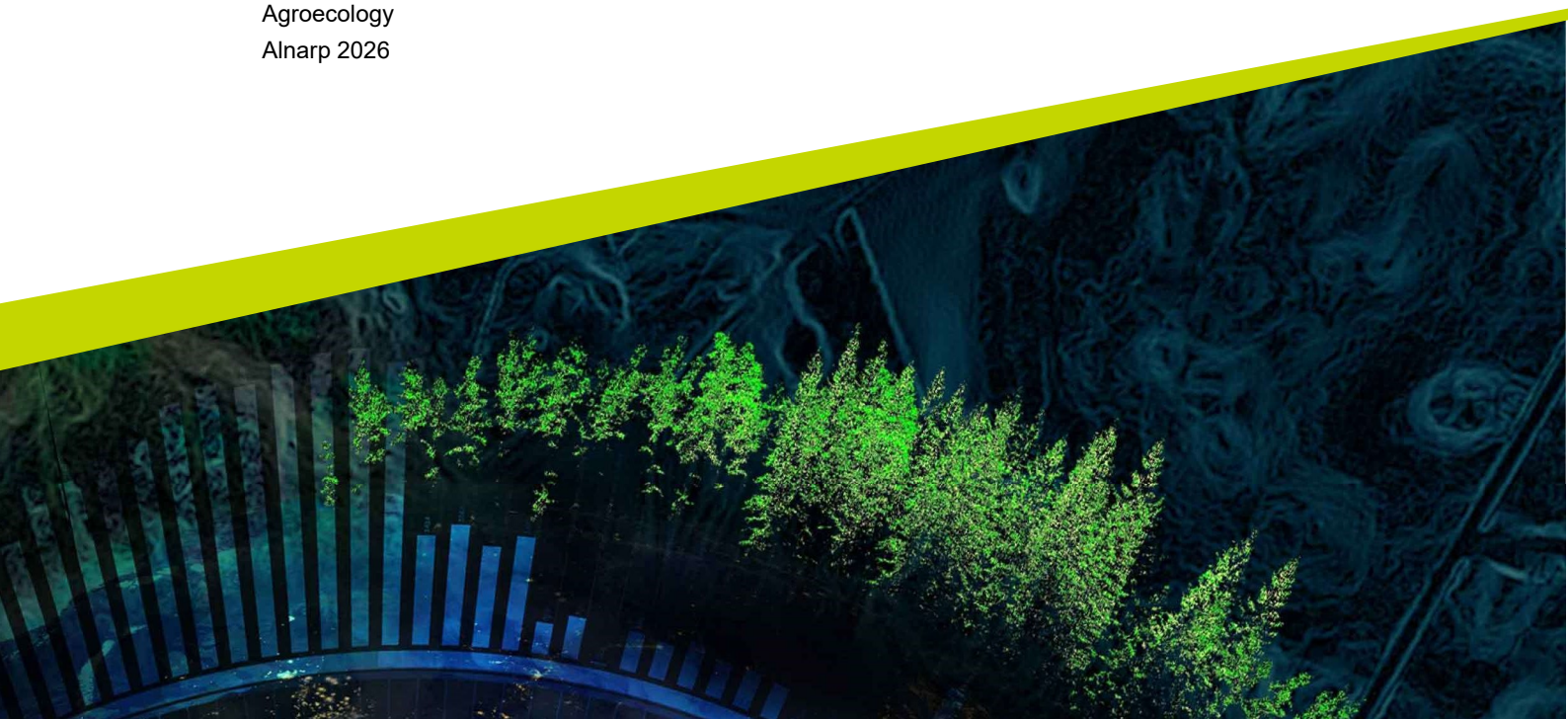
Rainwater Harvesting as a Climate Adaptation Strategy for Rural Households in Lubanja Village, Mityana District, Uganda

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Abstract

Rural households in sub-Saharan Africa face intensifying water insecurity as climate change increases rainfall unpredictability and extends dry seasons, threatening both food security and household water access. While the study is grounded in an agroecological perspective that considers whole farm and food systems, the sample reflects the diversity of livelihoods within the community, including smallholder farming households as well as small-scale traders and other residents whose water use and livelihood strategies are closely interconnected with local agricultural systems. Rainwater harvesting (RWH) has been widely promoted as a low-cost climate adaptation strategy, yet adoption rates in many rural contexts remain below expectations. Existing literature typically frames this as an awareness-practice gap, in which farmers are aware of RWH but fail to adopt it. This study examines whether that framing applies in Lubanja Village, Busimbi Sub-County, Mityana District, Uganda, where RUCID, a local NGO and agricultural training institution, is planning a community RWH support programme.

Using a mixed-methods case study design, this study collected data through a structured household questionnaire (n = 50) and informal interviews with community members (n = 8) and RUCID institutional representatives (n = 2). The questionnaire addressed climate perceptions, current RWH practices, formal awareness of RWH as a defined technology, attitudes and expectations, and barriers to adoption, which were subsequently analysed across economic, informational, social, and environmental dimensions.

Fisher's exact and Fisher-Freeman-Halton exact tests were used to test associations between adoption status and individual characteristics, and thematic analysis was used to identify recurring patterns in interview and open-ended questionnaire data, which are used throughout the Results to illustrate and explain the quantitative findings. Findings reveal a 60.5% adoption rate of informal rainwater collection among Lubanja respondents; among these adopters, 65.4% had never heard of RWH as a formally defined concept, and this same subgroup had also received no water management training. Many adopters reported practising rainwater collection without prior formal RWH awareness or water-management training, driven by direct experience of water scarcity, a pattern distinct from the conventional awareness-practice gap. Yet these practices were found to be functionally insufficient to meet reported dry-season needs: the large majority of adopters reported that stored rainwater did not last through the dry season, and reported water use prioritised household and livestock needs over crop irrigation, consistent with reduced crop yields and crop loss being among the most widely reported dry-season impacts.

These findings suggest that the primary gap in Lubanja is not between awareness and adoption, as hypothesised, but between existing informal practice and the functional adequacy required for that practice to reliably meet household needs through the dry season. RWH programming in this and comparable contexts should prioritise storage infrastructure support and technical upgrading of existing practice, while building awareness of standardised approaches, rather than defaulting to awareness-raising or behaviour change as the primary intervention mode. The study contributes to a broader understanding of how households in resource-constrained settings can develop informal, experience-based water management practices without prior formal knowledge of RWH as a defined system, with implications for agroecologically oriented rural development programming.

Keywords: local knowledge; awareness-practice gap; water storage adequacy; technology adoption; agroecology; dry-season water security

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Abbreviations

Abbreviation	Description
ANOVA	Analysis of Variance
ASA	Articulação Semiárido Brasileiro (Brazilian Semi-Arid Articulation)
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
IF	Informal Interview respondent (community respondent code prefix, e.g. IF-01)
KI	Key informant (RUCID representative code prefix, e.g. KI-01)
NGO	Non-Governmental Organisation
RUCID	Rural Community in Development
SES	Socioeconomic Status
RWH	Rainwater Harvesting
SSA	Sub-Saharan Africa

1. Foreword

This thesis began not with a research question, but with something I had already learned during the two years of the Agroecology programme: a habit of seeing a problem as several connected issues, storage, labour, affordability, instead of one single technical problem.

In 2025, I had the chance to use this way of thinking in practice. I travelled to Lubanja Village, Mityana District, Uganda, to work with RUCID, a local NGO and agricultural training college working to strengthen smallholder farming communities through agroecological approaches. RUCID already had a partnership with SLU, and I was glad to be part of it. RUCID was planning a rainwater harvesting programme and wanted to understand more about what the community already knew, already have been doing, and what they really needed.

Once I started visiting households, this habit of looking for connected issues was immediately put to the test. I expected to find a familiar pattern: farmers who knew rainwater harvesting was useful but had not yet started doing it, held back by limited money and knowledge. What I found instead was more interesting. Two thirds of the households I visited were already collecting rainwater, using tanks, roof-eave containers, and systems they had built themselves through years of experience with water scarcity. Most of them had never even heard the term "rainwater harvesting." They were simply doing it. This gap, between what people were already doing and what formal knowledge gave them credit for, became the central question of this thesis.

Writing this down also meant facing a harder question: whether research like mine, coming with questionnaires to ask people who were struggling to eat about water storage, was even asking the right questions. I found the clearest answer to that question in something I had not asked at all. One woman I interviewed, one of the poorest among everyone I spoke with, told me what kind of support she really wanted, and her words reframed the whole study: "I don't choose money because the money will be finished but the skills will not." I had come with questions about awareness and adoption. She already knew exactly what she needed.

That fieldwork was only the beginning of the thinking this thesis demanded of me. Looking back at the process of writing it, the biggest change in me has been my willingness to redo a lot of work once a real methodological problem is pointed out. One clear example was when I had initially defined the scope of respondents incorrectly, and my supervisor pointed this out in time for me to correct it, which affected the reported adoption rate and several other results. Once I understood why, I reworked the sample and recalculated the statistics, including switching from chi-square to Fisher's exact test for the small sample

size. Through this, I also learned how to choose and justify the right statistical test for a small, non-random sample, something I had never had to do before.

I hope this work will be useful, to RUCID, to researchers interested in how communities build knowledge outside formal systems, and to future students who arrive expecting to find one thing and discover another.

2. Introduction

Smallholder farmers across Sub-Saharan Africa (SSA) form the backbone of the agricultural workforce and contribute the majority of the region's food production, yet they operate under conditions of severe climate vulnerability. In SSA, 95% of cultivated land depends on rainfed agriculture, and approximately 41% of the regional population, around 260 million people, lives in drought-prone drylands (Biazin et al. 2012). Rainfed agriculture in SSA has the lowest agricultural productivity per unit of water among all major world regions (Rockström et al. 2002), meaning that the threat climate change poses to rainfall reliability translates directly into a threat to regional food security.

In East Africa, the expected impacts of climate change are particularly pronounced, including increased frequency and severity of droughts, more frequent localised flooding, and declining crop yields (Mubiru et al. 2018). In Uganda, agriculture contributes approximately 25% of GDP and supports around 72% of the working population, with 54% of agricultural households being smallholder farms whose production depends almost entirely on rainfall (Mubiru et al. 2018; Thompson & Gyatso 2020). Unlike large-scale commercial farming, smallholder households in Uganda typically lack irrigation infrastructure, crop insurance, and credit mechanisms that could buffer the effects of climate variability, meaning that even minor changes in rainfall timing, intensity, or reliability can directly lead to crop failure, livestock loss, and food insecurity. Increasingly erratic weather patterns have negatively affected soil moisture and made it difficult for farmers to plan key agricultural activities, posing a serious threat to food security and livelihoods (Mubiru et al. 2018).

These impacts extend beyond the agricultural calendar. Reduced and increasingly unpredictable rainfall leads to fewer available water points during the dry season, forcing households to walk longer distances or purchase water (Mubiru et al. 2018). Women are disproportionately affected: they bear primary responsibility for household water collection, yet hold land titles, a key determinant of control over water-related investment decisions, in only a minority of cases (Nanteza et al. 2022; CGIAR GENDER Impact Platform 2024).

Rainwater harvesting (RWH) has been increasingly recognised as a low-cost, decentralised climate adaptation strategy suited to smallholder farming communities facing this combination of rainfall dependence and limited infrastructure (Biazin et al. 2012).

However, the effectiveness of RWH is not guaranteed: it depends on local rainfall patterns, available resources, and the technical knowledge and social context of the communities involved (Vohland & Barry 2009; Biazin et al. 2012). Across sub-Saharan Africa, a recurring pattern has been documented in which farmers hold positive attitudes towards RWH without this translating into

adoption, commonly referred to as the awareness-practice gap (Kanyi et al. 2017; Bessah et al. 2022). Understanding both why adoption itself remains uneven across different contexts, and the specific material and informational constraints that limit the reliability of existing practice, is essential for designing interventions that can effectively support water security in specific local contexts.

Existing district-scale evidence indicates that RWH adoption in Mityana District is already widespread but that many existing systems remain technically inadequate to reliably meet household water needs during the dry season (Nanteza et al. 2022). Whether this pattern holds at the household level in a specific community, and what it implies for programme design, cannot be answered by district-scale infrastructure data alone.

This study was conducted in Lubanja Village, Busimbi Sub-County, Mityana District, in direct partnership with RUCID (Rural Community in Development), a local NGO that has identified community-based rainwater harvesting as a priority area for its planned programming but has not yet secured the community-level evidence base needed to design it. The purpose of this study is to provide that evidence base: an empirical diagnosis of local perceptions, existing practices, and adoption constraints, produced specifically to inform RUCID's programme design decisions before implementation begins.

District-scale evidence suggests that RWH adoption in Mityana is already widespread, though often technically inadequate (Nanteza et al., 2022), and that RWH has spread substantially across Uganda as a self-initiated coping strategy rather than through formal programming (Mubiru et al., 2018). However, evidence at this scale can motivate a general programming priority but cannot answer the household-level, operational questions a specific community programme must resolve, such as which barriers dominate locally and what forms of support residents themselves identify as most valuable. Whether this district-level pattern also holds at the household level, and what it would mean for RUCID's planned programme if it does, is the question this study sets out to answer.

3. Research Objectives

The overall aim of this study is to produce an empirical needs diagnosis of rainwater harvesting (RWH) practice in Lubanja Village, Busimbi Sub-County, Mityana District, Uganda, to inform the design of RUCID's planned community RWH programme. Rather than evaluating RWH as a technology in general terms, the study assesses the specific conditions of this community, what residents already know, already do, and already need, as the empirical basis on which programme design decisions should be made.

To achieve this aim, the study pursues four specific objectives:

1) to document local residents' perceptions of how climate change has affected water resources and agricultural production, and to explore how these perceptions relate to their reported decisions regarding water storage;
2) to assess the current extent and form of rainwater collection practice among Lubanja residents, and to compare this with the level of formal awareness of RWH as a defined technology;
3) to evaluate the functional adequacy of existing rainwater harvesting practice relative to self-reported household water needs through the dry season;
4) to identify the economic, informational, social, and environmental factors that constrain households' ability to practise RWH effectively, and to determine the forms of support that residents themselves identify as priorities.

Each objective corresponds to a specific decision RUCID's programme design must resolve: whether climate-risk communication is a necessary starting point (Objective 1); whether the community needs to be introduced to RWH as a new practice, or supported in practices it has already begun (Objective 2); whether existing systems require modest reinforcement or more substantial redesign (Objective 3); and which forms of support should be prioritised, and how, across the community (Objective 4).

These objectives are pursued through a mixed-methods case study combining a household survey, informal interviews with community members and RUCID staff, and field observations conducted in Lubanja village. Building on district-scale evidence that RWH adoption in Mityana is widespread but often technically inadequate (Nanteza et al., 2022) and that RWH in Uganda has spread substantially as a self-initiated coping strategy (Mubiru et al., 2018), this study examines, through Objectives 2 and 3, whether a similar pattern holds at the household level in Lubanja: that informal rainwater collection practices are already widespread, that this practice coexists with limited formal awareness of RWH as a defined concept, and that existing storage appears insufficient relative to reported household water needs during the dry season. The pattern observed at

the household level has a direct, practical consequence for for Objective 4 and for RUCID’s programme design: if this coexistence holds, it suggests the planned programme may be more effectively designed as a technical-upgrading intervention, rather than an awareness-raising or behaviour-change intervention aimed at non-practising households. Together, answers to these four questions indicate whether RUCID's programme should prioritise climate-risk communication, technical upgrading, awareness-building, or targeted resource allocation, and how support should be sequenced across the community.

4. Background

4.1 Climate Change and Smallholder Agriculture in Sub-Saharan Africa

Smallholder farmers in Sub-Saharan Africa (SSA) produce the majority of the region's food and form the backbone of rural economies, yet they operate under conditions of severe climate vulnerability. In SSA, 95% of cultivated land depends on rainfed agriculture, and an estimated 41% of the population, approximately 260 million people, lives in drought-prone drylands (Biazin et al. 2012).

Unlike commercial farming, smallholder systems typically operate without the buffering mechanisms, irrigation infrastructure, crop insurance, and formal credit, that would allow households to absorb a bad season rather than being immediately exposed to its consequences. This structural lack of buffering capacity is what converts ordinary rainfall variability into a recurring livelihood risk, rather than an occasional disruption. In East Africa, the expected impacts of climate change are particularly significant, including increased frequency and severity of droughts, more frequent localised flooding events, and declining crop yields (Mubiru et al. 2018). As noted in the Introduction, agriculture underpins both Uganda's economy and its rural livelihoods, and this dependence is structured almost entirely around rainfall rather than managed irrigation. This rainfall dependence is not evenly distributed: as the following sections detail, its consequences are shaped by district-specific rainfall patterns, seasonal timing, and the presence or absence of local institutional support. Uncertainty in the onset and end of rainy seasons makes it difficult for farmers to plan key agricultural activities such as planting, posing a serious threat to food security and livelihoods. These difficulties are further compounded by a severe shortage of weather information in rural areas, making smallholder farming itself a high-risk enterprise (Mubiru et al. 2018).

Scientific literature confirms that these vulnerabilities are intensifying as climate change alters regional rainfall patterns. Analysis of historical meteorological data from two Ugandan districts spanning 1938 to 2012 shows a declining trend in monthly rainfall amounts and number of rainy days, concentrated particularly in the key crop-growing months of April to June and September to November (Mubiru et al. 2018). Over the same period, average maximum temperature in Hoima rose by 0.8°C and in Rakai by 0.5°C between 2007 and 2012, consistent with the broader warming trend across East Africa (Mubiru et al. 2018). In southwestern Uganda, analysis of Lake Mutanda rainfall data from 1981 to 2020 provides further corroboration: 67.3% of surveyed farmers reported reduced rainfall, and 57.9% noted a deterioration in rainfall distribution over the past 20 to 30 years (Turyasingura et al. 2024).

A methodologically significant feature of this literature is that farmer perceptions of climate change have, in comparable Ugandan contexts, been shown to correspond closely with instrumental meteorological records (Mubiru et al., 2018; Turyasingura et al., 2024). This correspondence provides methodological grounding for treating farmer perception data, of the kind collected in this study, as a meaningful signal of real environmental change rather than a source of distortion; Section 7.2 returns to this point in relation to the present findings.

The impacts of climate-driven water stress extend beyond the agricultural calendar. Reduced and increasingly unpredictable rainfall leads to fewer available water points during the dry season, forcing households to walk longer distances or purchase water (Mubiru et al., 2018). This seasonal water-point scarcity compounds the agricultural pressures already described: households facing crop stress from unreliable rainfall simultaneously face rising costs and time burdens simply to secure domestic water, a dual pressure that intensifies during the same dry-season months when agricultural water need is also highest.

Livestock systems are affected in parallel: in the two Ugandan districts studied by Mubiru et al. (2018), more than 85% of farmers in Rakai and 78% in Hoima identified inadequate livestock feed and drinking water as major climate-related impacts, further narrowing the livelihood space available to smallholder households.

These material pressures are not evenly distributed within the household. In rural sub-Saharan Africa, women bear primary responsibility for household water collection and are disproportionately affected, as they must spend more time fetching water and thus have less time available for productive activities and income generation (CGIAR GENDER Impact Platform 2024). In Uganda and across East Africa more broadly, women have very limited control over water resources and participation in investment decisions, leaving them facing double vulnerability as climate-driven water stress intensifies (Nanteza et al. 2022; CGIAR GENDER Impact Platform 2024).

Although these trends and their impacts are well documented, and although broader community-level water governance in Uganda has received some research attention, a gap remains specifically in relation to rainwater harvesting: existing studies have not systematically examined the household- and community-level conditions shaping RWH adoption in Mityana District specifically, nor connected household perceptions and existing informal practice to the institutional environment surrounding a specific planned intervention. Thornton et al. (2018), drawing on research across 45 sites in five regions, found that although most smallholder farmers had made some incremental adjustments to their farming practices over the previous decade, these changes rarely reached the scale needed to meaningfully strengthen household resilience to climate shocks, of which water security is one central, but understudied, component. The factor most reliably

distinguishing sites with higher from lower adaptation rates was not the accessibility of technologies themselves, but the strength of the local enabling environment, composed of supporting organisations, collective action, and access to climate information (Thornton et al. 2018). This finding points directly to the gap that the present study aims to address: in Uganda's Mityana District, there remains a lack of systematic understanding of how community-level conditions, including current perceptions, existing practices, and the institutional environment, affect households' capacity to cope with climate-driven water insecurity through rainwater harvesting.

4.2 Study Area

4.2.1 Mityana District

Mityana District is located in Uganda's Central Region, approximately 73 kilometres northwest of Kampala, within the Lake Victoria Crescent agro-ecological zone (Senabulya, 2023). The district covers an area of approximately 1,580 square kilometres, with a total population of around 330,000 and an average household size of four persons (Nanteza et al. 2022). The district is predominantly agricultural, with major crops including banana (matooke), maize, beans, cassava, coffee, and groundnut. Coffee is an important cash crop connecting Mityana farmers to Uganda's export economy.

