Swedish International Development Authority - SIDA

RainWater

AN UNDER-UTILIZED RESOURCE

John Mbugua
&
Erik Nissen-Petersen

NAIROBI
March 1995

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Front cover photo: Water collection from a dam in Laikipia
Photo: R.Winberg

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FOREWORD

The Purpose of This Booklet

The booklet is mainly directed towards staff at medium-level of management involved in the planning and implementation of rural development programmes. It is intended to impart on the reader the potential and the basic technology of rainwater harvesting. The material contained therein is based on practical experience gained in the implementation of a rainwater harvesting project in rural Kenya.

The first chapter explains in general terms the potential use of rainwater harvesting (Rwh) and its additional benefits which can make people self-reliant in improving their standards of living without necessarily degrading the natural resource base.

Chapter II presents a case study of a successful example of rainwater harvesting in Laikipia District, a semi-arid area in Kenya.

The third chapter is aimed at encouraging planners, policy makers and field staff in promoting the use of rainwater harvesting as a the primary source, an alternative to, or as a supplementary to other water systems. It contains some important social and economic factors that should be taken into consideration during the planning and implementation of rainwater harvesting projects.

Chapter IV provides technical information on the construction of water tanks based on roof catchment.

A list of references on published materials containing technical details on rainwater harvesting technologies is appended at the end of the booklet.

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CHAPTER I. RAINWATER HARVESTING

1.1 INTRODUCTION

Water is essential to all life - human, animal and vegetation. It is therefore important that adequate supplies of water be developed to sustain such life. Development of water supplies should, however, be undertaken in such way as to preserve the hydrological balance and the biological functions of all ecosystems. This is especially so in marginal lands.

In other words, human endeavor in the development of water sources must be within the capacity of nature to replenish and to sustain. If this is not done, costly mistakes will occur with serious consequences. The application of innovative technologies and the improvement of indigenous ones should therefore include management of the water sources to ensure sustainability and to safeguard the sources against pollution.

The World Health Organization (WHO) of the United Nations estimates that 80% of diseases in the third world are attributable to inadequate water supplies and poor sanitation. The social and economic consequences of inadequate water are not only dehumanizing, but are also costly in terms of health and lost economic productivity.

Rainwater catchment systems have, for many centuries, been successfully utilized by people all over the world. In our time rainwater is collected from many types of surfaces to provide water for domestic use, livestock, agriculture, and fish farming. Rainwater is also used as a supplement to piped water supplies. The scale of application of rainwater harvesting technology is, however, still low in Africa and there is great potential for expanding the use of rainwater in the continent.

The primary source of freshwater is precipitation in the form of rain and snow. However, only 20% of the total global precipitation falls on land surfaces and of that only 9% stays on the land in forms of rivers, lakes, wetlands, reservoirs and as ground water. An illustration of the dynamics of rainwater is depicted in Figure 1.

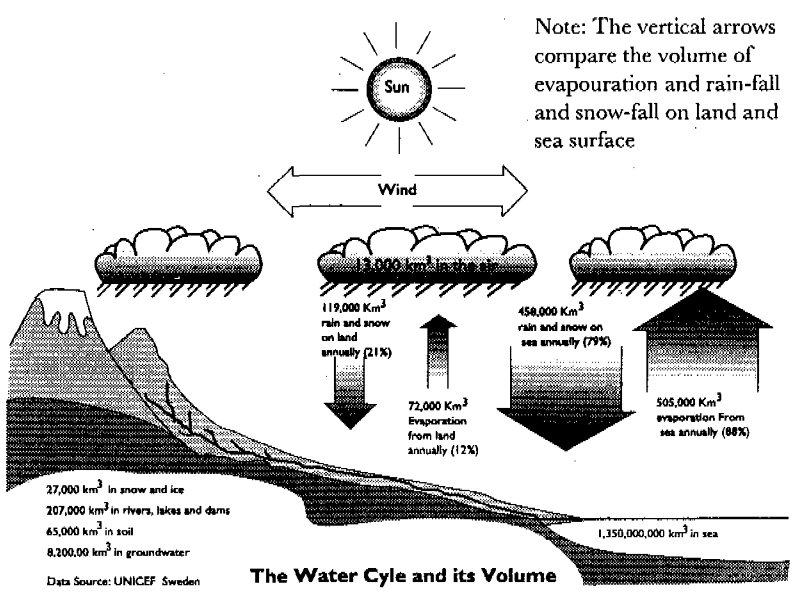

Figure. 1 The Global Water Cycle and its Volume

1.2 The Situation in Kenya

Kenya's Seventh Development Plan (1994-1996) states that as of 1993 the coverage of drinking water supply was 35% in the rural areas (much less in Arid and Semi Arid Lands areas(ASAL)) and 50% in the informal urban settlements. The plan also quotes that in 1991 an estimated 17 million Kenyans (approximately 75% of the population) were without reasonable access to clean water.

Vast rural areas situated away from rivers are nearly always under-developed with regard to water. It is an experience that whenever funds become available for water development, drilling of boreholes and piped water are usually given preference. On many occasions the boreholes sunk yield insufficient water or contain salty water. The cost of operating and maintaining boreholes, pumps, the associated equipment and fuel is usually above the capabilities of the department responsible for water and the community involved.

The annual rainfall in Kenya ranges from 150 mm to 2,000 mm annually. However, the amount of water available for utilization depends on the rate of run-off, evapo-transpiration, the watershed characteristics and the methods of interception at various point in the hydrological cycle. Evaporation losses from surface water on land in Kenya ranges from about 1,200 mm to 3,000 mm per year.

Based on the above considerations, it is estimated that the potential for rainwater harvesting in Kenya is approximately 42 million cubic metres per annum. This is equivalent to 5 litres of water per person per day. It is also estimated that by the year 2010, the rural communities in Kenya will depend on roof catchment for approximately 12% of their domestic water requirements.

In order to meet the expected demand, sustainable systems for rainwater harvesting must be developed. Past local approaches and experiences have proved that various types of technologies are available and can be applied easily at both village and household levels.

1.3 Promotion of Rainwater Harvesting

In spite of its potential, rainwater harvesting has not received adequate interest among policy makers, planners and water project managers in Kenya and the continent as a whole. Most use the available resources for the development of conventional and motorized water supply systems. They consider rainwater harvesting as competing with rather than supplementary to the conventional water systems. Low-cost options which people can afford and use for improving their standards of living is often overlooked. These attitudes and actions have hampered the development of institutions necessary for the promotion of rainwater harvesting on a nationwide scale. Yet the potential for increased use of rainwater for drinking as well as for agricultural production is high and the technologies involved within reach of the local economy.

Figure 2. **Irrigating vegetables with water from a ground tank by a simple suction pump.** - *R. Winberg*

Over the last 15 years, however, the number of supporters for expanded application of rainwater harvesting technologies has increased rapidly. Interested individuals and groups have organized themselves into two organizations in Kenya, namely:

1. The International Rainwater Harvesting Catchment Systems Association (IRCSA), established 1989 and which has had representation in Kenya since 1991. The Association's objectives are:
   (a) To promote and disseminate technologies on rainwater catchment systems on a world-wide scale;
   (b) To link together all those working on rainwater harvesting for the purpose of sharing information and experiences; and
   (c) To draw up international guidelines for the use of rainwater catchment technologies.

