

**CLIMATE-SMART AGRICULTURE**

# **RAINWATER HARVESTING PRACTICES FOR IMPROVING CLIMATE ADAPTATION FOR FARMERS IN UGANDA**



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# Acronyms

<b>ADB</b>	African Development Bank
<b>CAVA</b>	Cassava Adding Value for Africa
<b>CCAFS</b>	CGIAR Research Program on Climate Change
<b>CIDI</b>	Community Integrated Development Initiatives
<b>ERI</b>	Enabling Rural Innovation
<b>FBOs</b>	Faith-Based Organisations
<b>FGD</b>	Focus Group Discussion
<b>GOU</b>	Government of Uganda
<b>HH</b>	Household
<b>IRWH</b>	<i>In Situ</i> Rainwater Harvesting
<b>KIIs</b>	Key Informant Interviews
<b>LC1</b>	Local Council 1
<b>LU</b>	Livestock Unit
<b>MAAIF</b>	Ministry of Agriculture, Animal Industry and Fisheries
<b>MADDO</b>	Masaka Diocesan Development Organization
<b>NAADS</b>	National Agricultural Advisory Services
<b>NDP</b>	National Development Plan
<b>NGO</b>	Non-Governmental Organisation
<b>SSA</b>	sub-Saharan Africa
<b>VI</b>	Vi-skogen



# Executive summary

Poverty and food insecurity plague many countries in sub-Saharan Africa; this includes Uganda. To increase farmer's adaptive capacity and to increase their resilience to climate change and variability, *in situ* rainwater harvesting technologies and practices were promoted in the greater Masaka region, Uganda to enable farmers to sustainably produce food and generate income. This technical report presents the findings of a project aimed at documenting adoption of *in situ* rainwater harvesting technologies and practices by farmers to improve resilience and adaptive capacity to climate change and variability in Rakai district. Specifically the report describes the findings of study to analyse socioeconomic and cultural dynamics of target communities, and identifies *in situ* rainwater harvesting practices and technologies successfully used by farmers to adapt and increase resilience to the changing climate. In addition, analysis of the impacts of adopting *in situ* rainwater harvesting technologies and practices on food and income security are provided. The study also determined the opportunities to farmers from adoption of *in situ* rainwater harvesting practices and identified incentives and/or disincentives for adoption. Qualitative approaches were used to collect and analyse data. First, the study involved a desk review of available literature and focus group discussions with farmers who adopted *in situ* rainwater harvesting technologies and practices. Key informant interviews were carried out with stakeholders from non-governmental organisations (NGOs), faith-based organisations and extension agencies. In addition, questionnaire surveys with 150 respondents from 15 purposively selected villages were administered. Respondents were selected based on evidence of their household's adoption of *in situ* rainwater harvesting practices and technologies and from consultation with key stakeholders gathered through feedback workshops. Study findings show that the most adopted *in situ* rainwater harvesting technologies in Rakai district were Fanya juu1 trenches, Fanya chini2 trenches, soak away pits and side road drains. Findings also show that the appropriateness of a specific *in situ* rainwater harvesting technology depends on the land terrain, farm size and available labour. In general, adoption levels of the technologies are estimated at 35%, and have been increasing slowly but steadily since the 1970s. The main drivers of adoption of the technologies are i) the desire to build support systems to promote increased crop yields; ii) joint learning among farmers; iii) the need to enhance soil and water conservation and management; and iv) provision of support infrastructure for agricultural production. Although possible, higher adoption levels were not reached due to inadequate technical and social support infrastructure, and labour intensiveness of construction and maintenance of structures. The direct impact and usefulness of *in situ* technologies was found to be in improved crop yields leading to reduced food shortages and improved income security among beneficiaries. Although there is a lack of specific records, adoption of *in situ* technologies amid increasing incidence of prolonged droughts and unreliable rainfall has had an impact on the households. These impacts include persistent production of crops and livestock, which has contributed to visible proxy indicators of progress such as sustained volumes of cash and food crops mainly in form of matooke and coffee, and better housing among early adopters. Results further revealed that there are preconditions to be met to ensure scaling up and sustainability, such as creating community ownership and commitment to use of the technologies, continued education and joint learning among target beneficiaries. It was thus concluded that the technologies and practices, if well planned and properly implemented, can greatly help farmers to produce good quality and reasonable quantities of food and income amid climate change and variability. A key recommendation from this study is that holistic interventions involving key stakeholders are needed to ensure sustainability and scaling up of *in situ* rainwater harvesting technologies.



# 1. Background and introduction

## 1.1 Context and challenge of climate change

Many sub-Saharan Africa (SSA) countries including Uganda are known for poverty and the periodic occurrence of food insecurity, a situation which has been worsened by climate change and variability in the past two decades. It therefore remains difficult to achieve the agricultural development targets identified in National Development Plans (NDP) without addressing the impacts of climate change and variability among rural farming communities (UNDP, 2007). Although Uganda has registered economic growth of over 3% in recent years and a population growth rate of 3.03% (UBOS, 2014), one key setback that remains is persistent food shortages and acute poverty. In Uganda, prolonged dry seasons, floods, storms, mudslides, extreme rainfall and delayed and/or early rains have become more frequent and/or intense and are already having an impact on rain-fed subsistence farming practised by over 70% of farmers (Mugerwa, 2007; Larsson, 2005; Musebe *et al.*, 2010; Okonya *et al.*, 2013). While not much change in the total annual rainfall has been noticed across the country, its unreliable distribution has become a major concern for farmers. There are more heavy rainy days in short spans, implying that a lot of water goes to waste and excess water often causes run-off, soil erosion, floods, nutrient depletion and crop damage (Ngigi, 2003a). The long drought periods have also led to scarcity of pastures and drying up of water sources to the detriment of livestock production in most areas (Akpalu, 2005; Kyazze and Kristjanson, 2011). Irrigation cannot be used to address the drought problem in Rakai district because the available water sources are salty (FAO, 2005; Kyazze and Kristjanson, 2011). Therefore, the rainy season provides an opportunity for *in situ* rainwater harvesting at farm level to address crop and livestock water shortages during drought periods (Rockstrom, 2000; Ngigi, 2003a; Falkenmark and Rockstrom, 2006). This is why a lot of the effort by research and development agencies such as universities, NGOs, faith-based institutions and the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) have been geared towards rainwater harvesting with a goal of improving the resilience and adaptive capacity of farmers to climate change (Zziwa, 2012). *In situ* rainwater harvesting technologies (IRWHT) require small investment capital compared with other systems of obtaining water on farm and are thus appropriate for subsistence farmers. Thus farmers have been modifying farming practices and adopting soil and water management technologies since the early 1990s as a coping mechanism.

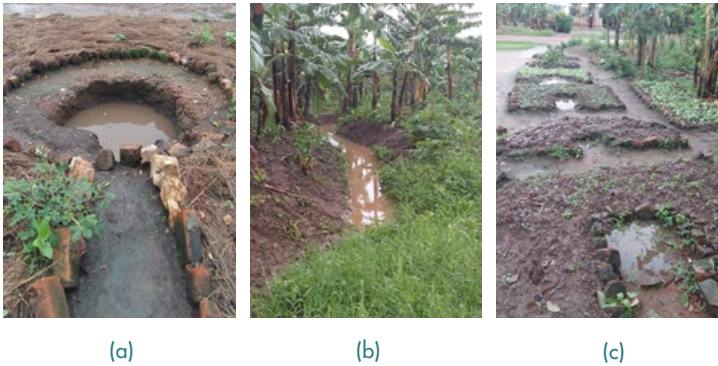


## 1.2 Description of *in situ* rainwater harvesting practices and their evolution in Uganda

*In situ* rainwater harvesting, also referred to as water conservation and run-off farming, is the process of trapping and channelling rainwater by digging water diversion and retention structures such as trenches, contour bunds and soak away pits. These structures divert floods or trap water for supplemental irrigation and provide small external catchments to improve rainfall infiltration, reduce surface run-off and control soil erosion (Hensley *et al.*, 2000; Ngigi, 2003b; Hatibu and Oweis, 2007; ADB, 2008). Topography and geographical location determine the soil and water conservation methods to be used, for example: sloping lands use contour bunds, terraces, retention ditches, vegetative buffer strips and stone lines, whereas flat areas use mulching and conservation tillage. IRWHT are implemented together with other soil and water management techniques, namely: ridging, mulching to maintain soil moisture and avoid water loss by evaporation, conservation tillage and manure addition (FAO, 2002). In the construction of IRWH structures, a trench is dug across the slope and the soil excavated is thrown either upward (*Fanya juu* trenches) or downhill (*Fanya chini* trenches) to form an embankment (Figure 1b). The embankments are usually stabilised with elephant grass, beans and vegetables which end up serving multiple functions as soil stabiliser and pasture/fodder for livestock. In addition, some farmers reported that vegetables and potatoes are usually grown on the *in situ* structures to stabilise them. *Fanya juus* are more popular since after 2 to 3 years the land between the two trenches levels up forming a terrace (Vohland and Barry, 2009). To allow water in the trench to infiltrate uniformly and prevent soil erosion, tie bunds with a width of 0.3 m are constructed at intervals of 2 m. Trenches and contour bunds were introduced in the 1950s by political leaders then in a top-down approach and farmers were compelled to adopt them; this practice was not fully sustainable because of the approach used (Ngigi *et al.*, 2003).