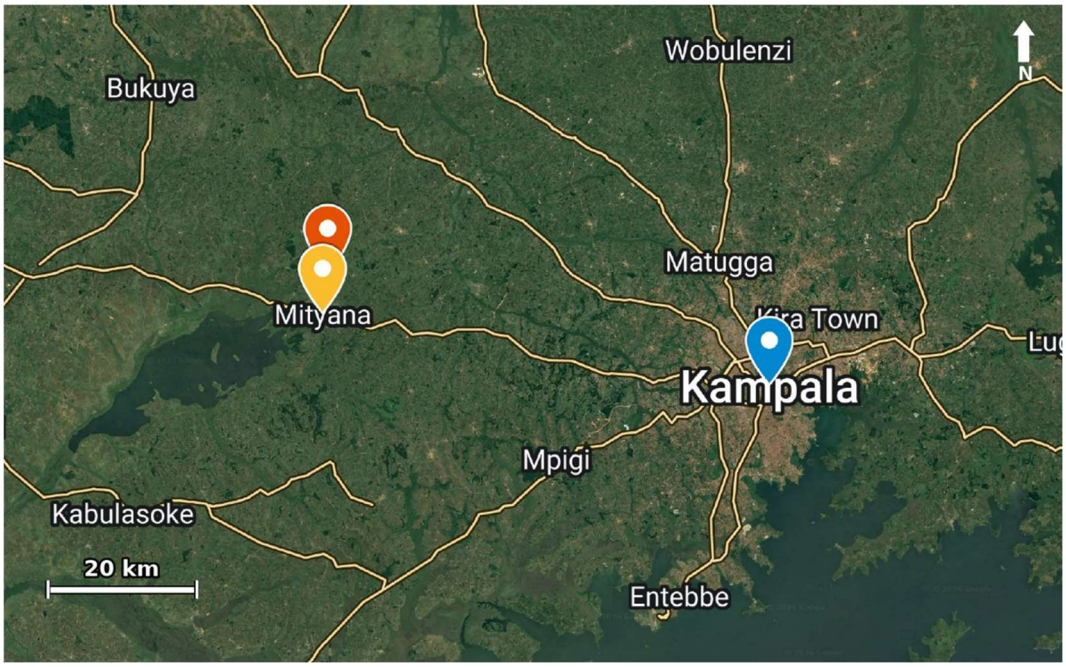


Figure 1 Location of Lubanja Village relative to Mityana Town and Kampala, the capital of Uganda. The red marker indicates Lubanja Village (the study site); the yellow marker indicates Mityana Town; the blue marker indicates Kampala. Base map: Google Satellite (©2026 Google).

Mityana District has a bimodal rainfall pattern: the main rainy season runs from March to May (MAM) and the secondary rainy season from September to November (SON), with peak rainfall in April and October respectively (Nanteza et al. 2022). Based on CHIRPS satellite rainfall data covering 1981 to 2017, mean annual rainfall is approximately 1,300 mm, with inter-annual variation ranging from 1,000 to 1,700 mm (Nanteza et al. 2022). There is significant spatial variation across the district: northern sub-counties such as Kalangaalo, Bulera, and Kikandwa receive between 140 and 156 mm per season, while southern sub-counties such as Butayunja, Maanyi, and Kakindu receive only 125 to 130 mm per season (Nanteza et al. 2022).

In terms of existing RWH infrastructure, the district has 327 documented RWH tanks, of which 55.7% are privately owned by households, and 62% have a storage capacity of between 5,000 and 15,000 litres (Nanteza et al. 2022). As discussed in Section 4.3.3, however, the majority of these systems are too small to reliably meet household dry-season needs.

In terms of water supply more broadly, the district has 1,707 domestic water points serving approximately 295,229 people, of whom 194,897 are in rural areas; 602 water points have been out of operation for more than five years and are considered abandoned (Ministry of Water and Environment, Uganda, n.d.).

4.2.2 Lubanja Village

Lubanja Village, the primary field research site of this study, is located in Busimbi Sub-County, Mityana District, approximately 4.5 km north-northeast of Mityana Town, at coordinates approximately 0.44°N, 32.05°E, with an elevation of around 1,256 metres. Within the spatial rainfall distribution of Mityana District described above, Busimbi Sub-County falls within the mid-range rainfall zone (Nanteza et al. 2022).

Lubanja has a mean annual temperature of approximately 23.8°C, with February the warmest month (mean approximately 24.78°C) and June–July the relatively cooler months (mean approximately 22.97–23.17°C). The annual number of rainy days is approximately 265, with mean relative humidity of 82.6%. Rainfall is markedly seasonal: November is the wettest month (mean approximately 510 mm) and July the driest (mean approximately 91 mm). This local pattern is consistent with the bimodal rainfall regime described for Mityana District as a whole: Lubanja also shows a secondary rainfall peak in April (mean approximately 355 mm), though this March–May season is somewhat less pronounced locally than the dominant September–November season. During the dry season from June to August, rainfall drops sharply, creating a clear gap between water supply and agricultural water demand (WeatherandClimate.com, 2024). This rainfall distribution gives household water storage direct practical relevance for bridging dry-season shortfalls.

4.2.3 RUCID

RUCID (Rural Community in Development) combines the roles of NGO and training institution, with a focus on organic agriculture. It is based in Lubanja Village, Kigogozi LC1, Busimbi Sub-County, Mityana District, and has served the community for more than 20 years, working to improve livelihoods through rural development and organic agriculture education. Its core programmes include organic farmer training, youth and women empowerment, ecotourism, and demonstration garden development, and over the past two decades RUCID's programmes have trained more than 590,000 farmers across Uganda (RUCID, n. d.).

RUCID also operates a College for Organic Agriculture, funded by The Tudor Trust (UK), offering diploma and certificate training. The RUCID campus has an installed decentralised rainwater harvesting system and fuel-efficient wood stoves (ArchDaily, 2018). RUCID has identified community-based rainwater harvesting as a priority area for future programming, but implementation has not yet begun due to funding constraints. This study aims to provide an empirical foundation for RUCID's planned programme.

4.3 Rainwater Harvesting as a Climate Adaptation Strategy

Rainwater harvesting refers broadly to the collection and storage of rainfall for agricultural, domestic, or livestock use. As a low-cost and decentralised water management approach, RWH has been increasingly recognised as a practical climate adaptation strategy suited to smallholder farming communities in sub-Saharan Africa, where formal irrigation infrastructure is severely limited and dependence on rainfall is extremely high (Biazin et al. 2012). Evidence for its effectiveness spans multiple ecological contexts and scales, though actual outcomes depend greatly on the technical design of the system, local rainfall and soil conditions, and the social conditions that constrain adoption and maintenance.

4.3.1 Technical Categories and Their Applicability

Biazin et al. (2012) distinguish four main categories of commonly practised rainwater harvesting and management techniques in SSA. In situ techniques retain rainfall at or near where it falls, enhancing infiltration and reducing surface runoff and soil evaporation, without requiring a separate catchment area. Common approaches include tied ridges, furrow damming, conservation tillage, and mulching, which work by improving soil water content in the crop rooting zone. Micro-catchment techniques collect surface runoff from a small fixed area within farm boundaries, typically 10 to 500 square metres, and direct it to a planting area or infiltration structure. Examples include half-moon catchments, planting pits

(zai), stone bunds, and contour ridges, widely used in the Sahel, East Africa, and southern Africa.

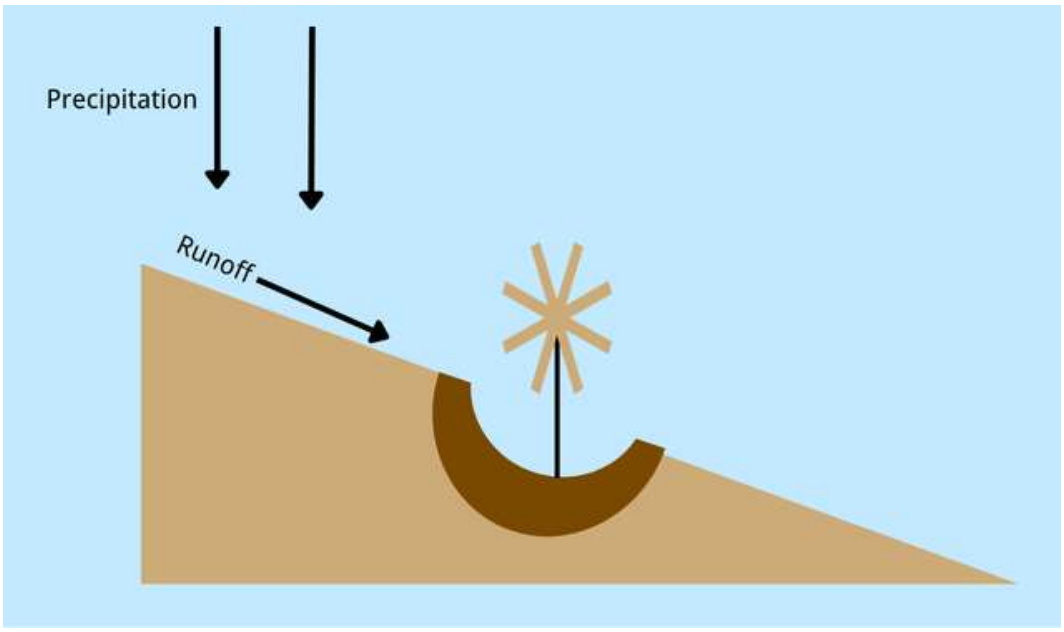


Figure 2. Schematic representation of micro-catchment rainwater harvesting. Runoff generated on a small, fixed catchment area is directed a short distance to a planting pit or basin (target), where it infiltrates directly into the root zone; no intermediate storage structure is used. Author's own illustration, based on the technique description in Biazin et al. (2012).

Macro-catchment techniques harvest runoff from larger external areas, stored in ponds, cisterns, or shared reservoirs for supplemental irrigation or community water supply.

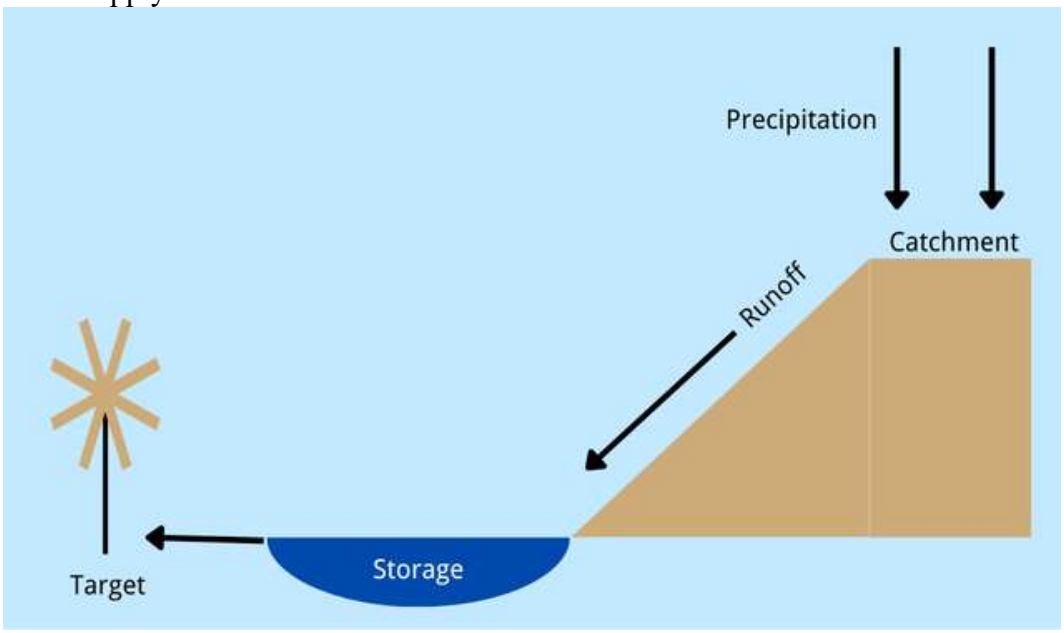


Figure 3. Macro-catchment techniques harvest runoff from larger external areas, stored in ponds, cisterns, or shared reservoirs for supplemental irrigation or community water

supply. A fourth category covers techniques that maximise plant water uptake through response farming, genetic adaptation, and agronomic management, which fall outside the scope of this study.

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In resource-limited contexts, in situ and micro-catchment approaches are generally more feasible than large-scale infrastructure, as they can be implemented using local materials and require minimal external inputs (Biazin et al. 2012). Importantly, many of these techniques are not entirely new introductions but represent improvements on indigenous practices that have been maintained across generations in sub-Saharan Africa. Overall, improving traditional practices has proven more effective than introducing entirely new technologies, and there is a clear need to identify, build upon, and promote existing indigenous RWH systems rather than replacing them with externally designed alternatives (Biazin et al. 2012). This principle, that informal, locally developed practice constitutes a starting point rather than a deficiency to be corrected, recurs as a structural theme later in this thesis.

These four categories, however, describe techniques oriented primarily towards agricultural productivity. A related but conceptually distinct form of RWH, rooftop catchment directed towards domestic storage rather than field-level infiltration or irrigation, is not captured by this typology, yet, as Section 7.3 shows, it is the dominant form of practice observed in Lubanja.

4.3.2 Evidence of Effectiveness

Field research across SSA confirms that appropriately applied field-level RWH techniques can meaningfully improve soil water availability and crop productivity, with reported gains of up to 30% in rooting-zone soil water content and 30 to 50% in crop yield across a range of techniques and contexts (Biazin et al., 2012). One case illustrates the scale of the effect: a three-year Tanzanian trial found that pairing tied ridging with mineral fertiliser lifted maize grain yields sixfold relative to unfertilised flat planting, from around 1 to 6 Mg per hectare, nearly tripling rainfall productivity in years of close-to-normal rainfall (Jensen et al., 2003, as cited in Biazin et al., 2012). Comparable gains have been documented elsewhere in the region, in Ethiopian and Zimbabwean tied-ridge systems, Tanzanian rice paddies, and South African basin tillage (Araya & Stroosnijder, 2010; Motsi et al., 2004; Raes et al., 2007; Hensley et al., 2000; Walker et al., 2005, all as cited in Biazin et al., 2012).

At a larger scale, Garg et al. (2022) synthesised evidence from 25 agricultural watersheds across India's semi-arid tropics, finding that RWH interventions lifted the water table by 2.6 to 6.9 metres, intensified cropping by 40 to 100%, and raised household incomes by 50 to 200%, with soil erosion falling by around 70%

and investment typically recovered within three years. These figures come from South Asian rather than sub-Saharan conditions, but, as Chapter 8 discusses, they offer a useful benchmark for the returns RUCID's programme might expect were it to extend beyond domestic storage into field-level water management.

4.3.3 RWH in the Uganda and Mityana Context

In Uganda, household RWH has become one of the fastest-growing local innovations in smallholder farming communities, with approximately 89.6% of households surveyed in Rakai District adopting it as a coping strategy to deal with increasing water scarcity (Mubiru et al. 2018).



Figure 4. Field photographs illustrating the smallholder farming context in Lubanja Village. (a) A homestead with cattle grazing near the house, alongside jerrycans used for manually transporting water, illustrating the reliance on livestock and the physical effort involved in water collection typical of smallholder households in the study area. (b) Crops near banana plants and ditches dug between rows in a small vegetable garden, illustrating the single-crop cultivation methods commonly observed in local farming practice.

However, despite the widespread nature of this spontaneous adoption, existing systems often lack technical guidance. Nanteza et al. (2022) found that in Mityana District, 97% of existing RWH systems were technically undersized relative to a high-demand scenario (50 litres per person per day for a 90-day dry season), a standard sufficient to cover drinking, cooking, bathing, and laundry needs. Critically, their analysis showed that this gap was not due to rooftop catchment areas being too small, but rather because household decisions about tank storage capacity were made without reference to any technical design parameters: households purchased or built tanks based on financial capacity and subjective judgement, rather than systematically calculating required storage based on rooftop area, household size, and seasonal rainfall variability (Nanteza et al. 2022).

This district-scale infrastructure pattern raises a question this study is positioned to answer at the community level: whether the same configuration, widespread spontaneous practice paired with technical undersizing, holds specifically among Lubanja households, and whether the mechanism Nanteza et al. (2022) infer from physical tank measurements (subjective, non-technical sizing decisions) is consistent with how residents themselves describe their own practices. Confirming this at the household level, rather than assuming it applies uniformly across the district, is a necessary step before RUCID can responsibly design a programme response.

4.3.4 Governance and Social Infrastructure as Enabling Conditions

The experience of Brazil's semi-arid region provides an instructive comparative case, demonstrating the conditions needed to scale RWH from informal household-level practice to broader reach. Between 2003 and 2016, Brazil's One Million Cisterns Programme (P1MC) constructed more than 1.2 million household rainwater cisterns across the semi-arid Northeast, reaching some of the country's most water-scarce rural communities (Lindoso et al. 2018). The programme's success lay not in the technical complexity of the intervention, because the slab cistern itself is a simple and low-cost structure, but in the governance model that underpinned it: a decentralised system coordinated nationally by the civil society organisation ASA, in which local NGOs served as implementation agents, local craftspeople were trained and participated in construction, and each installation was accompanied by mandatory water resource management and civic education training (Lindoso et al. 2018). In areas where the governance model was most fully developed, such as the state of Bahia with its well-organised civil society networks, adoption rates were highest and community ownership was most durable. In areas where local NGOs were weak or absent, such as parts of Ceará, adoption was lower and more fragile (Lindoso et al. 2018). Notably, after 2014, when mandatory training requirements were removed and implementation was opened to local government bodies unable to maintain these requirements, programme quality and sustainability declined markedly, indicating that technical support and community education are not optional add-ons to an RWH programme but structural prerequisites for its effectiveness.

The evidence reviewed above establishes a general pattern in the RWH literature: effectiveness depends less on the technical characteristics of the system itself than on the social, institutional, and informational conditions surrounding its design, installation, and maintenance. Whether this general pattern applies specifically to Lubanja, and in what form, is precisely the question RUCID needs answered before committing programme resources: is the priority awareness-raising, technical support, financial support, or some combination specific to this

community? District-scale data on Mityana (Nanteza et al., 2022) suggest technical inadequacy is likely to be part of the answer, but district-scale data cannot tell RUCID what its programme should prioritise at the level of an individual village. That determination requires the community-level diagnosis this study provides.

4.4 Factors Influencing RWH Adoption: The Awareness-Practice Gap

Although the technical potential of rainwater harvesting is well documented, adoption rates among smallholder farmers in sub-Saharan Africa remain uneven and frequently fall short of what physical conditions would allow. A consistent finding across multiple national contexts is that many farmers who hold positive attitudes towards RWH do not translate this into practice, a phenomenon commonly referred to as the awareness-practice gap (Kanyi et al. 2017; Bessah et al. 2022). Understanding the factors underlying this gap provides the framework against which the findings of this study can be assessed, including whether the gap in Lubanja takes the conventional form described here. The literature identifies four main categories of factors: economic constraints, limited technical knowledge and access to information, social factors including gender dynamics, and environmental uncertainty.

4.4.1 Economic Constraints

Economic barriers are consistently identified in the literature as the most frequently cited obstacle to RWH adoption, and their mechanisms are multi-layered. The first layer is the upfront investment cost: the installation costs of water storage equipment, including tanks, guttering, pipes, and fittings, are often impossible for smallholder households with limited and unstable incomes to meet all at once (Sithole et al., 2025). A second, less visible layer is the broader absence of credit, insurance, or savings mechanisms in many smallholder contexts, which limits households' ability to convert recognition of RWH's long-term value into upfront investment (Sithole et al., 2025). This layer was not directly probed in the present study's instruments and is discussed here as general context rather than as a locally confirmed constraint. The third layer is ongoing maintenance costs: complex systems whose maintenance requires materials and skills not locally available often fall into disuse over time even when initially installed with external support (Biazin et al. 2012). These three layers combine to mean that the economic barriers to RWH adoption are not simply a matter of not being able to afford the initial purchase, but a structural constraint operating throughout the full adoption cycle.

In Mityana District, this economic barrier is relatively well documented. Nanteza et al. (2022) estimated that upgrading existing household RWH systems to a high-demand standard, defined as 50 litres per person per day for a 90-day dry season, would cost between 600 and 1,250 USD per household, compared with a mean annual household income of approximately 1,500 USD in the district. Even at the low-demand threshold (15 litres per person per day), 25% of existing systems were found to be insufficient, indicating that even under conservative assumptions the gap between current practice and effective water security is considerable. This local data illustrates the scale of the economic barrier in the Mityana context: the problem is not that farmers are unwilling to invest, but that in the absence of external support, the cost of effective water storage structurally exceeds the capacity of most households. This makes effective RWH structurally unachievable for the majority of households without external intervention, rather than simply a matter of insufficient willingness to invest.