2. **The "Kenya Rainwater Association" (KRA)** is in the process of registration with the following objectives:
   (a) To promote sustainable rainwater harvesting by means of dissemination of information via a network;
   (b) To undertake research and to participate in conferences and workshops;
   (c) To create awareness among communities; and
   (d) To supplement the Government and (NGO) Non Governmental Organizations efforts in setting out guidelines for the use of rainwater harvesting technologies in Kenya.

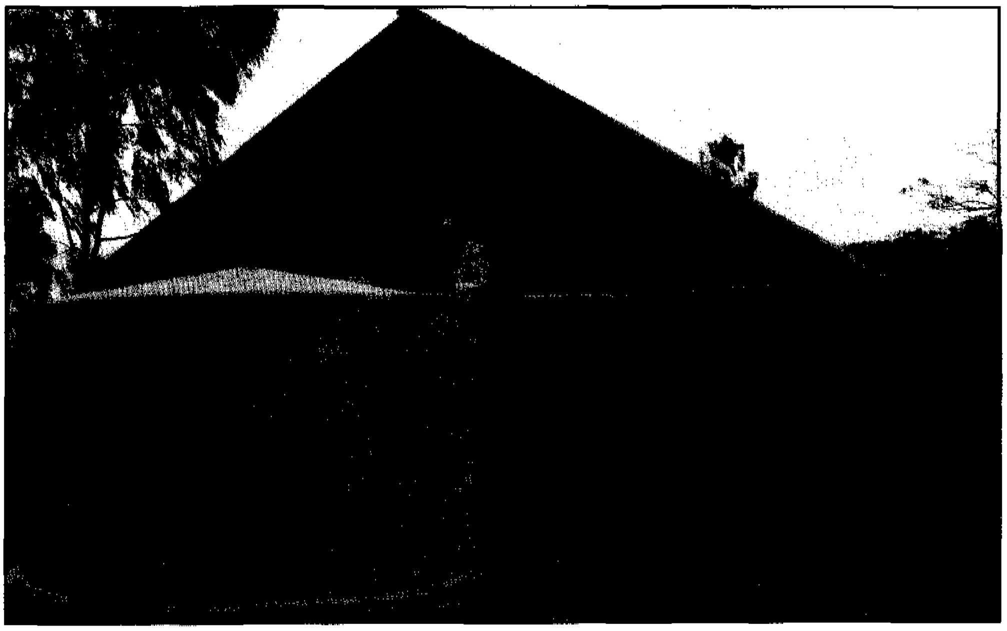

Figure 3. The Ministry of Health supports rainwater harvesting for drinking water through its environmental health component - *R. Winberg*

1.4 USES OF HARVESTED RAINWATER

Depending on quality, there are several uses of harvested rainwater, namely:

(a) Clean rainwater is suitable for drinking and domestic use;

(b) Harvested rainwater, when slightly contaminated by sediments, can be utilized for livestock watering and for construction; and

(c) Rainwater harvested from run-off from soil surfaces and roads is heavily sedimented. It is very useful for seasonal flooding of farmland (i.e. run-off farming) because the sediments are derived from the top soil which contains rich plant nutrients.

1.5 POTENTIAL IN THE VARIOUS AGRO-ECOLOGICAL ZONES

The economy of Kenya is based on agriculture and the majority of the population live in the rural areas and depend on agriculture for their livelihood. As noted in Section 1.2, the annual rainfall in Kenya ranges from 150 to 2,000 mm per annum. The main determinant of successful agriculture is annual and seasonal amount and reliability of rainfall. Based on rainfall and other criteria, high potential areas constitute 12% of land, semi-arid areas 6% and arid areas 72%. The remaining 8% is not suitable for human habitation.

High potential areas are, in many ways, better endowed than the ASALs. There are many rivers and streams that run all the year round. In addition, the amount of rainfall is higher and more reliable from one season to the other. As a result, water harvesting is more feasible and convenient because rains fill up reservoirs more frequently.

On the other hand, rainwater is the most accessible water source in ASALs. Homesteads, schools, livestock and wildlife are usually served through rainwater harvested in one way or other. For this reason, the Ministry of Agriculture, Livestock Development and Marketing and the Ministry of Land Reclamation, Regional and Water Development promote rainwater harvesting techniques particularly in the ASAL regions. The donor community and NGOs based in Kenya have similarly supported the development of small scale water supply systems based on rainwater harvesting at both community and household level.

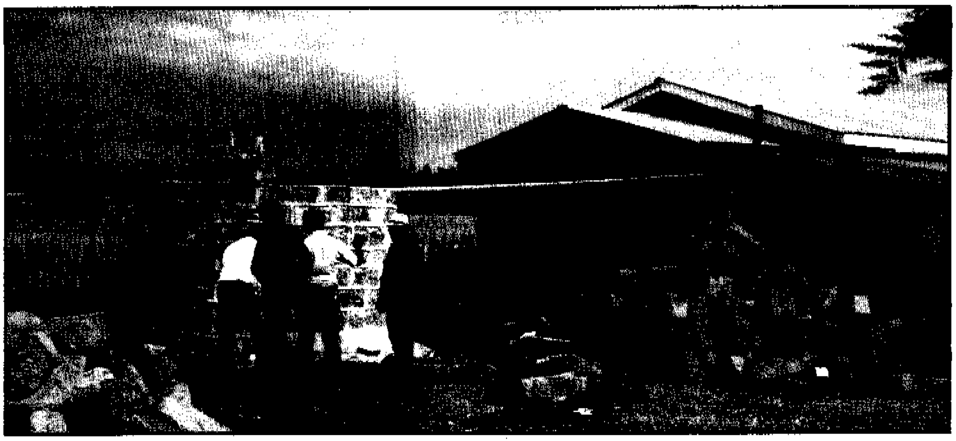

Figure 4. A water tank being built at a homestead by men. - *J.Mbugwa*

1.6 Rainwater Harvesting at Household Level

Rainwater harvesting at household level for domestic use has been the most popular and has been successfully applied. The main reason is that the user, who is usually a woman:

(a) owns the water supply system;

(b) is responsible for its maintenance;

(c) controls the use of water thereby avoiding misuse which would otherwise drain the reservoir before the next rains; and

(d) can collect water at the doorstep, thus saving time and energy. This enables her to attend to the many other tasks of managing a rural household and to participate in community affairs.

The above advantages also accrue to households which collect ground surface water for livestock and for run-off farming.

Figure 5. One of the water jars for domestic water built by women. - *R. Winberg*

1.7 RAINWATER HARVESTING AND THE ENVIRONMENT

Run-off arising from uncontrolled rainwater is the greatest agent of soil erosion, which subsequently gives rise to other forms of land degradation, including desertification. This is especially so in ASALs where the rainfall is erratic and the soils are fragile.

Ironically, the highest priority of the people inhabiting ASALs is water for human and livestock consumption, as well as for other socio-economic development programmes. In order to sustain the productive natural resource base of the areas concerned, the environment must be conserved by controlling and conserving water from run-off. The amount of run-off is approximately 50% of the rain that falls on bare soil without vegetation. Water harvesting therefore serves the dual purpose of preserving the environment and providing water - the most needed commodity.

