NATURAL RESOURCES SYSTEMS PROGRAMME

***PROJECT REPORT*[1]**

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NRSP Production System

Semi-Arid

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EXECUTIVE SUMMARY

To establish the baseline data, a three-stage survey was conducted using both participatory approaches and questionnaire interviews. The results show that the current extent and performance of rainwater harvesting, in the study area, is as follows.

i) A substantial number of households (HHs) are already using RWH systems especially for crop production. For example, the macro-catchment RWH system that includes the excavated bunded basins (*majaluba*) for rice production, is practiced by an estimated 28,000 HHs in Maswa District.

ii) Rainwater harvesting is practiced for crop production and for domestic water supply by more than 60% of the households. Rainwater harvesting for livestock water needs practiced by less than 40% of the households.

iii) *In-situ* RWH systems are predominant in the study areas. A good proportion of households in Maswa and Same Districts also practice at least one type of the macro-catchment systems. However, only about one quarter or fewer HHs practice macro-catchment systems with storage.

iv) It is estimated that current farm sizes treated with RWH range from 0.6 to 1 ha per HH. This is small and there is scope for expansion of area under RWH per HH.

v) It is difficult to estimate the number of livestock benefiting from RWH. This is because the true number of livestock owned are rarely revealed. However, rough estimates show that more than 24,000, 6,000 and 4,000 livestock units are benefiting from RWH in Maswa, Mwanga and Same districts, respectively.

vi) Most of those using macro-catchment RWH systems have adopted the technology since the 1990s. There has been a doubling in the adoption of most of the RWH techniques in the ten-year period between 1990 and 2000. Maswa District has seen the most rapid expansion in RWH especially in relation to excavated bunded basins (*majaluba*) for the production of paddy rice.

vii) Maize yield in RWH systems is between 1.3 and 3.2 t/ha compared to the potential of 5 t/ha. The rice yields are currently 3.2 t/ha compared to a potential of 6 t/ha.

In general, there is a substantial number of households practicing RWH systems. More importantly most schemes have been initiated, financed and developed by the farmers themselves, with minimal external assistance.

The opportunity for improving performance of existing systems lies in intensification. For the crop production systems there is a need to improve the effectiveness and productivity of the harvested water through further improvement of agronomy. The other opportunity lies in introducing and promoting macro-catchment systems among those who are already using in-situ approaches. Performance of water diversion and storage structures is another opportunity for research and development projects. Currently there performance of these systems is poor due to inadequate design, operations and maintenance. Finally increasing the knowledge of stakeholders appears to still be the priority area for intervention.

ACRONYMS AND DEFINITIONS

ASDS	Agricultural Sector Development Strategy of Tanzania, approved in October, 2001
ASPS	Agricultural Sector Program Support
Charco-dam	A water hole excavated in a relatively flat terrain to collect and store surface run-off
DRD	Division of Research and Development of the Ministry of Agriculture and Food Security
DRDI	DRD – Institute
GM	Gross Margin
HH	Household
HHH	Head of Household
IMTR	Institute of Meteorological Training and Research
Lambo	A small reservoir behind an earth dam
Majaluba	Excavated bunded basins or cultivated reservoirs used to harvest and store rainwater for the production of rice in semi-arid areas of Tanzania
Masika	The long rainy season
MTR	Mid-term Review
Ndiva	Storage pond
PDC	Professional Development Course
PIDP	Participatory Irrigation Development Project – An irrigation project based on RWH systems. It is funded by the Tanzania Government using loan funds from IFAD.
PT	PATCHED-THIRST
RELMA	Regional Land Management Unit of Sida, based in Nairobi Kenya, and working in Eritrea, Ethiopia, Kenya, Uganda, Tanzania and Zambia.
RWH	Rainwater Harvesting
SIAC	Statistis in Agricultural Climatology
Sida	Swedish International Development Agency
SUA	Sokoine University of Agriculture
ToT	Training of Trainers
Vuli	The short rainy season
WPLL	Western Pare Lowlands

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1. INTRODUCTION

1.1 Background

Since 1992, the Faculty of Agriculture of Sokoine University of Agriculture has been implementing a research program on Soil-Water Management. The main purpose of the program is ***to develop, test and promote appropriate and socio-economically viable management interventions for optimizing the capture and utilization of rainfall in semi-arid areas of Tanzania***.

Research and promotion of Rainwater Harvesting (RWH) technologies is one of the major projects being undertaken under the program. Phase I of the project Evaluation and Promotion of Rainwater harvesting in Semi-Arid Areas (1992 to 1996) under DFID funding, was a collaborative venture between Sokoine University of Agriculture and University of New Castle Upon Tyne. The project, through a combination of fieldwork and computer modeling aimed at the following:

- To evaluate and demonstrate viable cropping systems based upon rainwater harvesting techniques, and
- To develop a model of the RWH process as an aid to identify best-bet options.

Phase II (1996 –1999) put more emphasis on on-farm experimentation, more farmer participation, consideration of macro catchment RWH systems, and closer links with DRDI and NGO's. As a result of these phases of the project:

- A computer model "PARCHED-THIRST" which simulates processes in a RWH system, has been produced.
- Performance of RWH systems under different conditions has been fully evaluated. The results were reported in a Special Issue of Tanzania Journal of Agricultural Sciences (Vol. 2 No 2, 1999), with the title Rainwater Harvesting for Crop Production in Semi-Arid Tanzania.
- Further more, a planning guide handbook on rainwater harvesting was published with kind assistance of Sida's RELMA. This has been distributed widely and has contributed towards raising the awareness on RWH.

The goal and purpose of the project **Assessment of RWH Demand and Efficacy** were:

Goal Improved strategies for the integrated management of natural resources within catchments **developed** and **adopted** to reduce poverty.

Purpose: Productivity of water in rainfed agriculture **improved** through accelerated uptake and intensive use of rainwater harvesting.

Outputs (*as revised during MTR*):

(i) Knowledge of the role and value of rainwater harvesting systems in semi-arid areas by all stakeholders, INCREASED.

(ii) Decision support system to assist planners, extension staff and others to plan, design and implement rainwater-harvesting systems further DEVELOPED and VALIDATED.

To produce the project outputs the following activities were carried out:

Activity 1.1: Produce baseline data of current extent of rainwater harvesting (macro-catchments) within each farming system (Western Pare lowlands and Maswa District), including up take over time.

Activity 1.2: Quantify the opportunities for improving performance of existing systems, and for future expansion of rainwater harvesting in the same areas.

Activity 1.3: Describe and quantify the role of road and rail infrastructures in facilitating introduction of rainwater harvesting systems.

Activity 1.4: Undertake (relatively simplistic) economic analysis of costs and benefits of rainwater harvesting systems (actual and potential) in each district, and assess the evidence for poverty alleviation.

Activity 1.5: Specify criteria for selection of “model” sub-catchments (for phase 2).

Activity 1.6: Confirm the training needs of District Council extension staff, NGOs, and other agencies responsible for assisting farmers to implement rainwater-harvesting systems in both areas.

Activity 1.7: Develop appropriate training materials (in Kiswahili) and disseminate within target districts.

Activity 1.8: Deliver “Training of Trainers” courses in each target district.

Activity 1.9: Design and implement courses to increase the awareness by policy makers and others of the role of rainwater harvesting systems for agricultural production in semi-arid areas of Tanzania.

Activity 2.1: Review performance of current version of the Decision Support System (DSS) (computer model and paper version), for assessing where and when macro-catchment based rainwater harvesting systems are appropriate (a “reality check”).

Activity 2.2: Identify modifications needed to improve the performance of the DSS.

In summary, the project was designed to achieve the following:

(i) **Produce** baseline data of the extent of actual and potential areas for RWH, and profitability of RWH systems in Maswa, Mwanga and Same districts.

(ii) **Develop** training materials and **train** trainers on several aspects on RWH in the target and other interested districts.

(iii) **Assess** and improve the performance of PARCH-THIRST model.

1.2 Target Areas

The research was located in two target sites, representing semi-arid areas of Tanzania. The locations were the Pare lowlands within Mwanga and Same districts in North East Tanzania, and Maswa District in Shinyanga Region, South of Lake Victoria (Map 1).

The Mwanga and Same districts are characterized by two major agro-ecological zones, namely the highlands and lowlands. The Pare Mountains are located to the South East of the Mt. Kilimanjaro, between 600 and 2,424 m above sea level. The Western side of the mountains is the leeward side and thus receives low amounts of rainfall. The mountain slopes are steep, abruptly joining with plains which extend to the Pangani River.

It is important to mention that the study area was located in the Pangani Basin. The basin is very important in Tanzania and is often affected by water scarcity. Important characteristics of the basin include:

- It has a total area of 42,200 km^2 of which 2,320km^2 are within the Republic of Kenya,
- The upper limit of the basin is on the Mt. Kilimanjaro and Mt. Meru,
- More than 50% of the basin is arid or semi-arid with annual rainfall of less than 500 mm and potential evapo-transpiration of more than 2,000 mm per year,
- More than 55% of the water flow in the basin comes from the slopes of Mt. Kilimanjaro, and
- Has an estimated high potential of groundwater.

Further, the basin is very important in the country for the following reasons:

- It has been utilized for hydropower generation since 1934. Currently, there are five power plants in the basin with a capacity to generate about 100 MW and requiring a discharge of 45 m^3/s. There are plans to add another three plants to generate about 45 MW more. However, this will not require extra water.

- The basin is home to among the oldest traditional irrigation systems in the country. These are the furrow systems found on the slopes of Mt. Meru, Mt. Kilimanjaro, and the Pare and Usambara mountain ranges. It is estimated that there are over 2,000 furrow based traditional irrigation schemes in the basin.

- Large scale irrigation is also important in the basin. This includes
  - Lower Moshi irrigation scheme > 1,100 hectares,
  - Sugar production by the Tanganyika Planting company (TPC) – about 6,400 hectares,
  - NAFCO-Kahe farms – about 1,800 hectares, and
  - Numerous coffee estates.
- More than 50,000 ha are irrigated in the basin during the dry season.

In particular the Western Pare Lowlands (WPLL) have the following characteristics:

- The lowlands fall within the Maasai steppe agro-ecological zone, which is characterized by rolling plains with reddish sandy clay soils of relatively low fertility formed on basement complex rocks.

- Annual rainfall is in the range of 500 to 800 mm with bimodal pattern, with about 200 mm in *Vuli* and 400 mm in *Masika*.

- Potential evapotranspiration is over 2,000 mm per year.

Most of the residents of the WPLL are at most 3rd generation immigrants from the Pare Highlands. These highlands have one of the highest population density in the country. Therefore, the production potential, although high, has been exploited to the limit. This together with good communication links and employment opportunities brought about by the construction of a railway and highway (Tanga / Dar es Salam to Arusha and onwards to Nairobi), has promoted recent population shifts into the western lowlands.

Attempts to promote adoption of drought resistant sorghum as a food security measure have been mate with resistance in favour of maize production. However, due to low rainfall and high potential evapo-transpiration, seasonal soil-water deficit is a major constraint to maize production and other high water demanding cropping options. Improvement of rainwater management is therefore a priority requirement in WPLL.

Maswa District falls within the extensive central semi-arid agro ecological zone, which is characterized by gently undulating plains with long slopes and wide valley bottoms. Annual rainfall ranges between 600 and 900 mm with a transitional regime. Availability of adequate soil-moisture for plant growth is a major constraint, mainly due to the occurrence of long dry-spells during the growing season.

The land use pattern is linked to the recurrent topo-sequence of soils (Figure 1), known as Sukumaland catena and first described by Milne (1936). Up to the 1980s, common crops grown were cotton and other drought resistant crops. However, in recent years farmers preferences have shifted in favour of maize and paddy rice as dual purpose crops. Rice cropping system based on RWH techniques involving excavated bunded fields known as *majaluba*, is now a common component of the farming system.

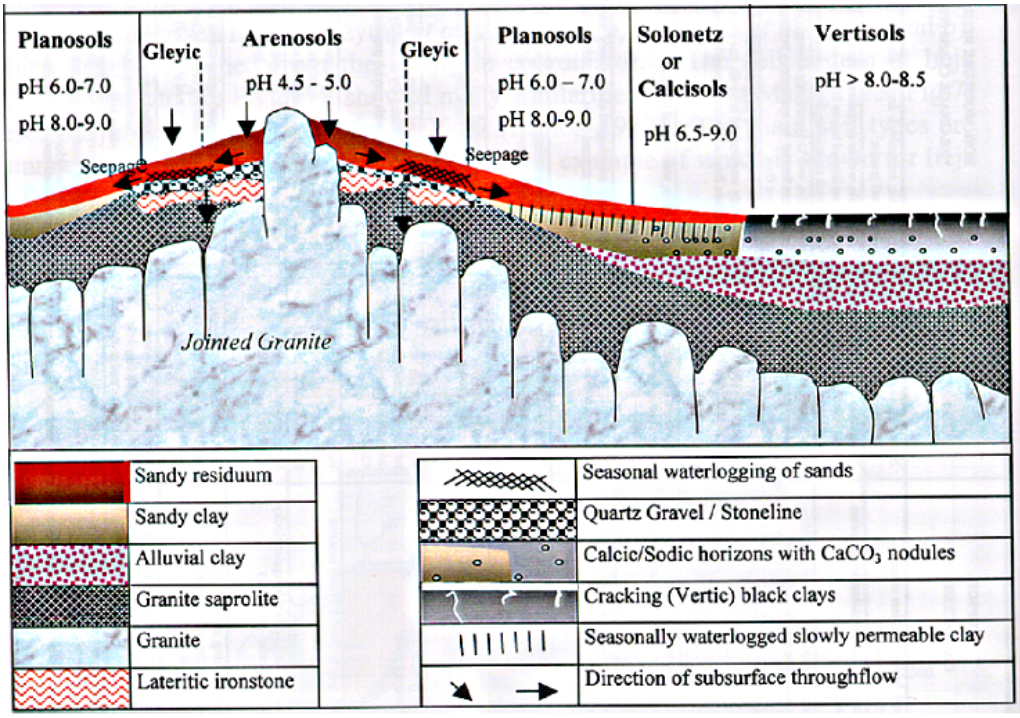
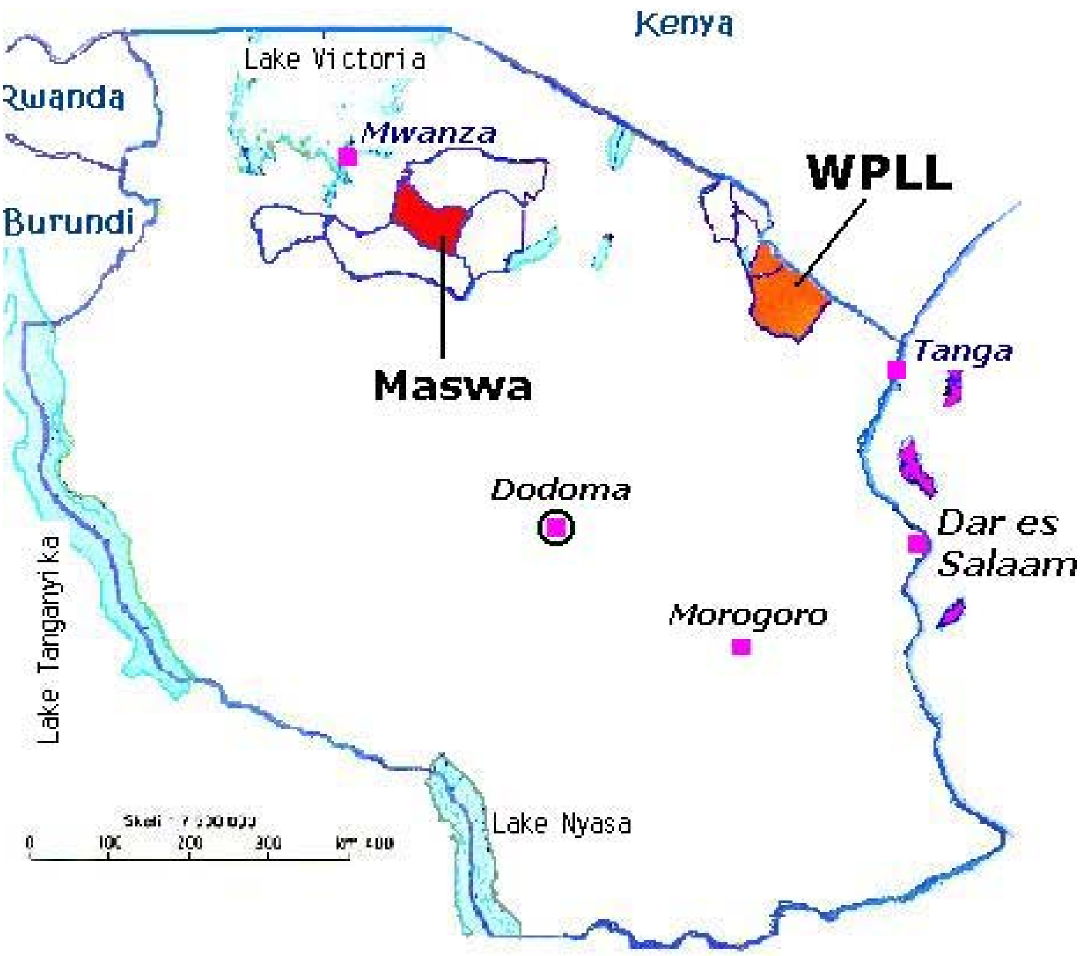


Figure 1: A typical cross-section of the Sukumaland catena (after Payton, 2000)



Map 1: Location of the research target areas in Tanzania

1.3 Scope and Outline of this Annex

This Annex is one of the 11 annexes of the Final Technical Report (FTR) of the project. The full list of the annexes is as follows:
Annex A: Extent and Performance of RWH
Annex B: Role of Road and Rail Infrastructure in RWH
Annex C: Economic Analysis of RWH Systems
Annex D: Development of Training Programs and Materials
Annex E-1: Training Slides for the ToT Course
Annex E-3: Draft Extension Booklets on RWH
Annex E-3: Draft Extension Leaflets on RWH
Annex F: Training and Awareness Raising
Annex G: Final Project Inventory

The purpose of this annex is to present the current status of RWH in WPLL and Maswa District. It is dived into four sections. In the next section, the methodology used for data collection and analysis is presented and described. Section 3 of this report presents the tables and description of results from the processing and analysis of data. A discussion to answer some of the key questions under activities 1.1 and 1.2 of the project is given in section 4. Finally, this report is supported with 11 appendixes.

