DOMESTIC ROOF WATER HARVESTING IN THE HUMID TROPICS

TASK D

REPORT – D_4

HOUSEHOLD STRATEGIES FOR OPERATING TOTAL AND PARTIAL DRWH TO ACHIEVE WATER SECURITY UNDER STRESS CONDITIONS RECOMMENDED PRACTICES

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HOUSEHOLD STRATEGIES FOR OPERATING TOTAL AND PARTIAL DRWH TO ACHIEVE WATER SECURITY UNDER STRESS CONDITIONS: RECOMMENDED PRACTICES

1 Introduction

This is the fourth milestone report in a series of six reports. This report attempts to highlight the practices adopted by rainwater user communities to achieve household water security. In doing so the report has attempted to separate out households using rainwater as a total water source and those using as a partial source. However, in a country like Sri Lanka, where the annual average rainfall exceeds 2000 mm and with a strong commitment to supply "water for all by year 2010" total rainwater user communities hardly exist. It could be possible that there are isolated cases, especially on high mountainous areas where people depend on total rainwater due to the absolute difficulty in collecting water in these environments.

This report discusses rainwater collection practices in four locations. Two locations are categorized as dry with an annual rainfall average of less than 800mm and two locations categorized as wet with an annual average rainfall of more than 2000mm. Further, one of the two dry locations are on the coastal line thus, the natural ground water is saline and non consumable. The other dry location situated in the Southern province approximately 35km inland from the coast. Ground water in this location can be categorized as "hard" with a high mineral content, hence not suitable for drinking. The two wet locations are situated in the central hills and in the southern hills. In both the locations rainfall is high with more than one reliable source for collecting water.

With the geographical differentiation of the locations, water availability and quality of water, people's behavior and use of water varies. Strategies to conserve water depends largely on the assurance of water availability, its quality and quantity.

This report discusses the hydrological context of harvesting rainwater, use of multiple sources, different practices and conditions of harvesting rainwater, water saving measures, few case studies of actual practices and possible good rainwater harvesting practices that are presently prevalent in Sri Lanka.
All findings and illustrations in this report are exclusively from Sri Lankan rainwater harvesting practices

Total and Partial Rainwater Harvesting

Before proceeding any further it would be prudent to understand the difference between total and partial rainwater harvesting. While there are no accepted definitions for these types, one would assume total rainwater harvesting to describe dependence on rainwater for all household needs from one hydrological cycle to another. Partial rainwater harvesting, on the other hand refers to use of rainwater in combination with some other sources of water to achieve household water security. While this definition emphasizes water quantity as the main factor, water quality too plays an important role in achieving water security within either total or partial rainwater harvesting.

In the Sri Lankan context, collecting adequate quantity of water to satisfy household needs is possible, provided there are large storage tanks. However, the quality of water in these tanks often deteriorates with time, thus, warranting the collection of good quality water from other sources. Under this situation the practice may not qualify as a total rainwater harvesting. The question therefore would be, whether we could call the period where a household totally depends on rainwater "a total rainwater harvesting practice". If we adopt this definition, there are number of cases in Sri Lanka where total rainwater harvesting is practiced. Usually the time period varies from two weeks to two months immediately after the rains. In extreme cases this period can extend to as much as 7-8 months (households located in high mountains with only 1-2 members).

Partial rainwater harvesting, which is commonly practiced in Sri Lanka refers to use of more than one source of water, including rainwater as one of the sources. Contribution from rainwater into the total household water budget can vary from 5%-70% depending on location and rainfall regime.

There are number of best practices of partial rainwater use in Sri Lanka. This can vary from using one or two other water sources with rainwater or it can be as much as five to six other sources with rainwater. In all such situations there appears to be perfect harmony in satisfying the household water budget. For such households, partial rainwater harvesting has improved their household water security.

Hydrology and Harvesting Rainwater

Where do people harvest rainwater and under what conditions?. In Sri Lanka, People harvest rainwater everywhere and under all conditions, may they be extreme dry or wet. Sri Lanka receives an annual average rainfall of 2500mm with a variation between 800 and 5000mm. As such rainwater can be collected provided there is adequate catchment area available. The rainfall pattern in Sri Lanka indicates both a seasonal and a regional variation. The concentration of annual rainfall into specific periods in different zones can create considerable shortages of water during the months of low rainfall. A typical rainfall pattern in Sri Lanka will indicate a peak rainfall (monsoon) period in December to January and an inter-monsoon period of March to May; additionally October to November has a moderate rainfall. Thus, the typical dry period falls between June and September when the rainfall can drop to less than 100mm cumulative in certain instances. However, the problem lately has been that the inter-monsoon rains have very often failed to realize to their maximum potential or have failed totally, causing severe hardships to rural communities. This situation sometimes results in a dry spell of more than 8 months.

It is in this situation that multiple source of water in conjunction with rainwater harvesting becomes important. As mentioned in the last section almost all-rural people (other than those who have pipe-borne water) use more than one source for water. Communities settled in the dry coastal area use a larger number of water sources than communities settled in non-coastal dry areas. Communities in the wet Hill Country use a lesser number of water sources. However all these communities employ rainwater irrespective of the number of other sources they use. There is no definite system for

selecting water from a number of rival sources, however people are concerned about the drinking water sources. For instance drinking-water wells are specifically identified and if water is brought from bathing wells, water is always boiled before consumption. One of the primary concerns of rainwater users is to conserve rainwater as a reserve and use water from other multiple sources during the rainy season. During the dry season people will still use less rainwater and more of other waters, thus stretching the concept of "rainwater reserve". The social infrastructure in Sri Lanka is such that even in the driest periods there is at least one source of good water to which people have access. If all sources deplete in a worse case scenario, then the local authorities would step in to provide water to houses by state-owned Bowsers.