Soil and water conservation measures, planting of trees and promotion of other forms of vegetative cover are some of the important measures in the prevention of land degradation and the preservation of the environment. Communities should therefore be persuaded through dialogue, training and extension to undertake the following measures:

(a) Re-vegetation of bare and open lands;

(b) Afforestation and vegetation of communal hills;

(c) Planting of individual and communal woodlots; and

(d) Planting trees around homesteads.

This is particularly important in rangelands and other communal lands in the ASALs where excessive overgrazing has resulted in the removal of the vegetative cover and left the soil bare. With good management, vegetation in ASAL areas could regenerate and provide the much needed fodder for livestock, food security and fuelwood while at the same time improving the environment.

Figure 6. A check-dam for rehabilitation of a gully - *R. Winberg*

1.8 OTHER USES OF RAINWATER

Several benefits accrue from well managed rainwater harvesting practices. A few examples of the benefits and end uses are described below. All the applications cited are labour intensive, require little purchased inputs, and are easy to construct and maintain.

Ground Water Recharge

Properly managed rainwater is essential for groundwater recharge, the main source of water for streams, rivers and boreholes. Good soil and water conservation and agroforestry practices facilitate infiltration of rainwater to recharge groundwater. The upper 10 metres or so of groundwater is termed *shallow groundwater* and is the main source of water for trees, hand-dug wells, sub-surface dams and shallow boreholes.

Run-Off Farming

Run-off farming is the technical term for level contours or bench terraces made of soil which force rainwater to infiltrate into the soil where it falls.

Micro-Irrigation

Micro-irrigation is a system in which rainwater run-off is diverted from catchment area to, for example, a tree seedling by means of a small V or U shaped soil bunds, or to crops planted within bunds or terraces.

Macro-Irrigation

In macro-irrigation, run-off from an outside catchment area such as a road, roof, compound or hill, is diverted to farmland situated at a slightly lower elevation by means of slightly sloping bunds made from soil or stones.

Flood-Diversion (Spate) Irrigation

River-diversion (or Spate) irrigation is a seasonal flooding of farmland. Run-off water comes from a seasonal water source which has been blocked by a small dam or weir made of stones or soil packed in sacks in such a way that the dammed water spills over to a point lower than the river bank.

Supplement to Other Water Systems

Rainwater harvesting is also used as a supplement to other water supply schemes. This is mainly applicable to situations in which boreholes and piped water systems are unreliable, or in situations where other water sources, such as rivers and lakes, are too distant or too polluted.

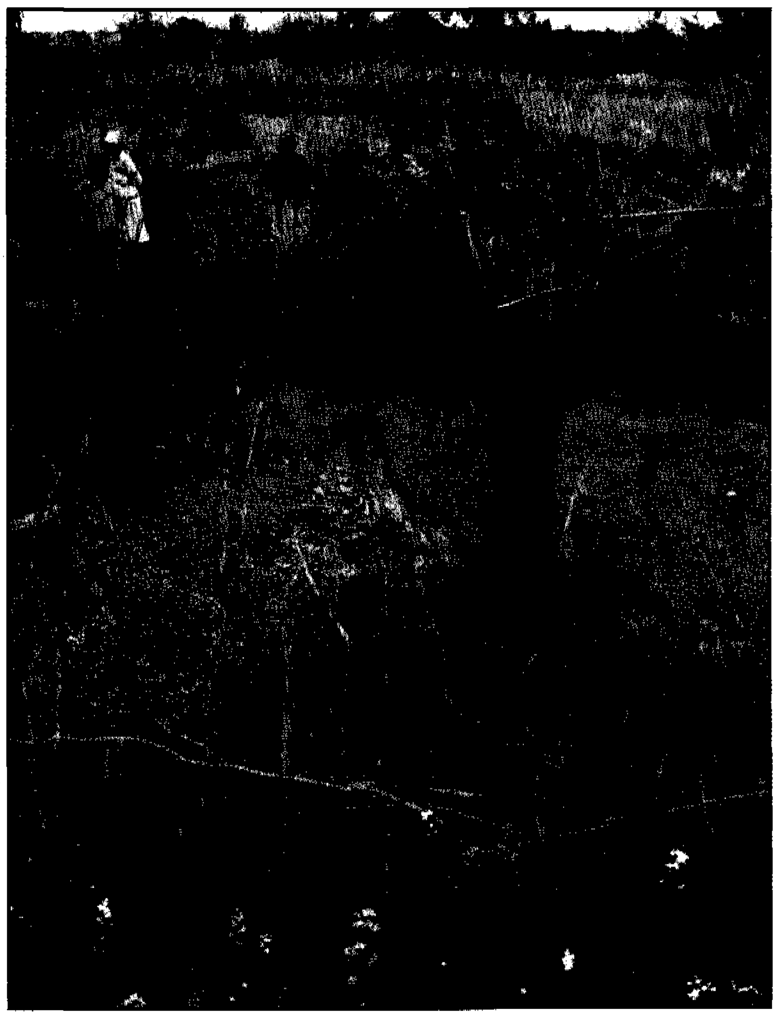

Figure 7. One of the many pounds tanks built for growing vegetables, it may later be up-graded to a lined ground tank - *R. Winberg*

CHAPTER II A CASE STUDY FROM LAIKIPIA IN KENYA

2.1 BACKGROUND

This chapter describes the experiences gained during the planning and implementation of a rainwater harvesting project in three locations of Laikipia District (Sipilili, Olmoran and Machunguru Locations). The project demonstrated that a well planned rainwater harvesting initiative can bring about a sustainable development to a community in an isolated and marginal area far away from river water sources.

Laikipia District lies on the leeward side of Mount Kenya and has an annual average rainfall of approximately 700 mm. Rain falls in two distinct seasons, the long and short rains. The area is categorized as a semi-arid. The communities in the three locations are subsistence farmers, growing crops (mainly maize and beans) and keeping livestock (cattle, sheep and goats). There are frequent droughts, resulting in frequent crop failure and decimation of livestock.

2.2 PRIOR TO THE PROJECT

Prior to the initiation of the rainwater harvesting project, the majority of the people living in the three locations did not have access to clean water. The only source of domestic water was from earth dams situated far away. The dams were also used for livestock watering. There was considerable soil erosion arising from inappropriate farming practices, resulting in heavy sedimentation of the water dams. Both these factors rendered the water unsafe for human consumption.

The heavy sedimentation of the dams reduced the volume of water such that there were times when water was not available, even for domestic use. The dams had to be desilted manually every third year, a tiresome effort for the communities.

