Efficient Water Use for Agricultural Production (EWUAP) Project

BEST PRACTICES FOR WATER HARVESTING AND IRRIGATION

Uganda

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December 2007

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Glossary of terms and units used

Brick Tank	A tank constructed of bricks
Ferro Cement Tank, FCT	Tank structure/frame is usually made from wire mesh and a mortar of sand and cement is used to make the wall
Hectare, ha	10,000 $m^2 \approx 2.5$ acres
Irrigation: Large Scale	Command area more than 500 ha
Irrigation: Medium Scale	Command area between 50 and 500 ha
Irrigation: Small Scale	Command area less than 50 ha
Matoke	Green banana cooked for food. Staple food in Uganda
US Dollar (one)	Equals 1,700 Uganda Shillings
Valley dam	On-stream embankment for trapping and storing of surface runoff from a catchment area
Valley tank	On-stream valley excavation of a reservoir for trapping and storing surface runoff from a catchment area

List of acronyms

AEZ	Agro Ecological Zone
BQ	Bill of Quantities
DAO	District Agriculture Officer
DRWH	Domestic Roof Water Harvesting
DWD	Directorate of Water Development
DWO	District Water Officer
ET_o	Reference Evapotranspiration
GoU	Government of Uganda
FCT	Ferro Cement Tank
JICA	Japanese International Cooperation Agency
LC	Local Council
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MoWLE	Ministry of Water, Lands and Environment
NAADS	National Agricultural Advisory Services
NARO	National Agricultural Research Organisation
NGO	Non-governmental Organization
NWP	National Wetlands Programme
O&M	Operation and Maintenance
PBG	Partially Below Ground
PMA	Plan for Modernisation of Agriculture
RWH	Rainwater Harvesting
TOR	Terms of Reference
URWA	Uganda Rainwater Association
UWASNET	Uganda Water and Sanitation NGO Network
WES	Water and Environmental Sanitation
WID	Wetland Inspection Division
WUA	Water Users Association

1.0 Introduction

There is a growing pressure to reduce the amount of water allocated for agricultural production mainly because of increasing demands from expanding urban centres, industry, mining, recreation and tourism. Agriculture is, therefore, expected to produce more crop per given volume of water if the system is to be sustained as a viable activity. Such a growing threat can best be addressed in a comprehensive way by collectively dealing on the subject at a basin level.

The Efficient Water Use for Agricultural Production (EWUAP) is one of eight projects of the Nile Basin Initiative's (NBI) Shared Vision Program (SVP). The EWUAP project is desired, therefore, to be a first step in bringing together the regional and national stakeholders in the riparian countries to develop a shared vision on common issues related to the increase of the availability of water and its efficient use for agricultural production.

The main thrust of the EWUAP Project is to establish a forum to assist stakeholders at regional, national, and community levels to address issues related to efficient use of water for agricultural production in the Nile Basin.

The improvement in water use efficiency has to be supported by knowledge and information sharing and this requires identification, documentation and dissemination of technologies and best practices from within and/or outside of the basin. Sharing of information could also be effected through study tours and field visits to sites of best practices with proven track record in terms of using technologies.

The study on profiling best practices on water harvesting and small scale irrigation is therefore aimed at providing knowledge and information on water harvesting, community managed irrigation, and public/private managed irrigation in Uganda to be used and shared locally, regionally and internationally.

The study was conducted in Uganda. Figure 1 below shows the map of Uganda.

Figure 1: Map of Uganda and drainage system

1.1 Objective of the study

The main objective of the study was to identify and document best practices, sites of best practices, and list and provide a profile of potential institutions. The specific objectives of the study were to:

i. Identify, list, and document best practices in the areas of Water Harvesting, Community-Managed Irrigation, and Public and Private-Managed Irrigation nationally;

ii. Select few pre-eminent practices from the list of best practices and technically provide a profile or detailed description of the pre-eminent practices;

iii. Identify best practice sites for water harvesting, community managed irrigation, and public and private managed irrigation;

iv. Profile the selected best practice sites with indigenous and/or modern techniques since a selected number of these sites will be targeted for visits by national and/or regional practitioners for the exchange of experiences, and share of knowledge and information on the best practices on water harvesting, community managed irrigation and public- private irrigation;

v. Identify and list national institutions to be considered for twinning activities and then select and recommend few and provide a detailed profile description of these institutions with potential to organize and conduct capacity building activities and implement field level demonstrations or pilot activities in water harvesting and irrigation.

1.2 Approach and Methodology used

The methodologies used by the consultant included;

i. Desk studies.

Apart from relevant documents and literature provided by the client, the consultant collected all relevant materials from relevant institutions such as Makerere University and other institutions of higher learning, National Agricultural Research Organization (NARO), National Agricultural Advisory Services (NAADS), Ministry of Agriculture Animal Industry and Fisheries (MAAIF), National Farmers Association, District Agricultural Offices, Directorate of Water Development (DWD), Wetland Inspection Division (WID), Uganda Water Harvesting Association, Consultancy Firms and Non Governmental Organizations engaged in agriculture and water harvesting and reviewed them for the purpose of extracting information from them. The output of the desk study was a preliminary report including criteria for best practices, a system for ranking and prioritizing of sites and schemes, a long list of best practices and best practice sites. It also included technologies associated with water harvesting, community managed irrigation and public-private irrigation and a checklist for collection of information/field data.

ii. A consultative meeting with EWUAP/PMU in order to review the inception report, working documents (criteria for best practice, a system for ranking and prioritizing of sites and schemes), and fill gaps and prepare for collection of field data. The output of the meeting was an improved working document, selected potential sites per component and field work plan.

iii. Field visits to collect secondary data to fill gaps which were identified in the inception report and during the consultative meeting. The agreed working documents were used for the data collection. The data collected included, *inter alia*, gender aggregated data, socio economic data, and Global Positioning System (GPS) readings to be used in Geographic Information System (GIS) map preparations.

iv. Data analysis and report writing. The agreed system for ranking and prioritizing of sites and schemes and criteria for best practices are some of the tools that were used in data analysis. The data was analyzed by a multidisciplinary group of experts including gender, agricultural, economic and irrigation/water engineering experts.

2.0 Agro Ecological Zones (AEZ) of Uganda

Uganda's temperatures show little variation throughout the year with maxima ranging between 25º - 31ºC for most areas. Rainfall distribution has generally been categorised as:-

High: Over 1 750 mm per annum - 4% of the land area
Moderate: 1 000 - 1 750 mm per annum 70% of the land area
Low: Under 1 000 mm per annum 26% of the land area

Rainfall distribution in Southern Uganda is bimodal, allowing two crops annually, and adequate grazing for livestock throughout the year. Around Lake Victoria the annual rainfall averages 1 200 - 1 500 mm, and is well distributed. To the north, the two rainy seasons gradually merge into one. Dry periods at the end of the year become longer, with annual rainfall ranging between 900 - 1 300 mm, this restricts the range of crops that can be grown. These conditions are not suitable for bananas but favour extensive livestock production. The influence of soils, topography and climate on the farming systems in Uganda has led to the dividing of the country into seven broad agro ecological zones. These zones are based on soils, topography, rainfall and major crops grown. They include:-

1. The banana-coffee system

In this system, rainfall is evenly distributed (1 000 - 1 500 mm) on soils of medium to high productivity. The areas cultivated per capita are small, under one hectare. Banana and coffee are the main cash crops; root crops and several annual or biennial food crops are on the increase. Maize is a secondary cash crop and sweet potatoes a secondary food to bananas. Livestock is generally not integrated into the system, but dairy cattle are gaining prominence. The typical land holding is 2 - 4 hectares. The vegetation is mainly forest-savannah mosaic with pastures suitable for intensive livestock production.

2. The banana-millet-cotton system

Rainfall for this system is less stable than for the banana-coffee system, so there is greater reliance on annual food crops (millet, sorghum and maize). In the drier areas, livestock is a main activity. The vegetation is moist *Combetrum*/*Terminalia*/ *Butyrospermum* savannah with moderate biomass production.

3. The montane system

This is found at higher elevations between 1 500 - 1 750 meters above sea level. The area receives high and effective rainfall and cloud cover. Banana is a major staple as well as sweet potatoes, cassava and Irish potatoes. Arabica coffee is prevalent at above 1 600 meters. Some temperate crops like wheat and barley are grown. High population intensities and intensive agriculture are the norm because of small holdings of about 1.5

hectares. Feeding crop residues to livestock is a common practice.

4. The Teso system

The area receives bimodal rainfall on sandy-loams of medium to low fertility. The dry season is longer, from December to March. The vegetation association is moist *Combetrum*/*Butyrospermum* and grass savannas; short grassland which is ideal for grazing. The staple foods are millet, maize and sorghum; other crops are oil seed crops (groundnuts, sesame - *Sesamum indicum* - and sunflower) with cotton as the major cash crop. Mixed agriculture (crops and livestock) is practised. Cultivation by oxen is the main agricultural technology. Livestock are kept extensively in those areas which are tsetse-fly free. The use of crop residues as fodder is very common in the Teso System. The average farm size is about 3 hectares.

5. **The northern system**

The rainfall in areas of this system is less pronouncedly bimodal with about 1200 mm annually. Rainfall in the far north and north-east of the country (Kotido and Moroto) is uni-modal and too low (under 800 mm) and erratic for satisfactory crop production. The dry season is so severe that drought tolerant annuals are cultivated; these include finger millet (*Eleusine coracana)*, sesame, cassava and sorghum. Tobacco and cotton are major cash crops. The grassland is short and communal grazing abounds. This area is well-known for its pastoral system with semi nomadic cattle herding.

6. **The West Nile system**

The rainfall pattern resembles that of the northern system, with more rain at higher altitudes. Mixed cropping is common with a wide variety of crops. The system is in the sub-humid zone where the vegetation community is moist *Butyrospermum*/*Combetrum*/*Terminalia* grassland. Livestock activities are limited by the presence of tsetse fly. As in the northern system, tobacco and cotton are major cash crops.

7. **The pastoral system**

This system covers some districts in the north-east, parts of Western and Central Districts. Annual rainfall is low (under 1 000 mm). The system is characterized by short grassland where pastoralism prevails with extensive nomadic grazing. Mixed herds are common but with no sound information on cattle- small ruminant ratios for optimum grassland use.

Figure 2 and Table 1 below show the agro-ecological zones and the districts founding each of the AEZ respectively. Figure 3 shows graphically the rainfall patterns and moisture deficits.

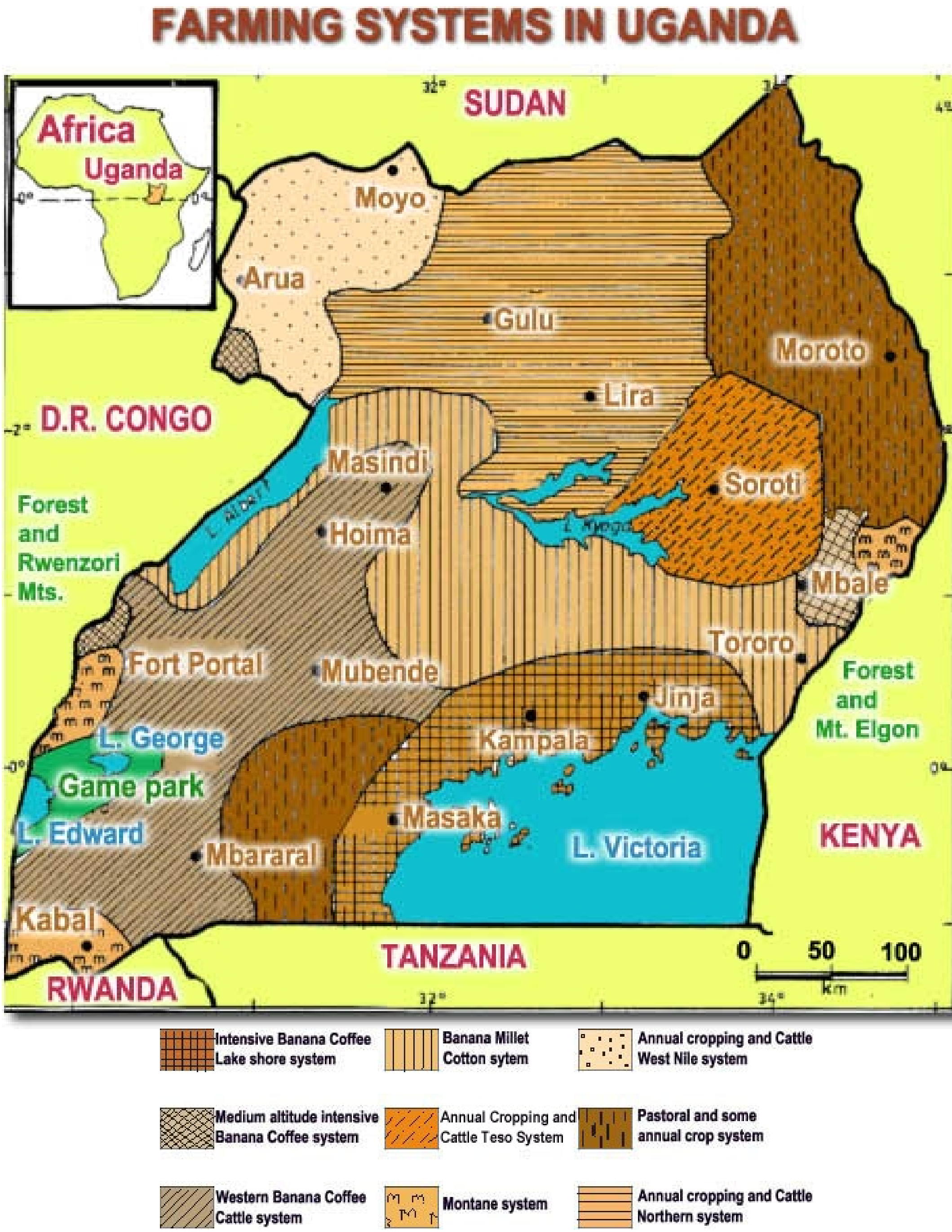

Figure 2: Agro-ecological Zones of Uganda

Table 1: Summary of agricultural systems of Uganda ***(Source: Basic facts on agricultural activities in Uganda, MAAIF, 1995)***

Farming system, AEZ	Description	Districts	Practice of RWH and Irrigation
1, Banana/Coffee System	• Rainfall is evenly distributed (1 000 - 1 500 mm) • Soils of medium to high productivity. • Crops; banana, coffee are the main cash root crops, maize, sweet potatoes secondary food to bananas. • Vegetation is mainly forest-savannah mosaic	Bundibugyo, parts of Hoima, Kabarole, Mbarara, Bushenyi, Mubende, Luweero, Mukono, Masaka, Iganga, Jinja, Kalangala, Mpigi and Kampala	Relatively low practice of roof water harvesting, valley tanks/dams, supplemental irrigation
2. Banana/Millet/Cotton System	• Rainfall is less stable than for the banana-coffee system, • There is greater reliance on annual food crops (millet, sorghum and maize). • In the drier areas, livestock is main activity. • Vegetation is moist savannah with moderate biomass production.	Kamuli, Pallisa, Tororo, parts of Masindi and Luweero	Relatively low practice of roof water harvesting, valley tanks/dams, supplemental irrigation, paddy rice
3. Montane System,	• Elevations between 1 500 - 1 750 m above sea level. • Rainfall; High and effective cloud cover. • Crops; banana, sweet potatoes, cassava and Irish potatoes. Arabica coffee, wheat and barley above 1 600 m. • High population intensities and intensive agriculture, small holdings of about 1.5 hectares.	Kabale, Kisoro, parts of Rukungiri, Bushenyi, Kasese, Kabarole, Bundibugyo, Mbarara, Mbale and Kapchorwa	In situ RWH, terraces, conservation structures, contour bunds
4. Teso systems	• Bimodal rainfall. The dry season is longer, from December to March • Soils; sandy-loams of medium to low fertility. • The vegetation is moist and grass savannas; short grassland which is ideal for grazing. • Crop; millet, maize, sorghum; groundnuts, sesame (*Sesamum indicum*), sunflower, cotton • Mixed agriculture (crops and livestock). Cultivation by oxen. The average farm size is about 3 hectares.	Soroti, Kumi, Kaberamaido	Paddy rice, valley tank/dam, supplemental irrigation
5. Northern System	• Rainfall; less pronouncedly bimodal with about 1200 mm annually. The dry season • Crops; finger millet (*Eleusine coracana)*, sesame, cassava, sorghum, tobacco and cotton • Vegetation; short grassland	Gulu, Lira, Apac, Kitgum	supplemental irrigation, limited RWH

Farming system, AEZ	Description	Districts	Practice of RWH and Irrigation
6. Pastoral System	• Annual rainfall is low (under 1 000 mm). • Vegetation; short grassland where pastoralism prevails with extensive nomadic grazing. • Mixed herds are common but with no sound information on cattle: small ruminant ratios for optimum grassland use.	Kotido, Moroto, parts of Mbarara, Ntungamo, Masaka, Ntungamo, Masaka and Rakai	High practice of Valley dams/tanks, roof water harvesting , Supplemental irrigation

Farming system, AEZ	Description	Districts	Practice of RWH and Irrigation
7. West Nile System	• Rainfall; pattern resembles that of the northern system, with more rain at higher altitudes. sub-humid zone • Mixed cropping is common with a wide variety of crops. • Vegetation community is moist grassland. Livestock activities are limited by the presence of tsetse fly • Crops; finger millet (*Eleusine coracana)*, sesame, cassava, sorghum tobacco and cotton	Moyo, Arua and Nebbi	supplemental irrigation, limited RWH

Figure 3 shows the reference evapo-transpiration rates, effective rainfall and water deficit for AEZ1. The figures for the other AEZs can be seen in the appendices

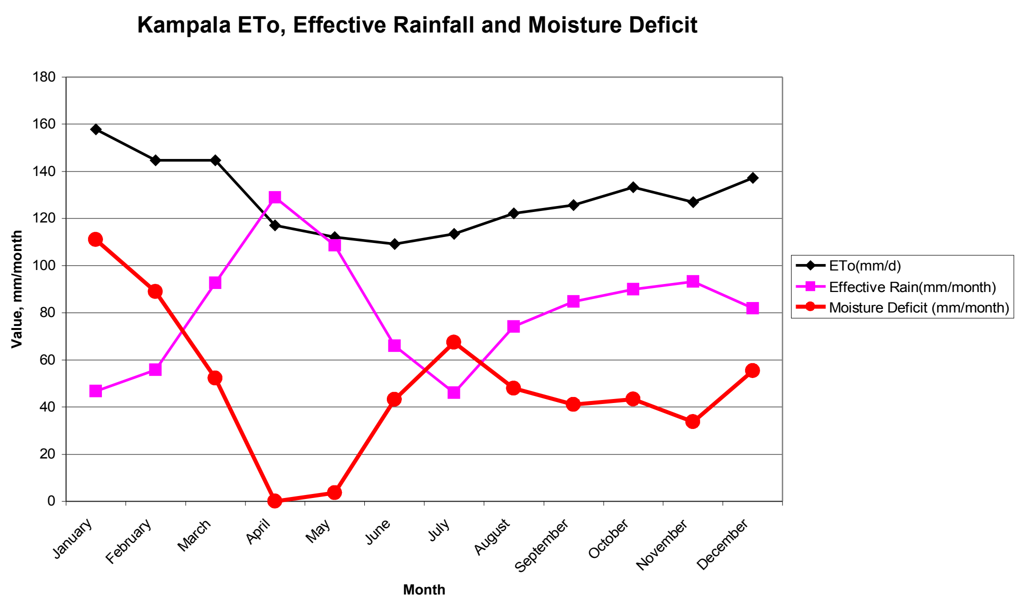

Figure 3: ETo, Effective Rainfall and Moisture Deficit in AEZ 1

It can be seen from figure 3 that the rainfall pattern in AEZ 1(Banana/Coffee System) is bimodal and relatively distributed over the whole year. Water shortage for both agriculture and domestic use is not acute. Therefore irrigation and water harvesting practice are not widely used in this zone.

Figure A4 in the appendices shows that the rainfall pattern in AEZ 2(Banana/Millet/Cotton System) is bimodal but less evenly distributed over the whole year. The long dry season (December – February) is more pronounced than in AEZ 1. Water shortage for both agriculture and domestic use is acute only in the long dry season. Therefore irrigation and water harvesting practice are more widely used in this zone.

Figure A5 in the appendices shows that the rainfall pattern in AEZ 3 (Montane System) is bimodal but less evenly distributed over the whole year. The long dry season (June – August) is more pronounced than in AEZ 1. Water shortage for both agriculture and domestic use is acute only in the long dry season. In situ water harvesting/conservation practice is more widely used in this zone due to steep slopes.

Figure A6 in the appendices shows the rainfall pattern in AEZ 4 (Teso systems). It is bimodal but less pronounced, merging almost into one rainy season. The long dry season (November – March) is more pronounced. Water shortage for both agriculture and domestic use is acute in the long dry season. The area is also a cattle keeping area. Therefore water harvesting and paddy rice irrigation (due to flat terrain) are widely practised.

Figure A7 in the appendices shows the rainfall pattern in AEZ 5(Northern System). It is bimodal but less pronounced, merging almost into one rainy season. The long dry season (December – March) is more pronounced. Water shortage for both agriculture and domestic use is acute in the long dry season. Here there is only one growing season and limited cattle keeping. Therefore water harvesting and irrigation are not widely practised.