*In situ* water harvesting structures such as *Fanya juu* trenches, contour bunds and soak away pits were re-introduced in Rakai district in the 1990s and were mostly adopted and/or passed on from earlier generations (Kiggundu, 2002). Other farmers have adopted micro pits (30 cm × 30 cm), semi-circular bunds (3.2–7.0 m diameter), contour bunds/trenches (*Fanya juu*) (bunds 30–60 cm deep and 45–150 cm wide; trenches 30–60 cm deep and 40–90 cm wide) and soak away pits to enhance infiltration and uniform water distribution. It should be noted that *in situ*


RWH systems work efficiently where the water holding capacity of the soil is high and rainfall received is equal to or more than the crop water requirement (Hatibu and Oweis, 2007). *In situ* technologies help in reserving soil water within the rhizosphere where plant roots efficiently take it up and this method is needed for moisture-stressed areas. The small external catchment system is another technology where the run-off is diverted and directly applied to the cropland and this has soil fertility enhancement benefits in cases where run-off collected from grazing lands, road drainages and gullies is diverted into plantations. Micro-catchment systems also utilise direct run-off which is generated within the field and water is concentrated on a single crop such as fruit trees or a garden established along the contour. Ridges and mounds are also *in situ* systems in which water is captured and allowed to infiltrate within the micro-catchments formed between the four mounds that are initially constructed. In the process, there is an increase in plant water availability in the root zone and maximisation of plant water uptake capacity.



**Figure 1:** Some *in situ* rainwater harvesting practices: (a) soak away pit (micro-catchment) in a kitchen garden; (b) *Fanya chini* trench with pasture embankment; (c) U-structures, an *in situ* rainwater collection structure in a kitchen garden

### 1.3 How IRWH practices help farmers to address climate change challenges and risks

The basic principle used in IRWH is to start by preventing run-off and promoting infiltration of the rain falling directly on the field. There is evidence of reduced soil erosion, improved infiltration capacity and visibly better yields on farms that have adopted IRWH technologies and practices coupled with good land husbandry management practices in Rakai district. Different households have adopted the innovations, resulting in food self-sufficiency with the surplus food being sold to generate income. Due to diversion of excessive run-off into stored systems within the crop lands, the washing away of soil nutrients, pesticides and fertilisers into surrounding water bodies is lessened. This in return improves the quality of natural and aquatic ecosystems and



contributes to environmental sustainability (Rockstrom, 2002). Case studies in south-western Uganda revealed that incorporating *Fanya juu* or *Fanya chini* trenches in banana plantations enhanced the banana bunch sizes (Ngigi, 2003b). This was attributed to the trenches acting as retention ditches that stored the diverted water from road run-off and conserved the soil moisture for a longer period compared with plantations without such structures (Yosef and Asmamaw, 2015). Well-managed *in situ* rainwater harvesting systems have helped in improving water holding capacity of soils while increasing the water available for crop growth. In addition, *in situ* structures contribute to lessening floods in and around the garden thus contributing directly to risk reduction and crisis management for resilience among poor farmers.

## 1.4 Objectives

The objective of the project was to document *in situ* rainwater harvesting technologies and practices adopted by farmers to improve resilience and adaptive capacity to climate change in Rakai district. The study specifically involved:

- Describing the socioeconomic and cultural dynamics of the target communities
- Identifying *in situ* rainwater harvesting practices and technologies used by farmers to adapt and increase resilience to the changing climate
- Analysing impacts of adoption of *in situ* rainwater harvesting technologies and practices on food and income security
- Documenting opportunities to farmers from adoption of *in situ* rainwater harvesting practices
- Identifying drivers and/or disincentives for adoption of *in situ* rainwater harvesting technologies

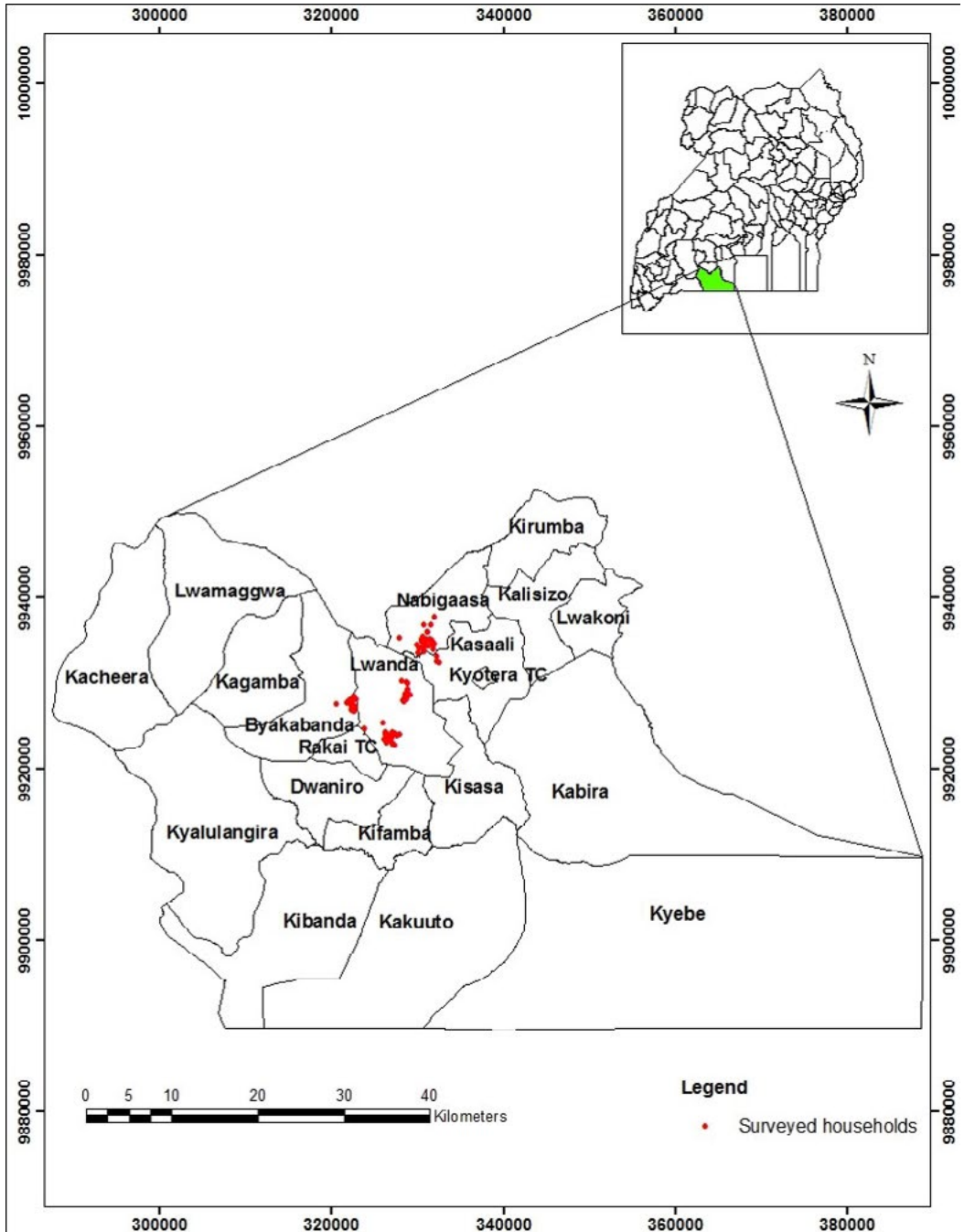
## 1.5 Methods

The study was conducted through five focus group discussions (FGDs) with farmers who adopted *in situ* rainwater harvesting practices. The most active men and women members of farmer groups were selected by farmer group leaders to participate in the FGDs. Key informant interviews (KIIs) with 15 stakeholders from NGOs, faith-based organisations and extension agencies were carried out. In addition, questionnaire interviews were also administered with 150 respondents from 15 purposely selected villages based on visible evidence of adoption of *in situ* rainwater harvesting practices and/or technologies.