Therefore the rainwater tanks supplement other household water sources and act as a ready reserve, thus, giving the inmates a "sense" of water security. While water security in numerical terms can vary within a continuum, the sense of having a water reserve at home enhances the rural livelihood options and mobility, which can only be expressed by the **satisfaction written all over their faces.** Litreally no model will capture the true feeling of a household when water is an assured supply. It is the same feeling a dry zone farmer derives by "seeing" water in his village reservoir, which is the life blood of the rural community.

2 General Practices of Harvesting Rain Water

As mentioned earlier rainwater is harvested for all means, everywhere, by almost everybody who has the "need". Sri Lanka, which possesses a rich hydraulic civilization knows the value of water, hence water management was a prime concern of most of its citizens (unfortunately this tradition has been changing with globalization and open economic policies). Collection and storage of rainwater was practised by our forefathers, starting from the 5th century BC by King Kassapa in the famous Sigiriya rock fortress.

Traditional Rainwater Harvesting Practice

A number of traditional rainwater-harvesting practices have been documented by Ariyabandu (1998), in the report entitled "Wisdom of Traditional Rainwater harvesting in Sri Lanka". Presently these systems are almost non-existent or very rarely practised with other more conventional practices. The prime reason for using these methods at present is to increase the water availability at household level.

Conventional Rainwater Harvesting Practice

In most rural Sri Lanka, houses have two units, the main living house and the kitchen house. In most cases the roofs (one side) of these two houses taper towards one side forming a sufficiently large catchment area to harvest rainwater. Under this practice, an improvised gutter (made out of folded tin sheet) will carry the water to an open tank constructed right under the roof interface (Figure 1). There are no downpipes under this system, thus, water falls freely during rains. The size of these tanks can vary from 300 to 1000 litres. Collected water is used immediately depending on the demand. There are no special practices to conserve this water. It basically acts as a stock tank during the wet

period. There is no regular pattern of maintenance of these tanks but if the water get contaminated due to excessive organic matter or accidental falling of small mammals, it will be cleaned immediately, using the next rainfall. Usually these tanks have an outlet at the bottom for cleaning and emptying the tank. Water use in these tanks takes place mostly during the rains. In the dry periods one often finds these tanks have become ideal breeding grounds for mosquitoes, as a few inches of water is always left in them. However, those who have the means to bring water from distance places, in large quantities (usually transported in tractors), also store such water in these tanks. According to one affluent villager, these tanks can hold five barrel (200litres) of water he transports from 8 km away. Therefore, these conventional tanks act as a durable storage in the dry season too.

In the extreme dry period of the North Western province, one finds large tanks excavated in the ground to collect rainwater. These tanks can vary from $1m^3$ to $15m^3$ in case of individual households and up to $200m^3$ in case of ones found in temples (Figures 2and 3). These tanks collect mostly surface run-off, but holds water for about six months in case of individual tanks and the temple tank is supposedly providing water to the community for nearly ten months in an year. In colloquial terminology, these are called *Pathahas.* People use this water mainly for bathing, washing clothes, personal washing. One of the added advantages of these *pathahas* is that the water collected is not saline as in the case of most of the ground water found in the area. Hence, there is a personal preference of people to use these *pathahas* for personal hygienic practices. As these structures are large tanks constructed in the ground and the uses are for non-consumptive purposes, there are no standard maintenance practices.

Informal Rainwater Harvesting Practice

This is the most commonly used system to collect rainwater. All households in most rural areas use some form of informal rainwater collection system. The most common employs the 200 litre barrels that are freely available in rural areas (Figure 4). Besides these drums there are other types of container such as plastic Jerry-cans of 40-60 litre capacity and many kinds of kitchen utensils, buckets etc. As in the case of conventional rainwater harvesting, most of the water collected by these informal methods is also used for immediate needs. Usually informal rainwater collection makes an important contribution to household water security during the rainy season. With the increase in water availability due to such informal water collection, the travel time to collect water from other sources decreases, opportunity cost increases and the quality of water increases - thus there is a general improvement in water security. However, the improvement in water security is only short term, as cessation of rain will terminate the opportunity for informal rainwater collection.

In the dry season these containers are hardly used. However, they do come into play again when intermittent rain starts in the inter-monsoon period. The containers used in informal water collection provide important storage for stocking bowser water delivered by the local authorities (Figure 5). While only 4-5 cans of water (45 litres each) is allowed for each household by the local authorities, people get up to 7-8 cans by paying the bowser driver. This extra water is some times stored in these containers.

Institutional Rainwater Harvesting Practice

Institutional support for rainwater harvesting is a recent phenomenon. The institutionalisation commenced with the Community Water Supply and Sanitation Project (CWSSP) and has been subsequently perpetuated by development NGOs and Provincial Authorities. Under institutionalised rainwater harvesting, two basic systems each with $5m^3$ storage were introduced. These storage tanks improved household water security by providing a "water reserve" at homestead. Most households used this water "reserve" in combination with other water sources to satisfy household water needs. People in different ecological surroundings have used various practices to obtain water to satisfy such needs. In most of these practices Rainwater Harvesting has been a major contributory factor in achieving water security. Subsequent sections in this report explains the measures adopted to sustain household water security and illustrates the practices adopted in few cases from different ecological zones. However, institutional rainwater harvesting has so far provided the best option in combination with other sources to attain adequate household water security.