2. METHODOLOGY

2.1 Sampling Procedure

2.1.1 Village and sub-villages

A multistage sampling technique was adopted. Mwanga and Same districts are divided into two agro-ecological zones as described in section 1.2. The lowlands were selected for this survey as they receive lower rainfall than the highlands. In Mwanga District, all the 25 villages in the lowlands were included in the study. In Same District, all the 12 villages that are located in WPLL were included. The whole of Maswa District is categorized as semi-arid and therefore all the 78 villages were included in the study. Further, in WPLL all the sub-villages in each of the selected villages were included in the study. Therefore, the study involved 68 and 79 sub-villages in Mwanga and Same districts, respectively. Because of the high number of sub-villages in Maswa District, it was necessary to survey only a sample. The sample was composed by randomly selecting 25 % of sub-villages of each village.

2.1.2 Households

Five percent of household heads from selected sub-villages were randomly chosen to make up a study sample. In total, 1,360 households (338 in Mwanga, 321 in Same and 701 in Maswa) were finally chosen for the survey.

2.2 Data Collection

Data was collected through meetings, focus group discussions with key informants, and individual interviews using a structured questionnaire.

2.2.1 Key informant interviews

Before each focus group interviews, short meetings were held with village leaders. Key informants were people that were knowledgeable in RWH practices in their village and sub-villages. For this reason, chairpersons of villages and sub-villages, and extension staff at ward and village levels constituted the key informant interviews.

Key informant interviews were held at ward level, grouping together several villages. There were two separate sessions of about three hours for each ward. The first session brought together village chairpersons and extension staff. The second session involved only the sub-village chairpersons. Therefore, each meeting involved 10 to 15 key informants. Researchers facilitated the discussion and started by explaining the objective of the survey. The discussions focused on identification of the extent and performance of RWH in the respective village or sub-village. This included information on demographic characteristics, land use, agricultural and livestock production activities, rainfall characteristics, water availability for different uses, and the potential for RWH. Techniques of RWH currently in use, areas and activities where RWH is mostly practiced and areas suitable for RWH for various activities were also discussed.

2.2.2 Structured interviews

a) Types of questionnaires and design

Five different questionnaires were used in this study. These were, questionnaire for:

- Village chairpersons survey in WPLL (Appendix 1)
- Village chairpersons survey in Maswa (Appendix 2)
- Sub- Village chairpersons survey in WPLL (Appendix 3)
- Households survey in WPLL (Appendix 4)
- Households survey in Maswa (Appendix 5)

The questionnaires were designed to capture data on demographic characteristics, agricultural and livestock production activities, RWH techniques and major constraints. It was necessary to use different questionnaires at village, sub-village and household level interviews because the information required at village level was general for the village, while that at sub-village level, was narrowed down to cover only the small sub-village area. The questionnaires used for interviews in WPLL and Maswa were also different due to differences in farming systems.

b) Pre-testing

The questionnaires were pre-tested in the respective areas, mainly to ensure consistency of the questions and their clarity to the respondents.

c) Selection and training of enumerators

In each district, one research associate was recruited to undertake the field data collection. These were people trained in agriculture and familiar with the target areas. They were MSc., Diploma and Certificate holders, for Maswa, Mwanga and Same districts respectively. Together with the researchers, the research associates were involved in questionnaire design and pre-testing as well as in sampling. In this way they received the necessary training in the required survey. In addition, since the workload was high, it was necessary to use enumerators. These were selected from district staff. In Maswa District, a total of 16 enumerators were used, and two were used in each of Mwanga and Same districts. The enumerators were given a one-day training and then supervised in the field by researchers for at least three days, to ensure consistency and accuracy.

d) Administration

Administration of the questionnaire to key informants was implemented during the focus group interviews. The household survey was conducted by visiting different individual heads of households at home or in the field. It was however difficult to fix appointments in some areas because the survey coincided with peak period of the farming season.

2.3 Data Processing and Analysis

Processing of data was accomplished by statistical analysis using the Statistical Package for Social Sciences (SPSS/PC$^+$) computer program. The process involved coding, entry, checking and analysis of data.

Descriptive statistics parameters (means, percentages and cross-tabulations) were the main outputs of the analysis.

3. RESULTS

3.1 Rainfall, Water and Crop Production

3.1.1 Rainfall characteristics: perceptions of village chair persons

In WPLL, the village chairpersons with the help of extension staff were requested to characterize the short rainy (*Vuli*) seasons and the long rainy (*Masika*) seasons during the immediate past five years (1996 – 2000). Their perceptions are depicted in Table 1(a). In WPLL, most villages indicated that rainy seasons considered good were those of 1997 and 1998.

In Mwanga District, during 1997 seasons, rainfall was considered good in 8 (32%) villages, and 12 (48%) villages during the *Vuli* and *Masika*, respectively. In the *Masika* of 1998, 12 (48%) villages experienced good rainfall in the district.

Similarly during 1997 seasons, rainfalls were described as good in 5 (42%) villages, and 6 (50%) villages in Same District for *Vuli* and *Masika* seasons, respectively. In the 1998 long rainy season, 7 (58%) of the surveyed villages in district considered that they received good rainfall.

In Maswa District, the rainfall season is unimodal. More than three-quarters of respondents considered 1997/98 to be a good season despite the *El-Nino* effect. The other remaining years were considered by a majority to have moderate to poor rainfall.

Key informants were also asked to point out incidences of floods in their respective villages for the period between 1996-2000. They indicated that floods occurred only in 1997 and 1998. Table 2 shows the incidences and effects of floods in the study area according to the respondents. Cases of floods were reported to have affected up to 21 (27%) villages in Maswa, 11 (44%) villages in Mwanga District and 4 (33%) villages in Same District, respectively (Table 2(a)).

The effects of floods involved destruction of crops in the fields, infrastructure and settlements. Destruction to crops was ranked as the most damaging at 6 (24%) and 4 (33%) villages in Mwanga and Same districts, respectively. In Maswa, destruction to residences (32%) was considered to be the most serious.

These findings show the diversity of rainfall within and between localities. They also show how the rainfall is perceived to fluctuate between seasons and years. This is an indication for the need for RWH to ensure reasonable water availability for productive use throughout the year. It must however, be noted that in some cases a high percentage (up to 50%) were not able to give opinion on the quantity of rainfall. This may indicate that this approach of judging characteristics of rainfall may not be very reliable. However, since rain recording is very limited in the study area, this approach is necessary. Therefore, efforts are required to calibrate the perceptions of key informants.

Table 1(a): Rainfalls characteristics as perceived by village chairpersons in WPLL

Year[1]	Perception	Mwanga District (n = 25)				Same District (n = 12)			
		Vuli		*Masika*		*Vuli*		*Masika*	
		Villages		Villages		Villages		Villages	
		No.	%	No.	%	No.	%	No.	%
1995/96	No rains			0	0			0	0
	Poor			7	28			2	17
	Moderate			2	8			3	25
	Good			5	20			3	25
	No opinion			11	44			2	17
1996/97	No rains	3	12	0	0	1	8	0	0
	Poor	6	24	1	4	2	17	1	8
	Moderate	3	12	4	16	2	8	3	25
	Good	4	16	12	48	2	17	6	50
	No opinion	9	36	9	36	4	34	2	17
1997/98	No rains	0	0	0	0	0	0	0	0
	Poor	3	12	1	4	4	33	2	17
	Moderate	6	24	3	12	1	8	2	17
	Good	8	32	12	48	5	42	7	58
	No opinion	8	32	10	40	2	17	1	8
1998/99	No rains	1	4	0	0	0	0	0	0
	Poor	9	36	5	20	3	25	3	25
	Moderate	2	8	6	24	2	17	5	42
	Good	3	12	3	12	4	33	3	25
	No opinion	10	40	11	44	3	25	1	8
1999/00	No rains	3	12	9	36	2	17	0	0
	Poor	11	44	6	24	6	50	9	75
	Moderate	0	0	0	0	2	17	1	8
	Good	1	4	10	40	1	8	0	0
	No opinion	10	40			1	8	2	17
2000/01	No rains	3	12			0	0		
	Poor	7	28			0	0		
	Moderate	2	8			2	17		
	Good	3	12			4	33		
	No opinion	10	40			6	50		

[1]The Vuli season occurs across years. For example, the 1996/97 rows refer to Vuli of 1996/97 and Masika of 1997

Table 1(b): Rainfalls characteristics as perceived by village chairpersons in Maswa District (n=78)

Season	Rainfall characteristics	Villages No.[1]	%
1995/96	Poor	17	22
	Moderate	23	30
	Good	11	14
	No opinion	27	35
1996/97	Poor	24	31
	Moderate	25	32
	Good	12	15
	No opinion	17	22
1997/98	Poor	6	8
	Moderate	6	8
	Good	61	78
	No opinion	5	6
1998/99	Poor	12	15
	Moderate	35	45
	Good	16	21
	No opinion	15	19
1999/00	Poor	19	24
	Moderate	32	14
	Good	7	9
	No opinion	20	26

[1] No. = Number of respondents

Table 2(a): Incidences of floods in target districts

	Affected Village					
	Maswa		Mwanga		Same	
Season	No.	%	No.	%	No.	%
1999/00	2	3				
1997/98	21	27	11	44	4	33
1994/95	3	4				
1993/94	2	3				
1992/93	1	1				
1981/82	1	1				

Table 2(b) Effects of floods of 1997/98 in target districts

	Affected Village					
	Maswa (n = 78)		Mwanga (n = 25)		Same (n = 12)	
Effect	No.	%	No.	%	No.	%
Destruction to residence	21	27	2	8	3	25
Destruction to crops	14	18	6	24	4	33
Destruction to infrastructure	8	10	3	12	1	8

3.1.2 Water availability

The key informants at village level were asked to identify sources of water in their respective villages, for domestic and livestock. This section presents the findings.

3.1.2.1 Water for domestic use

Availability of safe and clean water for domestic use is also a problem in semi-arid areas of Tanzania. It is common to see people crowded around small holes dug in the ground, in search of water. Critical issues here are the safety of water for human health and its availability in reasonable quantities throughout the year.

The findings show that water for domestic uses is obtained from five sources, namely:

- Pipe system,
- Ephemeral streams and rivers,
- Wells,
- Lakes and large reservoirs, and
- Harvesting from rooftops.

Table 3a shows that about 52% of sampled villages in Mwanga District depend on ephemeral streams for domestic water. Water is also harvested from rooftops during the rainy season for domestic purposes. However, this practice is limited to households with corrugated iron sheet roofs. The table also shows that 72% of villages in Mwanga District indicated that rooftops are important sources of domestic water. However, only 40% of households benefit from this source. Water harvested from rooftops is stored in small containers. Actually, this technology cannot supply water beyond the rainy season, due to very small capacity of the storage facilities. Lakes and reservoirs are also important source of domestic water, in Mwanga District. Furthermore, about l% of sub-villages in Mwanga indicated that charco-dams; which are often used for livestock watering, are also used to supply domestic water.

In Same District, water availability for domestic uses present a different picture (Table 3b). About 11 (91%) villages have some access to pipe water system. Ten villages (83%) access this service throughout the year. However, the proportion of households benefiting from pipe water is low. Only 57% of total population accesses this service. This also indicates that either water pipes are not extended to all sub-villages or the supply is unable to meet the demand. Alternative sources of domestic water are ephemeral streams, wells, and collection of rainwater from rooftops. Village chairs mentioned that rooftops are important source of domestic water to 50% of the surveyed villages in Same District whereby 40% of households benefit. Like in Mwanga, the water harvested is stored in small sized containers.

In Maswa District, 83% of the villages depend on ephemeral streams and rivers for domestic water supply. Shallow wells are also a common source of water supply for domestic use, with 74% of villages benefiting from the wells. However, only 24% of the villages have access to piped water, mostly available only during the rainy season. Regardless of the source, the water availability does not go very far beyond the rain season, for the majority.

Table 3: Availability of water for domestic uses

a) Mwanga District (n= 25) [1]

Source of water	Extent of use by villages		Benefiting HH (%)	Period of availability of water	Benefiting villages	
	No.	%			No.	%
Pipe system	12	48	65	During the rainy season only	5	20
				Whole year	7	28
Ephemeral streams and rivers	13	52	15	During the rain season only	7	28
				Whole year	6	24
Wells	4	16	42	During the rain season only	2	8
				Whole year	2	8
Lakes and reservoirs	6	24	100	During the rainy season only	6	24
				Whole year	6	24
Harvesting from Rooftops	18	72	40	During the rainy season only	18	72
			0	Whole year	0	0

[1] n = number of surveyed villages

b) Same District (n=12) [1]

Source of Water	Extent of use by villages		Benefiting HH (%)	Period of availability of water	Benefiting villages	
	No.	%			No.	%
Pipe system	11	91	57	During the rainy season only	10	83
				Whole year	1	8
Ephemeral streams and rivers	11	91	76	During rain season only	2	17
				Whole year	7	58
Wells	5	42	43	During dry season	3	25
Harvesting from Rooftops	6	50	40	During rain season only	6	50

c) Maswa District (n= 78)[1]

Source of water	Extent of use by villages		Benefiting HH (%)	Period of availability of water	Benefiting villages	
	No.	%			No.	%
Pipe system	19	24	54	During the rainy season only	15	19
				Whole year	3	4
Ephemeral streams and rivers	65	83	63	During the rain season only	34	44
				Whole year	22	28
Wells	58	74	54	During the rain season only	36	46
				Whole year	8	10
Harvesting from Rooftops	32	41	14	During the rainy season only	32	41
			0	Whole year	0	0

3.1.2.2 Water for livestock

Water for livestock is obtained from five different sources (Table 4). These are:

- Charco-dams (water holes dug in a flat terrain to store surface runoff),
- Pipe system,
- Ephemeral streams and rivers,
- Lakes and large reservoirs, and
- Harvesting from rooftops.

Just like domestic water, key informant at village level indicated that only a few sources provide water for livestock throughout the year. The most important source of water for livestock is ephemeral streams. Other sources are pipe systems, charco-dams and large reservoirs. For WPLL, ephemeral streams provide water for livestock to 20 (80%) villages in Mwanga and 10 (83%) villages in Same District (Table 4).

Charco-dams and ephemeral streams are the major sources of water for livestock in Maswa District. Seventy six percent of villages have access to water from charco-dams whereas ephemeral streams supply water to 22% of the villages. Harvesting rainwater from rooftops contributes the least water for livestock. Again this is mainly because of very small capacity of storage facilities used in conjunction with harvesting water from rooftops.