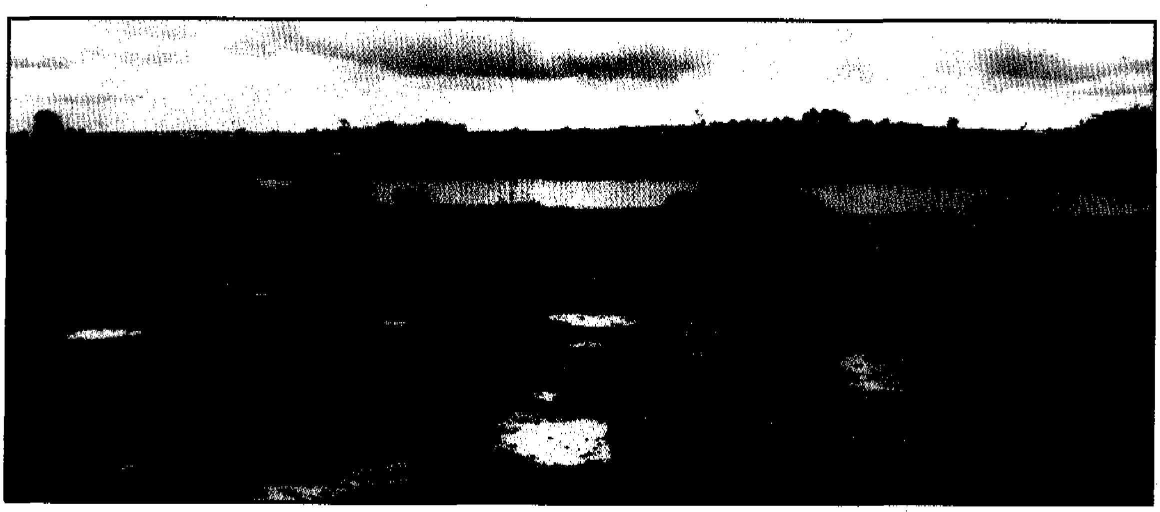

Figure 8. A dam under going desiltation - *R. Winberg*

In addition, many households had no pit latrines and the level of basic hygiene was low. Unavailability of safe water, low levels of nutrition and poor sanitation exacerbated the poor health status. The overall situation at the homesteads was that of despondency, dependency, desperation and insecurity. Many of the subsistence farmers abandoned their plots and went to urban centres in search of employment.

It was in the light of the above circumstances that the Laikipia West Communities in 1985 requested the Church of the Province of Kenya to initiate a community based resources mobilization project.

The project is still operating. It has apart from its own activities worked in partnership with MOH's environmental Hygiene Programme, MOA's Soil Conservation activities, UNDP supported Pastoral Water Programme and others

Figure 9. Participatory decision-making by group members - *J. Mbugua*

2.3 SURVEY AND ASSESSMENT

Participatory rural appraisal (PRA) was used as the method for the identification of the major problems. The exercise involved the villagers. The PRA pointed to the need for a human centred approach in which peace, security, raising of the quality of life, preservation of the environment, justice and democracy were to be important elements of development.

From the PRA, it became evident that the type of land use and farming practices in the area were unsuitable as they resulted in serious soil erosion, gully formations, general land degradation and inadequate agricultural production to sustain the families.

Water was identified as the top priority among the community. The traditional sources were too distant from homesteads. Women were spending considerable time in fetching small quantities of water. In addition the supplies had been rendered inadequate and unsafe by sedimentation and other forms of pollution. Assessments showed that other sources of water, such as ground water extractable through boreholes, was at great depths and often saline. It was therefore necessary to design an intervention that was based on both social and technical considerations.

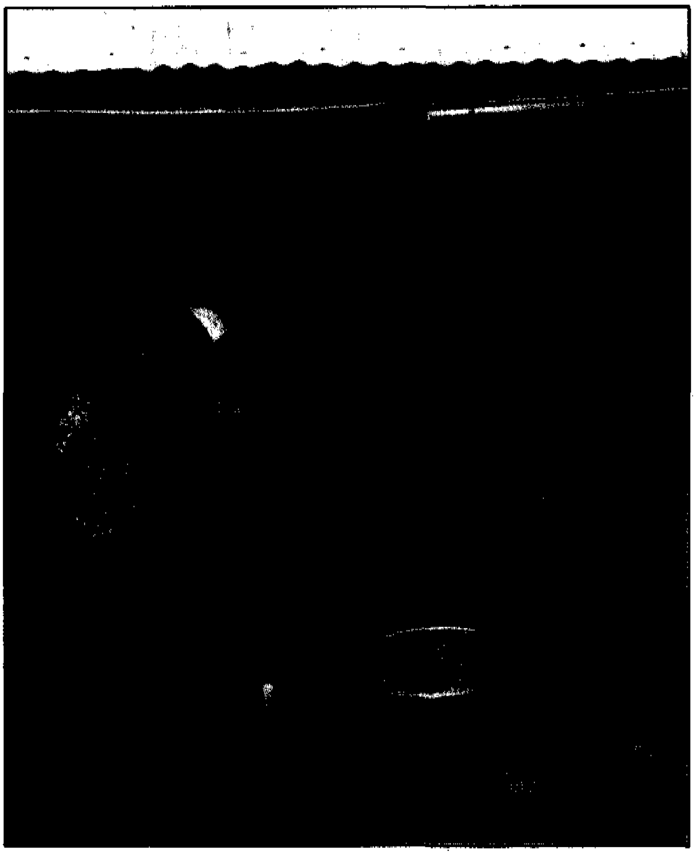

Figure 10. Even a small roof catchment system can give advantages - *R. Winberg*

Rainwater harvesting was considered a feasible option and a suitable entry point for other areas of social and economic development such as the improvement of health and agriculture. The concept of rainwater harvesting was not new to the communities as many homesteads were already using household utensils to collect drinking water from roof catchments. A few had developed techniques of collecting run-off water for irrigating their home gardens.

However, only 25% of homesteads had roofs with corrugated iron sheets essential for roof catchment water harvesting. It therefore became necessary to gradually develop various techniques to obtain water for households.

2.4 ROOF CATCHMENT SYSTEMS

The programme begun by introducing 200 litre oil-drums and 2,500 litre water jars for collection of roof catchment water. From the demonstrations of the potential of rainwater harvesting in these small containers, the communities decided to venture into larger systems such that at the end of the project, they had constructed 10,000 litre ferro-cement tanks.

The extension strategy adopted involved provision of technical advise, for example on the calculation of the correct volume of a tank in relation to the roof area and the amount of expected rainfall. Training was also provided in the construction techniques such as the proper material mix, the slope of the gutter and the importance of the splash-guard. Thereafter, the villagers did the actual construction.

Both men and women participated in the programme. Women built the jars on site while men were more interested in being trained in techniques of tank building. One outcome of the project was that it promoted a gender balanced participation in planning as well as in construction and maintenance of the water facilities.

2.5 RUN-OFF FARMING

Laikipia is a semi-arid district and soil moisture is the most limiting factor in crop production. Supplemental moisture therefore ensures a harvest. Farmers were therefore encouraged to practise run-off farming. The technique involved directing run-off from roads and upper reaches of slopes by bunds made of soil and stones into ground water tanks or directly into the gardens for macro-irrigation.

Farmers were also encouraged to practise soil conservation, to establish tree seedling nurseries and to plant trees around the boundaries of their farms, along the contours and around their homesteads. They were also encouraged to plant communal and individual woodlots. Planting of vegetative cover along soil conservation bunds was also promoted. It is claimed that these practices increased food production on a sustainable basis.