Conditions for Harvesting Rain

There are a few basic factors for harvesting rain. In Sri Lanka, the primary reasons are adequacy and convenience. These two factors play an important role both in combination and separately. In the Dry Zone it is primarily for adequacy in the dry season and convenience in the wet season. In the wet zone it is primarily for convenience due to availability of other water sources and secondly, may be to improve water availability at homestead. The other basic justification for harvesting rain is quality of water. Often it is the physical quality of water that matters. In the coastal area, and in some parts of southern inland and north-central dry zones, ground water is saline or "hard". Thus, it becomes non-potable or unusable for personal washing and bathing. In such situations rainwater harvesting has been the only source for achieving household water security.

3 Water Management and Quality Improvement Measures

Water saving and quality improvement are two key factors that determines the water security of a household. In Sri Lanka, the rainwater using community has employed numerous ways to achieve this end. Basically there are two factors that affect the maintenance of water quality and water management, namely technical factors and management strategies.

Technical Factors

Technical factors vary from annual rainfall to storage tank construction. On an average there is adequate rainfall available in Sri Lanka for successful harvesting of rain to mitigate a normal dry period. However, there are isolated areas in the dry zone where the rainfall is very low thus requiring very large containers to store water to cope the normal dry period. The rainwater community under study uses a 5000 litre tank for storage of water. Initial constructions have proved it to be robust and durable. However, there are number of technical drawbacks of this structure, which came to be known only after the use of these tanks for at least two seasons. One of the prime concerns of rainwater

harvesting assembly was maintaining quality of water. In the original construction there were a few pitfalls that directly effected water quality, namely:

1) inappropriate covers on rainwater tanks
2) inadequate filtering mechanisms between the gutter and downpipe and between the downpipe and tank.
3) lack of (or user unfriendly) first-flush systems.

While these were the main technical drawbacks, users have adopted various measures to overcome these problems and improve the quality of water.

Inappropriate tank covers:- in this context two issues have to be considered, excessive cover weight and inadequate sealing of the tank opening. For the former problem, a few people have devised their own wooden covers attached to the tank mouth with two hinges. This gives a cover which can be manipulated easily. To remedy inadequate sealing of the tank, people have used two methods. One, the commonest, is to place polythene sheets on top of the tank opening under the lid. The other is to insert old bicycle tube into the gap between the opening and the cover. A further innovation practised by some people is to have mosquito-proof netting as a layer between the tank opening and the cover. All these measures, invented by users, provide a layer preventing insect vectors from getting into the tank. More specifically this reduces mosquito breeding in tanks which has become an emerging problem in Sri Lankan rainwater harvesting systems.

The second issue is the filtering mechanism. At the initial stage, RWH systems were constructed without any filtering mechanisms, so people had to invent their own methods of filtering. For this purpose, they have used netting or cloth filters at the gutter-downpipe interface and cloth filters at the downpipe-tank interface. These usually prevent leaf litter and large size material that comes with rainwater. However due to their temporary nature people have to replace these filters a number of times during a rainy season.

'First-flushing' is another technique people use to maintain the quality of water. While most first-flush devices are not user-friendly, people have rendered them more effectively by manually removing the connection between the gutter and the down pipe (Figure 6). Some others who own underground tanks have, in the mountainous areas in Badulla/Bandarawela, devised still simpler first-flush systems, where the first one hour of rain can be flushed out without much difficulty. The innovativeness about these methods is that they can be handled even by a small child.

Management Factors

Besides the technical factors, good management is required to mitigate a dry period. People in different ecological environments have devised their own ways to manage water. RWH system management measures adopted to maintain the quality of water include:

1) cleaning the roof before the onset of the wet season and before every seasonal rain;
2) cleaning the tank before the wet season;
3) cleaning gutters and downpipes and replacing filtering material before the rains.

Besides these, common water-conservation practices include:
1) using more water from other sources and conserving the rainwater as a reserve;
2) reusing water for more than one activity, i.e. using water used for washing vegetables to wash utensils;
3) reducing the number of washings in cooking practices;
4) curtailing lending water to neighbours.
5) abstaining from all high water consuming activities (washing clothes, bathing) at home and instead travelling to rivers, lakes and reservoirs for such activities;
6) shifting labour from less important activities to hauling water;
7) strengthening the household water budget by using informal rainwater collection;
8) changing sanitary practices - in extreme water scarce situations people have shifted from water-seal type toilets to pit toilet or open air defecation.

More detailed location-specific water use practices will be dealt in the next section on different case studies under varying environmental conditions.

4 Case Studies on Water Use Practices

In this section an attempt is made to illustrate the different water-use practices of rainwater users in four different climatic regimes. Two case studies are from the water-stressed Dry Zone and two case studies from the Wet Zone

Case study No.1 Sooriyawawe Village

General Situation
Location- Southern Dry Zone
Rainfall annual average - less than 800mm
Community - predominantly farming.
Ground water- saline (can't be consumed).

For this rural farming community, water is the most critical resource may it be for agriculture or domestic use. This area receives only one rainfall peak during the November-December period. This wet season rain can prolong untill about February with rainfall reducing to about 20-30% of the peak season rainfall. The rest of the period is intermittent rain or very marginal rain as it is experienced at present.