Figure A8 in the appendices show that the rainfall pattern in AEZ 6(Pastoral System) is bimodal but less evenly distributed over the whole year. The long dry season (June – August) is more pronounced than in AEZ 1. Water shortage for both agriculture and domestic use is acute in the long dry season. This is a pastoral area and therefore water harvesting for both animals and domestic use is widely practised.

Figure A9 in the appendices show the rainfall pattern in AEZ 7(West Nile System), similar to the Northern System. It is bimodal but less pronounced, merging into one rainy season. The long dry season (December – March) is more pronounced. Water shortage for both agriculture and domestic use is acute in the long dry season. Here there is only one growing season and limited cattle keeping. Therefore water harvesting and irrigation are not widely practised.

2.1 Irrigated Areas in Uganda in relation to AEZ

Due to the fact that farmers can produce at least one crop or two per year using rain fed agriculture, irrigation development is rather low in Uganda although the need for irrigation is becoming increasingly serious due to unreliable rainfall and the effect of global warming.

The largest irrigation potential areas in Uganda are found in the Lake Kyoga catchment (Teso systems and Banana/Millet/Cotton System), the Western Region (Montane System and Banana/Coffee System), the Albert Nile Valley (West Nile System**)** and in the Jinja, Iganga districts on Lake Victoria in the southeast of the country (Banana/Coffee System). Table 2 shows potential areas for irrigation in Uganda while table 3 shows current irrigation areas in Uganda.

Table 2: Location and size of potential land suitable for irrigation (Source: Halcrow, 1964)

Region	Estimated potential (Hectares)	AEZ
A. Albert Nile Valley	22,260	7
B. Aswa River catchment	3,640	5
C. Karamoja and N.E. Teso	10,117	6, 4
D. Lake Salisbury area	11,332	4
E. North Bugisu and Sebei	9,308	3, 2
F. Lake Kyoga Basin	81,750	2, 4
G. South Busoga	22,259	1
H. Western region Rift valley Plains	25,090	3, 2
J. Katonga River and Lake Wamala	1,214	1
K. Koki lakes and Orichinga Valley	2,024	6
Total	**188,890**	

Table 3: Current irrigation area in Uganda *(Source: Irrigation sub-sector review, FAO, 1999)*

Irrigation project	District , AEZ	Source of Water	Main Crops	Command area (ha)	Present irrigated area(ha)	AEZ
Formal Schemes						
Mubuku	Kasese ,	Sebwe/Mubuku	Onions Vegetables Alfalfa	600	430	3
Kimbimba(Tilda)	Iganga	Kimbimba reservoir	Rice	600	600	1
Doho	Tororo(Butaleja)	Manafwa	Rice	1000	1000	2
Kiige	Kamuli	Nabigaga Lake	Citrus	150	10	2
Ongom	Lira	Owomwri/ Ongom River	Citrus	40	10	5
Labori	Soroti	Kyoga Lake	Vegetables	40	0	4
Atera	Apac	Kyoga Lake	Rice, Vegetables	20	0	5
Agoro	Kitgum	Agoro River	Rice, Vegetables	120	120	5
Olweny	Lira	Olweny	Rice	50	50	5
Small- Scale						

	Tororo	Mpologoma Lumbika Manafwa	Rice	24,500	24,500	2
	Iganga	Mpologoma Kitumbezi Lumbuye	Rice	2,400	2,400	1
	Pallisa	Mpologoma	Rice	10,800	10,800	2
	Others		Rice	15,650	15,650	
Commercial						
Nyamugasani	Kasese	Nyamugasani	Vegetables, Cotton, Sugarcane, Maize, Rice	360	10	3
Lugazi	Jinja	Victoria Lake	Sugarcane	2000	50	1
Kakira	Mukono	Sezibwe	Sugarcane	600	50	1
Total				**58,930**	**55,650**	

Formal irrigation development in the country commenced in the 1960s with the following schemes:

- The Mubuku irrigation settlement scheme in the Kasese District was established as a settlement scheme with gravity irrigation and water intakes from Sebwe and Mubuku rivers. Its command area was 600 ha, of which 430 ha were irrigated as at 1998.
- The Kiige scheme in the Kamuli District has Lake Nabigaga as a water source for sprinkler irrigation of citrus fruits. Its command area was 150 ha, of which 10 ha were irrigated as at 1998.
- The Labori and Odina schemes were abstracting water from Lake Kyoga for sprinkler irrigation; the Labori scheme, in the Soroti District, had a command area of 40 ha but by 1998 no irrigation took place.
- The Ongom scheme in the Lira District is a sprinkler irrigation scheme for citrus fruits with water from a reservoir of 4 500 m^3 capacity. The scheme had a command area of 40 ha, of which 10 ha were irrigated as at 1998.
- The Atera irrigation scheme in the Apac District was designed to abstract water from the Nile through pumping and subsequent gravitational flow through pipes and water hydrants to the fields. The scheme had a command area of 20 ha but by 1998 no irrigation took place.
- The Agoro self-help irrigation project in the Kitgum District is a gravity-fed scheme with intake from the Agoro River. All of its 120 ha command area was irrigated as at 1998.
- In the 1970s the Chinese initiated the development of rice schemes, with the Kibimba rice scheme as a rice technology development scheme and the Doho rice scheme for seed multiplication and popularization of production. The Kibimba scheme is in the Iganga District and has a command area of 600 ha, all of which was irrigated by 1998. The Doho scheme in the Tororo District has a command area of 1 000 ha, all of which was irrigated by 1998.

- Floriculture private-sector farmers started green houses concentrated in the Lake Victoria area in the 1990s.
- The latest Government constructed and implemented scheme, the Olweny swamp rice irrigation project with a command area of 50 ha, went into operation in 1997 (nucleus site) and 2001 (Itek and Okile).

The progress in formal irrigation has been very slow and with limited success. One reason is the top-down approach adopted in most schemes. The farmer-based schemes of Mubuku, Doho and Agoro were considerably more successful. On the other hand, informal small-scale irrigation has been increasing, especially for rice, vegetable and fruit production. The increased area of informal rice production is a result of technology adoption from the Chinese in the Kibimba Rice Scheme. Informal small-scale irrigation is practised mostly in the southeast of the country. Currently a FAO pilot project is adopting a bottom-up approach at 7 small-scale irrigation sites with an area of about 36 ha and about 100 farmers.

As at 1998 the area equipped for irrigation was 5 580 ha, most of which is located in the southeast part of the country in the districts between Lake Victoria and Lake Kyoga. Of this, 2 330 ha were actually irrigated. Surface irrigation is the main irrigation technique, while 230 ha are equipped for sprinkler irrigation. Localized irrigation is practised on a pilot-scale at three sites.

Large, medium and small scale irrigation

Large schemes (> 500 ha) dominate the sector with 4 800 ha equipped, medium schemes account for 680 ha and **small schemes (< 50 ha)** for 100 ha. Surface water is almost exclusively used as water source. By 1998, about 53 350 ha of fringes of swamps were cultivated, of which 3 570 ha were equipped in 1987.

The Mubuku irrigation scheme is considered to be the food basket for the Kasese district. This is because, in addition to the provision of employment, farmers from different highly populated districts moved to settle in the scheme. The scheme also acts as a seed multiplication centre for maize, soya beans and groundnuts. It has currently accessed European markets for the export of okra and French beans in addition to supplying the tomato sauce factory in Kasese with raw materials (tomatoes and papayas).

The Kibimba rice scheme (private sector) provides work for to the surrounding community while the Doho rice scheme has substantially raised the standard of living of its farmers. This is demonstrated by the sprouting permanent buildings, rice milling machines and changed eating habits of the farmers coupled with the education of children. Rice from Doho finds its way to Rwanda and occasionally to the Democratic Republic of Congo.

For small-scale (1-4 ha) systems it was found that, for all crops, gross margins from treadle pump technology are higher than the gross margins under rain fed cultivation. In the case of motorized pumps with surface irrigation, gross margins for coffee, maize, beans, cassava and bananas are less than the gross margins under rain fed cultivation. However, under motorized pumps with sprinkler irrigation, all crops except coffee, cassava and bananas (rice is not considered for irrigation under sprinklers) gave higher gross margins. In all three cases of supplementary irrigation technologies, tomatoes, onions and rice give distinctly increased gross margins compared to rain fed cultivation. Preliminary results from the introduction of supplementary irrigation to cloned coffee show an annual yield of 5.6 tonnes/ha of green coffee. This is more than twice the 2.5 tonnes/ha yield obtained before introducing supplementary irrigation.

The following costs for irrigation development were estimated:

- Treadle pump, including 50 m polyethylene pipe, with surface irrigation: US $150-600/ha;
- Treadle pump, elevated drums and low pressure, low volume sprinklers: US$1 250/ha;
- Simple gravity-fed system in lowlands: US$150/ha;
- Small motorized pump including 50 m polyethylene pipe, and surface irrigation: US $600-1 200/ha;
- Portable sprinkler systems: available in Uganda for about US$2 500/ha;
- Localized systems: on-farm installation cost of about US$4 000/ha.

Estimates on annual average costs of operation and maintenance range between US$32-395 where the lower figure applies to treadle pump irrigators while the higher to motorized pump irrigators.

2.2 Criteria for Prioritization of potential for best practices and best practice sites and schemes

The sites were examined to provide key information by answering questions such as:

- What is the water use efficiency of the technology/site/scheme? - Water use efficiency can be measured in terms of production per cubic meter of water diverted, ratio of water diverted to water utilized, etc.
- How are the systems managed?
    - Do formal Water Users Associations (WUA) or management committees exist?
    - How effective are such user groups in operation and maintenance of the scheme? Or what is the level of participation/cooperation of members?
    - Do the WUA have legislation governing it? Is it sufficient or does it need modification? Is it registered?
    - Is the public sector involved in the management, operation and maintenance of the scheme? What is the level of involvement? Is its involvement necessary?

○

- To what extent has the technology/scheme fulfilled its objectives or solved the problem?
- What levels of economic/social benefits have been achieved?
- Is the technology affordable, acceptable and sustainable?

The criteria used for prioritizing best technologies and practice sites can be seen in table 4.

Table 4: Summary of Criteria for Prioritizing Best Technologies and Best Practice Sites

Criteria for Best Technology/Practices	**Criteria for Best Practice Site**
Water use efficiency,%	Efficiency (water use, application), %
Estimated number of community members that adopt technology	Yield increase/profits %
Technical support	Number of community members that have adopted Practice
Affordability	Availability and effectiveness of Water users association
Spare parts availability	Level of maintenance
Operation and maintenance simplicity	Environment management
Level of solution to problem	Market for product

The criteria for water harvesting and that of irrigation may differ slightly but is based on the above general criteria. Tables A1 to A5 in the annexes show the ranking of the best technologies and sites for the different technologies. The practices/technologies or site/schemes that scored the highest marks, while answering the above questions, had the highest potential.

The practices and sites are found in the different Agro Ecological Zones (AEZ) of Uganda. Most of the water harvesting sites are found in the pastoral system zone while irrigation sites are in the banana-millet-cotton and Teso systems.

3.0 Identification and Assessment of Best Practices and Technologies

3.1 Selection Process and Salient features

The various technologies/practices of irrigation and water harvesting practised in Uganda were identified through literature review from relevant institutions/organizations and discussion with relevant stakeholders. The institutions and organizations contacted include FAO, MAAIF, NARO, UWASNET, DWD, URWA, Makerere University, Kyera Farm and Rwetanga Farm.

Most parts of Uganda experience at least a long rainy season and other parts two rainy seasons. Therefore the farmers can produce at least one crop a year and irrigation is only practised during the dry season at small scale level.

Small-scale informal irrigation has been practised in Uganda since the 1940s. The majority of the irrigated areas are located on the fringes of swamps. Smallholder irrigation is considered 'informal irrigation' as smallholders developed it spontaneously without planning and with little or no technical assistance; often the technology used is basic and sometimes inappropriate. Formal irrigation development in the country commenced in the 1960s (see table 3). Tables 5-7 show the technologies/practices identified in irrigation and water harvesting in Uganda.

The choice of best practice/technology was influenced by the following criteria:

- Appropriate solution to problem
- Affordability and cost
- Availability of spare parts
- Technical support availability
- Acceptability of the technology
- Water use efficiency of the practice

3.1.1 Water Harvesting

Rainwater harvesting (RWH) is defined as the method of inducing, collecting, storing and conserving surface runoff for domestic, agriculture and environmental purposes in water stress areas. This often involves collecting rainwater from a catchment area and channelling the runoff into a delivery system, which finally leads to a storage system. The storage system may include;

- Small pots, water jars corrugated galvanized tanks, plastic tank and Ferro cement/masonry tanks for domestic system.
- Subsurface masonry tanks, ponds and valley tanks/dams for livestock watering and
- In-situ, internal and external storage for agriculture production and environmental conservation.

3.1.1.1 Long list of best practices

Table 5 shows a list of best practices/technologies for rainwater harvesting used in Uganda

Table 5: List of water harvesting technologies/practices found in Uganda

Water harvesting Technology/ practice	Use	Example Location of practice	Attributes					
			benefit	Acceptability	Cost	Spare parts availability	Technical support	Water use efficiency
Valley dam	Watering animals, domestic	Mbarara, Luwero	Water Time Health	Fair/ Poor	High $100,000 -200,000	Local materials	District DWD NARO MAAIF	Average (high ET losses)
Valley tank	Watering animals, domestic	Mbarara, Luwero	Water Time Health	Good/ Fair	Average $20,000 -100,000	Local materials	District DWD NARO MAAIF	Average (high ET losses)
Pots, jars	Domestic	Masaka, Mbarara	Water Time Health	Good	Cheap $85 - 160	Local materials Town	Group NGO DWD Individual	High (low evaporation losses)
Corrugated galvanized/ plastic tanks	Domestic, backyard irrigation	Bushenyi, Masaka, Mbarara	Water Time Health	Good	Fair Up to $3,000	Kampala Town	District DWD	High(low evaporation losses)
Ferro cement tanks	Domestic, backyard irrigation	Mbarara, Masaka	Water Time Health	Good	Fair $300-1,000	Local materials Town	Group Manson NGO DWD Individual	High(low evaporation losses)
Brick masonry tanks	Domestic, backyard irrigation	Mbarara, Masaka	Water Time Health	Good	Fair $300-1,200	Local materials Town	Group Manson NGO DWD Individual	High(low evaporation losses)
Subsurface masonry tanks	Domestic, backyard irrigation	Mbarara, Masaka	Water Time Health	Good	Fair $300-1,700	Local materials Town	Group Manson NGO DWD	High(low evaporation losses)
Rock catchment	Domestic Backyard irrigation	Luwero	Water Time Health	Good	Average up to $10,000	Local materials Town	District DWD	High(low evaporation losses)
In-situ, internal and external storage for agriculture	Agricultur e, environm ent	Luwero, Mbarara, Bushenyi, Masaka	Yield increas e Soil conserv ation	Good	Cheap Farm labour	Local	District MAAIF NARO	Low (evaporation and seepage losses)

3.1.1.2 Evaluation of best practices/technologies

The various water harvesting technologies from table 5 can be evaluated using the criteria points. The best technologies are the ones that can be afforded by the beneficiaries and solve the problem of water shortage. The best options also are those where materials for installation and maintenance as well as technical support are available locally for sustainability. The water harvested should also be efficiently used and managed by the user. The result of the ranking can be seen in table (A1) in the appendices. From table (A1) the best practices include: Ferro-cement tanks, in-situ storage for agriculture and valley tanks.

3.1.2 Community Managed (Small Scale) Irrigation

Irrigation schemes can be large scale (> 500 ha), medium scale scheme (50 – 500ha) or small scale (< 50 ha). In Uganda most of the irrigation systems are either public or private. The community managed systems are mainly found in the rice growing areas of Eastern Uganda and vegetable growers using low input technologies such as treadle pump.

Table 6 shows a list of irrigation technologies used in Uganda.

Table 6: List of irrigation technologies/practices found in Uganda

Irrigation Technology/practice	Crops	Example Location of practice	Attributes					
			benefit	Maintenance management	Cost	Spare parts availability	Technical support	Water use efficiency
Furrow	Vegetables, cotton, maize	Mubuku scheme	Increased yield	Poor	Low	Local	District MAAIF NARO	Low
Basin	Rice	Pallisa Tororo Kimbimba Doho	Increased yield	Average	Low	Local	District MAAIF NARO	Low
Sprinkler	Fruits, vegetables, flowers	Kiige, Ongom	Increased yield	Poor	High	Kampala	District MAAIF NARO	High
Drip	Flowers	Kampala, Entebbe	Increased yield	Poor	High	Kampala	District MAAIF NARO	High
Treadle pump	vegetables	Rural, peri – urban (Jinja)	Increased yield	Poor	Low ($ 100-150)	Kampala	District MAAIF NARO	Average
Watering can/bucket	Vegetables, nurseries	Urban, rural areas	Increased yield (small production)	High	Low	Town Kampala	District MAAIF NARO	Average
Gravity flow/flooding	Various	Where elevation difference exists, rural areas	Increased yield	Average	Low	Local	District MAAIF NARO	Low

3.1.2.2 Evaluation of best practices/technologies

The best technologies are the ones that can be afforded and managed by the beneficiaries. The best options also are those where materials for installation and maintenance as well as technical support are available locally for sustainability. The technology should have high water use efficiency so that water is not wasted. The result of the ranking can be seen in table (A2) in the appendices. From table (A2) the best practices include: basin irrigation for rice production, watering can/bucket and treadle pumps for vegetable production.

3.1.3 Public Private Managed (Large Scale) Irrigation

Most of the large scale irrigation schemes in Uganda are public. A private large scale irrigation scheme is Kimbimba (Tilda) rice scheme. They use basin irrigation. The other public schemes use furrow and basin irrigation. There are several firms producing flower around Kampala and Entebbe. They use drip/hydroponics and sprinkler irrigation. These are not considered because they do not have community members adopting their technology.

4.0 Identification and Assessment of Best Practice Sites

4.1 Selection Process, Salient features, and Results

The best sites should have high water use efficiency, be managed effectively, be properly maintained, be profitable, benefit the farmers and community, have good environment management (water borne diseases, chemicals). The site may not necessarily have all the above mentioned attributes to be considered a best practice site but may have a few good attributes which give it a higher rating than others. Description of the best sites can be found below but the detailed description can be found in the fact sheets attached separately.

4.2 Water Harvesting

Table 7 shows a list of the best practice sites for water harvesting.

Table 7: List of Water Harvesting Sites

Water harvesting Site, ownership	District	Type , use	Choice factors /Criteria					
			Environ't mgt	Maintenance ,mgt	Estimated Cost	Earning /profitability from sale of water per year	Technical support availability	Water use efficiency
Kyalulangira , Kiziba and Kyalulangira village. (community)	Rakai	FCT, 40m^3 Domestic	Good	Good	High $1,800	**$0.3/20liter** 0.3*40,000/20= $600 600*4 =$2,400	Manson URWA	High
Kikagati Sub county, Kamubisi village (community)	Isingiro	Partially Underground FCT Tank (80m^3) Domestic	Good	Good	High $ 1,800	**$0.3/20liter** 0.3*80,000/20= $1,200 1,200*4 =$4,800	Manson URWA	High
Kyanyanda village Rugaga sub county (community)	Isingiro	Open underground Tank Circular (180 m^3) Production	Good	Good	Community contribution 16 bags of cement and 4 tonnes of sand	0.3*180,000/20 = $2,700 2,700*4 = $10,800	Manson URWA	High
Masha Sub county (individual) Edward Kanyarutoky e	Isingiro	FCT 12 m^3 Domestic	Good	Good	$900	0.3*12,000/20= $180 1180*4 =$720	Manson URWA Ankole dioceses	High
Ekiryotozi Kashongi sub county	Kiruhura	Valley tank (10,000m^3) Hand pump Domestic Watering animals	Good	Good	$24,000	Enough clean water for community and animals 0.1*10,000,000/20 =$50,000	District Ankole dioceses	Average
Kyamuyimba, Kamira sub county	Luwero	Valley Tank (10,000 m^3) domestic, watering animals	Good	Good	$60,000	Enough clean water for community and animals 0.1*10,000,000/20 =$50,000	District	Average

4.2.2 Evaluation, prioritization and description of best practice sites

The best practice sites were evaluated and ranked as shown in table A3 in the appendices. Table A3 shows the best practice sites that include: Ekiryotozi valley tank, Edward Kanyarutokye FCT and Kyamuyimba valley tank.

4.2.3 Description of Edward Kanyarutokye FCT

This area, in which the best practice site is located, suffers severe water shortage in the dry season. Women have to travel about 6 Km to fetch water. The cost of water varies from $0.12 -0.3 per 20 litre. The project was implemented by Ankole Diocese, in collaboration with Uganda Rain Water Association (URWA) while Uganda Water and Sanitation NGO Network (UWASNET) provided technical and financial support. Mr.Edward contributed labour, food and more than 50 %of funds required. The roof water harvesting system is composed of roof, gutters, closed Ferro cement tank and taps. Design, budget and bills of quantities were prepared before construction. The cost of the system was about Sh.1, 600,000/= ($930).

The tank capacity is 12,000 litres. The family uses on average 100l per day and water can last for over 3 months. The technology has achieved the objective of providing adequate and cheap water for domestic use. The family saves about $720 annually from water for domestic use computed as follows; before construction of the tank the family used to buy water at Sh. 500/= ($0.3) per 20 litre jerry can. In one year the tank can provide at least 12,000*4 = 48,000 litres. The amount of money saved by the family = (48,000/20)* 0.3 = $720.