4.4.2 Technical Knowledge and Access to Information

In Ghana, probit regression analysis of 344 maize farmers by Bessah et al. (2022) provides quantitative evidence that institutional information channels play a central role in RWH adoption: limited access to extension services was significantly negatively associated with adoption ($p < .05$), while having access to weather information increased the probability of adoption by 0.183 ($p < .01$). Despite this, the proportion of both adopters and non-adopters in the sample who had access to weather information was extremely low, consistent with findings from other SSA countries, indicating that the absence of institutional information channels is not a marginal issue but a structural one: the information channels most predictive of adoption behaviour are precisely those most inaccessible to the majority of rural households (Bessah et al. 2022). In Kenya, Kanyi et al. (2017) similarly found that farmers relied primarily on informal channels such as neighbours, family members, and media, rather than formal advisory networks for information about RWH, limiting the depth and technical accuracy of their understanding of RWH systems. In Uganda, insufficient farmer knowledge and the absence of extension and advisory support have been identified as key constraints on the uptake of water management technologies, alongside uncertain land tenure and poor infrastructure (Thompson & Gyatso 2020). Across all these contexts, the consequence of relying on informal information channels is the same: practice tends to remain at a simple and improvised level, rather than developing into technically designed water storage systems capable of reliably meeting household dry-season water needs (Kanyi et al. 2017; Bessah et al. 2022).

This pattern is consistent with wider evidence from agricultural technology adoption research. Thornton et al. (2018) found across 45 study sites in five regions that access to supporting organisations and climate information was the

factor most consistently associated with higher levels of household food security and agricultural adaptation. Sites with stronger institutional support and more comprehensive climate information provision showed clearly higher proportions of households actively improving their agricultural practices, suggesting that the institutional dimension of technology access is at least as important as the characteristics of the technologies themselves (Thornton et al. 2018).

However, the relationship between knowledge access and practice is not invariably one in which knowledge precedes action. Evidence from severe water-scarcity contexts raises the possibility of an alternative pattern, in which practice precedes formal knowledge rather than following from it, developing instead as an improvised response to immediate need. Mubiru et al. (2018) and Biazin et al. (2012) point in this direction at the national and continental scale respectively, and Nanteza et al. (2022) suggest a Mityana-specific version of it: although households independently installed RWH systems, 97% of these were technically undersized relative to actual household need. Whether this configuration, rather than the conventional awareness-practice gap, describes Lubanja specifically, and what it would mean for how RUCID's programme should be targeted, is a question this study is designed to answer.

4.4.3 Social Factors: Gender and Community Organisation

Social factors play an important and often underestimated role in shaping RWH adoption patterns. At the household level, the gendered division of labour and resource access creates a systematic asymmetry: who bears the burden of water insecurity and who has the capacity to take action are frequently not the same person（CGIAR GENDER Impact Platform，2024）. Women in sub-Saharan Africa are typically responsible for household-level water collection and management, yet face significant barriers to participation in water governance and decision-making processes (CGIAR GENDER Impact Platform 2024). Although women in Africa actively participate in cultivation and income-generating activities, this does not translate into control over water resources or climate adaptation decisions: social norms around land ownership favour men, and in agriculture only 32% of women hold land titles (jointly or solely) and only 13% hold sole ownership, a structural disadvantage that directly limits women's decision-making influence over water-related investments (CGIAR GENDER Impact Platform 2024).

In the specific context of RWH adoption, Kanyi et al. (2017) found in a study of 310 smallholder farmers across four sub-counties in Kenya that women held significantly more positive attitudes towards RWH than men, $t(308) = -2.72$, $p = .007$, with a small effect size (Cohen's $d = 0.34$). However, while attitudes showed a statistically significant positive correlation with adoption ($r = .23$, $p < .05$), the correlation between socioeconomic status and adoption was near zero

(r = .03), suggesting that the gap between positive attitudes and actual practice is explained not by differences in motivation or economic conditions but by differences in structural capacity to act (Kanyi et al. 2017). Furthermore, an ANOVA test showed that the overall difference in RWH attitudes across socioeconomic status groups was statistically significant (p = .04); Gabriel post hoc tests further revealed that farmers in the low SES group had significantly higher mean attitude scores than those in the high SES group (p = .02), indicating that the most resource-constrained group was the most enthusiastic about RWH, precisely because they directly bear the costs of water scarcity (Kanyi et al. 2017). This finding reflects the broader pattern documented at the SSA level: women and low-income farmers tend to show higher motivation to adopt water-saving technologies than other groups, but their capacity to act on this motivation is constrained by structural inequalities in resource access (Kanyi et al. 2017; CGIAR GENDER Impact Platform 2024).

At the community level, the presence or absence of organised groups, levels of social trust, and institutional support have been shown to influence whether RWH is adopted individually or collectively (Vohland & Barry 2009). Where community organisation is weak and external support structures are absent, adoption tends to remain fragmented and small in scale, even when physical conditions are favourable. Lindoso et al. (2018) found, by contrast, that in the Brazilian semi-arid context, the large-scale diffusion of household cisterns was due not to improvements in the technology itself but to a decentralised governance model in which local NGOs and community organisations played a central role in implementation and training. This finding suggests that collective action, trusted intermediaries, and community-level institutions. In other words, social infrastructure are prerequisite conditions for the wider adoption of RWH technology in resource-limited settings.

4.4.4 Environmental Uncertainty

The fourth category of factors, less frequently discussed in the literature but directly relevant to this study, is the role of environmental uncertainty itself as an adoption barrier. When farmers are uncertain about when the rainy season will begin, how long it will last, or whether total rainfall will be sufficient to fill storage containers, the perceived value of investing in RWH infrastructure decreases (Vohland & Barry 2009).

This climate uncertainty creates a paradox: the communities most deeply affected by rainfall variability and drought pressure, and most in need of water storage solutions, may also be the least confident that an RWH investment will reliably pay off.

The probit regression results reported by Bessah et al. (2022) reveal the specific magnitude of this paradox. Their model's marginal effects show that

farmers who perceived changes in rainfall timing had a 0.335 lower probability of adopting RWH ($p < .05$), farmers who perceived a decrease in rainfall amount had a 0.233 lower probability of adoption ($p < .01$), while farmers who had access to weather information had a 0.183 higher probability of adoption ($p < .01$) (Bessah et al. 2022). These figures reveal a counterintuitive mechanism: farmers who are most sensitive to climate change, in the absence of access to weather information, tend to be more likely to abandon RWH and instead seek other more immediately controllable coping strategies.

This is consistent with Kanyi et al.'s (2017) analysis drawing on prospect theory: under conditions of uncertain investment returns, the perception of climate variability itself reinforces risk aversion rather than encouraging adoption. This mechanism is particularly pronounced in contexts where information access is lacking, as the absence of weather forecasts and seasonal predictions prevents farmers from converting climate perceptions into informed investment decisions.

A similar dynamic has been documented in Uganda: Mubiru et al. (2018) found in both study districts that rainfall uncertainty was one of the cross-cutting factors constraining the uptake of RWH and other water management technologies, alongside cost pressures and insufficient technical know-how. This environmental dimension of adoption behaviour is directly relevant to the present study's context, as respondents widely reported a perception of declining rainfall predictability alongside persistent dry-season water shortages. Whether farmers who perceive climate change become more hesitant about investing in RWH, or instead more motivated to do so, is one of the core questions this study sets out to examine in Lubanja.

4.5 The Awareness-Practice Gap: Theoretical Framework and Research Gaps

The four categories of adoption barriers reviewed in Section 4.4, economic, informational, social, and environmental, each independently constrain the promotion of RWH. Taken together, however, they point towards a more fundamental pattern: awareness of the benefits of a technology and a positive attitude towards its adoption do not reliably translate into practice. This section examines the theoretical foundations of this awareness-practice gap and identifies the specific research gaps that this study aims to address.

4.5.1 Theoretical Explanations for the Gap

The persistence of the awareness-practice gap in agricultural technology adoption has been an important subject of theoretical inquiry. Kanyi et al. (2017) drew on the Diffusion of Innovations framework (Rogers, 2003, as cited in Kanyi et al., 2017) to explain RWH adoption patterns among smallholder farmers in

Kenya, identifying five attributes that determine whether a technology is adopted: perceived relative advantage over existing practice, compatibility with existing farming systems, technical complexity, trialability (the extent to which it can be experimented with on a limited basis), and observability of results. Technologies that perform well on these dimensions tend to diffuse more rapidly, while technologies that perform poorly on any single dimension encounter resistance even when farmers are generally aware of their benefits. Applying this framework to RWH, Kanyi et al. (2017) noted that most improved systems going beyond simple container collection perform poorly on at least two dimensions: complexity, because the technical knowledge required for installation and maintenance is essentially unavailable through local channels in rural Kenya and similar contexts; and trialability, because the upfront costs of installation prevent resource-constrained households from experimenting incrementally.

The Theory of Planned Behaviour (Ajzen, 1991, as cited in Kanyi et al., 2017) provides a complementary explanation. The theory distinguishes between attitude towards a behaviour, the subjective norms surrounding it, and perceived behavioural control, an individual's belief, based on available resources and skills, in their own ability to perform the behaviour. Even where attitudes are highly positive and social norms are supportive, low perceived behavioural control arising from economic constraints, insufficient technical knowledge, or lack of institutional support may prevent the conversion of intention into action. Applying this framework to RWH adoption in Kenya, Kanyi et al. (2017) found that although attitude was a statistically significant predictor of adoption, socioeconomic status was not, suggesting that the gap between positive attitudes and actual practice is explained not by differences in motivation but by differences in structural capacity to act. Additionally, Kanyi et al. (2017) draw on prospect theory to suggest that uncertain returns may heighten farmers' risk aversion towards long-term RWH investment, particularly where rainfall variability is high (see Section 4.4.4). Whether this mechanism operates in Lubanja, where interview and questionnaire data show climate perceptions to be near-universal but attitudes towards RWH overwhelmingly positive, is examined in Chapter 7.

Thornton et al. (2018), drawing on a multi-country study across 45 research sites in five regions, found that 57% of smallholder farmers in the sample were classified as 'hanging in': focused on maintaining livelihoods, not actively intensifying production, and highly vulnerable to shocks. Although many had made incremental adjustments to their farming practices over the previous decade, these changes rarely reached the scale needed to significantly improve food security. Critically, the enabling environment, composed of supporting organisations, collective action, access to climate information, and community awareness, was found to be the decisive factor distinguishing sites where farmers

were able to 'step up' from those where they remained constrained. Sites with stronger institutional support showed clearly higher household adaptation rates. This finding reinforces the argument that the awareness-practice gap does not primarily originate in individual attitudes or knowledge, but in the structural and institutional conditions that determine whether positive attitudes can be converted into action.

4.5.2 Evidence from the RWH Literature

The awareness-practice gap is well documented in the specific context of RWH adoption in sub-Saharan Africa. Bessah et al. (2022) found that in Ghana, most farmers who had not adopted RWH expressed familiarity with the basic concept of rainwater collection and recognised its potential benefits, yet cited financial constraints, inadequate equipment, and lack of extension services as reasons for non-adoption, a pattern consistent with theoretical expectations that structural rather than attitudinal barriers drive the gap. In a systematic review of water scarcity adaptation strategies in SSA, Sithole et al. (2025) noted that although farmers were aware of and generally endorsed various RWH and irrigation technologies, their adoption and continued use depended on access to capital investment and maintenance support, and on connections to local markets, factors systematically absent in the most resource-constrained farming communities. Sithole et al. (2025) also specifically noted gaps in the literature itself: systematic evaluations of the cost-effectiveness and scalability of adaptation strategies across different agroecological contexts remain limited, and many studies rely on small-scale case studies, limiting the generalisability of their findings.

In the specific context of Uganda, Nanteza et al. (2022) documented that most existing RWH systems in Mityana District are technically undersized relative to household needs, with upgrade costs exceeding most households' capacity in the absence of external support.

Synthesising the theoretical frameworks and empirical evidence reviewed above, the awareness-practice gap is not a single or uniform phenomenon. In certain contexts, particularly where extension services are absent, formal knowledge channels are weak, and water scarcity is severe, a distinctly different variant may emerge: one in which informal practice is already widespread, but has developed in the absence of the technical knowledge needed to make that practice effective. This variant is consistent with the evidence from Uganda: rainwater harvesting has spread as a local coping strategy driven by immediate water need rather than formal guidance (Mubiru et al., 2018), and existing systems have been found to be systematically undersized precisely because households installed them without technical guidance on appropriate sizing relative to rooftop area and seasonal rainfall variability (Nanteza et al., 2022). This variant is further consistent with Biazin et al.'s (2012) continental-scale observation that RWH

techniques across SSA are most effective when they build on indigenous practices already maintained across generations, rather than replacing them with externally designed alternatives, a design principle that presupposes the same underlying pattern: informal, locally developed practice as the starting point rather than the endpoint of intervention. In this variant, district- and national-scale secondary evidence (Mubiru et al., 2018; Nanteza et al., 2022) suggests that the relevant intervention target may be the gap between action and adequacy rather than between awareness and action. However, this evidence was not collected to answer programme-design questions at the village level, and does not indicate whether the pattern holds among Lubanja households specifically, nor what forms of support local residents themselves identify as priorities. This study uses primary household-level data to test whether this pattern holds in Lubanja and to translate it into the specific, prioritised recommendations RUCID's programme requires.

4.5.3 Research Gaps Addressed by the Present Study

Despite the body of evidence reviewed above, existing literature is insufficient in three key respects, each of which corresponds directly to a core characteristic of the context in which this study is situated, and each of which limits what RUCID could currently draw on to design its programme with confidence.

The first gap concerns geographical representation. The vast majority of quantitative RWH adoption studies have been conducted in West Africa, particularly Ghana (Bessah et al., 2022), and East Africa, particularly Kenya (Kanyi et al., 2017). Uganda, and specifically the context of Mityana District, remains substantially underrepresented in the literature. Whether the patterns documented in these settings, including the relative importance of institutional information channels, the gendered structure of adoption constraints, and the role of rainfall uncertainty as a risk-aversion trigger, apply to Lubanja Village is a question existing research cannot answer, and one RUCID cannot safely assume the answer to when designing a locally targeted programme. This study addresses this gap by generating primary data from Mityana District, enabling a direct examination of whether the adoption barrier profile documented in the broader literature corresponds to the specific configuration of constraints in the local context.

The second gap concerns methodological depth. Most existing studies document the awareness-practice gap solely through survey data, without integrating field observations or qualitative data to understand the specific mechanisms through which structural barriers operate at the community level. The physical condition of existing infrastructure, the role of local institutions such as RUCID, and the everyday realities of water management in resource-limited settings remain underexplored in the quantitative literature (Sithole et al., 2025).

Survey frequencies alone would tell RUCID which barriers are most commonly cited, but not how those barriers interact with existing infrastructure, household decision-making, or RUCID's own institutional role, information a programme designer needs and a single-method study cannot supply. This study addresses this gap by combining questionnaire data, informal interviews, and systematic field observation, providing a more grounded account of how barriers manifest in practice.

The third gap concerns the level at which existing evidence operates. Mubiru et al. (2018) documented the spread of RWH in Uganda at a national scale, and Nanteza et al. (2022) documented systematic technical undersizing at a district scale in Mityana through GIS-based infrastructure analysis. Neither study collected household-level data on perceptions, awareness, or self-reported adoption reasoning, and neither was designed to inform the design of a specific community programme. This creates a practical gap for organisations such as RUCID: national- and district-scale evidence can motivate a general programming priority, but cannot answer the operational questions a programme must resolve, including which households to prioritise, what specific barriers dominate locally, and what forms of support residents themselves identify as most valuable. This study addresses this gap by collecting primary household-level data in Lubanja, testing whether the pattern identified in secondary data holds locally, and translating the results into a decision-relevant, prioritised set of programme recommendations.

5. Materials and Methods

5.1 Research Design

This study employs a mixed-methods case study approach to examine local residents' perceptions of climate-related water stress, current rainwater harvesting practices, and the conditions shaping their adoption in Lubanja Village, Mityana District, Uganda. A case study design was selected because it allows for an in-depth investigation of a specific context, in this case, a smallholder farming community with limited water resources and an emerging interest in RWH, while capturing the complexity of social, economic, and environmental factors that influence adoption behaviour (Yin, 2018).

This study adopts a pragmatic mixed-methods design (Creswell, 2013), combining quantitative and qualitative data to address complementary aspects of the research questions. Quantitative data from the household questionnaire describe the distribution and frequency of practices, perceptions, and attitudes across the sample, while qualitative data from informal interviews and open-ended questionnaire responses are analysed within an interpretivist orientation (Bryman, 2016), aiming to understand how local residents perceive, experience, and make sense of climate change impacts and rainwater harvesting within their specific social and environmental context. This combination allows the study to describe patterns across the sample while also attending to the meaning residents themselves attach to their practices and circumstances.

The primary data source is a structured questionnaire, supplemented by informal interviews and field observations to provide contextual depth that quantitative methods alone cannot capture.

5.2 Study Area and Participant Selection

Data were collected from respondents in Lubanja Village and Mityana town, Mityana District, central Uganda. Lubanja was selected as the primary study site due to its reliance on smallholder agriculture, its exposure to seasonal water scarcity, and the presence of RUCID (Rural Community in Development) as a local partner organisation with an interest in RWH promotion. Of the 50 questionnaire respondents, 43 (86%) were located in Lubanja and 7 (14%) in Mityana town. Because all seven Mityana town respondents were current RWH adopters (see Results), the analysis presented in this thesis treats the 43 Lubanja respondents as the primary analytic sample; the seven Mityana town respondents are described separately and are not included in the disaggregated statistical comparisons. The combined-sample figures are reported only in the Abstract and Conclusion for overall summary purposes.

This study employs a combination of purposive and convenience sampling. Purposive sampling was used to ensure that respondents had relevant knowledge of local water use and agricultural practices, prioritising smallholder farmers, small-scale traders, and community members familiar with local environmental conditions. This inclusive approach reflects an agroecological understanding of rural livelihoods as interconnected across farming and non-farming activities within the same water and food system, rather than treating agricultural and non-agricultural households as separate populations. Convenience sampling was applied within this group to recruit participants who were available and willing to participate during the period of data collection. Respondents were recruited using a combination of purposive and convenience sampling until a target sample of approximately 50 households was reached across Lubanja and Mityana town. Figure 5 shows their approximate geographic distribution. Because this is a purposive/convenience sample rather than a probability sample, the percentages reported throughout this thesis describe the characteristics of this specific sample rather than estimated prevalence rates in the Lubanja population as a whole, and statistical significance should not be interpreted as though the sample had been randomly drawn from that population.

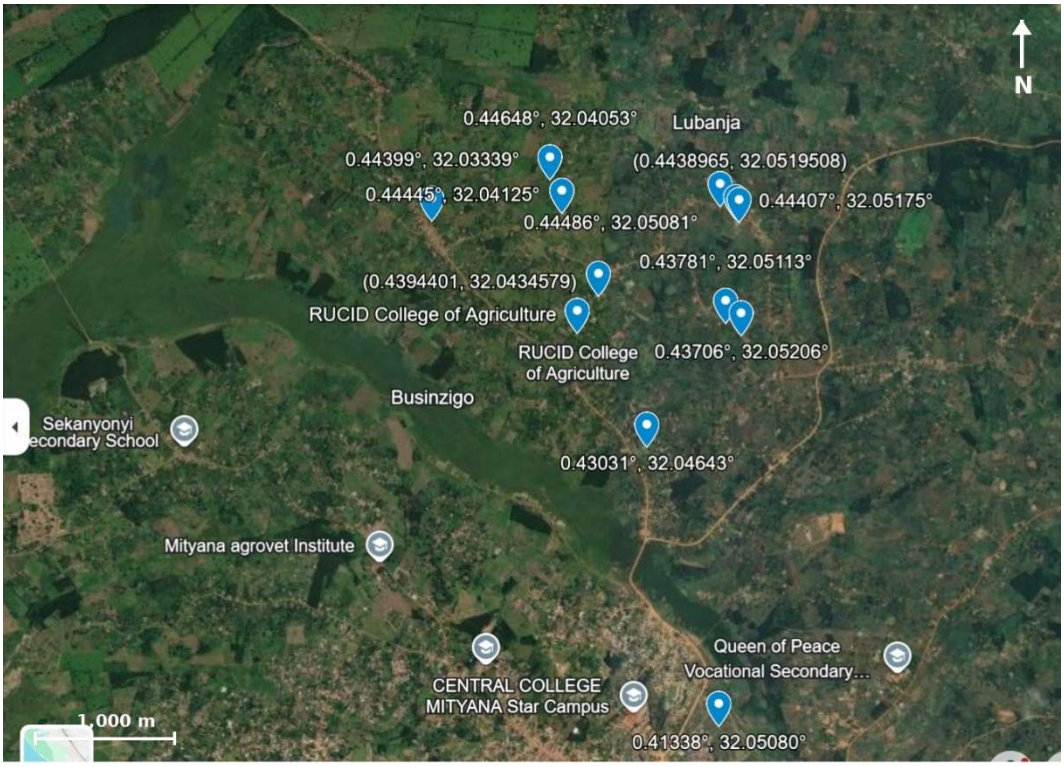


Figure 5. Approximate locations of the 50 household questionnaire respondents in Lubanja, Busimbi Sub-County, Mityana District, Uganda, clustered into 10 markers representing approximately five households each, together with the location of RUCID College of Agriculture. Of these, 43 respondents were located in Lubanja and 7 in Mityana town. Base map: Google Satellite (©2026 Google).

