INITIATIVE ON
Climate Resilience

Evaluating the Livelihood Outcomes of the Solar-Powered Water System on Drought Resilience in Hanzila Village, Southern Zambia

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Executive Summary

Zambia has experienced drought recently. Droughts have caused severe impacts on people's livelihoods, the environment and the economy. For instance, low rainfall threatens most of Zambia, particularly the Southern Province, as observed during the 2023/2024 farming season, which affected agricultural productivity, crop failure and food scarcity. There has also been reduced water in most of the streams, rivers, and groundwater sources, which either dried up or operated at critically low levels. This rendered it difficult to access clean water for drinking, domestic purposes, irrigation, and livestock.

In 2023, the ACTION Grant Program, in collaboration with the Ministry of Agriculture and the District Council, supported the development of a solar-powered borehole in Hanzila, Southern Zambia to enhance resilience to climate change impacts. This innovative work aimed at illustrating how the community-led construction of water infrastructures in rural contexts can mitigate the effects of climate change, for instance, droughts, by providing segmented water availability for domestic purposes, livestock, and agriculture.

The assessment of the livelihood outcomes began by establishing how the solar-powered borehole installed has improved access to an adequate water supply to enhance climate change adaptive measures and resilience among the Hanzila community after its installation. The assessment was done to determine the extent to which it has met its developmental objectives of reducing the effects of climate change by sustainably increasing the community's resilience.

Sampling for the evaluation included participants for qualitative interviews and quantitative interviews. For quantitative interviews, a sample of forty households of persons aged 18 and above who resided in Hanzila were drawn from the community. Almost equal numbers of males and females were selected. Further, all research participants represented people accessing various water needs, including drinking water and other domestic uses, livestock watering, and irrigation. Further, in this study, participants for the Focused Group Discussions (FGDs) were purposively sampled. Purposive sampling was used to select research participants who had knowledge about the implementation of the borehole, either technically or through community conversations. The sampling strategy also aimed at ensuring that different age groups, both sexes and with regard to occupation, i.e., livestock keeping or crop farming, participated in the focused group discussion. The discussion focused more on the responsibilities of women and men in managing water at the household level and women and men engaged in livestock and crop farming.

Further, the sample comprised the water committee and the leaders of the community. Research participants also provided details of the usage of the borehole, difficulties encountered, and perceived effects on drinking, watering of livestock, and crop irrigation. The water committee provided insights into borehole maintenance, operation, and measures to ensure water supply reliability.

With regards to the pre-implementation of the solar-powered borehole as the baseline for the outcome assessment, the people of Hanzila used different sources of water, including hand pumps, hand-dug wells, rivers and streams, scoop holes and rainwater. They were multipurpose utilisations involving uses such as drinking, cooking, cleaning, washing, watering livestock, and irrigation. However, due to the growing demand, they congested the only source of water, a borehole with a hand pump that supplied water for drinking, domestic work, and livestock. This resulted in long hours being spent waiting to access water. Some households avoided waiting long hours trying to access water for drinking and ended up using unclean sources to access water for drinking. The study found that 20% of the respondents indicated having used water from sources such as streams and scoop holes for drinking and other uses in the home to avoid spending long hours at the borehole waiting their turn to get water. Such sources endangered people's health by exposing them to waterborne illnesses. Regarding open sources for drinking and/or other domestic uses, none of the respondents indicated that they used the source after the solar-powered borehole was installed. The solar-powered borehole had clean water which has helped people access safer water and also has reduced their chances of contracting waterborne diseases. It has also reduced the time taken for people to access water because the community has 10 taps distributed in various locations within the village, and this allows people to access water simultaneously without having to face the hardship of queuing for access.

Before the implementation of the borehole, 63% of the respondents indicated that they used water sources more than 500 meters away, as opposed to only 13% that indicated using water that is 500 meters away. In addition, the number of households that started practising gardening activities has increased since the implementation of the solar-powered borehole. Before the solar-powered borehole was done, only 23% of the male and female respondents had their own gardens for crop and gardening activities, whereas 77 did not have gardens. The proportion of respondents with gardens and those doing gardening activities has increased from 23% to 69% since the implementation of the borehole. This illustrates that once the solar-powered borehole was installed in Hanzila, farmers could get water all year round, which promoted farming. It also helped them practice crop diversification, where they grew crops like maize, tomatoes, cabbage, kale, sweet bananas, onions, chillies, and Chinese cabbage. On the other hand, 31% of the household respondents indicated they do not have gardens.

In addition to the mere provision of food production, the gardens now cater for economic needs, whereby farmers take their produce to Monze town markets to earn some income for their families. For each day that their produce is taken for sale, farmers earn on average ZMW250 (USD10) to ZMW1,000 (USD40). This has helped to enhance financial stability and helps people to have funds to purchase food not readily grown within the village to enable families to afford balanced meals for healthy growth and development of children. Also, the revenue derived from the sale of these crops is channelled into other income-producing ventures within the community, including small-scale marketing of other household necessities.

Generally, livestock management has improved since the installation of the solar borehole. Firstly, the percentage of people who use distant streams and rivers for cattle watering has gone down from 52% pre-solar borehole implementation to 20% post-solar borehole implementation. About 48% of the respondents did not own any cattle. Farmers take their cattle to water points supplied by the borehole, where watering is done using large basins.

Despite the many benefits seen after installing the solar-powered borehole, some challenges persist. For example, households that did not live near the laid-out pipes and taps still had to travel a longer distance to access water. For others, they had to pay extra funds to extend the supply lines to their homestead for an infrastructure that was provided to the community free of charge. While extending supply lines availed households that were situated further from the water access points, it also meant that they needed to pay something to access what the community got freely. There were still households that could not afford to extend supply lines closer to the homestead. Such households still had to walk far to the new taps and hardly benefitted from reduced distance to access water, which was one of the challenges the solar-powered borehole was trying to address in the Hanzila community.

There are also challenges concerning agricultural-related activities that support crop irrigation in the gardens. One of the pertinent issues concerns the lack of conveyance, such as pipes to water to fields. About 40% of the respondents indicated that the lack of supply lines to convey water into their fields posed a constraint. People had to physically carry water using buckets from taps in the field, which was labour-intensive. On the other hand, 29% did not highlight the lack of conveyance as a challenge, and 31% did not have gardens.

The installation of the solar-powered borehole in Hanzila represents a significant technological advancement for the community, introducing new challenges alongside its benefits. Unlike the familiar hand pumps maintained by community-appointed pump minders, the solar-powered system requires specialised knowledge and skills for operation and maintenance. Community members lack the expertise in maintaining and repairing its components, which differ significantly from traditional pumps. This is a source of concern regarding the borehole's general sustenance.

Despite a few challenges noted from the Hanzila solar-powered borehole, the borehole presents best practices for replication in other communities to enhance access to water for multiple uses in remote communities such as the Hanzila village. The impact of the solar-powered borehole on community development, particularly in providing a reliable water source for crop production, for example, shows that people can be food secure even when facing droughts and the impacts of climate change. People can now grow crops that provide them with good nutrition and create income from the sales.

Community engagement from the onset of the project is critical. In the six-steps participatory process followed, community members provided insights into the actual problems they face and how solutions such as the solar-powered borehole can help alleviate some of the problems. Involving community members in community initiatives such as the solar-powered borehole also helped to instil ownership of the infrastructure, as evidenced by the measures put in place to safeguard it, such as shifting the control box used to operate the borehole to one of the water committee members' houses for safety.

1. Introduction

Enhancing Community Climate Resilience through Water Infrastructural Development

Global repercussions of climate change have continued to manifest throughout the world. There is information on seasons of drought existence, periods of flooding and higher temperatures characterised by wide occurrence and severity (Nicholls et al. 2012; Seneviratne et al. 2021). Global warming is caused by climate change, which affects both the structure of natural systems and human societies. Climate change causes changes in the regimes of various regions, creating more disasters such as droughts, high temperatures and floods, which are becoming increasingly frequent (Mukheibir and Ziervogel 2007, IPCC 2021). These events cause extreme hardship and even death, especially for the most affected groups (IPCC 2014). Low-income rural people face the effects of climate change most severely. Still, they have a very small capacity to adjust, primarily owing to the limited amount of money to adapt to climate change (IPCC 2014, World Bank 2013). Significant droughts lessen people's ability to grow crops to sustain and support a livelihood leading to poverty that compels people to migrate. Farmers, pastoralists and rural households who practice rain-fed farming are at a greater risk because of rainfall dependency, which increases the effects of drought (FAO 2016, World Bank 2013). As lack of water worsens during drought conditions, the availability of safe and clean drinking water, toilets or latrines, and hygienic practices are also severely affected, increasing the health risks among the already vulnerable populations, in particular women and children (UNICEF and WHO, 2019).

The challenges faced in this context require both immediate response measures during the climate emergency and long-term measures to improve resilience and maximise adaptability to the situation at hand.Community-based initiatives, including the establishment of solar-powered boreholes as sustainable water source development, can be helpful in averting the problems of climate-induced water shortage. These technologies enable the population to access water and eliminate the need to rely on erratic rainfall, thus increasing the community's ability to adapt to climate change.

Increased efficiency of water management practices is vital in increasing climate resilience in rural areas as it provides for the economy, sustains ecosystems and makes communities less vulnerable to the consequences of climate change, including droughts, floods and extreme weather events (GIZ 2023). The vulnerability of water resources and a significant challenge for all skilled forward-looking residents carries the focus in the expansive water management strategy for radical change highlighted even by global committees including United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) 27 (CRFS Alliance 2022).

Most regions in the Southern African countries, Zambia included, have been experiencing persistent droughts. Droughts have impacted the availability of water resources to meet people's water needs. Yet, having adequate access to water resources is a lifeline for people, particularly in rural communities where water is needed for drinking and other domestic purposes, as well as water required for crop and livestock watering during dry seasons (GIZ 2023). Having regular water supplies enables farmers to keep their crops and livestock thriving during drought periods, which in turn reduces people's susceptibility to food shortages. In addition, adequate moisture in fields through water harvesting or drip irrigation and the practice of agroforestry enable rural people to adapt to new climatic situations and use water in a more efficient manner (Ray and Majumder 2024).

Yet, countries like Zambia continue to experience reduced availability of water over time mainly for drinking, other domestic uses, animals, hygiene and sanitation, agriculture, construction, and other commercial purposes (Delia 2022, Patel et al. 2015, WHO-UNICEF 2015). These challenges affect the rural population more because of the limited availability of water infrastructure needed to access water for multiple uses. As a result, rural communities would resort to accessing water from open scoop holes and streams despite such sources being unclean and may pose health risks to water users (Mweemba et al. 2023a).

However, the geology and landscape of some rural parts also contribute to this list's many problems. Some communities are located in areas that are pretty distant from the primary water supply sources. This means people in such locations must cover long distances to access water. Covering long distances takes time that could have been allocated to other livelihood activities. In addition, it also requires a lot of energy from people to carry heavy loads of water from distant sources. As a result, the amount of water that can be transported back home is significantly reduced due to the time and energy factor (Mweemba et al. 2023b).

Performing the task of getting water for domestic use is even more difficult in areas with an environment that has some physical characteristics, such as hilly terrain. In many communities, it is common to find women and children, particularly the young ones, who are forced to carry water over long distances, sometimes balancing the water on their heads to ensure that there is sufficient water for use in different activities, including drinking. Also, men have to go long distances to fetch water, mainly for livestock and, at times, for agriculture. The impacts of climate change aid these circumstances. Recent vulnerabilities of agriculture are characterised by increased casualties of climate change in terms of temperature and decreased production of rainfall (Jain 2007, Thurlow et al. 2009).

The southern part of Zambia has also undergone changes in average annual rainfall (Jain 2007). Moreover, temperature increases have contributed to increased water loss in the region, which heightens the water challenge. As a consequence, there has been increased competition for limited water resources.

Reduced rainfall affects most small-scale farmers who depend on rainfall for agriculture. The intensity and recurrence of drought and drying conditions have made agricultural productivity even more difficult to sustain (IAPRI 2021). For example, the 2023/2024 farming season caused severe losses in crops due to inadequate amounts of rainfall. The drought also affected the standard water availability, whereby most of the streams, rivers and groundwater sources became dry, and others reached their lowest record. This impacted negatively on the ability of people to gain access to clean water for drinking, domestic purposes, food preparation, and the support of agriculture and livestock. This is even more so since vulnerable groups are affected, especially the rural population, who would experience even less access to water.

Addressing these challenges requires an integrated approach, which involves various measures. For example, it may include the development of water infrastructure with the participation of the communities for which such infrastructure is intended. It may also include investing in rainwater harvesting mechanisms to enhance water availability for irrigation. Constructing infrastructure for different purposes, including drinking, domestic purposes, livestock watering, and small-scale irrigation, is essential in building resilience to various challenges related to inadequate access to water at the community level (Mweemba et al. 2023b, OECD 2018, World Bank 2020). In addition, having adequate water storage and distribution channels provides opportunities to have sustained water supply even during drought instances. In addition, having sustainable water and adapting to the impacts of climate change are also important issues that can sustain people's livelihoods. For example, having water to irrigate crops during periods of droughts or during dry periods of the year can contribute to improving people's general well-being through enhanced food (IWMI 2022).

As the impacts of climate change intensify and increase people's vulnerabilities, it is important to include approaches within activities intended to reduce the impacts of climate change in community programmes. Addressing the negative impacts on water resources, for example, communities can be supported with the right tools and knowledge to sustain their water resources. Moreover, ensuring that rural communities have adequate water resources is one sure way to support human life for people because this translates to improved health and enhanced economic activities. It is also necessary for attaining sustainable development. It improves the quality of life for current and future generations. This was the goal of developing the solar-powered borehole in Hanzila community in Monze District, Southern Province, Zambia, from February 2023 onwards. This was done in partnership with the ACTION Grant Program together with the Monze District Council in the Southern Province of Zambia and the Ministry of Agriculture, which is the focus of this report.

1.1. Background of the ACTION Project

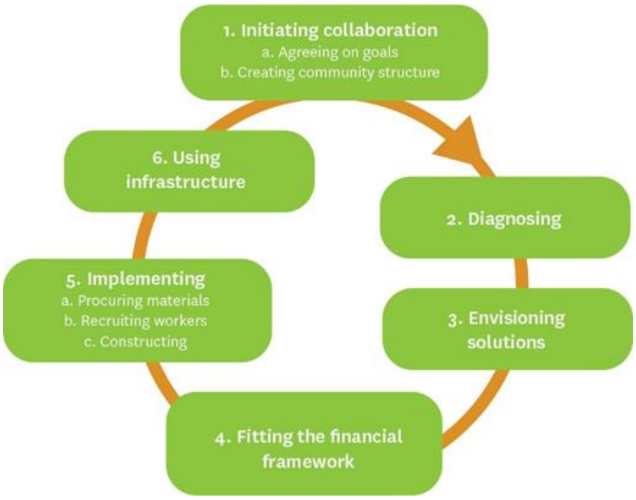
The case of "Water Access and Management in Community-based Water Tenure" in Hanzila village of Monze District, part of the CGIAR Initiative on Climate Resilience (Amarnath et al. 2023, Mweemba et al. 2023b), describes the new approaches for mitigating the challenges of climate change through the integrated planning processes and community participation. The study of this case shows the polycentric planning of water management, food security, and sustainable land use using the vertical bottom-up and top-down and horizontal cross-sectoral approaches. The case has focused on the use of water to support people's livelihoods, including drinking, other domestic uses, livestock, and crop production. Embedded in the community-based water tenure system, local communities have fair access to water resources.