Mr. Edward belongs to Rukuuba Rain Water Harvesting Association made up of 13 members. Members organise training programs and help each other with labour and materials during construction. The Group trained a mason to help in construction and maintenance. A number of community members have already adopted the technology.

Figure 4: Ferro Cement tank (12 m^3) for Mr. Kanyarutokye Edward

4.2.4 Description of Ekiryotozi dam

The community through Ankole diocese and with the help of Christian Engineering in Development (CED) constructed the valley dam in1999 in order to solve the problem of acute water shortage for cattle and humans, especially during the dry season. It was designed by CED and constructed with full participation of community members and its cost was Sh. 40,000,000/= ($24,000).

The main sources of funding were Ankole diocese, UWASNET, URWA and CED, and the community. The community contributed labour and local materials and that is why the cost of the valley tank was only $ 24,000 otherwise a 10,000 m3 valley tank usually costs about $60,000 or more ($1 = Sh. 1,700/=).

The structure is made up of an excavated reservoir measuring 70* 30* 5 m (≈10,000m3), an in let which is well vegetated, a spillway and infiltration gallery connecting the reservoir to a shallow well and a hand pump located outside the fence of the protected valley tank. The reservoir is fenced with barbed wire and vegetation to keep away humans and cattle from accessing the water directly that could lead to polluting the water and damaging the structures.

The valley dam serves about 2,000 people and 1,000 herds of cattle especially during the dry season. The community and the cattle access water through the hand pump. The water from the shallow well is clean and has fairly good quality. The community uses the water for domestic use and for watering of animals. They boil the water for drinking and store it in clean containers (buckets, jerry cans, pots).The water source is adequate to satisfy the needs of the community for both domestic and watering of animals. Before the valley tank was constructed water shortage was so acute and member could buy a 20 litre jerry can for Sh.500/= ($0.3). So the 10,000 m3 water stored could fetch (10,000,000/20)*0.3 = $150,000 There is a strong water users association which collects water fee from members and use the money for operation and maintenance . For example they repaired the hand pump when it broke down recently.

Good fencing and thick vegetation at inlet for filtration

Figure 5: Ekiryotozi dam Kashongi sub county Kiruhura district

Hand pump outside fence. Water flows to well through infiltration gallery. No contamination of water source with cow dung

Figure 6: Ekiryotozi dam hand pump

4.2.5 Description of Kyamuyimba Valley tank

The community with the help of the district and DWD staff identified the site and constructed the valley dam in 2004 in order to solve the problem of acute water shortage for cattle and humans, especially during the dry season. DWD provided the funds. The hydrological studies were carried out by WEGS consultants with input from the present consultant and the design was done by Kagga engineers on behalf of DWD. The hydrological and design reports are available at DWD office in Kampala. Community members participated in the construction especially in the provision of employed labour.

The facility costed Sh. 100,000,000/= ($60,000) being funded by DWD. The community contributed in provision of paid labour and local materials. The structure is made up of an excavated reservoir measuring 70* 35* 4 m (≈10,000m3), an inlet which is well vegetated, a spillway and treadle pumps connecting the reservoir to watering troughs located downstream outside the fence of the valley tank. The reservoir is fenced with barbed wire and vegetation to keep away humans and cattle from accessing the water directly that could lead to pollution of the water and damaging the structures. The community and the cattle access water through the treadle pumps.

The community uses the water for domestic purposes and for watering of animals. They boil the water for drinking and store it in clean containers (buckets, jerry cans, pots).The water source is adequate to satisfy the needs of the community for both domestic and watering of animals. There is a weak water users association.

Figure 7: Kyamuyimba valley tank

Figure 8: Kyamuyimba valley tank in let with good cover and fencing

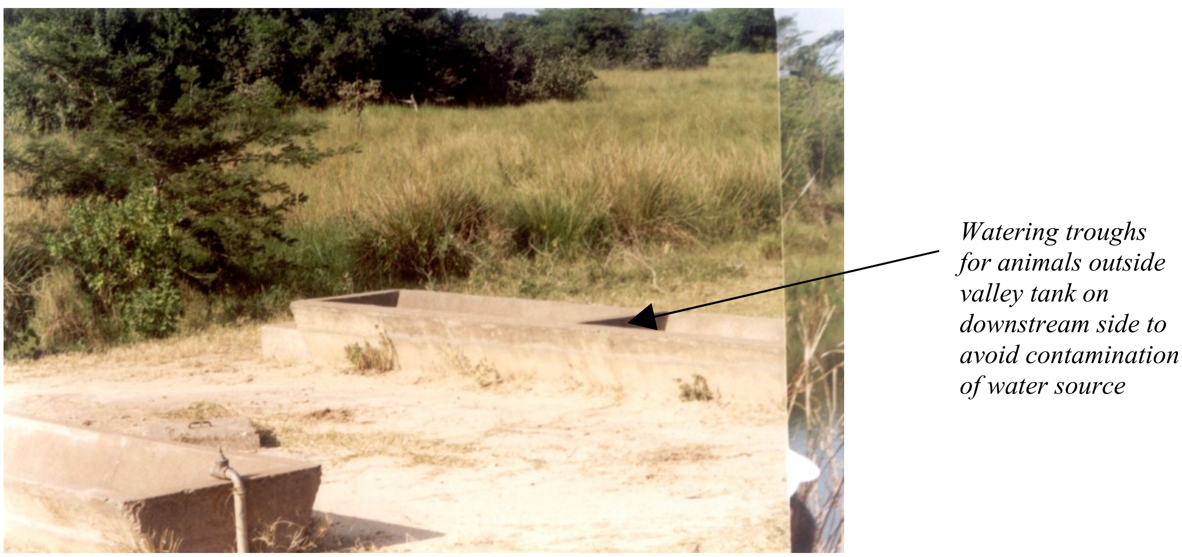

Figure 9: Kyamuyimba valley tank watering troughs

4.3 Community Managed (Small Scale) Irrigation

The best sites should have a high water use efficiency, increased yields, be properly maintained and managed, have high community participation, have good environment management (water borne diseases, chemicals) and be profitable. The community managed systems are mainly found in the rice and vegetable growing areas of Eastern Uganda using low input technologies such as treadle pump. They are usually informal and therefore there is little or no documentation about them.

4.3.1 Long list of best practice sites

Table 8: List of Community Managed (Small Scale) Irrigation Sites

Irrigation Site, ownership	District	Crops	Choice factors					
			Environment mgt	Maintenance mgt	Yield increase	Management structure	Marketavail ability	Water use efficiency
Iganga Paddy rice growers communities	Iganga	Rice	average	average	High	average	Good	Low
Pallisa Paddy rice growers communities	Pallisa	Rice	average	average	High	average	Good	Low
Tororo Paddy rice growers communities	Tororo	Rice	average	average	High	average	Good	Low
Mr.Sembusi Richard Bulenge Village Buwunga sub county Private/commu nity	Masaka	Coffee, banana, pineapple, coffee nursery, fish pond	Good	Good	High 2 ton/acre	Average	Good	Low
Mr. Mpinde Livingstone Katolerwa village Kibinge sub county. Private	Masaka	Coffee, coffee nursery	Good	Good	High Before 380 bags per 20 acres Now 680 bags per 20 acres	Average	Good	Low

4.4 Public- Private Managed (Large Scale) Irrigation

The table below shows a list of best practice sites for large scale irrigation.

Table 9: List of best practice sites for large scale irrigation

Irrigation Site, ownership	District	Crops	Choice factors					
			Environment mgt	Maintenance	Yield/yield increase	Management structure	Management	Water use efficiency
Mubuku	Kasese	Onions Vegetables Alfalfa	Fair	Poor	Good	MAAIF	Poor	Low
Kimbimba (Tilda)	Bugiri	Rice		Good	Good	Good , Private	Good	Average
Doho	Tororo (Butaleja)	Rice	Fair	Average	Good	MAAIF	Average	Low

Irrigation Site, ownership	District	Crops	Choice factors					
			Environment mgt	Maintenance	Yield/yield increase	Management structure	Management	Water use efficiency
Mubuku	Kasese	Onions Vegetables Alfalfa	Fair	Poor	Good	MAAIF	Poor	Low
Kiige	Kamuli	Citrus	Fair	Poor	Average	MAAIF/community	Poor	Low
Ongom	Lira	Citrus	Fair	Poor	Average	MAAIF/community	Poor	Low
Labori	Soroti	Vegetables	Fair	Poor	Average	MAAIF/community	Poor	Low
Atera	Apac	Rice, Vegetables	Fair	Poor	Average	MAAIF/community	Poor	Low
Agoro	Kitgum	Rice, Vegetables	Fair	Poor	Average	MAAIF/community	Poor	Low
Olweny	Lira	Rice	Fair	Poor	Average	MAAIF/community	Poor	Low

4.4.2 Evaluation, prioritization and description of best practice sites

The best practice sites were evaluated and ranked as shown in tables A4and A5 in the appendices. From table A5 the best practice sites include: Kimbimba, Doho, Mubuku and Olweny for large scale. Table A5 gives the best practice sites for Private/community managed irrigation schemes identified as; Mr.Sembusi Richard of Bulenge Village, Buwunga Sub County and Mr. Mpinde Livingstone of Katolerwa village, Kibinge Sub County.

Description of Mr. Sembusi Richard's gravity irrigation system

Mr. Sembusi started diverting water to his field during dry seasons to water his crops. He later attended some training for farmers on irrigation under a FAO project and got better ideas on how to control and distribute the water in the field and he improved the system. He places some obstacle in the stream in order to raise the water level at an upstream point. He then opens the side of the stream so that water flows in a channel that he has already prepared. The land has a gentle uniform slope and water is able to flow to the field by gravity. The channel extends to his neighbours who use the same water source.

In the field he prepares a set of field channels taking water to the different parts of the field. He directs the water to flow to a particular part of the field by blocking the others channels using soil. Around the coffee and banana crops, he prepares a small basin into which he pours water by collecting it from the channel using a bucket or some other container. The water flowing in the channels also water the root zone when the channel passes near the crops. He makes a schedule for irrigation such that when one neighbour is irrigating, he and the others do not. Each neighbour is allocated certain days of the week for irrigation. Within his own field, he irrigates sections of the field on different days.

He however, does not have a system of measuring the amount of water applied during each irrigation session. He uses his experience and at times under applies or over applies water. The water use efficiency is therefore low but it is cheap as he does not have to pump the water. His yields have increased by over 100% and earns about Sh. 2,200,000 ($1,300) per acre. He therefore earns about $650 per acre from increased yields due to irrigation. It is a sustainable system since it is a farmer's initiative, installed and managed by him. The system is cheap and profitable.

Description of Doho Rice Scheme

The farmers have been using the flood plains of river Manafwa for production of Paddy rice. They faced a big challenge of how to control the flood waters. In 1976, GoU through the Chinese government started Doho rice scheme in order to solve this problem. Earth embankments were constructed to stop the floods from inundating the fields and part of the river water was diverted to flow through a canal to irrigate the flood plains. At first three blocks were opened and in 1985 three new blocks were added. New varieties were introduced and up to1993 the yields were very high (1,800- 2,000 Kg/acre or 4,500 -5,000Kg/ha). After 1993 when the Chinese left, management was transferred to MAAIF and by 1996 the yield went down to 1,000 - 1,300 Kg/acre or 2,500 - 3,250Kg/ha). By 1997 yields had dropped to 1,000 Kg/acre.

From 2003 to 2005, JICA introduced some new technologies (seed selection, seed bed preparation, planting in lines) and the yield has gone up to 1,200 Kg/acre or 3,000 Kg/ha. The scheme has a farmers association known as 'Doho Rice Scheme Farmers Association' which is registered and has eleven executive members. The membership fee is Sh. 10,000/= or $6 per year but not all members have paid. The association mobilises farmers to participate in O&M, regulates water allocation, and settles disputes. MAAIF is responsible for the overall management and maintenance of the main structures, which responsibility she has fulfilled below average. The rice produced is mainly for local market. The farmer gets about 1,200 Kg/acre per season and there are two seasons in a year.

Before the project, yields were low and the project has increased yields by over 80%. The farmer sells his rice at Sh.800/Kg ($ 0.5/Kg). Therefore he earns 1,200*2* 0.5* 1/1.8= $667/ acre/year more than before because of increased yield due to the project. Doho rice scheme has achieved its objective of controlling the floods and providing livelihood for the community. Over 4,000 farmers benefit from the scheme and their lives have been changed for the better, although the scheme is not performing up to its maximum potential.

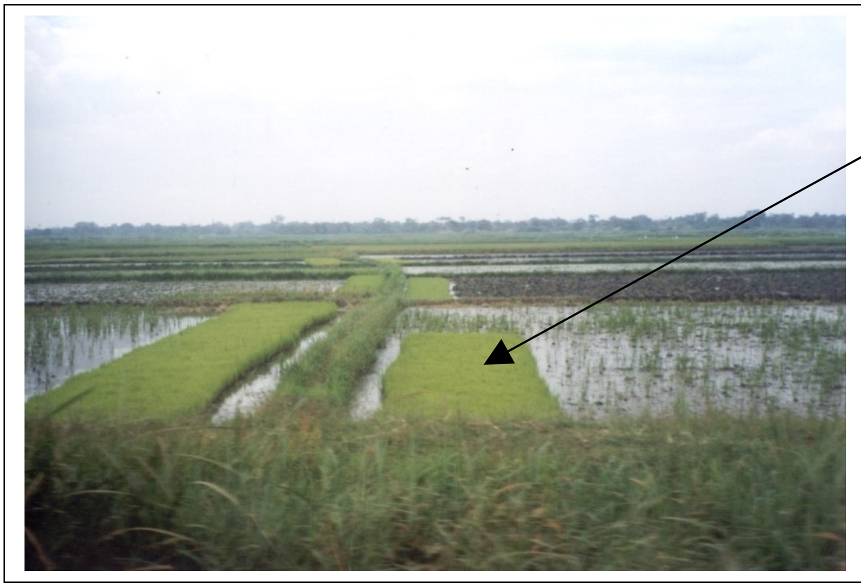

Figure 10: Doho Irrigation scheme nursery bed

Figure 11: Doho Irrigation scheme field bunds for water control

Figure 12: Doho out growers' fields

Figure 13: Doho rice scheme poor water control structure

Figure 14: Doho rice scheme damaged water control structure

5.0 Field Visits, Findings in Relation to Expectations and Final Short List

The field visits were conducted to gather primary and secondary data to fill gaps in data obtained during desk study.

Doho and Kibimba rice schemes and two Masaka farmers were visited to obtain information on irrigation works. One farmer is Mr. Mpinde Livingstone of Kibinge sub-county. He grows coffee (20 acres) and Matoke (5acres). The other farmer is Mr.Sembusi Richard of Buwunga Sub County.

For water harvesting, sites in Isingiro, Kiruhura and Luwero districts were visited; Isingiro for roof water and Kiruhura and Luwero for valley tanks. Surface Ferro cement tanks are preferred to subsurface ones because they are easy to construct and maintain. The subsurface is difficult to repair in case of cracks. It is also difficult to clean. It is cheaper to construct a surface tank than subsurface. Therefore farmers prefer the surface Ferro cement tanks.

Table 10: Field visit; best practice sites for water harvesting

Water harvesting Site, ownership	District GPS readings	Type , use	Attributes					
			Environment mgt	Maintenance ,mgt	Cost	Revenue from sale of water in one year/dry season	Technical support availability	Water use efficiency
Masha Sub county (individual) Edward Kanyarutokye	Isingiro 36 243910E 9927332 N Elv 1,373m	FCT 12 m^3 Domestic	Good	Good	$510	0.3*12,000/20 =$180 1180*4 =$720	Manson URWA Ankole diocese	High
Masha Sub county (individual) Saasi Jane	Isingiro 36	FCT tank (6, m^3) Domestic	Good	Good	$410	0.3*6,000/20= $90 90*4 = $360	District Ankole diocese	High
Ekiryotozi Kashongi sub county, community	Kiruhura 36 244932E 9973333 N Elv 1,339m	Valley tank 10,000 m^3	Good	Good	$24,000	0.1*10,000,000/20 =$50,000	District Ankole diocese	Average
Kyamuyimba, Kamira sub county , community	Luwero 36 444675E 0106454 N Elv 1,063m	Valley tank 10,000 m^3	Good	Good	$60,000	0.1*10,000,000/20 =$50,000	District DWD	Average

The valley tank visited is in Kiruhura district. This site is well managed. It is fenced and water is filtered through infiltration gallery leading to a shallow well equipped with a hand pump. Its inlet is covered with thick vegetation which filters the runoff before it enters the tank. The spillway is also well maintained.

Table 11: Field visit; best practice sites for Irrigation

Irrigation site, ownership	**District GPS readings**	**Attributes**						
		Community management/participation	**Environment mgt**	**Maintenance ,**	**Cost**	**Yield/ha**	**Technical support availability**	**Water use efficiency**
Doho rice scheme Community/ public	Butaleja (Tororo)	Good/high	Average	Poor	Big	3 tons /ha/harvest 2 harvests a year	MAAIF	Low
Kimbimba (Tilda) rice scheme, private	Bugirir	Average	Good	Good	Big	3.5 -4 tons/harvest 2.3harvests a year	Firm	Average
Mr.Sembusi Richard Bulenge Village Buwunga sub county Private/community	Masaka	Good	Good	Good	Low ,gravity flow, self construction	High 2 ton/acre	District MAAIF	Low
Mr. Mpinde Livingstone Katolerwa village Kibinge sub county. Private	Masaka	Good	Good	Good	Average, FAO funded	High Before 380 bags per 20 acres Now 680 bags per 20 acres	District MAAIF	Low

6.0 Short Listing and Ranking of Best Practices/Technologies

6.1 Prioritization and Selection processes and Results

The selection of the best practices and sites was accomplished using the ranking system developed and confirmation of the ranking results through field visits. The field visits did confirm that the practices/sites selected through the process of ranking were indeed the best. Some of them did not fulfil all the criteria for best sites but have outstanding attributes above other practices/sites in the country. The final lists are presented below.

6.1.1 Water Harvesting

The best practice for roof water harvesting was found to be surface FCT. It is cheaper to construct than the brick, under ground, plastic and corrugated iron tanks. It does not crack easily and is easy to repair and maintain by individual farmers or local masons. Local materials for construction such as sand and stones are available and cheap.

The best practice for valley tank was found to be Ekiryotozi dam in Kashongi sub county of Kiruhura district. This site satisfies almost all the criteria for best practices. The water users association is active and maintenance and management of the facility is very good. The next best site is Kyamuyimba, Kamira Sub County, Luwero district with similar attributes.

The detailed BQs for the various types of water tanks can be seen in the appendices, tables A6-A8.

6.1.2 Community Managed (Small Scale) Irrigation

The best site for community managed irrigation was found to be Mr.Sembusi Richard of Bulenge Village Buwunga Sub County. It is a gravity irrigation system whereby water is diverted from a river upstream and directed through canals to the fields. Water is applied to the crops by use of buckets. The system is used by a group of about five farmers, with Mr. Sembusi being the lead farmer. The water use efficiency is low but the system is cheap, has good water control system, profitable and is well managed.

6.1.3 Public-Private Managed (Large Scale) Irrigation

The best site for public/private managed irrigation was found to be Doho rice scheme in Buteleja (Tororo) district. Although the water use efficiency and management are poor, community participation is very high (4,385) and the yields are above average (3 tons/ha/season).

The next best practice site is Kimbimba (Tilda) rice scheme. The yields are high (3.5 -4tons/ha/season) and the system is well managed. However, community participation and benefit is limited since it is private.

7.0 Guidelines and Related Issues Considering Country Experiences in relation to the three components

In Uganda there are no guidelines for irrigation and water harvesting apart from guidelines for smallholder paddy rice cultivation in seasonal wetlands, wetland edge gardening and some policies and legislations.

Guidelines for wetlands

One of the strategies in the Uganda Government's mission of agricultural modernisation is the fullest exploitation of agricultural potential with respect to resource endowment and comparative advantage while at the same time conserving the resources for future generations. This strategy identifies the districts of Iganga, Kumi, Pallisa, Bugiri and Tororo in the east as areas of high activity in wetland rice cultivation.

Studies on rice cultivation conducted by the National Wetlands Programme, NWP, have produced a variety of conclusions and recommendations on the use of wetlands for rice production. Some of the most significant of these are listed below.

- Apart from three large scale irrigated rice schemes in Iganga (Bugiri), Tororo (Butaleja) and Lira districts, paddy rice in eastern Uganda is grown by smallholder farmers under rain-fed conditions apparently without any technical guidance from MAAIF or other sources.
- Paddy rice yields produced by small farmers in eastern Uganda are declining due to improper management of plant nutrients, soils and water. Hence, there is a need to put across recommendations and mitigation measures to avert continuing reduction of yield and further wetland conversion.
- Above ground, biodiversity (fauna, flora and habitats) was found to be greatly modified by rice cultivation due to destruction of the natural wetland vegetation including trees. Below ground biodiversity (especially earthworms and insects) was not found to be affected in the same way as evidenced by the absence of soil compaction, traffic pans and abundance of slickenside in the soil profiles.

It is therefore important that guidelines be provided for current and potential future rice farmers so that wetlands can be used in a sustainable manner and negative effects mitigated through their application. Some of the guidelines produced include: Guidelines for Smallholder Paddy Rice Cultivation in Seasonal Wetlands and Guidelines for Wetland Edge Gardening (see bibliography).