Figure 11. Once an eroded piece of land, now fertile garden - *R. Winberg*

Maize Production

Maize production increased as a result of improved land use and run-off farming. In Machunguru area, for example, yields were 8 bags of 90 kg each (720 kg) per acre prior to the project. Today, good farmers attain yields of 20 bags (1,800 kg) per acre. The additional maize stover produced is fed to livestock during dry periods.

Figure 12. Maize residues are cut for fodder using an extended panga - *R. Winberg*

Figure 13. Vegetable and fruit production for varied diet and cash income- *R. Winberg*

Vegetable Growing

Prior to the programme, the area did not grow any vegetables. These were obtained from Nyahururu and Nyandarua some 100 km away. Improved land use and run-off farming has enabled vegetable production to meet household requirements and surpluses for sale to augment household incomes. In addition, farmers have diversified their crops from the traditional maize and beans to include potatoes, carrots, kales, onions, soya beans, millet, bananas and fruit trees. This diversity has contributed greatly to food security and balanced diets.

Agro-Forestry and Afforestation

Prior to the project, the semi-arid area had very few trees, the original trees having been cut down for building, charcoal burning and for fuelwood. As part of the development package, the project encouraged production of tree seedlings and planting of trees within homesteads, along farm boundaries and contours, as well as on-farm woodlots and afforestation on communal hill tops. Enterprising farmers derived considerable incomes from sale of seedlings.

Figure 14. Tree seedlings for sale and for planting in homesteads - *R. Winberg*

Water Harvesting

A number of ground tanks were built by the community, thus taking advantage of, and maximizing on, the efforts made and the benefits accruing from soil and water conservation. Run-off water from roads, upper reaches of slopes as well as from roof catchments was directed towards these tanks. The water so harvested had various end uses including vegetable production and livestock watering.

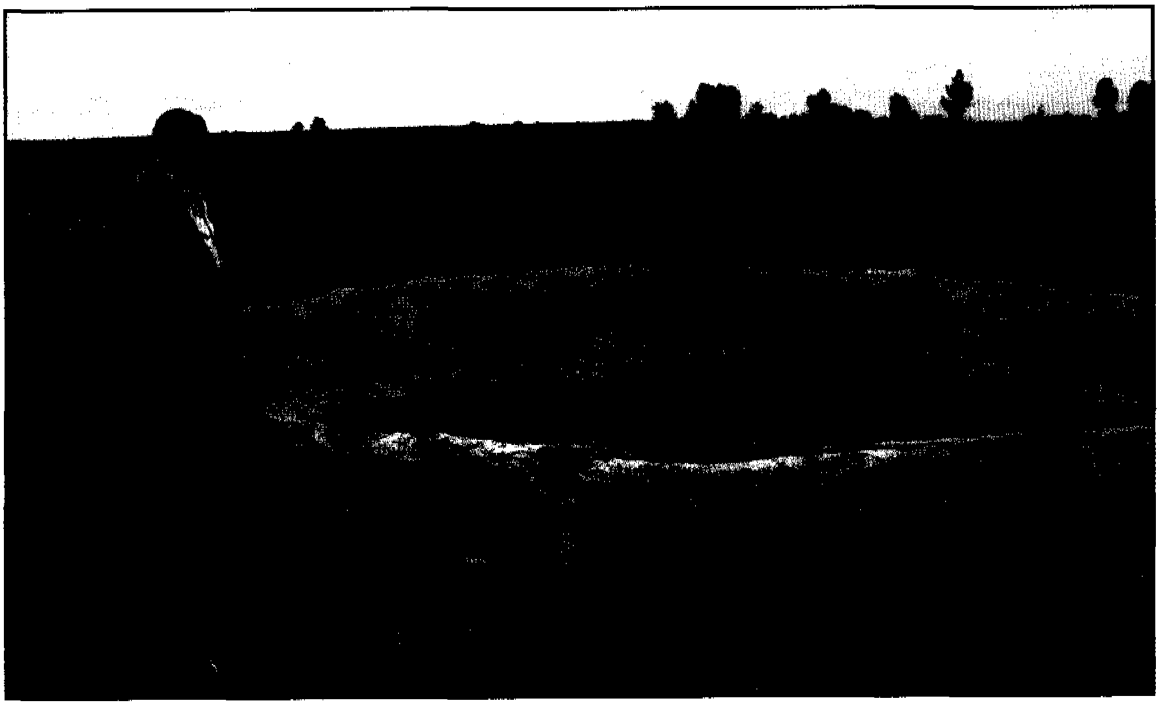

Figure 15 One of the many ground tanks built for vegetable growing - *R. Winberg*

2.6 HEALTH AND SANITATION

Although the programme was centred on provision of water as the entry point, it had some spin-offs and positive effects on other sectors of community development. This is attributed to the fact that members of the community were interacting continuously in a participatory manner, exchanging ideas and learning from each other. In addition, the existence of an organized community made it easier for extension services from other agencies to deliver advise. Specifically, the health sector had impact as illustrated by examples cited below.

Incidence of Diseases

The use of contaminated water resulted in high incidences of water-borne diseases, in which stomach ailments were prevalent. Costs for medical treatment for a family were as high as KShs 700. Availability of clean drinking water from roof catchments reduced the disease incidences, resulting in less sick days, increased economic activity of members of households and savings in medical expenses.

Malnutrition

It was also observed that increased levels of food production, accompanied by crop diversification reduced the once prevalent high levels of malnutrition. Households had improved calorie intake and varied diets than was the case before the project.

Home Improvement

The number of households with corrugated iron sheet roofs increased from 25% to 70% during the 10 year period. At the same time the number of houses with sufficient rooms to accommodate family members, and those showing some improvements increased from 40% to 70%.

Sanitation

As is the case with water, availability of toilet facilities is essential to public health. The number and types of latrines built was continuously monitored during the project period. In the whole project area the percentage of simple pit latrines doubled, improved latrines tripled and VIP latrines rose from zero to 24 % as shown in the Table 1.

Table 1. The percentage and type of latrines built in the three locations

Location	Simple Pit Latrine		Improved Pit Latrine		VIP Latrine	
	.Before	After	Before	After	Before	After
Sipilili	75	100	20	50	0	10
Machunguru	50	100	10	50	0	9
Olmoran	20	100	5	10	0	5

Figure 16. Children washing hands after using a VIP-latrine - *R. Winberg*

2.7 OVERALL PERFORMANCE

The performance of the project can be measured by its outputs and the benefits it brings to the community. Approximately 1,000 tanks of various types and sizes were built by the communities themselves with technical advise and essential material assistance by the project. Approximately 9,600 people have access to water as shown in Table 2.

Table 2. The number of tanks built and the number of people served.

Location	No of tanks built	No. of people Served
Sipilili	500	5,600
Machunguru	200	1,500
Olmoran	300	2,500
Total	1,000	9,600

Similarly, an increasing number of households became involved in various rural development activities that did not exist in the area prior to the project. The percentage of households involved in vegetable growing, tree planting, tree seedling production and house improvement increased as indicated in Table 3.

Table 3. Percentage of households participating in new activities.

Activity	Before	After
Vegetable Growing	0	100
Afforestation and Agroforestry	0	90
Tree Nurseries	0	50
House Improvement	40	70

2.8 OVERALL ASSESSMENT

Several independent evaluation teams state that after 10 years of implementation, the programme has considerably improved the living standards of the communities with regard to water availability, health improvements, farm management and the overall socio-economic factors that affect the people. The project was planned and implemented in such manner that the activities initiated should be self-perpetuating, replicable and sustainable.