It should also be noted that the gender composition of the sample is likely to reflect the conditions of data collection rather than the population distribution alone. Fieldwork was conducted at the onset of the rainy season, which coincides with the peak agricultural labour period in Lubanja. Most male respondents were occupied with field work during the day, and several households were visited twice without locating available male members. The respondents who were present and able to participate were predominantly older women, alongside a smaller number of male respondents across age groups who were interviewed during rest periods or after completing daily farm tasks. The higher female representation in the sample is therefore partly an artefact of seasonal fieldwork constraints rather than a reflection of differential willingness to participate.

In addition to the structured questionnaire, informal interviews were conducted with 8 of the 50 questionnaire respondents (IF-01 to IF-08). A separate set of key informant interviews was also conducted with two RUCID programme coordinators (KI-01 to KI-02), who were among the 50 questionnaire respondents.

5.3 Questionnaire Survey and Informal Interviews

5.3.1 Design and Theoretical Basis

The structured questionnaire (Appendix 1) and the informal interviews were developed together, drawing on the same body of literature on rainwater harvesting, climate adaptation, technology adoption among smallholder farmers, and rural water resource management. The design drew on studies examining RWH applications in East Africa and other developing regions, including research on rainwater management and agricultural productivity in drought-prone smallholder systems (Rockström et al., 2002), RWH and water security in East Africa (Qi et al., 2019), RWH as a climate adaptation strategy (Abdullah & Rahman, 2015), and RWH techniques for drought mitigation (Shaikh & Birajdar, 2024).

The design of both instruments was also informed by established theoretical frameworks in agricultural technology adoption research, particularly the Diffusion of Innovations Theory (Rogers, 2003, as cited in Kanyi et al., 2017), which emphasises that technology adoption is shaped not only by economic conditions but also by knowledge, social norms, resource availability, and perceived complexity. These frameworks guided the decision to examine not only whether respondents practise RWH, but also their perceptions of rainfall change, their understanding of RWH systems, the barriers they face, and their need for external support, questions that were then distributed across the questionnaire's structured items and the interviews' more open-ended follow-up.

The questionnaire was not pilot tested prior to full deployment due to time constraints in the field. However, the wording of both the questionnaire and the

interview topic guide was reviewed with local RUCID staff prior to use, and language was simplified throughout to ensure suitability for oral administration and translation. Most closed-ended items included an "other" option to capture responses not anticipated by the predefined categories, which limited the extent to which the absence of formal piloting affected data collection. One limitation did emerge during fieldwork: the item on the cost of accessing water assumed a binary distinction between paying and not paying for water itself, whereas several respondents who did not pay directly for water still described indirect costs associated with reaching it, such as motorcycle transport fares, indicating that this item's framing of "cost" did not fully capture the range of expenses respondents associated with water access.

5.3.2 Questionnaire Structure and Question Types

The final questionnaire comprised 32 questions organised across five thematic sections: (A) background information, including age, gender, location, and agricultural training history; (B) water sources and dry season experience; (C) rainwater collection practices, with separate question sets for current collectors and non-collectors; (D) awareness and perceptions of RWH systems; and (E) barriers and future improvements. The distinction between current collectors and non-collectors, used throughout Section C and in the analysis that follows, is based on a broad operational definition: any deliberate use of a container, whether a purpose-built tank, a jerrycan, a basin, or any other vessel, to collect and store rainwater for later use is counted as collection practice, regardless of the container's size, permanence, or capacity. This broad definition reflects the study's diagnostic purpose: the aim is to establish whether, and in what form, residents are already engaging in rainwater collection, rather than to assess practice against a predefined technical standard. Distinctions in scale and technical adequacy, rather than being used to draw a boundary around what counts as RWH, are instead examined directly as a separate dimension of practice.

Three question types were used, each selected for specific reasons. Multiple-choice questions were used extensively because rural households in the study area typically rely on several water sources simultaneously and face multiple overlapping barriers to RWH adoption; restricting respondents to a single answer would have produced an incomplete picture of local water practices, and this format also facilitates frequency analysis. Simplified Likert-type questions were used for attitudinal and perceptual items, such as perceived water sufficiency during the dry season (Yes / Sometimes / No), willingness to adopt RWH, and perceptions of rainfall change; a full five-point scale was not used because the educational diversity of the sample and the oral administration context made simpler response formats more appropriate, easier to translate, and less prone to misunderstanding. Open-ended questions were included in small number to

capture information that structured options could not adequately reflect, such as the reasons behind non-adoption decisions, suggestions for future improvements, and descriptions of local water management practices; responses were recorded in handwritten notes during the survey and later transcribed for thematic analysis. Throughout the questionnaire, items with a yes/no/sometimes response format were single-select by design. All other items, including those addressing barriers and support needs, allowed respondents to select multiple applicable options, reflecting the open-ended and exploratory nature of these questions; this is reflected in the percentages reported in the Results, which do not sum to 100%. Full details of how the questionnaire and interviews were administered, including language, translation, participant selection, and interview settings, are provided in Section 5.3.6.

5.3.3 Informal Interview Topics and Format

In addition to the structured questionnaire, informal interviews were conducted with a subset of respondents during the same field visits to gather more contextual information about water use practices, existing infrastructure, and attitudes towards RWH. The interviews were guided by a set of recurring topics (Appendix 2) derived from the research questions and the same literature base described above, including: local perceptions of rainfall change and dry-season experience; household and agricultural water use practices; existing RWH methods and their practical limitations; awareness of and attitudes towards RWH systems; barriers encountered in implementing or improving RWH; and views on the most helpful types of support available.

The study used informal interviews rather than strictly semi-structured interviews. While semi-structured interviews follow a predetermined question guide with relatively consistent structure across respondents, the interviews in this study emerged more naturally during questionnaire visits, field observations, and everyday interactions, with question order and content adjusted flexibly in response to respondents' answers and the immediate context of the conversation. This approach was chosen for three reasons. First, some respondents were unfamiliar with formal interview settings, and a more conversational style helped to establish trust and encouraged more natural expression. Second, the reliance on oral translation made strict adherence to a fixed question sequence difficult to maintain, and informal interaction was better suited to the communication conditions in the field. Third, many aspects of RWH and water use practices in the study area are embedded in everyday routines rather than explicitly articulated knowledge, and respondents were more likely to describe these practices freely in the context of natural conversation than in response to formal questions. The informal interviews were therefore used as a complementary data source to

contextualise and elaborate on the questionnaire findings, rather than as a standalone qualitative dataset.

5.3.4 Interview Participants and Selection

In addition to the structured questionnaire, informal interviews were conducted with a subset of community respondents during field visits to gather more contextual information about water use practices, existing infrastructure, and attitudes towards RWH. Priority was given to individuals who appeared more willing to engage in extended conversation during the questionnaire visit, as well as those whose household circumstances and existing water storage infrastructure appeared broadly representative of patterns observed across the sample. Purposive selection additionally ensured balanced representation of adopters and non-adopters, given that this contrast is central to the study's research questions. Given the small number of community interviews, these accounts should be read as illustrative rather than representative of the full sample.

Two separate key informant interviews were also conducted with the Principal and the CEO of RUCID, both of whom were among the questionnaire respondents. These interviews focused on the organisation's current activities, future plans for community-based RWH, assessments of community readiness, and constraints related to funding and technical capacity. Given their institutional roles, these accounts are handled separately from community respondent data and are cited in the thesis as institutional data.

5.3.5 Field Observations

Field observations were conducted throughout the data collection period alongside questionnaire administration and interviews, providing direct, observable evidence to complement respondents' self-reported practices and to help contextualise the technical condition of existing RWH infrastructure discussed in the adoption literature (e.g. Biazin et al., 2012; Nanteza et al., 2022). Observations focused on the physical condition and type of existing water storage infrastructure, including open containers, storage tanks, guttering systems, and improvised collection arrangements, as well as the immediate physical environment, including topography, land use, proximity to water sources, and vegetation. Observational notes were recorded in the researcher's field notebook and are used to supplement and contextualise the survey and interview findings where relevant, particularly in the discussion of current RWH practices and their technical limitations.

5.3.6 Administration, Translation, and Data Handling

The questionnaire and informal interviews were administered together during the same household or site visits. Both were conducted with the support of a

single RUCID staff member, who served as oral translator and interpreter throughout data collection and was also responsible for liaising with and recruiting participating farmers. The questionnaire was written in English and translated orally into Luganda by the translator during administration; informal interviews were conducted in a mixture of Luganda and English, with interpretation provided by the same translator as needed. Where certain concepts, such as "rainwater harvesting system", lacked a direct local equivalent, the translator was instructed to describe the concept in terms of familiar local practices rather than using technical terminology, in order to minimise translation bias; for example, Q25 was administered as "Wali owuliddeko ku ngeri gye balembekamu amazzi g'enkuba?", accompanied by a functional description of the practice as a way of gathering, storing, and later using water, rather than as a standalone technical term. Question and topic wording was further simplified by the researcher, in consultation with the translator, to reduce the risk of misinterpretation during translation. Each questionnaire took approximately 8–15 minutes to complete, and where an informal interview followed, it lasted approximately 30 minutes. RUCID's role in this study was twofold: the organisation provided the local staff member responsible for translation and participant recruitment, and is also the intended implementer of the RWH programme this thesis is designed to inform.

Data collection took place across a range of settings, including respondents' homes, farmland and surrounding areas, community public spaces, and RUCID's offices. The setting had a practical influence on the content of conversations: respondents interviewed near their fields tended to discuss water problems in relation to specific agricultural activities and physical infrastructure, while conversations in community or institutional settings more often addressed topics of training, support, and community-level initiatives. These contextual differences are reflected where relevant in the presentation of interview data. As most interviews took place in the course of questionnaire visits and everyday field interactions, all interviews were audio-recorded using a mobile phone for later reference. Handwritten field notes were also taken during or immediately after each interaction, and post-visit written summaries were compiled by reviewing the recordings to extract key points and representative quotations. The handwritten notes, informed by this review of the recordings, formed the primary basis for the qualitative data used in analysis. All records were anonymised during processing, with respondents identified only by code (IF-01 to IF-08 for community respondents; KI-01 and KI-02 for the RUCID key informants), and all data were used solely for academic purposes.

5.4 Data Analysis

5.4.1 Quantitative Analysis

Quantitative data from the questionnaire were analysed using descriptive statistical methods to summarise the distribution of responses across all variables, including frequencies and percentages. A comparative analysis was conducted to examine differences between respondents who collect rainwater (adopters, n=26) and those who do not (non-adopters, n=17) across a range of demographic, perceptual, and attitudinal variables.

Associations between RWH adoption status and key variables (gender, age, agricultural training, perceived dry-season water sufficiency, and reported financial barriers) were tested using Fisher's exact test for the three 2×2 comparisons (gender, agricultural training, financial barriers) and the Fisher-Freeman-Halton exact test for the two comparisons with more than two categories per variable (age group, water sufficiency), avoiding the small-sample limitations of chi-square approximations. Here, "agricultural training" refers to self-reported prior participation in any form of agricultural training, of any type or duration (Section 6.4.2), rather than occupational status as a farmer; each of these five variables was tested against RWH adoption status (yes/no) as the 2×2 or 2×n contingency structure. Statistical significance was evaluated at a threshold of $p < .05$. Because the sample ($n = 43$) is a purposive/convenience rather than a probability sample, these results are interpreted as exploratory rather than confirmatory, and are presented alongside descriptive data to provide context.

Quantitative data, including descriptive statistics, were tabulated and analysed in Microsoft Excel. Fisher's exact and Fisher-Freeman-Halton exact test p-values were computed using the online Fisher's Exact Test Calculator provided by MedCalc. The choice of exact tests over chi-square approximations, given the small and non-random sample, was confirmed in consultation with Adam Flöhr, a statistician at SLU.

5.4.2 Qualitative Analysis

Responses to open-ended survey questions and informal interview content were analysed using a hybrid deductive-inductive thematic analysis, following the six-phase framework described by Braun and Clarke (2006). The four barrier categories established through the literature review (economic, informational, social, and environmental; Section 4.4) were defined prior to coding and used as an initial deductive framework, which had also informed the design of the questionnaire and the interview topic guide; additional codes were generated inductively from the data where recurring patterns were not captured by these categories.

In the first phase, the researcher familiarised herself with the data by repeatedly reading through handwritten open-ended questionnaire responses and interview summaries prepared from audio recordings, noting initial impressions and recurring patterns.

In the second phase, the four literature-derived categories were applied to organise open-ended questionnaire responses and interview summaries; closed-ended questionnaire items were coded separately according to the scheme established during questionnaire design (Section 5.3.2; Appendix 3). Where segments of data described patterns not captured by these categories, such as concerns about children's safety or a preference for skills-based over financial support, additional inductive codes were generated directly from the data. All codes, whether derived from the literature-informed categories or generated inductively during analysis, are summarised in Appendix 4, together with representative examples. Coding of qualitative data was carried out in Microsoft Excel, with interview and open-ended survey excerpts organised by respondent and assigned code.

In the third phase, codes were grouped into potential themes by identifying patterns of similarity and connection. For example, codes such as "no money for equipment", "cannot afford a tank", and "cost is too high" were grouped under the broader theme of economic barriers to adoption.

In the fourth phase, themes were reviewed against the original data to verify that they accurately represented the content of respondents' answers and were clearly distinguishable from one another. Themes with significant overlap were merged where appropriate.

In the fifth phase, each theme was defined and named to reflect its specific scope and its relationship to the research questions. The themes identified at this stage directly informed the structure of the Results and Discussion chapters.

In the sixth and final phase, the analysis was integrated into the written report. Illustrative examples drawn from open-ended questionnaire responses and interview notes were selected to support the presentation of each theme, and findings were related back to the research questions and the existing literature.

5.5 Ethical Considerations

This study was conducted in accordance with SLU's general guidance on research ethics; based on this guidance, no formal ethical review or permit was required for this project, as it did not involve medical interventions, vulnerable populations, or the collection of sensitive personal data. Permission to conduct fieldwork was obtained through correspondence with RUCID's Chief Executive Officer, Samuel Nyanzi, who authorised the research and provided a signed, RUCID-stamped confirmation of attachment; no separate letter of introduction from local government authorities was sought.

Informed consent was obtained from all participants prior to data collection. Before each questionnaire session or interview, a local staff member read the full consent statement aloud, covering the purpose of the study, the voluntary nature of participation, the right to withdraw at any time without consequence, the confidential treatment of all responses, and the intended use of data for academic purposes only. Participants confirmed their agreement verbally. In cases where photography was conducted, written consent forms were used, as participants were asked to agree explicitly to the potential use of images in research outputs.

No personally identifiable information was collected through the questionnaire. All data were anonymised during entry and processing, and respondents are referred to throughout this thesis using numerical or code identifiers only. Interview notes and audio recordings were stored on the researcher's personal tablet, without upload to external storage or password protection, and access to the raw material was limited to the researcher throughout the study. All raw interview recordings and notes will be deleted within one year of thesis submission and archiving.

5.6 Artificial Intelligence Disclaimer

Generative AI (Claude, Anthropic) was used during the preparation of this thesis as a writing support tool, under my direction and subject to my review at every step. Specific uses included: (1) verifying and cross-checking statistical calculations against my own dataset; (2) proofreading and cross-checking the manuscript for consistency, including locating and revising passages containing overclaiming or overly strong language, inconsistent terminology across chapters, and other issues flagged by my supervisors; and (3) identifying inconsistencies in the manuscript, such as incorrect table and figure cross-references, citation formatting, and duplicated or missing text. All interpretive claims, conclusions, and final wording decisions in this thesis are my own. I take full responsibility for the accuracy and integrity of the final text.

6. Results

6.1 Respondent Characteristics

A total of 50 respondents completed the household questionnaire. Of these, 32 were female (64%) and 18 were male (36%). The majority (86%, n = 43) were located in Lubanja and the remainder from Mityana town (14%, n = 7). No respondents were under 18 years of age. The largest age groups were 45–59 and 60 and above, each accounting for 32% of the sample (n = 16), followed by 30–44 (22%, n = 11) and 18–29 (14%, n = 7). Thirty respondents (60%) had received some form of agricultural training, while 20 (40%) had not. Because all seven Mityana town respondents were current RWH adopters (see below), the 43 Lubanja respondents are treated as the primary analytic sample in the sections that follow; the seven Mityana town respondents are described separately at the end of this section.

Of the 43 Lubanja respondents, 26 (60.5%) reported currently collecting or storing rainwater in some form and are referred to throughout this chapter as adopters. The remaining 17 respondents (39.5%) did not collect rainwater and are referred to as non-adopters. Table 1 summarises the distribution of adopters and non-adopters by gender and agricultural training status.

Table 1. Respondent characteristics by RWH adoption status (n = 43)

Characteristic	Adopters (n = 26)	Non-adopters (n = 17)	Total (n = 43)
Female	18	9	27
Male	8	8	16
Age 18–29	4	2	6
Age 30–44	5	6	11
Age 45–59	9	4	13
Age 60+	8	5	13
Agricultural training (yes)	19	9	28
Agricultural training (no)	7	8	15

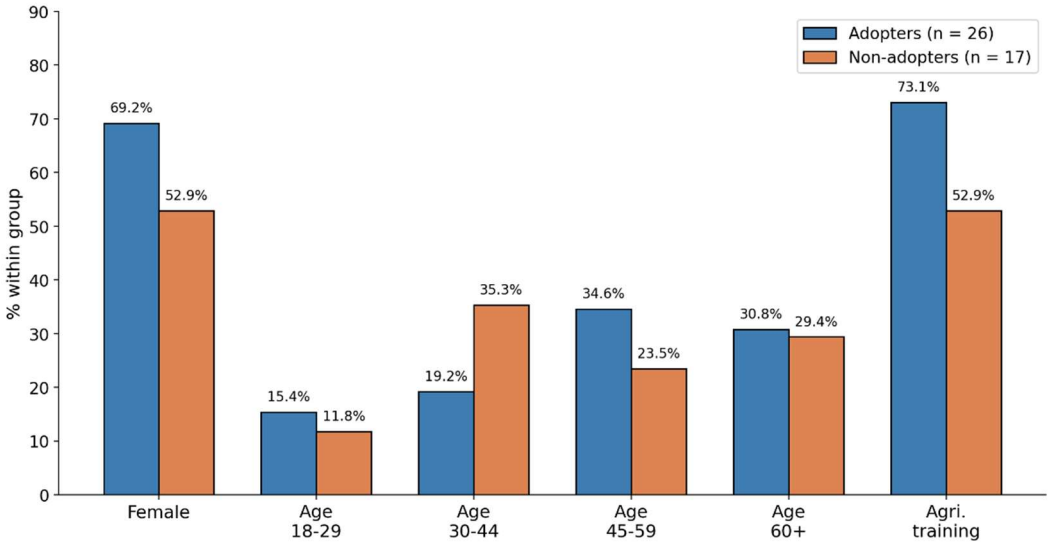


Figure 6. Distribution of respondent characteristics by RWH adoption status (%), showing gender, location, age group, and agricultural training among adopters (n = 26) and non-adopters (n = 17).

As noted above, all seven respondents from Mityana town were current RWH adopters. Because the analysis in this chapter uses the 43 Lubanja respondents as the primary analytic sample, these seven town respondents are not included in the exact-test comparisons or in the other disaggregated statistics reported below.

Descriptively, the seven Mityana town respondents consisted of five women and two men, with three aged 60 and above, three aged 45–59, and one aged 18–29. Two had received agricultural training and two had previously heard of RWH as a formally defined concept; these two respondents were the RUCID key informants (KI-01 and KI-02), whose institutional roles make their awareness of RWH unsurprising and not representative of community-level exposure. The remaining five town respondents, none of whom had received water-management training, reported collecting rainwater without prior formal RWH awareness, a pattern broadly consistent with that observed among Lubanja adopters. Given the small size of this subgroup, these observations are reported descriptively and are not included in the statistical comparisons presented below.

Informal interviews were conducted with 8 community respondents (IF-01 to IF-08) and 2 RUCID institutional representatives (KI-01 and KI-02); participant characteristics are summarised in Table 2.