Policies and legislation

The two major policies of the Government of Uganda impacting on irrigation development are the National Water Policy (1999) and the Plan for Modernization of Agriculture, PMA (2000). In addition, the National Policy for the Conservation and Management of the Wetlands (1995) gives a basis for the planning and development of rice irrigation.

The law relating to irrigated agriculture is scattered over many pieces of legislation. There is no legislation that deals specifically with irrigated agriculture.

The Constitution of Uganda 1995 vests in the State the duty to protect important natural resources including water and to take all practical measures to promote a good water management system.

The Water Statute 9/1995, among others, provides for the use, protection and management of water resources and supply and for the constitution of water and sewerage authorities. The objectives of the statute are, *inter alia*, to allow for the orderly development and use of water resources for purposes other than domestic use, such as irrigation and agriculture, in ways that would minimize harmful effects to the environment. Domestic use, as interpreted herein, includes use for the purpose of irrigating a subsistence garden. A subsistence garden means a garden not exceeding 0.5 ha in area, appurtenant to or used in connection with a dwelling or group of dwellings and the produce is for subsistence and not sale or barter. General rights to use water for irrigation where there is a natural source of water are limited to irrigating a subsistence garden. Extraction of water is prohibited unless authorized.

The National Environment Statute 4/1995 provides for the sustainable management of the environment among other things and it establishes the National Environment Management Authority (NEMA). Projects relating to dams, rivers and water resources are to be considered for environmental impact assessment before they can take off. The NEMA, in consultation with the leading agency, is required to establish minimum water quality standards for different uses including water for agricultural purposes.

The Local Governments Act 1/1997 aims to put into effect the decentralization and devolution of functions, powers and services. The provision and maintenance of water supplies is vested in the district councils in liaison with the Ministry responsible for Natural Resources.

The Water Resources Regulations 9/1997 provide for the procedure through which one can obtain a water permit.

The Environmental Impact Assessment Regulations 13/1998 require a developer seeking to implement a project for which an environmental impact assessment is required under the statute to carry out such an assessment.

8.0 Evaluation of limitations and opportunities of the described best practices

The opportunities and limitations of the best practices/technologies for replication and scaling up can be seen in table 12.

Table 12: Opportunities and limitations of best practices/technologies for replication and scaling up

Type of Technology	Best Practice Site /Technology	Opportunities	Potential areas/AEZ for replication	Limitations
Water harvesting	Surface FCT of Mr. Edward Kanyarutokye	• Use mainly local materials (sand, stones) • Relatively cheap and durable • Easy to construct and maintain • Adequate rainfall • Preference by farmers	• In all AEZ • Where iron/tile roofed housing exists • Cattle corridor	• Needs iron/tile roof • Need training on how to construct • Expensive for below average farmer
	Ekiryotozi valley tank	• Use mainly local materials(clay, sand, gravel) • Big storage (10,000m^3) • Adequate rainfall • Good soil (clay)properties in valleys	• Cattle corridor • In all AEZ	• Expensive for communities with below average income • Water borne diseases • Requires good maintenance • Requires Good land management in catchment area
Community Small scale irrigation	Mr.Sembusi Richard's gravity irrigation system	• Cheap to construct and operate • Available streams/rivers in most parts of country	• Mountainous areas • In all AEZ	• Requires difference in elevation between field and water source • Permanent source of water
Public Private Large scale irrigation	Doho rice scheme	• Plenty of wet lands/stream, especially in the eastern part of Uganda • Available technology	• Where there are wetlands	• Requires good water control especially during floods
	Tilda (Kimbimba) rice scheme	• Plenty of wet lands/stream, especially in the eastern part of Uganda • Available technology	• Where there are wetlands	• Requires good water control especially during floods

9.0 Potential Cooperation between National Stakeholders for Field Level Demonstration

There are number of institutions/stakeholders in Uganda that have high potential for cooperation in field level demonstration of best practices. Table 13 gives their addresses, strengths or specialisations and mandates.

Table 13: List of Potential Cooperating National Stakeholders/Institutions for field level demonstration of best practices

Stakeholders/ Institution	Address	Mandate	Strength/specialisation	Facilities
Depart of Agricultural Engineering, Makerere University	P. O. Box 7062, Kampala Uganda. Contact person: Michael Iwadra miwadra@agric.mak.ac.ug miwadra@yahoo.co.uk tel. +256-0772-446325	Train, carry out research and outreach in Agricultural Engineering (including irrigation and water harvesting}	• More than 6 members of staff with post graduate degrees in soil and water and environment engineering. • Specialisations: irrigation, water, water quality, EIA,	• Sprinkler and drip irrigation system • Family drip system • Valley dam reservoir • Water quality test equipment • Surveying equipment • Computer lab • Workshop • Soil survey equipment and lab facilities
Agricultural Engineering and Appropriate Technology Research Institute (AEATRI), Namalere, NARO	Agricultural Engineering and Appropriate Technology Research Institute P. O. Box 7144, Kampala Tel/Fax: 041-566161 E-mail: aeatri@starcom.co.ug	Carry out research and out reach in agricultural engineering	• At least two members of staff with post graduate degrees in soil and water engineering • Specialisations: hydropower, irrigation and water	• Family drip system • Treadle pumps • Roof water harvesting structure • Workshop
Uganda rainwater Association (URWA)	Plot 15, Stretcher Road Ntinda, P.O. Box 34209 Kampala, Uganda urrwa@infocom.co.ug urwa@searnet.org tel.+256-0414-285654 +256-0312-276766	Promotion of rainwater management and strengthen the capacity of members to implement rainwater harvesting activities	• Experience in water harvesting • Networking • Training • Advocacy	• Office space • Vehicles • Computers • Video equipment
Uganda Water And Sanitation NGO Network (UWASNET)	Plot 475 Butabika road, Luzira, P.O Box 33396, Kampala, Uganda ngocoord@uwasnet.org +256- 41- 223135 +256-772- 617710	To promote partnership between NGOs and other sector stakeholders in water and sanitation sector in Uganda and to contribute to the development and implementation of sector policies, strategies and guidelines	• Nation wide structures in place • Good networking capacity • Well funded	• Office space • Vehicles • Computers
Ministry of Agriculture Animal Industry	P. O. Box 102 Entebbe Uganda Tel.+256 41	Support, promote and guide the production of crops, livestock and	• Nation wide structures in place • Good networking	• Office space • Vehicles • Computers

and Fisheries(MAAIF)	320841/320981	fisheries so as to ensure improved quality and quantity of agricultural produce and products for domestic consumption, food security and export	capacity • Well funded	
Directorate of Water Development (DWD)	22/28 Port Bell Road, Luzira. P. O. Box 20026 Kampala, Uganda Tel. +256- 41- 505945	Promote co-ordinated, integrated and sustainable water resources and provision of water for all social and economic activities.	• Nation wide structures in place • Good networking capacity • Well funded • Water engineers	• Office space • Vehicles • Computers
Kyera farm	Birere Sub county, Isingiro District, P. O. Box 1577 Mbarara kftcmba@yahoo.com Tel. +256-772-540139/464659	To train community members in low cost technologies of roof water harvesting and promote integration of sanitation and rainwater harvesting programme in the district and promote sustainable organic farming	• Experience • Qualified staff • Good network with other organisations	• Rain water tank construction equipment • Training facility
Tilda (Kimbimba) Rice scheme	P.O. Box 23019 Kampala, Uganda Tel. +256-41-4250000.	To sustain ably produce rice for commercial purpose	• Good business experience • Qualified staff • Good organisations	• Workshop • Infrastructure for paddy rice

10.0 Conclusions and Recommendations

As can be seen from table 10, the best roof water harvesting is FCT and valley tank for on stream surface runoff harvesting. These technologies are mainly used in the pastoral AEZ where there is acute water shortage for both domestic use and animal watering during the dry season. These technologies are relatively cheaper to install and manage than similar category technologies. The cost of construction can be recovered in one year. The FCT technology effectively solves the problem of water shortage for domestic and backyard irrigation. As a result the farmers have adopted the technology. The conditions for replication of the technologies can be seen in table 12.

Women have to walk several km to fetch water for domestic use and the cost of water can go beyond $0.3 per 20 litres. Cattle keepers have to walk several km in search of water and times crossing international boundaries. There are reports of death of animals and severe drop in milk production due to drought. A lot of time, which could otherwise have been used productively elsewhere is spent in looking for water. The water in most cases is of poor quality and its continued use can lead to a prevalence of water borne diseases.

Due to the fact that farmers can produce at least one crop or two per year using rain fed agriculture, irrigation development is rather low in Uganda although the need for irrigation is becoming increasingly serious due to unreliable rainfall and the effect of global warming. Farmers can have in most cases some harvest though this harvest could be increased by 50% or 100% or more if supplemental irrigation was used. Most farmers are not aware of the benefit of irrigated agriculture or they consider it to be too expensive. Paddy rice is the most commonly practised irrigation in Uganda in the wetlands of the east. The drier areas such as the pastoral AEZ and the western rift valley also practice irrigation to some extent.

As can be seen from tables 11, A4 and A5 the best irrigation practice is the paddy rice and gravity. Although these practices are not so good in relation to some criteria such as water use efficiency, they have been found t to excel due to high profitability, affordability and adoptability by the communities.

Apart from guidelines developed by WID for smallholder paddy rice cultivation in seasonal wetlands and guidelines for wetland edge gardening, there are no national guide lines for rainwater harvesting and irrigation.

Therefore, the development of National guidelines for irrigation and water harvesting is very important. Applied research for demonstration of benefit of irrigated agriculture and for improvement of water use efficiency for the gravity systems is vital for increased and sustainable adoption of irrigation technology in Uganda. Research and demonstration of efficient and sustainable wetland resources utilisation for agricultural production is vital.

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Appendices

Table A1: Ranking of best practices/technologies for Rain Water Harvesting

Ranking of best practices/technologies

Ranking Criteria		Score	Valley dam	Valley tank	Pots, jars	Corrugated galvanized/plastic tanks	Ferro cement tanks	Brick masonry tanks	Subsurface masonry tanks	In-situ, internal and external storage for agriculture
			Technology							
Efficiency (water use, application), %	<30	1								
	30- 40	2								2
	40- 60	3								
	60-80	4	4	4						
	>80	5			5	5	5	5	5	
Estimated number of community members that adopt technology	<3	2	2			2			2	
	3 to 6	4						4		
	6 to 10	6			6					
	10 to 20	8		8			8			
	>20	10								10
Technical support	Strong	5								
	Slight	3	3	3	3	3	3	3	3	3
	No	1								
Affodability	Not affordable	1								
	Community	4	4			4				
	Individual	5		5	5		5	5	5	5
Cost	cheap	4			4					4
	fair	3				3	3	3	3	
	Average	2		2						
	High	1	1							
Spare parts availability	No	2								
	Yes, local, town	4	4	4		4			4	
	Yes, local	5			5		5	5		5
Operation and maintenace simplicity	Complex	1	1							
	Average	3		3					3	
	Simple	5			5	5	5	5		5
Level of solution to problem	Low	1			1					
	Average	8				8	8	8	8	8
	High	10	10	8						
		Total	29	37	34	34	42	38	33	42
		Rank	6	3	4	4	1	2	5	1

Table A2: Ranking of best practices/technologies for Irrigation

Ranking of best irrigation practices/technologies

			Irrigation Technology						
Ranking Criteria			Furrow	Basin	Sprinkler	Drip	Treaddle pump	Waterimng can/bucket	Gravity flow/flooding
		Score							
Efficiency (water use, application), %	<30	1							
	30- 40	2	2						2
	40- 60	3		3			3	3	
	60-80	4			4				
	>80	5				5			
Estimated number of community members that adopt technology	<3	2	2		2	2			2
	3 to 6	4					4	4	
	6 to 10	6							
	10 to 20	8		8					
	>20	10							
Technical support	Strong	5							
	Slight	3	3	3	3	3	3	3	3
	No	1							
Affodability	Not affordab	1							
	Community	4	4	4	4	4			4
	Individual	5					5	5	
Cost	cheap	4					4	4	
	fair	3	3	3					3
	Average	2							
	High	1			1	1			
Spare parts availability	No	2							
	Yes, local, town	4			4	4	4	4	4
	Yes, local	5	5	5					
Operation and maintenace simplicity	Complex	1							
	Average	3	3		3	3	3		3
	Simple	5		5				5	
Level of solution to problem	Low	1							
	Average	8							
	High	10	10	10	10	10	10	10	10
		Total	32	41	31	32	36	38	31
		Rank	4	1	5	4	3	2	5

Table A3: Ranking of best practice site for Rain water Harvesting

Criteria			Ranking of best Sites					
			Kyalulangira FCT	Kamubisi underground FCT	Kyanyanda open underground tank	Edward Kanyarutokye FTCT	Ekiryotozi VT	Kyamuyimba VT
		Score						
Water use efficiency,%	<30	1						
	30- 40	2						
	40- 60	3						
	60-80	4			4		4	4
	>80	5	5	5		5		
Yield increase/profits %	<40	1						
	40- 60	2						
	60- 80	3						
	80-100	4	4	4	4	4		4
	>100	5					5	
Number community members adopted technology	<3	1						
	3 to 6	2		2	2			
	6 to 10	3	3					
	10 to 20	4				4		
	>20	5					5	5
Water users association	no	0						
	weak	3	3	3	3	3		5
	strong	5					5	
Level of maintenance	poor	1						
	average	3		3	3			3
	good	5	5			5	5	
Envronment management	poor	1						
	average	3						
	good	5	5	5	5	5	5	5
Market for product	poor	1						
	seasonal	3						
	readily availabble	5	5	5	5	5	5	5
		Total	30	27	26	31	34	31
		Rank	3	4	5	2	1	2

Table A4: Ranking of best practice site for community Irrigation

Criteria		Score	Ranking of best Sites: Mr.Sembusi Richard Bulenge Village, Masaka	Mr. Mpinde Livingstone Katolerwa village	Palisa Paddy rice growers communities	Iganga Paddy rice growers communities	Tororo Paddy rice growers communities
Water use efficiency,%	<30	1			1	1	1
	30- 40	2	2	2			
	40- 60	3					
	60-80	4					
	>80	5					
Yield increase/profits %	<40	1					
	40- 60	2					
	60- 80	3			3	3	3
	80-100	4					
	>100	5	5	5			
Number community members adopted technology	<3	1		1			
	3 to 6	2	2				
	6 to 10	3					
	10 to 20	4					
	>20	5			5	5	5
Water users association	no/very weak	1		1	1	1	1
	weak	3					
	strong	5	5				
Level of maintenance	poor	1					
	average	3			3	3	3
	good	5	5	5			
Envronment management	poor	1					
	average	3			3	3	3
	good	5	5	5			
Market for product	poor	1					
	seasonal	3					
	readily availabbl	5	5	5	5	5	5
		Total	29	24	21	21	21
		Rank	1	2	3	3	3

Table A5: Ranking of best practice site for large scale Irrigation

			Ranking of best Sites								
Criteria			Mubuku	Kimbimba(Tilda)	Doho	Kiige	Ongom	Labori	Atera	Agoro	Olweny
		Score									
Water use efficiency,%	<30	1									
	30- 40	2	2		2	2	2	2	2	2	2
	40- 60	3		3							
	60-80	4									
	>80	5									
Yield increase/profits %	<40	1									
	40- 60	2									
	60- 80	3				3	3	3	3	3	3
	80-100	4	4		4						
	>100	5		5							
Number community members adopted technology	<3	1									
	3 to 6	2									
	6 to 10	3				3	3	3	3	3	
	10 to 20	4									
	>20	5	5	5	5						5
Water users association	no	0									
	weak	3	3	3	3	3	3	3	3	3	3
	strong	5									
Level of maintenance	poor	1	1			1	1	1	1	1	1
	average	3			3						
	good	5		5							
Envronment management	poor	1									
	average	3	3	3	3	3	3	3	3	3	3
	good	5									
Market for product	poor	1									
	seasonal	3									
	readily availabble	5	5	5	5	5	5	5	5	5	5
		Total	23	29	25	20	20	20	20	20	22
		Rank	3	1	2	5	5	5	5	5	4

Table A6: BQ for brick tanks

			BRICK MASONARY TANKS ABOVE THE GROUND												Tarpulin	
			FCT10M3		20M3		30M3		10M3		15M3		20m3		1.5m3	
Description	**Unit**	**Unit cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**
	Pc	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Tap	cu.m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Sand	tonne	10,000	3	30,000	4	40,000	4	40,000	4	40,000	6	60,000	6	60,000	1	10,000
Aggregate	tonne	20,000	1	20,000	1	20,000	2	40,000	3	60,000	3	60,000	3	60,000		-
Hardcore	tonne	25,000	2	50,000	3	75,000	4	100,000	4	100,000	5	125,000	4	100,000		-
Expanded metal	each	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	2	40,000		-
Eucalyptus poles, 3mlong	each	3,000	6	18,000	12	36,000	12	36,000	15	45,000	18	54,000	20	60,000	4	12,000
Reinforcement bars: 10mm dia	m	17,000	1	17,000	1	17,000	1	17,000	1	17,000	1	17,000	2	34,000		-
Cement	bag	25,000	8	200,000	10	250,000	12	300,000	21	525,000	25	625,000	28	700,000	2	50,000
Binding wire	kg	3,000	6	18,000	10	30,000	12	36,000	15	45,000	15	45,000	16	48,000	4	12,000
Nails: assorted	kg	3,500	1	1,750	1	3,500	15	52,500	1	3,500	1	3,500	1	3,500	1	3,500
GI pipe, 2" dia	m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000		-
GI pipe, 0.5" dia	m	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000
HDPE pipe, 2.5" dia	m	3,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500		-
GI bend, 0.5" dia	each	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500		-
GI end cap, 2" dia	each	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500		-
chicken mash	roll	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000		-
Gutters	sheet	10,000	2	20,000	4	40,000	4	40,000	10	100,000	10	100,000	10	100,000	2	20,000
Plastict sheetiing	metre	3,000	2	6,000	4	12,000	4	12,000	6	18,000	6	18,000	6	18,000	2	6,000
Down pipe	piece	10,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000
Sisal	roll	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000
Gunny Bags		1,000	6	6,000	10	10,000	16	16,000	20	20,000	22	22,000	25	25,000	2	2,000
Water proof cement	kg	2,500	8	20,000	10	25,000	12	30,000	18	45,000	22	55,000	25	62,500		-
Ring wire	pipes	3,000	6	18,000	8	24,000	15	45,000	20	60,000	30	90,000	30	90,000		-
Plain wire	roll	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	2	120,000		-
Coffe Mesh	metre	5,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	3	15,000
				636,250		**794,000**		**976,000**		**1,290,000**		**1,486,000**		**1,652,500**		**175,500**
Skilled Labour	manday	8,000	7	56,000	7	56,000	7	56,000	7	56,000	7	56,000	7	56,000	5	40,000
Helpers	manday	6,000	10	60,000	3	18,000	3	18,000	3	18,000	3	18,000	3	18,000	4	24,000
Transport	trips	60,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	1	60,000
				296,000		**254,000**		**254,000**		**254,000**		**254,000**		**254,000**		**124,000**
				932,250		**1,048,000**		**1,230,000**		**1,544,000**		**1,740,000**		**1,906,500**		**299,500**
Without Local materials				**835,250**		**904,000**		**1,035,000**		**1,316,000**		**1,476,000**		**1,658,500**		**282,500**
Without local materials and labour				**539,250**		**650,000**		**781,000**		**1,062,000**		**1,222,000**		**1,404,500**		**158,500**

Table A7: BQ for surface tanks

							FERRO CEMENT TANKS ABOVE THE GROUND							
			FCT4M3		6M3		7.5M3		10M3		15M3		20m3	
Description	**Unit**	**Unit cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**
Basin	Pc	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Tap	cu.m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Sand	tonne	10,000	3	30,000	4	40,000	4	40,000	4	40,000	6	60,000	6	60,000
Aggregate	tonne	20,000	1	20,000	1	20,000	2	40,000	3	60,000	3	60,000	3	60,000
Hardcore	tonne	25,000	2	50,000	3	75,000	4	100,000	4	100,000	5	125,000	4	100,000
Expanded metal	each	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	2	40,000
Welded mesh(BRC)	piece	200,000	1		1		1		1	200,000	1	200,000	1	200,000
Eucalyptus poles, 3mlong	each	3,000	6	18,000	12	36,000	12	36,000	15	45,000	18	54,000	20	60,000
Reinforcement bars: 10mm d	m	17,000	1	17,000	1	17,000	1	17,000	1	17,000	1	17,000	2	34,000
Cement	bag	23,000	8	184,000	10	230,000	12	276,000	21	483,000	25	575,000	28	644,000
Binding wire	kg	3,000	6	18,000	10	30,000	12	36,000	15	45,000	15	45,000	16	48,000
Nails: assorted	kg	3,500	1	1,750	1	3,500	15	52,500	1	3,500	1	3,500	1	3,500
GI pipe, 2" dia	m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
GI pipe, 0.5" dia	m	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000
HDPE pipe, 2.5" dia	m	3,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500
GI bend, 0.5" dia	each	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
GI end cap, 2" dia	each	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500
chicken mash	roll	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000
Gutters	sheet	10,000	2	20,000	4	40,000	4	40,000	10	100,000	10	100,000	10	100,000
Plastict sheetiing	metre	3,000	2	6,000	4	12,000	4	12,000	6	18,000	6	18,000	6	18,000
Down pipe	piece	10,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000
Sisal	roll	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000
Gunny Bags		1,000	6	6,000	10	10,000	16	16,000	20	20,000	22	22,000	25	25,000
Water proof cement	kg	2,500	8	20,000	10	25,000	12	30,000	18	45,000	22	55,000	25	62,500
Ring wire	pipes	3,000	6	18,000	8	24,000	15	45,000	20	60,000	30	90,000	30	90,000
Plain wire	roll	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	2	120,000
Coffe Mesh	metre	5,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000
				620,250		**774,000**		**952,000**		**1,448,000**		**1,636,000**		**1,796,500**
Skilled Labour	manday	8,000	7	56,000	7	56,000	7	56,000	7	56,000	7	56,000	7	56,000
Helpers	manday	6,000	10	60,000	3	18,000	3	18,000	3	18,000	3	18,000	3	18,000
Transport	trips	60,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000
				296,000		**254,000**		**254,000**		**254,000**		**254,000**		**254,000**
Total				**916,250**		**1,028,000**		**1,206,000**		**1,702,000**		**1,890,000**		**2,050,500**
Without Local materials				**809,250**		**874,000**		**1,001,000**		**1,264,000**		**1,416,000**		**1,592,500**
Without local materials and labour				**513,250**		**630,000**		**763,000**		**1,030,000**		**1,184,000**		**1,363,500**