CHAPTER III PLANNING RAINWATER HARVESTING PROJECTS

3.1 THE TERM 'PROJECT'

The term "project", as used in this chapter includes the entire process of conception, initiation, planning, construction, operation and maintenance of a rainwater based system. A project can be an individual household level initiative, or a broader community undertaking by several members of a self-help group with similar interests and objectives.

3.2 INITIATION OF A PROJECT

Initiation of a project is the most critical phase in the entire process. People themselves must identify and define their perceived needs and aspirations, based on their objectives and the resources available to them. The idea and the request for assistance for a rainwater development project should originate from the water-users themselves and not from government or donor staff, otherwise the project will be perceived as an external intervention and will not receive the necessary community support in the subsequent operation and maintenance.

3.3 OWNERSHIP OF A PROJECT

Water development projects normally require external inputs in terms of essential physical material and technical advice. Although the community is the recipient of such assistance, it should own the project. Beneficiaries should not be simply viewed as providers of free labour. They should be actively involved in all aspects of planning, implementation and management of the intended project. Project staff should, on their part, consider themselves as facilitators in the development of a community conceived water project.

Community participation can, in practice, be achieved through holding of meetings with all the beneficiaries of the project. A "Participatory Approach", in which water users assume a leading role as the true owners of the project, should be applied in making all decisions affecting the project. "Participatory Rural Appraisal" (PRA) methodologies, being fundamental for the successful implementation and sustainability of any project which promotes self-reliance, are well documented. Some references dealing with this subject are appended at the end of this booklet.

The participatory approach usually takes time to implement. However, if correctly applied, it has the advantage of bringing together the eventual beneficiaries in such manner that everybody becomes a stake-holder by agreeing to the objectives of the project and on how best to achieve them. Each member of the community clearly understands his/her role in the construction and management of the water resource. Once a general concensus is achieved, no problems would be anticipated during the implementation, management and maintenance phases.

3.4 INVOLVEMENT OF ALL GENDERS

Women and children are the main beneficiaries of improved domestic water supplies, sanitation and environmental hygiene programmes. Men tend to be more concerned with water for farming and livestock. It is therefore essential that both men and women be involved in the initial discussions and decision making on the scope and the eventual end use of water. They should all be involved in the planning, construction and control of water use and sanitation facilities.

3.5 Rules and Regulations

Once a self-help group has been formed, members should elect a chairperson, a secretary and a treasurer, and the deputies to these positions. A few more members should be elected to the committee to make it more representative, to cater for special groups and to bring in special expertise that may exist in the community to the committee. It is advantageous to register the self-help group with the Ministry of Culture and Social Services since the Ministry provides advise on the formulation of by-laws, rules and regulations governing a self-help group.

3.6 Agreement Between the Cooperating Partners

An agreement should be signed between the beneficiaries and eventual owners of the project (water users) on the one hand, and the benefactors (donor agency or government department) on the other, binding the cooperating partners in the implementation of the project as a joint undertaking. Such agreement should contain at least the following elements:

(a) The objectives of the project;

(b) The design of the project;

(c) Procedures for construction of the project;

(c) The budget and the contribution of each party; and

(d) By-laws and regulations governing the use and maintenance of the water system.

(e) Ownership agreed

3.7 Affordability and Viability

Proposals for water projects often become unaffordable and unviable for a variety of reasons. To begin with, those originating the idea may be over-ambitious and unrealistic in terms of the scope and size of the project. Secondly, the type of technology proposed for developing the water system may be inappropriate or too expensive in relation to the purpose for which the project is intended to serve. Thirdly, the majority within the community may refuse to participate, thus putting a big burden on the willing few. Such mistakes may be avoided by applying PRA methodologies.

External assistance to self-help groups should consist of presentation of a range of viable technological options and their comparative costs of construction and maintenance. Consideration should also be given on the possibility of making a water project self financing, e.g. through increase in farm production, fish-farming, brick-making or simply, the sale of water.

3.8 Grass Root Institutions

The development at grass-root level is a broader and more complex process than the commonly held objective of achieving economic growth. It involves learning and gaining new experiences and insight on the dynamics, values and practices of rural communities by working with them. In the process, the most important goal should be the strengthening of the democratic processes through which the user groups determine their common interests, objectives and aspirations. This will, in turn, ensure that the user groups have access to their resources and control over their own destiny. Through democratization, the communities will be in a position to determine their priorities, develop their economic potential and express their political policies commensurate with their needs and aspirations.

In spite of the general acceptance of the principles of involving community participation in the management of their own affairs, the results achieved have so far been limited. This is especially so in the development and management of community water supplies.

Kenya is famous for the large number of community based organizations (CBOs). This is particularly so in the large number of women groups which are well organized and mobilized for development projects. Such groups and individual initiative offer good opportunities for the promotion and development of rainwater harvesting systems.

3.9 FINANCING OF PROJECTS

Poor conception and implementation of donor aided projects have negative and undesirable effects on the community and on the projects themselves. This arises in situations where communities are not involved in the planning and implementation of the projects. The net result is that the donor finances the entire project and assumes the costs of operation and maintenance. The community becomes donor-dependent and, when donor funds are no longer available, the project collapses and the community is worse off than before.

Kenya is also known for her Harambee spirit and communities are always ready to pay to reasonably costed projects where they see clear benefits. Rainwater projects is an example of a project that could be financed by the community itself, and where everybody pays in cash or in kind. A family without cash could, for example, sells a goat to raise cash. Such self-financing arrangements reduce and and could actually eliminate the misuse of public resources such as funds, transport and materials.

3.10 MONITORING AND EVALUATION

Monitoring and evaluation of projects are desirable features in any development programme. They are intended to ensure that the planned activities are implemented as originally designed and that resources are utilized in an accountable way. Donors are mainly interested in the accountability and effectiveness of their funds and should not continue monitoring completed projects. The communities should monitor and evaluate their own projects and perfomance. They know best how to utilize their resources, and their accounting and book keeping systems may not conform to those applicable in government or donor institutions. In undertaking M&E activities, donors and government officials should be careful not to antagonize the community and their elected officials.

External M&E should therefore only be undertaken at the group's request, or when the group decides, in a participatory manner, that it requires technical or economic advice on running, expanding or diversifying their projects.

3.11 TECHNOLOGY

Indigenous ideas presented by the user-groups, when carefully assessed on technical grounds and supported by training, should result in projects manageable and maintainable by the communities themselves with minimum backstopping by donors and technocrats. The precondition to such projects are that they should be simple, easy to operate, manageable in scope, not reliant on imported technology, and have low maintenance costs.

CHAPTER IV CONSTRUCTION OF ROOF CATCHMENT TANKS

4.1 CALCULATING HOUSEHOLD WATER DEMAND

Most semi-arid regions in Kenya have two rainy seasons. In between are two dry periods of about 180 days without rains. A water tank should therefore have a volume large enough to supply water for at least 180 days. A good size tank and judicious use of water ensure water availability during the rainy seasons and during the intervening dry spells.