The study underscores the need for local commitment to investment in public water infrastructure, including boreholes. Advancing water access and climate resilience investment portfolios continue to enhance people's ability to access water and better manage the impacts of climate change. Thus, engaging communal water tenure in participatory planning strengthens the sense of accountability and ownership of the members of the community in the communal water resources. Improved infrastructure ownership also assures sustainable management in aspects such as operation and maintenance of the resources. Engaging communities in decision-making regarding integrated water access in communities is very important, primarily to ensure all the needs of the people are met and to ensure accountability and sustainability of the resources (Jiménez et al. 2019, United Nations 2003, van Koppen et al. 2020). The CGIAR Initiative on Climate Resilience is an example of such integrated strategy for implementing a climate response through the community's water tenure and optimised planning framework, as demonstrated by the Hanzila village case study.

In 2023, under the CGIAR Initiative on Climate Resilience, the ACTION Grant Program initiated a project towards enhancing community climate fragility (Mweemba et al. 2023b). Due to the many problems experienced by the community in relation to water, including the availability of only one communal borehole with a hand pump, which experiences congestion, whereas open sources such as streams and scoop holes were drying up for livestock watering as well as human and crops during the dry season, the ACTION Grant Program was developed to alleviate the water problems. The goal of the program is to reduce water challenges that are worsened by the impacts of climate change, specifically droughts when people have a greater chance of losing their available water supply due to the drying up of water sources. This initiative entailed putting in place a solar-powered borehole facility within the Hanzila community.

As documented in Mweemba et al. 2023b, this planning and construction process from February to September 2023 was locally-led. The ACTION Grant program implemented water infrastructure technology using a locally led participatory planning process adapted from IWMI Working Paper 194 (van Koppen et al. 2020). It started with the establishment of contacts and an assessment of current access to water and challenges faced (baseline diagnostic). This was followed by envisioning solutions that fit the financial framework, implementation, and use phases (see box). Challenges during this process were examined to understand their implications for project effectiveness, such as technical expertise, funding constraints to extend the pipeline for some community members, and unforeseen construction hurdles.

After about ten months of system operation and water use, the arrangements for the functioning of the borehole and livelihood outcomes started to emerge. The present study was conducted in July 2024 to assess these early livelihood outcomes for climate resilience compared to the baseline and how the participatory planning and construction processes are likely to affect the longer-term sustainability of borehole operation and maintenance. This, in turn, can inform potential replication and upscaling of strengthened climate resilience across Zambia, and elsewhere.



(Source: van Koppen et al. 2020)

i) **Step 1: Initiating Collaboration:** The first step is to initiate contact between project implementers and the community to initiate collaboration, set project goals, and create a structure for achieving the goals.

ii) **Step 2: Diagnosing:** The second phase of the engagement focuses on diagnosing the community's existing resources and challenges, which the project will try to resolve.

iii) **Step 3: Envisioning Solutions:** Step three is about understanding the challenges faced by the community to pave the way for finding solutions that respond to the existing challenges. The solutions are proposed by communities facing the challenges because they are better placed to recommend context-specific solutions.

iv) **Step 4: Fitting the financial framework:** Once the preferred water solutions addressing the impacts of climate change are identified, costs to address the proposed infrastructure are determined and sourced to address community challenges.

v) **Step 5: Implementation:** Once the preferred water infrastructure is chosen and funds secured, the next stage is to implement the water infrastructure with the participation of the local community as primary users of the water infrastructure.

vi) **Step 6: Using infrastructure:** The last step was to monitor and evaluate the project's impact to ensure that initial plans and purpose for developing the project were still aligned.

Figure 1:Stepwise participatory process to implement a community-led water infrastructure to enhance resilience to agriculture and food securityObjectives of the Study

The study's overall objective was to conduct a comprehensive evaluation of the impact of a solar-powered borehole on community water access and livelihoods as the borehole's various benefits, and on effects of the participatory process on the sustainability and future prospects, lesson learned and recommendations.

The following are the goals of the evaluation of the solar-powered borehole:

Evaluate the effectiveness of the solar-powered borehole in building sustainable community resilience to climate change, social transformation and drought mitigation.

Assess the management, maintenance and utilisation of the solar-powered borehole in Hanzila, the views and impact of the participatory planning and construction approach adopted, and the livelihood impacts of the infrastructure on the community, particularly women and the most marginalised.

Identify challenges encountered with accessing and using the borehole, lessons learned, and best practices for similar interventions in the future.

2. Methodology

Research Issues

This section presents how the assessment of the solar-powered borehole was achieved almost a year after its implementation.

2.1.1. Selection of Study Participants

This evaluation adopted a mixed quantitative and qualitative method. For the qualitative part of the study, 40 household respondents were sampled from members of Hanzila community. Sampling was restricted to only members of Hanzila community to ensure a better understanding of how the public infrastructure implemented for the community is impacting the community as a whole. The sample ensured that there was representation from both men and women. An almost equal number of sexes was achieved, i.e. 19 men and 21 women.

Further, the sample of community members represented people with various water needs, such as drinking, irrigation, and livestock watering. All 19 men in the sample tended to cattle or small livestock. Some women owned cattle but were not involved in tending to it, though they participated in tending to small livestock such as chickens, goats and sheep. Part of the users, both men and women, were engaged in small-scale farming, particularly gardening. Further, women, children, and some young men collected domestic water from the solar-powered borehole for drinking, bathing, cooking, cleaning dishes, and other household needs.

The sample included 10 water committee members – 5 women and 5 men. These provided insights into how they supported the borehole infrastructure's management and maintenance.

For qualitative interviews, participants for the focused group discussion (FGDs) were selected using a purposive approach. This approach was used to select participants with direct experience or knowledge relevant to understanding how the solar-powered borehole was implemented, current outcomes, and usage.

Two focused group discussions were conducted. The first one comprised of 11 men and 10 women. These were mainly ordinary community members who provided insights into their usage patterns, challenges encountered, and perceived benefits. However, it was essential to ensure diversity among research participants. Therefore, the sampling strategy included factors such as age, gender, and people involved in different livelihood activities, such as ordinary small-scale farmers engaged in gardening and cattle keepers and those involved in rearing small livestock. The aim of ensuring the diversity of participants was to understand how boreholes have influenced people’s livelihoods in areas where water supply is needed.

The second FGD was open to a large number with no restriction on participation, provided participants were from Hanzila community. 72 people (men and women) attended the large meeting. The discussion aimed to get as much insight as possible from people about how the solar-powered borehole influenced their lives and their challenges.

Figure 2:Community members during FGDs in Hanzila Community

(Photo: Agricom Media 2024)

2.1.2. Conducting the Interviews and Data Collection

During the household interviews, respondents were asked questions regarding their access to access before the installation of the solar-powered borehole and any observed changes since the borehole was implemented. Respondents were asked questions about any changes in livelihood opportunities and general livelihoods since the implementation of the borehole. Other questions asked were the operation and maintenance of the borehole. A structured interview questionnaire (Annex 1) was used to ensure consistency and thoroughness in addressing questions for the rainy season and the dry season. Responses were recorded digitally to facilitate ease of analysis and interpretation.

The FGDs conducted with community members, i.e., ordinary members, pastoralists, small-scale farmers, and the water committee members, gathered information about the impact of the solar-powered borehole on community water access and how water was used. Similar interviews were conducted with committee members of Hanzila borehole.

Before each interview, the purpose of conducting the study was communicated to all study participants. Providing accurate information was also emphasised to ensure that the data collected truly reflected what was on the ground. The researcher also encouraged the groups to respect each other's opinions and value each contribution. A structured discussion guide (see Annex 2) was used with specific questions about the borehole's installation and its impact on the community.

Efforts were made to ensure that all interview participants had their voices heard. Recognising that there would be divergent views from men, women and youth, the researcher ensured all participants had equal opportunities to contribute their views. While some members seemed unwilling to participate, they were encouraged to share their opinions based on their experiences since the borehole installation. Further, probing questions were also used deliberately to bring out specific issues that might not have been immediately apparent.

Interviews were recorded with the participant's consent. Recording devices were used to capture the conversations and interactions among participants during the FGDs. This ensured that all discussions were accurately captured.

Interview with the key informant from the local authority investigated the local authority's role in enhancing access to water supply in rural areas. The interview also explored how local authorities ensured the sustainability of existing water infrastructures in rural communities. Annex 4 provides details of interview questions used to conduct the investigations.

2.1.3. Data Analysis

Quantitative data captured electronically was exported to Excel and SPSS for analysis. The analysed data produced tables or figures that were used to interpret information and included in the report.

With regards to information from the FGDs and key informant interviews, the data was coded by systematically categorising text into themes and developing concepts to show the outcomes of the discussions. Key issues highlighted during the interviews by research participants were included in the report as part of the research findings.

2.2. Report Structure

The preceding sections introduced the study's background and purpose and the research methods employed. Based on earlier literature (Mweemba et al. 2023b), the following section provides a comprehensive overview of how the borehole was developed, from initiating community conversations to the actual implementation of the water infrastructure and its use.

The next sectionin this report highlights key findings of the evaluation of the livelihood outcomes of the usage of the borehole since its implementation, including challenges faced.

The next section of the report looks at the role of the local authority in supporting access to water resources in rural communities, and then the report ends with discussing and drawing key conclusions from the report and making policy recommendations.

3. Overview of the Participatory Process for the Implementation of the Solar-Powered Borehole

The borehole was implemented through a step-wise process elaborated under 2.1, adapted from IWMI Working Paper 194 (van Koppen et al. 2020). These included engaging with the community and diagnosing solutions to address the challenge. The steps further looked at fitting into the financial framework, selecting the site, and budgeting and securing funding for the project. After the implementation phase follows monitoring the usage of the water infrastructure.

3.1. Step 1: Initiating Collaboration

The ClimBeR team, in collaboration with government officials from the Ministry of Agriculture, conducted a field visit to Hanzila village to initiate discussions on the ACTION project. This initiative aimed to create a platform where community members could participate in developing an infrastructure that is suited for their context.

Figure 3:: Initial engagement with community members, ClimBeR Team and Government Officials from the Ministry of Agriculture

(Photos: Agricom Media 2023)

The first contact with the community was intended to understand contextual issues of Hanzila community and the challenges they face within their community. Community members including, men, women, youth and community leaders, highlighted a number of water related challenegs they experienced in relation to water for drinking, irrigation and livestock watering.

3.2. Step 2: Diagnosis

Most highlighted issues are similar to the challenges of most rural communities in Zambia. In rural communities without adequate water infrastructure or with limited conveyance, people's lives revolve around searching for water for drinking, cooking and cleaning surroundings. Muller (2012) identified such practices as something that takes a lot of time and effort from people's lives (Muller 2012). In Hanzila community, people rely on multiple sources of water. Before installing the solar-powered borehole, these included boreholes equipped with hand pumps, and deep and shallow wells, some with motorized drills and others using makeshift pulleys, and open sources like rivers, streams, and scoop holes (Mweemba et al. 2023b). During the rainy season, people also harvest rainwater for household uses but this water is being used only for the rainy season and not kept beyond the rainy season due to the lack of infrastructure to conserve water.

All water sources in Hanzila community served multiple purposes: drinking, bathing, cooking, washing clothes, and productive activities such as watering livestock and crops and making bricks. Throughout the rainy season and into mid-year, open sources like streams and scoop holes provided sufficient water. However, as the year progressed, these sources dried up, leaving many households with limited options of water for their needs such as drinking, cooking, and watering livestock while also using them for gardening.

Reduced rainfall and persistent droughts continued to compromise the quantity of water in these sources over the years. For example, open sources, which were once reliable all year round, began drying up sometime mid-year. The rest of the year would have completely no water for people to use affecting domestic and agricultural needs. This meant that when nearby open sources dried up, men and young men had to walk long distances to find bigger streams and rivers or dams to provide water for the cattle. In addition, households that had small gardens near the streams could no longer manage to have water for the crops and were forced to stop their gardening activities.

The only public borehole equipped with a hand pump in Hanzila remained the community's most reliable water source that provided the entire community with water all year round when other sources dried up. In addition, the borehole equipped with a hand pump had clean water that was suitable for drinking compared to open sources that got contaminated from being open access. At the nearby school, there was another borehole that was primarily owned and managed by the school. Access to water at the school's borehole was restricted for the public. The water at that borehole was reserved for school-going children and the school staff. The broader community could only be allowed access for drinking and access was not always guaranteed.

Despite the public borehole being reliable all year round, it got overcrowded, a situation that reduced the quantities of water for each household. The borehole served approximately 500 households and animals in the village and provided water for irrigating gardens. Meeting the high demand for all water needs caused difficulties in access, especially during peak times when most people needed to get water to start cooking or brought back livestock to drink water. The high demand also caused people to stay in long queues for a long time waiting their turn to get water. Women, primarily responsible for securing water for drinking and household needs, were more under pressure to ensure their households had sufficient water. Sometimes, they had to walk long distances to access water from other less congested sources, a situation that caused strain carrying heavy buckets on their heads. Men also had to walk long distances to take their cattle to drink water or wait long hours at the borehole before their turn to water their livestock. This competition for water access sometimes led to conflicts, as some people grew impatient and disputes over water access became common. Additionally, during the dry season, water use for gardening was disallowed to prioritise essential needs like drinking and livestock watering. This limited opportunities for income from vegetable gardening.

Further, the borehole frequently broke down because of it being used continuously without rest. When this happened, it caused further stress to the users because it meant the community were left without any reliable and clean water source to use within reach and had to go to distant places to access water.

Following discussions of key challenges communities faced with available water sources, they gathered to map out existing water sources on pieces of paper to show what resources the community had. The meetings saw active participation from diverse community sectors, including pastoralists, crop farmers, local leaders, elderly individuals, and youth (Mweemba et al. 2023b). The inclusive process of ensuring participation from all groups and users of water in the community was intended to ensure a comprehensive understanding of water access points in the entire village, how they were used, and the challenges people faced in using all the mapped-out water resources in the village.

Using pieces of paper, participants highlighted points where scoop holes, open water sources, wells and boreholes were found, as shown in Figure 4 below. They also specified which sources were used for specific water needs such as drinking, other domestic uses, livestock, and crop watering.

Figure 4:Community members mapping water resources within the community and identifying solutions to enhance water access

(Photos: Mweemba 2023)

3.3. Step 3: Envisioning Solutions

The objective of this process was to allow community members to envision solutions that respond to the water challenges they identified for their community. They came up with various, including the development of dams and weirs, solar-powered boreholes, and additional hand pumps for the village to have adequate water for all their needs. After thorough discussions and guidance on cost implications for each of the proposals brought forward, the community settled for a solar-powered borehole as the best plausible option that would meet the community's primary water needs. The solar powered borehole was most plausible because it was seen as a solution to water for drinking and other dometic uses and reducing challenges of congestion when accessing water. it was also seen as a better solution to enhance access to water for irrigating gardens and also provding adequate water for livestock watering.

3.4. Step 4: Fitting the Financial Framework

The ACTION team secured funding totalling ZMW 438,688.80 (approximately USD 17,548[1] for the entire project. This included developing the solar-powered borehole and its associated infrastructure, such as pipes, taps, tank stand, solar panels and other accessories.