Table A8: BQ for underground FCT

			FERRO CEMENT TANKS UNDER THE GROUND										
			FCT10M3		15M3		20M3		40M3		50M3		
Description	**Unit**	**Unit cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**
Sand	tonne	10,000	3	30,000	4	40,000	4	40,000	4	40,000	6	60,000	6
Aggregate	tonne	20,000	2	40,000	2	40,000	3	60,000	4	80,000	4	80,000	5
Hardcore	tonne	25,000	2	50,000	3	75,000	4	100,000	4	100,000	5	125,000	4
Expanded metal	each	20,000	2	40,000	2	40,000	3	50,000	3	60,000	3	60,000	4
Eucalyptus poles, 3mlong	each	3,000	6	18,000	12	36,000	12	36,000	15	45,000	18	54,000	20
Reinforcement bars: 10mm dia	m	17,000	1	17,000	1	17,000	1	17,000	1	17,000	1	17,000	2
Cement	bag	25,000	8	200,000	14	350,000	15	375,000	35	875,000	40	1,000,000	70
Binding wire	kg	3,000	6	18,000	10	30,000	12	36,000	15	45,000	15	45,000	16
Nails: assorted	kg	3,500	1	1,750	1	3,500	15	52,500	1	3,500	1	3,500	1
HDPE pipe, 2" dia	m	3,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500	3
chicken mash	roll	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1
Gutters	sheet	10,000	2	20,000	4	40,000	4	40,000	10	100,000	10	100,000	10
Plastict sheetiing	metre	3,000	2	6,000	4	12,000	4	12,000	6	18,000	6	18,000	6
Down pipe	piece	10,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2
Water proof cement	kg	2,500	8	20,000	14	35,000	15	37,500	35	87,500	40	100,000	70
Ring wire	pipes	3,000	6	18,000	8	24,000	15	45,000	20	60,000	30	90,000	30
Coffe Mesh	metre	5,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	2
				569,250		**833,000**		**991,500**		**1,621,500**		**1,843,000**	
Skilled Labour	manday	8,000	12	96,000	15	120,000	17	136,000	20	160,000	22	176,000	30
Helpers	manday	6,000	12	72,000	15	90,000	17	102,000	3	18,000	3	18,000	3
Transport	trips	60,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	3
				348,000		**390,000**		**418,000**		**358,000**		**374,000**	
Total				**917,250**		**1,223,000**		**1,409,500**		**1,979,500**		**2,217,000**	
Without Local materials				**809,250**		**1,072,000**		**1,213,500**		**1,754,500**		**1,958,000**	
Without local materials and labour				**461,250**		**682,000**		**795,500**		**1,396,500**		**1,584,000**	

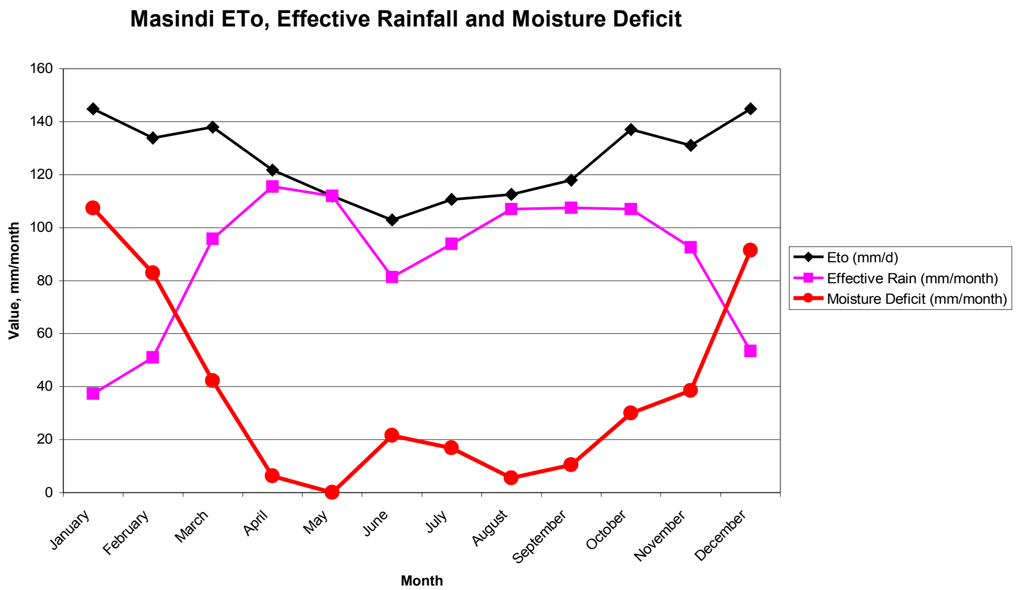


Figure A4: ETo, Effective Rainfall and Moisture Deficit in AEZ 2

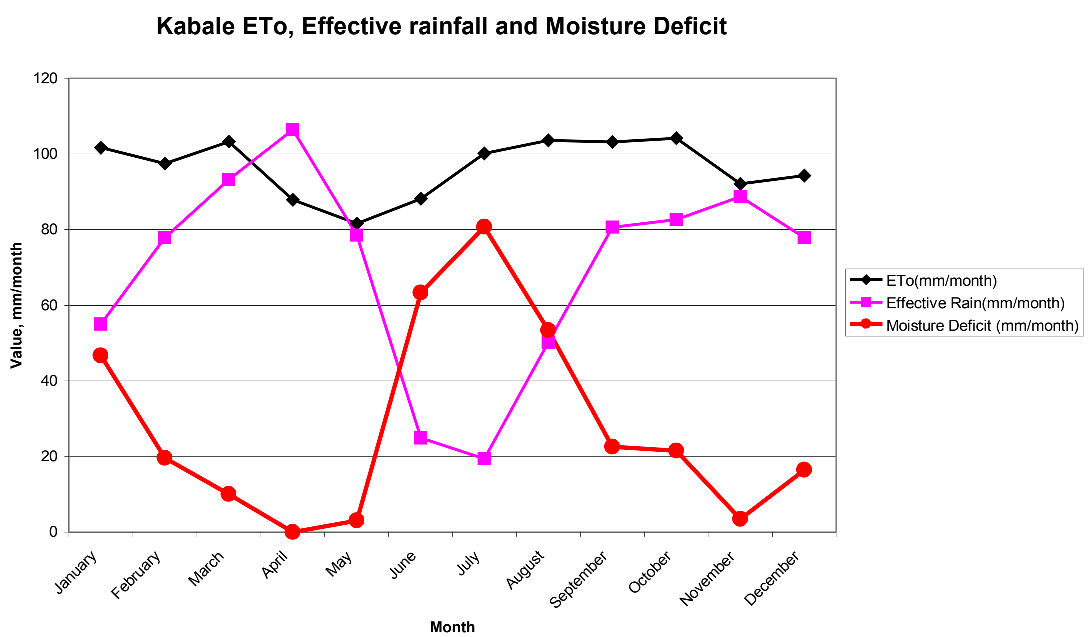


Figure A5: ET_o, Effective Rainfall and Moisture Deficit in AEZ 3

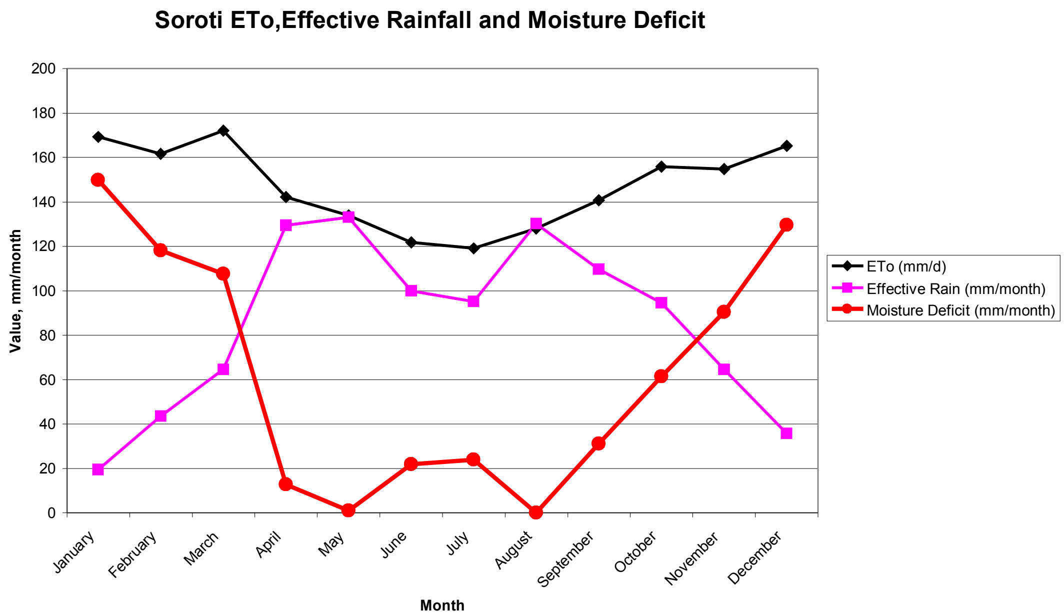


Figure A6: ET_o, Effective Rainfall and Moisture Deficit in AEZ 4

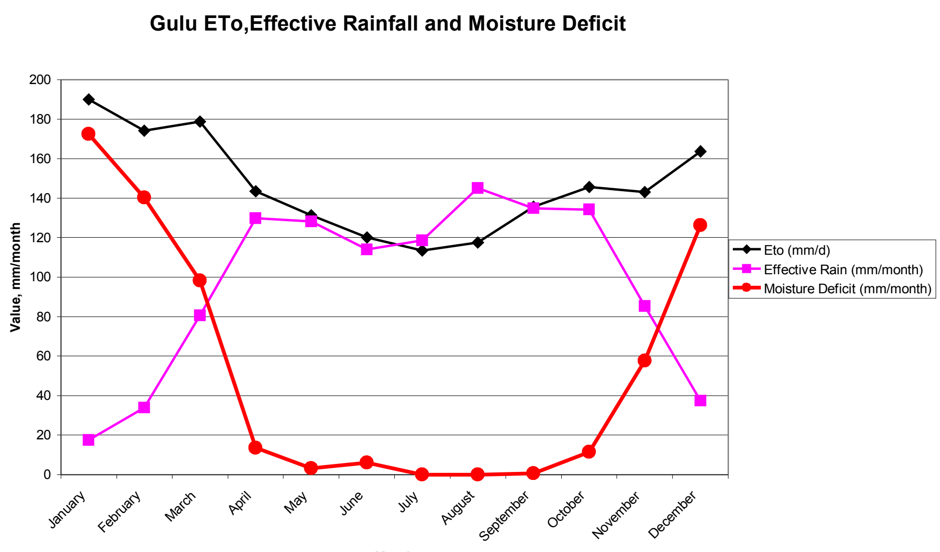


Figure A7: ET_o,Effective Rainfall and Moisture Deficit in AEZ 5

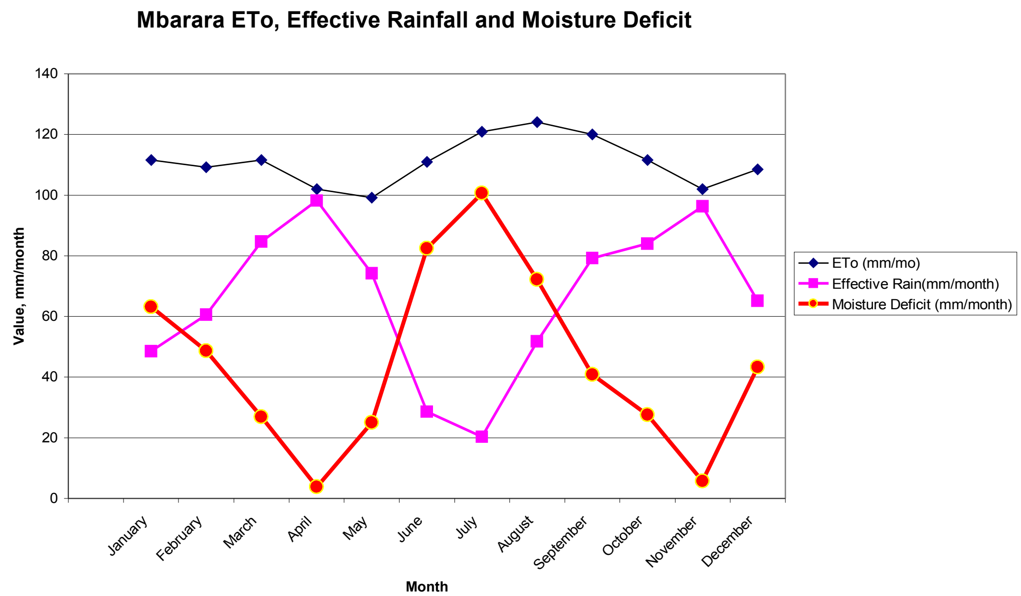


Figure A8: ET_o, Effective Rainfall and Moisture Deficit in AEZ 6

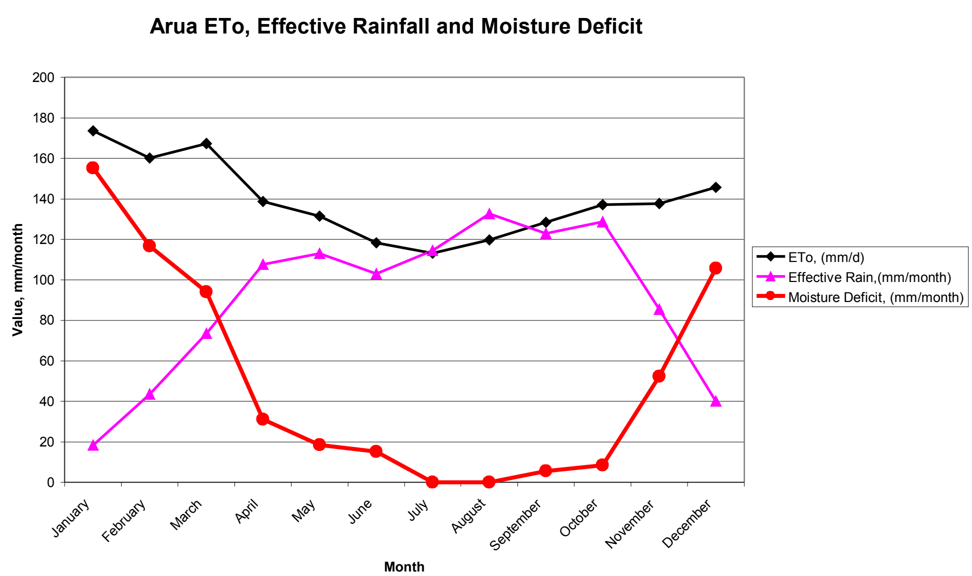
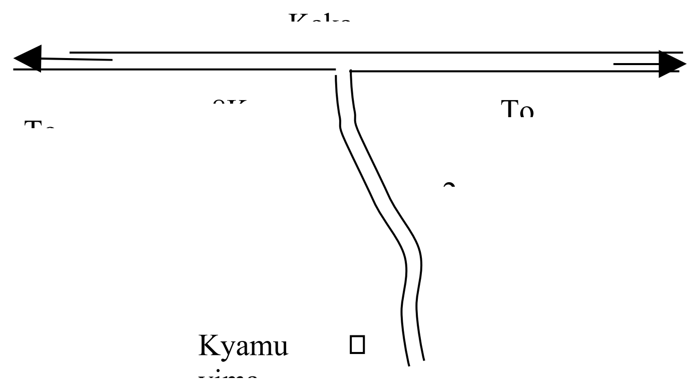


Figure A9: ET_o, Effective Rainfall and Moisture Deficit in AEZ 7

Appendix

Rain Water Harvesting in Kyamuyimba

Date of Visit 05/12/07	Category: Runoff Water Harvesting , valley tank (open pond)
Name of Site: Kyamuyimmba	Either water Harvesting; Community Irrigation or Private Public Irrigation
	Sketch Map of Site 
Geographic location of practice:Luwero district, Kamira sub county, Kymuyimba	
(GPS) Coordinates: 36N 444675 E, 0106454N, Elv. 1,063m	
Description of the Community: The facility serves about 30 house holds (200 people) and up to 10,000 heard of cattle in the dry season. Domestic water is collected by women and children	
Characteristics of the area: gently sloping, mixed farming	
Climate (AEZ) + Description: Pastoral system	
Average annual rainfall (mm) 900	
Months of Short Rains:	
Months of Main Rains:	August, September, October, November
Mean annual ref. crop Evapotranspiration (mm):1,400	
Predominant soil type:	Medium
Topography:	rolling plateau
Slope:	gentle slopes
Erosion:	low
Period of year during which used: dry season	
Period of year during which benefits utilized: all year round	
Water Source: rainfall runoff	
Cultivated area:	

Technical Description: The community with the help of the district and DWD staff identified the site and constructed the valley dam in 2004 in order to solve the problem of acute water shortage for cattle and humans, especially during the dry season. DWD provided the funds. It was designed Kagga Engineers and constructed with participation of community members especially in provision of employed labor. The structure is made up of an excavated reservoir measuring 70* 35* 4 m (≈10,000m3), an in let which is well vegetated, a spillway and treadle pumps connecting the reservoir to watering troughs located downstream outside the fence of the protected valley tank. The reservoir is fenced with barbed wire and vegetation to keep away humans and cattle from accessing the water directly thereby polluting the water and damaging the structures. The community and the cattle access water through the treadle pumps. The community uses the water for domestic use and for watering of animals. They boil the water for dri	
Technical Details: The hydrological studies were carried out by WEGS consultants and the design by Kagga engineers on behalf of DWD. The hydrological and design reports are available at DWD office in Kampala.	
Useful in: It is good water source for animals in areas which experience prolonged dry seasons. However, the rainy season preceding the dry season must have enough rainfall to generate enough runoff to be harvested and stored in the reservoir. The sites should have sufficient catchment area to generate the required runoff. Also land management in the catchment must be good(soil and water conservation ,good land cover, no over grazing, etc)	**Limitations**: Siltation is high if catchment area is degraded. Siltation fills up the reservoir and limits the useful life of the reservoir. Soil and geological conditions which lead to excessive seepage losses limits amount of useful water stored. Amount of rainfall and size of catchment area can be a serious limitation.
Geographical extent of use: In Uganda in the cattle corridor, the pastoral system AEZ. In the Nile Basin it can be used in the pastoral dry areas where rainfall is adequate for harvesting.	Effectiveness: The water users association is not active and effective in operation and maintenance the facility. The community no longer suffers from water shortage during the dry season but the community doesn't feel like it really owns the facility. It is is a government initiated project with limited community participation.
Other Sites where used: All over the cattle corridor	
Cost: The facility cost Sh. 100,000,000/= ($60,000). The sources of funding were DWD. The community contributed in provision of paid labor and local materials. ($1 = Sh. 1,700/=.)	**Operation and Maintenance arrangements**: The facility is operated and maintained by the community through the water users committee. The committee collects fee from members when ever there is need for repair and members also provide labor for maintenance. But the committee isn't so effective. For example they have failed to repair damaged treadle pumps.
Benefits: Before construction of the valley tank, the community members had to travel several km in search of water for their animals during the dry season. Now they have reliable water source nearby.	**Water User Association or User Group**: There is a water committee comprising of seven members in place. The Chair person is the LC III chair man. They collect money from pastoralists who bring their animals for watering. The pastoralist pay Sh, 300/= ($0.2) per heard of cattle per season. This money is supposed to be used for maintenance of the Facility. However, damaged treadle pumps have not been repaired.