Under this weather pattern, water for domestic use becomes a severe problem. The households are not provided with any homestead water facility. The only facilities that have been provided by the State are community tube wells, in which the water is too saline to drink. There is however one public well in which water can be used for drinking and cooking. The rest of the water is obtained from natural sources and the rainwater tanks. People in this area resort to collecting water from the village reservoir, from small seasonal rivers and at times by digging holes in the riverbed. Besides these sources

households in this village get water from the local authorities delivered by bowser to the doorstep. However, bowser water is provided only during the dry months from June to October. But if the dry period prevails longer (as in this year, 2000) this service will be continued till the normal rains are received.

Meeting the Drinking Water Needs

These people use three sources for drinking water during the dry season, the premium quality water comes from the local authorities (delivered to the house), next best is the dug-well water which is limited to one source in the village, the third is rainwater from both institutionalised and informal systems. In a severe dry situation people travel about a kilometre to get drinking water because even the village drinking-water well runs dry. Hence, in acute stress situations people use four water sources for drinking water.
Local authorities deliver 4 cans of water per household for a week. However, in some instances people receive up to 7 cans depending on the size of the family and its financial capacity. Rainwater use for drinking purposes is restricted to the first two months of the wet season. However, some households who maintain their tanks, use rainwater for a longer period even for drinking. Under this situation, people use to boil rainwater before consumption. This indicates that people believe the quality of rainwater is good for drinking during the rains and deteriorates in storage. However, boiling improves the quality of water to consumable level. While this remains the practice of most households with rainwater tanks, those who do not have proper water abstraction systems and underground tanks use informal means of rainwater collection for drinking purposes. Under such a situation water collected in the tanks is used for other purposes than drinking. This indicates that when faced with technical deficiencies, people revert to using informal systems which are more convenient than attempting to correct technical defects. Besides using these two sources of water, people fetch water from the village well to supplement household premium quality water needs. This water is primarily used for drinking and also used for cooking when the quality of water from other sources deteriorates.

Meeting the Cooking Water Requirement

Water for food preparation is as important as drinking. In Sri Lanka, cooking is divided into two activities, washing of food and cooking of food. Usually the former activity takes most water. During the rainy season, rainwater is used for cooking. During non-rainy periods rainwater is used for cooking after straining the water. Under dry conditions water brought for drinking is used for cooking , while washing of food prior to cooking is done with saline water from neighboring wells or tube wells. By this method the people save the good quality water brought from distance sources. While this remains as one type of practices, some others adopt different practices for conserving precious water. In another instance, householders use rainwater for drinking only during the rains. Water for cooking is always brought from dug wells as the quality of well water during rains is less saline. However, with the cessation of rain and increase in saline conditions in ground water people revert back to rainwater for cooking. This particularly happens when there is inadequate household labour to fetch water from other sources.

Meeting Washing and Bathing Water Requirements

During the wet season most of the washing is done with rainwater, but for bathing people prefer the reservoir or bathing wells. However, during the peak rain months of November and December people use rainwater from the tank due to adequate water availability. During water stress dry periods, washing of clothes often takes place at the reservoir but under sever stress situations, with drying up of reservoirs people shift to rivers for washing. The worst case scenario in this situation is the drying up of the only river in the area. Under this situation people resort to digging holes in the riverbed in search of water. While water can be found in most cases the quality of water is often brackish making it difficult to soap clothes. During this period people often reduce the number of clothes washed and try to reduce the number of visits for washing. Bathing too follows a similar process but sources of bathing are usually restricted to the reservoir and the river. However, washing of cloths of infants and small children takes place at home with rainwater. For this purpose people tend to save rainwater and use other water sources for activities of adults.

Meeting Water Need for Sanitary Purposes

As sanitary purpose water does not require very high quality standards, people use both brackish and rain water. While rainwater can be a limited source, brackish water from tube wells are available for most times. However, in sever stress situations people have adopted more unhygienic open defecation methods to use less water for ablution

*Strategies to maintain household water security during stress periods***.**

1) Use number of water sources. In this case five to seven sources (including washing)
2) Bring more water from other sources
3) Use bowser water only for drinking and cooking
4) Wash clothes and bathe using outside sources i.e. reservoirs and rivers
5) Reduce activities that consume more water from the rainwater tank
6) Cook two meals at one time (most rural people prefer freshly-cooked food)
7) Change sanitation from high to low water-consuming practices.
8) Use poor quality water (brackish) for washing food prior to cooking
9) Clean the rainwater tank and the roof prior to the onset of wet season rains
10) Clean gutters and downpipes
11) Adjust first-flush systems to be user friendly
12) Clean filtering material and refilling prior to rain
13) Use mosquito netting on the tank opening and instal mesh filters (temporarily) at the gutter/downpipe interface.
14) Use cloth filters at the downpipe/filter interface
15) Seal the tank opening permanently to avoid contamination.
16) Disconnect the downpipe during the dry season to avoid small animals climbing from the roof
17) Collect first-flush water in separately constructed surface tanks for non-premium use.

The following is an account of a household which maximises the use of multiple sources of water to attain household water security.

The household has three members. They use water from three sources:- water delivered by the local authority in bowsers, water brought from the village drinking-water well, and stored rainwater.