## 1.6 Geographical area of the case study

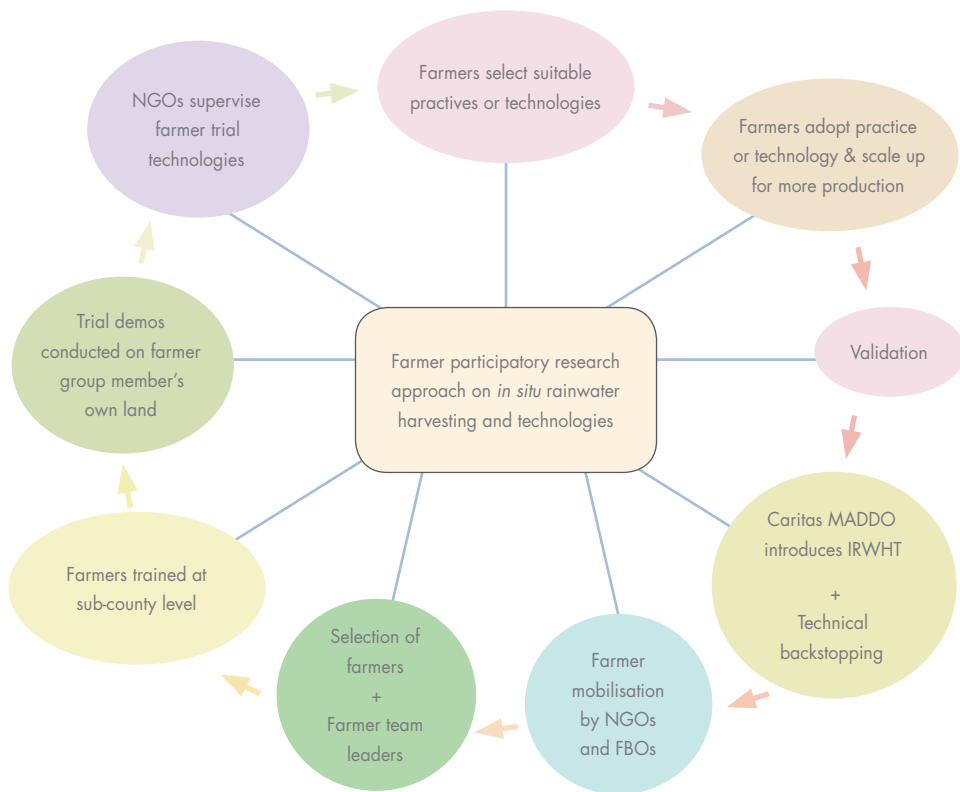
The geographical range where IRWH practices and technologies have been used is Rakai district, which is located in the south-western part of the Central Region of Uganda, west of Lake Victoria, lying between longitude 31°E, 32°E and latitude 0°S (Figure 2). Its southern boundaries are part of the international boundary between Uganda and Tanzania. It is bordered by Lyantonde district in the north-west, Masaka district in the north, Kalangala district in the east, Kiruhura district in the north-west and Isingiro district in the south-west. The district has three counties, 18 sub-counties and three town councils and covers an area of 4,909 km<sup>2</sup>. The technologies and practices were mainly adopted in the sub-counties of Nabigasa, Ddwaniro, Kanoni, Kasaali and Lwanda. Rakai district has an estimated population growth rate of 2.06% and a total population of 518,008, of which 51.1% are females (UBOS, 2014). It is the 11<sup>th</sup> most populated district out of the 112 districts in Uganda. About 96% of the population is rural, a situation which reflects the agricultural nature of the district economy. The rainfall pattern is bimodal, spread over two growing seasons; the first rains occur between March and May and the second rains from August to December (Mubiru, 2010). The district has mild temperatures, ranging from 12.5 to 30°C, with average minimum and maximum temperatures of 11.6°C and 27.3°C, respectively (GOU, 2004). The area has an altitude of over 1,260 m above sea level. These conditions result in an average evapotranspiration rate of 3.26 mm/day which necessitates soil and water management interventions in the district if farmers are to continue practising profitable agriculture.

**Figure 2:** Map of Rakai district showing areas where IRWH is being implemented



# 2. Development process of IRWH technologies and practices

Figure 3 shows the process used in development of *in situ* rainwater harvesting technologies.



**Figure 3:** Development process of *in situ* rainwater harvesting technologies

## 2.1 Farmer mobilisation

Farmer mobilisation was done through local leaders, religious leaders, faith-based organisations (mainly Caritas Masaka Diocesan Development Organization (MADDO)) and other NGOs. During farmer mobilisation, public meetings were the most used method, accounting for about 41% of methods used, combined with about 31% use of one-on-one word of mouth, about 5% use of cell phones, similar to use of mobile public address at 5%, and about 3% use of the group training workshop method. Individual and agency visits were the least used methods, accounting for about 2% and about 1%, respectively.




## 2.2 Sensitisation on the use of the practices and technologies

Sensitisation on technology use helps individuals get information from important referents about the ease of use or the perceived usefulness of the technology introduced, which enables individuals to form stable perceptions of use or usefulness and influences adoption of the technology (Dusengemungu and Kibwika, 2010; Olupot *et al.*, 2014). Farmers who belonged to farmers' groups were involved in the various trainings and demos; this emphasised the need to integrate non-group members into various *in situ* trainings so they can get first hand training on *in situ* technologies. Besides, the trainings were very short, lasting only three to five days which was not enough to acquire prerequisite knowledge and skills. Group training workshops were the most used method for sensitisation on use of '*in situ*' technologies in Rakai district, accounting for about 37%, followed by about 24% use of public meetings and about 9% use of one-on-one word of mouth. Mobile public address was the least used method, accounting for about 1% use, followed by about 2% use of agency visits and about 3% use of individual visits, as well as 3% use of on-farm demonstrations. Community-based trainers were also used as a media to mobilise and sensitise more farmers through groups. This also involved capacity building in areas of group level monitoring and supervision of already constructed structures as well as individual level technology uptake. It was reported that government extension agents initially in 1996 forced farmers to adopt *in situ* technologies but when the extension staff withdrew, farmers abandoned the practice. However, under voluntary uptake, those who had joined groups sustained their on-farm structures. Model farmers located in the area provided training and inspired some of the farmers to take up the technologies. Such models need to be further studied to establish their potential for promoting scaling-out and uptake of the *in situ* practices. It was further reported that selected farms with *in situ* practices were also used as learning platforms by schools, functional adult learning groups, university students, fellow farmers and NGOs.

## 2.3 Trial stage

The trial stage is a means of technology experimentation in a societal context with the aim of learning about the desirability of the introduced technology and enhancing further development and rate of use of a new technology (Lambrecht *et al.*, 2014). In Rakai district, individual farmer visits was the method used mainly for farmer mobilisation during trial of *in situ* technologies, accounting for 50% use, followed by individual visits at about 18% use, group training workshops at



about 11% use, farm-to-farm visits at 6% use and one-on-one word of mouth at about 5% use. Public meetings and farmer exchange visits were the least used methods for trial of *in situ* technologies on farm, each accounting for about 1% of methods used at this stage. *In situ* structure construction was collectively done but maintenance was mainly being done on an individual basis.

## 2.4 Individual uptake on farm

Individual uptake on farm is a critical stage of technology uptake, being a level that influences an individual user's efficacy towards adoption of the technology (Lissaman *et al.*, 2013). On-farm demonstration was the most used method for individual uptake of *in situ* technologies accounting for 51% use, followed by farm-to-farm visits at about 25% use, one-on-one word of mouth at about 5% use and on-farm demonstration at 3% use. Public meetings and farmer exchange visits were the least used methods for individual uptake of *in situ* technologies on farm, each one accounting for 1%. The elderly in the community also played an instrumental role in fostering the uptake of *in situ* practices. There was evidence of in-household uptake when children learned from their parents and grandparents and the practice was later replicated in their own fields after establishing their own households.

## 2.5 Follow up

During introduction of *in situ* technologies in Rakai district, individual visits was the most used method accounting for 26% of use, followed by agency visits at 19%, then public meetings, cell phones, on-farm demonstrations, group training workshops and farmer exchange visits, each method at 8% of use. One-on-one word of mouth was the least used method for follow-up on introduction of *in situ* technologies, accounting for 3% of use.

## 2.6 Sustainability strategies

The methods used to facilitate the process of sustainability of *in situ* technologies, were: agency visits, the most used method at 24% use; followed by individual visits and farm-to-farm visits, each at about 20% use, and public meetings at about 7% use. The least used methods for facilitating sustainability of *in situ* technologies included group training workshops at about 4% use, farmer exchange visits at about 4% use as well and, least of all, one-on-one word of mouth method at about 2% use. Group members were very instrumental in mobilising, participating in sensitisation workshops, conducting on-farm trials,



encouraging individual uptake, supervision and follow-up as well as sustaining the practices after exit of the technology promoter (e.g. MADDO, community integrated development initiatives [CIDI] and Cassava Adding Value for Africa project [CAVA]). The survey revealed that some of the NGOs did not put in place sustainability strategies, and as such there was inadequate supervision especially in the initial stages and after implementation which hindered adoption and sustainability of *in situ* rainwater harvesting practices. The presence of unreliable group members and lack of coordination among some group members also affected the construction of *in situ* structures. The ‘self-concept’ also played an important role in technology introduction on-farm, trials, uptake and sustainability where a number of farmers who had not attended any organised training or farmer-to-farmer knowledge sharing, took self-initiatives to learn the practices, try them on their farms, and sustained them for a period of 2–4 years of use. As one of the sustainability strategies, parents were encouraged to attend trainings with some grown up children in the household to make adoption easy and more sustainable.



# 3. Target beneficiary groups

## 3.1 Characteristics of target farmers

The survey revealed the main characteristics of both men and women beneficiaries of the *in situ* rainwater harvesting practices as summarised in Table 1.