Table 4: Availability of water for livestock

a) Mwanga District (n=25)

Source of water	Extent of use by villages		Benefiting HH (%)	Period of availability of water	Benefiting villages	
	No.	%			No.	%
Charco-dams	7	28	49	During the rainy season only	7	28
				Whole year		
Pipe system	11	44	49	During the rain season only	3	12
				Whole year	8	32
Ephemeral streams	20	80	68	During the rain season only	20	80
				Whole year	0	0
Lakes and reservoirs	3	12	100	During the rainy season only		
				Whole year	3	12
Harvesting from Rooftops	1	4	40	During the rainy season only	1	4
			0	Whole year	0	0

b) Same District (n=12)

Source of Water	Extent of use by villages		Benefiting HH (%)	Period of availability of water	Benefiting villages	
	No.	%			No.	%
Charco-dams	5	42	70	During the rainy season only	5	42
				Whole year	0	0
Pipe system	7	58	71	During rain season only	7	58
				Whole year	7	58
Ephemeral streams	10	83	61	During dry season	6	50
Rooftops harvesting	3	25	40	During rain season only	1	4

c) Maswa District (n=78)

Source of water	Extent of use by villages		Benefiting HH (%)	Period of availability of water	Benefiting villages	
	No.	%			No.	%
Charco-dams	59	76	73	During the rainy season only	45	58
				Whole year	12	15
Pipe system	17	22	17	During the rain season only	5	6
				Whole year	12	15
Ephemeral streams	56	72	67	During the rain season only	33	42
				Whole year	17	22
Harvesting from Rooftops	12	15	16	During the rainy season only	12	15
				Whole year	0	0

Findings from household survey showed that the main sources of water for livestock were ephemeral streams in all the three districts (Table 5). About 37%, 15% and 29% of respondents in Same, Mwanga and Maswa used ephemeral streams as source of water for livestock respectively. However, after the streams dry-up the livestock is shifted to other areas. In Maswa district, small ponds dug in dry sandy riverbeds, are also important. About 16% of respondents used this method. During the dry season, when rivers dry up, they dig holes in the sandy riverbed to get water for livestock.

During the dry seasons, water and pastures for livestock become scarce in WPLL. The most common strategy used by farmers is to move their livestock to areas where they can access these resources. Animals are shifted within the same district but in cases of severe drought they are moved to other districts and/or regions. Table 6 shows places where livestock are sent to and the duration. In Same District, 9 (75%) villages indicated that livestock is moved to other regions. The destination regions are Tanga (Lushoto and Korogwe districts) and Arusha (Simanjiro District). On average, livestock keepers in Same District send livestock away from their residence for 4 months each year.

In Mwanga District, it was reported that during shortages of water and pasture, farmers in 5 (20%) villages move their livestock within the district. Other 5 (20%) villages move their livestock to other districts within the region, namely Moshi Rural and even Same districts. On average livestock keepers send livestock away from their residence for 3 months in Mwanga District (Table 6).

In Maswa District, 32% of the village chairpersons reported that during water and pasture shortages; livestock keepers move their livestock to other districts. Those who move their livestock to other regions (Mbeya, Rukwa, Tabora and Singida) amount to 24% (Table 6). Only 15% move their stocks within the district. On average, livestock keepers send their stocks away from home for 3.5 months each year.

Table 5 Sources of water for livestock

Source	District					
	Same (n=321)		Mwanga (n=338)		Maswa (n=701)	
	No.	%	No.	%	No.	%
Charco-dam	6	2	1	1	82	12
Pipe system	32	10	22	7	4	1
Ephemeral streams	124	38	62	19	203	29
Well	17	5	N/A	N/A	5	1
Lake and reservoir	N/A	N/A	25	8	N/A	N/A
Storage pond (ndiva)	4	1	1	1	N/A	N/A
Springs (chemchem)	7	2	1	1	N/A	N/A
Small ponds in riverbeds	2	1	N/A	N/A	115	17

n = number of households

Table 6: Destinations of livestock transferred for water and pasture

District	Villages that transfer livestock			Period of stay away (months)
	No.	%	Destination	
Mwanga (n = 25)	5	20	Another ward (Lembeni, Kiria, Mwanga)	3
	5	20	Another district (Moshi rural, Same)	
	1	4	Another region (Arusha (Simanjiro))	
Same (n = 12)	1	8	Another ward (Kisiwani)	4
	0	0	Another district	
	9	75	Another region (Tanga, Arusha)	
Maswa (n = 78)	12	15	Within district (Within Maswa district)	3.5
	25	32	Another district (Shinyanga Rural, Meatu, Kahama Kwimba)	
	19	24	Another district (Mbeya, Tabora, Singida, Rukwa)	

3.1.2.3 Use of storage facilities

The extent of RWH was investigated further by asking the key informants to identify the use of storage facilities. Four types of storage facilities were mentioned to be used in WPLL. These included:

- Small containers estimated to be used in about 70% of the sub-villages.
- Small drums found in about 84% of sub-villages in Mwanga District.

- Storage ponds used to store water for supplementary irrigation of maize as well as in the production of vegetables. It was estimated that these are found in 23% of sub-villages in Mwanga District only.

- Charco-dams, which are normally used to supply water for livestock. However, in Mwanga District, 2 (1%) sub-villages mentioned that these charco-dams are also used to supply water for domestic use.

Table 7 shows that small containers and tanks are predominant storage facilities in WPLL. Seventy two percent and 69% of villages were said to depend on small containers to store water for domestic purposes in Mwanga and Same districts, respectively

Table 7: Structures used to store harvested rainwater for domestic use in WPLL

Type of structure	Number of sub-villages with the structure			
	Mwanga (n[1]= 79)		Same (n[1] = 68)	
	No.	%	No.	%
Small containers	57	72	47	69
Small tanks	66	84	26	26
Storage ponds	22	23	0	0
Charco-dams	2	1	0	0

[1]n=number of sub-villages

3.1.3 Types of crops grown in the study areas

Table 8 shows crops grown in the surveyed districts and to a lesser extent involvement in non-farm activities.

a) Mwanga

Maize is the most common crop produced in WPLL. It is produced in 24 (96%) villages in the district. Other food crops grown include beans, cowpeas, cassava, sorghum, sweet potatoes, green gram and bananas. Common cash crops are oil seeds such as groundnuts and sunflower. Groundnuts are grown in 10 (40%) of the surveyed villages and sunflower is produced in 7 (28%) villages. Other cash crops are cotton, castor, sugarcane, pigeon peas, green gram and coconuts. Common vegetables grown are tomatoes, cabbage and onions.

b) Same

Maize is produced in all 12 (100%) villages surveyed in Same District. Other food crops grown include beans, cowpeas, cassava, sorghum, sweet potatoes and bananas. Common cash crops are oil seeds such as groundnuts and sunflower. Sunflower is produced in 5 (42%) of the surveyed villages and groundnuts are produced in 4 (33%) villages. Other cash crops are similar to those grown in Mwanga District.

c) Maswa

Maize and sorghum are the major food crops in Maswa District, being grown by all 78 villages surveyed. Other food crops grown include beans, rice, cowpeas, cassava, green gram, sweet potato, chickpeas, bambaranuts and pigeon peas. Major cash crops include cotton, rice, sunflower, groundnuts and tobacco. Fruits and vegetables grown include tomato, cabbages, amaranthus, onions, mangoes, oranges, paw paw and water melon.

Table 8 Crops grown in the study area

Crop	Villages Growing the Crop					
	Mwanga		Same		Maswa	
	No.	%	No.	%	No.	%
Food crops						
Maize	24	96	12	100	78	100
Beans	22	88	7	58	8	88
Rice	1	4	N.A	N.A	62	79
Sorghum	4	16	2	17	78	100
Cow peas	15	60	2	17	18	23
Cassava	10	40	7	58	19	24
Green gram	3	12	N.A	N.A	5	6
Potato	4	16	7	58	66	85
Banana	1	4	4	33	N.A	N.A
Finger millet	N.A	N.A	N.A	N.A	20	27
Chick peas	N.A	N.A	N.A	N.A	7	9
Bambara nuts	N.A	N.A	N.A	N.A	3	4
Pigeon peas	N.A	N.A	N.A	N.A	1	1
Cash crops						
Groundnuts	10	40	4	33	17	22
Cotton	5	20	4	33	71	91
Delicos lablab			4	33		
Rice	3	12	N.A	N.A	24	31
Castor	2	8	1	8	N.A	N.A
Sugarcane	4	16	2	17	4	5
Sunflower	7	28	5	42	41	53
Pigeon peas	3	12	N.A	N.A	2	3
Beans	5	20	3	25	2	3
Green gram	4	16	N.A	N.A	N.A	N.A
Coconuts	4	16	N.A	N.A	N.A	N.A
Tobacco	N.A	N.A	N.A	N.A	8	10
Fruits and Vegetables						
Tomato	12	48	7	58	67	86
Cabbages	9	36	6	50	18	23
Amaranths	6	24	4	33	10	13
Onions	8	32	4	33	20	26
Mangos	12	48	8	66	14	18
Oranges	2	8	N/A	N/A	2	3
Paw paw	2	8	N/A	N/A	5	6
Anona	1	4	N/A	N/A	N/A	N/A
Peppers	1	4	2	17	N/A	N/A
Water melon	1	4	1	8	5	6

Note: Percentages don't add to a hundred due to multiple responses

3.2 Extent of use of Rainwater Harvesting

The dominance of maize in all the farming systems is notable despite semi-aridity of these areas. Farmers use various RWH techniques to ensure a good maize crop as indicated in the next section. It is worth noting also that in some years farmers experience total maize crop failure.

3.2.1 Perceptions of village chairpersons on the meaning of RWH

Before identifying the extent of RWH, it was necessary to get a common understanding of RWH. Respondents were therefore requested to explain their perception on RWH.

Table 9 shows that up to 33% of key informants at village level in Same District claimed to know nothing about RWH. However, in general RWH was perceived as either:

- Diversion of water from gullies to crop fields (13-48%) and/or
- Using rooftops to harvest water for domestic uses (25-33%) and/or
- Constructing charco-dams (9 –28%) and/or
- Constructing ridges and excavated bunds (5%).

These results indicate that there is diversity among respondents on the understanding of RWH.

At the same time when given a list of RWH techniques and asked to identify those being practiced in their villages, the results showed that various RWH techniques are already being practiced (Table 10). These include deep tillage, making large planting pits, terraces, ridges, diverting water from rangelands to the fields, collecting rainwater from rooftops and floodwater diversion. This shows that many households are already practicing some form of rainwater harvesting but do not recognize it as such. The extent of use of these different methods is as described in the next sub-section.

Table 9: Perceptions of village chairpersons on extent of use of RWH

Perception of meaning of RWH	Number of respondents					
	Mwanga (n = 25)		Same (n = 12)		Maswa (n=78)	
	No.	%	No.	%	No.	%
Diverting water from ephemeral streams to the fields	12	48	5	42	10	13
Harvesting and storing water for domestic use	8	32	3	25	26	33
Constructing charco-dams	7	28	2	17	7	9
Constructing ridges and excavated bunds	N/A	N/A	N/A	N/A	4	5
Know nothing about RWH	1	4	4	33	19	24

3.2.2 Range of RWH techniques

The range of RWH techniques in the study area, can be broadly classified into 3 groups:

a) In-situ

In-situ RWH, also known as soil-water conservation, comprises a group of techniques for preventing runoff and promoting infiltration. The aim is to retain moisture that would otherwise be wasted as runoff from the cropped area. Rain is conserved where it falls, but no additional runoff is introduced from elsewhere. Some of the in-situ RWH techniques practiced in Maswa and WPLL include deep tillage, large planting pits, ridging and terracing.

i) Deep tillage

Deep tillage involves loosening of soil and the creation of a rough soil surface. This facilitates water infiltration and improves soil-water regime for crop/plant growth. Key informants explained that this is the oldest technique of rainwater harvesting in their places. Common crops grown under this technique are maize and beans. Often the technique is used in combination with others. The technique is common in 22 (88%), in 10 (83%) and in 41(53%) of villages in Mwanga, Same and Maswa districts respectively.

ii) Large planting pits

The aim of large planting pits is to concentrate rainwater into a small area and optimize its availability to seed, and plant roots. By so doing water availability for growth is significantly improved. It was indicated that, this technique is mainly used for maize and tree crops in WPLL and cotton in Maswa District. This technique is practiced in 14 (56%), in 6 (50%) and in 8 (10%) of villages in Mwanga, Same and Maswa districts, respectively.

iii) Terraces

Terraces are level or nearly level steps constructed or formed on the contour and separated by embankments. In the study area, these are made on steep land by constructing stone embankments. The technique reduces runoff, soil erosion and improves water infiltration. This technique was reported to be used in 3 (25%) villages in Same District. Common crops grown using the technique are maize and onions. In Mwanga District, 6 (24%) villages reported to be using terraces as a technique of RWH. Common crops grown under the technique are maize, beans and vegetables. In Maswa, terraces and ridges are commonly used in 42 (54%) villages and the major crop produced under this technique is sweet potatoes.

iv) Ditches (*Makinga Maji*)

The technique involves making of infiltration ditches that slow down runoff and store it to allow increased infiltration into the soil. The ditches also protect the land from erosion. The key informants were of the opinion that the technique is used in 5 (20%) villages in Mwanga and in 10 (83%) villages in Same. Common crops grown with this technique are maize, beans and vegetables in Mwanga and maize only in Same. In Maswa District, ditches are common in only 2 (3%) villages and used mainly in vegetable production.

b) Macro-catchment

This comprises a group of techniques for collecting run-off from large external catchment upstream of the harvesting area. Some of the macro-catchment RWH techniques practiced in the study area are stream flow/gully diversion, diversion from rangelands, diversion from roads, footpaths and stock routes, and excavated bunded basins.

i) Diverting run-off from rangelands

The technique involves diversion of floodwater from rangelands, or bush land (catchment area) to cultivated fields or storage structures such as charco-dams. The key informants considered that the technique is used in 10 (40%) villages in Mwanga and 3 (25%) villages in Same District. Common crops grown are maize, beans and rice in Mwanga and maize only in Same District. In Maswa District diverting rainwater from rangelands to the fields is practiced in 13 (17%) and crops produced are paddy and maize.

ii) Flood water diversion

This system involves the diversion of water from ephemeral streams and conveying it to a cropped area or storage structures. It involves some kind of diversion and conveyance structures. Table 10 shows that informants at village level recognized this system to exist in 10 (40%), in 1 (8%) and 10 (13%) of villages in Mwanga, Same and Maswa districts, respectively.

iii) Excavated bunded basins (EBB)

This technique was mentioned to be important in Maswa district particularly for paddy production. Results from key informant survey indicated that 62 (79%) villages practice EBB in Maswa District (Table 10(c)).

c) Macro-catchment with storage

This includes structures used to store water harvested by using macro-catchment RWH techniques. Examples include storage ponds (ndiva), charco-dams, and ponds in riverbeds.

Table 10: RWH techniques used in crop production in the study area

a) Mwanga District (n = 25)

Type of Technique	Extent of use by villages		Crops grown with the system		
				Extent	
	No.	%	Type	No.	%
Deep tillage	22	88	Maize	19	76
			Beans	3	12
Large planting pits	14	56	Maize	12	48
			Beans	1	4
Ridges/terraces	6	24	Maize	6	24
			Beans	2	8
			Vegetables	3	12
Ditches	5	20	Maize	4	16
			Beans	1	4
			Vegetables	2	8
Diverting water from rangelands	10	40	Maize	10	40
			Beans	2	8
Rooftops harvesting	1	4	Maize	1	4
Flood water diversion	11	44	Maize	11	44
			Beans	2	8
			Rice	1	4

n = Number of villages

b) Same District (n=12)

Type of Technique	Extent of use by villages		Crops grown with the system		
				Extent	
	No.	%	Type	No.	%
			Maize	10	83
Deep tillage	10	83	Beans	2	17
Large planting pits	6	50	Maize	3	25
			Maize	1	8
Ridges/terraces	3	25	Onions	2	17
Ditches	1	8	Maize	1	8
Diverting water from rangelands	3	25	Maize	2	17
Flood water harvesting	1	8	Maize	1	8

c) Maswa District (n = 78)

Type of Technique	Extent of use by villages		Crop grown with the system		
				Extent	
	No.	%	Type	No.	%
Deep tillage	41	53	Maize	41	53
Large planting pits	8	10	Cotton	8	10
Ridges/ Terraces	42	53	Sweet potatoes	42	53
Diverting water from rangelands	13	17	Paddy	13	17
Excavated bunded basins	72	92	Paddy	72	92

3.2.3 Area treated with RWH

At sub-village level, key informants were requested to estimate the cropped area treated with RWH. A summary of their perceptions is given in Table 11. As earlier indicated RWH in WPLL, is largely for maize production. The total area reported to have maize under RWH is about 2,412 hectares in Same District, while in Mwanga is 333 hectares. In Maswa District only 261 ha of maize are estimated to be cultivated under RWH. In Maswa RWH is largely used for paddy (3,999 ha) and sorghum (2,716 ha).