Quantities used are:
Bowser water 3 x 45 litre cans per week.= 19 litres/day.
Well water: 3 x 12 litre pots per day = 48 litres/day
Rainwater: unspecified intermittent use (possibly 2 pots per day = 24 litres/day)
Total consumption- 19+48+24 =91 litres/day giving 30 lcd (litres per capita per day)

This amount must be increasing to about 35-38 lcd during the wet season. However, the quality of drinking water will be poorer because there is no bowser supply during the wet season.

The strategies adopted by this particular household to achieve water security are:
1) Using screen filters at the gutter/down pipe interface
2) Using cloth filters at down pipe/filter inter face
3) Sealing the tank opening to prevent contamination. They open the tank only twice a year for cleaning once before the traditional New Year festival in April and once before the wet season.
4) Bathing and washing is always done in the reservoirs or rivers.
5) Using poor quality (brackish) water is used for washing food prior to cooking .
6) Reduce washing and bathing

Using these strategies this particular household combines the use of the three water sources to fulfil their entire household water requirement for the whole year.

Case study No: 2 Madurankuliya Village

General Situation
Location: North Western Dry Zone
Annual average rainfall: less than 800mm
Community: Predominantly hired labour
Ground water: Very saline (can't be drunk)

Water is the most limiting factor for this community. This area receives rain only during November-December and the rest of the year is mostly dry. However, during 2000 even the usual November rains have failed. This makes the community extremely vulnerable to domestic water scarcity. There are dug-wells and tube-wells constructed by the State and by private individuals but their water can't be used for consumption due its very high salinity. The high salinity in the area is due to the effect of the nearby Putullum Lagoon. There are only two good quality water sources for this community. The first is a dug-well in a private estate about 2 km away and the other is purchased water. Water from the first source is free but only limited quantities are given in the morning (usually from 6 to 11 am). Unlike in most other areas, there is no supply of water by local authorities to this village. As a result people use 5 to 7 sources of water to meet household water demand. While institutionalised rainwater harvesting is not popular in the area, there is informal rainwater collection from roof run-off for domestic use and surface run-off collection into large diameter earth ponds (*Pathaha*). Water from these pathahas is used for non-consumptive uses.

Meeting the Drinking Water Needs

There are four sources from which people obtain water for drinking. Out of these only one can be relied on for a continuous supply of water. The well in the Nallethanni Estate provides drinking water to the village but water is rationed at only one 45 litre can per family per day. The second source is water purchased from the nearest town centre, whose price depends upon the mode of transport. When water is delivered by cart or bicycle a 45 litre can costs approximately Rs.25. (Rs.0.44/litre); when it is transported by three-wheel scooter 3 cans cost Rs.50 (Rs.0.37/litre) and when a bowser-full (2000 litres) of water is delivered it cost Rs.800 (Rs.0.40/litre). The common method of purchasing water is from bicycle water vendors. Though per litre cost of water is maximum in this method, people opt for this mode due to the low lump-sum cost involved. These bicycle water vendors earn about Rs.300 per day during the dry period by selling water. Traditions of water vending had been in existence in the area. There is evidence to say that in the olden days, cart water vendors use to sell water to households and they use to store water in 1000 litre tanks which could be properly protected from external contamination.(Figure 7). If people are not financially capable of buying water they take water from the temple water tank. The village temple has a water tank with two compartments, each having an approximate capacity of about 2225 litres of water. During the dry period the Salt Co-operative bowser gives a tank full of water per week. Though this water is for the purpose of the temple at least 15 families in the same vicinity use this water under stress conditions. This water in only used for drinking. The second compartment of the tank is filled when there are special religious functions in the temple. Besides these sources, people collect rainwater from roofs into various containers during the rainy season. However, this water is limited to a very short period due to poor storage facilities. People know that rainwater is better than most of the ground water found in the area but they do not seems have the enthusiasm to invent systems to store water for a longer period. Though there is an old rainwater harvesting tank (5000 litre capacity) in the temple, it is in total abandoned state due to lack of interest and not due to ignorance.

Meeting Cooking-water Needs

There are no special methods of meeting food-preparation water needs. The water that is brought for drinking is used for cooking as well. However, people sometimes use tube-well water for cooking, though the water is more saline. Incidentally this is done to save on the better quality water brought from other sources. Cooking is sometimes limited to once a day to save on water. These practices have now become a routine - thus people take it as part of life.

Washing, Bathing and Water for Sanitary Use

Due to very high salinity in ground water, the main problem in the area is water for hygienic and sanitary use. As explained in the preceding sections, drinking and cooking water can be found though it is difficult. Water demand for non-consumptive activities is high, and meeting it in this area is difficult due to the poor quality of water. Incidentally this becomes a crucial problem in water-stress situations. The strategy adopted to mitigate this situation is the construction of large ground ponds (*pathahas*) to collect

surface run-off. Most households have their own *pathahas* of approximately $15m^3$. These ponds are filled during the short wet period and the water can last for about 6 months. Water required for bathing, washing and sanitary use is taken from these ponds. As the ponds collect rainwater, the chemical quality of the water is good and it is non saline. Therefore, people can use this water for bathing by applying soap and washing clothes with ample use of soap. Water for sanitary purposes is also taken from these ponds. When household ponds deplete under severe water stress conditions, people use the large *pathaha* ($200m^3$) in the village temple. According to the chief priest of the temple at least 100 families in the village use this water for non-consumptive purposes during drought periods. However, even the temple *pathaha* is not an eternal source. It too depletes to a level that water can't be used for any productive purposes. Under this situation its water only helps to recharge the groundwater which is saline in nature. This situation usually happens when the drought prolongs due to delayed monsoons or complete failure of monsoons. Under this situation people are forced to use saline ground water for washing and bathing. The following are some of the strategies used to minimise the effect of water stress:-

1) Reduce bathing and washing of clothes.
2) Use detergent soap powder instead of cake soap for washing clothes
3) Use shampoo instead of soap when bathing
4) Purchase water even for bathing. A rare occurrence, where some well-to-do households buy 4 cans (180 litres) of water for Rs 75 for bathing. Information reveals that this quantity of water is adequate for two people to bathe.
5) Those who do not have the means to purchase water, travel about two km for bathing and washing.