**Table 1:** Characteristics of farmers that use *in situ* rainwater harvesting structures

Farmer characteristic	Percentage of farmers with the characteristic
Belong to a farmer group	77.9
Participate actively in agricultural training	92.4
Have bigger piece of land	16.8
Do joint planning with their spouses and children	55.7
Receptive to visitors	84.0
Do farming as a business	54.2
Participate in other developmental projects	80.9
Have a diversity of enterprises on their farm	67.9
Have a food security mind for their families	88.5
Have higher incomes	64.9
Aware about climatic change impact/shocks	76.3

n=150

It was observed that farmers who belong to farmer groups and participate actively in agricultural trainings have sustained the use of the various *in situ* structures due to continued education as well as the ability to pool labour and work collectively on the construction and maintenance of the structures. In addition, farmers who are receptive to guests and community development partners have also continued to use these structures and this has led to other benefits such as attracting other projects into their area. These again are usually farmers who are receptive to participating in other developmental projects and also have a food security mind for their families. It was also noted that farmers who are climate smart elite also embrace the use of *in situ* structures for soil and water conservation benefits. Other aspects that keep the use of *in situ* structures alive within Rakai district are the diversity of enterprises on the farm and the higher incomes that are generated from better yields. The majority of farmers using the *in situ* water harvesting structures were aged between 20 and 78 years with an average age of 43 years (Table 2).

**Table 2:** Age categories and types of *in situ* technologies used by smallholder farmers

Age category	Percentage of farmers using the different <i>in situ</i> technologies			
	<i>Fanya juu</i>	<i>Fanya chini</i>	Soak away pit	Side road channels
11–20	1.5	0.8	0.0	0.8
21–30	9.9	12.2	2.3	6.1
31–40	15.3	21.4	9.2	13.0
41–50	12.2	16.0	4.6	9.2
51–60	12.2	15.3	6.9	4.6
61–70	3.8	6.1	1.5	3.1
71 +	2.3	2.3	0.0	0.8

n=150

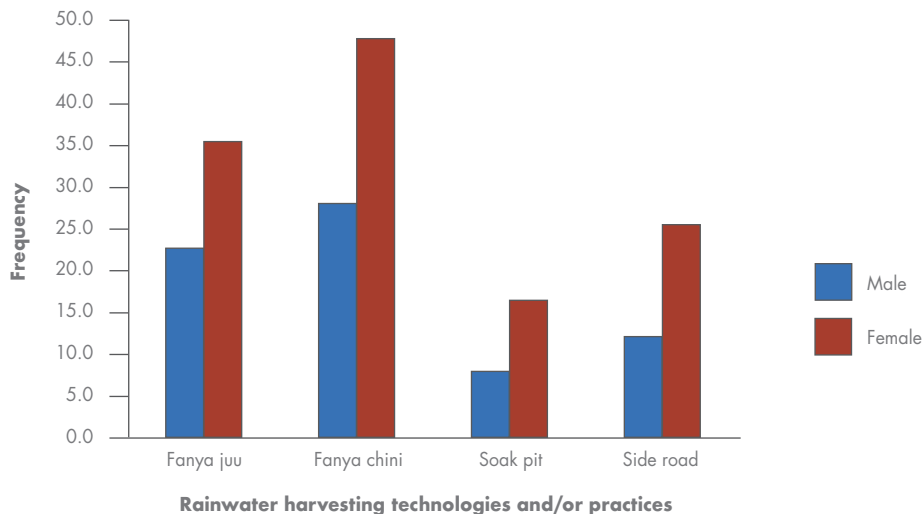
As expected, adoption of *in situ* technologies was highest in the middle age group of 31–40 with more farmers using the *Fanya chini* and *Fanya juu* structures.

## 3.2 Institutions, partners, implementing agencies and actor support services

A number of stakeholders supported the promotion and adoption of *in situ* rainwater harvesting practices and its related technology packages. The key actors in the mobilisation and sensitisation of farmers were mainly political leaders, religious leaders, community-based facilitators, National Agricultural Advisory Services (NAADS) extension service providers and NGOs such as Caritas MADDO, VI-Agro-forestry, World vision, CIDI and through the project on Enabling Rural Innovation (ERI) in Africa championed by the International Centre for Tropical Agriculture (CIAT). Sensitisation was mainly through training of trainers' workshops and farm level demonstration. Farmer groups and leadership played an important role in farmer mobilisation which was critical to the success of adoption of *in situ* technologies and practices. Given the political, economic and socio-cultural set up of rural communities, political leaders, NGOs and NAADS staff played the role of input-supply provision such as planting materials promoted alongside the *in situ* technologies and practices.

### 3.3 Gender-related roles

The survey revealed that more women than men took up use of the different *in situ* rainwater harvesting practices (Figure 4).



**Figure 4:** Adoption of IRWH technologies and practices by men and women

The study also revealed that gender issues are embedded and seem to have an influence on the adoption rate, levels and patterns of *in situ* practices adopted at household level. Gender seems to affect application of the technology in the banana plantations as some families are also taking on additional cash crops (e.g., tomatoes, Irish potatoes and cabbages). Women reported spending an average of 6 hours attending to such crops – mainly involved in land preparation, weeding, spraying and harvesting. These activities are carried out by women almost throughout the year on a daily basis. Combined with daily, household chores, hence leaves women with less time for the banana plantations and maintenance of the *in situ* structures. Several respondents said that most male household heads do not allow their wives to go for any training or join any village groups for fear of infidelity. Thus there is a need for male farmers to be sensitised on the benefits of group formation and women’s involvement in sensitisation seminars on use of *in situ* rainwater practices.

Table 3 shows the roles that various persons and genders (both male and female, children and adults) played during construction and maintenance of *in situ* structures.

**Table 3:** Gender division of labour for the different types of IRWHT

Activities in maintenance and management of IRWHT	Percentage of farmers by gender doing an activity				
	Male adult	Female adult	Female child	Male child	Various gender
<b>Construction activities for the <i>in situ</i> structures</b>					
<b>Site identification for the technology</b>	26.7	23.7	1.5	1.5	41.2
Use an <b>A frame</b> to mark out the site of the structure (contouring)	15.3	4.6	1.5	–	31.3
Take measurements of the width and depth of the structure	25.2	16.8	1.5	1.5	45.0
<b>Maintenance activities for the <i>in situ</i> structures</b>					
Plant grass/legumes to stabilise the embankment	17.6	30.5	2.3	–	14.5
De-silting the structures	23.7	28.2	2.3	3.8	32.1
Maintain the side walls of the structure (embankments)	21.4	26.0	2.3	3.1	32.1
Maintain depth and width structure to the recommended dimensions	21.4	24.4	2.3	5.3	27.5

For instance the construction of *in situ* structures required that farmers (i) identified an appropriate site to install the structures; (ii) took the appropriate measurements for depth and width of the structure; and (iii) used an ‘A frame’ to ensure the structure was constructed along the contour. Respondents reported that maintenance of the structures was also labour intensive as it entailed (i) stabilisation of the structures through planting of grass and/or legumes; (ii) de-silting the structures; and (iii) maintenance of side walls, depth and width of the structures and hence was dominated by male and female adults. Results further revealed that pooled labour was the most commonly used labour for those farmers that belonged to groups. This type of labour did not discriminate between men and women; every one played their part to ensure that the structures were constructed and maintained. Pooled labour was also critical during site identification, using the ‘A frame’ as well during the actual digging of the different structures. For those farmers that decided or had no access to pooled labour, men took the lead in all predominantly construction activities. Women on the other hand contributed more to maintenance activities which included the stabilisation of the structures, maintenance of side walls, depth and width of the structures. There was also predominant use of pooled labour in construction activities, and use of family labour in maintenance of the structures. The survey revealed that there was lesser use of hired labour to construct and maintain the *in situ* structures. Even the few who hired labour reported that the benefits generated from the improved yields outweighed the cost of labour that was involved in constructing the structures and better still a greater percentage of labour costs were incurred at the initial stages of construction rather than maintenance.

# 4. Types of *in situ* rainwater harvesting technologies used by farmers

## 4.1 Description of key types of *in situ* rainwater harvesting structures

The use of *in situ* water technologies is not new in Rakai district. At least 25% and 37% of the respondents have been using soak away pits and side road drains, respectively, since 1991 (Table 4 and Figure 5). Most farmers are mainly using the *Fanya juu* and *Fanya chini* *in situ* structures and the number of structures on a farm depends on the slope and land area (Figures 6 and 7). The two types of *in situ* rainwater harvesting structures were the most popular in the area with 57.3% and 74% of farmers having *Fanya juu* and *Fanya chini* technologies, respectively. Whereas most farmers were trained by different organisations some have also copied from fellow farmers, an indication that well-trained farmers are able to train fellow farmers. There were also some modifications and innovations to the designs and construction of the *in situ* structures by farmers geared towards enhancing their performance. Some farmers (e.g., in Nabigasa 'A' village) modified the design of the soak pits to include use of polythene sheets and sieves, and covering the pit to collect plantation run-off water to be used for irrigation and domestic use. Farmers are also constructing soak away pits in their kitchen gardens to enable all year round growing of vegetables (Figures 8 and 9).