Results from household survey show that proportion of farmers who practice deep tillage is higher in WPLL (70% and 57% in Same and Mwanga districts respectively) as compared to other RWH techniques (Table 12). Further to this even the area under deep tillage, as reported by household heads, is larger than that under other techniques. In Maswa District, results show that more people practice ridging and terracing as compared to other techniques. Excavated bunded basins, used for rice growing, ranks number two in Maswa District, where it is practiced by 44% of respondents. However, in general, the results show that in-situ RWH systems are predominant in the study area. The table also shows that a higher percentage of households practice macro-catchment RWH in Maswa District as compared to WPLL.

Table 11: Households practicing RWH for crops

Purpose of RWH	Estimate of HH practicing RWH			
	Mwanga (n = 7,900)		Same (n = 5,916)	
	No.	%	No.	%
Vegetable production	6,557	83	1,972	33
Fruits production	79	1	782	13
Trees production	3,002	38	2,040	34
Pasture production	0	0	0	0

Table 12: Extent of use of RWH

RWH Techniques	District								
	Same (n = 321)			Mwanga (n = 338)			Maswa (n = 701)		
	No.	%	Area (ha)	No.	%	Area (ha)	No.	%	Area (ha)
Deep tillage	223	70	160	194	57	120	254	36	243
Rooftop RWH	39	12	N/A	101	30	N/A	31	4	N/A
Ridging/terracing	30	9	21	8	2	5	458	65	438
Stream/gully flow diversion	150	47	107	38	11	24	2	1	2
Diversion from rangelands	4	1	3	20	6	12	127	18	121
Charco-dams	14	4	N/A	5	2	N/A	41	6	N/A
Storage ponds (ndiva)	51	16	N/A	8	2	N/A	N/A	N/A	N/A
Excavated bunded basins	N/A	N/A	N/A	3	1	2	308	44	294
Pitting	3	1	2	20	6	12	N/A	N/A	N/A
Small ponds in dry river bed	N/A	N/A	N/A	N/A	N/A	N/A	138	20	N/A

n = number of respondents

3.3 Macro-catchment RWH for Crop Production

3.3.1 Storage structures

Storage structures like small ponds (*ndiva*) are important in RWH for crop production. This is mainly because the rains are erratic and sometime last for a short period. These ponds are normally constructed at a relatively higher (upland) area but supply water both to upland and lowland area.

In the surveyed villages, only a few storage ponds with limited capacities exist in some villages. In Same District, 5 (42%) villages reported presence of storage ponds. These villages are Mwembe, Bangalala, Makanya, Hedaru and Mgwasi. These storage ponds are listed against their villages in Table 13(b). Only Bangalala, Makanya and Hedaru managed to estimate the number of households and area that are served by the storage ponds.

Mghungani and Manoo storage ponds in Bangalala village serve substantial number of households. They serve 300 households each. Mghungani supplies water to feed 240 ha in the long rainy seasons and 160 ha in the short rainy seasons. However, only 14 ha receive water from Mghungani pond in the dry season. Manoo storage pond feeds 120 ha during long rains and 80 during the short rainy season. Another important storage pond is Nkwini located at Makanya village, which serves 370 households and 148 ha during the long rainy season.

In Mwanga District, there are six storage ponds located in 6 (24%) villages (Table 13(a)). These villages are Ngulu, Kiruru Ibweijewa, Kisangara, Lembeni, Butu and Kigonigoni. Of all, Nkanamwa storage pond in Kiruru Ibweijewa village is the most important in terms of number of households and area served. It serves 202 households and feeds 20 ha, 6 ha and 1.2 ha during *Masika*, *Vuli* and dry season, respectively. Next to Nkanamwa is Sungo water pond in Butu village, which serves 30 households and feeds 20 ha, 10 ha and 6 ha in *Masika*, *Vuli* and dry season, respectively. Respondents indicated that most of these storage ponds are constructed over a long period of time. This is mainly because they are usually constructed manually using very simple tools such as hand hoes, axes and spades. Despite the job being tedious, farmers invest their labour in this exercise because without such effort crop productivity is very low.

Table 13: Use of Storage ponds ('ndiva') for crop production

a) Mwanga District

Name of Storage pond	Villages	Location	No. of benefiting households	Area (ha) getting water during:		
				Masika	*Vuli*	Dry season
Mabashula	Ngulu	Mabashula	10	3	3	2
Nkananwa	Kiruru ibwa ijewa	Mighareni	202	20	6	1
Songoa	Songoa	Songoa	60	12	3	0
Rughwini	Lembeni	Rughwini	10		5	1
Sungo	Butu	Butu	30	20	10	6
Kwabongo	Kigonigoni	Kwakihindi	30	12	8	1

b) Same District

Name of Storage pond	Villages	Location	No. of benefiting households	Area (ha) getting water during:		
				Masika	*Vuli*	Dry season
Mghungani	Bangalala	Vikunguru	300	240	160	14
Kinyang'a	Bangalala	Kinyang'a	70	28	28	12
Mkanyeni	Bangalala	Mkanyeni	140	56	48	12
Manoo	Bangalala	Kwanyongo	300	120	80	0
Mchikatu	Bangalala	Mchikatu	70	28	14	2
Nkwini	Makanya	Nkwini	370	148	0	0
Lungwana	Hedaru	Lungwana	60	60	20	8
Kauzeni	Hedaru	Gundu	40	24	10	6
Mputwa	Hedaru	Kijomu	40	24	10	6

3.3.2 Intakes and canals

Apart from storage ponds, other important structures for RWH for agricultural production are intakes and canals for diverting water from ephemeral streams flowing across the villages.

In Mwanga District there are 10 ephemeral streams with 16 intakes and canals used for crop production (Table 14a). These are located in 7 (28%) villages. The largest ephemeral stream is Kirinama (Mala) flowing across Kigonigoni village. The stream has two intakes, Usangi and Kigonigoni. In total the two intakes serve 800 households and feed 140 hectares in the long rainy season, 70 hectares in the short rainy season and 18 hectares in the dry season. On average each household posses less than 0.2 of a hectare of the area fed by this stream during the long rainy season, and less than 0.1 of a hectare during the short rainy season. The area fed by these intakes during the dry season is negligible compared to population to be served. Table 14a shows the intakes and canals used for crop production in Mwanga District.

In Same District there are two ephemeral streams, which have 13 intakes/canals (Table14b). The most important village for RWH in Same District is Makanya village. There are two ephemeral streams (Vudee and Nkwini) that flow through the village. Canals are constructed from each stream to facilitate water distribution for crop production. About 800 households get water from Vudee ephemeral stream where 184 ha benefit. About 370 households get water from Nkwini ephemeral stream. In total 148 ha are fed by this stream. The estimation as reported here by the perception of villagers, is very low as compared to the actual figures reported in Annex B. Also the household survey shows that the average size of land benefiting from RWH, per household is 0.9 ha. This implies that for the estimated 800 households, the total area should be 720 ha, which compares well with the actual area measured and reported in Annex B.

In Maswa District, there are 8 villages with a total of 15 intakes used for crop production. These intakes supply water to 4,359 hectares during rainy season thereby benefiting 1,682 households.

Of importance to note here is that there are some RWH structures that have collapsed due to various reasons and are not currently utilized (Table 16). At the same time there are some whose potential is underutilized due to lack of maintenance or poor design. The benefits from rainwater harvesting can therefore be increased in some cases with rehabilitation work on these structures.

3.4 Macro-catchment RWH for Livestock Production

The most commonly used RWH technique for livestock production is diversion of run-off and storage. For Mwanga District (Table15), there are 13 charco-dams located in 5 (20%) villages. These are Kiruru ibweijewa (3), Kiria (3) Toloha (3) Mgagao (3) and Kiverenge (1). All the charco-dams in Mwanga are communally owned. The respondents in Mwanga District indicated the number of livestock benefiting from these charco-dams to be about 6,260. However this is an underestimate given the fact that, there is a strong traditional belief among livestock keepers that if one counts the animals, the herd/flock does not expand.

In Same District there are 12 communally owned charco-dams located in 6 (50%) villages, which are Bangalala, Same Mjini, Njoro, Ishinde and Gavao (Table 15). In addition to communal charco-dams, there are 32 privately owned charco-dams in Same District, 26 in Makanya, 5 in Bangalala and 1 in Same Mjini. It is estimated that both the communally and privately owned charco-dams provide water to about 3,700 livestock units. Private charco-dams also provide water for domestic use to the owner. There are charco-dams that are completely out of use in Same District. These include Kirinjiko chini (in Bangalala) and Hedaru (Mabomani).

In Maswa District, charco-dams have been constructed in 19 (24%) villages to provide water for livestock use (Table 15). An estimate of 24,315 livestock benefit from water supplied by charco-dams.

Table 14: Intakes and canals used for crop production in the study area

a) Mwanga District

Village	Ephemeral stream	Name of Canal/intake	No. of benefiting households	Area (ha) getting water during:		
				Long rains	Short rains	Dry season
Kiruru Ibwe Ijewa	Nkananwa	Mighareni	300	24	6	N/A
		Majighwini	N/A	12	24	6
	Chang'ombe	Chang'ombe	40	10	N/A	N/A
Butu	kirurumo	Butu ugweno	400	320	160	40
Kwakoa	Mgigili	Kwakoa	250	40	24	2
		Kwasekei	250	40	24	2
Kambi ya simba	Mvingoni	mtiliko	200	120	80	N/A
	Mwanjo	Rema	500	40	32	2
		Mshasheni	800	60	40	4
		Mkalanyika	300	24	12	4
Kigonigoni	Ndurumo/mvureni	Kampisi	100	24	12	1
		Kwakihindi	800	20	10	2
	Kirinama/mala	Kigonigoni	200	60	10	2
		Butu usangi	600	80	60	16
Total			4,740	874	494	95

b) Same District

Village	Ephemeral stream	Canal/intake	No. of benefiting households	Area (ha) getting water during:		
				Long rains	Short rains	Dry season
Makanya	Vudee	Salim kuku	800	184	184	0
		Matamila				
		Ng'ambo				
		Wandea				
		Maganda				
		Swedi				
		Mwembe				
	Nkwini	Kashana	370	148	148	0
		Diksoni				
		Azimio la mbali				
		Mramba pesa				
		Mikohoni				
		Mbugani				

c) Maswa District

Village	Sub-village	Name of intake	Number of benefiting households	Area (acres) getting water during rainy season	Area (Acres) getting water during dry season
Mwabayanda		Mwanhuzi	12	672	-
		Mwandu	8	30	-
		Mwabayanda	18	46	-
		Sadamu	10	18	-
Ndala na Ngokolo		Gulumwashi	314	1,410	-
		Hinduki	210	814	-
Ilamata		Ngado	50	59	-
		Mwamabuli	50	59	-
Kuliani		Ijinga	201	-	-
		Magarata	113	-	-
Njiapanda	Ngegemo	Ngegemo	62	140	
	Mwamagaka	Mwamagaka	104	311	
Masanwa	Masanwa	Shambuli	354	-	
Buhungukila		Gaga	176	800	
Seng'wa	Nyashimba	Seng'wa			
Total			1,682	4,359	

Table15: Extent of use of charco-dams that are operational and under communal ownership

District	Number of Villages	Number of operational charco-dams
Mwanga	5	13
Same	5	12
Maswa	43	103
Total	53	128

Table 16 Charco-dams that are non-operational

District	Number of Villages	Number of non-operational charco-dams
Mwanga	1	1
Same	2	2
Maswa	21	40
Total	24	43

3.5 Performance of RWH

3.5.1 Crop production

At sub-village level, key informants were requested to estimate the cropped area treated with RWH. A summary of their perceptions is given in Table 17(a). As earlier indicated, RWH in WPLL, is largely for maize production. The total area reported to have maize under RWH in the WPLL is about 2,412 hectares in Same District, and 333 hectares in Mwanga District. In Maswa District, only 261 ha of maize are estimated to be cultivated under RWH. In Maswa RWH is largely used for paddy (3,999 ha) and sorghum (2,716 ha).

Key informants were also requested to give their opinions on the level of maize and paddy yields under different RWH systems as shown in Table 17(b). They reported that maize and paddy yields of up to 3,240 kg/ha and 3,228 kg/ha respectively can be obtained under RWH in the study areas. Apart from field crops, RWH is also used for production of vegetables, fruits, as well as tree crops.

Table 17(a): Crops grown under RWH and their estimated area

Crop	Area (ha)		
	Mwanga	Same	Maswa
Paddy	N/A	N/A	3,999
Cotton	N/A	N/A	1,518
Sorghum	N.A	28	2,716
Maize	333	2,412	261
Sweet potatoes	0	0	308
Vegetables	24	12	0
Beans	6	0	0
Sugarcane	1	0	0

Table 17(b): Estimated maize and paddy yields (Kg/ha) under different RWH techniques

RWH techniques	Yields kg/ha		
	Mwanga[1]	Same[1]	Maswa[2]
Large planting pits	1,512	2,484	N/A
Ridges and terraces	1,998	2,862	N/A
Diversion ditches	1,593	1,620	N/A
Diverting from rangelands	1,350	3,240	N/A
Diverting from ephemeral streams	1,350	2,970	N/A
Excavated bunded basins	N/A	N/A	3,228

[1] Maize yields [2] Paddy yields

In the WPLL, RWH is more important during Vuli season. Table 18 (a) and (b) shows estimates made by the households regarding areas and yields of maize and paddy (rice) in WPLL and Maswa District, respectively. Table (18 a) shows that in the WPLL the area under RWH during Vuli season (511ha) is higher than during Masika season (445 ha). In Same only 69 hectares were cultivated with maize during Vuli 2000/2001 compared to 331 hectares with RWH for the same season. This is mainly because the rains are unpredictable resulting into very low yields. Average maize yield without rainwater harvesting was 268 kg/ha compared to 1,019 kg/ha obtained with RWH during the Vuli of 2000/2001 in Same District. The maize yields obtained with RWH during Vuli exceed that obtained during the Masika season.

It can also be noted that in both Same and Mwanga, the number of farm plots under maize crop with RWH during Vuli season is higher than those cultivated without RWH and even those cultivated during Masika season. For example only 79 farm plots were under maize without RWH during the Vuli rains of 2000/2001 in Same compared to 367 that were under maize with RWH. Table 18 (b) shows that higher yields are obtained when combinations of RWH techniques are used.

This data shows the importance of RWH for food security and poverty alleviation in these areas, which are traditionally categorized as marginal. The productivity of these areas can be substantially improved with investments in RWH.

Table 18 (a) Estimated Yields: (Vuli 2000/2001 and Masika 2000)

District	Season		Cultivated area (ha)	Yields (Kg/ha)[1]
Mwanga	Vuli (n=267)	With RWH (n=259)	180	568
		Without RWH (n=8)	8	51
	Masika (n=192)	With RWH (n=181)	127	416
		Without RWH (n=11)	10	5
Same	Vuli (n=446)	With RWH (n=367)	331	1,019
		Without RWH (n=79)	69	268
	Masika (n=427)	With RWH (n=350)	318	262
		Without RWH (n=77)	68	209
Maswa		With (n=293)	330	1,279

[1] Yield for maize WPLL and rice in Maswa
n= Number of farm plots

Table 18 (b): Estimated yields (Kg/ha) under different RWH techniques

RWH techniques	Yields kg/ha		
	Mwanga[1]	Same[1]	Maswa[2]
In-situ only	500	1,500	
In-situ & diversion (combined)	750	2,000	
Excavated bunded basins (EBB)	N.A	N.A	1260
EBB and Diversion (combined)	N.A	N.A	2160

[1] Maize yields [2] Paddy yields

3.5.2 Livestock production

Although a good number of charco-dams have been constructed in the study area, water for livestock is still problematic due to poor performance of these structures. Key informants pointed that on average charco-dams retain water for 7 months, 4 months and 4 months after the rainy season in Maswa, Mwanga and Same districts, respectively (Table 20).

There are cases where charco-dams retain water for 2-3 months only after the rains. It is important to note that some of the charco-dams are completely out of use. Key informants indicated that there are up to 26(38%) charco-dams that are out of use in Maswa District. Similarly in WPLL there are 2 (17%) and 1(8%) charco which are not operational in Same and Mwanga, respectively. Siltation is the main problem for poor performance of the charco-dams.