Stakeholders and beneficiaries: The beneficiaries are the community members. The GoU through DWD is the funder of the facility. The objective is to provide water during the dry season when there is acute water shortage. The community is responsible for O&M. The facility so far has achieved its objectives but management has to be improved for sustainability. Who are the main beneficiaries	**Enabling Environment:** The GoU has a plan for modernization of agriculture (PMA). In this plan provision of water for animals and irrigation is an important element. Therefore GoU supports such projects. beneficiary involvement demand based interventions
Training support: The Community members who participated in the construction of the valley tank got on job training	Extension support: . District Agriculture Office and Water Office provide extension support.
Environment benefits: The inlet is heavily vegetated and this helps to filter eroded soil particles carried in the runoff. The water which enters the reservoir is relatively clean. Pollution of water source through direct access by humans and animals has been avoided by fencing and provision of treadle pump and watering troughs out side the fence. Water wastage is also minimized by use of treadle pump. Water is available all year round. Sustainability economic aspects cultural environmental aspects technical	**Social/Cultural acceptability**: Facility is highly acceptable socially and culturally. Women and children can also use the facility without any hindrance
Advantages: The demand for water is high and therefore the community has vested interest in the success and sustainability of the facility. The community is involved in operation and maintenance. There is a water users committee in place to ensure proper operation and maintenance of the facility.	**Disadvantages**: There is possibility of increased water borne diseases as the water provides good breeding ground for the carriers and pathogens. Excessive soil erosion in the catchment area reduces the life span drastically.
Scaling Up: Conditions for replicability include: adequate amount of rainfall, enabling soil and geological conditions, high demand for water which results into community commitment in construction, operation and maintenance; also adequate income of community members so that they can contribute financially, apart from labour contribution.	What is potential for applying all/parts of initiative elsewhere? (Score from 1 to 10 on list below with 10 being highly

		applicable)
		I [9] Transfer of practice to another group/culture/land-use system, etc.
		II [10] Easy to transfer the practice, but with minor adaptations for local conditions
		III [8] Transfer possible, but significant modifications/prerequisites to consider.
		IV [3] Difficult to transfer the practice. Need experienced support.
		V [0] It would be impossible to transfer the practice. Too site specific.
		Other specific remarks: (e.g., agreements, regulations, provisions regarding Intellectual Property Rights, etc.)
Best Practices: The water user's committee is in place. The quality of water from the shallow well water use efficiency is relatively much better than from similar facilities without treadle pump. The facility has been fulfilling its objective of provision of water for domestic and animal watering		
Contact Organization: Luwero District Agricultural/Water Office		
Type of organization:	Contact person: Mr.Okwir Emmanuel, District Agricultural mechanization Officer	
[ ] government organization	Contact details	
[ ] private organization		
[ ] NGO &/or CBO		
[ ] international agency		
[ ] other:		
Lessons learnt: (at various stages of the realization of the works, describe any lessons learnt that would improve upon future similar interventions)		
Planning: Demand driven projects and beneficiary involvement leads to success in planning and implementation.		
Design Community involvement leads to ownership and acceptance of the design		
Construction Labour contribution by community reduces cost of construction. But in this case, the community offered paid labor and therefore their sense of ownership is not that high		
Implementation Community participation leads to real ownership of facility by community		
O&M For sustainability, the community must be given basic training on O&M and be given the responsibility.		
Beneficiary involvement is a must for success		
Realization of benefits: Such as markets; achieving better returns - crop selection &/or market linkages etc).		
Other Remarks or observations:		
Contact person completing form:Michael Iwadra		
Contact details Department of Agricultural Engineering, Makerere University, P.O.Box 7062 Kampala, Uganda. Tgel.+256-772-446325. e-mail: miwadra@agric.mak.ac.ug		

Legend for Water harvesting schemes	
1. Open Pond - excavated in natural conditions	
2. Haffir/ crescent shaped dam/Water Ponds/Pans	
3. Small Dam - earth embankment	
4. Sub-Surface Dam	
5. Sand Dam	

6. Well - shallow hand dug - with SSI		
7. Well - Deep hand dug - with SSI		
8. Spring Development for SSI and/or other uses		
9. Roof Water Harvesting (Domestic Use)		
10. Runoff Water Harvesting (Domestic Use)		
11. Runoff Water Harvesting (Agricultural/Homestead Use)		
12. Rock and other surface catchment systems		
13. River water harvesting (diversions) for small scale irrigation		
14. Spate Irrigation		
15. Recharge Structures		
16. Insitu Water harvesting Measures/ Soil and Water Conservation techniques on arable rainfed lands		a. Conservation tillage
		b. Planting Pits
		c. Katumani Pit
		d. Semi-Circular Bunds
		e. Negarim
		f. Tied Contour ridges
		g. Contour Stone Bunds
		h. Fanya Juu
		i. Earth Bunds with external catchment
		j. Contour ridges with external catchment

BOQ: Construction of Ferro Cement Tanks above the Ground

															Rain Jar	
			FCT4M3		6M3		7.5M3		10M3		15M3		20m3		1.5m3	
Description	**Unit**	**Unit cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**
Basin	Pc	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Tap	cu.m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Sand	ton	10,000	3	30,000	4	40,000	4	40,000	4	40,000	6	60,000	6	60,000	1	10,000
Aggregate	ton	20,000	1	20,000	1	20,000	2	40,000	3	60,000	3	60,000	3	60,000		-
Hardcore	ton	25,000	2	50,000	3	75,000	4	100,000	4	100,000	5	125,000	4	100,000		-
Expanded metal	each	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	2	40,000		-
Welded mesh(BRC)	piece	200,000	1		1		1		1	200,000	1	200,000	1	200,000		-
Eucalyptus poles, 3mlong	each	3,000	6	18,000	12	36,000	12	36,000	15	45,000	18	54,000	20	60,000	4	12,000
Reinforcement bars: 10mm dia	m	17,000	1	17,000	1	17,000	1	17,000	1	17,000	1	17,000	2	34,000		-
Cement	bag	23,000	8	184,000	10	230,000	12	276,000	21	483,000	25	575,000	28	644,000	2	46,000
Binding wire	kg	3,000	6	18,000	10	30,000	12	36,000	15	45,000	15	45,000	16	48,000	4	12,000
Nails: assorted	kg	3,500	1	1,750	1	3,500	15	52,500	1	3,500	1	3,500	1	3,500	1	3,500
GI pipe, 2" dia	m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000		-
GI pipe, 0.5" dia	m	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000
HDPE pipe, 2.5" dia	m	3,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500		-
GI bend, 0.5" dia	each	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500		-
GI end cap, 2" dia	each	4,50		4,50	1	4,50		4,50	1	4,50	1	4,50	1	4,5		

		0	1	0		0	1	0		0		0		00		-
chicken mash	roll	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000		-
Gutters	sheet	10,000	2	20,000	4	40,000	4	40,000	10	100,000	10	100,000	10	100,000	2	20,000
Plastic sheeting	metre	3,000	2	6,000	4	12,000	4	12,000	6	18,000	6	18,000	6	18,000	2	6,000
Down pipe	piece	10,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000
Sisal	roll	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000
Gunny Bags		1,000	6	6,000	10	10,000	16	16,000	20	20,000	22	22,000	25	25,000	2	2,000
Water proof cement	kg	2,500	8	20,000	10	25,000	12	30,000	18	45,000	22	55,000	25	62,500		-
Ring wire	pipes	3,000	6	18,000	8	24,000	15	45,000	20	60,000	30	90,000	30	90,000		-
Plain wire	roll	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	2	120,000		-
Coffe Mesh	metre	5,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	3	15,000
				620,250		**774,000**		**952,000**		**1,448,000**		**1,636,000**		**1,796,500**		**171,500**
Skilled Labour	Monday	8,000	7	56,000	7	56,000	7	56,000	7	56,000	7	56,000	7	56,000	5	40,000
Helpers	Monday	6,000	10	60,000	3	18,000	3	18,000	3	18,000	3	18,000	3	18,000	4	24,000
Transport	trips	60,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	1	60,000
				296,000		**254,000**		**254,000**		**254,000**		**254,000**		**254,000**		**124,000**
Total				**916,250**		**1,028,000**		**1,206,000**		**1,702,000**		**1,890,000**		**2,050,500**		**295,500**
Without Local materials				**809,250**		**874,000**		**1,001,000**		**1,264,000**		**1,416,000**		**1,592,500**		**268,500**
Without local materials and labour				**513,250**		**630,000**		**763,000**		**1,030,000**		**1,184,000**		**1,363,500**		**146,500**

BRICK MASONARY TANKS ABOVE THE GROUND															Tarpulin	
			FCT10M3		20M3		30M3		10M3		15M3		20m3		1.5m3	
Description	**Unit**	**Unit cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**
	Pc	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Tap	cu.m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Sand	ton	10,000	3	30,000	4	40,000	4	40,000	4	40,000	6	60,000	6	60,000	1	10,000
Aggregate	ton	20,000	1	20,000	1	20,000	2	40,000	3	60,000	3	60,000	3	60,000		-
Hardcore	ton	25,000	2	50,000	3	75,000	4	100,000	4	100,000	5	125,000	4	100,000		-
Expanded metal	each	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	2	40,000		-
Eucalyptus poles, 3mlong	each	3,000	6	18,000	12	36,000	12	36,000	15	45,000	18	54,000	20	60,000	4	12,000
Reinforcement bars: 10mm dia	m	17,000	1	17,000	1	17,000	1	17,000	1	17,000	1	17,000	2	34,000		-
Cement	bag	25,000	8	200,000	10	250,000	12	300,000	21	525,000	25	625,000	28	700,000	2	50,000
Binding wire	kg	3,000	6	18,000	10	30,000	12	36,000	15	45,000	15	45,000	16	48,000	4	12,000
Nails: assorted	kg	3,500	1	1,750	1	3,500	15	52,500	1	3,500	1	3,500	1	3,500	1	3,500
GI pipe, 2" dia	m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000		-
GI pipe, 0.5" dia	m	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000
HDPE pipe, 2.5" dia	m	3,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500		-
GI bend, 0.5" dia	each	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500		-
GI end cap, 2" dia	each	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500		-
chicken mash	roll	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000		-
Gutters	sheet	10		20		40		40,		10	1	100	1	10		20,

		,000	2	,000	4	,000	4	000	10	0,000	0	,000	0	0,000	2	000
Plastic sheetiing	metre	3 ,000	2	6 ,000	4	1 2,000	4	12 ,000	6	1 8,000	6	18 ,000	6	1 8,000	2	6, 000
Down pipe	piece	10 ,000	2	20 ,000	2	20 ,000	2	20, 000	2	20 ,000	2	20, 000	2	20 ,000	2	20, 000
Sisal	roll	3 ,000	1	3 ,000	1	3,000	1	3 ,000	1	3,000	1	3 ,000	1	3,000	1	3, 000
Gunny Bags		1,000	6	6 ,000	10	1 0,000	16	16 ,000	20	20 ,000	2 2	22, 000	2 5	25 ,000	2	2, 000
Water proof cement	kg	2 ,500	8	20 ,000	10	25 ,000	12	30, 000	18	45 ,000	2 2	55, 000	2 5	62 ,500		-
Ring wire	pipes	3 ,000	6	1 8,000	8	24 ,000	15	45, 000	20	60 ,000	3 0	90, 000	3 0	90 ,000		-
Plain wire	roll	60, 000	1	60 ,000	1	60 ,000	1	60, 000	1	60 ,000	1	60, 000	2	12 0,000		-
Coffe Mesh	metre	5 ,000	2	1 0,000	2	1 0,000	2	10 ,000	2	1 0,000	2	10 ,000	2	1 0,000	3	15 ,000
				636,250		**794,000**		**976,000**		**1,290,000**		**1,486,000**		**1,652,500**		**175,500**
Skilled Labour	manday	8 ,000	7	56 ,000	7	56 ,000	7	56, 000	7	56 ,000	7	56, 000	7	56 ,000	5	40, 000
Helpers	manday	6 ,000	10	60 ,000	3	1 8,000	3	18 ,000	3	1 8,000	3	18 ,000	3	1 8,000	4	24, 000
Transport	trips	60, 000	3	180 ,000	3	18 0,000	3	180 ,000	3	18 0,000	3	180 ,000	3	18 0,000	1	60, 000
				296,000		**254,000**		**254,000**		**254,000**		**254,000**		**254,000**		**124,000**
				932,250		**1,048,000**		**1,230,000**		**1,544,000**		**1,740,000**		**1,906,500**		**299,500**
Without Local materials				**835,250**		**904,000**		**1,035,000**		**1,316,00 0**		**1,476,000**		**1,658,500**		**282,500**
Without local materials and labour				**539,250**		**650,000**		**781,000**		**1,062,000**		**1,222,000**		**1,404,500**		**158,500**

Construction of Ferro Cement Tanks under the Ground

			FCT10M3		15M3		20M3		40M3		50M3		90m3	
Description	**Unit**	**Unit cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**
Sand	ton	10,000	3	30,000	4	40,000	4	40,000	4	40,000	6	60,000	6	60,000
Aggregate	ton	20,000	2	40,000	2	40,000	3	60,000	4	80,000	4	80,000	5	100,000
Hardcore	ton	25,000	2	50,000	3	75,000	4	100,000	4	100,000	5	125,000	4	100,000
Expanded metal	each	20,000	2	40,000	2	40,000	3	50,000	3	60,000	3	60,000	4	80,000
Eucalyptus poles, 3mlong	each	3,000	6	18,000	12	36,000	12	36,000	15	45,000	18	54,000	20	60,000
Reinforcement bars: 10mm dia	m	17,000	1	17,000	1	17,000	1	17,000	1	17,000	1	17,000	2	34,000
Cement	bag	25,000	8	200,000	14	350,000	15	375,000	35	875,000	40	1,000,000	70	1,750,000
Binding wire	kg	3,000	6	18,000	10	30,000	12	36,000	15	45,000	15	45,000	16	48,000
Nails: assorted	kg	3,500	1	1,750	1	3,500	15	52,500	1	3,500	1	3,500	1	3,500
HDPE pipe, 2" dia	m	3,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500
chicken mash	roll	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000
Gutters	sheet	10,000	2	20,000	4	40,000	4	40,000	10	100,000	10	100,000	10	100,000
Plastic sheetiing	metre	3,000	2	6,000	4	12,000	4	12,000	6	18,000	6	18,000	6	18,000
Down pipe	piece	10,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000
Water proof cement	kg	2,500	8	20,000	14	35,000	15	37,500	35	87,500	40	100,000	70	175,000

Ring wire	pipes	3,000	6	18,000	8	24,000	15	45,000	20	60,000	30	90,000	30	90,000
Coffe Mesh	metre	5,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000
				569,250		**833,000**		**991,500**		**1,621,500**		**1,843,000**		**2,709,000**
Skilled Labour	manday	8,000	12	96,000	15	120,000	17	136,000	20	160,000	22	176,000	30	240,000
Helpers	manday	6,000	12	72,000	15	90,000	17	102,000	3	18,000	3	18,000	3	18,000
Transport	trips	60,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000
				348,000		**390,000**		**418,000**		**358,000**		**374,000**		**438,000**
Total				**917,250**		**1,223,000**		**1,409,500**		**1,979,500**		**2,217,000**		**3,147,000**
Without Local materials				**809,250**		**1,072,000**		**1,213,500**		**1,754,500**		**1,958,000**		**2,887,000**
Without local materials and labour				**461,250**		**682,000**		**795,500**		**1,396,500**		**1,584,000**		**2,449,000**

Construction of Brick Masonry Tanks above the Ground

																Tarpulin
			FCT10M3		20M3		30M3		10M3		15M3		20m3		1.5m3	
Description	**Unit**	**Unit cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**
	Pc	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Tap	cu.m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
Sand	tonne	10,000	3	30,000	4	40,000	4	40,000	4	40,000	6	60,000	6	60,000	1	10,000
Aggregate	tonne	20,000	1	20,000	1	20,000	2	40,000	3	60,000	3	60,000	3	60,000		-
Hardcore	tonne	25,000	2	50,000	3	75,000	4	100,000	4	100,000	5	125,000	4	100,000		-
Expanded metal	each	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	2	40,000		-
Eucalyptus poles, 3mlong	each	3,000	6	18,000	12	36,000	12	36,000	15	45,000	18	54,000	20	60,000	4	12,000
Reinforcement bars: 10mm dia	m	17,000	1	17,000	1	17,000	1	17,000	1	17,000	1	17,000	2	34,000		-
Cement	bag	25,000	8	200,000	10	250,000	12	300,000	21	525,000	25	625,000	28	700,000	2	50,000
Binding wire	kg	3,000	6	18,000	10	30,000	12	36,000	15	45,000	15	45,000	16	48,000	4	12,000
Nails: assorted	kg	3,500	1	1,750	1	3,500	15	52,500	1	3,500	1	3,500	1	3,500	1	3,500
GI pipe, 2" dia	m	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000		-
GI pipe, 0.5" dia	m	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000	1	2,000
HDPE pipe, 2.5" dia	m	3,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500	3	10,500		-
GI bend, 0.5"	each															

dia		1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500		-
GI end cap, 2" dia	each	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500		-
chicken mash	roll	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000		-
Gutters	sheet	10,000	2	20,000	4	40,000	4	40,000	10	100,000	10	100,000	10	100,000	2	20,000
Plastict sheetiing	metre	3,000	2	6,000	4	12,000	4	12,000	6	18,000	6	18,000	6	18,000	2	6,000
Down pipe	piece	10,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000	2	20,000
Sisal	roll	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000
Gunny Bags		1,000	6	6,000	10	10,000	16	16,000	20	20,000	22	22,000	25	25,000	2	2,000
Water proof cement	kg	2,500	8	20,000	10	25,000	12	30,000	18	45,000	22	55,000	25	62,500		-
Ring wire	pipes	3,000	6	18,000	8	24,000	15	45,000	20	60,000	30	90,000	30	90,000		-
Plain wire	roll	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	2	120,000		-
Coffe Mesh	metre	5,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	2	10,000	3	15,000
				636,250		**794,000**		**976,000**		**1,290,000**		**1,486,000**		**1,652,500**		**175,500**
Skilled Labour	manday	8,000	7	56,000	7	56,000	7	56,000	7	56,000	7	56,000	7	56,000	5	40,000
Helpers	manday	6,000	10	60,000	3	18,000	3	18,000	3	18,000	3	18,000	3	18,000	4	24,000
Transport	trips	60,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	3	180,000	1	60,000
				296,000		**254,000**		**254,000**		**254,000**		**254,000**		**254,000**		**124,000**
				932,250		**1,048,000**		**1,230,000**		**1,544,000**		**1,740,000**		**1,906,500**		**299,500**

Without Local materials				**835,250**		**904,000**		**1,035,000**		**1,316,000**		**1,476,000**		**1,658,500**		**282,500**
Without local materials and labour				**539,250**		**650,000**		**781,000**		**1,062,000**		**1,222,000**		**1,404,500**		**158,500**

Comparative Analysis of options by (Cost, Capacity, Reliability/ Durability

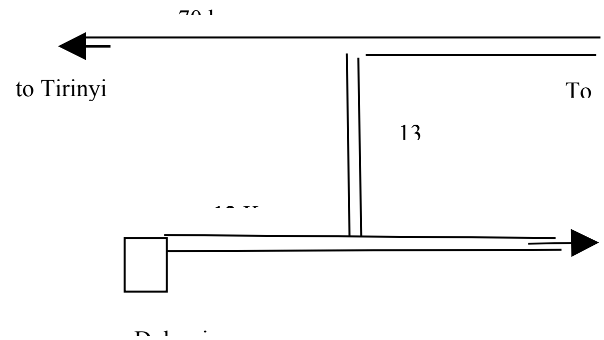
RWH systems	**Cost**			**Material Availability**	**Durability**	**O&M**	**Required Expertise**	**Other Advantages /Disadvantages**
	All materials bought and labor	**Without local materials**	**Without Labor Local Materials &Labour**					
FCT4m3	**916,250**	**809,250**	**513250**	Materials accessible to community.	If well maintained it lasts for up to 30 years.	Easy (replace gutters)	Masons trained specifically	**Advantages**
								Requires a group to be able to raise the required materials
								Extraction water is easy
								Contamination of water is minimized if well managed
								Incase of damage it is easily detected
								Easy to clean
								Disadvantage
								The capacity is low for diverse use and if dry season is longer.
								Relatively expensive for most households to afford.
FCT6m3	**1,028,000**	**874000**	**630000**	Available	As above			As in 1 above
FCT 7.5m3	**1206000**	**1001000**	**763000**					As in 1 above, However ideal for a household and the roof catchments area of most rural households.