The project invited qualified vendors to bid to construct a borehole in Hanzila village. As proposed by the ACTION Grant Program in the Terms of Reference (TORs) for bidders, this borehole was designed to have an approximate depth of 100 meters into the ground and a solar-powered pump system. The borehole was also to have a 10,000-liter storage tank and an elevated tank stand to ensure good gravity flow of water supply.

Regarding pipelines, the TORs recommended a network of pipes connecting the borehole to 10 strategically located taps. The distribution of the taps mostly covered the area allocated for irrigation and some areas situated closer to people's homesteads.

[1] Throughout this report the Zambian Kwatcha (ZWM) is converted into USD at the rate of USD1 to ZWM25.

Potential bidders submitted their proposals showing details of the bill of quantities and cost estimate required to complete the work on borehole implementation.

During the selection process, emphasis was placed on evaluating bids with the most competitive costs. In addition, bidders who showed experience in working on similar projects in collaboration with the community were also considered. The last consideration for selecting bidders was their experience in executing similar projects funded by multilateral donors.

Following the evaluation of the bids, the project to develop the solar-powered borehole was awarded to one contractor, who subsequently entered into agreements to commence work on the borehole. The contractor committed to executing the project strictly following specified standards and ensuring quality implementation of the borehole. They also committed to adhere to timelines outlined in the project plan.

Although the contractor initially did not follow the agreed-upon depth of the borehole, this was corrected before community members could use the borehole, and that challenge was addressed amicably.

3.5. Step 5: Implementation

Determining the precise site for the implementation of the borehole began in June 2023 when the ACTION Grant facilitator convened a meeting with the contractor and community members to agree on the location of the borehole. It was essential to ensure community participation in this process to ensure fair access to water to as many community members as possible and all groups—i.e., women, men, children, small-scale farmers, and livestock keepers. This collaboration was also essential to preempt any future disputes over ownership privileges.

It was agreed during the initial gathering that the site that had to be selected was to be centrally located and accessed by all to meet all water needs initially prioritised by community members. Fortunately for the Hanzila community, the village already had 3 hectares of land jointly owned by the community. The land was allocated to the community by the local chief as an area that the community could use to run any project the community came up with. Initially, the community had applied to request land from the Local Chief to work on various community projects, including the dairy milk project, and the Local Chief allocated a piece of land to the community. This was also documented through a letter addressed to the community, in which the chief granted permission to the members of the Hanzila community. This means that the land tenure where people proposed drilling the borehole was already the property of the entire community. Moreover, this ensured that there was a clear understanding among community members that installing a borehole on publicly owned land meant that no individual in the community could claim ownership of the land and water infrastructure once it was developed. Everyone would have equal access to land and water resources. Therefore, by default, communally owned land was considered the first choice for a place where the borehole could be implemented. In addition, regarding gardening activities, the land had sufficient space to accommodate all people who needed to use the space for small-scale gardening. The area also had enough room for livestock watering, provided a watering trough was constructed to support it.

In addition, within the general publicly owned land, other siting criteria required a location to protect the borehole and its components from theft. This means that the borehole site had to be located somewhere closer to people's homesteads, which would help to ensure the borehole's parts were secured. Putting up the borehole at a location far from people's homesteads meant risking some of its significant components of being exposed to theft.

The other consideration for site selection was a location that would provide sufficient water yields. Geophysical surveys were conducted to ensure that the site selected had adequate groundwater reserves that could sustain a consistent water supply throughout the year. During transect walks involving community members, ACTION facilitator, and contractors to assess all potential sites that met the suggested criteria of having adequate water reserves, three locations out of the four preselected sites qualified under geophysical surveys. The three sites showed potential for sufficient water yield. However, one of the three was immediately disqualified because of the unfavourable distance from people's homesteads, leaving two locations.

The last two locations were subjected to another criterion. The last criterion was to have a site that would be a fair distance from most households to ensure that people did not have to walk long distances to access water, particularly water for drinking and domestic uses. Despite these considerations, some households were still situated further from the sites, as has always been the case for communal water resources. Some homesteads would always fall outside advantaged locations because people's homesteads are usually spaced.

After careful deliberation and technical evaluation, a site located approximately 100 meters from a few homesteads was chosen as the most suitable as it met most of the proposed criteria.

To kick-start the drilling process, the contractor obtained the necessary permits from the local authority. After that, the drilling of the borehole was started in July 2023. During the whole borehole implementation process, community members, including groups of young men who monitored the drilling process closely, participated actively. The community members' involvement was important to ensure that what had been agreed upon in the contract was adhered to. For example, community members monitored the area to ensure that the correct depth of the borehole was reached and that the materials used were of good quality.

Once drilled at the agreed-upon location, it was also essential to establish how the supply lines would be laid to discharge water outwardly to cover a radius of 1 kilometre. Taps were strategically installed in select parts of the village where the community members suggested it would be good to have access to water resources reasonably. The 3-hectare plot proposed for gardening activities received the highest concentration of taps. This was intended to facilitate widespread public use and maximise the utility of the infrastructure for agricultural purposes.

To further enhance accessibility to water for drinking and other domestic uses, some taps were put up near people's homesteads in various directions within the village. However, because some households were situated much further from the 1-kilometre radius where the taps were installed, some had to invest in extending the water supply closer to their homes using their own money, while those without sufficient resources to extend supply lines closer to their homesteads lost out on this household connection that brought water closer to people's homesteads. This meant they covered a much longer distance to carry water from the taps to their homes than other people within the village.

Throughout the development and implementation phases, the Department of Rural Water Supply officials from the district government were on hand to oversee and supervise the construction of the infrastructure. Their participation was essential to ensure that the contractor adhered to the government's recommended standards for drilling boreholes in rural areas.

3.6. Step 6: Using the Infrastructure

The borehole was handed over to the community in September 2023 after the completion of its implementation. The borehole now serves the community, providing water for all community primary needs – drinking and other domestic uses, livestock and crop watering.

The water committee, which was voted in by the community to monitor how the borehole was being used, supports the use and management of the borehole.

3.6.1. Water Committee for Hanzila Solar-Powered Borehole

Following borehole implementation, it was essential to discuss and ensure that the community would maintain and sustain the borehole over time for current and future generations.

Through a participatory process, community members identified individuals who exhibited the necessary dedication to effectively manage water and other community resources and enforce communal rules. Understanding the nominee's capability was guided by their active contribution towards other community projects, where they asserted themselves and provided leadership for the community's wellbeing. Both men and women were nominated based on their leadership qualities and commitment to enhancing the borehole's sustainability. Some nominees were selected for their practical knowledge of maintaining previously used hand pumps.

The nominees underwent a voting procedure following the nomination process to select ten members to form the Hanzila Solar-Powered Borehole Committee. The committee chosen had five males and five females selected to run the affairs of the borehole. Within the Hanzila Solar-Powered Borehole Committee was a chairperson, vice-chairperson, secretary, treasurer and ordinary committee members. Each of these has different responsibilities. For example, the chairperson is responsible for presiding over community meetings related to the water points within the committee and for holding community meetings with community members or users of the borehole. When absent, the duties of the chairperson are conducted by the vice-chairperson. On the other hand, the secretary is responsible for taking minutes during community meetings related to borehole management, and the vice secretary assists them. The two are also responsible for taking care of all relevant correspondence within the village, and they help the chairperson ensure that word gets to community members about any proposal or agreement on the borehole.

The treasurer receives all monetary contributions related to the borehole. They also maintain records showing savings from community contributions towards the borehole's maintenance. Other committee members participate as caretakers of the borehole and oversee that rules related to the borehole are enforced.

3.6.2. Management of the Efficient Use of the Solar-Powered Borehole by the Water Committee

The water committee is responsible for managing and maintaining the solar-powered system in Hanzila. On a day-to-day basis, the committee oversees how the borehole operates and ensures that it functions well. They have put in place measures to ensure that the borehole operates well.

The first measure is to ensure that they address the safety of essential components, such as the submersible pump and the control box, which had previously been stolen. Committee members have since implemented stringent measures to ensure the theft does not reoccur. For example, the control box has been shifted from the earlier location at the borehole site and placed in one of the houses nearby belonging to a committee member to safeguard it. The turning on and off to operate the borehole is done from the house, and the borehole is powered through the extended extension code placed to reach the borehole from the house. Further, on top of the submersible pump, the committee and the contractor placed concrete on top of the opening to make it difficult for anyone wishing to access it. This measure has contributed to the safety of the borehole parts. Other hard-to-steal parts placed at the borehole's site are monitored regularly to ensure that no one tempers with the parts. The location of the borehole also has a security light equipped with motion sensors to light up at night when the sensors pick up any movement. The feature allows people to be alert whenever the security light goes on.

Secondly, the committee manages water access by implementing and enforcing access schedules for various water uses. For example, to ensure equitable access to water for drinking and other domestic uses, water for livestock and watering vegetable gardens per household, Hanzila community has implemented a rotating schedule. Accordingly, each household takes turns using the water from the borehole for irrigation purposes. The gardens were divided into different sections for watering. If households from the first section water their crops on day one, they voluntarily abstain from using the water for irrigation on the following day until it's their turn again on the third day. During the days they are not watering, other households in another section of the community step in to use the water for their own garden needs.

"…to ensure that we all have adequate water for watering our vegetable gardens, we give each other turns. If a household waters its crops on day one, it will not water its crops for the next day until the third day. In the meantime, on the days they don't water, other households will take turns to water the crops. All this is done to avoid straining the pump and ensure adequate water for all uses," – Female respondent in a focused group discussion.

Furthermore, livestock are given a dedicated two-hour window daily to access water from the solar-powered borehole. This arrangement is planned to guarantee enough water for other critical purposes within the community, such as drinking and gardening. In contrast, access to water for drinking and other domestic needs is available without any time restrictions throughout the day.

The rotation system for accessing water in Hanzila community is important for many reasons. Firstly, it prevents overburdening the borehole pump, ensuring it operates efficiently. Without rules governing the rotation of water usage, allowing community members to access water simultaneously would lead to the pump operating continuously, day and night. This relentless use could damage the infrastructure over time. Further, the rotational system allows for adequate time to replenish groundwater levels. For example, no water pumping is done after midday once the tank is full to allow groundwater resources to replenish. In addition, spacing out usage ensures that the community maintains a sustainable water supply that meets the needs of all households, not just for gardening but also for other essential uses such as drinking, cooking, and hygiene.

Secondly, the rotating schedules promote the required community cooperation and unity. It encourages households to work together and support one another in managing shared resources responsibly. This collaborative approach raises a sense of unity and collective responsibility among community members for their common resource, as everyone understands the importance of conserving and using water prudently.

Moreover, this system helps optimise water usage for agricultural purposes. By allowing each household to irrigate their crops in a structured manner, based on a predefined schedule, they ensure that all gardens receive sufficient water without straining the borehole or compromising water availability for other crucial activities. The rotating schedule for watering vegetable gardens exemplifies the Hanzila community's commitment to sustainable resource management.

"… we know that we need to preserve our water, and therefore, we have adopted this rotational method of water usage also to safeguard the groundwater resource whilst saving our community's well-being for the long term", – Male respondent in a focused group discussion.

A few committee members have been given the responsibility of overseeing adherence to the above measures to ensure everyone follows agreed-upon rules.

Lastly, the water committee is responsible for collecting financial contributions from community members that are contingency funds to cover any eventuality of the borehole breaking down in future or needing some parts replaced. On a monthly basis, they collect ZMW30. This is equivalent to USD1.20. The pooling of finances through regular monetary contributions will ensure a quick turnaround in fixing the borehole should there be a need for some maintenance because of the availability of funds in the coffers. As of July 2024, the water committee members had collected a sum of ZMW 5,800, equal to USD224. This was collected over a period of 8 months from some of the water users. It was also mentioned that some households had skipped some of the months and were yet to pay. However, it was not mentioned how many households had not met their obligations to contribute fully towards the maintenance of the borehole.

3.6.3. Challenges of Maintaining a Solar-Powered Borehole by the Water Committee

The installation of the solar-powered borehole represents a significant advancement for the Hanzila community, marking its first introduction of such technology. Unlike traditional hand pumps that community members are familiar with maintaining as pump minders, the operation and troubleshooting of solar-powered equipment demand specialised knowledge and training currently lacking among community members. During the focused group discussion with water committee members, it was mentioned that:

"…we are so happy to have a borehole of this nature because it does a lot for us, and we are the envy of our neighbouring villages. However, we do not have the skills to know what needs to be done to repair the parts should we face problems in the future. We have pump minders who were trained to maintain the hand pumps. Still, this borehole needs specialised skills, which none of us possess." – Male respondent in a focused group discussion.

This shows that transitioning to solar-powered systems from traditional hand pumps introduces new complexities. For example, community members accustomed to manual pumps must now adapt to managing and understanding the precise positioning of solar panels for maximum sunlight exposure and troubleshooting electrical faults, which require technical skills beyond the mechanical expertise they currently possess for boreholes equipped with hand pumps. There is a need for training programs that are essential to equip community members, particularly water committee members, with the necessary skills to operate and maintain the solar-powered borehole effectively. However, such training has not yet been initiated for Hanzila community, and there are plans within the community to reach out to the local authority responsible for rural water supply development to get training on operating and maintaining the solar-powered borehole.

"…we have decided to contact the Local Authority because they are responsible for rural water supply programmes in this district. We wish to ask them to provide us with training on maintaining this kind of borehole or provide us with the basics that we will need should we encounter a breakdown of parts in the future." — Male respondent in a focused group discussion.

4. Findings of the livelihood outcomes

This sections presents findings of the evaluation of livelihood outcomes following the installation of the solar-powered borehole. This section presents findings on the impacts of the borehole in enhancing access to water for drinking, improving health outcomes, enhancing access to water for irrigation and livestock watering among households within Hanzila community.

4.1. Impact of the Solar-powered Borehole on Drinking and Domestic Water Use

4.1.1. Drinking and Other Domestic Water Uses and Livelihood Benefits

To understand the impact of the solar-powered borehole on drinking and domestic use, the study began by evaluating the primary water sources used for drinking and domestic use in Hanzila community before and after installing the borehole.

Before installing the solar-powered borehole, most respondents, accounting for 67%, in Hanzila community relied on the borehole equipped with a hand pump to access water for drinking and domestic uses. Results further show that 20% of respondents reported accessing water from open sources such as streams and scoop holes, whereas 13% indicated that they accessed water from deep wells (Figure 5).