Table 19 shows performance of charco-dams in terms of water retention. Up to 50% of charco-dams are remaining with only a fraction of their initial storage capacity due to siltation. Charco-dams, which once retained water for the whole year, currently hold water only during the rainy season. Often, there are no strategies for operation and maintenance (O & M).

Due to lack of strategies for operation and maintenance, useful life for RWH structures supplying water for livestock is short. Table 20 shows useful life for RWH structures used to supply water for livestock. Perceptions of key informants indicated that ponds in dry river beds have the shortest life span of a maximum of only two years. For some structures, the life span is shorter in Maswa than in Same District. Respondents estimated that charco-dams have a life span of 1-20 years in Maswa but 15-76 years in Same. Reasons for observed differences could help in instituting better management practices for charco-dams.

As for ponds in dry river beds (*makomero*) which are very efficient in storing water, a better approach would be to construct them using stones. The capital required to invest in a charco is very high given the low income of the households in the survey areas. To overcome this problem, farmers have adopted a strategy of spreading the construction cost by increasing the charco size progressively over the years. As for livestock keepers with big herds, the amount of money required to construct a charco can be obtained by selling two or three heads of cattle.

Table 19: Performance of charco-dams in the study area

District	No of charco-dams				Benefits		
	Communal		Private		No of benefiting animals	Months with water	
	Operational	Non-operational	Operational	Non-operational		range	Average
Maswa	103	26	N/A	N/A	14,661	3-12	7
Mwanga	13	1	N/A	N/A	6,263	2-12	5
Same	12	2	32	0	3,700	1-12	4

Table 20: Average construction costs, maintenance cost and useful life various RWH structures

District	RWH structures	Initial investments (Tshs)		Maintenance cost (Tshs)/year		Useful life (Years)	
		Min	Max	Min	Max	Min	Max
Maswa	Charco-dams	35,000	88,000	13,000	62,000	1	20
	Excavated bunded basins	16,000	27,000	6,000	8,000	1	30
	Ponds in dry river beds	14,000	40,000	15,000	-	1	2
Same	Charco	202,770	287,820	49,750	178,400	15	76

3.5.5 Potential for improving performance of RWH

The ultimate goal of any RWH technology is to make the enterprise competitive and comparable to other sectors in the generation of benefits from utilisation of water. This can be achieved through the following:

(i) Development, adaptation and adoption of in-field water application systems. The principles of how this can be achieved are already known.

(ii) Development of an efficient operation and maintenance (O&M) schedule. Currently, operation and maintenance services are very poor or lacking. Many projects have failed because of poor O&M. It is important therefore, that operation and maintenance service provision is sustained even if provided by private business.

3.6 Typology of Users of RWH

The characterization of users of RWH is important for targeting RWH technologies. In this study, gender and age of heads of household are used to assess the extent of RWH in addition to resource availability mainly labour and land.

3.6.1 Gender

Table 21(a), (b) and (c) show the relationship between gender of head of household and RWH techniques used. The table shows that, there is no clear evidence of differences in RWH techniques by gender. Notable however, is that no female-headed households are practicing pitting, in Same District, or charco-dams, borders and excavated bunded basins (majaluba) in Mwanga District, or small ponds in dry ephemeral streams (*makomero*) in Maswa District. This is likely related to the purpose or use of the harvested water e.g. charco-dams in Mwanga are mainly for livestock, which is largely a male responsibility. Practicing the different techniques can also be related to labor requirements. For example, pitting in Same and construction of small ponds in Maswa require large inputs of labor. Therefore, female-headed households who cannot hire labor are unlikely to practice such techniques.

Table 21 Use of RWH technologies by gender of household heads

a) Mwanga District (n=338)

	Households using RWH					
	Male headed households (n=262)		Female headed households (n=75)		Total	
RWH technique	No.	%	No.	%	No	%
Deep Tillage	153	58	49	65	202	60
Rooftop RWH	88	34	20	27	108	32
Ridging and terracing	5	1	2	3	7	2
Ephemeral stream/gully flow diversion	35	13	4	5	39	12
Diverting water from rangelands	18	6	4	5	22	6
Charco-dams (Malambo)	1	1	0	O	1	1
Storage Ponds (Ndiva)	5	1	2	3	7	2
Pitting	18	7	1	1	19	6
Borders	1	1	0	0	1	1
Excavated bunded basins (Majaluba)	2	1	0	0	2	1

b) Same District (n = 321)

	Households using RWH					
	Male headed households (n=276)		Female headed households (n=74)		Total	
RWH technique	No.	%	No.	%	No	%
Deep Tillage	183	66	51	69	134	42
Rooftop RWH	37	13	9	12	46	14
Ridging and terracing	4	1	2	3	6	2
Ephemeral stream/gully flow diversion	118	43	39	53	157	49
Diverting water from rangelands	5	2	0	0	5	2
Charco-dams (Malambo)	13	5	2	3	15	5
Storage Ponds (Ndiva)	23	8	4	5	27	8
Pitting	3	1	0	0	3	1
Borders	23	8	4	5	27	8

c) Maswa District (n=701)

RWH technique	Households using RWH					
	Male headed households (n=608)		Female headed households (n=91)		Total	
	No.	%	No.	%	No	%
Deep Tillage	268	44	31	34	299	43
Rooftop RWH	28	5	9	10	37	5
Ridging and terracing	441	72	68	75	509	73
Ephemeral stream/gully flow diversion	2	1	0	0	2	1
Diverting water from rangelands	112	19	19	21	131	20
Charco-dams (Malambo)	45	7	4	4	49	7
Storage Ponds (Ndiva)	0	0	0	0	0	0
Pitting	0	0	0	0	0	0
Borders	0	0	0	0	0	0
Excavated bunded basins (Majaluba)	294	48	49	54	343	49
Small ponds in dry river beds	132	22	9	20	141	21

3.6.2 Age

Age is related to RWH, through experience and labor availability. Notable in Tale 22 (b) is the fact that pitting in Same District is largely practiced by the young farmers up to 40 years old. This is because the pits need to be dug every season. It is likely that the elderly cannot manage to do so. Deep tillage and ephemeral stream flow diversion is used by all age groups. For example in Same district about 52% of farmers divert ephemeral flows. No marked difference between farmers according to age groups.

Table 22: Use of RWH technologies by age groups

a) Mwanga District (n=338**)**

RWH Technique	Number of households using RWH					
	Household head age group					Total
	<=30 n=77	31-40 n=104	41-50 n=68	51-60 n=41	>60 n=45	
Deep Tillage	30(38)	60(58)	45(66)	28(78)	3(8)	201(59)
Rooftop RWH	35(45)	35(34)	18(26)	10(24)	9(20)	107(32)
Ridging and terracing		3(3)	3(4)	0(0)	1(2)	7(2)
Ephemeral stream/gully flow diversion	7(11)	18(17)	7(10)	2(5)	5(11)	39(12)
Diverting water from rangelands	5(7)	7(7)	4(5)	3(7)	3(6)	22(6)
Charco-dams (Malambo)	0(0)	0(0)	0(0)	0(0)	1(2)	1(1)
Storage Ponds (Ndiva)	0(0)	4(4)	2(3)	3(7)	1(2)	10(3)
Pitting	7(0)	3(3)	7(10)	1(2)	1(2)	19(6)
Borders		1(1)	0(0)	0(0)	(0)	1(1)
Excavated bunded basins	0(0)	0(0)	2(3)	0(0)	0(0)	2(1)

n = number of respondents
(a) = number in the brackets represent percentages

b) Same District (n=321)[1]

RWH Technique	Number of households using RWH					
	Household head age group					
	<=30 n=48	31-40 n=84	41-50 n= 68	51-60 n=58	>60 n=63	Total
Deep Tillage	35(73)	62(74)	53(78)	43(74)	42(67)	235(73)
Rooftop RWH	7(15)	9(11)	10(15)	14(24)	9(14)	49(15)
Ridging and terracing	0(0)	2(2)	3(4)	2(3)	0(0)	7(1)
Ephemeral stream/gully flow diversion	25(52)	42(50)	35(51)	38(66)	27(42)	167(52)
Diverting water from rangelands	2(4)	0(0)	0(0)	2(3)	1(2)	5(1)
Charco-dams (Malambo)	4(8)	4(5)	3(4)	3(5)	2(3)	16(5)
Storage Ponds (Ndiva)	6(12)	9(11)	8(12)	14(24)	13(21)	50(15)
Pitting	2(4)	1(1)	0(0)	0(0)	0(0)	3(1)
Borders	4(8)	7(8)	5(7)	6(10)	3(5)	25(8)

c) Maswa District (n=701)

RWH Technique	Number of households using RWH					
	Household head age group					
	<=30 n=113	31-40 n=224	41-50 n=164	51-60 n=116	>60 n=84	Total
Deep Tillage	52 (46)	100(45)	73(45)	47(41)	29(35)	301(43)
Rooftop RWH	4(4)	11(5)	9(5)	6(5)	7(8)	37(5)
Ridging and terracing	81(72)	172(77)	118(72)	80(69)	60(71)	511(73)
ephemeral stream/gully flow diversion	1(1)			1(1)		2(1)
Diverting water from rangelands	18(16)	38(18)	28(17)	26(22)	22(26)	132(20)
Charco-dams (Malambo)	4(4)	8(4)	9(5)	7(6)	2(2)	30(4)
Excavated bunded basins (Majaluba)	50(44)	115(51)	76(46)	59(51)	43(51)	343(49)
Small ponds in dry river beds	21(19)	40(18)	39(24)	31(24)	20(24)	151(22)

3.5.3 Labour availability and RWH

Labour is a critical resource in rural areas because most activities depend on manual labour. There is very limited use of labour saving technologies. Often farmers use simple hand tools. Household labour force is therefore one of the most limiting factors in rainwater harvesting. Most of the RWH structures are constructed manually. It is difficult however to relate between current household labour force with RWH techniques. This is because most RWH structures are constructed over a very long period of time. Also there are labour sharing systems between households and to a lesser extent labour hiring. For these reasons there is no direct relationship between current household labour force and the RWH technique practiced. However, Tables 23 (a), (b) and (c) indicate that households with smaller labour force tend to practice wider range of RWH techniques.

Table 23: Use of RWH technologies and labour force availability

a) Mwanga District (n=338)

	Number of households practicing RWH				
	Labour – No. of people per household				Total
RWH Technique	1-3 n=293	4-6 n=31	7-10 n=5	>10 n=0	
Deep Tillage	177(60)	19(61)	4(80)	0(0)	200(59)
Rooftop RWH	99(34)	7(23)	1(20)	0(0)	107(32)
Ridging and terracing	5(2)	2(6)	0(0)	0(0)	7(2)
Ephemeral stream/gully flow diversion	37(13)	2(6)	0(0)	0(0)	39(12)
Diverting water from rangelands	18(6)	3(10)	1(20)	0(0)	22(7)
Storage Ponds (Ndiva)	7(2)	2(6)	1(20)	0(0)	10(3)
Pitting	19(6)	1(3)	0(0)	0(0)	20(6)
Borders	1(1)	0(0)	0(0)	0(0)	1(1)
Excavated bunded basins (Majaluba)	0(0)	1(3)	1(20)	0(0)	2(1)

b) Same District (n=321**)**

	Number of households practicing RWH				
	Labour – No. of people per household				
RWH Technique	1-3 n=242	4-6 n=54	7-10 n=7	>10 n=3	Total
Deep Tillage	179(74)	41(76)	5(71)	2(67)	227(71)
Rooftop RWH	36(15)	8(15)	1(14)	0(0)	45(14)
Ridging and terracing	6(2)	0(0)	0(0)	0(0)	6(2)
Ephemeral stream/gully flow diversion	111(46)	26(48)	3(43)	3(100)	143(45)
Diverting water from rangelands	2(1)	2(4)	1(14)	0(0)	5(2)
Charco-dams (Malambo)	12(5)	7(13)	0(0)	0(0)	19(6)
Storage Ponds (Ndiva)	42(17)	7(13)	1(14)	0(0)	50(16)
Pitting	3(1)	0(0)	0(0)	0(0)	3(1)
Borders	19(8)	5(9)	0(0)	1(33)	24(7)

c) Maswa District (n=701)

RWH Technique	Number of households practicing RWH				
	Labour – No. of people per household				Total
	1-3 n=387	4-6 n=235	7-10 n=59	>10 n=9	
Deep Tillage	167(43)	95(40)	30(51)	3(33)	295(42)
Rooftop RWH	24(6)	12(5)	0(0)	0(0)	36(5)
Ridging and terracing	297(77)	159(68)	47(80)	5(56)	508(72)
Ephemeral stream/gully flow diversion	1(1)	1(1)	0(0)	0(0)	2(1)
Diverting water from rangelands	72(19)	40(17)	16(27)	4(44)	132(20)
Charco-dams (Malambo)	17(4)	22(9)	9(15)	0(0)	48(7)
Excavated bunded basins (Majaluba)	187(48)	114(49)	32(54)	7(78)	340(49)
Small ponds in dry river beds	69(18)	55(24)	13(22)	4(44)	141(21)

3.5.4 Number of farm plots and RWH

Traditionally small holder farmers own small plots of lands located in different areas within the villages and sometimes outside the residential villages. This partly is a result of system of land inheritance, where by a parent subdivide his/her farmland among children. Also, as a risk management strategy, farmers prefer to have plots located in different geographical areas.

Table 24 (a) (b) and (c) show that there is no marked difference between farmers with a few number of plots as compared to those with large number of plots in respect to practicing RWH. For example 200 (73%) 179 (82%), and 112 (45%) farmers in Same, Mwanga and Maswa respectively, owning 1-3 plots of farmland practiced deep tillage. On the other hand only 5 (83%), 1 (100%) and 10 (40%) farmers in Same, Mwanga and Maswa respectively owning more than 7 plots of farmland, practicing deep tillage. This shows that farmers with fewer plots are more likely to adopt intensification practices including RWH.

Table 24: Use of RWH technologies and number of farm plots owned by a farmer

a) Mwanga District (n=338)

RWH Technique	Groups of number of farms			
	1-3 n=217	4-6 n=24	>7 n=1	Total
Deep Tillage	179(82)	21(88)	1(100)	201(59)
Rooftop RWH	62(29)	7(29)	0(0)	69(20)
Ridging and terracing	4(2)	2(8)	0(0)	6(2)
Ephemeral stream/gully flow diversion	34(16)	5(21)	0(0)	39(12)
Diverting water from rangelands	17(8)	5(21)	0(0)	22(6)
Storage Ponds (Ndiva)	6(3)	3(13)	1(100)	10(3)
Pitting	19(9)	0(0)	0(0)	19(6)
Borders	1(1)	0(0)	0(0)	1(1)
Excavated bunded basins (Majaluba)	1(1)	1(4)	0(0)	2(4)

b) Same District (n=321)

RWH Technique	Number of farms plots owned			
	1-3 n=274	4-6 n=34	>7 n=6	Total
Deep Tillage	200(73)	29(85)	5(83)	234(73)
Rooftop RWH	43(16)	12(35)	0(0)	55(17)
Ridging and terracing	4(1)	1(3)	1(17)	6(2)
Ephemeral stream/gully flow diversion	131(48)	21(62)	5(83)	157(49)
Diverting water from rangelands	4(1)	1(3)	0(0)	5(2)
Charco-dams (Malambo)	13(5)	3(9)	0(0)	26(8)
Storage Ponds (Ndiva)	44(16)	5(15)	2(33)	51(16)
Pitting	3(1)	0(0)	0(0)	3(1)
Borders	19(7)	7(21)	0(0)	26(8)

c) Maswa District (n=701)

RWH Technique	Groups of number of farms			
	1-3 n= 250	4-6 n=408	>7 n=25	Total
Deep Tillage	112(45)	176(43)	10(40)	298(43)
Rooftop RWH	13(5)	21(5)	0(0)	34(5)
Ridging and terracing	150(60)	329(81)	22(88)	501(71)
Ephemeral stream/gully flow diversion	0(0)	2(1)	0(0)	2(1)
Diverting water from rangelands	49(20)	74(18)	4(16)	127(18)
Diverting water from roads, stock routes and footpaths	0(0)	1(1)	0(0)	1(1)
Charco-dams (Malambo)	20(8)	25(6)	4(16)	49(7)
Excavated bunded basins (Majaluba)	94(38)	222(54)	20(80)	336(48)
Small ponds in dry river beds	25(10)	118(29)	4(16)	137(20)

3.6 Constraints Limiting RWH Use

Based on the analysis of the extent of RWH use, there is an indication that the potential for RWH has not yet been fully utilized. It was therefore necessary to identify the critical limiting factors to adoption of RWH in the three districts. Thus, respondents at village, sub-village, and household levels were requested to identify major constraints to adoption of RWH in their respective locations. The results are presented in this section.