Table 2. Informal interview participants (n = 10: 8 community respondents, 2 RUCID key informants)

ID	Gender	Age	Agricultural training	Location	RWH practice
IF-01	Male	60+	No	Lubanja	Adopter

IF-02	Female	45–59	Yes	Lubanja	Adopter
IF-03	Female	18–29	Yes	Lubanja	Adopter
IF-04	Male	18–29	Yes	Lubanja	Adopter
IF-05	Female	30–44	Yes	Lubanja	Non-adopter
IF-06	Female	45–59	Yes	Lubanja	Non-adopter
IF-07	Male	60+	No	Lubanja	Non-adopter
IF-08	Male	30–44	Yes	Lubanja	Non-adopter
KI-01	Male	60+	Yes	Lubanja	Adopter
KI-02	Male	60+	Yes	Lubanja	Adopter

6.2 Perceptions of Climate Change and Water Availability

The questionnaire allowed respondents to select more than one rainfall-change option simultaneously, including "no notable change" alongside other options; of the seven respondents who selected "no notable change", three also selected "more unpredictable", while four selected only "no notable change". Excluding these four, 39 of the 43 Lubanja respondents (90.7%) reported experiencing some change in rainfall patterns. The dominant perception was of increased rainfall unpredictability, reported by 74.4% of respondents (n = 32). 37.2% (n = 16) reported that total rainfall amounts had decreased, and 25.6% (n = 11) perceived shorter rainy seasons. 16.3% (n = 7) selected "no notable change" (either alone or alongside another option), and no respondent selected "not sure".

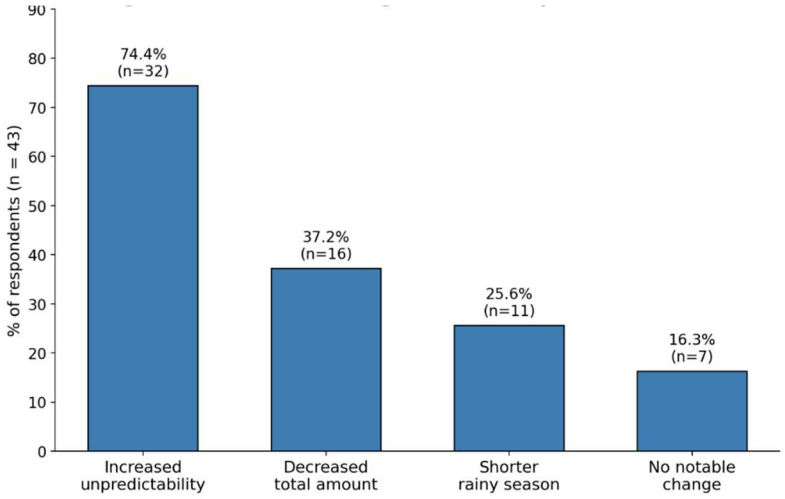


Figure 7. Perceived changes in rainfall patterns reported by respondents (n = 43).

Perceived changes were broadly consistent across adopters and non-adopters: 73.1% of adopters (n = 19) and 76.5% of non-adopters (n = 13) described rainfall as more unpredictable, indicating that climate-related perceptions are shared across the sample regardless of current rainwater collection behaviour.

Perceived rainfall change co-occurred with reported dry-season water stress. Across the Lubanja sample, 72.1% of respondents (n = 31) reported not usually having enough water during the dry season, and a further 23.3% (n = 10) reported having enough only sometimes. Only 4.7% (n = 2) reported consistent dry-season water sufficiency. This pattern was similar across both groups: 76.9% of adopters (n = 20) and 64.7% of non-adopters (n = 11) reported insufficient dry-season water, indicating that water stress is a near-universal condition that transcends current adoption status.

Respondents relied on multiple water sources simultaneously. Rainwater and well water were equally the most widely used sources (67.4%, n = 29 each), followed by tap water (25.6%, n = 11), borehole water (11.6%, n = 5), and purchased water (4.7%, n = 2). This figure is somewhat higher than the 26 respondents classified as adopters in Section 6.2: 25 of the 26 adopters reported rainwater as one of their water sources, and a further four non-adopters also reported rainwater as a source: one purchased rainwater from a neighbouring household, and three drew water from a stream formed by rainwater runoff behind their homes without collecting or storing it themselves. These practices reflect access to rainwater through means other than a household's own dedicated collection or storage system, and are therefore not captured by the adoption variable used in this thesis.

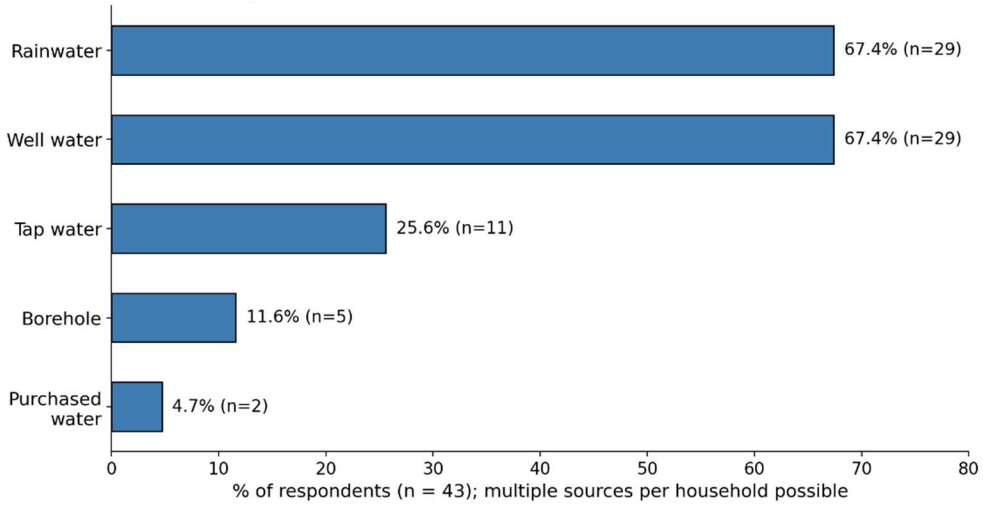


Figure 8. Household water sources in use among respondents (n = 43; multiple sources per household possible).

The most frequently reported dry-season challenges were long distance to water sources (72.1%, n = 31), livestock problems (65.1%, n = 28), reduced crop yields (53.5%, n = 23), high cost of water (41.9%, n = 18), and crop loss (20.9%, n = 9). No respondent reported experiencing no dry-season problems, indicating that water stress affects all households across multiple dimensions simultaneously.

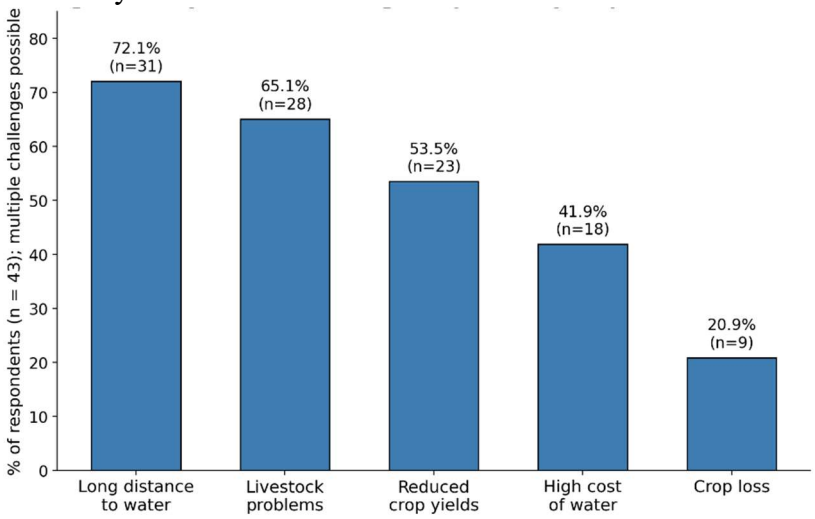


Figure 9. Dry-season challenges reported by respondents (n = 43; multiple challenges per household possible).

These quantitative patterns were consistently reflected in the informal interview data. All eight community respondents described rainfall as more unpredictable than in previous years and linked this directly to difficulties in agricultural planning and household water management. Several respondents described how dry-season scarcity shaped daily routines in concrete ways: IF-05 described spending money on boda-boda motorcycle transport to reach a well approximately 40 minutes away, with each journey yielding only a limited quantity of water that was then difficult to store adequately; IF-07 reported purchasing rainwater from a neighbour at 500 Uganda shillings per jerrycan in the dry season, compared with 250 shillings in the rainy season, illustrating how seasonal scarcity directly increases household expenditure; and IF-08 relied solely on a nearby stream that dries out entirely during the dry season, leaving the household without any accessible water source during the most critical period of the year. The RUCID institutional representatives similarly identified rainfall variability as a central structural challenge, with KI-01 noting that despite considerable total rainfall in the region, its concentration in short unpredictable events means most of it runs off before communities can make use of it: "there's a lot of rain but not stable, it comes when it comes; when it doesn't come, it doesn't come" (KI-01, personal communication, 2026).

6.3 Rainwater Harvesting Practices, Awareness, and Attitudes

6.3.1 Current Collection Practices

Of the 26 adopters, the most common collection method was the use of a water tank, reported by 76.9% (n = 20). Placing containers such as jerrycans or buckets under the roof eaves was reported by 46.2% (n = 12).

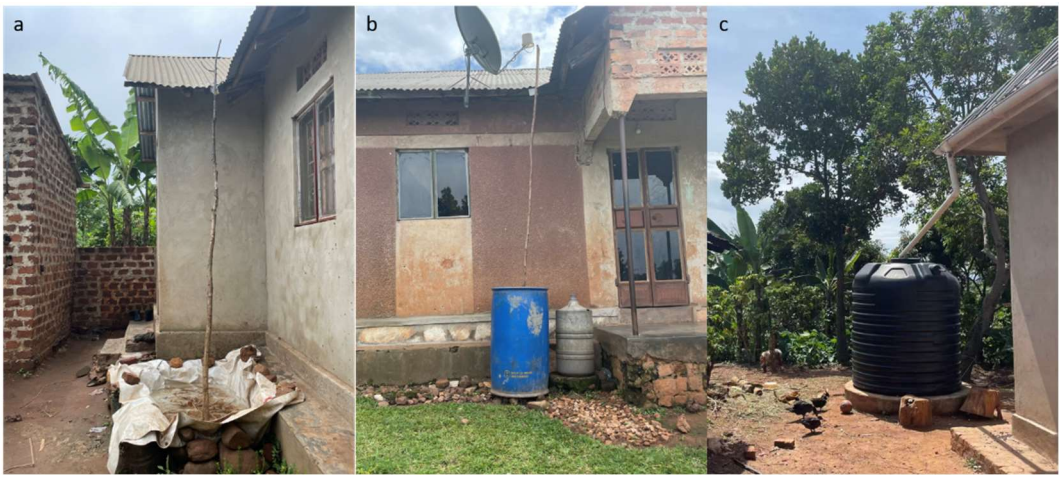


Figure 10. Examples of household-level rainwater harvesting practices observed in Lubanja Village, illustrating the range of informality documented in this study, from improvised collection to more established systems. (a) At one household, a tarpaulin sheet weighted with stones is used at ground level to capture runoff channelled by a wooden pole against the roofline; water is collected without a permanent storage container. (b) At a different household, a repurposed industrial drum and a metal container are used to collect roof runoff, with a wooden pole propped against the roofline to guide water flow; no gutter connects the roof edge to the containers. (c) At a third household, a more established system consisting of a manufactured plastic storage tank connected to the roof via PVC guttering and a downspout represents a comparatively higher level of technical adequacy.

These two methods are functionally distinct: water tanks store larger volumes for extended periods, while roof-eave containers represent simpler and lower-cost approaches to capture. Channels directing rainwater towards crops were used by 15.4% (n = 4) and ponds or small dams by 7.1% (n = 2). No respondent reported in-soil absorption techniques. Many adopters used more than one method simultaneously, reflecting a pragmatic approach to combining available collection infrastructure.

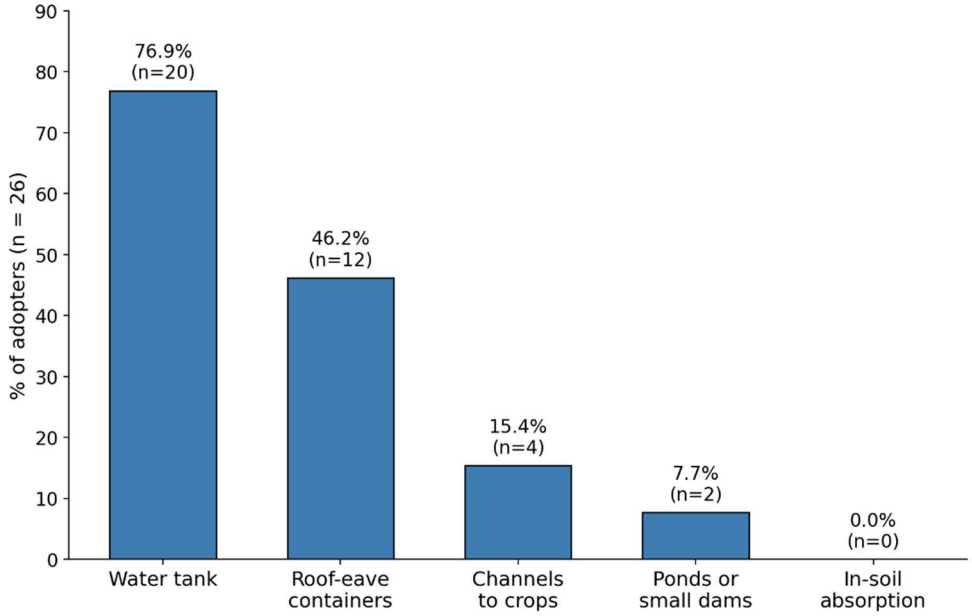


Figure 11. Rainwater collection methods among adopters (n = 26; multiple methods per household possible).

Collected rainwater was used primarily for household purposes and livestock watering. Among adopters, 92.3% (n = 24) reported household use and 88.5% (n = 23) reported livestock watering. Drinking water accounted for 42.3% (n = 11), while irrigation accounted for 15.4% (n = 4). This low proportion using rainwater for irrigation is notable given that reduced crop yields and crop loss were among the most widely reported dry-season problems.

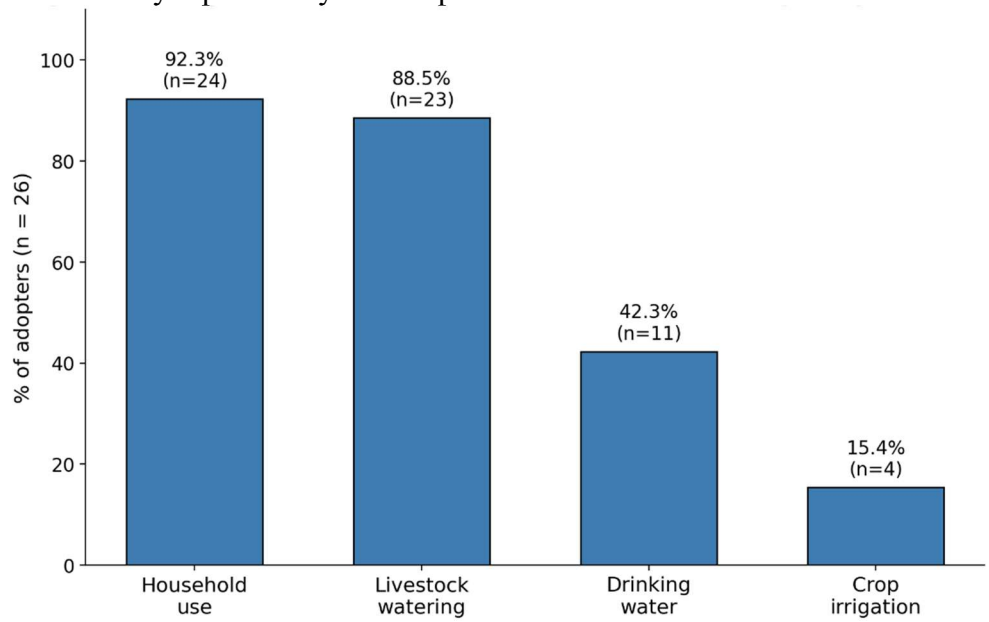


Figure 12. Reported uses of collected rainwater among adopters (n = 26; multiple uses per household possible).

Informal interviews provided further detail on collection practices. IF-01 described a large underground water tank capable of storing collected rainwater for approximately three months without deterioration, which represented one of the most technically sophisticated systems encountered during fieldwork. IF-02 described using underground tanks in combination with channels directing runoff towards agricultural fields, one of only a small number of respondents who had developed systems oriented towards agricultural as well as domestic use. IF-03 used a combination of roof-eave containers and a water tank, with collected water used primarily for livestock and drinking rather than crop irrigation.

6.3.2 Storage Duration and Sufficiency

Despite the widespread adoption of rainwater collection, the large majority of adopters reported that stored water did not last through the dry season.



Figure 13. Variation in rainwater storage infrastructure observed across households in Lubanja. (a) An underground concrete cistern with a fitted access hatch, representing a substantial, permanent storage investment. (b) An above-ground manufactured plastic tank connected to roof guttering via a downspout, situated on a raised concrete platform. (c) An intermediate bulk container (IBC) adapted for rainwater storage and connected to a downpipe. These examples illustrate the range of storage solutions in use, from substantial fixed infrastructure to adapted, low-cost alternatives.

Two related but distinct indicators point to storage insufficiency among adopters. First, in terms of storage duration, 19.2% (n = 5) reported stored rainwater lasting less than two weeks, 42.3% (n = 11) approximately one month, and 23.1% (n = 6) approximately two months; only 15.4% (n = 4) reported that stored rainwater lasted the entire dry season. Second, when asked directly whether their stored water was sufficient, 61.5% of adopters (n = 16) reported that it was not sufficient during the dry season, with a further 30.8% (n = 8) reporting it was only sometimes sufficient; only 7.7% (n = 2) considered their stored water consistently adequate. Taken together, these two separately measured indicators are consistent with one another: 92.3% of adopters reported that their stored

rainwater either ran out before the end of the dry season or only sometimes lasted long enough to meet household needs.

6.3.3 Formal Awareness of RWH

In this thesis, formal awareness of RWH is defined narrowly as prior exposure to rainwater harvesting as a named, formally defined system, rather than as a measure of technical knowledge or competence. Despite the relatively high rate of informal collection practice, only 32.6% of respondents (n = 14) reported having previously heard of rainwater harvesting as a formally defined technology or system. The remaining 67.4% (n = 29) had not. Most significantly, 65.4% of adopters (n = 17) had never heard of RWH, and all 17 of these had also received no water management training, meaning that 65.4% of adopters had been practising rainwater collection without either formal awareness of RWH as a defined concept or any relevant technical training. Among the 14 respondents who had heard of RWH, the primary information source was media, cited by 50.0% (n = 7). Other farmers and family or friends each accounted for 14.3% (n = 2), extension officers for 7.1% (n = 1), and no respondent cited NGOs or community projects as a source. The very limited reach of formal institutional channels is consistent with the low rates of water management training reported in Section 6.4.2, and points to a context in which most current collection practice has developed outside any formal knowledge system, a pattern examined further in relation to technical knowledge barriers in Section 4.4.2.

6.3.4 Perceived Benefits, Attitudes, and Willingness

Despite low formal awareness of RWH as a defined concept, perceived benefits of rainwater collection were widely reported. The most commonly cited benefit was increased water availability during the dry season, reported by 72.1% of respondents (n = 31), followed by lower water costs (46.5%, n = 20), better crop production (37.2%, n = 16), and more reliable farming (23.3%, n = 10). Attitudes towards improving current rainwater collection were strongly positive across the sample: 97.7% of respondents (n = 42) indicated they would like to improve how they currently collect or store rainwater.

Among non-adopters, all 17 respondents (100%) reported having at some point considered collecting rainwater. When asked whether they would collect rainwater if given adequate support, in the form of money, materials, or training, all 17 non-adopters (100%) indicated they would.

Informal interviews reinforced this broadly positive orientation. IF-05 expressed a clear preference for skills-based support over financial assistance, reasoning that money could run out but knowledge and skills would remain: "don't choose money because the money will [be] finished but the skills will not" (IF-05, personal communication, 2026). This preference was expressed

specifically in relation to the form support should take, rather than as a substitute for material need: elsewhere in her responses, she also cited a lack of adequate storage containers as a barrier to collection, without specifying which skills she had in mind. IF-03 noted that rainwater was perceived as preferable to well or borehole water due to lower chemical content, adding a water quality dimension to the perceived benefits of collection. IF-04 highlighted that improved water storage near the school would reduce the distances students needed to travel for water, a benefit also mentioned by two other respondents, including a female questionnaire respondent who separately identified the risk to children walking to the borehole as a dry-season problem and reduced risk to children as a corresponding benefit of rainwater collection. This reflects the community-level significance of water access that extends beyond its direct agricultural function.