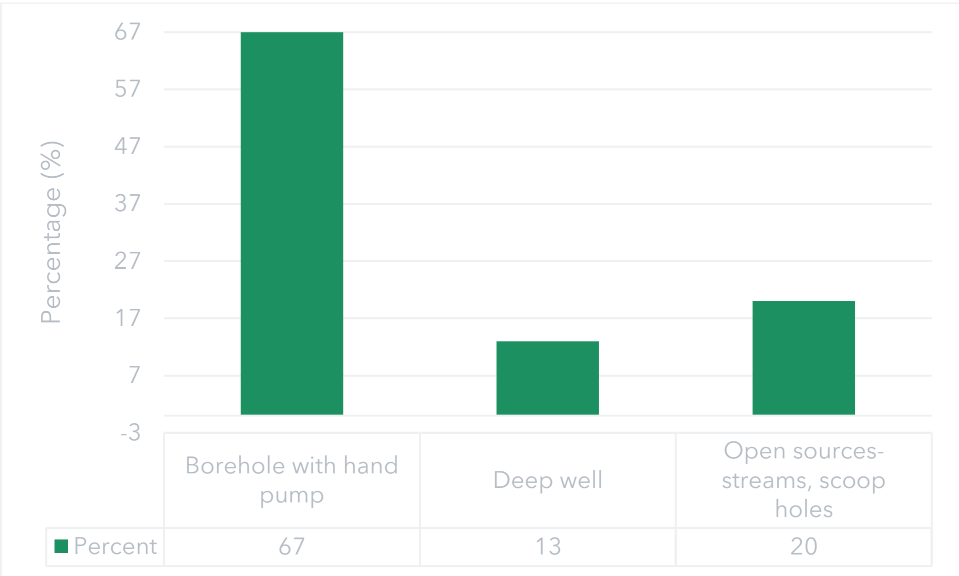


Figure 5:Important sources of water previously relied on for drinking and domestic use in Hanzila community before the installation of the solar-powered borehole (N=40)

(Source: Household Survey 2024)

Currently, 86% of the respondents reported using water from the solar-powered borehole from their homesteads or taps situated closer to their homes for drinking and domestic use. Results further show that 8% relied on water from wells for drinking and domestic use, whereas 6% indicated that they used the borehole equipped with a hand pump to access water for drinking and domestic use. No household has reported using water from open sources such as streams and scoop holes to drink and for domestic use (Figure 6).

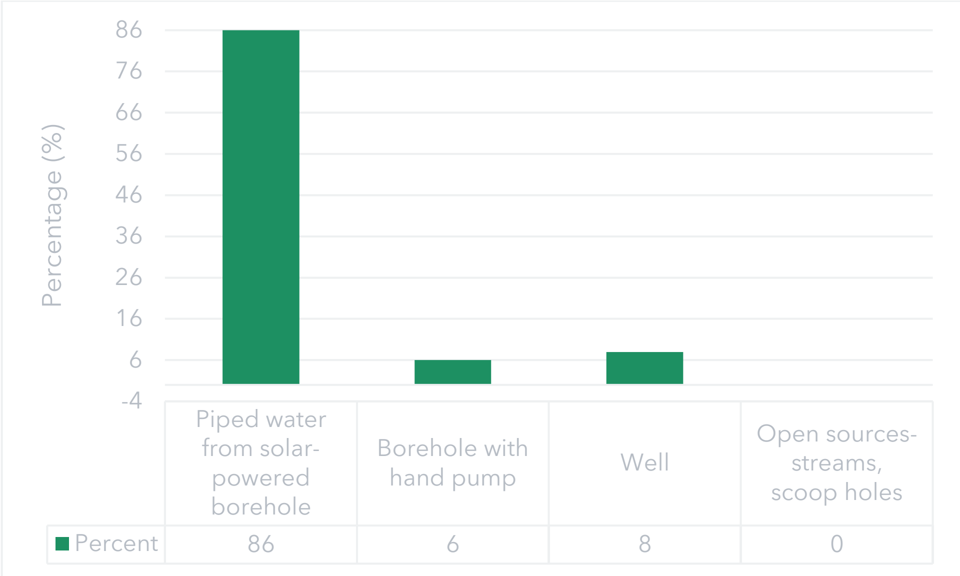


Figure 6:Important sources of water used currently for drinking and domestic use in Hanzila community (N=40)

(Source: Household Survey 2024)

The survey found that in terms of distance to access water before and after the installation of the solar-powered borehole, 63% of the respondents indicated that they covered over 500 meters to access water for drinking and other domestic uses (Figure 7).

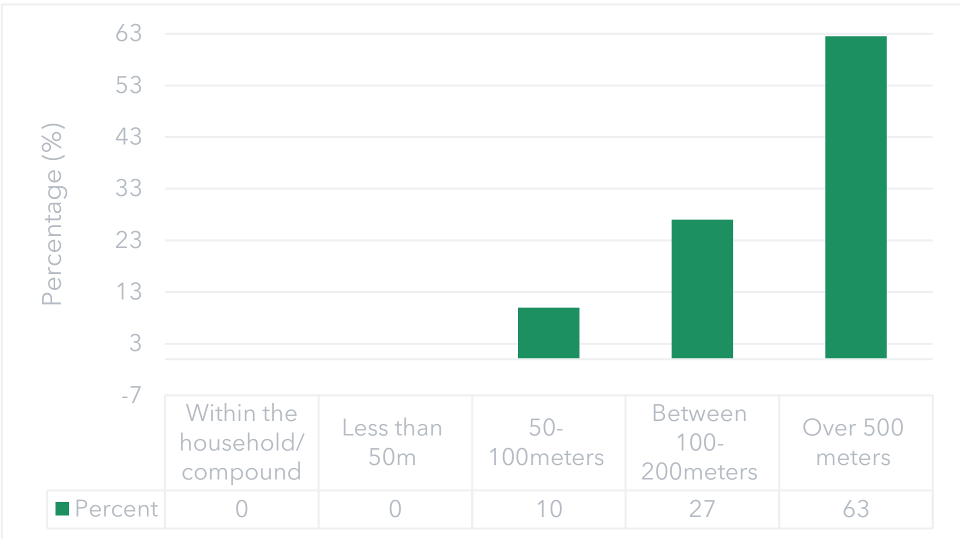


Figure 7:Distance to the important sources of water used for drinking and domestic uses before the implementation of the solar-powered borehole (N=40)

(Source: Household Survey 2024)

On the other hand, only 13% of the respondents indicated they travelled over 500 meters for water needed for drinking and domestic use after the implementation of the borehole (see Figure 8). Further, results show that 38% of the respondents interviewed travelled between 100 and 200 meters to access water. Additionally, 20% of respondents reported having water available within their households, while another 20% travelled between 50 and 100 meters to obtain water for drinking.

The results indicate that the distances covered to collect water for drinking and other domestic uses have reduced for a larger proportion of the community since they began using the solar-powered borehole.

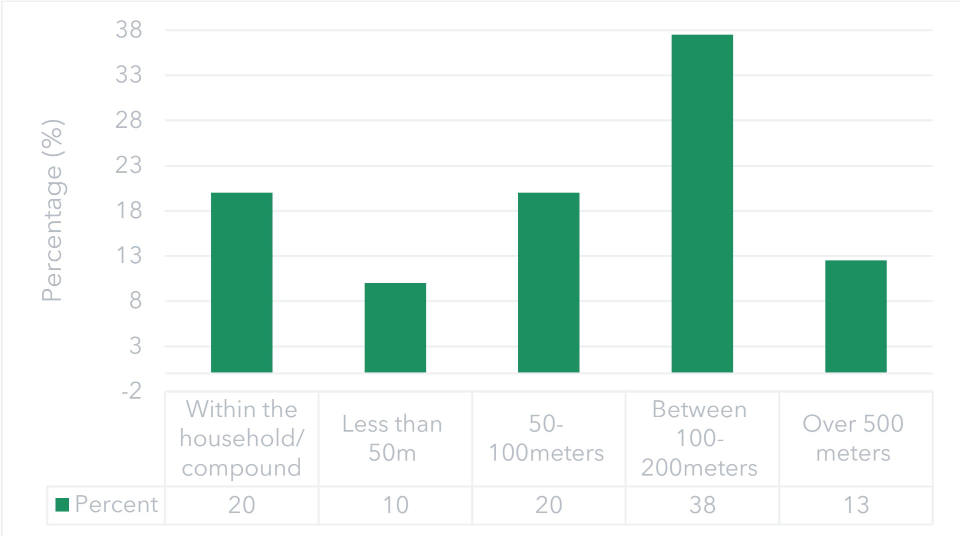


Figure 8:Distance to the important sources of water currently used for drinking and domestic uses (N=40)

(Source: Household Survey 2024)

The new solar-powered borehole has modernised drinking and domestic water access for Hanzila village. Women and children enduring long queues and spending long periods to fetch water have now reduced. While 54% of the interviewed households reported that it took more than an hour to queue up and wait to access water for drinking and domestic uses before borehole implementation (Figure 9), there are no households currently accessing water from the solar-powered borehole, indicating queuing for more than 30 minutes to access water for drinking and domestic uses (Figure 10).

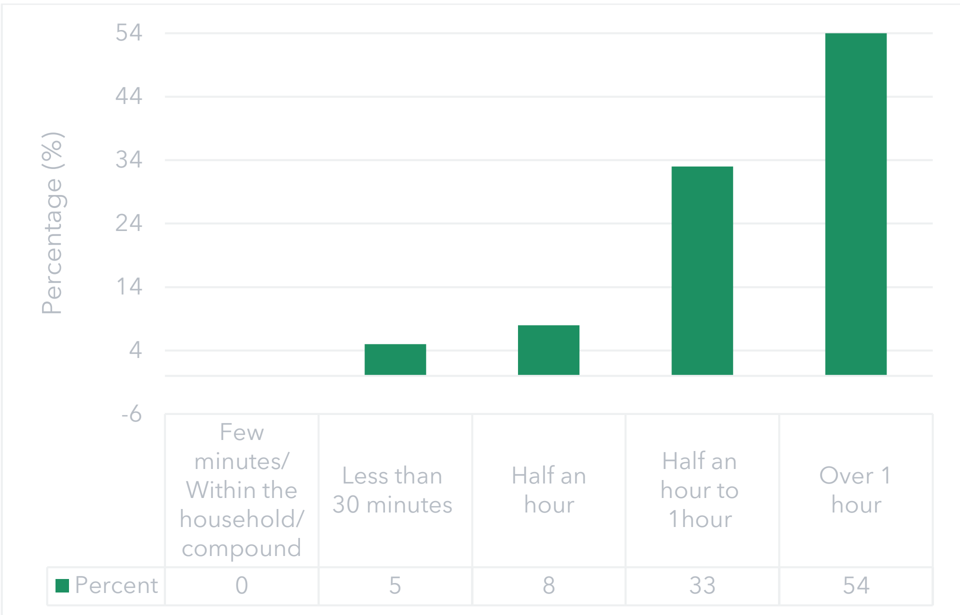


Figure 9:Time spent to access water for drinking and domestic uses prior to borehole implementation in Hanzila village (N=40)

(Source: Household Survey 2024)

Results show that most respondents, accounting for 70%, reported spending less than 30 minutes accessing water, whereas 25% reported that they spent only a few minutes or did not queue up to access water because water was within their compound. Only 5% indicated they spent half an hour to access water (Figure 10).

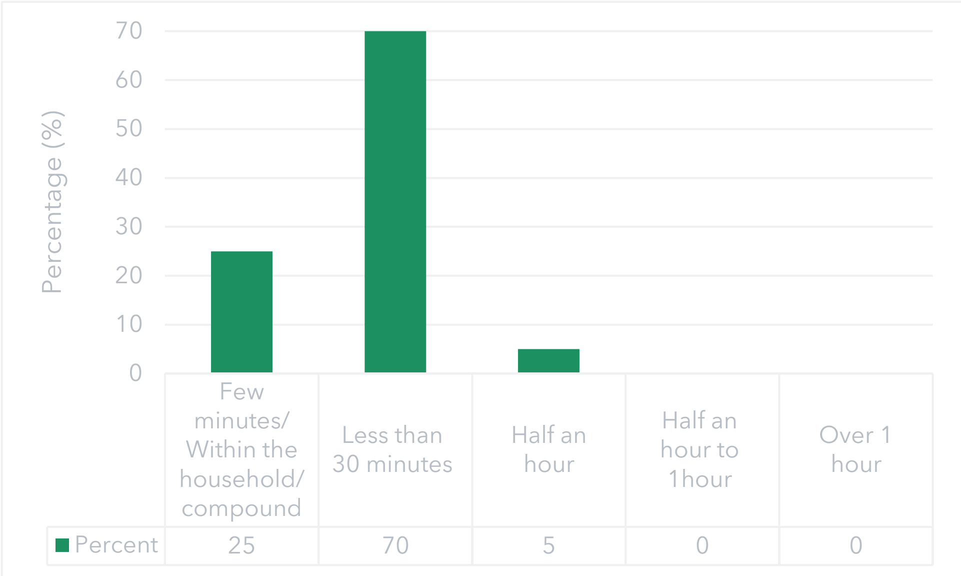


Figure 10:Time spent to access water for drinking and domestic uses from the solar-powered borehole in Hanzila village currently (N=40)

(Source: Household Survey 2024)

Installing 10 taps spread across various locations within the village allows multiple people to access clean water simultaneously without queuing for water.

Figure 11:A tap installed in the village, ensuring quick and easy water access for drinking and domestic uses currently

(Photo: Mweemba 2024)

With a number of taps that were put up in different locations, it allowed many people to access clean water easily within the community. This convenience has not only eliminated the need for long waiting periods. Still, it has also allowed women to dedicate more time to their families and household chores without the fatigue of fetching water from overcrowded sources. One respondent also noted this during the focused group discussions:

"…nowadays, we have plenty of time to focus on other tasks like cooking and even find time to relax and spend with family. We no longer worry about searching for water or enduring long queues to fill just one or two containers that wouldn't suffice for all our household needs. Within minutes, we can fill all the containers in our home with water for drinking, cleaning dishes and washing clothes. This allows us enough time to clean our homes and dishes promptly", – Female respondent in a focused group discussion.

4.1.2. Challenges of Unequal Access to Water for Drinking and Other Domestic Uses

One of the most noted challenges relates to the unequal access to water resources for drinking and domestic uses. Community members who reside further from the piped water supply lines and the installed taps experienced difficulties accessing water. In addition, they also had to have some form of trade-offs to access water. For example, community members living in the northern and southern parts of the village had to spend extra funds of their own funds to extend the supply lines. For an infrastructure that was provided to the community at no cost to the people, this arrangement doesn't seem fair for those who had to pay for supply lines, as this cost only affected this segment of the community. Moreover, households that could not afford to extend the supply lines ended up losing out entirely on the convenience of accessing water for drinking and domestic uses at locations closer to their homestead. This situation highlights that poverty can still impact how people gain access to public water resources within a community even when such resources are intended to benefit everyone including the vulnerable.

"… we know that it is okay for us to extend the pipes to our homes or at least closer to our homes, but due to limitations in funds, we can't afford to do this, and therefore, we fail to fully utilise water from the borehole like those households that are situated closer to the borehole", – Female respondent in a focused group discussion.

This challenge meant that while some households experienced improved access to water after paying for the extension and others still enjoyed closer access to the infrastructure without making any investment, as the infrastructure was free of charge to the community, others remained disadvantaged in terms of distance because they were unable to afford to pay for the extension of the infrastructure. As opposed to bringing equality to a community, the development of the solar-powered borehole caused some inequality because some segments of the community ended up being disadvantaged when accessing public water infrastructure. In this case, even having limited financial resources to pay for the extension contributed to some segments of the population within the community being disadvantaged from the benefits of close access to the borehole. This shows how poverty and vulnerability can cause people to be excluded from benefits that should be enjoyed by the whole community.