Some people start bathing with saline water, use one container of non-saline water before using soap, wash off the soap with another containerful of non-saline water, bathe with saline water and finally complete by washing with another container of non-saline water. This practice can be performed only by those who have access to at least a small quantity of good quality water during stress periods. The priests in the temple practice this system as they get their quota of good quality water from the Salt Co-operative delivered to the temple every week.

The distribution of water use by a typical household in the village can be illustrated by the following data:

Water from the tube well	30%	(saline water)
Informal RWH	5%	(good water)
Own *pathaha* water	20%	(surface run-off)
Own well	35%	(saline water)
Temple pathaha	5%	(surface run-off)
Drinking water well	5%	(good water)

Though there is no institutionalised RWH in this village, people have been using rainwater at household level for both consumptive and non-consumptive purposes.

Case study No: 3 Narangdeniya Village

General Situation
Village - Location -Southern Wet Zone
Annual rainfall average - 2400mm
Community – Small-holder tea/cinnamon
Groundwater quality - good

With this high rainfall, there is no significant water stress problem in the area. This area receives a typical bimodal pattern of rainfall with peaks in November and April.. The rest of the year receives substantial amount of precipitation from inter-monsoonal rains. While availability of water on the whole is good, accessibility becomes a problem for many households. As the area has an undulating landscape, dug wells are only possible in the valley areas. There is one tube well in the village but water supply schemes are not possible due to the high elevation of settlements. However there are number of natural springs which are good seasonal water sources. People use 4 to 5 sources of water to meet household demand. In most cases the highest water use is from the rainwater tank. Despite all these water sources, there is a water-scarce period from July to September. During this period most natural springs run dry and well water depletes. This is a partial stress period where people have to queue up long hours to fetch water from limited water sources.

Meeting the Drinking Water Demand

During the wet period spanning from November to May there is no major problem of water due to plentiful availability in almost all sources. This includes rainwater, where people use tank water for drinking. However, people have adopted various strategies to ensure quality of rainwater, such as

1) cleaning the roof and tank before the rains
2) using cloth filters to remove organic matter
3) using polythene sheet to cover the tank opening prior to closing with the lid

Besides these strategies to improve the quality of rainwater in the tank, people also adopt informal rainwater harvesting and open-air rainwater harvesting to improve household drinking water security.

If drinking water has to brought from the bathing well due to scarcity in drinking wells and rainwater tank, then water is always boiled before use.

Meeting Food-preparation Water Demand

Rainwater is the main sources of water for cooking. However, when rainwater depletes or quality deteriorates, people use drinking water for cooking as well. Thus, both these activities are given equal importance with respect to water. As rainwater is used from the tank, all measures taken to maintain the quality of tank water apply to cooking water as well. Besides tank maintenance, people attempt to save on water for cooking during water-short periods. Cooking two meals together and reusing water for two activities in cooking are some of the common practices observed.

Meeting Washing, Bathing and Sanitary Water Requirements

Sanitary water requirement is satisfied by rainwater and there is no major water shortage situation with respect to sanitary water. In the absence of rainwater people always bring water from the bathing well for this purpose. If water shortage becomes severe, people tend to use toilets close to the bathing well, where water hauling can be easier. Washing and bathing also takes place at the bathing well. However, during the rainy season some people use informal rainwater for washing, thus saving the rainwater in the tank for other priority activities. During water-short dry seasons people reduce the number of times they visit for washing and try to reuse washing water for gardening. During scarcity periods households refrain from giving water from the rainwater tank to neighbours. By this they attempt to increase the household water security.

Proportions of water use from different sources by villagers indicate that they give a high priority to rainwater use. This has become possible due to the weather pattern in the area. Indicative proportions of water use from different sources are given below.

Rainwater tank	70-80 %
Drinking water well	10-20 %
Bathing water well	8-10 %
Natural springs	2-3 %

Unfortunately, rainwater tank filters were not established in this village and most of the effort taken therefore was to improve the quality of water.

Case study No: 4 Bindunuwawe Village

General Situation

Location	Central Wet Zone
Community	Tea small holders/Government workers
Ground water quality	Good

All the households in the community own $5m^3$ institutionalised RWH tanks. Due to the location of the village in the central highlands, the average rainfall is around 2800mm. Most of the rain is received from October to February. June and September are dry months. Due to the rainfall pattern and landscape, there are a number of natural springs and dug-wells in the area. These sources provide good quality drinking water to the community. Besides, most households in the community use rainwater throughout the year. There is no reported water-stress condition. However, during the dry months there are partial stress conditions due to depletion or quality deterioration of water in the rainwater tanks.

Meeting the Drinking Water Requirement

Drinking water requirement for most part of the year is satisfied with rainwater. Hence, all efforts are taken to collect adequate quality water from roof run-off. The following technical and management strategies are used to satisfy the drinking water demand.