**Table 4:** Types of *in situ* rainwater harvesting practices and technologies and their promoters

Type of <i>in situ</i> water technology	% of respondents using the technology	Promoters who introduced the <i>in situ</i> technology to the farmer					
		NGO	Farmer group	Fellow farmers	NAADS	Government extension officer	Community facilitator
<i>Fanya juu</i>	57.3	66.7	5.4	13.3	5.4	8.0	1.4
<i>Fanya chini</i>	74.0	58.8	7.2	19.6	2.0	11.4	–
Soak away pits	24.4	40.6	3.3	43.9	3.3	6.1	3.3
Side road drains	36.6	52.2	8.5	27.0	4.1	6.3	2.2



**Figure 5:** *Fanya juu* trench in farmer's garden



**Figure 6:** Run-off collected in a *Fanya chini* water channel after light rainfall

## 4.2 Main crops where *in situ* rainwater structures are used

Farmers urged that *in situ* structures are very labour intensive and therefore were constructed in crop fields that had perennial crops (mainly bananas and coffee) with high economic importance and in kitchen vegetable gardens for sustained nutritional benefits (Table 5). It was also noted that *in situ* structures are not constructed on borrowed or rented land due to uncertainty about the seasons they will be allowed to use the land. Farmers also reported use of *in situ* structures for annual crops because such crops are intercropped with coffee or bananas and/or grown on the trenches to stabilise the structures.

**Table 5:** Types of crops where *in situ* water structures are used

Type of structure	Percentage of respondents using a technology in a specific crop field					
	Coffee	Banana	Maize	Beans	Potato	Vegetables
<i>Fanya juu</i>	66.7	100.0	10.7	8.0	4.0	6.2
<i>Fanya chini</i>	60.8	100.0	11.3	5.2	4.0	16.0
Soak away pit	20.0	100.0	15.6	3.1	12.5	21.9
Side road drains	62.5	100.0	12.5	10.4	10.4	16.7

n=150

## 4.3 Types and lifespan of *in situ* structures

Table 6 shows the dimensions, utilisation and lifespan of various *in situ* structures. Farmers reported that the type, dimensions and number of structures on farms varied from one individual farmer to another depending on land size, terrain



**Figure 7:** Run-off collected in a soak away trench in a banana plantation after light rainfall

and labour available. It was also noted that the majority of farmers did not know the A-frame method or its purpose; an indication of the need for more sensitisation on standard measurements for sizing various *in situ* structures. Farmers also reported that the service life of structures varied from 5 to 9 years and that service life was dependent on frequency and degree of maintenance. It was also reported that routine maintenance of structures changes their dimensions, especially depth; hence some farmers argued that it is better to start with shallower structures to attain a longer service life before reaching levels where plant roots cannot draw water from the soil. Farmers have also discovered that *Fanya chini* should be constructed with ‘steps’ in order to control the speed of water and also allow for more even distribution of water.

**Table 6:** Dimensions, utilisation and lifespan of different *in situ* technologies

Types of <i>in situ</i> water technology	Farmer perceived dimensions, requirements and lifespan				
	Average no. of structures on farm	Average no. required by the farm	Average depth (ft)	Average width (ft)	Average lifespan (years)
<i>Fanya juu</i>	3 (1–11)	6 (2–20)	2 (1–4)	2 (1–3)	9 (1–15)
<i>Fanya chini</i>	4 (1–20)	7 (1–50)	2 (1–3)	2 (2–3.5)	6 (1–15)
Soak away pits	1 (1–4)	3 (2–10)	3 (1–10)	4 (2–6)	6 (1–10)
Side road drains	3 (1–8)	5 (1–6)	2 (1–5)	2 (2–3)	5 (1–6)

Note: The values in parentheses indicate the ranges of structures that farmers have on their fields

Farmers on average had three and four *Fanya juus* and *Fanya chinis* respectively but it was a general consensus that at least six *Fanya juus* and six *Fanya chinis* were adequate for a farm size of 1 hectare. Soak away pits and road side drains were constructed in gardens to harvest run-off from roads as well as collect water in a more central place. It was observed that the different types of structures complemented each other and had to be in the same field to cater for both gentle and steep slopes. In this respect, farmers on average had one soak away

pit and at least three side road drains. It was also noted that farmers who had appropriately constructed *in situ* water harvesting structures were those belonging to farmer groups.



**Figure 8:** Soak away trench on a banana plantation

## 4.4 Other complementary technologies and practices promoted

*In situ* rainwater harvesting practices though important were alone not sufficient to motivate farmers and address all soil and water conservation-related challenges faced by farmers in Rakai district. Thus soil and water enhancement strategies were also promoted to complement the *in situ* technologies and practices to ensure a holistic intervention for the farming communities in Rakai district. The most common practices that were used alongside the *in situ* structures for enhancing soil and water conservation were mulching, intercropping, planting of trees among crops (popularly known as agro-forestry) and crop rotation. Other less popular practices included: roof water harvesting, fallowing land, the use of no tillage practices and use of organic manure and inorganic fertilisers to enhance soil fertility as well as green manure.



**Figure 9:** Soak away pit in a kitchen garden

# 5. Adoption of *in situ* practices and technologies

This section discusses the adoption of *in situ* rainwater harvesting practices and technologies by the farming community and the factors that led to the levels of adoption. It also covers the observed trends in adoption of technologies and practices over time, the opportunities arising from the technologies and the drivers of the observed adoption trend.

## 5.1 Levels of adoption of various *in situ* practices and technologies

There was differential adoption among the different *in situ* technologies, with *Fanya chini* and *Fanya juu* registering the highest number of adopters (74% and 57.3%, respectively, Table 7) and this is higher than what Caritas reports. This is expected because of the spill-over effects from the first users and also the fact that Caritas MADDO had an in-built sustainability mechanism for the continued use of these two practices to enhance scaling out even after the end of project life in 2013. *Fanya chini* was adopted more than *Fanya juu* because of their less cumbersome nature during construction and maintenance. Side road drains and soak away pits registered approximately 36% and 24% adoption rates, respectively, with the sole objective of enhancing the volume of run-off that ends up in the in-garden trenches. These technologies were older practices that have been frequently used in the 1970s and Caritas MADDO did not adequately promote them alongside *Fanya chini* and *Fanya juu*. Much as roadside drains and soak away pits have been around the district for some time, few persons use them currently because they were generally promoted for accessing road maintenance benefits as opposed to rainwater harvesting in the early 1960s.

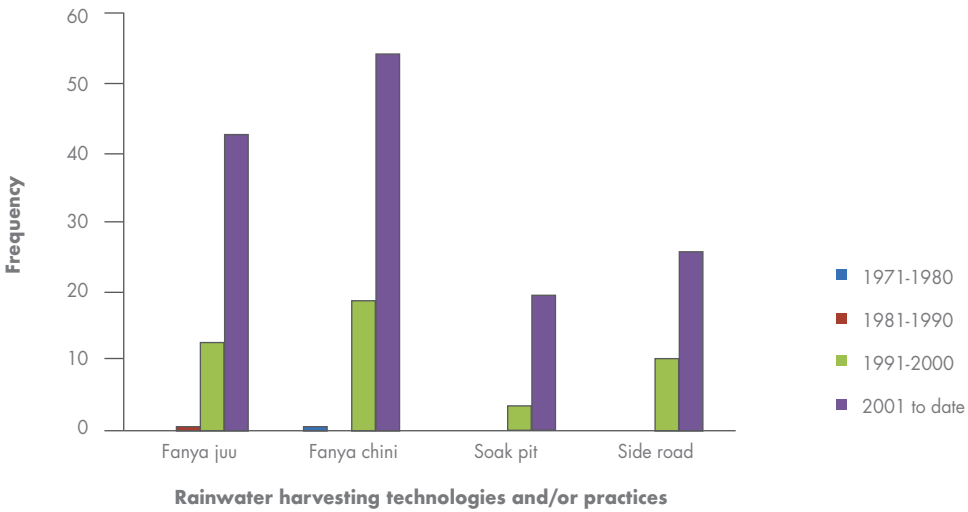
**Table 7:** Adoption of *in situ* rainwater harvesting practices in Rakai district

Types of <i>in situ</i> water technology	Percentage of respondents using the technology
<i>Fanya chini</i>	74.0
<i>Fanya juu</i>	57.3
Side road drains	36.6
Soak away pits	24.4

n=150

## 5.2 Trend of adoption over time

The adoption trends of *in situ* rainwater harvesting technologies over the past four decades are shown in Figure 10, which revealed that there was very limited use of *in situ* rainwater harvesting structures from 1971 to 1990 and this was attributed mainly to the prevailing favourable climatic conditions. The figure further shows that adoption of *in situ* rainwater harvesting structures has been on the rise since 1991 and this is partly attributed to the fact that these technologies have been massively promoted to address the food demands of an ever growing population.