Further, the limitation in accessing water from the borehole continues to complicate people's daily lives. Those who still find themselves far away from the borehole still rely on old sources such as wells and sometimes hand pumps. Some of these sources are shared with nearby villages and this still leads to increased time and effort spent fetching water, a challenge the solar-powered borehole was supposed to solve. Moreover, the physical strain of transporting water from distant sources continues to be a burden, especially for elderly individuals and school-going children. However, with significantly lower number of people using the hand pump, compared to how it was previously, queuing for water long hours has reduced for those still relying on such sources.

4.1.3. Impact of the Solar-powered Borehole on Health and Well-being

The preceding sections highlighted some unclean water sources, such as scoop holes used as alternative water sources, particularly during peak congestion periods at the then-existing clean borehole equipped with a hand pump. According to the household survey, such water sources contributed to diarrheal diseases. Responding to the question of whether respondents had perceived any health benefits since they began using water from the solar-powered borehole, 80% reported that cleaner and safer water they consumed reduced incidences of waterborne diseases that were most prominent when people had to rely on unclean sources such as scoop holes to access water for drinking and other domestic uses. The other 19% of the respondents did not highlight reduced incidences of waterborne diseases by using clear and safer water from the solar-powered borehole (Table 1).

As can be seen from the study findings, most respondents reported that installing the solar-powered borehole has been instrumental in enhancing community health by eliminating the need to fetch water from contaminated sources such as scoop holes previously used for drinking. This improvement is particularly beneficial for children, ensuring good digestion and preventing diarrheal diseases that can have physical and mental repercussions. As noted by a female respondent during the focused group discussion,

"…We no longer experience diarrheal diseases, and our children no longer suffer from such diseases since we started using this borehole water. We always have access to clean water and don't complain of accessing water at unclean sources as we did previously when we had no choice but to rely on water from scoop holes, which was contaminated and also accessed by livestock." — Female respondent in a focused group discussion.

Table 1:Perceived health benefits since people began using the solar-powered borehole to access water for drinking and other domestic uses (N=40)

Perceived Benefits	Response	Percent
Cleaner and safer water reduced incidences of waterborne diseases.	Yes	80
	No	19
	No response	1
Personal hygiene has improved (regular bathing and hand washing)	Yes	74
	No	26
	No response	0

(Source: Household Survey 2024)

Further, results show that 74% of the respondents indicated that personal hygiene at the household level had improved, with people taking regular baths and practising handwashing since installing the solar-powered borehole (Table 1). Findings of the household survey were also highlighted during the focused group discussion when one respondent reported that,

"… We now bath every day because we have reliable water that can be accessed without much effort. Even a quick look at the children can tell you that they are bathed every day and do not have dirt accumulated on their skins for many weeks." — Male respondent in a focused group discussion.

"… Our children's skin also looks healthy due to regular baths that are now taken more often than before when they used to have skin diseases such as scabies. Clothes are no longer smelly as they are washed whenever they are dirty instead of wearing the dirty clothes for many days." — Male respondent in a focused group discussion.

In addition, school-going children now wear clean uniforms and ensure they bathe before going to school. This has been an important improvement from what they experienced when children had a first queue up for water, which often caused delays and impacted their punctuality and school performance.

Furthermore, it was mentioned during the women's focused group discussions that chores like washing clothes, which were previously done using water from scoop holes and sometimes not done due to an inadequate water supply, were now being done regularly and closer to people's homes because water was readily available.

Women also reported that the increased water supply has significantly enhanced hygiene practices at household level the household level. An example was given where women indicated that previously, multiple people would share a single cup without washing it between uses, because they avoided 'misusing' water washing utensils continuously. Currently, after each use, people wash the cups due to sufficient water available before being reused to drink water. Furthermore, storage containers are thoroughly cleaned with soap before being filled with clean drinking water. There is also a renewed focus among the community on food hygiene. Fruits and vegetables are regularly washed with clean water before consumption or cooking.

4.2. Impact of the Solar-powered Borehole on Enhancing Agricultural Practices

4.2.1. Water Uses for Agriculture and Livelihood Benefits

In Hanzila community, like most Zambian rural communities, vegetable gardening is primarily done in the dry season. In contrast, the rainy season is reserved for growing staple foods such as maize and cassava and cash crops such as groundnuts, tobacco, and cotton that are grown on a large scale and cannot rely on shared borehole water to grow crops. Moreover, such crops are grown away from villages, and resources such as solar-powered boreholes cannot conveniently supply water because there would be a need to invest in supply lines. Therefore, this study only assessed water access for vegetable gardens during the dry season, when it is most relevant.

To evaluate current practices in vegetable gardening, the study examined the proportion of respondents who had gardens they tended to during the dry seasons before and after implementing the solar-powered borehole.

Before the implementation of the borehole, some households had gardens near public water sources, such as boreholes equipped with hand pumps and wells and also near open sources, which they tended to. As can be seen from the results, only 23% of the respondents indicated owning gardens where they grew crops before the borehole was implemented (Figure 12).

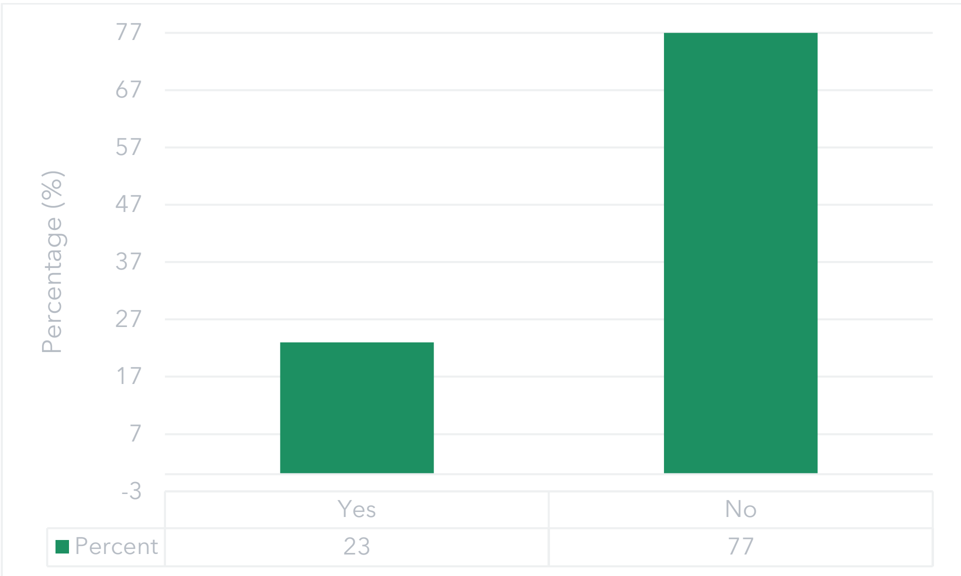


Figure 12: Proportion of households that were engaged in growing crops in gardens before the installation of the solar-powered borehole (N=40)

(Source: Household Survey 2024)

Results show that 69% of the interviewed households reported owning a garden where they are growing crops (Figure 13).

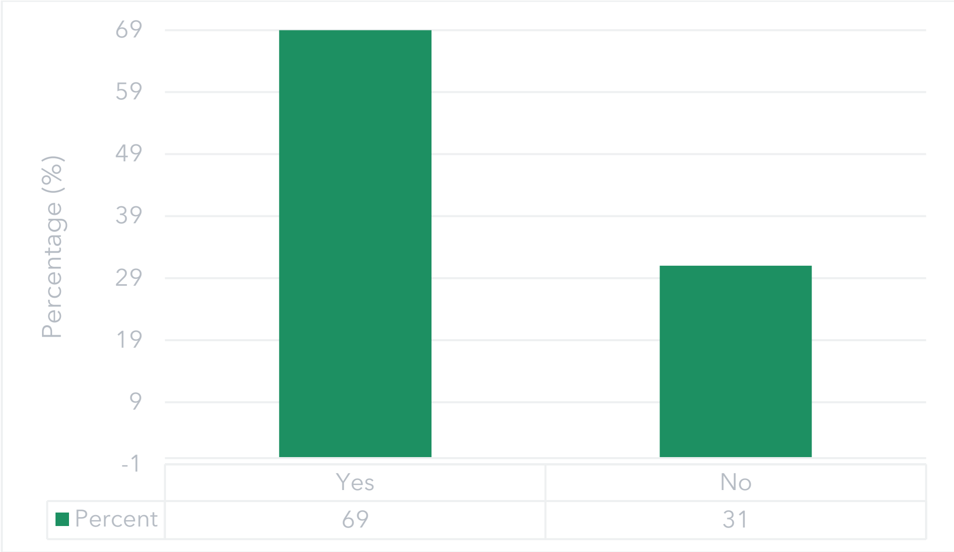


Figure 13:Proportion of households currently engaged in growing crops in gardens since the installation of the solar-powered borehole (N=40)

(Source: Household Survey 2024)

Results shown in Figures 12 and 13 show that the number of people growing crops in their gardens has increased by 200% since installing the solar-powered borehole. This rise in gardening activities over the past year is attributed to the availability of piped water from the borehole, which has provided a significant proportion of households with improved access to water and land for their gardens.

Regarding types of water used for gardening, Figure 14 shows that 51% of respondents reported using piped water from the solar-powered borehole to irrigate their garden crops. Other water sources used currently to irrigate crops in gardens include open sources, such as streams, weirs, and dams, accounting for 12% of the responses, and water from the wells, accounting for 6% of the responses. No households reported using water from the community public hand pump or harvesting rainwater for their gardens. Furthermore, 31% of respondents did not participate in gardening activities (Figure 14).

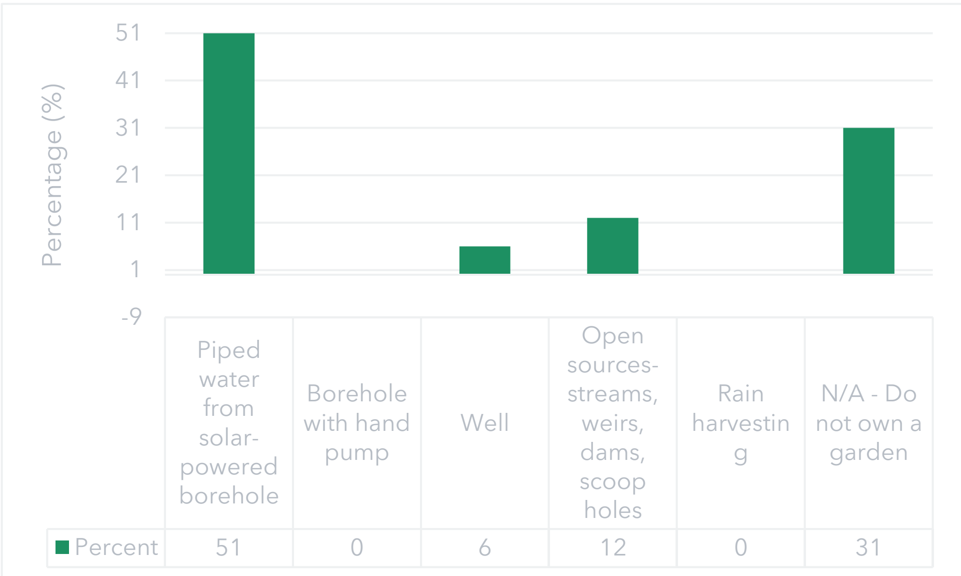


Figure 14:Important sources of water used for gardening in Hanzila community (N=40)

(Source: Household Survey 2024)

Comparing results obtained among water sources used for gardening before introducing the solar-powered borehole, 9% of of people who owned gardens (23% of total sample) indicated that they used open sources, i.e. streams, weirs or dams, to water their gardens. Further, the study found that only 8% of the respondents used the public borehole equipped with a hand pump, and 6% relied on wells (mostly private) to water crops in their gardens (see Figure 15).

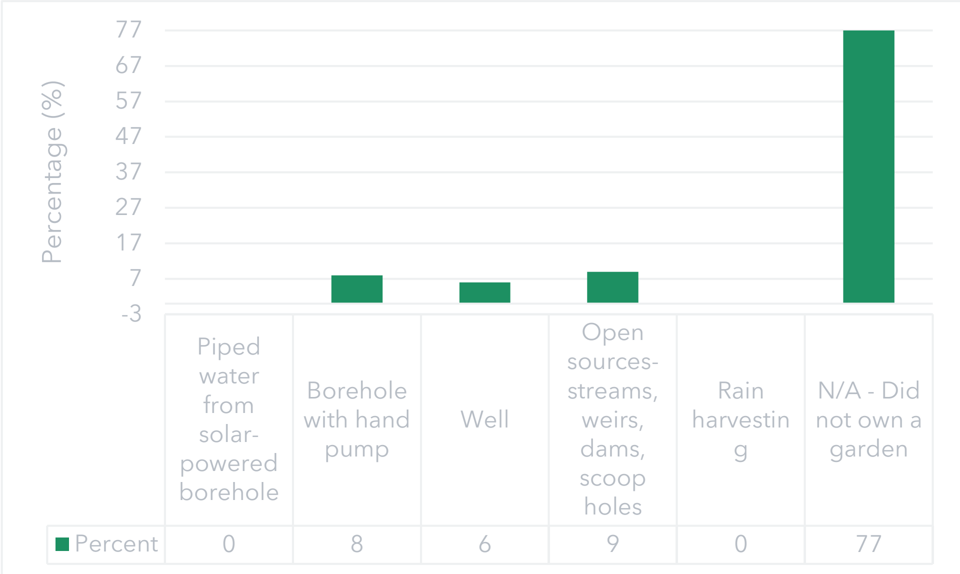


Figure 15:Important source of water used for gardening before installation of the solar-powered borehole (N=40)

(Source: Household Survey 2024)

A separate focused group discussion was with women involved in gardening activities. They reported that by installing the solar-powered borehole in the Hanzila community, they were able to cultivate various crops such as maize, tomatoes, cabbage, kale, sweet potatoes, onions, chillies, and Chinese cabbage, among others. Before the installation of the borehole, however, a few households that were involved in gardening only produced tomatoes and kale because these were mainly for home consumption. From the produce, very little was sold to earn income because people faced limitations in accessing water to irrigate.

> "…Currently, we grow several crops in our gardens, such as maize, tomatoes, cabbage, kale, sweet potatoes, onions, chillies, and Chinese cabbage. Most of these are only grown now because previously, we did not have sufficient water to grow them. A few people who could access water mostly grew kale and tomatoes for household consumption. There was also very limited that was sold."– Female respondent in a focused group discussion.

Women further highlighted that the crops grown now were crucial in supplementing household food needs and generating income through local markets, primarily in Monze town. This contributed to enhancing food security at the household level.

The study has established that the solar-powered borehole has reduced the community's dependence on seasonal rainfall, which is unpredictable. Of the 69% of respondents who indicated owning a garden where they were currently growing crops, all respondents indicated that the solar-powered borehole allowed them to reduce their reliance on rainfall and also be in a position to cultivate during the droughts period (Table 2).

Table 2:Perceived benefits of using the solar-powered borehole for vegetable growing (N=40)

Perceived benefits	Response	Percent
Reduced reliance on rainfall	Yes	69
	No	0
	N/A – Do not own a gardening	31
Can cultivate crops during drought periods	Yes	69
	No	0
	N/A – Do not own a gardening	31
Able to produce crops throughout the year due to water availability	Yes	59
	No	10
	N/A – Do not own a gardening	31
Increased income from selling vegetables	Yes	54
	No	15
	N/A – Do not own a gardening	31

(Source: Household Survey 2024)

During the focused group discussions involving both men and women, it was heard that vegetable farmers can now plan for their planting and harvesting of crops more effectively because of the availability of water from the solar-powered borehole.