6.4 Factors Influencing RWH Adoption

6.4.1 Economic and Material Barriers

Lack of money was identified as a challenge by 74.4% of respondents (n = 32), followed by lack of knowledge (58.1%, n = 25), lack of containers (51.2%, n = 22), and lack of materials (51.2%, n = 22). Space constraints were cited by 20.9% (n = 9), maintenance difficulties by 9.3% (n = 4), and uncertain rainfall by 4.7% (n = 2).

Among non-adopters specifically, economic and material barriers were even more dominant. 94.1% of non-adopters (n = 16) cited lack of money for equipment as a reason for not collecting rainwater, and 82.4% (n = 14) cited absence of storage containers. By contrast, lack of knowledge was cited by only one non-adopter (5.9%) as a reason for non-adoption, and no non-adopter cited rainfall unreliability. Only one non-adopter (5.9%) reported having sufficient water from other sources as a reason for not collecting. This pattern contrasts with the 58.1% of respondents who identified lack of knowledge as a general challenge to RWH.

The barrier profile was broadly similar across adopters and non-adopters: among adopters, 73.1% (n = 19) also identified lack of money as a challenge, compared with 76.5% (n = 13) of non-adopters; 61.5% of adopters (n = 16) identified lack of knowledge, compared with 52.9% of non-adopters (n = 9). The absence of systematic differences in reported barriers between the two groups is consistent with the non-significant Fisher's exact test result for financial barriers ($p = 1.000$). This suggests that economic and material constraints are conditions shared broadly across the community, affecting adopters and non-adopters alike.

Informal interviews provided concrete illustrations of how these constraints operated in practice. IF-01 described an underground water tank on the farm that could not be fully utilised because the property lacked the pump and electrical

infrastructure required to draw water from it, a case in which existing infrastructure was rendered non-functional by gaps in access to electricity and associated equipment, rather than by the absence of storage capacity itself. IF-07 described purchasing water from a neighbour at 500 Uganda shillings per jerrycan during the dry season, double the 250-shilling rainy-season price, with additional transport costs, as the most accessible coping strategy available in the absence of personal storage capacity.

6.4.2 Technical Knowledge and Information Access

Formal knowledge of rainwater harvesting was extremely limited across the sample. As noted in Section 6.3.3, only 32.6% of respondents had ever heard of RWH as a defined technology, and only 7.0% (n = 3) had received any training specifically in water management. Among those who had received agricultural training of any kind (65.1%, n = 28), the specific type of training varied: crop production was most commonly reported (53.5%, n = 23), followed by pest and disease control (23.3%, n = 10), soil management such as mulching or erosion control (14.0%, n = 6), water or irrigation management (7.0%, n = 3), and marketing (2.3%, n = 1). Training directly relevant to soil and water conservation, the areas most closely tied to RWH practice, therefore accounted for a small share of respondents' overall agricultural training exposure. Formal institutional channels, extension services and NGO programmes, reached only a small minority of respondents with RWH-related information.

Despite this, two-thirds of the sample were already practising some form of rainwater collection, having developed these practices independently of formal awareness or training. Interview data confirmed this pattern: IF-01, IF-02, and IF-04 all described having developed rainwater collection practices through observation of neighbours and direct experience of dry-season scarcity, without any formal guidance. When asked about support priorities, several non-adopters placed training and technical advice ahead of financial assistance. IF-05 explicitly ranked knowledge first among her support needs, and articulated a clear understanding that technical capacity would outlast any one-time financial intervention. KI-01 similarly identified awareness of low-cost construction methods as a critical missing element, stating that external input could "increase awareness on the low-cost containers and technical advice in construction of low-cost containers" (KI-01, personal communication, 2026). KI-02 identified the need for technical guidance at a community scale, noting that effective water management required understanding not only how to harvest rainwater at the household level but also "how to recharge groundwater" (KI-02, personal communication, 2026). These interview accounts illustrate perceived knowledge gaps, but should not be read as suggesting that knowledge is the dominant constraint overall. As Section 6.5 shows, storage containers, a material need, were

identified as a priority far more frequently than training or technical advice across the sample as a whole; material and financial support therefore remain at least as central to RUCID's programme design as the technical knowledge gaps illustrated above.

6.4.3 Social Factors

Fisher's exact test and the Fisher-Freeman-Halton exact test were used to assess whether the differences observed between adopters and non-adopters were larger than would be expected simply by chance, examining whether adoption status was associated with gender, age, agricultural training, perceived dry-season water sufficiency, or reported financial barriers (Table 3).

Table 3. Exact tests of association between RWH adoption status and respondent characteristics (n = 43).

Variable	N	Test	p
RWH adoption vs Gender	43	Fisher's exact	.343
RWH adoption vs Age group	43	Fisher-Freeman-Halton exact	.728
RWH adoption vs Ag. training	43	Fisher's exact	.206
RWH adoption vs Water sufficiency	43	Fisher-Freeman-Halton exact	.642
RWH adoption vs Financial barrier	43	Fisher's exact	1.000

Note. One or more expected cell counts are less than 5 for each comparison. All p-values are two-tailed. Significance threshold α = .05.

None of these associations reached statistical significance, as summarised in Table 3. Because the sample (n = 43) is a purposive/convenience rather than a probability sample, these results are interpreted as exploratory rather than confirmatory. Descriptively, women were somewhat more represented among adopters (69.2%, n = 18) than among non-adopters (52.9%, n = 9), but this difference did not reach statistical significance in the current sample. These non-significant results do not, on their own, establish that adoption outcomes are shaped by structural community-wide conditions rather than individual characteristics; they indicate only that this sample did not detect such differences, which is consistent with, but does not confirm, a structural explanation.

Among non-adopters, 52.9% (n = 9) reported that their main dry-season water source was not reliable, 23.5% (n = 4) reported it was only sometimes reliable, and the remaining 23.5% (n = 4) reported it as reliable. Access to alternative water sources was also constrained by distance and cost. Over half of non-adopters (58.8%, n = 10) reported needing to walk more than 30 minutes to their main water source. Accessing this source also carried a cost for many: 47.1% (n = 8) paid directly for water, and a further group described costs arising indirectly, such as motorcycle transport fares, even where the water itself was free; among

all non-adopters who described some form of cost burden, the majority characterised it as "very expensive" rather than "somewhat expensive". These material access constraints help explain why non-adopters may view rainwater collection favourably despite not yet practising it. Several interview respondents described social and situational factors that compounded material barriers in ways not captured by the questionnaire alone. IF-05, a female respondent in the 30–44 age group with agricultural training, described a situation in which material and social constraints were closely intertwined: the nearest well was approximately 40 minutes away by boda-boda motorcycle, requiring payment for transport with each journey, yet the quantity of water retrievable per trip was insufficient for household and livestock needs, and adequate storage containers were unavailable to accumulate supply across multiple trips. She noted explicitly that even when she obtained water, the absence of suitable storage meant she could not build up reserves against the dry season. IF-06 noted that her house was not yet complete and anticipated beginning to collect rainwater once construction was finished, illustrating how household infrastructure development stages interact with the decision to invest in water storage. IF-07, a single male respondent in the oldest age group, described a pattern of reliance on social networks for water access, purchasing rainwater from a neighbour, as the most immediate coping strategy in the absence of personal storage capacity.

6.4.4 Environmental Uncertainty

Uncertain rainfall was the least frequently cited general barrier to RWH across the sample, identified by only 4.7% of respondents (n = 2), with near-identical low rates among adopters (3.8%, n = 1) and non-adopters (5.9%, n = 1). This general-barrier question is distinct from the specific reasons non-adopters gave for not collecting rainwater themselves: when asked directly, no non-adopter cited rainfall unreliability as their personal reason for not collecting. This finding is notable given that 74.4% of the sample perceived rainfall as more unpredictable in recent years, indicating that awareness of rainfall variability has not functioned as a deterrent to rainwater collection in this context.

Interview data offered some insight into how respondents understood this. Several adopters described their collection practices as a direct response to rainfall unpredictability rather than a behaviour undermined by it: IF-02 described having invested in underground storage precisely because she could no longer rely on tap water during the dry season, and IF-01 described a system specifically designed to capture and store large volumes from rainfall events for use across the dry period. In this context, rainfall variability appears to function as a motivation for water storage rather than a deterrent to investing in it.

6.5 Support Needs and Willingness to Adopt

Across the Lubanja sample, the most frequently identified support need was better storage containers, cited by 83.7% of respondents (n = 36), followed by training (60.5%, n = 26), technical advice (58.1%, n = 25), financial support (53.5%, n = 23), and community-level water systems (7.0%, n = 3). This ranking was broadly consistent across adopters and non-adopters, though with some differences in emphasis. Containers were reported more frequently by non-adopters (94.1%) than adopters (76.9%), as was financial support (non-adopters: 64.7%; adopters: 46.2%), while training (adopters: 61.5%; non-adopters: 58.8%) and technical advice (adopters: 65.4%; non-adopters: 47.1%) were reported somewhat more frequently among adopters. These differences are based on small descriptive percentage differences within this sample and were not formally tested.

Table 4. Identified support needs by adoption status (multiple responses permitted)

Support need	Lubanja respondents (n = 43)	Adopters (n = 26)	Non-adopters (n = 17)
Better storage containers	83.7% (n=36)	76.9% (n = 20)	94.1% (n = 16)
Training	60.5% (n = 26)	61.5% (n = 16)	58.8% (n = 10)
Technical advice	58.1% (n = 25)	65.4% (n = 17)	47.1% (n = 8)
Financial support	53.5% (n = 23)	46.2% (n = 12)	64.7% (n = 11)
Community-level water systems	7.0% (n = 3)	—	—

Note. Percentages sum to more than 100% as respondents could identify multiple support needs. Community-level water systems were not disaggregated by adoption status in the original data.

All 17 non-adopters (100%) stated they had at some point considered collecting rainwater, and all 17 indicated they would do so if given adequate financial, material, or technical support. Together with the near-universal willingness to improve among adopters (97.7%), these findings indicate that positive orientation towards rainwater collection is very high across the sample, and that the gap between current practice and desired practice is structural rather than motivational.

The RUCID institutional representatives identified community-level interventions as particularly important alongside household-level support. KI-01 proposed that collective action to channel runoff towards agricultural land, guided by appropriate technical advice, could significantly increase water availability across the community as a whole, noting that "all farmers can collect water and direct the water to their gardens" (KI-01, personal communication, 2026) rather

than allowing rainfall to flow off the land unused. KI-02 similarly identified the potential for a community-scale water reservoir as a means of providing more reliable water access for multiple households simultaneously, and emphasised that any such system would require structured technical guidance to design and implement effectively.

7. Discussion

7.1 Informal Practice Precedes Formal Awareness: An Inverted Gap

The household-level data collected in this study extend, at the level of individual respondents, a pattern that district- and national-scale secondary evidence had previously only indicated indirectly. Nanteza et al. (2022) inferred technical inadequacy from physical infrastructure measurements without asking households what they knew or how their practices had developed; Mubiru et al. (2018) documented RWH's rapid spread in Uganda without probing the relationship between that spread and formal awareness. The present findings speak to this pattern directly: a majority of Lubanja respondents were already collecting rainwater in some form, yet most of these adopters had never heard of RWH as a formally defined concept and had received no water management training. Practice, in other words, appears in many cases to have preceded formal technical knowledge rather than following from it, consistent with, at the household level, what the secondary evidence for this district had only implied. For RUCID's programme design, this pattern does not rule out a role for awareness-raising interventions in Lubanja: a majority of respondents still identified lack of knowledge as a barrier, and training and technical advice ranked highly among self-identified support needs. It does, however, point towards technical upgrading of practices already in place as at least as important a priority. It suggests that technical upgrading of practices already in place may be a more urgent need than awareness-raising alone in Lubanja. This finding should, however, be read with the sample's recruitment process in mind: because respondents were identified by a RUCID staff member with a stated preference for farmers already engaged and considered active, the sample likely over-represents households already connected to RUCID, and the reported adoption rate may not generalise to less engaged or harder-to-reach community members.

This pattern is consistent with evidence from comparable East and Central African contexts. African Technology Policy Studies Network (2013), documenting rainwater collection practices in Bahi District, Tanzania, found that communities in semi-arid villages had independently developed improvised collection techniques, including hanging cloth at roof edges to filter runoff into buckets and digging shallow catchment depressions in open spaces surrounding houses, without access to formal RWH guidance or technical training. As in Lubanja, these practices had arisen from direct experience of water scarcity rather than from engagement with formal extension services or NGO programmes. Crucially, African Technology Policy Studies Network (2013) also found that over 90% of households expressed willingness to adopt improved techniques once

shown feasible low-cost modifications, a figure closely paralleled by the 97.7% of Lubanja respondents who indicated they would like to improve their current collection practices, and the 100% of non-adopters who stated they would adopt if given adequate support. Taken together, these findings suggest that the starting point for RWH support in such contexts is not the construction of awareness, but the technical upgrading of practices that communities have already independently initiated.

At the continental scale, Zvobgo et al. (2022) provide further corroboration. Their structured assessment of water sector adaptation responses across Africa found that indigenous knowledge and local knowledge are already widely influencing the implementation of water adaptation measures, particularly rainwater harvesting, water conservation, and irrigation, in East, West, and Southern Africa. Yet only 10.4% of African governments included this indigenous and local knowledge in formal national adaptation planning documents (Zvobgo et al., 2022). This institutional gap between what communities are already doing and what formal adaptation channels acknowledge closely mirrors the local pattern documented here: community-level practice that has developed outside formal knowledge systems, and which therefore remains invisible to, and unsupported by, the institutions best positioned to strengthen it. Zvobgo et al. (2022) explicitly recommend integrating multiple knowledge sources, including indigenous and local knowledge, into coordinated adaptation planning, a recommendation with direct implications for how RUCID and district-level extension services might approach their planned RWH programming.

7.2 Climate Perceptions and Their Motivational Role

As established in Section 4.1, farmer perceptions of climate change in comparable Ugandan contexts have been found in some studies to correspond with instrumental meteorological records. The present findings are broadly consistent with this regional evidence: a large majority Lubanja respondents reported experiencing some change in rainfall patterns, and most described rainfall as more unpredictable, comparable to the 67.3% of farmers in southwestern Uganda who reported reduced rainfall over the past two to three decades (Turyasingura et al., 2024). This is further consistent with Mubiru et al.'s (2018) documentation of a declining trend in monthly rainfall and number of rainy days in key crop-growing months across two Ugandan districts, alongside rising temperatures. This study did not include local meteorological validation, so the present data cannot independently confirm that respondents' perceptions accurately reflect measured climate trends in Lubanja specifically. The correspondence between the present community-level data and these documented regional patterns nonetheless lends plausibility to the perception data collected here, consistent with the methodological point made in Section 4.1.

Notably, environmental uncertainty was the least frequently cited barrier to rainwater collection across the sample, and no non-adopter cited rainfall unreliability as a reason for not collecting, suggesting that perceived rainfall unpredictability was not commonly experienced as a deterrent in this sample. Interview data illustrated one way this may operate for at least some respondents: several adopters described their collection systems as a direct response to rainfall unpredictability, a means of capturing and storing water precisely because its occurrence had become less predictable. This account holds for these individual respondents; the absence of rainfall unreliability as a cited barrier does not, on its own, establish that unpredictability motivated investment across the sample as a whole. This finding differs from the pattern reported by some adoption studies in West Africa, where rainfall uncertainty has been found to act as a risk-aversion trigger that discourages investment in water storage infrastructure (Bessah et al., 2022). A plausible explanation for this divergence is that in Lubanja, where most respondents reported insufficient dry-season water, the cost of not collecting is experienced as so high that even uncertain rainfall is perceived as worth capturing, a dynamic consistent with the observation by Nanteza et al. (2022) that Mityana District households face systematic water insecurity that motivates adoption despite structural constraints. This also complicates Kanyi et al.'s (2017) prospect-theory account, in which perceived climate variability should heighten risk aversion and discourage investment: in Lubanja, the same perception appears instead to function as a driver of investment, suggesting that where the cost of inaction is high enough, uncertainty can motivate rather than deter action.

7.3 The Gap Between Practice and Technical Adequacy

While informal collection is widespread, the data reveal a critical gap between the existence of collection practices and their self-reported sufficiency. Among adopters, most respondents reported that stored rainwater either did not last through the dry season or only sometimes did, with storage periods extend far beyond the full dry season, typically around one month, and for a significant number of users, less than two weeks. Given that the dry season in Lubanja extends from June to August, even households with storage capacity are unable to bridge the period of peak water scarcity through their current systems. This pattern of widespread but reportedly insufficient practice is broadly consistent with Nanteza et al. (2022), who found that 62% of existing RWH tanks in Mityana District have a storage capacity of only 5,000 to 15,000 litres, substantially below what would be required to reliably meet household dry-season needs, and that upgrade costs exceed most households' capacity without external support. The present findings are broadly consistent with the district-scale pattern

described by Nanteza et al. (2022): RWH adoption does not appear to be the binding constraint; reported storage sufficiency does.

However, the present data indicate that a storage-sufficiency gap exists, through respondents' own reports of storage duration and sufficiency, without directly testing why individual households arrived at their current storage capacity. Nanteza et al.'s (2022) explanation, that households size their tanks based on financial capacity and subjective judgement rather than systematic calculation against rooftop area and seasonal demand, is drawn from district-scale infrastructure analysis rather than from this study's own respondents. What the present data do show is that affordability is the most frequently cited constraint on RWH practice (Section 6.4.1), which is consistent with, though does not on its own confirm, Nanteza et al.'s account of undersized, subjectively determined tank capacity in this district.

The nature of this gap may also help explain why only a few of adopters used collected rainwater for crop irrigation, despite reduced crop yields and crop loss being among the most widely reported dry-season problems (53.5% and 20.9% of respondents, respectively). Where total storage volume is insufficient to cover the full dry season, households may face an implicit triage between water uses: domestic consumption and livestock watering, both immediate and non-deferrable, would take precedence over crop irrigation, which can in principle be partially compensated by other strategies such as drought-tolerant varieties or adjusted planting dates. This pattern may reflect both household prioritisation of domestic and livestock needs under scarcity and the domestic orientation of existing collection systems themselves, rather than a lack of agricultural priority; the present data cannot establish which of these factors, or what combination of them, is driving the observed pattern. This distinction has potential implications for how RUCID's planned programme should be designed, and is consistent with the broader recommendation in the RWH literature for technology support to be calibrated to actual household water budgets and seasonal demand profiles (Biazin et al., 2012; Vohland & Barry, 2009). Relatedly, the dominant practices in Lubanja, tanks and roof-eave containers, belong to a domestic-oriented form of rooftop catchment, conceptually distinct from the field-level in situ and micro-catchment techniques reviewed in Section 4.3.1 that the wider literature associates with agricultural productivity gains. Current practice therefore appears oriented primarily towards domestic rather than irrigation use, though this cannot be fully separated from the effect of limited storage volume with the present data.

7.4 Structural Barriers Rather Than Attitudinal Constraints

Fisher’s Exact tests found no significant association between adoption status and any of the individual characteristics examined, including gender, age,

agricultural training, perceived dry-season water sufficiency, or financial barriers. This is consistent with the descriptive pattern: economic and material barriers were reported at similarly high rates by both adopters and non-adopters, and no barrier type showed a marked distributional difference between the two groups. This pattern does not, on its own, establish that adoption status reflects structurally determined circumstances rather than individual characteristics; it indicates only that no such differences were detected in this sample, which is consistent with a structural explanation without confirming it.

These results are broadly consistent with those of Bessah et al. (2022), who found in their study of RWH adoption among maize farmers in Ghana that structural factors, particularly access to capital and extension services, were stronger predictors of adoption outcomes than attitudinal variables. The present findings extend this conclusion in a specific direction: where Bessah et al. (2022) documented a positive attitude-adoption relationship that was mediated by structural constraints, the Lubanja data suggest that even the adoption-non-adoption distinction itself may be more a function of situational variation, in roof structure, existing container access, or household construction stage, than of systematic differences in motivation or willingness. IF-06's account of planning to begin rainwater collection once house construction was complete, and IF-07's reliance on purchasing rainwater from a neighbour as the most accessible interim strategy, both illustrate how structural and situational factors, rather than attitudinal ones, determine collection behaviour. This interpretation is reinforced by the finding that all non-adopters expressed willingness to adopt with support, and that all had previously considered doing so.

The dominant role of material and economic barriers is further supported by the support needs data: storage containers were the most frequently identified need, ranked ahead of training, technical advice, and financial support. This hierarchy is particularly striking given that formal knowledge of RWH was so limited across the sample: even without knowing what RWH is as a formal concept, the community accurately diagnosed storage infrastructure as the binding constraint on effective practice. This stands in contrast to the findings of Kanyi et al. (2017), whose study of RWH adoption across Kenyan counties identified awareness and social status as central enabling factors, with training and information access playing a key mediating role in translating positive attitudes into adoption behavior. The divergence between these two contexts suggests that the relative importance of knowledge versus infrastructure as adoption constraints is not fixed, but varies with the degree of pre-existing informal practice: where communities have already independently initiated collection behavior, as in Lubanja, the binding constraint shifts from awareness to technical capacity, and infrastructure support becomes the more urgent intervention lever than information provision. The relatively high ranking of training among self-

identified support needs, despite this shift, may in part reflect respondents' awareness of RUCID's existing role as a training provider, rather than solely an independent assessment of need; this possibility is consistent with the broader limitation regarding RUCID's dual role in this study.