Village and sub-village leaders, and extension officers mentioned the following as being the major problems in the adoption and utilization of RWH in WPLL:

- Poor technical knowledge on RWH,
- Shortage of cash capital,
- Inappropriate equipment and machinery for constructing RWH structures,
- Conflict between crop producers and livestock keepers,
- Poor coordination among RWH users, and
- Siltation of storage structures.

Poor knowledge was mentioned to affect 23(92%) villages with RWH potential in Mwanga District. In Same District, 7 (58%) villages said they face the same problem thus limiting the progress of RWH technologies (Table 25). This constraint was followed by lack of cash capital to invest in RWH technologies. It was reported in 10(40%) villages and 5(42%) villages in Mwanga and Same districts respectively. Conflict between pastoralists and crop producers affected 6(24%) villages in Mwanga and 2(17%) villages in Same.

In Maswa District, poor knowledge was cited as the main constraint limiting RWH use for rice production and livestock keeping by 36% and 34% of villages, respectively.

At individual household, 26%, 38% and 61% of respondents in Same, Mwanga and Maswa districts, respectively mentioned low performance of RWH systems as the major constraint to RWH (Table 26). This constraint is largely a consequence of poor RWH structures in terms of design and capacity.

Other constraints are destruction of fields and RWH structures by floods (22%), poor knowledge and technical know-how to construct RWH structures (24%) and poor knowledge and technical know-how to construct RWH structures (38%) for Same, Mwanga and Maswa districts, respectively (Table 26). The conflicts between crop producers and livestock keepers bear a national dimension. The major strategy advocated is village land use planning that has not been always effective. Poor knowledge and technical know-how was also identified as a constraint in the adoption of RWH in the study area.

3.7 Uptake of Rain Water Harvesting over Time

An attempt was made to estimate the uptake of a range of RWH techniques over time. Methodologically this is difficult to be done through a cross sectional interview, mainly because of lack of records and poor recall among farmers. Thus the available data gives just an indication of the uptake over time, as presented in Table 29 (a) (b) and (c). Notable is the fact that in 1940 only a few respondents indicated existence of RWH techniques. This is mainly because of the age group of the respondents. In Same District, rooftop and ephemeral stream/gully flow diversion are the only techniques mentioned for 1940. In Mwanga, ephemeral stream/gully flow diversion and deep tillage are the oldest techniques mentioned to have started in 1950s. For Maswa District, there are more techniques identified that started in 1940s (Table 29 c).

In all the districts there is an indication that there is an increase of uptake for all the RWH techniques, over time, with most adoptions said to have occurred in the 1990s. This data require further follow-up and checking.

Table 25: Constraints to RWH (at village and sub-village levels)

a) WPLL

	Number of villages affected			
	Mwanga (n= 25)		Same (n=12)	
Constraint	No.	%	No.	%
Poor knowledge and technical know-how	23	92	7	58
Shortage of cash capital	10	40	5	42
Lack of tools/ equipment	11	44	2	17
Conflicts between crops vs livestock	6	24	2	17
Siltation of RWH structures	4	16	1	8

b) Maswa (n=78)

	Number of villages affected			
	Rice production		Livestock production	
Constraints	No.	%	No.	%
Poor knowledge and technical know-how	28	36	27	35
Shortage of cash capital	7	9	9	12
Lack of tools/ equipment	16	21	15	19
Conflicts between crops vs livestock	1	1		
Siltation of RWH structures	3	4	1	1
Little rains	11	14	4	5
Poor soils	1	1	N.A	N.A
Poor coordination	1	1		

Table 26: Constraints to RWH (at household level)

Constraint	District					
	Same (n=179)		Mwanga (n =63)		Maswa(n=527)	
	No.	%	No.	%	No.	%
Poor knowledge and technical know-how	5	3	15	24	199	38
Shortage of capital	17	9	11	17	87	17
Low performance of RWH systems	47	26	24	38	324	61
Lack of proper working tools	16	9	11	17	111	21
Destruction of fields and RWH structures by floods	39	22	8	12	49	9
Inadequate RWH structures	27	15	1	2		
Inadequate storage capacity	4	2				
Siltation of RWH structures	1	1			7	1
Destruction of fields by livestock	28	16			3	1
Too small catchment areas					8	2
Rapid seepage of harvested water	4	2				
Poor water allocation procedures	13	7				

n = number of households that responded to the question
Note: Percentages don't add to 100% due to multiple responses

Table 29 Cumulative Numbers of Households Practicing Various RWH Techniques

a) Mwanga (n=338)

Year	Number of respondents practicing									
	Deep Tillage	Rooftop RWH	Ridging and terracing	Ephemeral stream/gully flow diversion	Diversion from rangeland	Diversion from roads, stock routes and footpaths	Charco-dams	Storage ponds (ndiva)	Pitting)	Excavated bunded basins
1940	0	0	0	0	0	0	0	0	0	0
1950	6	0	0	1	0	0	0	0	0	0
1960	17	2	0	3	1	0	0	0	0	0
1970	31	6	3	3	1	1	0	1	0	0
1980	58	15	3	7	2	1	0	3	0	0
1990	132	41	4	17	8	1	3	7	4	1
2000	194	101	8	38	16	4	5	8	20	3

b) Same (n=321)

Year	Number of respondents practicing								
	Deep Tillage	Rooftop RWH	Ridging and terracing	Ephemeral stream/gully flow diversion	Diversion from rangeland	Charco-dams	Storage ponds (ndiva)	Pitting	Borders
1940	0	1	0	1	0	0	2	0	0
1950	1	3	0	2	0	0	2	0	0
1960	7	5	0	6	1	1	4	0	0
1970	26	11	0	12	1	1	12	0	0
1980	67	20	1	29	1	2	22	0	0
1990	134	30	2	71	2	6	30	0	14
2000	223	39	4	150	4	14	51	3	26

c) Maswa (n=701)

Year	Number of respondents practicing								
	Deep Tillage	Rooftop RWH	Ridging and terracing	Ephemeral stream/gully flow diversion	Diversion from rangeland	Charco-dams	Excavated bunded basins	Small ponds in dry river beds	Small ponds on open areas (makomero)
1940	1	0	5	0	1	1	3	2	1
1950	3	0	10	0	3	3	6	2	1
1960	18	2	40	0	7	4	19	10	2
1970	55	5	98	0	16	7	54	27	5
1980	106	9	190	0	34	17	109	56	7
1990	186	16	310	1	71	28	195	87	12
2000	254	31	458	2	127	41	308	121	17

4. DISCUSSION

Often pipe system provide domestic water for only a small proportion of the population. Majority obtains domestic water from open and shared sources between human and livestock. Most sources do not supply water very far beyond the rainy seasons. As water problem for livestock become severe, farmers move their livestock away from their permanent residence. Productive forces / labor (mainly male youths and sometimes, school children) is responsible for looking after the livestock when away from home. On average livestock keepers send livestock away from their residence for at least 3 months a year. This is a measure of the level of performance of RWH for supplying water to livestock. There is scope for improving these systems in the study area. As a follow-up to these findings, SWMRG and SAIPRO are currently helping charco owners in Makanya village to improve storage capacity.

The dominance of maize and rice production in the study areas despite semi-aridity of these areas, is a testimony to the need for improved management of rainwater. Farmers are already using various RWH to overcome soil-moisture shortage for these crops. High percentage of households practice macro-catchment techniques in Maswa as compared to WPLL. This is because in Maswa District, paddy is also produced under RWH. Since paddy production is more water demanding than maize, macro-catchment is necessary as *in-situ* techniques do not capture adequate amount of water.

It is worth noting also that in some years farmers experience total crop failure indicating poor performance of the employed techniques. There is an indication that the available runoff resources are already exploited to the limit. For example in Annex B, it is shown that in some areas the catchment area to crop basin area ratio are as low as 3:1. Therefore, in most areas the logical improvement will be intensification in the area already under cultivation. For example, integration of manure into the system can effectively increase yields and thus total production.

It was noted that in WPLL, RWH for crop production is more important during Vuli season than Masika. The number of farm plots under maize crop with RWH during Vuli season was higher than those cultivated without RWH and those cultivated with RWH during Masika season. This is because rainfall is relatively good during Masika compared to Vuli seasons. Another reason is that, those cultivating fields further upstream do not plant during Vuli and hence their fields produce more runoff for those downstream.

A combination of RWH techniques was found necessary to ensure reasonable yields as compared to a single technique. The results from this study have demonstrated the importance of RWH for food security and poverty alleviation in these areas, which are traditionally categorized as marginal. Here again lies the opportunity for intensification. the fields in which *in-situ* RWH systems are already installed, are well prepared for effective exploitation of advanced RWH systems such as macro-catchment with or without storage. This is because the fields are already prepared for effective utilization of water. This reinforces the point that opportunity for improving the productivity of RWH systems in the study areas, lies in intensification.

Intensification will also be a starting point in improving RWH with storage systems. Performance of the storage facilities was found to be low compared to potential. Some of RWH structures have collapsed due to various reasons and are currently not utilized. At the same time, there are some whose potential is underutilized due to lack of maintenance or poor design. Areas and livestock units supplied with rainwater harvesting structures can therefore be increased in some cases with rehabilitation work on these structures.

5. CONCLUSIONS

This study has shown that there is already a high level of adoption of *in-situ* RWH systems. The adoption of macro-catchment RWH systems, which are more complex by nature, was found to vary between 18% - 62% of the households. It was found that only about one quarter or fewer HHs practice macro-catchment systems with storage. In general, there is a substantial number of households practicing RWH systems. More importantly most schemes have been initiated, financed and developed by the farmers themselves, with minimal external assistance.

The opportunity for improving performance of existing systems lies in intensification. For the crop production systems there is a need to improve the effectiveness and productivity of the harvested water through further improvement of agronomy. The other opportunity lies in introducing and promoting macro-catchment systems among those who are already using in-situ approaches. Performance of water diversion and storage structures is another opportunity for research and development projects. Currently there performance of these systems is poor due to inadequate design, operations and maintenance. Finally increasing the knowledge of stakeholders appears to still be the priority area for intervention.

APPENDIX 1:

Questionnaire for Village Chairpersons in WPLL

1. Name of district: …………………………………………………………………..
2. Name of ward: ……………………………………………………………………..
3. Name of village: ……………………………………………………………………
4. Number of sub-villages: …………………………………………………..……
5. Number of households: ……………………………..………………………
6. Population size: females ………………… males …………children…..………
7. Village area and land use
   (i) Size of village (acre): ………………………………..
   (ii) Size of total area set aside for residential purposes, including schools and other buildings (acres)…………
   (iii) Size of the area used for agricultural production during:
      - Long rains: ……………………………………
      - Short rains: ……………………………………
      - Dry season: ……………………………………
   (iv) Size of the area under perennial crops (e.g. fruit trees) (acres)………………
   (v) Size of the area used for grazing livestock (acres) ……………………
   (vi) Size of the area under forest (acres): ………………………………………….
   (vii) Size of the area under other uses (specify):…………………………..………..
   (viii) Size of open area ………………………………..
8. Mention crops that are produced in your village

Food crops	Cash crops	Fruits and vegetable crops

B: **RAINFALLS SITUATION AND WATER AVAILABILITY IN THE VILLAGE**

9. For the last 5 years describe the rainfall situation,

Short rains	Situation	Long rains	Situation
2000/2001		2000	
1999/2000		1999	
1998/99		1998	
1997/98		1997	
1996/97		1996	

10. Has your village ever experienced floods or landslides that caused negative effects (destruction)?

Year	Source of water that caused floods	Effects

11. What are the sources of water for domestic uses?

Source	Period of availability	Number of benefiting households
Pipe serves		
Gullies/rivers		
Wells		
Harvesting from roofs		
Others (specify)		

12. What are the sources of water for livestock production?

Source	Period of availability	Number of benefiting livestock keepers
Charco dams		
Pipe services		

Gullies/rivers		
Wells		
Harvesting from roofs		
Others (specify)		

13. For how long (month/year) do livestock keepers shift their livestock in search of pasture and water?

(i) Months ………………………

(ii) To where? district……………………………………..……

division……………………………………..……

ward ……………………………………..……

C: RAINWTER HARVESTING

14. How is RWH understood in your village?

……………………………………………………………………………………………………

15. Give information on RWH for annual crops (e.g. Maize):

(a) Number of households/farmers practicing RWH: ………………………..

(b) The leading locations in practicing RWH in the village

Name of place	Location (sub-village)	Total cultivated area (acres)	Major crop

C: Which are the RWH techniques that are practiced in crop production in your Village

Techniques	Places where it is practiced	Major crop	Yield level (bags/acre)
Deep tillage			
Large planting pits			
Ridges and terraces			
Water barriers			
Diverting water from rangelands			
Harvesting rain water from roof tops			
Diverting water from gullies/rivers into fields			
Others			

(d): Please give information on water storage ponds (*Ndiva*) which are used for RWH in your village?

Name of storage pond (ndiva)	Location	Year of construction	Number of benefiting HH	Acres that get water during		
				Long rain	Short rain	Dry season

(e) Please give information on Intakes/canals used for diverging water directly from gullies /rivers to the fields

Name of gullies/rivers	Name of intake/canal	Year of construction	Number of beneficiaries	Acres that get water during:		
				Long rains	Short rains	Dry season

16. Give information about RWH for livestock
    (a) How many farmers /livestock keepers harvest and store rain water for livestock?
    ………………………………………………………………
    (b) Mention methods (storage structures) used to store rain water after harvesting
    (i) ………………………………………… (ii) ………………………………
    (iii) ………………………………………. (iv)………………………………
    (v) ………………………………………. (vi ………………………………

(c) Please give information about charco dams which provide water for livestock in your village

(i) Charco dams that are currently operational

Name	Location	Year constructed	size			Number of benefiting livestock	No. of Months the dam provide water
			Length	Width	Depth		

(ii) Charco dams that are out of order

Name	Location	Year constructed	When did it get out of order	Reasons

(iii) Charco dams that are still under construction

Name	When did construction begin	Why is it not yet completed

(d) Privately owned charco dams

Name	Location	When was it constructed	Purpose

17. Give information on RWH for different uses

Use	Number of households practicing	Place/sub-village where it is practiced
Domestic use		
Vegetable production		
Fruit production		
Seedling/tree production		
Fodder production for livestock		

18. Who disseminates technology of RWH in your village?
    (i) ……………………………………………………………………………………..
    (ii)……………………………………………………………………………………..
    (iii)…………………………………………………………………………………..

19. Are there places in your village where RWH can be practiced but not utilized? Please mention those places and estimate their sizes

Name of a place	Acres

20. What are the problems affecting rain water harvesting in your village
    (i)……………………………………………………………………………………..
    (ii)……………………………………………………………………………………..
    (iii)……………………………………………………………………………………..

21. Name one place in your village which you think is best suited for RWH for different crop and livestock production activities
    i) Crop production:
    ………………..………………………………………………………………………
    ii) Grazing for livestock:
    ………………………………………………………………………..
    iii) charco dam for livestock:
    ……………………….…………………………………………………………………

Appendix 2

Questionnaire for village chairpersons - Maswa

A: **BACKGROUND INFORMATION**

1. Name of district: ………………………………………………………..
2. Name of ward: …………………………………………………………..
3. Name of village: …………………………………………………………
4. Number and names of sub-village: ……………………………………………………

…………………………………………………………………………………………..
…………………………………………………………………………………………
…………………………………………………………………………………………..