## 5.3 Adoption trends and current number of farmers who have adopted

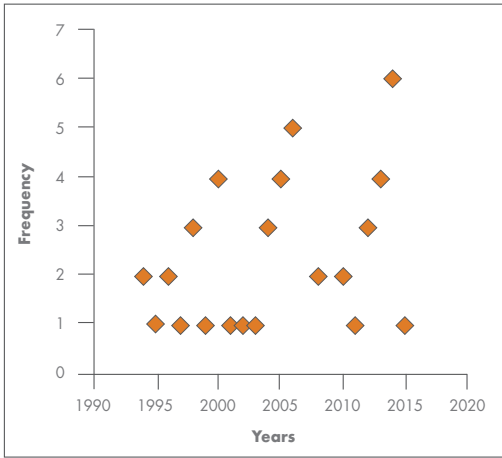
The scatter plots in Figure 11 show that an increasing number of households adopted IRWH practices and technologies since the early 1970s to date. The graphs indicate that *Fanya juu* and *Fanya chini* have been in use since 1970. Secondary data from Caritas MADD0, which was the main promoter of the rainwater harvesting technologies in the greater Masaka region, showed that about 680 farmers have adopted the technologies and practices in Rakai district alone. It was also established that adoption levels in the farming villages of Rakai district are on average 35%. However, the number of adopters keeps growing every year since the technologies were promoted with a revolving fund, involving paying back to new beneficiaries, to ensure that at least an additional 30 farmers join every year. In addition, Figure 11a, c and d shows that the adoption trends rose steadily from 2000 onwards and this was partly attributed

**Figure 10:** Adoption trends of IRWHT in Rakai district since 1970

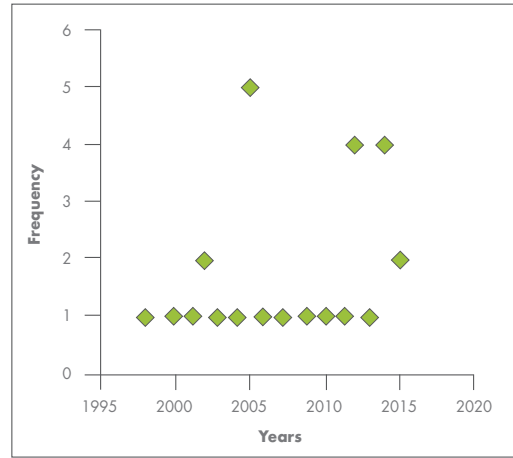


to drastic climate variability with more visible occurrence of unreliable rainfall patterns and amounts adversely affecting crop yields. Consequently there have been increased awareness campaigns on climate smart interventions by various government and non-government agencies to help farmers adapt (Okonya *et al.*, 2013; Mubiru, 2010). Therefore, the period from 2000 when the adoption took a steady increase in momentum particularly with *Fanya juu* and *Fanya chini in situ* structures (Figure 11a, c and d) was mainly an indication of community adoption of the promoted technologies by farmers to allow them to cope with climate change.

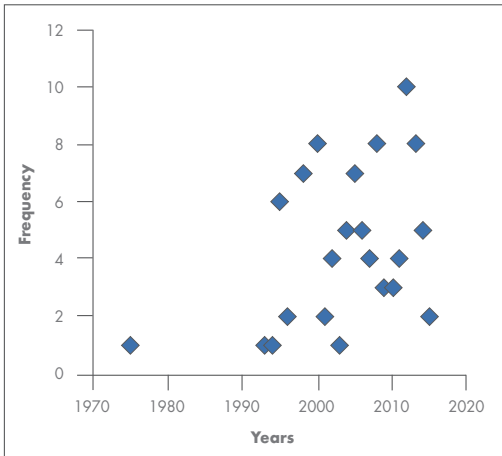
The FGDs revealed that there is increasing adoption of *in situ* rainwater harvesting practices and technologies especially among commercial-oriented coffee and banana farmers who have fully appreciated the benefits of *in situ* rainwater harvesting practices. However, much more sensitisation and awareness creation of the potential benefits of the practices versus the difficulties is still needed among the youth. It is thus not surprising that *in situ* rainwater harvesting structures are common in a number of banana and coffee plantations in Rakai district. It was also reported during the FGDs that there is still a lack of coordination among stakeholders promoting the *in situ* rainwater harvesting practices and technologies in Rakai district, something which limits synergistic benefits that would accrue to farmers from complementary climate smart-related interventions.



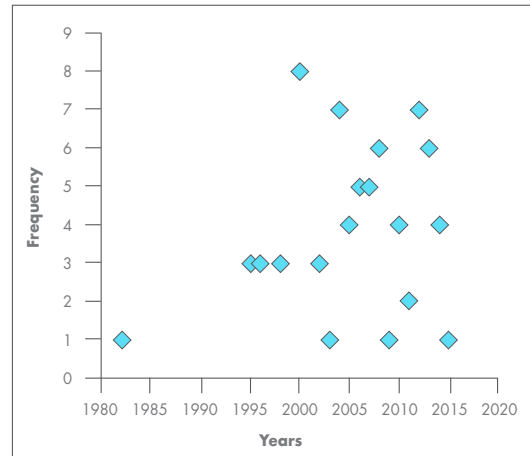
(a)



(b)



(c)



(d)

**Figure 11:** Adoption trends of *in situ* rainwater harvesting technologies: (a) roadside structures; (b) soak away structures; (c) *Fanya chini* structures; (d) *Fanya juu* structures

# 6. Drivers of success of IRWH technologies and practices

## 6.1 What contributed to the levels of adoption?

The study revealed that it took 2–3 years to learn lessons and identify success factors or incentives to the adoption process. There are four major categories of incentives, drivers and innovations that encouraged farmers to invest in use of *in situ* rainwater harvesting technologies despite the heavy investment in labour and farm equipment. First, the desire to build support systems to promote increased crop yields; second, joint learning among different stakeholder groups and farmer communities; third, the need to enhance soil and water conservation and management strategies; and fourth, provision of other support infrastructure for agricultural production. Table 8 also shows the underlying factors under each incentive. The percentage column shows the proportion of respondents who reported a specific driver of success.

**Table 8:** Drivers of success of IRWH technologies and practices

Incentives, opportunities and drivers	% of respondents
<b>1. Building support systems to promote increased crop yield</b>	
Introduction of a holistic package of technologies	80.9
Increased group cohesion and team work	77.1
Attracted different NGOs that promoted the use of <i>in situ</i> practices	74.0
<b>2. Joint learning among different stakeholder groups and farmer communities</b>	
Better quality of crops that are harvested to attract market	96.2
Gained more knowledge on the practices through training	88.5
Attracted visitors and built relationship with other actors	84.7
Attracted other projects to work with farmers	76.3
Made our farms learning platforms for formal institutions	30.5
<b>3. Enhancing soil and water conservation and management strategies</b>	
Enhanced soil moisture retention within the farm	96.9
Decreased soil erosion and washing away of top soil	93.1
Increased soil fertility within the farm	91.6
Decreased flooding of the farm fields	59.5

**4. Provision of other support infrastructure for agricultural production**

Act as platforms for planting livestock feeds	<b>61.8</b>
Used as in-garden footpath	<b>38.2</b>
Used as channels for fertiliser application	<b>32.8</b>
Suppressed the growth of weeds in the farm gardens	<b>30.5</b>

Enhancing soil and water conservation was the over-arching incentive that drove farmers to adopt use of *in situ* structures given the fact that Rakai is one of the most water-stressed districts in the cattle corridor of Uganda. It should be noted that Uganda's cattle corridor is a broad zone stretching from south-western to north-eastern Uganda, dominated by pastoral rangelands. While it is not currently classified as semi-arid, this corridor has many semi-arid characteristics including: high rainfall variability and periodic late onset of rains/droughts (Okonya *et al.*, 2013; Stark, 2011). Therefore, *in situ* rainwater harvesting practices can be scaled up to such areas particularly those involved in crop husbandry. The survey revealed that *in situ* rainwater harvesting structures were promoted alongside agricultural, nutritional, financial management, hygiene and sanitation and energy saving technologies and practices that made the package more attractive to farmers, particularly the youth. In addition, the presence of NGOs such as MADDO and CIDI for farmer mobilisation and sensitisation and demonstration of *in situ* practices, motivated farmers and eased adoption of *in situ* rainwater harvesting practices. Farmers acknowledged that the learning took place in groups but later at an individual level when they tried out the practices on their farms, which made it easier for the farmers to learn and do the right thing on their farms. Joint learning and pooling of labour among group members helped farmers to realise good *in situ* structures which made their farms model learning sites for fellow farmers and other institutions such as schools. The survey also revealed improved soil fertility retention. Soils were no longer being heavily washed away and driven downstream because the *Fanya juu* structures were particularly designed to hold any soil escaping from the farm land due to their location at the boundary of farms on gentle slopes. The *Fanya chini* structures, on the other hand, served to evenly distribute the water within the entire farm thus improving water infiltration. It was reported that *in situ* rainwater harvesting structures suppressed the growth of weeds, provided footpaths within farmers' fields and also served as fertiliser application points. Farmers with livestock reported that they were attracted to *in situ* structures because they also served as a platform for planting livestock feed, in addition to stabilizing the *in situ* structures.


## 6.2 Disincentives or limiting factors to adoption

Despite the benefits that farmers derived from the adoption of *in situ* structures as a climate smart practice, several disincentives also impeded full adoption and/or appreciation of the technologies and practices. The main disincentives were: (i) inadequate technical and social support infrastructure for adoption; (ii) poor construction of the structures; and (iii) labour intensity as summarised in Table 9.