1) Collect rainwater from both sides of the roof. Usually in Sri Lanka one side of the roof is used to collect water to the $5m^3$ tank and the other side is used for informal

rainwater harvesting. Though the latter is termed informal, depending on the capacity of the household large quantities of water can be collected especially when 200 litre barrels are used for the purpose. Informal water collection off-sets the demand for more formally collected rainwater, therefore the length of rainwater use can be extended.

2) Cleaning the roof at least 2 times a month and prior to every rain (especially during the intermittent-rain period). Also more frequent cleaning of the roof during times of high winds.
3) Having a screen filter at the gutter/down pipe interface and use of the first-flush device effectively.
4) Having a cloth filter to the faucet
5) Cleaning and refilling the filter before the wet season.
6) Closing the tank opening with a polythene sheet prior to closing with the tank lid.

All these strategies are adapted to maintain the quality of water for consumption purposes. However, when water depletes in the tank, households adopt water-conserving practices and also engage in bringing more water from other sources. Some of these management practices are;

1) Reducing use of tank water for high water consuming activities and employment of well water for these activities. Usually washing of clothes and personal washing are the first two activities to be shifted from rainwater to well water.
2) Cooking two meals together. Usually it is the breakfast and lunch
3) Reusing water for more than one household activity.

Besides water conserving management activities, when water is in short supply people tend to collect more water from other sources. During scarce periods some hoard water at home in barrels. Fortunately these households have adequate labour to fetch water from other sources even in scarce situations. In severe water-short situations people sometimes travel up to two km to collect water. This indicate that even during water-scarce periods good quality water is available, though the number of water sources is less than in the wet season, thus travel and waiting time is relatively more.

Washing, Bathing and Sanitary Water Demand

Households in this village do not consider water for the above activities as a significant problem. During the wet season there is adequate water in the rainwater tank and during the dry months water for non-consumptive uses are available in other water sources. It is only the number of water sources that get reduce during the dry season. Otherwise water is available within the village.

It is interesting to note that the number of water sources people use to satisfy household water demand declines significantly with the increase in rainfall. These villagers mainly depend on the rainwater tank for household water. However, there is always reference to another source during the dry period or to supplement the household water demand. In this village dug wells have provided the supplementary water in most cases and the use of a tube well has been mentioned by few households. Natural springs are also used but they do not make a very significant contribution.

5 Recommended Strategies to Meet Household Water Demand

It is difficult to recommend one single strategy to meet household water demand that is applicable to all communities. Different communities have their own strategies to meet the water demand. This to a great extent depends on the economic situation of the household, education level, sense of ownership and accountability. The best practice that can be recommended from the cases sited above is a combination of both technical and management practices. However, acceptance or rejection of these practices depends totally on the households based on the available resources.

Technical specifications and practices

1) Use an institutionalised rainwater-harvesting tank of standard size to collect roof run off.
2) Use a standard filter with proper filtering material.
3) Install standard gutters to collect maximum roof run off. If the roof area is large, only one side of the roof will be adequate to collect water to a $5m^3$ tank.
4) Ensure proper fixing of gutter-downpipe connection and downpipe-filter connections

5) Use a screen filter at the gutter-downpipe interface and a cloth filter at the downpipe-filter connection. (Figure 8). Change the cloth filter periodically to ensure proper filtering.
6) The tank lid should seal the tank mouth (Figure 9). If not, a temporary sealing material like rubber cycle tubes should be recommended. The ideal situation should be to seal the tank lid permanently and open it only when cleaning is required.
7) Include a water-monitoring orifice in the tank lid. This should be properly secured with a stopper when not in use. This practice will allow users to monitor the water level in the tank without any unnecessary contamination of the water in it.
8) Rainwater tanks should have a drain outlet and an overflow pipe but it should be protected with mosquito netting.
9) All surface tanks should have a water faucet and it is recommended to have a cloth strainer fixed to the faucet to further clean the water.
10) First-flush systems should be more user-friendly, or at least easy to handle, like the one found in Palavi in Puttalum district.
11) First-flush systems should be flexible enough to keep out the unwanted small rains from collecting in the tank. This is particularly important during the dry season when small rains can carry large amount of pollutants from roof surfaces.
12) It is good practice to collect first-flush water into a separate tank for non premium water use. This can be done by simply connecting an extension to the existing first-flush system (Figure 10).
13) If tank openings can't be sealed, it is recommended that at least a mosquito-proof screen be used to close the tank opening prior to closing with the lid (Figure 11)

Management Practices

1) It is always recommended to use multiple sources of water to maximise on the use of rainwater.
2) Use good quality water only for drinking and cooking i.e. bowser water delivered to the house in drought conditions.
3) Use informal Rainwater collection systems to collect roof run-off to ease the demand on formal rainwater collection.
4) Use protective water conservation methods to store water brought to the house. Specially applicable in severe water short situations with saline/brackish water ground water conditions.
5) Clean the roof at least 2-3 times a month and prior to the wet season and more frequently during times of high winds.(Figure 12)
6) Cleaning the filter prior to every wet season
7) Checking and replacing cloth filters periodically
8) Disconnecting the downpipe during the dry season to avoid small animals climbing and contaminating the roof.
9) Reusing water for more than one household activity.
10) Boiling rainwater before drinking
11) Use other means of rainwater harvesting, possibly surface run off as found in Madurankuliya. This water can be used for non premium quality water, thus, reducing the demand on rainwater collected through roof run off.