FCT 10m3	**1,702,000**	**1,264,000**	**1,030,000**	Available	As above		Masons trained on Tank construction may be needed	As in 1 above, More expensive than the previous and requires amore larger catchments to be able to fill effectively. However provides more adequate water.
FCT15m3	**1,890,000**	**1,416,000**	**1,184,000**	Available	As above		Masons trained on Tank needed	As above
								Requires larger surface for catchments.
FCT20m3	**2,050,500**	**1592500**	**1363500**	Available	As above		Masons trained on Tank construction	Fairly expensive although it provides more Storage capacity. It would be an ideal for a household if it were not of its inhibitive cost.
Brick Masonry above the ground.	**932250**	**835250**	**539250**	Available materials in most localities	Very durable		Any trained mason can construct it	**Advantages**
								Store enough water depending on the capacity
								Relatively cheaper in comparison to FCTof a similar Capacity and location.
								Disadvantages
								Not easy to repair
								It prone to collapse in larger designs.
Brick Masonry (Below the ground)								**Advantages**
								Relatively cheaper in comparison to FCT of a similar Capacity and location.
								Easy to repair
								Contains larger capacities
								Disadvantages
								Easy contaminated
Tarpaulin	**299500**	**282500**	**158500**					**Advantages**

								Easy to clean
								Cheaper (Cost effective
								Stores enough water for small families
								Does not require high technical skill
								Not labor intensive
								Disadvantages
								Easily destroyed by termites and rats
								Limited by geology.
								Danger to children if not covered
								Little water for big family
								Possible contamination from runoff
Rain Water Jar	**295500**	**268500**	**146500**	All materials are available	At least 6 years guarantee period. Though not that durable		Any ordinary Mason or Person can be trained to make a rainwater jar.	**Advantages**
								Portable
								Easy to clean
								Requires much attention in production process
								Cheaper than most DRWH Systems
								Disadvantage
								Stores little water
								Less thickness gauge makes it easy to crack
								Requires a mould for construction
								FCT UNDER GROUND
FCT10M3	**917250**	**809,250**	**461,250**					Surrounding ground gives support allowing lower wall thickness thus lower costs
								Easy to construct using traditional materials

								Relatively cheaper compared to above the ground due to lower material requirements.
								Stores enough water for the family.
								Easy to repair/maintain in case of damage.
								§ It provides Value for money in light of comparative costs per m3 of other related above the ground FCTs.
								Disadvantages
								Extraction water not easy
								Danger to children and animals if a tank is not covered.
								Roots can damage the structure.
								Damage not easily detected
								Contamination of the tank from the ground is more common
								Requires specialized training.
FCT15M3	**1223000**	**1,072,000**	**682,000**					As in above
FCT20M3	**1409500**	**1,213,500**	**795,500**					As in above
FCT40M3	**1979500**	**1,754,500**	**1,396,500**					As in above
FCT50M3	**2217000**	**1,958,000**	**1584000**					As in above
FCT90M3	**3147000**	**2,887,000**	**2,449,000**					As in above,
								Very expensive for a household and it Ideal for communal and Institutional settings.
1. Recommendations and Conclusions.								
Rainwater jar would an ideal for households with low incomes as they gradually update it to a more reliable higher capacity.								
Ferro cement tanks are Ideal than other tanks due to their durability, costs, less danger to households								

Large scale Irrigation in Doho

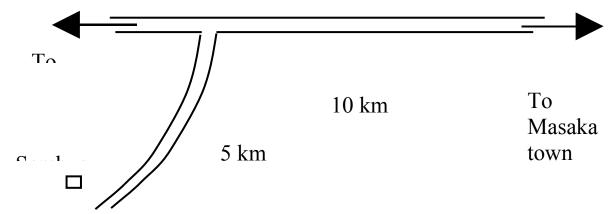
Date of Visit 20/11/07	Category: Community/private large scale irrigation
Name of Site: Doho rice scheme	Either water Harvesting; Community Irrigation or Private Public Irrigation
	Sketch Map of Site 
Geographic location of practice: Doho,Butaleja District	
(GPS) Coordinates:36N 614867E, 0105444N, Elv. 1,101m	
Description of the Community: It is a government scheme but land is given out to farmers. There are 4,385 tenants. There is also about 2,000 out growers upstream and down stream.	
Characteristics of the area: Flat flood plain	
Climate (AEZ) + Description: Banana/Millet/Cotton System, humid tropic. Vegetation is moist savannah with moderate biomass production	
Average annual rainfall (mm)1,340	
Months of Short Rains:	March -May
Months of Main Rains:	August - November
Mean annual ref. crop Evapotranspiration (mm):1,580	
Predominant soil type:	medium
Topography:	plains
Slope:	gentle slope
Erosion:	low in plains ,high in mountain
Period of year during which used:	All year round
Period of year during which benefits utilized: All year round	
Water Source: River Manafwa. Reliable water supply	
Irrigated area: About 1,000ha	

Method of water abstraction: River diversion, gravity. Cheap supply of water. No pumping	
Water delivery infrastructure: Open earth canals. Big water losses due to seepage	
Type of water distribution: supply oriented	
Predominant on-farm irrigation practice: Surface: level basin,	
Major crops (with percentages of total irrigated area): Paddy rice, 100%	
Average farm size: . Divided into six blocks average size; 400 acres. 0.5 acre fields per farmer	
Type of management: joint government agency/farmer	
Technical Description: The farmers have been using the flood plains of river Manafwa for production of Paddy rice. They faced a big challenge of how to control the flood waters. In 1976, GoU through the Chinese government, started Doho rice scheme in order to solve this problem. Earth embankments were constructed to stop the floods from inundating then fields and part of the river water was diverted to flow through a canal to irrigate the flood plains. At first three blocks were opened and in 1985 three new blocks were added. New varieties were introduced and up to1993 the fields were very high (1,800- 2,000 Kg/acre or 4,500 -5,000Kg/ha). After 1993 when the Chinese left, management was transferred to MAAIF and by 1996 the yield went down to 1,000 - 1,300 Kg/acre or 2,500 - 3,250Kg/ha). By 1997 yields drop to 1,000 Kg/acre. From 2003to 2005, JICA introduced some new technologies (seed selection, seed bed preparation, planting in lines) and the yield has gone up to 1,200 Kg/acre or 3,000 Kg/ha. The scheme has	
Technical Details: The studies, design and construction was carried out by the Chinese government on behalf of GoU. The documents are not available at the scheme but are believed to be somewhere at MAAIF, though it has been difficult to trace.	
Useful in: This technology is best suited for flat wetland/flood plain areas where there's plenty of water for paddy and the soils are clayey	**Limitations**: If flood control is not possible, the rice fields could get damaged by floods. The fields should also be drainable during harvest period. The soils best suited are clay based soils. Sandy soils lead to excessive water losses through seepage.
Geographical extent of use: In general Eastern Uganda has plenty of wetlands/flood plains which could be used for irrigating paddy rice. In the Nile basin it could be used where such conditions exist	**Effectiveness**: Doho rice scheme has achieved its objective of controlling the floods and providing livelihood for the community. Over 4,000 farmers benefit from the scheme and their lives have been changed for the better, although the scheme is not performing up to its maximum potential.
Other Sites where used: Kimbimba (Tilda) rice scheme, Olweny rice scheme, community based rice fields in the eastern region	
Cost: The project is government project and the farmers do not pay for the water apart from association fee of $6 per year.	**Operation and Maintenance arrangements**: The main operation and maintenance is the responsibility of GoU (MAAIF). The farmers are responsible for the field canals and drainage. Each farmer is supposed to pay $6 per year and participate in the maintenance of the field canals.
Benefits: The farmer gets about 1,200 Kg/acre per season and there are twos seasons in a year. Before the project yield were low and the project has increased yields by over 80%. The farmer sells his rice at Sh.800/Kg ($ 0.5/Kg). Therefore he earns 1,200*2* 0.5* 1/1.8= $667/ acre/year more than before because of increased yield due to the project.	
Stakeholders and beneficiaries: The initiator of the the project is GoU as response to the problems faced by the farmers. Other actors such as Chinese government, JICA were invited by GoU. The direct beneficiaries are the over 4,000 farmers. They are responsible for the management of their field and maintenance of field canals and drainage	**Enabling Environment**: GoU support is was vital for the success of the project. The community also has vested interest because rice growing is the best means of making a living for the farmers in that part of Uganda

Who are the main beneficiaries		beneficiary involvement
Training support: 2003 - 2005 the farmers received training from JICA on improved methods of rice production.		Extension support: The GoU is presently trying to repair some of damaged embankments and other water control structures. This is improving the ability of the farmers to control the water.
Environment benefits: .The cactment area of river Manafwa in Mt. Elgon area is increasingly being degraded by farmers opening more land in the mountains for cultivation. This has resulted into increased erosion from the catchment area and siltation of irrigation and river channels. An integrated approach for the solution is required.		Social/Cultural acceptability: Socially and culturally acceptable, although children are some times negatively affected as they have to chase birds instead of going to school during near harvest period.
Sustainability	economic aspects cultural environmental aspects technical	
Advantages: The community will continue to operate and maintain the system since they depend on it for their lively hood. Although MAAIF has paid very little attention since 1993, the system is still running though with some technical problems. The number farmers befitting from the project is big, over 4,000. It is expensive but benefits are also big and this has been demonstrated and therefore GoU or NGOs can help replicate it at some other sites.		Disadvantages: Expensive water/ flood control structures, risk of spread of water borne diseases, destruction of natural habitats, sandy soils not appropriate
Scaling Up: No specific obstacles		What is potential for applying all/parts of initiative elsewhere?
		(Score from 1 to 10 on list below with 10 being highly applicable)
		I [8] Transfer of practice to another group/culture/land-use system, etc.
		II [9] Easy to transfer the practice, but with minor adaptations for local conditions
		III [9] Transfer possible, but significant modifications/prerequisites to consider.
		IV [7] Difficult to transfer the practice. Need experienced support.
		V [1] It would be impossible to transfer the practice. Too site specific.
		Other specific remarks: (e.g., agreements, regulations, provisions regarding Intellectual Property Rights, etc.)
Best Practices: .It is profitable, has many beneficiaries, water users association in place , members participate in operation and management of the system.		
Contact Organization: (For further information; site		Doho Rice Scheme, P. O. Box 518 Mbale, MAAIF P. O.

visits' etc)	Box 102 Entebbe
Type of organization:	Contact person: Sagula Wilberforce, Assistant Irrigation Officer
[ ] government organization	Contact details Tel. +256-782-653156
[ ] private organization	
[ ] NGO &/or CBO	
[ ] international agency	
[ ] other:	
Lessons learnt: (at various stages of the realization of the works, describe any lessons learnt that would improve upon future similar interventions)	
Planning: Farmers should be involved more intimately in the planning. In the case of Doho GoU did most of the planning work with minimum involvement of the farmers as such there are a lot disputes over land.	
Design Should be simple enough so that farmers can maintain it. Where possible local materials should be used so that the farmers can afford them later. For example the water control structure in the field is made of concrete and steel. When damaged, the farmers found it difficult to replace them. If wooden materials were used, probably the farmer will find it easier to replace them.	
Construction	
Implementation	
O&M The farmers should be responsible for O&M for sustainability. In this case because they knew hat MAAIF is the one responsible for the main O&M they did not pay much attention to it. MAAIF should provide only extension service	
Beneficiary involvement	
Realization of benefits: The provision of irrigation water is not enough to ensure high yields. It should be combined with good agronomic practices(better varieties, transplanting, planting in line, etc)	
Other Remarks or observations:	
Contact person completing form:Michael Iwadra	
Contact details Department of Agricultural Engineering, Makerere University,P.O.Box 7062, Kampala. E-mail: miwadra@agric.mak.ac.ug,Tel. +256-772-446325	

Community Based Irrigation (Sembusi)

Date of Visit 15/11/07	Category:
Name of Site: Mr. Sembusi , Bulenge Village	Either water Harvesting; Community Irrigation or Private Public Irrigation
	Sketch Map of Site 
Geographic location of practice: Bulenge Village, Buwunga sub county, Masaka district	
(GPS) Coordinates: 36N 0368026, 9955968, elv. 1,169 m	
Description of the Community: The group is called ' Bulenge Modernistic Farmers' It is made up of five members with Mr.Sembusi as the leader and main farmer.	
Characteristics of the area: undulating hills	
Climate (AEZ) + Description: Banana coffee system, humid tropics. Vegetation is mainly forest-savannah	
Average annual rainfall (mm) 1000 - 1 500	
Months of Short Rains:	March -May
Months of Main Rains:	August -December
Mean annual ref. crop Evapotranspiration (mm): 1550	
Predominant soil type:	medium
Topography:	undulating
Slope:	gentle
Erosion:	low
Period of year during which used:	dry season
Period of year during which benefits utilized: all year round	
Water Source: river	
Irrigated area: 10 ha annually .Mr Smusi about 3 ha	
Method of water abstraction: Gravity, diversion of river into channels which transport water to the field.	
Water delivery infrastructure: Open channel taking water to different parts of the field	
Type of water distribution: Water is supply is arranged on demand. When there is need for irrigation , water is diverted and flows to the fields	

<table>
<tr><td colspan="2">Predominant on-farm irrigation practice: Surface: flooding, basin</td></tr>
<tr><td colspan="2">Major crops (with percentages of total irrigated area): . Coffee,(90%) banana (5%,) pineapple (5%)</td></tr>
<tr><td colspan="2">Average farm size: 2.5 ha</td></tr>
<tr><td colspan="2">Type of management: Farmer-farmer-managed withvery limited government extension service</td></tr>
<tr><td colspan="2">Technical Description: Mr. Sembusi started diverting water to his field during dry season to water his crops. He later attended some training for farmers on irrigation under FAO project and got better ideas on how to control and distribute the water in the field and he improved the system. He places some obstacle in the stream in order to raise the water level at an upstream point. He then opens the side of the stream so that water flows in a channel that he has already prepared. The land has a gentle uniform slope and water is able to flow to the field by gravity. The channels extent to his neighbors who also use the same source. In the field he prepares a set of field channels taking water to the different parts of the field. He directs the water to flow to a particular part of the field by blocking the others channels using soil. Around the coffee and banana crops, he prepares a small basin into which he pours water by collecting it from the channel using a bucket or some other container. The water flo</td></tr>
<tr><td colspan="2">Technical Details: This is a farmer initiated irrigation system. No designs or studies were carried out.</td></tr>
<tr><td>Useful in: It needs gently sloping areas with water source at upper elevation than the field. Good sites could be at foot hills of mountains/hills from which rivers/streams flow.</td><td>Limitations: Water use efficiency is low (seepage and flooding), especially in sandy soils. In most cases water sources is below the field surface and in such cases gravity cannot be used.</td></tr>
<tr><td>Geographical extent of use: In Uganda gravity irrigation can be used in mountainous and hilly areas where topographic and soil conditions permit. Examples are Mt. Elgon and Rwenzori foot hills. Within the Nile basin the system can be used where such conditions exit in East Africa, Ethiopia and The Sudan</td><td rowspan="2">Effectiveness: The system has increased the yields of the farmer by more than 100%. It is cheap as it does not require energy to deliver water to the field.</td></tr>
<tr><td>Other Sites where used:</td></tr>
<tr><td>Cost: The farmer did not cost his labour but it took him a number of weeks to build the system and he is still improving it.</td><td>Operation and Maintenance arrangements: Mr.Sembusi and his friends operate and maintain the system. He gets extension services from district agriculture officer and MAAIF</td></tr>
<tr><td>Benefits: The farmer earns about Sh. 2,200,000 ($1,300) per acre. The yield increase is over 100% so therefore he earns about $650 per acre from yield increase due to irrigation.</td><td>Water User Association or User Group: The group has sir members with Mr. Sembusi as the chairman and lead farmer. They operate and maintain the system as a group.</td></tr>
<tr><td>Stakeholders and beneficiaries: The beneficiaries are the six farmers. Mr.sembusi is the initiator of the system and the others joined him. MAAIF and the district agriculture office provides some limited extension service.
Who are the main beneficiaries</td><td>Enabling Environment: Individual initiative. Available market for coffee.
beneficiary involvement
demand based interventions</td></tr>
<tr><td>Training support: Farmer trained on basic irrigation under FAO project</td><td>Extension support: MAAIF and district staff provide limited extension support</td></tr>
<tr><td>Environment benefits:
Sustainability economic aspects</td><td>Social/Cultural acceptability: No known social or cultural barrier</td></tr>
</table>

cultural environmental aspects technical	
Advantages: Sustainable system since it is farmer's initiative, installed and managed by him. The system is cheap and profitable	Disadvantages: Water use efficiency is low, potential flooding hazards,
Scaling Up: No specific conditions	What is potential for applying all/parts of initiative elsewhere?
	(Score from 1 to 10 on list below with 10 being highly applicable)
	I [10] Transfer of practice to another group/culture/land-use system, etc.
	II [10] Easy to transfer the practice, but with minor adaptations for local conditions
	III [7] Transfer possible, but significant modifications/prerequisites to consider.
	IV [3] Difficult to transfer the practice. Need experienced support.
	V [1] It would be impossible to transfer the practice. Too site specific.
	Other specific remarks: (e.g., agreements, regulations, provisions regarding Intellectual Property Rights, etc.)
Best Practices: It is cheap, profitable, easy to replicate,	
Contact Organization: (For further information; site visits' etc)	Agriculture Office Masaka
Type of organization:	Contact person: Kakoza Harish, District Agriculture Officer, DAO. Masska
[ ] government organization	Contact details 0782-489690
[ ] private organization	
[ ] NGO &/or CBO	
[ ] international agency	
[ ] other:	
Lessons learnt: (at various stages of the realization of the works, describe any lessons learnt that would improve upon future similar interventions)	
Planning: Farmers understand their environment and needs and they can initiated good systems	
Design Farmer's ideas and design can form basis for a good design	
Construction Simple implements coupled with knowledge can be used to construct a good system	
Implementation	
O&M	
Beneficiary involvement	
Realization of benefits: Such as markets; achieving better returns - crop selection &/or market linkages etc).	
Other Remarks or observations:	
Contact person completing form: Michael Iwadra	
Contact details Department of Agricultural Engineering, Makerere University, P.O.Box 7062, Kampala.Tel. +256-772-446325	

Ranking of Sites: Community Based Irrigation

Criteria			Mr.Sembusi Richard Bulenge Village, Masaka	Mr. Mpinde Livingstone Katolerwa village	Palisa Paddy rice growers communities	Iganga Paddy rice growers communities	Tororo Paddy rice growers communities
		Score					
Water use efficiency,%	<30	1			1	1	1
	30- 40	2	2	2			
	40- 60	3					
	60-80	4					
	>80	5					
Yield increase/profits %	<40	1					
	40- 60	2					
	60- 80	3			3	3	3
	80-100	4					
	>100	5	5	5			
Number community members adopted technology	<3	1		1			
	3 to 6	2	2				
	6 to 10	3					
	10 to 20	4					
	>20	5			5	5	5
Water users association	no/very weak	1		1	1	1	1
	weak	3					
	strong	5	5				
Level of maintenance	poor	1					
	average	3			3	3	3
	good	5	5	5			
Environment management	poor	1					
	average	3			3	3	3
	good	5	5	5			
Market for product	poor	1					
	seasonal	3					
	readily available	5	5	5	5	5	5
		Total	29	24	21	21	21
		Rank	1	2	3	3	3

Ranking of Best Sites: Large Scale irrigation

				Ranking of best Sites							
Criteria			**Mubuku**	**Kimbimba (Tilda)**	**Doho**	**Kiige**	**Ongom**	**Labori**	**Atera**	**Agoro**	**Olweny**
		Score									
Water use efficiency,%	<30	1									
	30- 40	2	2		2	2	2	2	2	2	2
	40- 60	3		3							
	60-80	4									
	>80	5									
Yield increase/profits %	<40	1									
	40- 60	2									
	60- 80	3				3	3	3	3	3	3
	80-100	4	4		4						
	>100	5		5							
Number community members adopted technology	<3	1									
	3 to 6	2									
	6 to 10	3				3	3	3	3	3	
	10 to 20	4									
	>20	5	5	5	5						5
Water users association	no	0									
	weak	3	3	3	3	3	3	3	3	3	3
	Strong	5									
Level of maintenance	poor	1	1			1	1	1	1	1	1
	Average	3			3						
	Good	5		5							
Environment management	poor	1									
	Average	3	3	3	3	3	3	3	3	3	3
	Good	5									
Market for product	poor	1									
	seasonal	3									
	readily available	5	5	5	5	5	5	5	5	5	5
		Total	23	29	25	20	20	20	20	20	22
		Rank	3	1	2	5	5	5	5	5	4

Ranking of Best Sites: Rain Water Harvesting

				Ranking of best Sites				
Criteria			Kyalulangira FCT	Kamubisi underground FCT	Kyanyanda open underground tank	Edward Kanyarutokye FTCT	Ekiryotozi VT	Kyamuyi mba VT
		Score						
Water use efficiency,%	<30	1						
	30- 40	2						
	40- 60	3						
	60-80	4			4		4	4
	>80	5	5	5		5		
Yield increase/profits %	<40	1						
	40- 60	2						
	60- 80	3						
	80-100	4	4	4	4	4		4
	>100	5					5	
Number community members adopted technology	<3	1						
	3 to 6	2		2	2			
	6 to 10	3	3					
	10 to 20	4				4		
	>20	5					5	5
Water users association	no	0						
	weak	3	3	3	3	3		5
	strong	5					5	
Level of maintenance	poor	1						
	average	3		3	3			3
	good	5	5			5	5	
Environment management	poor	1						
	average	3						
	good	5	5	5	5	5	5	5
Market for product	poor	1						
	seasonal	3						
	readily available	5	5	5	5	5	5	5
		Total	30	27	26	31	34	31
		Rank	3	4	5	2	1	2

Ranking Best sites in Rain Water Harvesting by Technology

Ranking of best practices/technologies										
			Technology							
Ranking Criteria			Valley dam	Valley tank	Pots, jars	Corrugated galvanized /plastic tanks	Ferro cement tanks	Brick masonry tanks	Sub surface masonry tanks	In-situ, internal and external storage for agriculture
		Score								
Efficiency (water use, application), %	<30	1								
	30- 40	2								2
	40- 60	3								
	60-80	4	4	4						
	>80	5			5	5	5	5	5	
Estimated number of community members that adopt technology	<3	2	2			2			2	
	3 to 6	4						4		
	6 to 10	6			6					
	10 to 20	8		8			8			
	>20	10								10
Technical support	Strong	5								
	Slight	3	3	3	3	3	3	3	3	3
	No	1								
Affordability	Not affordable	1								
	Community	4	4			4				
	Individual	5		5	5		5	5	5	5
Cost	cheap	4			4					4
	fair	3				3	3	3	3	
	Average	2		2						
	High	1	1							
Spare parts availability	No	2								
	Yes, local, town	4	4	4		4			4	
	Yes, local	5			5		5	5		5