**Table 9:** Disincentives to adoption of IRWH practices and technologies

Challenge/disincentive	% of respondents
<b>1. Inadequate technical and social support infrastructure for adoption</b>	
Inadequate farm implements to dig up the structures	71.8
Inadequate plan for sustainability of the practices when NGOs exited	
- Using farmer groups to reach out to farmers left out a lot of other persons	79.7
- No support was given to farmers' mindset change to adopt the technologies	
Poor social system to support increased uptake of the technology	
- Witchcraft accusations from non-adopters of the practice	62.8
- Theft of farm produce due to good quality	
<b>2. Poor construction of the structures</b>	
Susceptibility of structure wall to heavy rains (leading to damage/collapse)	51.9
Heavy rain causes flooding, leading to collapse of embankments	54.2
	41.2
<b>3. Labour intensity</b>	
Lack of labour to dig up the trenches and pits	70.2
Digging the structures is very labour intensive	87.0
Maintenance of the structures is very labour intensive	66.4
Routine maintenance changes the dimensions of the structures	58.0

Most (70%) of the respondents noted that no clear mechanisms were put in place to enhance the uptake of *in situ* rainwater harvesting technologies and practices. It was reported that Caritas MADDO used a group approach to reach out to farmers during the process of promoting the practices and hence only to a few farmers belonging to farmer groups. Thus, many farmers who would have taken up the practices were left out. Surprisingly beneficiary farmers were accused of using mysterious powers (call it 'witchcraft') to enhance their farm yields by those left out during implementation. It was also reported that the practices were promoted without provision of subsidies to help farmers acquire appropriate tools such as spades, rakes and wheelbarrows and this was a




disincentive to adoption of the structures for some farmers. Others argued that for sustainability reasons farmers in their farmer groups have to create innovative self-financing groups to acquire such expensive equipment and probably support their rotational use.

One farmer had this to say:

“Introduction of the IRWH technologies and practices was a very good idea. Nevertheless, it was not promoted with other appropriate equipment. For example: I needed a rake, a spade and a wheel barrow to help me in the construction and maintenance of my water trenches.”

Failure to emphasise co-investment was one of the weaknesses of the implementers of the *in situ* technologies so some beneficiaries looked at the technologies as entirely free. Farmer mindset and farmer laziness were also highlighted as major factors that impeded adoption of the *in situ* technologies. Respondents reported negative attitude and being indifferent about participation in the training and sensitisation meetings. In addition, there were no sustainability and follow-up mechanisms that were inculcated into the farmers so that they take up these practices as their own. Although Caritas MADDO used the existing community structures including government and community organs to institutionalise the use of *in situ* technologies, used community-owned resources and used community members to supervise the process, the communities did not fully appreciate the benefits in the approach. However, a few farmers surprisingly wanted Caritas MADDO to continue coming back from time to time to follow up their work on a more individual basis to give technical backstopping. Fortunately, a number of farmers are realising the benefits and are gradually taking over ownership of the technologies with some going the extra mile to seek advice from progressive farmers or early adopters. Farmers that adopted the *Fanya juu* and *Fanya chini* structures were advised to use prescribed depth dimensions during the construction. However, a key informant from Caritas MADDO revealed that some farmers did not use the recommended dimensions, citing obstacles such as either saving on space or limited labour for construction of the structures. Due to poor construction some structures became susceptible to heavy rains and floods; consequently many were damaged and/or collapsed prematurely (Table 9). The fact that the structures occupied productive land and acted as habitats for dangerous disease vectors as well as dangerous open water sources that could drown family members and small livestock also hindered adoption and scaling up of IRWH practices and technologies in some households. Labour was another disincentive that made it difficult for



smallholder farmers to adopt the use of *in situ* rainwater harvesting technologies. Over 85% of the respondents noted that digging the structures up, removal of excavated soil, routine maintenance of the structures and stabilisation of the structures were very labour intensive (Table 9).

## 6.3 Challenges to adoption of *in situ* IRWH technologies in Uganda

Although IRWHT have been reported to enhance food and fodder production in many parts of the world, the adoption of these technologies in SSA countries and particularly in Uganda has been slow or in extreme cases the technology has been abandoned. Farmers have often argued that the technology is both labour-intensive and fragile, as the structures break down easily in rough terrain (e.g., stony hill slopes). However, this might be due to the use of inappropriate tools or lack of other energy sources such as animal draft technology. Worse still, in many developing countries such as Uganda, women and girls still provide a significant amount of the farm labour as men and boys opt to work in trading centres and in factories. There are other challenges including the fact that much of the *in situ* harvested water is lost through evaporation and seepage in permeable soils. There is also difficulty in selecting and promoting appropriate RWHT interventions well-matched to the site-specific, biophysical and socio-economic conditions (Gowing *et al.*, 2003). Furthermore, there are constraints in policies, institutions, technologies and capacity which could help the farmers to apply the best systems on their farms.



# 7. Impacts, opportunities and challenges to adoption of IRWHT

## 7.1 Impacts of *in situ* rainwater harvesting technologies and practices

Over 90% of the farmers reported that use of *in situ* structures enhanced soil and water retention on their farms and ultimately improved crop yields and household incomes. Both men and women were well aware of the invaluable contribution of *in situ* water harvesting structures to improving farm yields amid climate change and variability. The positive impacts of adoption of *in situ* rainwater harvesting technologies were mainly on household food security and livelihoods. For instance 90.1% of respondents reported that more food is served in their households; almost 78% of the respondents reported that fewer crops are harvested to provide the same amount of food as before; and almost 91% confessed that they generate more household income as opposed to earlier days before adoption of *in situ* technologies (Table 10). The FGD further revealed that the increased yields as a result of adoption of IRWHT have lessened the burden on women, who are mostly concerned with looking for and preparing food for the households. Farmers also reported that the increased income as a result of increased yields has led to reduced household financial burdens particularly to the men for school tuition fees and scholastic materials. The additional income has also been used to buy other food stuffs to help balance diets in homes and to secure household assets, farm implements and farm inputs. The direct benefits such as payment of school fees, pocket money and school needs for children from sale of banana harvests were reported to motivate the children in maintaining the structures. Some farmers reported that the increased income from their farms has been re-invested in sustaining and maintaining the *in situ* structures while other farmers happily confessed to having used the additional income to hire farm labour, something which has enabled them to even increase the sizes of their banana and coffee plantations. An environmental impact and direct benefit of IRWHT has been reduced incidence of floods attributed to the presence of well-planned and well-maintained *in situ* rainwater harvesting structures.

**Table 10:** Impact of increased yield on household food security and income

Impact on household food security and livelihood	Percentage of farmers
More food is served in the household	90.1
Fewer crops are harvested to provide the same amount of food as used before	77.9
Generate more household income	90.8
- Income is used to pay for school fees	84.7
- Income is used to buy scholastic materials for school	83.2
- Income is used to buy other food stuff in the home	80.9
- Income is used to buy household assets	87.8
- Income is used to buy farming equipment	77.1
- Income is used to buy farm inputs	71.8
- Income is invested in sustaining and maintaining <i>in situ</i> structures	38.2
- Income is used to hire farm labour	48.9

Farmers in Rakai who have adopted *in situ* rainwater harvesting practices continue to produce significant volumes of cash and food crops in the form of *matooke*<sup>3</sup> (Figure 12) and coffee (Figure 13) and they also get stable yields amid increasing occurrences of prolonged droughts and unreliable rainfall patterns. A visit to a number of households of adopters revealed stores of food from previous seasons, yet there are also mature crops seen on farms despite prolonged droughts. Given the fact that a number of farmers are poor at record keeping, it is not easy to access the actual data on differences in the yield, food security and/or income levels of adopters compared with non-adopters in bad weather years. However, more compelling evidence of clear indicators of the impact of IRWHT needs to be gathered, probably in an independent study.



**Figure 12:** Garden with healthy and maturing crops in a drought period



**Figure 13:** Healthy coffee plantation despite drought period

## 7.2 Opportunities resulting from adoption

The adoption of *in situ* rainwater harvesting technologies helped farmers to attract students and researchers from various institutions who come to learn about IRWHT. Furthermore, adoption of IRWHT attracted NGOs that have promoted other climate change-related interventions within the area. In addition, farmers have also taken advantage of *in situ* rainwater harvesting practices and technologies to undertake commercial farming and diversify crops. The improved soil and water management has resulted in higher quality farm produce, something which has given farmers a competitive advantage at market outlets and thus higher incomes, leading to better standards of living and overall community development.



**Figure 14:** Cows and goats in zero grazing shelters

## 7.3 Challenges and unplanned effects from adoption of IRWHT

The study revealed that there were some challenges and/or unplanned effects that farmers experienced in the process of adopting *in situ* rainwater harvesting practices, which were likely to affect uptake and sustainability of the good IRWH technologies and practices. The challenges were:

- Reduced area of land for farming especially for farmers with small land holdings since *in situ* structures consume considerable portions of land
- How to ensure timely and appropriate maintenance of the structures
- How to initiate and or strengthen community-based sustainability plans for the technologies and practices – this challenge has particularly made maintenance and functionality of the structures questionable in the long run
- Dealing with witchcraft accusations and theft of good harvests allegedly by non-adopters, which probably affected some sceptical adopters’ readiness to take up and sustain the practices
- Heavy rains that usually cause flooding and collapse of structures and eventual destruction of crops.

There is also the risk of infants drowning in the deep trenches and the problem of trenches turning into breeding grounds for vectors such as mosquitoes, especially if they are constructed near homesteads.

