( ) Water jar No. .....
( ) Others (specify) .....

3. i) Do you like the type of tank you have
( ) Yes ( ) No (Give reasons) .....
ii) Why did you choose to construct water tanks?

.....

4. Are the tanks of the same design?
( ) Yes( ) No Why?

5. Tank dimensions
Diameter ..... metres Height ..... metres

6. Estimate capacity ..... gallon/litres/tank.

7. How much did the construction costs? (If uniform for the group at the beginning and the latest costs).

8. Has any tank needed repair?
( ) Yes( ) No

9. i) Do you engage artisan/mason in the construction?
ii) How much do you pay per tank or per day?

10. How much do the groups members participate in the construction?

ii) Water tank altitudes and Awareness

11. Which types of tank(s) are you aware of?
    ( )Ferrocement (cement and B.R.C)
    ( ) Masonry block (cut stones)
    ( ) Adobe block (mud)
    ( ) Underground water tank
    ( ) Corrugated iron
    ( ) Water jar
    ( ) Others (specify) .....

12. Why did you choose to construct the type of tank that you have?

13. In your view to what degree are the different tank (s) acceptable to the communities and why?

14. Why did you opt for rainwater tank rather than developing an alternative source of water?

D. Rainwater Harvesting Socio-Cultural issues

1. i) During the rains, in the past, did you collect and use rainwater?
    ( ) yes: How
    i) Are you still using any of the methods
    ( ) yes ( ) no
    Why .....

2. Is there a type of tank which is unacceptable for you to build.
    ( ) yes i) Which one? .....
    Why? .....

3. In your view what factors have influenced/are influencing adoption of rainwater harvesting technology?

4. In many groups, people prefer having members of the same sex, what are the major reasons for this?

5. How does community/family decision-making affect the acceptability and practice of rainwater harvesting techniques?

6. Which if the following roofing materials would you not collect water from?
    (Put Y for would and N for would not in the box).
    ( ) Corrugated iron
    ( ) Painted corrugated iron
    ( ) Asbestos
    ( ) Clay tiles
    ( ) Painted cement tiles
    ( ) Wooden shungles
    ( ) Thatch
    ( ) Cow dung

( ) Plastics

E. Interview with ESA Water Technicians

1. Area working on:
   Sub-location ..... Location .....
   Province .....

2. For how long .....? months/years

3. How has community participation affected success of community groups?

4. Through experience how does rainfall patterns/climatic in agro-ecological zones affecting the adaptability of rainwater harvesting techniques.

5. What kind of training do you expose the communities to influenced them to adopt rain water harvesting.

6. How has collaboration with other sectors agricultural administration/government or church organization influenced the success of rainwater harvesting in your area.

7. What benefit among your community can you accredit to the success of rainwater harvesting projects.

8. In your views are rainwater harvesting projects sustainable and what are your recommendations to those who have not adopt it.

9. What type of tanks are common in your working area and why?
   ( ) Ferrocement (cement and B.R.C)
   ( ) Masonry blocks (cut stones)
   ( ) Adopt blocks (mud)
   ( ) Underground water tank
   ( ) Corrugated iron
   ( ) Water jars
   ( ) Others specify

.....
Reasons.....
.....
.....

5.5. Tank Project Cost Elements

K: HARDWARE

No.	Item	Qty.	Unit	Unit Price	Price
1.	Cement	30	bags	380.00	11,400.00
2	1/4" Round bar	17	lengths	120.00	2,040.00
3	BRC no. 65	0.25	roll	11,50.00	2,875.00
4	Waterproof cement	8	kg	50.00	400.00
5	Black binding wire	3	kg	75.00	225.00
6	Chicken wire 72"* 11/2"* 30 m	1	roll	2,400.00	2,045.00
7	GI pipe 3/4"	2	6 m	1,086.00	362.00
8	GI elbow 3/4"	1	nr	25.00	25.00
9	GI bend 3/4"	1	nr	49.00	49.00
10	GI plug 3/4"	1	nr	15.00	15.00
11	GI tee 3/4"	1	nr	32.00	32.00
12	Lockable tap 3/4"	1	nr	180.00	180.00
13	Manhole cover	1	nr	1,500.00	1,500.00
14	Hose clip for 3" pipe	1	nr	70.00	70.00
15	Mosquito wire	0.5	m	220.00	110.00
16	Down pipe 3"	1	nr	120.00	120.00
		TOTAL K: HARDWARE Kshs			21,803.00

L. GUTTERS

No.	Item	Qty.	Unit	Unit Price	Price
1	Gutters 26 gauge	5	nr	224.00	1,120.00
2	Down pipes 3"	3	nr	120.00	360.00
3	Brackets	15	nr	12.00	180.00
4	Elbows for 3" down pipes	2	nr	120.00	240.00
5	Gutters end with 3" hole	1	nr	120.00	120.00
6	Gutter end without hole	1	nr	120.00	120.00
		TOTAL L: GUTTERS Kshs			21,803.00

M: LOCAL MATERIALS

No.	Item	Qty.	Unit	Unit Price	Price

1.	Sand	7 tons	100.00	700.00
2	Ballast 3/4"	3.5 tons	520.00	1,820.00
3	Hardcore	3.5 tons	100.00	350.00
4	Dressed stones 9"*9"	400 ft	15.00	6,000.00
5	Transport	4 lorry	3,500.00	14,000.00
			TOTAL M: LOCAL MATERIALS Kshs.	22,870.00

N: LABOUR

No.	Item	Qty. Unit	Unit Price	Price
1.	Fundi	tanks	2,000.00	2,000.000
2	5 local casuals	10 days	75.00	3,750.00
			TOTAL N: LABOUR Kshs.	5,750.00

O: MISCELLANEOUS

No.	Item	Qty. Unit	Unit Price	Price
1	Overheads	-	1,000.00	1,000.00
2	Water for construction	15 drum	50.00	750.00
3	Sugar bags	10 dag	30.00	30.00
4	Poles 2.55 m	30 nr	25.00	75.00
5	Transport		3000.000	3,000.00
			TOTAL O: MISCELLANEOUS Kshs.	4,879.00

Note: The sugarbags (O3) and the poles (O4) are 10 times re-usable. This is also how they are calculated.

O: MISCELLANEOUS

Code	Section	Price
K	HARDWARE	Ksh. 21,803.00
L	GUTTERS	2,140.00
M	LOCAL MATERIALS	22,870.00
N	LABOUR	5,750.00
O	MISCELLANEOUS	4,879.00
	TOTAL COST	Ksh. 57,442.00

5.6. General Questions

1. Name of the group.
2. Month and year the group started.
3. How did the group starts, through baseline survey or participatory rural appraisal or any other.
4. Indicate location and division the group is.
5. Number of members.
6. Number of men and women in the committee.
7. What is the group's monthly contributions.
8. What is the percent of female headed families in this groups?
9. What is average size of the families in this group.
10. What is the average source of income of this group.
11. What is the number and size of the tank.
12. What is the cost of the tank.
13. What is the number of fundis serving this group.
14. Has this group a bank account or not?
15. How often does this group meet (in a week or monthly specify)?
16. Which donor has given this group some assistance?
17. Which external support agency helped to start this groups?
18. Write down the most important rules that given this group?
19. What is the role of CDA, Chief in solving conflicts?
20. What is the role of the other local leaders in group's progress?
21. Name other groups in your area answer the above questions as our CPK groups.
22. What collaboration exists between the different sponsored groups that is CPK and others or between different groups?

23. How much money have they receive from their sponsors?

24. How reliable has the tank been (e.g. 2 months or one month dry period)?