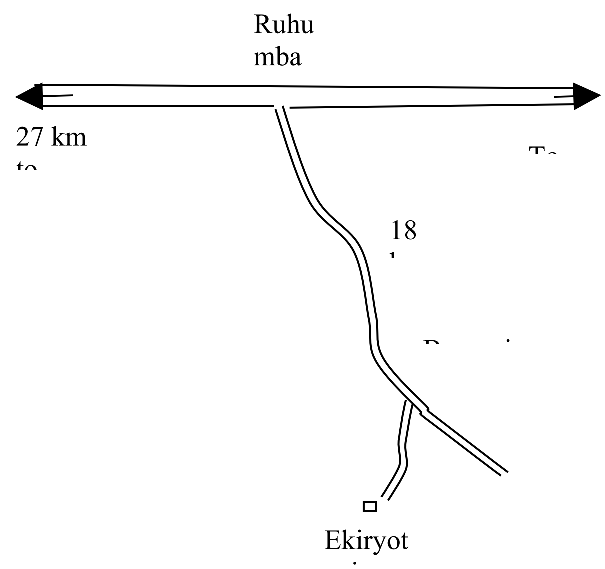
Operation and maintenace simplicity	Complex	1	1							
	Average	3		3					3	
	Simple	5			5	5	5	5		5
Level of solution to problem	Low	1			1					
	Average	8				8	8	8	8	8
	High	10	10	8						
		Total	29	37	34	34	42	38	33	42
		Rank	6	3	4	4	1	2	5	1

Irrigation Ranking by Technology

Ranking of best irrigation practices/technologies									
			Irrigation Technology						
Ranking Criteria			Furrow	Basin	Sprinkler	Drip	Treadle pump	Watering can/bucket	Gravity flow/flooding
		Score							
Efficiency (water use, application), %	<30	1							
	30- 40	2	2						2
	40- 60	3		3			3	3	
	60-80	4			4				
	>80	5				5			
Estimated number of community members that adopt technology	<3	2	2		2	2			2
	3 to 6	4					4	4	
	6 to 10	6							
	10 to 20	8		8					
	>20	10							
Technical support	Strong	5							
	Slight	3	3	3	3	3	3	3	3
	No	1							
Affordability	Not afforda ble	1							
	Comm unity	4	4	4	4	4			4
	Individ ual	5					5	5	
Cost	cheap	4					4	4	
	fair	3	3	3					3
	Averag e	2							
	High	1			1	1			
Spare parts availability	No	2							
	Yes, local, town	4			4	4	4	4	4
	Yes, local	5	5	5					
Operation and maintenance simplicity	Compl ex	1							
	Averag	3	3		3	3	3		3

	e								
	Simple	5		5				5	
Level of solution to problem	Low	1							
	Average	8							
	High	10	10	10	10	10	10	10	10
		Total	32	41	31	32	36	38	31
		Rank	4	1	5	4	3	2	5

Rain Water Harvesting at Ekiryotozi

Date of Visit 18/11/07	Category: Water harvesting: Valley tank (Open Pond)
Name of Site: Ekiryotozi Valley dam	Either water Harvesting; Community Irrigation or Private Public Irrigation
	Sketch Map of Site 
Geographic location of practice: Kasongi sub county, Kiruhura district, Ekiryotozi village	
(GPS) Coordinates:36N 244932E, 9973333N, elv. 1,339m	
Description of the Community: Estimated number of beneficiaries; 1,600 -2,000. Cattle; 1,000. Number of house holds; 350. Mixed farming. They grow crops and also keep cattle. Organized Christian community with active church leaders (Mr. Yokayasi Kotungire as chairman house of leity)	
Characteristics of the area: Undulating hills with grass, shrubs and bushes with patches o banana fields	
Climate (AEZ) + Description: Pastoral system with low annual rainfall (under 1 000 mm), characterized by short grassland where pastoralism prevails	
Average annual rainfall (mm) 924 mm	
Months of Short Rains:	Feb, Mar, April, May
Months of Main Rains:	Sept, Oct, Nov, Dec
Mean annual ref. crop Evapotranspiration (mm):1,346mm	
Predominant soil type:	Medium (sandy clay loam)
Topography:	Undulating hills
Slope:	>5%
Erosion:	Moderate

Period of year during which used: All year round but peak during the dry seasons	
Period of year during which benefits utilized: All year round	
Water Source: Run off from rainfall	
Cultivated area:	
Technical Description: The community through Ankole diocese with the help of Christian Engineering in Development (CED) constructed the valley damin1999 in order to solve the problem of acute water shortage for cattle and humans, especially during the dry season. It was designed by CED and constructed with full participation of community members especially in provision of labour and local materials. The structure is made up of an excavated reservoir measuring 70* 30* 5 m (≈10,000m3), an inlet which is well vegetated, a spillway and infiltration gallery connecting the reservoir to a shallow well and a hand pump located outside the fence of the protected valley tank. The reservoir is fenced with barbed wire and vegetation to keep away humans and cattle from accessing the water directly thereby polluting the water and damaging the structures. The community and the cattle access water through the hand pump. The water from the shallow well is clean and has fairly good quality. The communities use the water for domestic use and for watering of animals. They boil the water for drinking and store it in clean containers (buckets, jerry cans, pots).The water source is adequate to satisfy the needs of the community for both domestic and watering of animals. There is a strong water users association which collects water fee from members and use the money for maintenance and repair. For example they repaired the hand pump when it broke down recently.	
Technical Details: The design was carried out by CED and the studies carried and design is all contained in a report. The report can be found at Ankole diocese office in Mbarara with Rev Canon Yorokamu Rabboni. The valley dam serves about 2,000 people and 1,000 heard of cattle especially during the dry season.	
Useful in: It is good water source for animals in areas which experience prolonged dry seasons. However, the rainy season preceding the dry season must have enough rainfall to generate enough runoff to be harvested and stored in the reservoir. The sites should have sufficient catchment area to generate the required runoff. Also land management in the catchment must be good(soil and water conservation ,good land cover, no over grazing, etc)	Limitations: Siltation is high if catchment area is degraded. Siltation fills up the reservoir and limits the useful life of the reservoir. Soil and geological conditions which lead to excessive seepage losses limits amount of useful water stored. Amount of rainfall and size of catchment area can be a serious limitation.
Geographical extent of use: In Uganda in the cattle corridor, the pastoral system AEZ. In the Nile Basin it can be used in the pastoral dry areas where rainfall is adequate for harvesting.	Effectiveness: The water users association is active and effective in operation and maintenance of the facility. The community no longer suffers from water shortage during the dry season. The community owns the facility right from inception. They have participated actively in all stages of implementation.
Other Sites where used: All over the cattle corridor	
Cost: The facility cost Sh. 40,000,000/= ($24,000). The main sources of funding are Ankole diocese, UWASNET,URWA and CED, and the community. The community also contributed labour and local materials. That is why the cost of the valley tank is only $ 24,000. Otherwise a 10,000 m^3 valley tank usually costs about $60,000 or more. $1 = Sh. 1,700/=.	Operation and Maintenance arrangements: The facility is operated and maintained by the community through the water users committee. The committee collects fee from members whenever there is need for repair and members also provide labour for maintenance.
Benefits: Before the valley tank was constructed water shortage was so acute and member could buy a 20 liter jerry can for Sh.500/= ($0.3). So the	Water User Association or User Group: The community has elected a water users committee to manage the affairs of the valley tank. The committee is made up of 12 members with a

10,000 m^3 water stored could fetch (10,000,000/20)*0.3 = $150,000	chairperson, vice chair person, secretary, treasurer. Other members of the community participate in decision making during general meetings of the community, especially on Sundays after church service. Most of the water committee members are also church leaders.
Stakeholders and beneficiaries: The community of Ekiryotozi in collaboration Ankole diocese initiated the project to solve the acute water shortage experienced especially in the dry season. Ankole diocese contacted other stake holders such UWASNET, URWA and CED for technical and financial support.. Water harvesting and supporting communities in solving water problems is within the mandate of these NGOs. Who are the main beneficiaries	Enabling Environment: The community demanded the project in order to solve the problem of acute water shortage and NGOs supported it technically and financially. beneficiary involvement demand based interventions
Training support: The Community members who participated in the construction of the valley tank got on job training	Extension support: Ankole diocese helped to identify a technician for the repair of the hand pump when it broke down. The water committee paid for the costs.
Environment benefits: . The inlet is heavily vegetated and this helps to filter eroded soil particles carried in the runoff. The water which enters the reservoir is relatively clean. Pollution of water source through direct access by humans and animals has been avoided by fencing and provision of hand pump outside the fence. Water wastage is also minimized by use of hand pump. Water is available all year round. Sustainability economic aspects Cultural environmental aspects Technical	Social/Cultural acceptability: Facility is highly acceptable socially and culturally. Women and children can also use the facility without any hindrance
Advantages: The demand for water is high and therefore the community has vested interest in the success and sustainability of the facility. The community was involved right from conception of the idea, design and construction up to operation and maintenance. There is an active, effective and church oriented water users committee in place to ensure proper operation and maintenance of the facility.	Disadvantages: There is possibility of increased water borne diseases as the water provides good breeding ground for the carriers and pathogens. Excessive soil erosion in the catchment area reduces the life span drastically.
Scaling Up: Conditions for replicability include: adequate amount of rainfall, enabling soil and geological conditions, high demand for water which results into community commitment in construction, operation and maintenance; also adequate income of community members so that they can contribute financially, apart from labour contribution.	What is potential for applying all/parts of initiative elsewhere? (Score from 1 to 10 on list below with 10 being highly applicable) I [9] Transfer of practice to another group/culture/land-use system, etc.

	II [10] Easy to transfer the practice, but with minor adaptations for local conditions
	III [8] Transfer possible, but significant modifications/prerequisites to consider.
	IV [3] Difficult to transfer the practice. Need experienced support.
	V [0] It would be impossible to transfer the practice. Too site specific.
	Other specific remarks: (e.g., agreements, regulations, provisions regarding Intellectual Property Rights, etc.)

Best Practices: The cost of construction is lower than usual cost for similar size of valley tanks ($24,000 as opposed to $60,000 for 10,000 m^3 valley tank) due to good community participation. The water users committee is active and efficient in repairs and maintenance (e.g. repair of hand pump, fencing), and generally good management. The quality of water from the shallow well water use efficiency is relatively much better than from similar facilities without infiltration gallery and hand pump. The facility has been fulfilling its objective of provision of water for domestic and animal watering.

Contact Organisation: (For further information; site visits' etc) Ankole Dioceses P. O.Box 14 Mbarara.

Type of organisation:	Contact person:
[ ] government organization	Contact details Cannon Yorokamu Rabboni,Ankole dioceses, P. O. Box 14 Mbarara, Tel. 0772-562327. Norah Kotungire Vice Chair Person Water Committee
[ ] private organization	
[ ] NGO &/or CBO	
[ ] international agency	
[ ] other:	

Lessons learnt: (at various stages of the realization of the works, describe any lessons learnt that would improve upon future similar interventions)

Planning: Demand driven projects and beneficiary involvement leads to success in planning and implementation.

Design Community involvement leads to ownership and acceptance of the design

Construction Labour contribution by community reduces cost of construction

Implementation Community participation leads to real ownership of facility by community

O&M For sustainability, the community must be given basic training on O&M and be given tha responsibility.

Beneficiary involvement is a must for success

Realization of benefits: Such as markets; achieving better returns - crop selection &/or market linkages etc).

Other Remarks or observations:

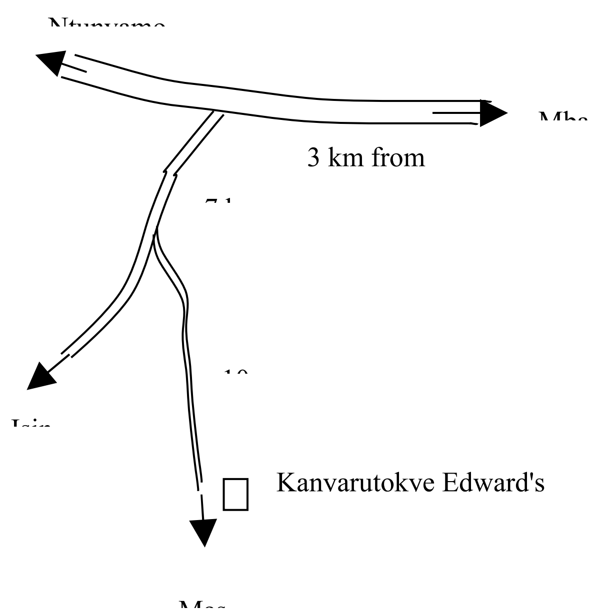
Contact person completing form: Michael Iwadra

Contact details Department of Agricultural Engineering, Makerere University, P.O.Box 7062 Kampala, Uganda. Tgel. +256-772-446325. e-mail: miwadra@agric.mak.ac.ug

Legend for Water harvesting schemes	
1. Open Pond - excavated in natural conditions	
2. Haffir/ crescent shaped dam/Water Ponds/Pans	
3. Small Dam - earth embankment	
4. Sub-Surface Dam	
5. Sand Dam	

6. Well - shallow hand dug - with SSI		
7. Well - Deep hand dug - with SSI		
8. Spring Development for SSI and/or other uses		
9. Roof Water Harvesting (Domestic Use)		
10. Runoff Water Harvesting (Domestic Use)		
11. Runoff Water Harvesting (Agricultural/Homestead Use)		
12. Rock and other surface catchment systems		
13. River water harvesting (diversions) for small scale irrigation		
14. Spate Irrigation		
15. Recharge Structures		
16. In situ Water harvesting Measures/ Soil and Water Conservation techniques on arable rainfed lands		a. Conservation tillage
		b. Planting Pits
		c. Katumani Pit
		d. Semi-Circular Bunds
		e. Negarim
		f. Tied Contour ridges
		g. Contour Stone Bunds
		h. Fanya Juu
		i. Earth Bunds with external catchment
		j. Contour ridges with external catchment

Roof Water Harvesting at Kanyarutokye Edward

Date of Visit 18/11/07	Category: Roof water harvesting
Name of Site: Kanyarutokye Edward	Sketch Map of Site 
Geographic location of practice: Masha Sub county, Isingiro District, about 20 Km from Mbarara town	
(GPS) Coordinates: 36 243910E; 9927332N, UTM	
Description of the Community: Family of 8 people	
Characteristics of the area: densely populated, acute water shortage in dry season	
Climate (AEZ) + Description: pastoral system with banana	
Average annual rainfall (mm) 924	
Months of Short Rains: Feb, Mar, April, May	

Months of Main Rains:	Sept, Oct, Nov, Dec
Mean annual ref. crop Evapotranspiration (mm):	1,346mm
Predominant soil type:	Medium (sandy clay loam)
Topography:	Undulating hills
Slope:	>5%
Erosion:	Moderate
Period of year during which used:	Mainly during dry season, June ,July, August, January, February
Period of year during which benefits utilized:	All year round
Water Source: Rainwater	
Cultivated area:	
Technical Description: This area suffers severe water shortage in the dry season. Women have to travel several Kms (about 6) to fetch water. The cost of water varies from $0.12 -0.3 per 20l. The roof water harvesting system is composed of roof, gutters, closed tank and taps. The tank capacity is 12,000 liters. The system cost about Sh.1,600,000/=($930) The family uses on average 100l per day and water can last for over 3 months. In one year the family needs to fill the tank 4times. Water for drinking is boiled and stored in a closed bucket. If the family were to buy the water it would have cost it (12,000/20)*0.3*4 = $720 in a year.	
Technical Details: The project was implemented by Ankole Diocese, with collaboration of Uganda Rain Water Association (URWA) and Uganda Water and Sanitation NGO Network (UWASNET) providing technical and financial support. Design, budget and bills of quantities were prepared before construction. Masons were trained to help the beneficiaries in construction and repair work.	
Useful in: Potential sites: Iron roofed houses, at least moderate amount of annual rainfall, other sources of domestic water not available or expensive or very far, available materials and technical know how	Limitations: size and availability of good quality of roof limits amount of water harvested. Amount of annual rainfall could be another limiting factor.
	Effectiveness: The tank capacity is 12,000 liters. The family uses on average 100l per day and water can last for over 3 months. The technology has achieved the objective of proving adequate and cheap water for domestic use.
Other Sites where used: Mbarara, Bushenyi, Masaka,Kabale,Luwero, Sembabule, urban centers,	

etc mainly but it can be used in any part of the country	
Cost: The system cost about Sh. 1,600,000/=($930). Ankole Diocese, with collaboration of Uganda Rain Water Association (URWA) and Uganda Water and Sanitation NGO Network (UWASNET) provided technical and financial support and Mr. Edward contributed labor, food and about 50 %of funds required.	Operation and Maintenance arrangements: The owner carries out maintenance activities such as cleaning, replacement/repair of gutters and minor repair on the tank. Major repair are handled by a trained mason and can consult URWA or Ankole Diocese
Benefits: The family saves about $720 annually from water for domestic use	Water User Association or User Group: Rukuuba Rain Water Harvesting Association (13 members). Members organize training and help each other with labour and materials during construction. Group trains a mason to help with construction and maintenance.
Stakeholders and beneficiaries: Ankole diocese and community members are the main initiators. URWA, UWASNET provided technical and financial support. Other stake holders are District Water Officer, Local Councils Who are the main beneficiaries	Enabling Environment: URWA, UWASNET and Ankole Diocese provided designs and support when community demanded. beneficiary involvement
Training support: Community members were trained on the job during construction of a few demonstration systems by URWA and Ankole Diocese. A mason was also trained to serve the members	Extension support: . Provided by Ankole diocese on demand by members
Environment benefits: (Whether it has been completed as part of part of watershed development or integrated management approach, how it fits in, visible benefits achieved in terms or water availability, reduction in erosion, vegetative growth etc). Sustainability economic aspects Cultural	Social/Cultural acceptability: No social or cultural rejection sited.
Advantages: High water demand especially in dry season, others sources far, community contributes both financially and materially, trained mason available, members trained, members have seen benefits practically,	Disadvantages: Polluted air with toxic substances may make water unsafe for domestic consumption
Scaling Up: (Are there specific conditions or obstacles which make it impossible to	What is potential for applying all/parts of initiative elsewhere?

replicate or transfer the practice elsewhere - e.g., a specific climate or specific cultural beliefs or social relations which are important for the success of this practice;)	
	(Score from 1 to 10 on list below with 10 being highly applicable)
	I [10] Transfer of practice to another group/culture/land-use system, etc.
	II [10] Easy to transfer the practice, but with minor adaptations for local conditions
	III [ ] Transfer possible, but significant modifications/prerequisites to consider.
	IV [ ] Difficult to transfer the practice. Need experienced support.
	V [ ] It would be impossible to transfer the practice. Too site specific.
	Other specific remarks: (e.g., agreements, regulations, provisions regarding Intellectual Property Rights, etc.)

Best Practices: (Why this site/ case is considered to be a successful best practice). Good management, ownership is individual, ferro cement tanks cheaper than other types of tanks, community participation higher than for other tanks, less maintenance and repairs need (does not develop cracks easily). Ferro cement tanks should be promote over other types

Contact Organisation: (For further information; site visits' etc)

Type of organisation:	Contact person:CannonYarokamu Rabboni
[ ] government organization	Contact details: Ruharo hill, Mbarara,P.O.Box 14 Mbarara
[ ] private organization	
[ ] NGO &/or CBO	
[ ] international agency	
[ ] other:	

Lessons learnt: (at various stages of the realization of the works, describe any lessons learnt that would improve upon future similar interventions)

Planning: involve beneficiary

Design: Involve beneficiary to achieve best and acceptable design

<u>Construction:</u> use local materials to lower cost
<u>Implementation:</u> training of beneficiary leads to technical competence and better management of system
<u>O&M:</u> Should be as simple as possible
<u>Beneficiary involvement</u>: at every stage so he/she owns facility
<u>Realization of benefits</u>: Such as markets; achieving better returns - crop selection &/or market linkages etc).
Other Remarks or observations:
<u>Contact person completing form</u>: Michael Iwadra
<u>Contact details:</u> Department of Agricultural Engineering, Makerere university P. O .Box 7062 Kampala, Uganda

Legend for Water harvesting schemes		
1. Open Pond - excavated in natural conditions		
2. Haffir/ crescent shaped dam/Water Ponds/Pans		
3. Small Dam - earth embankment		
4. Sub-Surface Dam		
5. Sand Dam		
6. Well - shallow hand dug - with SSI		
7. Well - Deep hand dug - with SSI		
8. Spring Development for SSI and/or other uses		
9. Roof Water Harvesting (Domestic Use)		
10. Runoff Water Harvesting (Domestic Use)		
11. Runoff Water Harvesting (Agricultural/Homestead Use)		
12. Rock and other surface catchment systems		
13. River water harvesting (diversions) for small scale irrigation		
14. Spate Irrigation		
15. Recharge Structures		
16. Insitu Water harvesting Measures/ Soil and Water Conservation techniques on arable rainfed lands		a. Conservation tillage
		b. Planting Pits
		c. Katumani Pit

		d. Semi-Circular Bunds
		e. Negarim
		f. Tied Contour ridges
		g. Contour Stone Bunds
		h. Fanya Juu
		i. Earth Bunds with external catchment
		j. Contour ridges with external catchment