These are practices adopted by rainwater user communities in various parts of the country. What possibly can be recommended is to use this as a checklist and adopt what ever is relevant and feasible. Importance of this list is, more measures one adopts better will be the quality and quantity of water available for it's users.

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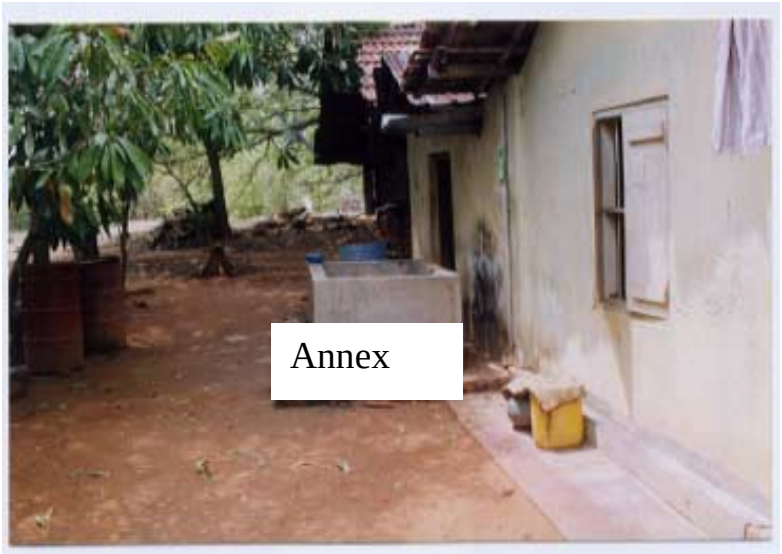

Annex

Figure 6

Figure 4

Figure 5

Figure 3

Figure 9

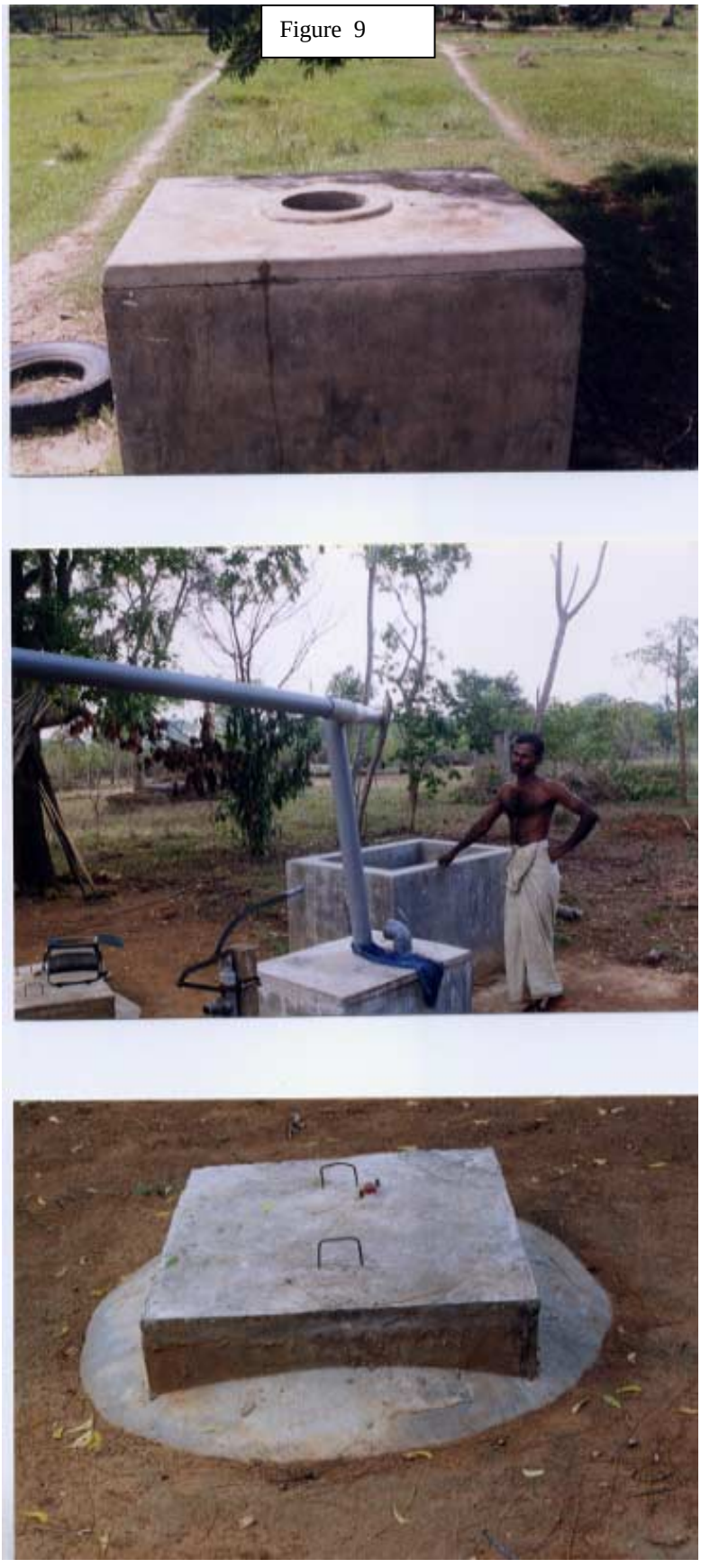

Figure 10

Figure 11

Figure 12