5. Number of households: ……………………………………………………
6. Population size: male …………female ………… children …………….
7. Village area and land use
   (i) Size of village (acre): ………………………………..
   (ii) Size of total area set for residential purposes, including schools and other building.(acres)…………
   (iii) Area used for agricultural production during:
      Rain season: …………………………………….
      Dry season: …………………………………….
   (iv) Area used grazing for livestock (acreage) ……………………
   (v) Area under forest/planted trees (acreage): ……………………
   (vi) Area under other uses (specify):………………………..………
   (vii) Size of open area ………………………………..
8. (a) Mention crops that are produced in your village

Food crops	Cash crops	Fruits and vegetable crops

(b) Please give information on production of paddy rice, cotton, maize and sorghum as indicated in the table:

Crop	Acreage under production in the village	% of households producing the crop	Acreage of whole HH farm	
			small	Large

B: **RAINFALLS SITUATION AND WATER AVAILABILITY IN THE VILLAGE**

9. For the last 5 years describe the rainfall situation, in your village

Season	Situation
1999/2000	
1998/99	
1997/98	
1996/97	
1995/96	

10. Has your village ever experienced floods or landslides that caused negative effects (destruction)?

Year	Source of water that caused floods	Effects/destruction

11. What are the sources of water for domestic uses?

Source	Months of availability	Percentages of benefiting households
Pipe services		
Gullies/rivers		

Wells		
Harvesting from roofs		
Others (specify)		

12. What are the sources of water for livestock uses?

Source	Months of availability	Percentages of benefiting livestock keepers
Charco dams		
Pipe services		
Gullies/rivers		
Wells		
Harvesting from roofs		
Others (specify)		

13. For how long (month/year) should livestock keepers shift their livestock in search of pasture and water**?**

(i) Months ………………………

(ii) Where is the destination? -: …district…………………………………..……

division……………………………..……

ward ……………………………..……

C: RAINWTER HARVESTING

14. How is RWH understood in your village?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

15.(a) Which are the RWH techniques practiced in your village

Techniques	Places where it is practiced	Major crops	Yield level (bags/acre)
Deep tillage			
Large planting pits			
Ridges and terraces			
Water barriers			
Excavated bund basins			
Diverting water from rangelands			
Rooftop harvesting			
Diverging water from gullies/rivers into fields			
Others			

(b). Give estimate of number of households/farmers who practice RWH …… ……… …..

(c) Mention the leading places in practicing RWH in your village

Name of places	Location	Total farms areas	Major crop

(d) Please give information on "charco dams", which are used for RWH in your village for crop production?

Name of charco dam	location (sub-village)	Year of constructed	Number of beneficiaries (households)	Acreage that get water	
				Rain season	Dry season

(e) Please give information about "Intakes" used for diverting water directly from gullies /rivers to the fields

Name of gullies/rivers	Name of intake/canal	Year constructed	Number of beneficiaries	Acreage's that get water during:	
				Rain season	Dry season

16. Give information on RWH for livestock

(a) On average, how many farmers /livestock keepers harvest and store rain water for livestock? ………………………………………………………………

(b) Mention techniques (storage structures) used to store harvested rainwater

(i) ………………………………………… (ii) ………………………………

(iii) ………………………………………. (iv)………………………………

(v) ………………………………………. (vi ………………………………

(c) Lease, give information on charco dams which provide water for livestock in your village

(i) Charco dams in use

Charco dam	location	Year constructed	size			No of benefiting livestock	No of Months the dam provides water
			length	width	depth		

(ii) Charco dams that are out of order

Charco dam	location	Year constructed	When did it get out of order	Reasons for destruction

(iii) Charco dams that are still under construction

Name of charco dam	Is it private or communally owned?	When was construction began?	Why not yet completed?

17. Give information on RWH for different uses

uses	Number of households practicing RWH	Places/sub-villages where RWH is practiced
Domestic uses		
Vegetable production		
Fruit production		
Seedling tree production		
Pasture production for livestock		

18. Who disseminate RWH technology in your village?

(i) ………………………………………………………………………………………..

(ii)……………………………………………………………………………………..

(iii)……………………………………………………………………………………..

19. Are there places in your village suited for RWH but are currently not utilized? Please mention those places and estimate their sizes

Name place	Acres

20. (a) What are the problems affecting RWH for paddy rice production in your village?

(i)…………………………………………………………………………………………..

(ii)…………………………………………………………………………………………..

(b) What are the problems affecting RWH for other crops production in your village

(i)…………………………………………………………………………………………..

(ii)…………………………………………………………………………………………..

(c) What are the problems affecting RWH for livestock production in your village

(i)…………………………………………………………………………………………..

(ii)..……………………………………………………………………………………

21. Mention one place in your village, which you think is best suited for RWH for crop and livestock production:

i) crop production: …………………………..……………………………………………

iv) Pasture production: ……………….……………………………………………..

v) Charco dam for livestock: …………………………..………………………………

22. For those people who depend only on agriculture; what are criteria used to group them into poor, moderate and good living standards. Using those criteria, give estimated figures of households in the various living standard groups.

a) Criteria used to differentiate households into various living standards

Living standard	criteria	Number of households in the village
Poor		
moderate		
good		

THANK YOU FOR YOUR COOPERATION

APPENDIX 3

Questionnaire for sub-Village Chairpersons in WPLL

1. Name of district: ………………………………………………………………..
2. Name of ward: …………………………………………………………………..
3. Name of village: ……………………………………………………………………
4. Name of sub-village: ……………………………………………………..……
5. Number of households: …………………………..……………………………
6. Population size: females ………………… males …………children…..………
7. Number of households with corrugated iron sheet roofed houses:……………
8. Please provide information on agriculture and livestock production in your sub-village:

Number of households engaged in farming	Number of households keeping livestock	Number of households producing horticultural crops

9(a). What are the criteria used to decide on whether to embark on production or not during short rainy season (vuli)

……..……………………………………………………………………………………

………………………………………………………………………………………………

Please give information on agricultural production activities during short rain season in your sub-village

	When the season is favorable	When the season is unfavorable
(b) How many household engage in farming in short rain season:		

(d) What were the average productions per acre for maize during short rain season?

Season	Highest production	Lowest production
2000/2001		
99/2000		
98/99		
97/98		
96/97		

B: RAINWATER HARVESTING

10. (a) Give information on rain water harvesting for crop production (e.g. maize) in your sub-village

(b) Number of households/farmers who practice RWH …………………………………..

(c) Mention the leading places in practicing RWH in your sub-village

Name of place	Location	Total farm area	Major crop

(c) Which are the RWH techniques practiced in your sub-village:

Technique	Places where it is practiced	Major crops	Yield (bags/acre)
Deep tillage			
Large planting pits			
Ridges and terraces			
Water barriers			
Diverging water from rangelands			
Harvesting rain water from rooftops			
Diverting water from gullies/rivers into fields			
Others			

(c) Please give information on water storage ponds (ndiva), which are used for RWH in your sub-village

Name of ndiva	Location	Year of construction	Number of beneficiaries (households)	Acres that get water during		
				Long rain	Short rain	Dry season

(d) Please give information on "Intakes" used for diverting water directly from gullies /rivers to the fields

Name of gullies/rivers	Name of intake/canal	Year of construction	Number of beneficiaries	Acres that get water during:		
				Long rains	Short rains	Dry season

11. Give information on RWH for livestock

(e) How many farmers /livestock keepers harvest and store rain water for livestock?

……………………………………………………………………

(f) Mention methods (storage structures) used to store rain after harvesting

(i) …………………………………………… (ii) ……………………………………

(iii) ……………………………………… (iv) ……………………………………

(v) ……………………………………… (vi ……………………………………

(g) Please give information on charco dams which provide water for livestock in your sub-village

- Charco dams that are currently operational

Name	Location	Year constructed	size			Number of livestock which benefit	No of months the dam holds water
			length	width	depth		

- Charco dams that are out of order

Name	Location	Year constructed	When did it got out of order	Reasons

- Charco dams that are still under construction

Name	When was construction began	Why is it not yet completed

(h) Privately owned charco dams

Name	Location	When was it constructed	Purpose

12. Give information on RWH for different uses

Use	Number of households practicing	Place/sub-village where it is practiced
Domestic use		
Vegetable production		
Fruit production		
Seedling/tree production		
Fodder production for livestock		

13. Give information on storage of harvested rainwater for different domestic uses.

Source of water	Storage structure	Number of households involved

14. For those who practice RWH for domestic uses, how long does the water last?

Very short period (weeks)	Long period (months)

15. What are the reasons that make some households/farmers not practice RWH technology:

(i) ……………………………………………………………………………………

(ii) ……………………………………………………………………………………

(iii) ……………………………………………………………………………………

(iv) ……………………………………………………………………………………

(v) ……………………………………………………………………………………

16. Give information on RWH for commercial vegetable production:

Vegetable crop	No. of households engaged in production	Acres under production			Yield per acre per year	Income/HH/year
		Long rain season	Short rain season	Dry season		

17. Has RWH ever caused negative effects? Mention them

1. ……………………………………………………………………………………
2. ……………………………………………………………………………………
3. ……………………………………………………………………………………

18. In which specific aspects do sub villagers need training in order to improve RWH?

....

....

19. Are there sub-villagers who attended any training on RWH? Yes / no

If yes, please mention aspects covered in the training and agency, which conducted the training

Agency who conducted the training	Type of training	When was it conducted?

APPENDIX 4

Questionnaire for households in WPLL

1. Name of district………………………………………………………………………
2. Name of ward: ……………………………………………………………………..
3. Name of village: ……………………………………………………………………...
4. Name of household head: ..……………………………………………………………
5. Sex of household head: male …………………… female …………………
6. Age of house hold head: years: ……………………………………………………
7. Number of household members who can work in farm ………………………...
8. Do you practice RWH for agricultural production? Yes/No

   If no, give reasons (arrange them in order of importance)

   i.………………………………………………………………
   ii.……………………………………………………………
   iii.…………………………………………………………
   iv……………………………………………………

9 Do you practice RWH for livestock production? Yes/No

   If no, give reasons (arrange them in order of importance)

   … i.………………………………………………………………
   …ii.……………………………………………………………
   …iii.…………………………………………………………
   …iv……………………………………………………

10 Do you practice RWH for other uses? Yes/No

   If yes, mention them

   i.………………………………………………………………
   ii.……………………………………………………………
   iii.…………………………………………………………
   iv……………………………………………………

If no, give reasons

   i.………………………………………………………………
   ii.……………………………………………………………
   iii.…………………………………………………………

FILL ANSWERS TO QUESTIONS NO.12 - 17 IN TABLE NO. 1

11 How many farms do you have?

12 Please mention location of each farm

13 please, indicate acreage for each farm.

14 please tell me, in which farm do you practice RWH?

15 when did you start practicing RWH? Give information for each farm

16 Mention crops that you grow for each farm?

17 What is the yield level for each farm? (rank in order of importance)

TABLE No. 1

	Place where farm is located (12)	Size in acres (13)	Practicing RWH (Yes/No) (14)	When did you start practicing RWH (15)	Crops (16)*	Yield in bags (17)**	
						Vuli 2000/01	Masika 2001
1							
2							
3							
4							
5							
6							
7							

* ** I bag = 6 tins @ tin = 18 kg

18 How many livestock do you have?

(i) Cattle……………… (ii)Goats ………………(iii) sheep……………….

(iv) Others (specify) …………………………………………………...

19. Where do your livestock get water during dry season?…………………………..

20. If source of water, for livestock is a charco dam, how many kilometers were you walking in search f or water for livestock before construction of the charco dam?
…………………………………………

21. Where do your livestock get pasture during dry season?…………………………

22.Considering livestock products such as milk, meat etc. what is the estimated actual loss/reduction in production while searching for water/pasture.

i. Reduced by one quarter ....
ii. Reduced by half ....
iii. Reduced by three quarters..........
iv. Others (Mention) ....

22. Fill in table No. 2 various costs associated to your private / communal charco dam

TABLE No. 2

Name of charco dam	Useful life	Type of maintenance	Maintenance cost			
			Tshs	Labour (Man days)		
				No. of people	No. of working hours/day	Number of working days
1						
2						
3						
4						

RAINWATER HARVESTING

Fill in answers to questions 22 – 28 in table 3

24 Which are the RWH technique do you practice?

25 Among those RWH techniques, which are important to you? (assign them numbers in order of importance starting with 1)

26 Please give reasons for your ranking in 25

27 Where did you get that technology?

28 When did you start practicing those techniques?

29 For each technique estimate cost of construction.

30 For each technique who is more responsible? (father = 1, mother = 2, both = 3)

TABLE 3.

	Technique (24)	Importance Rank (25)	Reason for importance rank (26)	How was technology obtained (27)	When the technique started being practiced (28)	Costs (29)	Responsible person (30)
1							
2							
3							

Fill in answers to question 31 - 33 in table. 4

31 For each RWH technique give the useful life

32 For each RWH technique give type of maintenance (e.g. year 1, 2, 3….)
33 Give maintenance cost

TABLE. 4

Technique	Useful life (31)	Maintenance (32)	Maintenance cost per year (33)			
1			Tshs	No. of people	NO. of working hours	Number of working days
2						
3						

Fill in answer to question 34 and 35 in table 5.

34 How do you compare your extent of RWH between 1999/2000 vuli season and 2000/01 seasons, has it increased, decreased or remained the same?

35 How do you compare your extent of RWH between 2000 and 2001 masika seasons, has it increased, decreased or remained the same?

36. Please give reasons to your response for question number 34 and 35.

TABLE NUMBER 5.

Extent of RWH: 99/00 Vs 00/01 Vuli seasons (34)	Reasons (35)	Extent of RWH:2000/ Vs 2001 masika seasons (34)	Reasons (35)
increased………… decreased………… the same……………			

[1] put V mark against the appropriate answer.

Fill in answers to question 37 and 38 in table 6

37. Are there any problems affecting your efforts in RWH (Yes/No**)**
If yes, mention and arrange them in order of importance.

38. For each problem, state how you overcome it

TABLE 6

Problems in Importance rank (37)	How to overcome (38)

39. What are your opinions on RWH for agricultural and livestock production?

40. Are there any changes in income since you started practicing RWH? Yes /No

THANK YOU VERY MUCH

APPENDIX 5

Questionnaire for Households Maswa district

SOKOINE UNIVERSITY OF AGRICULTURE

RAINWATER HARVESTING PROJECT

1. Name of district:……………………………………….…………………………
2. Name of ward: …………………………………..…………..………………..
3. Name of village: ………………………………………………………………...
4. Name of household head: …………………………………………………………
5. Sex of household head: male ……………………female ……………………
6. Age of house hold head: years: …………………………………..…………….
7. Number of household members who can work in farm ………………………...
8. Do you practice RWH for agricultural production? Yes/No

   If no, give reasons (arrange them in order of importance)

   i.…………………………………………………………………

   ii.……………………………………………………………….

   iii.…………………………………………………………….

   iv……………………………………………………….

9. Do you practice RWH for livestock production? Yes/No

   If no, give reasons (arrange them in order of importance)

   … i.…………………………………………………………………

   …ii.……………………………………………………………….

   …iii.…………………………………………………………….

   …iv……………………………………………………….

10 Do you practice RWH for other uses? Yes/No

   If yes, mention them

   i.…………………………………………………………………

   ii.……………………………………………………………….

   iii.…………………………………………………………….

   iv……………………………………………………….

If no, give reasons

   i.…………………………………………………………………

   ii.……………………………………………………………….

   iii.…………………………………………………………….

FILL ANSWERS TO QUESTIONS NO.12 - 17 IN TABLE NO. 1

11. How many farms do you have?

12. Please mention location of each farm

13. Please, indicate acreage for each farm.
14. Please tell me, in which farm do you practice RWH?
15. When did you start practicing RWH? Give information for each farm
16. Mention crops that you grow for each farm?
17. What is the yield level for each farm?(rank them)

TABLE No. 1.

	Place where farm is located	Size in acres	Practicing RWH (Yes/No)	When did you start practicing RWH	Crops	Yield level in bags
						2000/01 season
1						
2						
3						
4						
5						
6						
7						

18 How many livestock do you have?

(i) Cattle ………………… (ii) Goats ………………(iii) sheep……………….
(iv) Other livestock (specify) ……………………………………………

19 Where do your livestock get water during dry season?

i…………………………………
ii………………………………..
iii……………………………….

20 If source of water, for livestock is a charco dam, how many kilometers were walking in search of water for livestock before construction of the charco dam?
……………………………………………………………………………………………….

21 Where do your livestock get pasture during dry season?

i…………………………………
ii………………………………..
iii……………………………….

22.Considering livestock products such as milk, meat etc. what is the estimated actual loss/reduction in production as a result of walking long distance while searching for water/pasture

i. Reduced by one quarter ……….
ii. Reduced by half ……….
iii. Reduced by three quarters ……….
iv. Others (Mention) ……….

23. Fill in table No. 2 various costs associated with your private / communal charco dam.

TABLE No. 2

Name of charco dam	Useful life span	Type of maintenance	Maintenance costs			
1			Tshs	No. of people	No. of working hours/day	No. of days
2						
3						

RAINWATER HARVESTING

Fill in answers to questions 22 – 28 in table 3

24. Which are the RWH technique do you practice?
25. Among those RWH techniques, which are important to you? (assign them numbers in order of importance starting with 1)
26. Please give reasons for your ranking in 25
27. Where did you get that technology?
28. When did you start practicing those techniques?
29. For each technique estimate cost of construction.
30. For each technique who is more responsible? (father = 1, mother = 2, both = 3)

TABLE 3.