"…With the drought that we experienced this last season, we are not in a terrible place anymore because we now have a reliable source of water that has allowed us to continue farming activities within this community. This could not have been possible without the solar-powered borehole, and we would continue suffering like the rest of the people in this part of the country." – Male respondent in a focused group discussion.

With reliable access to water throughout the year, farmers can now irrigate their vegetable crops consistently. This newfound capability of being able to irrigate crops resulting from using water from the borehole infrastructure has increased agricultural productivity. It has also improved crop yields across the village. Fields that were once dormant because of not having adequate water are now flourishing with lots of crops. Moreover, due to the land allocated for crop production, farmers in Hanzila community are able to cultivate more diverse crops and expand their agricultural activities. Figure 16 is an example of a vegetable garden in Hanzila community having multiple crops.

Figure 16:A woman farmer in her newly established garden since getting access to solar-powered borehole water

(Photo: Mweemba 2024)

Beyond mere sustenance, the surplus produce from these gardens is a source of local economic activity as it finds its way to markets in the nearby town. The household survey found that 54% of the 69% engaged in vegetable growing indicated earning an income from the sales of vegetables from gardens (Table 2).

For example, once their crops are ready for harvest, small-scale farmers sell their produce in the Monze town market, earning income to meet their household needs. Daily sales range from ZMW250 (USD10) to ZMW1,000 (USD40). A box of tomatoes would fetch anything from ZMW250 (USD10), and in most cases, people carry several boxes at once. This has contributed to an enhanced economic situation at the household level and strengthened the community's resilience against food shortages and financial uncertainties. In addition, to a greater extent, families are able to use incomes from the sale of vegetables to purchase other household requirements and foods that cannot be grown in their gardens, such as the maize meal. Moreover, this financial stability enables them to afford a balanced diet, contributing to the health and well-being of children and the family at the household level.

> "… Once I sell my vegetables at the market in Monze town, I use the money I have earned to buy what I do not have at home, such as soap, sugar and cooking oil. This helps to continue sustaining the household, and we don't lack some of these essential foods and groceries that we cannot grow in our gardens." — Female respondent in a focused group discussion.

Figure 17:Freshly harvested tomatoes that are awaiting to be ripened and sold at the market

(Photo: Mweemba 2024)

Further, income from the sale of crops is reinvested into various income-generating activities within the communities. For example, some households use these funds to purchase goods they resell within the community and neighbouring villages. They buy basic household necessities like soap, sugar, salt, and cooking oil, then sell them to community members who hardly travel to town in Monze to purchase household necessities. This initiative enables people to have additional income for home use, which enhances the economic status of the household and the community at large.

Further, placing water taps in locations that are near the allocated fields for vegetable gardening has eased community gardening activities for both men and women. This has also reduced the physical strain of fetching water from distant places to water gardens. Community members are now able to spend more time cultivating their gardens without getting overly tired from long walks of accessing water. As a result, they can now grow various crops on a larger scale which improves their overall livelihoods. As indicated by one male during the focused group discussion:

"… our water source is very close to our gardens. It has become very easy for us to grow vegetables and water adequately without having to exert all our energies in obtaining water like we did when we had to pump water from the hand pump manually", – Male respondent in a focused group discussion.

During the focused group discussions, it was heard that having gardens where parents grew vegetables allowed them to teach their children the skill of gardening. Participants of the focused group discussions reported that such skills are important to learn for all children because they prepare them for being productive in future. It empowers children to be able to support themselves when they grow up and take away the burden on families of having young adults that depend on their parents for survival.

Due to easy access to water in the community, young people i.e., the youth have also become interested in doing gardening. This has made them spend most of their days working in their gardens, making them responsible young men and women. During the focused group discussion, participants mentioned that those who previously spent time drinking beer and engaging in other illicit activities have shifted their attention to farming activities and are now earning incomes that they use to support themselves and contribute to the household's well-being.

4.2.2. Challenges of Access to Water for Enhancing Agricultural Practices

While the solar-powered borehole in Hanzila community can be seen as a cornerstone of sustainable development for its ability to empower farmers to diversify their agricultural practices, increase their yields, and secure their livelihoods, the survey also probed whether respondents faced specific challenges related to water access to enhance agricultural activities. The two most notable challenges relate to i) some fields situated further from the main supply lines and taps lack conveyance, such as pipes to ease irrigation in their field. This accounted for 40% of respondents indicating that they lacked pipes to ease irrigation of their gardens. ii) About 39% of the respondents reported lacking gardening equipment such as sprinklers (Table 3).

The challenge of inadequate conveyance/pipes into fields among farmers whose fields are situated further from the supply lines faces difficulties in delivering water to crops in the gardens. This contributes to widening inequalities in agricultural productivity among those whose gardens are situated in more advantaged locations where they are closer to the taps and supply lines. The same goes for people lacking gardening equipment such as drip irrigation or sprinklers, which means they rely on conventional methods of carrying buckets from taps across the fields, which can be tedious and labour-intensive.

Table 3:Challenges of accessing water for enhanced agricultural activities from the solar-powered borehole (N=40)

Challenges	Response	Percent
Limited solar energy to run the pump	Yes	11
	No	58
	N/A – Do not own a gardening	31

Lack of proper conveyance for fields further from supply lines and taps	Yes	40
	No	29
	N/A – Do not own a gardening	31
Lack of gardening equipment, e.g., drip irrigation or sprinklers	Yes	39
	No	30
	N/A – Do not own a gardening	31
Denied access to use water from the borehole	Yes	0
	No	69
	N/A – Do not own a gardening	31

Only 11% reported that limited solar energy posed a challenge to running the pump (Table 3). Despite 11% of the respondents indicating that low solar energy challenged the running of the borehole, the challenge was also highlighted during the focused group discussions among men and women. Respondents highlighted that cold or cloudy days were not favourable for gardening activities because water output from the borehole was inadequate. Farmers expressed dissatisfaction with how much water could be generated using solar energy when the weather was cold or cloudy. This meant that crop watering was not achieved at the optimal capacity.

> "…We noticed that around May and June, when the temperature dropped and a few times we experienced rainfall, the borehole was not working optimally to pump the needed water. We concluded that this was due to limited sunlight that was causing the solar panels not to have sufficient sunlight to provide us with energy to run the borehole." – Male respondent in a focused group discussion.

No respondents reported facing the challenges of being denied access to water from the solar-powered borehole to irrigate their crops.

4.3. Hanzila's Role in Seed Production and Community Development

With the installation of the solar-powered borehole, 13 farmers in Hanzila community were identified by the Ministry of Agriculture to experiment with producing maize seed that can be used as seed crops in the 2024/2025 rainy season. Selected community members were approached to dedicate some of their fields to produce maize seeds for the upcoming rainy season.

"…The Ministry of Agriculture, through its local Camp Officers operating in our rural communities, has extended an opportunity for us to grow maize specifically for seed production, which will be sold to other farmers come the rainy season when rain-fed agriculture is practised. This promises significant development for the village because we see that we are now recognised and seen, and this will mark a new phase in agricultural entrepreneurship." – Male respondent in a focused group discussion.

Having communities participate in growing maize for seed has several benefits for the people in Hanzila community. First, it will boost agricultural activities within the community by ensuring that maize seeds are available for the community when the time to start farming arrives. Second, it will open up economic opportunities for the community because once they sell the maize seed to government after harvesting, they will generate income from it. Furthermore, working with the Ministry of Agriculture puts Hanzila community in the spotlight as a potential partner that the Ministry of Agriculture may consider working with even for the future. In addition, the community has potential to have enhanced food security by participating in seed production and strengthening its resilience against climate variability and economic uncertainties.

During the evaluation, preparations were underway in specific fields within the village for planting maize seeds that will be fortified and treated by the Ministry of Agriculture.

Figure 18:Prepared maize field for seed production in anticipation of the upcoming rainy season

(Photo: Mweemba 2024)

4.4. Impact of Solar-Powered Borehole on Water for Livestock

4.4.1. Water Uses for Livestock and Livelihood Benefits

To contextualise issues related to livestock watering in Hanzila community, the study began by understanding the proportion of respondents that owned cattle and small livestock such as goats, pigs, sheep and chickens. Further, the study tried to understand the water sources used for livestock watering in Hanzila community before and after the implementation of the solar-powered borehole. Two sets of questions were asked: one about watering cattle and another about watering small livestock such as chickens, goats, and sheep. Further questions were asked concerning the different seasons of livestock watering.

The survey showed the proportion of respondents who owned cattle before and after implementing the solar-powered borehole. Findings showed that 52% of households in the Hanzila community owned cattle after the borehole was introduced for livestock watering (see Figure 19). The same respondents' reported owning cattle before implementing the solar-powered borehole.

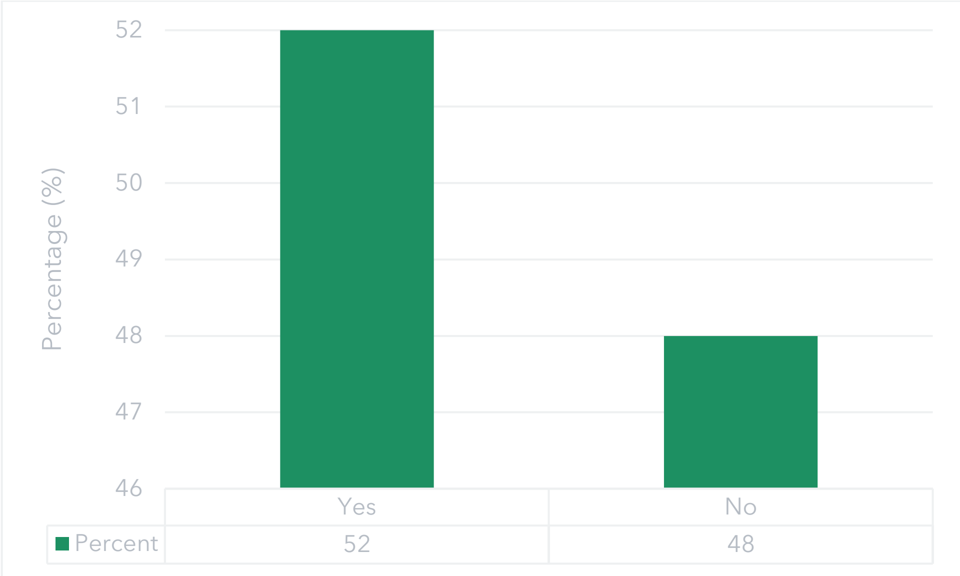


Figure 19:Proportion of households that owned cattle in Hanzila community (N=40)

(Source: Household Survey 2024)

Regarding ownership of small livestock such as goats, sheep, and chickens, 93% of respondents reported having at least one of these animals (see Figure 20). On the other hand, 7% of the respondents indicated that they did not own small livestock in Hanzila community.

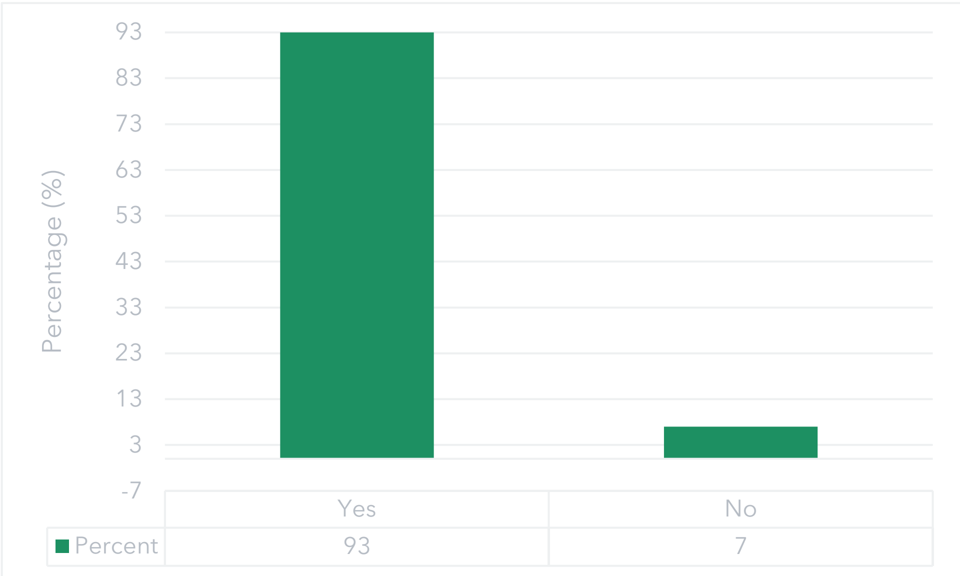


Figure 20:Proportion of households that owned small livestock (N=40)

(Source: Household Survey 2024)

During the rainy seasons, particularly before the borehole was implemented, 48% of the respondents watered their cattle using open sources such as streams, scoop holes, and dams. Furthermore, 4% reported using water from wells to water their livestock, and 48% of the respondents did not own cattle (Figure 21).

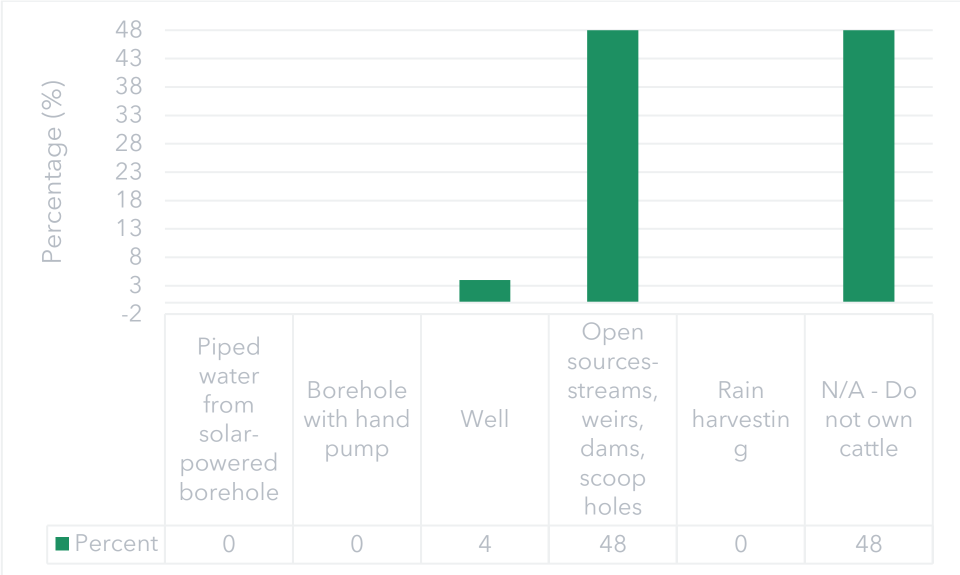


Figure 21:Most important source of water used for cattle watering in Hanzila community during the rainy season (N=40)

(Source: Household Survey 2024)

A slight shift in the types of water sources used for cattle watering was observed during the dry season. The study established that the most important water source used for cattle watering during the dry season was piped water from the solar-powered borehole at 28%, while 20% have opted to continue watering their livestock at open sources such as streams, weirs, dams and scoop holes. (Figure 22).