7.5 Gender and the Distribution of Water Burdens

The qualitative data provide important context: IF-05's account of spending on boda-boda transport to access a well 40 minutes away illustrates how the material cost of water access compounds household economic pressure during the dry season. This burden was not necessarily confined to women alone: IF-04, a male interview respondent, explicitly linked rainwater collection to reduced risk for children travelling to fetch water, a concern independently echoed in an open-ended questionnaire response from a female respondent. This suggests that the costs of inadequate storage are distributed across household members with limited capacity to influence investment decisions, rather than falling on women in isolation. Existing literature suggests that in comparable contexts, women bear a disproportionate share of the time, financial, and physical costs of water collection while having limited control over household investment decisions (CGIAR GENDER Impact Platform, 2024; Nanteza et al., 2022). Whether this specific pattern, of women and children bearing the costs while decision-making authority over RWH-related investment rests elsewhere in the household, holds in Lubanja could not be directly examined with the present interview data, as no respondent spoke explicitly to who within the household typically undertakes water collection or makes decisions about such investments, and the interview accounts drawn on above illustrate individual cases rather than a systematically observed division of labour. This remains an important question for future research, and for RUCID's programme design should it seek to ensure that support reaches those who both bear the burden and are positioned to act on it.

The non-significance of the gender-adoption association should be interpreted carefully. As Kanyi et al. (2017) note, gender effects on RWH adoption are often mediated by social status and access to resources rather than operating directly: women may be as motivated to collect rainwater as men, but face greater constraints on the capital investment required to do so effectively. In Lubanja, where economic barriers were cited at high rates by both male and female respondents, this mediation dynamic may have attenuated any direct gender-adoption association that might otherwise be detectable in a larger sample. The absence of a significant gender association is therefore not evidence that gender is unimportant, but rather that its effects in this context are more likely to operate through the distribution of material resources and decision-making power than through differences in adoption behaviour per se.

As noted in the Methods section, the higher female representation in the sample partly reflects the timing of fieldwork during the peak agricultural labour period rather than differential willingness to participate, and this should be taken into account when interpreting the descriptive gender distribution above.

7.6 Implications for Agroecological Programming

Agroecology, defined as the application of ecological concepts and principles to the design and management of sustainable agroecosystems (Altieri & Nicholls, 2005), emphasises that social capital formation and community agency are as integral to sustainable agricultural development as any technological intervention, what is key to local livelihoods is the capability of communities to innovate and adapt through processes grounded in local knowledge and organisation (Altieri & Nicholls, 2005). Rainwater harvesting itself reflects these principles: it captures and recycles a naturally occurring resource within the farm system rather than relying on external inputs, and, where storage supports domestic, livestock, and crop needs together, it treats water management as an integrated function of the whole farming system rather than a standalone technical intervention. The present findings suggest that any programme designed in this spirit should begin not from the premise that the community lacks knowledge or motivation, but from the premise that it possesses both, in the form of self-initiated informal collection practices grounded in direct experience, and that what is needed is technical upgrading of those practices rather than their replacement by externally designed systems.

Field-level water-management techniques, such as contour ridges, tied ridges, and mulching, extend this same logic further into crop production itself, and the wider literature associates them with soil-water retention and agricultural productivity gains (Biazin et al., 2012). Whether, and to what extent, such techniques are already practised informally in Lubanja was not examined by this study's instruments and remains an open question for future research or for RUCID's own community assessment.

Beyond the individual household, the water-use patterns documented in this study point to trade-offs that are characteristic of household-level water allocation across farming activities, rather than isolated technical constraints. The near-universal prioritisation of livestock watering alongside limited use for irrigation reflects an allocation logic in which water is distributed across competing household uses under scarcity, rather than a simple technology gap. Volumes were not measured, so this comparison reflects reported use patterns rather than the relative scale of livestock and crop water demand. This is consistent with the broader pattern in Ugandan smallholder systems, where crop and livestock activities routinely compete for the same limited household land and water resources (Mubiru et al., 2018). From an agroecological perspective, this is not

incidental: livestock and crops are interdependent components of the same household farming system, and a shortfall in water available for irrigation has downstream consequences for feed availability, manure production, and overall household resilience, consequences that are not visible if RWH is evaluated purely as a household drinking-water intervention. Programme design that treats domestic, livestock, and crop water needs as a single allocation problem, rather than three separate technical targets, is more consistent with an agroecological systems perspective than one that addresses storage capacity in isolation. This is consistent with the "Multiple-Use Water Services" approach advocated in the wider water-development literature, which treats households' multiple water needs, domestic and productive alike, as a single integrated starting point for service provision, rather than separating them into distinct sectoral targets (Van Koppen et al., 2006, as cited in CGIAR GENDER Impact Platform, 2024).

The gender composition of this sample, shaped in part by the timing of fieldwork during the peak agricultural labour period (Section 5.2), is itself suggestive of a labour dimension to water management in Lubanja that this study was not designed to measure directly but that agroecological analysis would treat as central. Women across sub-Saharan Africa are typically responsible for household-level water collection and management, yet remain largely excluded from formal decision-making over water resources, a structural asymmetry between who bears the burden of water insecurity and who holds the power to act on it (CGIAR GENDER Impact Platform, 2024). The predominance of older women among respondents available during the day is consistent with, though does not confirm, this broader regional pattern. An agroecological approach to programme design would treat the allocation of labour for water collection, storage maintenance, and management as a variable to be assessed explicitly, rather than assumed, since interventions that increase storage volume without considering who bears the labour of filling, maintaining, and managing that storage risk shifting burdens rather than reducing them.

Affordability was the most frequently cited barrier to RWH in this sample. Because this barrier was reported at similarly high rates by both adopters and non-adopters, it appears to constrain not only whether households can begin collecting rainwater, but also how adequately they can do so once they start, a distinction that may be relevant to equity considerations in how programme support is eventually designed and allocated. This concern is echoed in the wider literature on water-related technology adoption in sub-Saharan Africa, where wealthier households are consistently more able to afford storage tanks and pumps, while poorer farmers risk being excluded from the resulting benefits (Sithole, 2025). Because both adopters and non-adopters cited financial constraints at similarly high rates (Section 6.4.1), the capacity to invest in storage upgrades is unlikely to be evenly distributed across the community, and a programme that relies on

household co-financing risks reinforcing existing disparities between better-resourced and more constrained households. An agroecological framing of equity would treat this not as a side effect to be managed after programme design, but as a design parameter: subsidy structures, phased support, or in-kind contributions calibrated to household capacity are more consistent with strengthening community-wide resilience than a uniform cost-sharing model.

The community-scale water infrastructure options raised by both RUCID key informants, runoff channelling towards agricultural land and a shared reservoir, point towards a governance dimension of RWH that complements the household-level focus of this study. The strength of local collective action and community organisation has itself been identified as a key factor shaping whether new agricultural and water-management practices are taken up at scale (Thornton et al., 2018), and community-level organisation and institutional support have similarly been shown to influence whether RWH is adopted individually or collectively (Vohland & Barry, 2009). Agroecology's emphasis on community agency and locally grounded innovation (Altieri & Nicholls, 2005) suggests that these community-scale options should not be treated merely as a supplementary technical add-on, but as an opportunity to build on existing local knowledge and organisational capacity, given that most current RWH practice in Lubanja was itself developed informally, through experience and observation of neighbours, rather than introduced externally (Section 6.3). A programme that positions RUCID as a facilitator of community-led planning for shared infrastructure, rather than solely as a provider of household-level materials, would be more consistent with this agroecological orientation towards collective agency.

7.7 Limitations

Several limitations of the present study should be acknowledged. First, the sample size of 43 Lubanja respondents limits the statistical power of the analyses. Fisher's exact and Fisher-Freeman-Halton exact tests were used throughout to avoid the small-sample limitations of chi-square approximations; however, these tests, like chi-square, assume random sampling from the population of interest, an assumption not met by the purposive/convenience sample used here. The results are therefore interpreted as exploratory and descriptive rather than confirmatory, and the non-significant associations reported should not be interpreted as evidence of true null effects, they reflect both the absence of detectable systematic differences and the inherent uncertainty of small-sample inference. A larger, more statistically powered study would be needed to confirm or refute these patterns with greater confidence. Relatedly, because this is a purposive/convenience sample rather than a probability sample, the descriptive percentages and test results reported throughout this thesis should be read as characterising this

specific sample rather than as estimates of population-level prevalence or associations in Lubanja as a whole.

A further limitation concerns how respondents were identified. Recruitment was carried out by a RUCID staff member from among farmers already engaged in RUCID's ongoing activities, with a stated preference for those considered most active and willing to participate. This means the sample is likely to over-represent households already connected to RUCID and disposed towards agricultural or development interventions, and may not reflect the perspectives of less engaged or harder-to-reach community members.

Second, this study was conducted in a single village (Lubanja) in partnership with one NGO (RUCID), and the findings should not be read as generalisable conclusions about RWH adoption in Mityana District or Uganda more broadly. Sithole et al. (2025) note that many RWH adoption studies rely on small-scale case studies with limited generalisability, and this study is subject to the same constraint: it cannot establish, and does not attempt to establish, whether the patterns documented here hold across other villages or districts.

This limitation should be understood in relation to the study's purpose. This is a decision-support diagnostic study, commissioned to inform a specific programme decision by a specific organisation in a specific community; it is not a generalisability study, and was not designed to produce evidence that could be extrapolated beyond Lubanja. The appropriate standard against which to evaluate its findings is therefore not "can these results be generalised," but "do these results provide a more reliable basis for RUCID's programme design decisions than the district-scale secondary evidence or informal institutional judgement that would otherwise have been used." Judged against that standard, the triangulation of questionnaire, interview, and observational data provides a defensible, if locally bounded, evidence base. Extending these findings to other communities would require the kind of larger, comparative study that Sithole et al. (2025) identify as absent from the current literature.

Because this study collected data at a single point in time, it cannot establish that informal practice actually came before formal awareness, only that the two conditions exist together in this sample. The claim that practice came first is based on some interview accounts, not on the questionnaire data alone. As with any self-reported data, responses may be affected by memory or a tendency to give favourable answers, but the consistency between the questionnaire and interview data gives some confidence that responses reflect real experiences.

Additionally, this study relies on respondents' self-reported assessments of storage duration and sufficiency rather than direct technical measurement of roof catchment area, tank capacity, or household water demand; the storage-sufficiency gap identified here is therefore a self-reported rather than an independently verified technical finding.

A related limitation concerns the absence of a formal pilot test of the questionnaire instrument with the target community population prior to full deployment. The final version was reviewed by both supervisors and was informally tested with RUCID's College Principal, who served as the first respondent; however, it was not formally piloted with members of the target farming community before full administration. As a result, some issues with question wording or response options may not have been identified and corrected prior to data collection.

A further limitation concerns translation. A single RUCID staff member handled all translation and interpretation, for both the questionnaire and informal interviews, and also recruited participating farmers. Rather than formal back-translation, verification was limited to informally asking the translator to confirm the intended meaning of key items after data collection. Because interviews were interpreted in real time and later written up in English, some nuance in respondents' original speech, such as hedging or emphasis, may not have been fully preserved; the interview quotations used in this thesis therefore reflect the translator's rendering rather than respondents' exact words. Relying on a single person for both translation and recruitment also means that translation choices and rapport with respondents cannot be independently verified. Future research in this context should use more than one translator and pilot key terms with the community before data collection.

Furthermore, although all interviews were audio-recorded, the recordings were used to inform handwritten notes and post-visit summaries capturing key points and representative quotations, rather than to produce full verbatim transcripts; quotations used in this thesis therefore reflect the researcher's and translator's selection and rendering of what was said, rather than a complete word-for-word record.

A related limitation concerns RUCID's dual role in this study, as both the source of on-the-ground research support (translation and participant recruitment) and the organisation planning future RWH programming informed by this research. Respondents may have perceived a connection between their answers and their prospects of receiving future support from RUCID, potentially introducing social desirability bias or reflecting the influence of institutional power dynamics on how questions were answered. This concern is particularly relevant given the decision-support orientation of this study, where findings are intended to directly inform programme design.

Fifth, the gender composition of the sample was shaped in part by the timing of fieldwork during the peak agricultural labour period, which limited the availability of male respondents during data collection; this should be considered when interpreting gender-related findings.

8. Conclusion

This study set out to produce an empirical needs diagnosis of rainwater harvesting practice in Lubanja Village, Mityana District, Uganda, to inform RUCID's planned community RWH programme. The findings point to a pattern that departs from the assumptions typically underlying such programmes: informal rainwater collection is already widespread in Lubanja, but this practice largely developed without formal awareness of RWH as a defined concept, and existing storage is frequently insufficient to meet household needs through the dry season. Climate perception, far from deterring investment, appears to have motivated it. The binding constraint on effective water management in this sample is therefore not a lack of awareness or willingness, but the adequacy of existing storage capacity, a distinction that reframes RUCID's intervention priorities.

Three implications for programme design follow from this. First, storage infrastructure, rather than awareness-raising, appears to be the more urgent leverage point. Translating this into specific recommendations, however, requires a household-level diagnostic step rather than a uniform prescription: an assessment of household water demand, roof catchment area, local rainfall patterns, and required storage volume. Without this assessment, larger tanks risk simply replacing one poorly sized system with another; with it, storage recommendations can be calibrated to each household's actual dry-season needs rather than applied uniformly across the community.

Second, technical support should be designed as tiered rather than uniform. Because current adopters are already practising some form of RWH, but many have no formal awareness of RWH as a defined concept or water-management training, training content should be built around each group's actual starting point rather than their adoption status alone. A more appropriate structure would offer practice-upgrading training for existing collectors, introductory and foundational modules for non-collectors, and, for both groups, further guidance on sizing, catchment design, and maintenance tailored to household needs.

Third, RUCID's own role in implementation should be treated as a deliberate design decision rather than a default assumption. Comparable community-based water programmes elsewhere have shown that the technical simplicity of a storage structure is not sufficient on its own, and that outcomes tend to be stronger where construction is paired with structured water-management training delivered by a locally embedded organisation. As the established local implementer, RUCID is well positioned to consider building such training into the programme; however, whether this should be a required rather than optional component is a decision that would need to weigh RUCID's institutional capacity, available resources, and farmers' own preferences, rather than one that can be settled by comparative evidence alone. The same applies to the community-scale options, such as runoff

channelling and a shared reservoir, that RUCID's own representatives raised as possible complements to household-level storage.

These findings are bounded by the study's single-village scope, small convenience sample, and cross-sectional design, and are not intended to generalise beyond Lubanja. They nonetheless provide a more reliable, locally grounded basis for RUCID's next programme decisions than the secondary evidence or informal institutional judgement that would otherwise have informed them. Two questions remain open for future work: who within the household holds decision-making authority over water-related investment, and whether the pattern of practice preceding awareness observed here reflects a genuine developmental sequence, something only longitudinal research could confirm.

Ultimately, this study suggests that the more useful question for RUCID's programme is not how to introduce rainwater harvesting to Lubanja, but how to help a community that has already begun solving this problem for itself finish the job properly.

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Appendix 1: Questionnaire

Perceptions of Climate Change and Rainwater Harvesting: A Survey on Adaptation Strategies for Smallholder Farmers

Dear Participant,

My name is Yishan Jiang, and I am a Master's student at the Swedish University of Agricultural Sciences (SLU). This study is conducted as part of my MSc thesis and focuses on evaluating the applicability and sustainability of rainwater harvesting systems as a climate adaptation strategy in the Mityana region of Uganda.

The purpose of this research is to better understand local perceptions of climate change, water availability, and experiences or attitudes toward rainwater harvesting. The findings of this study aim to contribute to improved water management planning and climate adaptation strategies for smallholder communities.

Your participation in this study is entirely voluntary. You may choose not to participate or withdraw from the survey at any time without any negative consequences. There is no monetary compensation for participation. All responses will be treated with strict confidentiality, and no personally identifiable information will be collected. The data will be used only for academic purposes and presented in an anonymised form.

The questionnaire will take approximately 30–40 minutes to complete.

If you have any questions about the study, you may contact the researcher through the university.

Thank you for considering participation in this research.

Sincerely,

Yishan Jiang

MSc Student, Swedish University of Agricultural Sciences (SLU)

Consent

1. I agree to participate in this survey *

Mark only one oval.

☐ I agree to participate in this survey

By continuing with this survey, you confirm that:

• You have read and understood the information above;

• You agree to participate in this study;

• You agree to be photographed and have your images used;

• You consent to the processing of your responses for research purposes.

Section A: Background Information

2. Age *

Tick all that apply.

☐ Under 18
☐ 18–29
☐ 30–44
☐ 45–59
☐ 60+

3. Gender *

Mark only one oval.

☐ Female
☐ Male

4. Have you ever been in an agricultural training? *

Mark only one oval.

☐ Yes
☐ No

5. If Yes, what type of training have you been in? *

Tick all that apply.

☐ How to grow crops better
☐ How to manage water or irrigation
☐ How to improve soil (for example mulching or preventing erosion)
☐ How to control pests and diseases
☐ How to sell farm products or manage money

☐ Other: _____

6. Which town do you live in now?

Section B: Water Sources and Dry Season Experience

7. What are your main water sources? (You may select more than one option) *

Tick all that apply.

☐ Rainwater
☐ Borehole
☐ Well
☐ Tap water
☐ Lake/river
☐ Buy water
☐ Other: _____

8. During the dry season, do you usually have enough water? *

Mark only one oval.

☐ Yes
☐ No
☐ Sometimes

9. What challenges do you face during dry periods? *

Tick all that apply.

☐ Crop loss
☐ Reduced yields
☐ Livestock problems
☐ High cost of water
☐ Long distance to water source
☐ No major problems
☐ Other: _____

10. In recent years, how would you describe rainfall? (You may select more than one option) *

Tick all that apply.

☐ Less rain than before
☐ More unpredictable
☐ Shorter rainy seasons
☐ No clear change
☐ Not sure

Section C: Rainwater Collection Practices

11. When it rains, do you collect or store rainwater in any way? *

Mark only one oval.

☐ Yes → Skip to Question 12
☐ No → Skip to Question 16

Section C1 – For Those Who Collect Rainwater

12. How do you collect rainwater? (You may select more than one option) *

Tick all that apply.

☐ Containers under roof (buckets, jerrycans, drums)
☐ Water tank
☐ Pond or small dam
☐ Guide water to crops using channels
☐ Allow water to soak into soil around crops
☐ Other: _____

13. What do you mainly use the collected rainwater for? (You may select more than one option) *

Tick all that apply.

☐ Irrigation
☐ Livestock
☐ Household use
☐ Drinking
☐ Other: _____

14. During the dry season, does stored rainwater last long enough? *

Mark only one oval.

☐ Yes
☐ No
☐ Sometimes

15. How long is it possible to store the water during the dry season? *

Mark only one oval.

☐ Less than 2 weeks
☐ About 1 month
☐ About 2 months
☐ It lasts the whole dry season

Section C2 – For Those Who Do NOT Collect Rainwater

16. Why do you not collect rainwater? *

Mark only one oval.

- ☐ I have enough water from other sources
- ☐ I do not have storage containers
- ☐ I do not have money for equipment
- ☐ I do not know how to collect it
- ☐ I do not think it is useful
- ☐ Rainfall is not reliable
- ☐ No space for storage
- ☐ Other: _____

17. Regarding the main water source we asked about earlier, is this water source reliable during the dry season? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ Sometimes

18. Do you need to pay for this water? *

Mark only one oval.

- ☐ Yes
- ☐ No

19. If YES, is it too expensive for you? *

Mark only one oval.

- ☐ Not expensive
- ☐ Somewhat expensive
- ☐ Very expensive

20. How far do you need to walk to your main water source? *

Mark only one oval.

- ☐ Less than 10 minutes
- ☐ 10–30 minutes
- ☐ More than 30 minutes

21. Have you ever considered collecting rainwater? *

Mark only one oval.