To ensure availability throughout the year, it is important to ensure that:

(a) The tank is full of water at the beginning of a dry season; and

(b) The volume of water drawn per day does not exceed the estimated demand.

The volume of a water tank is estimated in relation to a family's demand, the supply capacity of the roof area and the rainfall. It would be preferable to build a larger tank than the estimated demand, if the extra cost is affordable.

If, on the other hand, the cost of the tank to meet the estimated household water requirements is in excess of resources available to the family, the required volume can be obtained in stages by building one jar every year until the total volume has been achieved. As an example the Thai Jar, which has a volume of 2,000 litres, requires only 3 bags of cement and binding wire or about 10 m^2 chicken wire to build.

4.2 CALCULATING THE VOLUME OF THE TANK

The required volume of a tank can be estimated as follows:

(1) First, estimate the demand of water for the dry season by:

  (a) Determining the number of persons in the household;

  (b) Determining the number of litres of water consumed per person per day; and

  (c) Determining the number of days without rain in the longest dry period of the year.

(2) Multiply the figures obtained in (a), (b) and (c). The result is the required volume of water to be stored in a tank.

EXAMPLE:

(1) To calculate household demand:

8 people x 5 litres x 180 days without rain = 7,200 litres or 7.2 cubic metres. This is equivalent to 35 oil drums of water.

(2) To estimate supply capacity of the roof:

Measure the length and width of the roof and multiply the measurements. The result gives the area in square metres which is available for collecting water. This area is called the roof catchment.

(3) To calculate the amount of rainwater that can be harvested:

Find the average annual rainfall in the area and multiply it with the square metres of roof catchment. For example, if the house is 10 m long and 6 m wide, and the rainfall is 500 mm (equal to 0.5 m), the amount of rainwater that can be harvested is:

10 m x 6 m x 0.5 m = 30 cubic meters of water or 30,000 liters of water. This is equivalent to 143 oil drums of water.

(4) Calculation for losses:

Loss of approximately 20% occurs due to splashing over the roof and gutter. This loss can be reduced to 10% if a splash-guard is fixed over the gutter. If 20% is deducted, the result is that the roof can supply 24,000 litres of water in a full year from a rainfall of 500 mm. With an estimated demand for the dry season of 7,200 litres, the tank volume should be at least 8,000 litres.

4.3 Calculation of Run-Off From Ground Surfaces

To calculate the run-off from ground surfaces, the reader is advised to use the tables contained in a manual entitled "Rain cathment and Water Supply in Rural Africa" whose reference is shown in the Appendix.

4.4 Shapes and Materials For Tanks

The most economical shape of a tank is a sphere (ball-shaped) because it gives the maximum volume for minimum of materials. Spherical tanks are, however, difficult to construct except when using PVC material. The second most economical shape is a semi-sphere (half-ball). Thousands of semi-sphere shaped tanks have been built as underground tanks using ferro-cement or clay and lime.

Communities prefer cylindrical shaped tanks. They are easy to build using, as a guide, a vertical pipe placed at the centre of the tank. Such tanks can be built using materials such as corrugated galvanized iron sheets, burned bricks, concrete blocks, quarry blocks, ferro-cement and PVC.

The most economical choice of shape and materials depends on skills of the artizan and the availability of local materials.

4.5 Roof and Manhole

To avoid contamination of water by dust, leaves and drowning animals such as lizards and rats, tanks should be covered by a roof or dome. Roofs and domes also eliminate evaporation losses. A dome made of ferro-cement is the cheapest and strongest. However, the technique requires more skill than the building of a flat roof of reinforced concrete.

A roofed tank must have a man-hole to allow the exit of the builder after completion of internal works and to facilitate subsequent entry for cleaning. Cleaning should be done at least every five years. The man-hole should be situated at the highest point of the roof or dome and should be lockable to prevent children falling into the tank.

4.6 Overflow and Water Tap

In order to utilize the whole volume of a tank for storage of water, the overflow should be situated at the highest point of the tank. For the same reason, the water tap should be situated at the floor of a tank but leaving a 3 cm nipple to serve as a dust trap. The draw-off pipe with the nipple and water tap should be situated on the concrete of the floor and not in the wall. A ground tank should be equipped with a hand pump. Alternatively, a tap station should be constructed.

4.7 An Elevated Foundation or a Tap -Station

Since the water tap is situated on the foundation of a tank, it is not possible to place a bucket under the tap. The foundation should therefore be raised to 60 cm above the ground by means of stones set in concrete. Alternatively, a 70 cm deep tap station with stairs should be built under the water tap.

It is cheaper to build a tap station than an elevated foundation except for small tanks and jars. A tank with a volume greater than 5,000 litres should not be build with an elevated foundation or in a place where the soil is unstable. A tank full of water is very heavy could crack an elevated foundation, thereby damaging the tank.

A tap station should have a drain to discharge waste water. The drain should consist of a two metre deep pit situated partly under the stairs but as far from the tank as possible. The pit should be filled with large stones some of which will form the steps. In case of blockage, the obstacle can be removed by hand. To avoid accumulation of dust and debris, the tap station should be covered with a door or lid.

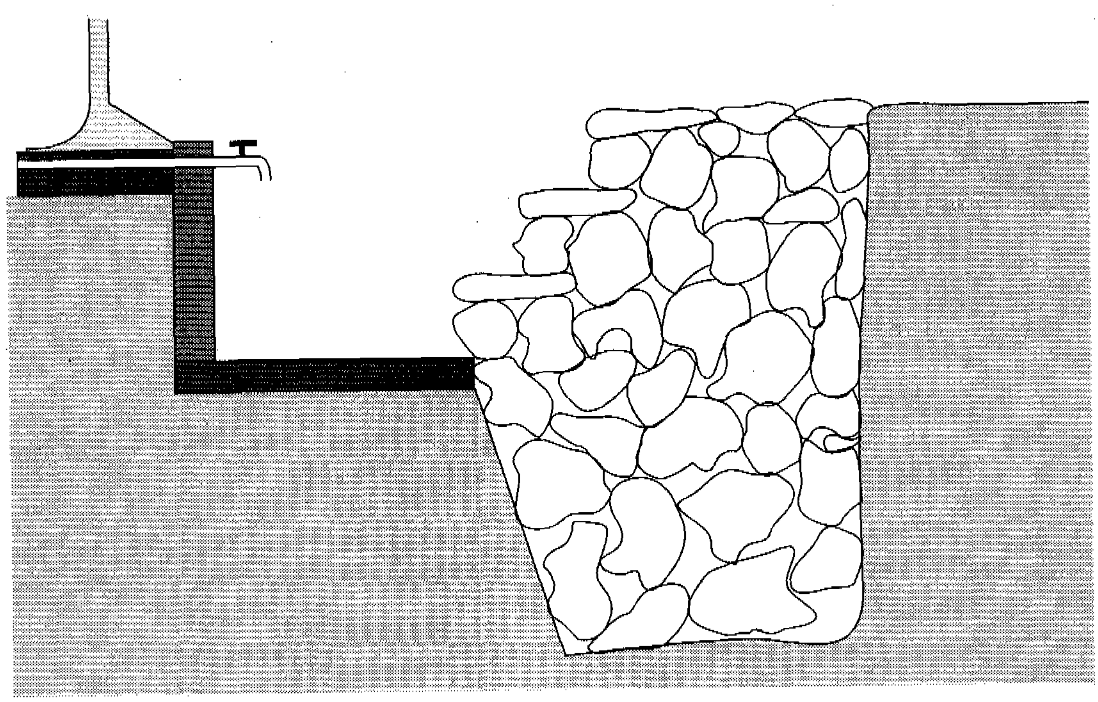

Figure 17 A tap station with drain to a pit

4.8 Gutter and Splash-Guard

It is not generally appreciated that the gutter is just as important as the tank in a roof catchment system. A splash-guard reduces the waste of rainwater from a roof by at least 10%, and its installation is therefore a good investment. Furthermore, if a roof does not have facia-boards, the gutter can hang in the splash-guard thus saving the cost of installing facia-boards.