	Technique (24)	Importance Rank (25)	Reason for importance rank (26)	How was technology obtained (27)	When the technique started being practiced (28)	Costs (29)	Responsible person (30)
1							
2							
3							

Fill in answers to question 31 - 33 in table. 4

31. For each RWH technique give the useful life

32. For each RWH technique give type of maintenance (e.g. year 1, 2, 3….)

33. Give maintenance cost

TABLE NUMBER 4

Technique	Useful life (31)	Maintenance (32)	Maintenance cost per year (33)			
1			Tshs	No. of people	No. of working hours	No of working days
2						
3						

Fill in answer to question 34 in table 5

34. How do you compare your extent of RWH over seasons, Does it increase or decrease?

TABLE. 5

Seasons	Increased	decreased	The same	reasons

Fill in answers to question 35 and 36 in table 6

TABLE 6

Problems in Importance rank (35)	How to overcome (36)

36 Are there any problems affecting your efforts in RWH (Yes/No)
If yes, mention and arrange them in order of importance.

37 For each problem, state how you overcome it

38 What are your opinions on RWH for agricultural and livestock production?

39 Are there any changes in income since you started practicing RWH? Yes /No

THANK YOU VERY MUCH

APPENDIX 6

Village and Locations with most RWH in Mwanga District

Village	Location	Major crops
Lembeni	Station	Maize
Mbambua	Kwaigingi	Sugarcane
Kiruru ibweijewa	Ibweijewa Mighareni Vumbai	Maize Maize Beans
Kwakoa	Ngorikoko Mgigili Mamboleo	Maize
Ngulu	Mkongea Mabshula	Maize/beans Maize
Toloha	Simu Gongoni	Maize
Kigogoni	Njiaya toloha	Maize
Mwanga	Mikuyuni	Maize
Kisangiro	Mforo	Maize
Kiruru Iwami	Lwami Mikameni Vudoi	Maize
Handeni	Guzero Mtoni	Maize Vegetables
Langata bora	Kazamwendo	Maize
Kivisini	Msangeni	Maize
Kwanyange	Msangeni	Maize
Kiria	MangulaiA Mangulai B	
Kifaru	Kitopeni Magerankunga Majengo	Maize/beans

APPENDIX 6 continues Village and Locations with most RWH in Same district

Village	Location	Major Crops
Mwembe	Kimunyu	Maize
Mferejini	Muungano juu Marwa juu	Maize/beans Maize/beans
Bangalala	Ijeta Heishitu Dido Mchikatu	Maize Maize Maize Sorghum
Same Mjini	Majevu Kavambughu	Maize Maize
Makanya	Ngambo Kwasasu Nkwini	Maize Maize Maize
Mabilion	Mabilioni (A) Mabilioni (B) Gama	Maize Dolicos lablab Potato
Chajo	Kavateta Mareti Bughuru Kambeni	Maize
Hedaru	Lungwana Gundu Kauzeni Mpatwa	Onions Potato Amaranths
Mgwasi	Kasapo Kimunyu Mgwasi	Maize
Gavao	Saweni	Maize Dolicos lablab

APPENDIX 7

Areas with Potential for RWH that are currently unutilized in Mwanga

Village	Location of area	Estimated Area (ha)
Kigonigoni	Kwakihindi	100
Nyabinda	Muungano	112
	Jauma	12
Kagongo	Kwafupi	60
	Bonde la mbwana	88
Kambi ya simba	Ubembe	3
	Ngeleni	4
Butu	Butu	400
Lembeni	Station	
	Kaili	
	Rughwini	
	Kisekibaha	
Kivisini	Korongo la lemwatu	300
	Korongo la kizika	63
	Korongo la mbuguma	182
Kwanyange	Korongo la mireni	327
	Korongo la lemwatu	286
	Korongo la wakili	312
Kiruru ibwe ijewa	Vumbeni	7
	Mighareni	8
	Heiria	6
	Chang'ombe	3
Kisangiro	Mandaka	
	Kisangiro	
	Kichwa cha ng'ombe	
Mwanga	Mikuyuni	
	Reli juu	
	Reli chini	
	Mwangondi	
	Kichagani	
Lang'at bora	Korongo la wagunya	23.2
Handeni	Mlima keketa	68
	Mlima bora	340
	Korongo la kisangiro	400
Kiria	Korongo la lang'ata Rimba	>400
	Korongo la lembeni	>400
	Korongo la njia panda	>20
	Korongo la lesuruwai	>400
Kiverenge	Korongo la kambola	1
	Mkababu	0.4
	Mghaa	0.8
Kiruru lwami	Mtalang'a	
	Vudoi	
	Mikameni	
	Lwami	

Ngulu	Kizungo	
	Mkongea	
	Kavagala	

Areas with Potential for RWH that are currently unutilized in Same District

Village	Location of area	Estimated Area (ha)
Mferejini	Ngamata	
	Lloirigingi	
	Ndilali	
	Konjiro	
Bangalala	Bangalala	216
	Kinyagusi	
Saweni juu	Bonde la Ngusero	684
Makanya	Korongo la vudee	
	Mitusini	
Mabilioni	Korongo la mbalazi	
	Korongo la munyuni	
Chajo	Kavateta	320
	Bughuru	300
Hedaru	Mto ashi	400
	Mto kauzeni	240
	Mto mpatwa	240
Ishinde	Vilendu	
Mgwasi	Kwanduju	
Gavao	Saweni	200

APPENDIX 8

Areas suitable for RWH for different enterprises in Mwanga District

Village	Location of area suitable for RWH		
	Crop production	Pasture production	Location of charco-dams
Toloha	Kizungo		Kizomba
Ngulu	Kizungo	Manyata	Kamorei
Kiruru Lwami	Iwami	Iwami	Iwami
Kisangara	Kirongaya	Mkizingo	Legurumo
Kiverenge		Kambola	Mghaa
Kiria	Korongo la Kiria	Isesurwa	Lesurwai
Handeni	Gusero	Bunge	Mabomani
Lang'ata bora	Kazamwendo	Korongolawagunya	Amboni
Mwanga	Mikuyuni		
Kisangiro	Mforo	Mandaka	Kisangiro
Kiruru ibweijewa	mighareni	Legurumo	Ibweijewa
Kwanyange	Mereni	Korongo la wakili	K/wakili
Kivisini	Lemwatu	Mbuguma	Mbuguma
Lembeni	Lembeni kote	Kaili	Kaili
Butu	Kwamteta	Katumbatu	Katumbatu
Kwakoa	Ngrikoko		Kwamgheni
Kambi ya simba	Kambiya simba yote		
Kagongo	Kwa mbwana	Kwa fupi	
Nyabinda	Korongo la mchanga		Kwa salim
Kigonigoni	Kwakihindi	Mbugani	
Mgagao	Makwibgwini	Kwaturu	Kauzeni

Areas suitable for RWH different enterprises in Same district.

Village	Crop production	Pasture production	Location of charco-dams
Mwembe	Mkonge	Kirinjiko	Kirinjiko
Mferejini	Korongo la Bagamoyo	Ngamata	
Bangalala	Bangalala mtoni	Makey	Kirinjiko
Same mjini	Ngusero	Kantoto	Masandare
Makanya	Bonde la suji kitivo	Navoli-chankoko	Navoli-chankoko
Mabilioni	Korongo la mbalazi		
Njoro			
Chajo	Kavateta	Kanyoki	Kaveta mkonga
Hedaru	Mto washa kitivo	Maguzo	Station
Ishinde	Vilendu	Igongo	Ngusero
Mgwasi	Muheza		Makame
Gavao	Sawenijuu	Saweni	Saweni

APPENDIX 9

Extent of use of charco-dams under communal ownership

a) Mwanga District

Village	Charco-dams	No. of months the charco retain water
Kiruru ibwe-ijewa	Mkababu	8
	Rurie	3
	Ibweijewa	3
Kiria	Loboo	4
	Lesuruwai	2
Kiverenge	Kandoto	6
Toloha	Nading'oro	
	Kizomba	
	Landara	
Mgagao	Mgagao	12
	Kauzeni	12
	Mashara	12

b) Same District

Village	Charco-dams	Location	Number of months the charco retain water
Bangalala	Mkosha	Makei	4
	Mghungani	Makei	12
Same mjini	Milonjonjo	Kavambughu	4
	Loisoito	Kitamri	3
	Mvarivari	Kitamri	3
	Kishaa	Masandare	4
Njoro	Naturi	Njoro	4
	Lengoroyo	Njoro	2
	Mbalimbali	Njoro	3
	Mvarivari	Njoro	1
Ishinde	Mlonjolonjo	Ishinde	4
Gavao	Kwasemtiri	Saweni	6

c) Maswa District

Village	Charco-dams	Location	Number. of months the charco retain water
Bukigi	Isaga Mwanguku Ifuga Mwangimba	Bukigi	6 6 6 7
Mwabayanda	Mwatawala	Mwandu	9
	Maswa	Mwandu	5
	Nhundi	Nhundi	6
	Zungitulya	Zungitulya	7
	Mapamba	Mwamiso	6

	Mwaludila	Mwasomi	8
	Mwagalabi	Bushuni	12
	Dishi	Dishi	12
Nyabubinza	Mwagakulu	Mwasomi	10
Jija	Mwatula	madukani	6
Malampaka	Kwale	Gangalika	10
	Mayeka	Mwalukuliko	10
Kadoto	Kangwa	Bugumwa	10
	Mwashabu	Mwasi	12
	Mwasighunyali	Ilam	
	Mwamasendi		
	Mwakundi		
Ilamata	Mwankoba		
Muhida	Bukindu	Muhida	3
Nguliguli	Mwamita	Iwelimo	9
	Lugulu	Ngunda	8
	Nhundagilo	Kisesa	8
	Nhumbili		8
	Masanja	Mwandu	8
Igunya	Zunzu	Igunya	
Binza	Madecofarm	Mwashigela	8
Mwang'anda	Bukundi	Bukundi	7
	Gumeza	Tigwa	11
	Shishiyu	Kakola	12
	Bugeshi	mjini	11
Shishiyu	Lubinza	Bmizi	12
	Kansa	Busongo	8
Gula	Chule	Busongo	9
	Mwamategela	Ikungu	6
Jihu	Mwambukuzi	Jihu	6
	Nyangugunwa	Kumalija	9
	Mwantonja	Nyalikungu	9
Shanwa	Nyalikungu		12
Buyubi	Bwawajosho	Buyubi	3
Zanzui	Zanzui	Mwamishigalo	9
	Nyabahoga	Migumo	8
	Nyabilulu	Nyazola	7
Nyashimba	Mwamabupu	Suligi	9
Sola	Sola	Sola	
Mwabayanda	Umoja	Mwamasinya	8
	Isomba	Bugalama	10
	Nyabuki	Mwakalega	9
	Isanga		9
Iyogelo	Ngw'adalama		9
	Gambala	Gabu	10
	Itengeja	Mwamenga asili	9
Bularama	Mwajigulu	Nkongolo	9
	Mboumba	Ngw'amazani	9
	Mwajipili	Mwaipondyo	9
	Mwalunguge	Iboja	9
kiduma	Mkologwi		9

Wigeleko	Wigeleko mashariki	Wigeleko mashariki	12
Njia panda	Sagenda	Ngegemo	12
	Ngwatula	Mwamagaka	12
Masanwa	Nyanza	Masanwa	9
Mwasayi	Mwajijabanda	Kusini	7
	Tukuyu	Mashariki	
Isulilo	Busamuda	Busamuda	6
Dulung'wa	Mwamigaka	Kashishi	8
	Mwamakomelo	Nyanguku	10
	Mwasabuya	Kashishi	10
Mwang'holo	Nyamikola	Mwang'holo	3
	Mwalandu	Ndole	6
	Mwanholo	Mwang'holo	3
	Mwanholo	Ndole	6
Zebeya	Jidesheshi	Mwamayeye	6
Mwamashindike	Kubalo,Manala,Malula		9
Mwamenge	Mwagushu	Mwagushu	12
	Mwamoga	Mwafula	12
	Mwanyindwa	Mwanyindwa	12
	Mwagikulu	Ligembe	12
Mwanhegele	Malya	Malya	12
Mwamihanza	Mwamihanza	Mashariki	12
Mwatumbe	Kasogi	Kadulu	7
	Kuliga	Kadulu	7
	Bushiya	Madukani	7
	Ngazari	Budula	10
	Kadinda	Budula	10
Masela	Masela	MAsela	9
Bushitala	Gatema	Gatema	5
	Millingi	Malanga	5
Mwabagalu	Mwasyatemi	Mwasyage	7
	Mwagofi	Mwasyage	7
	Mwashagembe	Zalwama	7
	Mwajemi	Mwabasi	
Mwanhonoli	Mwanhonoli	Mwanhonoli	12
	Mwamabiti	Mwanhonoli	12
	Mwanaope	Mwanhonoli	12
	Mwanabaya	Mwanhonoli	12
	Mwanabuhumo	Mwanhonoli	12
Kidaru	Kuzenza	Mwaseya	12
	Igonzela	Mwamalangwa	12
Sengwa	Sengwa	Sengwa	4

APPENDIX 10

Charco-dams that are non-operational

(a) Same district

Village	Charco-dam	Location	Year constructed	Date of being out of use	Reason Given
Bangalala	Kirinjiko chini	Kirinjiko	-	-	
Hedaru	Hedaru	Maboma	1990	1998	Destructed by El-Nino rains

(b) Maswa District

Village	Charco-dam	Location	Year constructed	Date of being out of use	Reason Given
Mwabayanda	Mwabayanda	Mwabayanda	1940	1990	Siltation
	Mboyele	Mwanhulugu	1959	1994	Siltation
Nyabubinza	Deshi	Deshi			Drought
	Mwakakula	Mwatomi			Drought
	Mwakalubi	Bushimi			Drought
Ilamata		Mwasis	1984		Siltation
Muhida	Mwalukele	Gumali	1957	1964	Siltation
Shishiyu	Mwanaloya	B.miruzi	1956	1964	
	Kumenwa	Twigia	1957	1991	Siltation
	Bunyoro	Ng'wankali	1973	1983	
	Radharo	kakola	1950	1986	
	Mwanagambula	Mwadui	1965	1975	
Lalago	Majebele	kayenze	1951	1979	Siltation
Gula	Shule	Busongo	1951	1984	
Jihu	Mwalukolo	Ikongu			Landslide
Buyubi	Bulubalo	Mwamashimba	1944	1999	Landslides
Zanzui	Ikindilo	Ikindilo	1976	1980	Poor management
Nyashimba	Mwajikungu	Bushshita	1968	1989	Siltation
Mwadila	Sali	Mwalutubo		1997/8	Siltation
	Iduku	Igongwa			
	Ishinga	Igongwa			
Kidema	Ngwakumbila	Mwawipondejo		1965	Poor coordination
	Ng'wawasangalu	Iboja		1970	
	Ng'wadese	Mwanzazani		1962	
Masanwa	Iwelimo	Iwelimo	1966	1996	
Isulilo	Busomoda	Busomoda	1955	1996	Construction work was incomplete
Zebeya	Zebeya	Simu		1966	Wall break

Kiloleli	Kirimu	kirimu		1974	
Mwamashindike	Nyangowa	Manala	1975	1989	Siltation
	Ngamba	Madukani			Poor coordination
	Noha	Mwanhuli			Poor maintenance
	Galaba	Madukani			Poor coordination
Mwamitumbe	Rugalila	Kadulu			Poor maintenance
	Kija	Kadulu			Poor coordination
Kinamwigulu	Ngwankoko	Ngwangoko			Wall break
	mwagasubi	Nghaya	1940	1976	Poor maintenance
	Mwatembua	Nyanumbili	1950		Poor maintenance
	Mwanghala	Ibanda	1930		Poor maintenance
	Mwagibolya	Ibanda	1918		Poor maintenance
Sayusayu	Sayusayu	Sayusayu	1947		Poor maintenance

APPENDIX 11

Private charco-dams in Same district

Village	Charco owner's name	Location	Uses
Mferejini		Milimani	Domestic/livestock
Bangalala	Ali Alfani Arufani Kangero Kadeghe Kangero Kimasha B/Shamba	Makei Makei Makei Makei Makei	
Same mjini	Hamed Kahungo	Majevu	Domestic/livestock
Makanya	Athumani Mshitu Kanyika Kirema Hoza Mariale Selemani Halfani Lawaridi Senkoro	Kwasasu Chankoko Tifatifu Naivoli Chankoko	Domestic/livestock
Hedaru	Eliamini Sembua	Lungwana	Livestock