As opposed to struggling to find water for cattle keepers with limited access to open sources when they dried up, the study has shown that since installing the solar-powered borehole, livestock in the Hanzila community have been provided with water through large basins. Currently, community members improvise with large basins to give water to their livestock because they have not yet built water troughs. Using the basins had reduced the burden on men who previously had to take their cattle to distant streams to water their livestock. With ample water available within the community, animals have consistent access to clean water, which is likely to improve the production of high-quality milk. When livestock produce large quantities of milk, the surplus can be sold which can enhance income at the household level. This was further highlighted during the focused group discussion:

> "… Our routine for livestock watering has changed. Some of us no longer need to move the cattle to distant streams to have water for drinking. We now just use hosepipes connected to the taps and put water in large basins where all our animals can get the water they need to drink", – Male respondent in a focused group discussion.

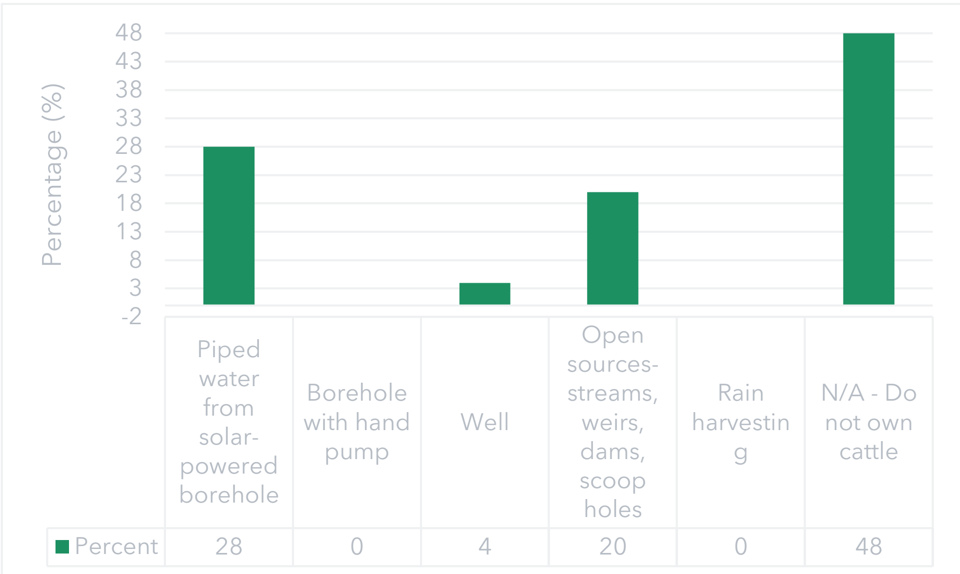


Figure 22:Most important source of water used for cattle watering in Hanzila community during the dry season (N=40)

(Source: Household Survey 2024)

Further, respondents during the focused group discussions mentioned that the presence of water within the community has reduced the need for animals to come into contact with those from neighbouring communities during watering. They indicated that contact with other animals previously increased the transmission of diseases among livestock. This resulted in high veterinary costs.

> "… For some of us who now have water from the solar-powered borehole, we don't necessarily need to take our animals to the public dams where they mix with other animals and catch diseases. Our costs for treating animals have also reduced because the animals don't mix a lot with other animals that may have diseases." – Male respondent in a focused group discussion.

Furthermore, having adequate access to water has encouraged farmers to adopt preventative measures that protect their livestock against illnesses, such as dipping animals to control ticks rather than transporting them to distant dip tanks. This shift reduces the time and effort previously spent on travelling to dip tanks and allows men to allocate more time to other productive activities, such as gardening.

The community of Hanzila plans to construct water troughs specifically for animal watering in the future to ensure an adequate water supply for the animals' wellbeing and continue providing sustainable solutions to livestock water for the village. Currently, community members, particularly men, have voluntarily engaged in making bricks, which will serve as building materials for the planned reservoirs.

> "… We have already started making bricks to construct a communal water reservoir where we will pump water to water our livestock. This is something that everyone in the community will use, so men are contributing their labour to make the bricks to build the reservoir," – Male respondent in a focused group discussion.

Several benefits are anticipated from the construction of the water trough that will be used for livestock watering in the community. Firstly, the water trough will provide reliable water for livestock, which will ensure that livestock in the community are well-hydrated throughout the year. In turn, this is expected to enhance the quality and quantity of milk produced by dairy animals and contribute to increased household incomes and food security. Secondly, the water troughs will mitigate the challenges of drying water sources during the dry season, causing animals to have an inadequate supply of water. This collective effort demonstrates the community's commitment to improving water management for animals. It also reflects their hands-on initiative to improve animal husbandry within the community.

For small livestock (chickens, goats, sheep), almost all respondents provided water in basins to water their livestock during the rainy and dry seasons. The study established that 89% of respondents indicated putting water in basins using piped water from the solar-powered borehole, whereas 4% watered their small livestock using a well. Results also show that 7% of the respondents indicated they did not own small livestock (Figure 23).

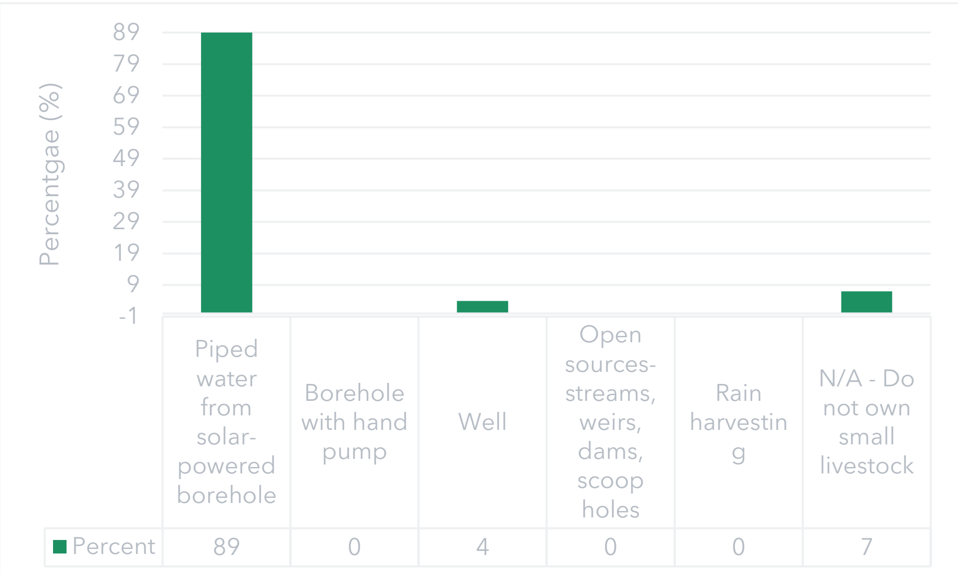


Figure 23:Sources of water used for watering small livestock in Hanzila community during the dry and rainy seasons (N=40)

(Source: Household Survey 2024)

4.4.2. Challenges of Accessing Water for Livestock Watering

Despite the presence of a solar-powered borehole in the community, many livestock keepers, particularly those with cattle, continue to move their herds to distant natural water sources like streams, rivers, or ponds. This is due to the lack of water troughs in the area that can store clean and sufficient water for the livestock. The study revealed that 33% of livestock owners cited the absence of water troughs as a significant challenge (see Table 4).

Additionally, some respondents noted that the designated two-hour watering times, as reported by 28% of cattle owners, were insufficient to meet their cattle's water needs.2 As a result, some cattle owners had to transport their animals to faraway streams, rivers, or ponds to ensure they had adequate water.

Table 4:Challenges of accessing water for cattle watering from the solar-powered borehole (N=40)

Challenges	Response	Percent
Limited solar energy to run the pump	Yes	9
	No	43
	N/A – Do not own cattle	48
No trough to water livestock	Yes	33
	No	19
	N/A – Do not own cattle	48
Inadequate time allocated for livestock watering	Yes	28
	No	24
	N/A – Do not own cattle	48
Denied access to use water from the borehole	Yes	0
	No	52
	N/A – Do not own cattle	48

Only 9% reported that limited solar energy posed a challenge to running the pump to get the required water for livestock watering. Further, no respondents reported facing the challenges of being denied access to water from the solar-powered borehole to water their cattle (Table 4).

Regarding the watering of small livestock, no significant issues were reported with accessing water from the solar-powered borehole. This is mainly because traditional methods of collecting water for small livestock have been in use for a long time, such as owners using basins to water small livestock. Unlike cattle, which require large amounts

[2] Detailed scheduling of livestock watering is explained in the subsequent sections

of water—estimated at 30 to 80 litres per day3—small livestock have lower water needs, making the existing methods sufficient for their requirements.

[3] https://education.nsw.gov.au/teaching-and-learning/animals-in-schools/animals-in-schools-species/animals-in-schools-cattle/cattle-food-water#:~:text=In%20general%20cattle%20require%2030,consumption%20of%20adequate%20water%20quantity.

5. The Role of the Local Authority in Supporting and Sustaining Locally-led Water Infrastructure Projects

5.1. Local Authority's Key Role in Partnering with ClimBeR Project for Rural Water Supply Development

The local authority plays a key role in collaborating with external partners. They typically participate in assessing the needs of their communities and identify areas where water infrastructure is lacking or insufficient. For instance, in early interactions, the local authority was instrumental in bringing Hanzila community to the attention of the ACTION facilitator. They highlighted Hanzila as a community with strong development aspirations that were not being achieved due to limited access to water resources. During this process, the local authority provided information on their understanding of the community's needs and provided insights into various projects that the community was already undertaking.

The local authority were also invited to be part of the initial meeting with the community, and represented by the Ministry of Agriculture, ensuring the integrated scope of ClimBeR's vision and goals and overseeing that the government guidelines were adhered to in rural water development.

The local authority continued to play a supportive role in the implementation process of the solar-powered borehole by issuing permits to the contractor for drilling the borehole after confirming that the selected site met the necessary criteria for rural water supply. Since the borehole capital costs were fully funded, the community was not required to make any upfront payment to receive the borehole. However, it remains the local authority's responsibility to ensure that the community can sustain the water infrastructure and that they have ownership and control over the water infrastructure. It is within the local authorities' mandate to ensure that existing water supply systems such as boreholes, wells, dams and other water infrastructures are functional and able to be sustained for a long of people.

> "…Part of our work is to ensure that we maintain and sustain all water infrastructure in our catchment, be it hand pumps, dams, wells, so that community beneficiaries can access such facilities over a long period and even for generations to come." – Key Informant, Monze District Council.

Part of the sustainability plans initiated by the local authority in Hanzila and elsewhere entails providing training for local communities on how to use and maintain the water infrastructure well. They also work to raise awareness among community members of the importance of safeguarding water resources to enhance the lifespan of the water infrastructure. The local authority also comes with mechanisms to report any incidences that may occur to the water systems so that corrective measures are implemented within the shortest possible time to avoid communities getting inconvenienced and to prevent the deterioration of the water infrastructure that may arise if allowed to have a longer downtime.

Hence, for the newly installed borehole, the local authority is responsible for supporting Hanzila community members with a training program that will help community members obtain basic knowledge about maintaining the solar-powered borehole effectively. During the interviews, the representative from Monze District Council indicated that:

> "… We do not have many communities that have solar-powered boreholes in the district, so we do not have routine training programmes for such boreholes as we do for boreholes equipped with hand pumps. However, for those that have such hand pump borehole infrastructure, we provide them with the necessary skills to troubleshoot common problems that are easy to manage. We also ensure that selected users of the borehole infrastructure understand the technical aspects of the solar-powered system so that community members are well-equipped with the knowledge and skills needed to operate and sustain the water infrastructure independently." – Key Informant, Monze District Council.

5.2. Opportunities to Scale Up the Locally-led Approach of of the ClimBer Project

After presenting the step-wise participatory approach adopted by the ClimBeR project to plan for the implementation of the solar-powered borehole, the local authority expressed its openess to adopting the approach for scaling up in upcoming water projects. This model involves engaging communities from the start to identify water-related challenges and develop solutions collaboratively. The local authority already implements community engagements while identifying water challenges for domestic uses that need to be resolved. In terms of formal process, the application process for the water infrastructure is first initiated by the community. According to government guidelines (Ministry of Local Government, 2010), community members are required to sit together through a participatory process and highlight key water challenges the community faces. This is followed by a formal application that community members make to the local authority requesting the implementation of the water infrastructure. Once received, the local authority assesses applications from various communities and conducts field visits to verify what is contained in the application. At this point, several communities that may have applied for water supply are visited for the verification processes. Once this process is complete, the local authority convenes a meeting to prioritise which communities have dire water needs, and those are the ones that are given first priority when implementing water infrastructure. This is usually for domestic uses only, without considering basic agricultural uses. The local authority then holds meetings with the communities that qualify for support in water supply. This is intended to understand the contextual issues in those communities before the boreholes are implemented. Previously, there were challenges when local authorities or any other developer implemented water projects without community involvement and understanding of local knowledge. For instance, boreholes were sometimes placed near graveyards or on sites deemed sacred by community members, which resulted in a reluctance to use the infrastructure despite significant investment. These experiences showed the importance of integrating local perspectives to avoid such challenges. Learning from the community about the uniqueness of different sites and their cultural significance, local authorities have better aligned how they develop water infrastructure projects which align with local contexts and priorities. This has shown that communities would have enhanced ownership of the infrastructure and ensure the successful use of the resources provided.

Once all these issues are ironed out, implementation is initiated. It is also important to note that the implementation of water infrastructure is also dependent on the availability of funding, as funding for such projects is not sufficient to meet all water demands coming from the community. Interviews with the local authority showed that despite the government's interest in enhancing access to water for rural communities, local authorities mentioned that they usually faced the challenge of supporting many communities with limited budgets for water supply.

However, with the current extreme and recurrent effects of climate change, local authorities need to proactively find financiers to support rural water supply for enhanced livelihood to improve access to water for drinking, other domestic uses, crop production, or livestock watering. Advanced technology, such as solar-powered, can be a solution of choice for rural communities that could enhance community resilience to climate change. Local authorities note it is a great initiative to ensure reliable and consistent water supply even in areas with erratic rainfall.

"… Where such boreholes are, we have seen how communities transform and use the water for many purposes, such as growing vegetables that help them earn income. It is time that we start making use of such investments to improve the lives of the people because we see that the impacts of droughts are many, and therefore, we need to reduce people's dependence on unreliable water sources, most of which dry up." – Key Informant, Monze District Council.

6. Discussion, Conclusions and Recommendations

The implementation of the borehole began by engaging communities to understand the existing water challenges and also ascertain the solutions that would address the challenges. This was important to achieve at the start of the project because it allowed community members to fashion an infrastructure that responds to challenges that are true to their context. Following engagements, communities also participated in identifying the sites that are most feasible to implement the borehole and reticulation, and that would meet different water needs in the community, including drinking, livestock watering, and gardening.

Participatory approaches are highly encouraged in any community project because community voices can bring to light real issues that the project should be targeting and also help to meet the community's diverse needs for their multi-faceted livelihoods. The ClimBeR project aligned closely with the Hanzila community's specific requirements and preferences because the initial engagement prioritised listening to proposals that were brought forward by community members. While this is the case, some community members may be marginalised or not at the same level in terms of access to implemented water infrastructure, not because they have been denied access but because they are situated in locations that are farther from the access points. Future projects should take into consideration increasing funding allocation that allows for expanded water supply systems that go beyond a shorter radius of 1 kilometre, for example, to ensure that water infrastructure intended for the entire community should really reach all members of the community in an equal manner.