A gutter should have a slope with a gradient of at least 1 cm for every 100 cm length. This facilitates quick discharge of roof run-off water, and without spill-over to the tank. The high velocity of the water in the gutter also clears the gutter of debris.

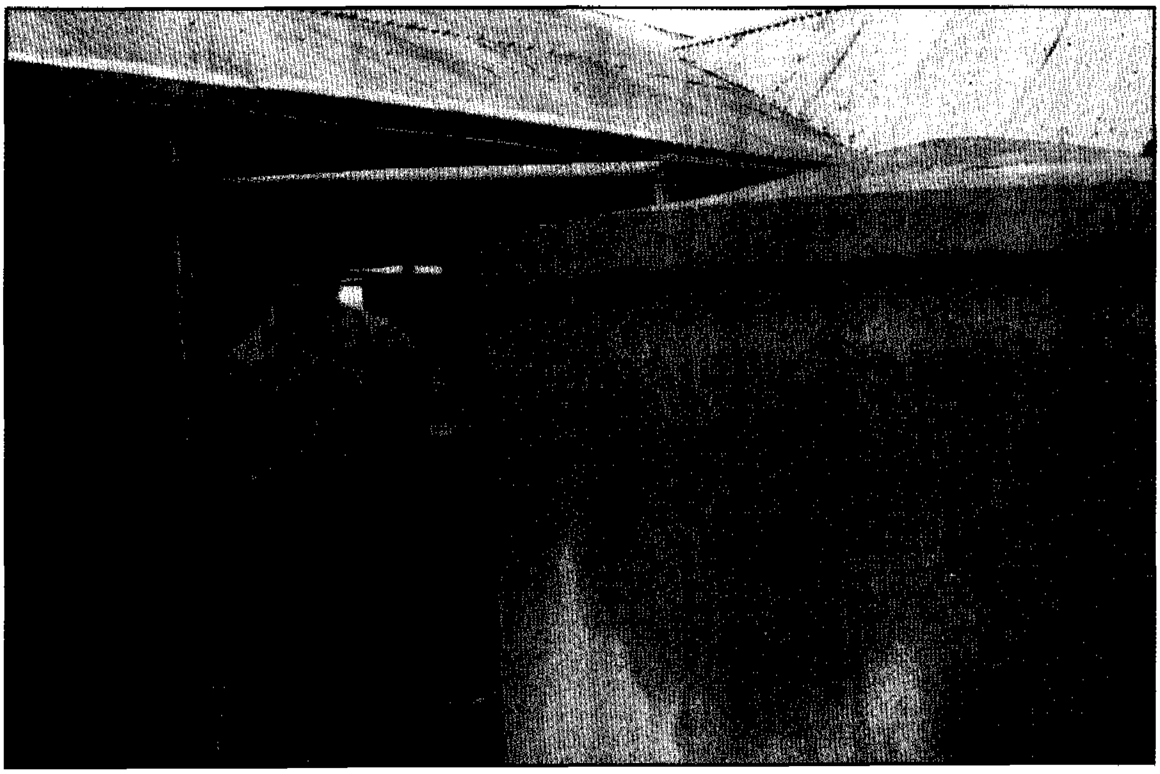

Figure 18. A gutter with splash-guard and self-cleaning foul flush - *R. Winberg*

Water from the down-pipe should pass through a foul flush which removes debris and dust before the water enters the tank. Several interesting designs have been tested but most of them, require maintenance which people tend to forget.

4.9 DOWN-PIPE, INLET HOLE AND FOUL FLUSH

The usual types of down-pipe are closed and have several sharp bends between the gutter and tank. These get easily blocked resulting in considerable waste of water. An efficient down-pipe should be straight and open to allow fast flow of water and easy entry to the tank, without obstructions. A down-pipe should therefore enter the tank through an inlet hole situated at the top of the dome or roof.

Instead of a fool flush a galvanized mesh sloping at 45 degrees over the inlet hole could help. It has the benefit of no maintenance except the replacement of the mesh when aged. The water from the down-pipe shoots through the mesh and all debris, except dust, hits the mesh and rolls off by gravity.

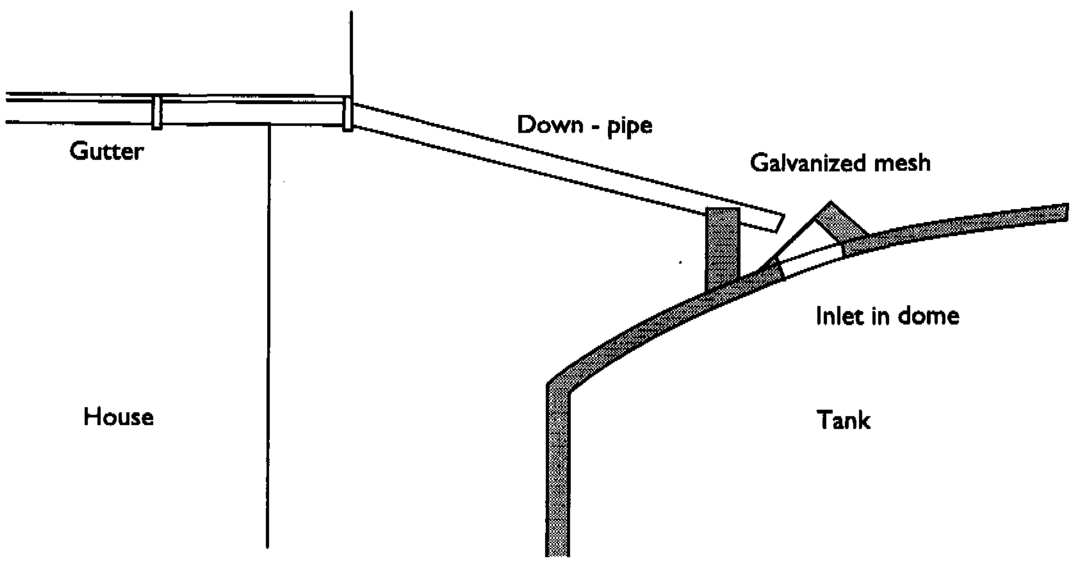

Figure 19. A gutter with down pipe and mesh protection of inlet.

APPENDIX

REFERENCE MANUALS FOR DETAILED INFORMATION OF RAINWATER TECHNOLOGIES

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