## 7.4 Strategies to overcome the challenges

Farmers reported that they had devised some strategies to overcome some of the above challenges, including: planting crops and fodder along the embankments to address the challenge of limited land for farming; working in farmer groups to help each other to periodically clear and maintain the trenches; calling upon NGOs to assist in provision of or subsidising some farm implements; and using income from sale of produce to help in acquiring such implements. Farmers suggested that witchcraft accusations should be addressed by intensifying awareness seminars and strengthening the revolving scheme to ensure that more beneficiaries are brought on board with time. Farmers also reported that a number of farmers are planting fruit trees and leafy vegetables along farm borders in a bid to minimise flooding and collapse of the trenches and the eventual destruction of crops. In addition, collapse of the trenches during heavy rains is being addressed by reducing trench measurements from 0.9 m depth by 0.9 m width to 0.6 m depth by 0.6 m width to minimise water overflow.



**Figure 15:** IRWH structures almost disappearing due to poor or lack of maintenance

# 8. Validation

The validation process involved key informant interviews, focus group discussions and field observation. The process targeted smallholder beneficiary farmers across gender and age (women, men and youth) who actually adopted the technologies and those who did not and emphasis was on identifying the observable and tangible changes on farms and/or households of the adopters. All relevant stakeholders were interviewed and they provided validation feedback. The validation process also involved a facilitated discussion session in a feedback workshop to help beneficiary farmers identify the observable changes on their farms as a direct result of adopting IRWHT among other objectives. The facilitators had a check list of anticipated changes to which farmers had to say Yes or No. It was reported that the key implementers of the practices, Caritas MADDO, are yet to undertake a detailed validation exercise to produce empirical data on increase in yields per crop per hectare, return on labour, gross margins and benefit cost ratio of the practice. However, a quick validation process revealed that IRWHT improved productivity of most farms in Rakai district. Visiting and talking to the households with and without the IRWHT revealed that there have been environmental, financial and/or economic benefits. Both women and men farmers have greatly benefited from the IRWH structures as evidenced by the visibly bigger *matooke* bunches in the banana plantations and better yields from coffee farms compared with plantations without or with fewer *in situ* rainwater harvesting structures. Sustained food production in the face of climate variability has been possible as farmers can now produce food even under prolonged drought seasons because of the improved soil moisture attributed to the adoption of IRWHT. The FGDs and KIIs further revealed that the adoption of IRWHT has eventually provided special benefit to females in the form of reduced labour to produce required edible food volumes and this has also contributed to improved diets of the children.



# 9. Potential for scaling up the IRWH technologies and practices

The KIIs and FGDs revealed that *in situ* rainwater harvesting practices and technologies have great potential for adoption in other areas of Uganda and beyond, particularly the banana and coffee growing agro-ecologies. With good mobilisation and sensitisation about the process of developing and maintaining the structures and a well-planned and systematic explanation of the benefits, the possibility of extending the IRWH practices and technologies to other areas is highly plausible. The advantage is that there are already existing farms within Rakai district and the greater Masaka region that can serve as model farms and demonstration gardens for the purposes of interesting other farmers from other areas. It was also noted that scaling out the use of *in situ* water technologies is multi-faceted and therefore requires multiple strategies by various stakeholders to attract new farmers to adopt the technologies.

The conditions that men and women living in other geographical areas need to ensure that the good practice is replicated, but adapted to the new context include:

- Adequate sizes of land to permit construction of the IRWHT without adversely reducing the available land for crops
- Existence/formation of functional farmer groups that have good group dynamics and are willing to adopt the technologies and support colleagues during the adoption process
- Targeting more middle-aged families that can obtain the prerequisite labour at the construction and maintenance stages
- Availability of soils with fairly good water retention capacities
- A fairly good distribution and intensity of rainfall to be harvested into the IRWH structures

The other requirements for replication of the practice on a larger scale (national, regional, international) will include multi-stakeholder analysis and involvement at the various stages of mobilisation, technology promotion, monitoring and evaluation of the adoption process.

## 9.1 Strategies for scaling up and sustaining use of *in situ* technologies

The strategies suggested by farmers as having high potential for scaling up IRWH technologies and practices among the smallholder farmers in Rakai district were broadly put into three categories:

1. Creating community ownership and commitment to use of the technologies
  - Local capacity on IRWHT should be built to pass on information from one generation to the next
  - Farmers should develop a sense of ownership and responsibility to sustain their IRWHT
  - Farmer groups should be strengthened to enhance self-policing and management of IRWH
2. Building sustainability mechanism for project continuity at community level
  - Local governments and other stakeholders should work together to sustain the IRWHT
  - NGOs should have in-built mechanisms for continued use of IRWHT after project completion
  - Promoting effective information flow systems for dissemination on *in situ* technologies
3. Continued education and joint learning among *in situ* technology users
  - Sensitisation about family planning to sustain the established *in situ* structures
  - Establishing knowledge dissemination avenues on benefits of using *in situ* structures
  - Establishing demonstration sites of IRWH practices for joint learning



# 10. Sustainability

The following are needed for use of IRWH technologies and practices to be institutionally, socially, economically and environmentally sustainable:

- Secure land tenure systems permitting long-term benefits to farmers from adoption of *in situ* rainwater harvesting structures without eviction
- Access to and affordability of fairly good implements to ease construction and maintenance of the structures
- Technology promotion mechanisms for supporting continued use of IRWH structures and effective information flow systems for wider information dissemination
- Knowledge and information dissemination avenues e.g., demonstration farms should be established for continued education and joint learning among *in situ* technology users
- Ensuring well-developed markets for farmers' produce and increased awareness about family planning as a strategy that could help farmers to have time to dedicate to farm activities including construction and maintenance of *in situ* structures.

In addition, community ownership and commitment are critical to the sustained use of IRWHT and hence it is necessary to build local capacity on the use of IRWH practices and empower communities to pass on information. Farmers and farmer groups should be strengthened to develop a sense of ownership and responsibility and to enhance self-policing and management of the *in situ* practices and technologies. There is also a need for well-planned exit strategies to ensure that once the promoters of technologies are out, community-based initiatives and platforms are already in place to carry out technical backstopping and help sustain the practice.

# 11. Conclusions

There were several *in situ* rainwater harvesting practices and technologies that were adopted by farmers in Rakai district, but *Fanya juu* trenches, *Fanya chini* trenches, soak away pits and side road drains were the most popular and most influential in enhancing resilience and adaptive capacity of farmers to climate change and variability. The lessons learned from the case study experience, for men and women, were that the appropriateness of a specific *in situ* rainwater harvesting technology depends on the land terrain, farm size and available labour. Promotion and adoption of IRWHT was enhanced by incentives to beneficiary farmers such as integrated support systems and avenues for joint learning. It was also concluded that inadequate technical and social support infrastructure and labour intensiveness of the IRWH technologies impeded adoption of IRWH technologies and practices in some villages. Prior knowledge of the proven benefits of any technology was also a very influential success factor for IRWHT adoption.

There are a number of proxy indicators of the direct impact and usefulness of *in situ* technologies mainly in the form of improved crop yields leading to reduced food shortages and improved food and income security among beneficiaries. This has eventually lessened the burdens for women who are charged with meeting the household food needs. In addition, adopters of *in situ* technologies have become environmentally, financially and/or economically sound and climate-resilient with better living standards compared with the non-adopters. Adoption of IRWHT has also enabled farmers to diversify and to have better quality farm produce for longer periods of the year which has given farmers a competitive advantage at market outlets.

One man said:

“I got training about construction and maintenance of *in situ* trenches and implemented what I had learned. I can now see the benefits on my farm in terms of more food from fewer banana plants than it was before.”

One woman had this to say:

“My farm is located on a hill and whenever it rained heavily all the soil would be washed away. When it shined, the soil would be so dry, and my bananas were too small to attract buyers! When Caritas MADDO taught us how to construct run-off harvesting channels, my banana garden changed drastically. My bananas are now bigger and I can even sell off some and get income which wasn't the case before.”



*In situ* technologies and practices are very labour intensive and hence should be promoted using a clearly streamlined process that creates awareness of anticipated benefits vis-à-vis the related costs. The process should be led by champions who are willing to invest time to work side by side with the farmers until they appreciate the importance of the technology. The process however should be farmer-owned/led to ensure sustainability and scaling out of the practices when the champions pull out. Much as there are increased adoption levels of *in situ* rainwater harvesting practices and technologies by group members in Rakai district, real knowledge regarding its implications, impacts and the techniques is still below the expected levels and there is also low coordination between government agencies and other stakeholders in promoting IRWHT. Therefore, there is a need for synergistic approaches among the various stakeholders promoting community development initiatives and special attention should also be paid to explaining the short- and long-term benefits of the initiatives among other things. *In situ* technologies are not attractive to the youth because of their labour intensity. Hence as a scaling out strategy, IRWHT should be promoted alongside other livelihood-changing activities: for example, group savings, adult literacy and other packages that enhance increased crop yield, farmer empowerment, trust and commitment to attract more farmers, especially the youth.

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## Endnotes

1. A *Fanya juu* trench is one where during trench construction the excavated soil is thrown upward to form an embankment.
2. A *Fanya chini* trench is one where during trench construction the excavated soil is thrown downhill to form an embankment.
3. *Matooke* is the local name for the food derived from banana plants. It is the most popular food in the central region of Uganda which makes up the majority of the population.



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