- ☐ Yes
- ☐ No

22. If YES, what stopped you from doing it?

23. If NO, why don't you want to do it?

24. If you had support (money, materials, training), would you consider collecting rainwater? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ Maybe

Section D: Awareness and Perceptions

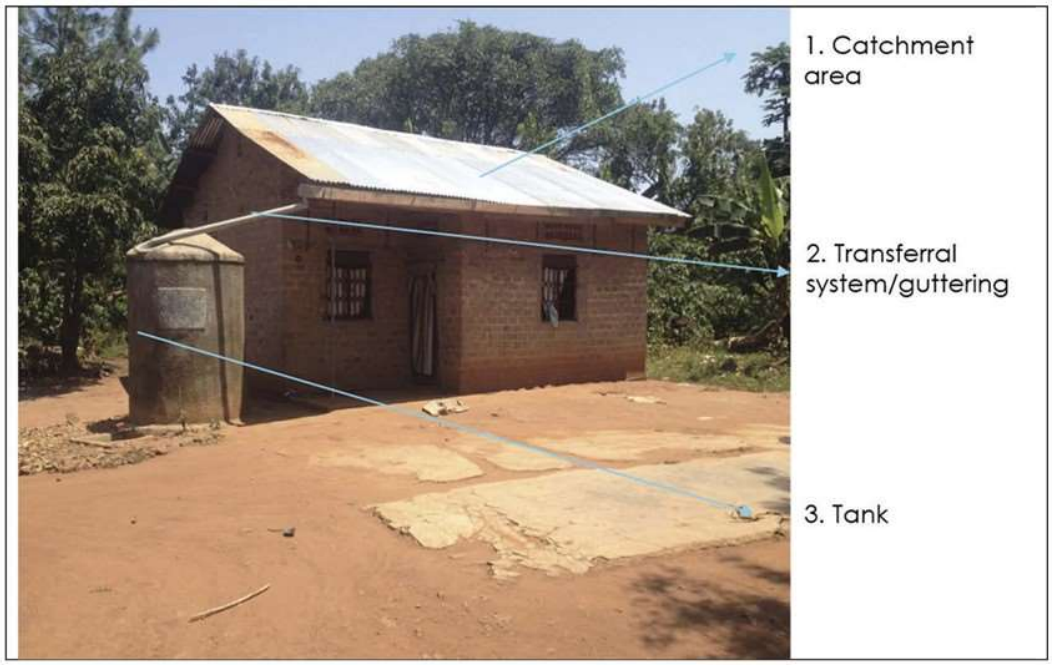
25. Have you heard of rainwater harvesting systems before? *

Mark only one oval.

- ☐ Yes
- ☐ No

A rainwater harvesting system is a way of collecting rain when it falls and saving it for later use. Instead of letting rainwater flow away, it is guided into tanks, ponds, or the soil, so it can be used during dry periods.

A picture of Rain Water Harvesting



26. If yes, where did you hear about rainwater harvesting? (You may select more than one option) *

Tick all that apply.

- ☐ Other farmers
- ☐ Extension officers
- ☐ NGOs or projects

☐ Media
☐ Family or friends
☐ Other: _____

27. What do you see as the main benefits of using rainwater harvesting systems? (You may select more than one option) *

Tick all that apply.

☐ More water during dry season
☐ Better crop production
☐ Lower water costs
☐ More reliable farming
☐ Other: _____

Section E: Barriers and Future Improvements

28. What do you see as the main challenges or risks of rainwater harvesting systems? (You may select more than one option) *

Tick all that apply.

☐ Lack of money
☐ Lack of materials
☐ Lack of knowledge
☐ No space to place the container
☐ No container to store the water
☐ Uncertain rainfall
☐ Maintenance difficulties
☐ Other: _____

29. Would you like to improve how you collect or store rainwater? *

Mark only one oval.

☐ Yes
☐ No
☐ Maybe

30. What support would help you most? *

Tick all that apply

☐ Financial support
☐ Training
☐ Better storage tanks
☐ Technical advice
☐ Community system
☐ Other: _____

31. Besides that, what other support do you think is needed? *

32. Is there anything else you would like to share regarding water management or rainwater harvesting in your community?

Appendix 2: Informal Interview Topic Guide

Informal interviews were not conducted using a fixed question script. Instead, they extended conversationally on topics already introduced through the structured questionnaire (Appendix 1), using open-ended prompts designed to probe the reasoning, trade-offs, and lived experience behind respondents' questionnaire answers, rather than repeating them. Prompts were adapted flexibly depending on the flow of each conversation and the respondent's adoption status, and were not administered as a fixed sequence.

1. Livelihood and water sources
Walk me through how you actually get water on a typical day, from noticing you need it to having it in hand.
When you use more than one water source, what determines which one you use for what?

2. Dry-season experience and rainfall perceptions
Can you describe the worst dry season you remember, and what problems it caused, in order?
Has the amount of rain changed, or mainly when it comes and how reliable it is?

3a. Current RWH practice (respondents who collect rainwater)
Can you describe exactly how the water moves, from your roof or field, to where it's stored, to where it's used?
What determines how long your stored water lasts, and what usually runs out first?

3b. Reasons for non-adoption (respondents who do not collect rainwater)
Was there a particular reason or condition that has kept you from starting, beyond cost?
You mentioned you would consider it with enough support; what would "enough" actually look like?
Can you describe what it actually costs you, in money or time, to get water right now?

4. Awareness and attitudes towards RWH
Where did you first hear about rainwater harvesting?
How does rainwater compare to your other water sources, in terms of reliability or quality?

5. Barriers and support needs

Of the things standing in your way, which one would you fix first if you could only fix one, and why that one?
You mentioned needing [money/training/containers]; can you describe a specific situation where the lack of that made a difference?
If you compare receiving money versus receiving training, what do you think would actually change for your household a year from now?

6. Additional themes raised opportunistically
The following themes were not raised systematically with every respondent, but were followed up when respondents introduced them spontaneously:
Perceived differences between rainwater and other water sources beyond reliability (e.g. taste, hardness, health)
Effects of water collection or its absence on household routines, including children's time, safety, or school attendance
Suggestions for community- or policy-level responses (raised primarily with RUCID key informants)

Appendix 3. Questionnaire Variable Coding Scheme

Section A: Demographic Information

Variable	Description	Coding
ID	Respondent ID	Numeric (1, 2, 3...)
Age	Age group	1 = <18, 2 = 18–29, 3 = 30–44, 4 = 45–59, 5 = 60+
Gender	Gender	1 = Female, 2 = Male
Ag-training	Attended agricultural training	1 = Yes, 0 = No

Training Types (Multiple choice)

Variable	Description	Coding
Train_crop	Crop training	1 = Yes, 0 = No
Train_water	Water/irrigation training	1 = Yes, 0 = No
Train_soil	Soil management	1 = Yes, 0 = No
Train_pests	Pest control	1 = Yes, 0 = No
Train_market	Marketing	1 = Yes, 0 = No
Train_other	Other training	Text

Location

Variable	Description	Coding
Town	Place of residence	Text

Section B: Water Sources (Multiple choice)

Variable	Description	Coding
Water_rain	Rainwater	1 = Yes, 0 = No
Water_Borehole	Borehole	1 = Yes, 0 = No
Water_well	Well	1 = Yes, 0 = No
Water_tap	Tap water	1 = Yes, 0 = No
Water_lake	Lake/river	1 = Yes, 0 = No
Water_buy	Purchased water	1 = Yes, 0 = No
Water_other	Other	Text

Water Sufficiency

Variable	Description	Coding
DryWaterEnough	Enough water in dry season	1 = Yes, 2 = No, 3 = Sometimes

Problems During Dry Season (Multiple choice)

Variable	Description	Coding
Problem_CropLoss	Crop loss	1 = Yes, 0 = No
Problem_yields	Reduced yields	1 = Yes, 0 = No
Problem_livestocks	Livestock problems	1 = Yes, 0 = No
Problem_cost	High water cost	1 = Yes, 0 = No
Problem_distance	Long distance	1 = Yes, 0 = No
Problem_none	No problem	1 = Yes, 0 = No
Problem_other	Other	Text

Rainfall Perception (Multiple choice)

Variable	Description	Coding
Rain_less	Less rainfall	1 = Yes, 0 = No
Rain_unpredictable	Unpredictable rainfall	1 = Yes, 0 = No
Rain_shorter	Shorter rainy season	1 = Yes, 0 = No
Rain_nochange	No change	1 = Yes, 0 = No
Rain_notsure	Not sure	1 = Yes, 0 = No

Section C: Rainwater Collection

Variable	Description	Coding
Collect_RW	Collect rainwater	1 = Yes, 0 = No

Collection Methods (Multiple choice)

Variable	Description	Coding
RW_roof	Containers under roof	1 = Yes, 0 = No
RW_tank	Water tank	1 = Yes, 0 = No
RW_pond	Pond/dam	1 = Yes, 0 = No
RW_channels	Channels	1 = Yes, 0 = No
RW_insoil	Infiltration	1 = Yes, 0 = No
RWH_other	Other	Text

Use of Rainwater (Multiple choice)

Variable	Description	Coding
Use_irrigation	Irrigation	1 = Yes, 0 = No
Use_livestock	Livestock	1 = Yes, 0 = No
Use_household	Household	1 = Yes, 0 = No
Use_drinking	Drinking	1 = Yes, 0 = No
Use_other	Other	Text

Effectiveness

Variable	Description	Coding

RW_enough	Enough during dry season	1 = Yes, 2 = No, 3 = Sometimes
RW_Duration	Storage duration	1 = <2 weeks, 2 = ~1 month, 3 = ~2 months, 4 = full dry season

Section C2: For Non-Collectors (Multiple choice)

Variable	Description	Coding
NoCollect_enough	Enough water already	1 = Yes, 0 = No
NoCollect_containers	No containers	1 = Yes, 0 = No
NoCollect_equipment	No equipment/money	1 = Yes, 0 = No
NoColletct_knowledge	Lack of knowledge	1 = Yes, 0 = No
NoCollect_useless	Not useful	1 = Yes, 0 = No
NoCollect_rainfall	Rain unreliable	1 = Yes, 0 = No
NoCollect_space	No space	1 = Yes, 0 = No
NoCollect_other	Other	Text

Section D: Water Access Conditions

Variable	Description	Coding
Source_Reliable	Water source reliable	1 = Yes, 2 = No, 3 = Sometimes
PayWater	Need to pay for water	1 = Yes, 0 = No
Water_Cost	Cost level	1 = Low, 2 = Medium, 3 = High
Water_Distance	Distance to water	1 = <10 min, 2 = 10–30 min, 3 = >30 min

Section E: Attitudes & Intentions

Variable	Description	Coding
Consider_RWH	Consider collecting RWH	1 = Yes, 0 = No
Yes_barriers	Barriers if considered	Text
No_reason	Reason for not considering	Text
Consider_ifsupport	Would consider with support	1 = Yes, 2 = No, 3 = Maybe

Section F: Awareness

Variable	Description	Coding
Heard_RWH	Heard of RWH	1 = Yes, 0 = No

Information Sources (Multiple choice)

Variable	Description	Coding
Source_farms	Farmers/training	1 = Yes, 0 = No

Source_officers	Extension officers	1 = Yes, 0 = No
Source_projects	NGOs/projects	1 = Yes, 0 = No
Source_Media	Media	1 = Yes, 0 = No
Source_family	Family/friends	1 = Yes, 0 = No
Source_other	Other	Text

Perceived Benefits (Multiple choice)

Variable	Description	Coding
Benefit_water	More water	1 = Yes, 0 = No
Benefit_crop	Better crops	1 = Yes, 0 = No
Benefit_cost	Lower cost	1 = Yes, 0 = No
Benefit_reliable	More reliable	1 = Yes, 0 = No
Benefit_other	Other	Text

Section G: Barriers (Multiple choice)

Variable	Description	Coding
Barriers_money	Lack of money	1 = Yes, 0 = No
Barries_materials	Lack of materials	1 = Yes, 0 = No
Barries_knowledge	Lack of knowledge	1 = Yes, 0 = No
Barries_space	Lack of space	1 = Yes, 0 = No
Barriers_nocontainer	No container	1 = Yes, 0 = No
Barries_uncertainrain	Rain uncertainty	1 = Yes, 0 = No
Barriers_maintenance	Maintenance issues	1 = Yes, 0 = No
Barriers_other	Other	Text

Section H: Improvement & Support

Variable	Description	Coding
Improve_RWH	Want to improve RWH	1 = Yes, 2 = No, 3 = Maybe

Support Needs (Multiple choice)

Variable	Description	Coding
Support_Financial	Financial support	1 = Yes, 0 = No
Support_training	Training	1 = Yes, 0 = No
Support_containers	Containers	1 = Yes, 0 = No
Support_technical	Technical support	1 = Yes, 0 = No
Support_communty	Community system	1 = Yes, 0 = No
Support_other	Other	Text

Appendix 4. Qualitative Coding Scheme

Codes were developed through thematic analysis (Braun & Clarke, 2006) of interview summaries prepared from audio recordings and open-ended questionnaire responses. Coding was informed by the four barrier categories established through the literature review (Section 4.4): economic, informational, social, and environmental. Additional codes were generated directly from the data where patterns were not captured by these categories. Representative examples are drawn from both data sources.

Barriers to RWH practice

Code	Definition	Example
Barrier_Money	Lack of financial resources cited as a constraint on RWH practice	"no money for equipment" (IF-07); "cost on transport" (Respondent 6, questionnaire)
Barrier_Container	Lack of adequate storage containers cited as a constraint	"The ability to collect water: containers and money for equipment" (IF-05)
Barrier_Knowledge	Lack of technical know-how cited as a constraint	Barriers_knowledge selected by IF-05, who ranked it first among barriers
Barrier_Space	Insufficient physical space or house incompleteness cited as a constraint	"the small house may not have enough water to collect" (Respondent 12, questionnaire); "house is incomplete" (IF-06)
Barrier_Maintenance	Difficulty maintaining existing systems	Selected by IF-06 as a barrier to RWH
Community_Collective	Reference to community-level rather than household-level action	"big dam may collect all of the water for whole community" (KI-02)

Perceptions of climate and water stress

Code	Definition	Example
Rain_Unpredictable	Respondent describes rainfall timing or occurrence	"There's a lot of rain but not stable..." (KI-01)

	as less predictable than before	
Season_Shortened	Respondent describes the rainy season as shorter in duration	Multiple interview respondents (IF-01, IF-03–IF-08) described rainy seasons as shorter
DrySeason_Impact	Respondent links water scarcity to a concrete dry-season consequence	"high cost on transport" (Respondent 6, questionnaire)

Current practice

Code	Definition	Example
Practice_Improvised	Description of a non-permanent or makeshift collection method	"under the roof: jerrycans and drums; the channels are not perfect" (Respondent 3, questionnaire)
Practice_Established	Description of a permanent storage structure	"underground water tank" (Respondent 12, questionnaire); IF-01's underground tank lasting three months
Storage_Insufficient	Respondent states stored water does not last through the dry season	IF-04: storage lasting "less than two weeks"
Awareness_Source	Respondent identifies where they learned about RWH	"from media" (IF-03, IF-05, IF-07); "from agricultural training" (KI-01)

Perceived benefits

Code	Definition	Example
Benefit_WaterSecurity	RWH seen as increasing water availability during the dry season	"be able to work on dry seasons" (Respondent 4, questionnaire)
Benefit_CostReduction	RWH seen as reducing the cost or effort of accessing water	"lower cost for transport" (Respondent 8, questionnaire)
Benefit_WaterQuality	RWH seen as providing cleaner or	"it's not hard water, is better than well or borehole" (IF-03)

	safer water than alternative sources	
Benefit_ChildSafety	RWH seen as reducing risk to children associated with fetching water	"no more long distances for students to get water" (IF-04); "lower risk for reaching water" (Respondent 45, questionnaire)

Support preferences

Code	Definition	Example
Support_Technical	Request for expert advice on system design, sizing, or maintenance	"need a expert to come and look around the farm to advise how to collect and with the pumping" (Respondent 4, questionnaire)
Support_SkillsOverMoney	Respondent explicitly prioritises training/skills over direct financial support	"don't choose money because the money will finished but the skills will not" (IF-05)

Popular science summary

In sub-Saharan Africa, climate change has led to unpredictable rainfall and prolonged dry seasons, placing immense pressure on rural households that rely on rainwater for drinking water and agricultural irrigation. Rainwater harvesting (RWH), the collection and storage of rainwater for later use, is generally considered a simple and low-cost solution. However, in many places, the number of people actually adopting rainwater harvesting is far lower than development organizations expect. The common explanation is that people simply do not understand rainwater harvesting: they assume that once they understand it, they will start doing it.

This research, conducted in Lubanja village, Mitiana district, Uganda, in collaboration with the local organization Rural Community in Development (RUCID), tested this hypothesis. Fifty households were surveyed, and follow-up interviews were held with community members and RUCID staff to find out what the local people already knew about RWH, what they were already doing, and what they said they needed.

Water insecurity during the dry season is a serious problem in Lubanja: 72.1% of the surveyed households said they did not usually have enough water to meet their needs. Faced with this, most did not wait for outside help. Approximately six out of ten of the households surveyed had already begun collecting rainwater in some form, mostly using water tanks or simple containers placed under the eaves, and nearly two-thirds of these households had never heard of the formal concept of "rainwater harvesting," nor had any received training on water management. In other words, faced with water shortages and unpredictable rainfall, they began experimenting with their own solutions.

Even so, this informal effort often falls short: over 90% of households that had started collecting rainwater reported that their stored water ran out before the end of the dry season, or was only occasionally sufficient, and nearly one-fifth said their water lasted less than two weeks. Almost everyone surveyed, regardless of whether they were currently harvesting rainwater, identified better storage containers as the most commonly requested form of support, more often than training or financial assistance.

These findings provide practical information for RUCID's project planning: the priority is not to convince people of the value of rainwater harvesting, because most already believe it and are already doing so. The priority is to help existing rainwater harvesting methods function better. This means investing in appropriately sized water storage facilities, rather than small, standardized containers; designing training programs that build upon existing practices rather than starting from scratch; and using water storage capacity as a household-level assessment metric, rather than assuming it's a given. This shift from raising

awareness to reinforcing existing informal practices can determine whether a project introduces a new idea or helps the community's own solutions ultimately work.

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Fact sheet

Water harvesting in Lubanja village - case study



How Lubanja Village Is Already Solving Its Water Problem

In **Lubanja village, Uganda**, water insecurity during the dry season is a serious, recurring problem. This fact sheet presents findings from a household survey of 43 farming households in Lubanja, together with follow-up interviews with 10 community members and RUCID staff. Rainwater harvesting is already widespread in the village, but existing systems are too small to last through the dry season. Reliable storage and targeted support are essential to close this gap.

Unpredictable rainfall is not stopping people, it is pushing them to act.
74.4% describe rainfall as more unpredictable.
4.7% say unpredictable rain stops them from collecting it, the lowest of any barrier

Rainwater is already being caught, but not yet supported

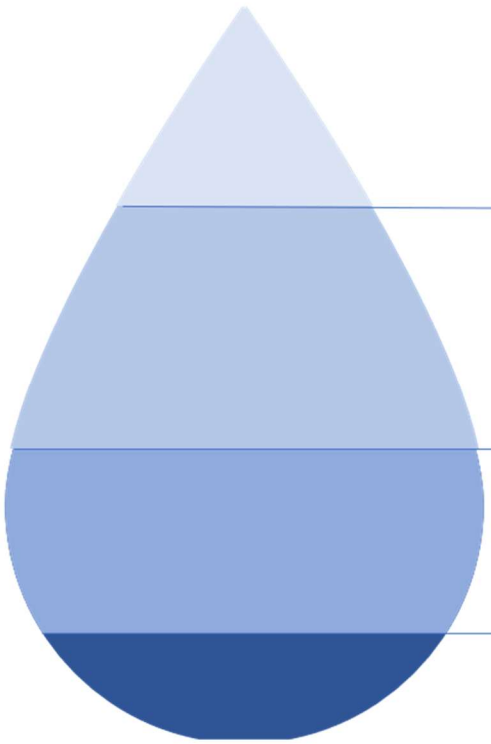
60.5% of households already collecting rainwater in some form

65.4% of adopters had never heard the term “rainwater harvesting”

0 out of 17 adopters who had never heard of RWH as a formal concept had received water-management training.

How long does stored water last

Everyday storage falls short of a full dry season.



19.2% stored water lasts less than 2 weeks

42.3% lasts about 1 month

23.1% lasts about 2 months

15.4% lasts the whole dry season

Based on the 26 households already collecting rainwater.

Growing need, limited capacity

The numbers below tell the same story from different angles: most households have started collecting rainwater on their own, but what they've built usually isn't big enough to last.

83.7% selected storage containers as a support need, the most frequently selected option overall. *All 43 households surveyed.*

92.3% of adopters say stored water doesn't last the dry season.
Among the 26 households already collecting rainwater.

100% of non-adopters willing to adopt **Rainwater Harvesting system** with adequate support
Among the 17 households not yet collecting rainwater.

What can be done

- Storage capacity could be prioritized.
- Training could be designed as an upgrade to existing systems, rather than an introduction.
- Technical support should be mandatory of any project, not an optional add-on service.



The rain is already falling.
Help households store enough of it.

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Based on an MSc thesis at SLU, drawing on a household survey (n = 43) and interviews with 10 respondents in Lubanja Village, Uganda.
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