Following the development of the borehole infrastructure, a study was initiated to assess what had been the livelihood outcomes of the solar-powered borehole in the Hanzila community. These include its impact on meeting set-out objectives for the project of enhancing resilience among community members to the impacts of climate change by enhancing access to water that supports drinking, livestock watering and crop irrigation all year round, including periods of water scarcity resulting from droughts.

The solar-powered borehole in Hanzila community is a technology new to the community. It departs from using traditional boreholes with hand pumps that are common in most rural areas and the use of other sources such as deep and shallow wells. It also causes a departure from relying on unsafe sources such as scoop holes to access water for drinking to a more sophisticated water supply system. This change was brought about to address various water challenges the community faced, including unreliable water access for drinking, livestock watering and crop irrigation. It was also intended to address the impacts of climate change, such as droughts and erratic rainfall patterns, which have become more recurrent over the years.

One of the objectives of the solar-powered borehole was to provide reliable access to clean water for drinking and other domestic uses. Before its installation, community members relied on a single borehole to access clean water for drinking, which had many people seeking access at the same time. This led to long waiting times for each household to access water. Implementing the solar-powered borehole has significantly improved access to water. There has been reduced queuing and time spent accessing water and also reduced distances for people to cover accessing water. This is because several taps have been installed in various locations within the community that allow people to access water from points that are convenient to them in relation to distance from their homes. The ten taps installed have increased access points meaning several people can access water at the same time using different access points.

Despite the positive outcome that the borehole has brought to the community of Hanzila, it has also created uneven access to water, particularly affecting people living farther from the piped water lines and installed taps. While the borehole was intended to benefit everyone's access and make life easy for the entire community, some households are currently not enjoying the full benefits of reduced distances to access water because their homes are situated farther from the points of access. In the initial contract agreement for installing the borehole, it was agreed that the borehole would only cover a radius of 1 kilometre, and taps would be installed within this recommended radius. Those that are situated farther from this distance had a choice to extend the supply lines to their homes at their own cost. This was done by those who could afford it. On the other hand, some community members could not afford to pay for the extension of supply lines and, therefore, continued to cover longer distances to access water from the borehole. Others have opted to continue accessing water from wells and other open sources closer to their homesteads to reduce the distances covered. This situation falls short of what the borehole was trying to achieve, which was to leave no one behind in improved access to water. The disparity also shows a broader issue of inequality in water access, where better-offs within a community can benefit from infrastructure that is provided free of charge if additional investment is made.

Installing additional taps or water points near the homestead situated farther from the borehole can also be a solution to address unequal access. Where project funding is limited in providing supply lines that cater for a shorter distance, community members can agree to contribute equally to installing water access points that favour all members of the community. This can be a community initiative to complement what was provided by the donor. Alternatively, local authorities can take up the initiative to balance water access by funding such initiatives to ensure equitable access to water for all community members.

Furthermore, future projects could request community members to make initial financial contributions to ensure that funds raised can be used in combination with resources from external donors to develop a larger and more effective water distribution systems. Involving the community to fund their local water project would mean enhance the overall infrastructure, and improve water access for a greater number of community members.

Secondly, the borehole was crucial in enhancing agricultural activities in Hanzila community by mitigating the community's exposure to climate change. Like many countries in the Southern part of Africa, Southern Zambia faces heightened vulnerability to climate variability, including prolonged droughts and unpredictable rainfall patterns. The solar-powered borehole ensures a more consistent water supply needed for small-scale crop farming, even during periods of water scarcity. Agricultural activities, such as vegetable gardening, contribute to food security and economic stability even during the dry season or in years with limited rainfall, such as the 2023/2024 rainy season, because the borehole remains operational throughout the year.

With the experience gained from implementing a powered borehole in a remote area such as Hanzila and the perceived benefits for agricultural activities and enhancing resilience to climate change, local authorities should be instrumental in developing water project proposals targeted at government and also external financiers to build water infrastructure such as the solar-powered borehole that respond to current water needs and address the impacts of climate change on agriculture. This will contribute to solving some of the challenges on farming brought about by reduced rainfall and recurrent drought conditions.

The solar-powered boreholes should also be considered for replication by local government as it technically feasible to be implemented in remote areas. Zambia has sufficient sunlight needed to power the pumps and other parts of the borehole. Using solar energy for powering the borehole is environment friendly and contributes to mitigating the impacts of climate change.

However, while considering implementing such technical infrastructure that is mostly new for most people in rural areas, it is recommended to factor in instilling knowledge and skills in community members on how to maintain and properly maintain the borehole. Hanzila community recently transitioned from using a traditional hand pump that they had used and known for many years to a much more sophisticated solar-powered system. This means that the new solar-powered borehole introduced new technical complexities that require specialised knowledge and skills to operate and maintain the borehole. Currently, there are a few people within the community who were trained to operate and maintain boreholes equipped with hand pumps. These were trained by the local authority. However, there is no one currently who has the skills to fix the solar-powered borehole in the Hanzila community, so the borehole had to experience some challenges. Training of a new cadre of people who can fix the borehole if it breaks down should be prioritised for the Hanzila community. In addition, the training should be tailored to the local context of Hanzila community, taking into consideration people's comprehension and literacy levels. Community members should also be informed of where to seek help for challenges that cannot be handled within the community to ensure a quick turnaround of borehole fixing should it experience a breakdown.

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• Annex 1: Household Interview Questionnaire

HOUSEHOLD QUESTIONNAIRE

INTRODUCTION

Good morning/afternoon/evening. My name is ...., and I am evaluating the solar-powered borehole installed in Hanzila community. This research aims to understand how the borehole has impacted your life, household, and community since its installation. We want to gather insights into various aspects of the project, including the installation process, stakeholder satisfaction, maintenance needs, and critical lessons learned.

Your household has been chosen for the interview because you reside in the Hanzila community and could benefit from the borehole in some way. We are interested in learning about the impact of the borehole on you and your household.

I appreciate your cooperation and your valuable insights. "May I begin the interview now?

☐

Yes ☐ ***(Proceed with details below)*** No ***(Thank the respondent & leave)***		
1. QUESTIONNAIRE IDENTIFICATION		
1.1	Questionnaire No	
1.2	Survey date (dd/mm/yy)	
1.3	Start Time	
2. DEMOGRAPHIC INFORMATION		
2.1	Respondent's gender ***(Don't ask, just take note)***	☐ 1. Male ☐ 2. Female
2.2	Age range of respondent ***(Only interview adults within the household – 18 years and above)***	☐ 1. 18 years old ☐ 2. 19 to 24 years old ☐ 3. 25 to 30 years old ☐ 4. 31 to 40 years old ☐ 5. 41 to 50 years old ☐ 6. 51 to 60 years old ☐ 7. Above 60 years old
3. DRINKING AND DOMESTIC WATER USES		
3.1	What sources of water do you currently use for drinking and domestic uses? ***(Tick all that apply)***	☐ 1. Solar-powered borehole ☐ 2. Borehole with hand pump ☐ 3. Well ☐ 4. Open sources – streams, scoop holes ☐ 5. Other specify _______________
3.2	Do you use alternative sources of water for drinking and domestic uses?	☐ 1. Yes ☐ 2. No ☐ 3. I don't know
3.3	What water sources were you using for drinking and domestic uses before installing the solar-powered borehole? ***(Tick all that apply)***	☐ 1. Borehole with hand pump ☐ 2. Well ☐ 3. Open sources – streams, scoop holes ☐ 4. Other specify _______________
3.4	As a household, do you have adequate access to water throughout the day for drinking and domestic uses from the solar-powered borehole?	☐ 1. Yes ☐ 2. No ☐ 3. There is an allocated period to access water for drinking and domestic uses ☐ 4. I don't know
3.5	Are you denied access to water for drinking and domestic uses from the solar-powered borehole? ***(If not denied, proceed to question 4.1!)***	☐ 1. Yes ☐ 2. No ☐ 3. I don't know
3.6	If you are denied access to the solar-powered borehole for drinking and domestic uses, what causes you to be denied access? ***(Tick all that apply!)***	☐ 1. That the borehole belongs to select people in the community ☐ 2. That we haven't paid the maintenance fee to use it ☐ 3. That we belong to another community ☐ 4. Other specify _________________
4. PERCEIVED IMPACTS OF SOLAR-POWERED BOREHOLES ON DRINKING AND DOMESTIC WATER		

4.1	What is the current distance to your primary water supply for drinking and domestic uses?	☐ 1. Within the household/compound ☐ 2. Less than 50m ☐ 3. 50-100meters ☐ 4. Between 100-200meters ☐ 5. Over 500 meters ☐ 6. I don't know
4.2	What was the distance to your main source of drinking and domestic water supply before you started using the solar-powered borehole?	☐ 1. Within the household/compound ☐ 2. Less than 50m ☐ 3. 50-100meters ☐ 4. Between 100-200meters ☐ 5. Over 500 meters ☐ 6. I don't know
4.3	How long does it take to access water round trip? ***(Exclude time used to do other household errands)***	☐ 1. A few minutes/ Within the household/compound ☐ 2. Less than 30 minutes ☐ 3. Half an hour ☐ 4. Half an hour to 1hour ☐ 5. Over 1 hour ☐ 6. I don't know
4.4	Before installing the solar-powered borehole, how long did it take to access water for drinking and domestic uses a year ago?	☐ 1. A few minutes/ Within the household/compound ☐ 2. Less than 30 minutes ☐ 3. Half an hour ☐ 4. Half an hour to 1hour ☐ 5. Over 1 hour ☐ 6. I don't know
4.5	Have you perceived any health benefits since you started using water from the solar powered borehole? ***(Tick all that apply!)***	☐ 1. Yes, cleaner and safer water reduced incidences of waterborne diseases. ☐ 2. Yes, personal hygiene has improved (regular bathing and hand washing) ☐ 3. No ☐ 4. Other, specify _______________
4.6	How was your health and hygiene before using water from the solar-powered borehole? ***(Tick all that apply!)***	☐ 1. We did not bath every day because of inadequate water supply ☐ 2. We sometimes drink water from open sources (streams and scoop holes), which causes diarrheal diseases ☐ 3. Nothing has changed ☐ 4. Other, specify _____________
5. WATER FOR CROP GROWING/GARDENING		
5.1	Do you have a garden where you are currently growing crops? ***(If they do not have a garden, skip to question 8.1***)	☐ 1. Yes ☐ 2. No
5.2	Did you own a garden before the borehole installation where you regularly grew crops?	☐ 1. Yes ☐ 2. No
5.3	What sources of water do you currently use for vegetable gardening? ***(Tick all that apply)***	☐ 1. Solar-powered borehole ☐ 2. Borehole with hand pump ☐ 3. Well ☐ 4. Open sources – streams, weirs, dams, scoop holes

		☐ 5. Rain harvesting ☐ 6. Other specify _______________ ☐ 7. N/A – Do not own a garden
5.4	Do you use alternative sources of water for vegetable gardening?	☐ 1. Yes ☐ 2. No ☐ 3. I don't know
5.5	What water sources were you using for vegetable gardening before installing the solar-powered borehole? ***(Tick all that apply)***	☐ 1. Borehole with hand pump ☐ 2. Well ☐ 3. Open sources – streams, weirs, dams, scoop holes ☐ 4. Rain harvesting ☐ 5. Other specify _______________ ☐ 6. N/A – Did not own a garden
6. CHALLENGES OF ACCESSING WATER FOR CROP GROWING/GARDENING		
6.1	Do you have adequate access to water from the solar-powered borehole for agricultural purposes?	☐ 1. Yes ☐ 2. No ☐ 3. There is an allocated period to access water for drinking and domestic uses ☐ 4. I don't know
6.2	What challenges do you face in accessing water from the solar-powered borehole? ***(Tick all that apply!)***	☐ 1. Limited power to run the borehole ☐ 2. Lack of proper conveyance for fields further from supply lines and taps ☐ 3. Lack of gardening equipment, e.g., drip irrigation or sprinklers ☐ 4. Denied access to use water from the borehole ☐ 5. Other specify______________
7. PERCEIVED IMPACTS OF SOLAR-POWERED BOREHOLES ON VEGETABLE GARDENING		
7.1	Ask respondents to list the perceived benefits of using solar-powered for their gardening. ***(Tick all that apply!)***	☐ 1. Able to produce crops throughout the year because of the availability of water ☐ 2. Increased income from vegetable sales ☐ 3. Reduced reliance on rainwater ☐ 4. Cultivate during drought periods ☐ 5. Other specify _______________
8. WATER FOR LIVESTOCK WATERING		
8.1	Do you own cattle? ***(If they do not own cattle, skip to the end of the interview***)	☐ 1. Yes ☐ 2. No
8.2	What sources of water do you use for cattle watering during the rainy season? ***(Tick all that apply)***	☐ 1. Solar-powered borehole ☐ 2. Borehole with hand pump ☐ 3. Well ☐ 4. Open sources – streams, weirs, dams, scoop holes ☐ 5. Rain harvesting ☐ 6. Other specify _______________
8.3	What water sources do you use to water cattle during the dry season? ***(Tick all that apply)***	☐ 1. Borehole with hand pump ☐ 2. Well ☐ 3. Open sources – streams, weirs, dams, scoop holes

		☐ 4. Rain harvesting ☐ 5. Other specify _______________
8.4	Do you own small livestock, i.e., chickens, goats, sheep, etc? ***(If they do not own small livestock, skip to question 9.1)***	☐ 1. Yes ☐ 2. No
8.5	What sources of water do you use to water small livestock, such as chickens, goats, and sheep, during the rainy season? ***(Tick all that apply)***	☐ 1. Solar-powered borehole ☐ 2. Borehole with hand pump ☐ 3. Well ☐ 4. Open sources – streams, weirs, dams, scoop holes ☐ 5. Rain harvesting ☐ 6. Other specify _______________
8.6	What sources of water do you use to water small livestock, such as chickens, goats, and sheep, during the dry season? ***(Tick all that apply***	☐ 1. Solar-powered borehole ☐ 2. Borehole with hand pump ☐ 3. Well ☐ 4. Open sources – streams, weirs, dams, scoop holes ☐ 5. Rain harvesting ☐ 6. Other specify _______________
9. CHALLENGES OF ACCESSING WATER FOR LIVESTOCK WATERING		
9.1	Do you have adequate access to water from the solar-powered borehole for livestock watering?	☐ 1. Yes ☐ 2. No ☐ 3. There is an allocated period to access water for drinking and domestic uses ☐ 4. I don't know
9.2	What challenges do you face in accessing water from the solar-powered borehole?	☐ 1. Limited power to run the borehole ☐ 2. No troughs for livestock watering ☐ 3. Inadequate time allocated for livestock watering ☐ 4. Denied access to use water from the borehole ☐ 5. Other specify______________
END OF INTERVIEW AND THANK THE RESPONDENT!		

- ## Annex 2: FGD Interview Guide for Community Members

INTRODUCTION

Thank you for joining us for this interview. As you already know, the ClimBeR project implemented a solar-powered borehole in this community last year for various purposes. We want to evaluate how the borehole has impacted your lives since its installation.

We have developed an interview guide with specific questions that will cover the situation before the implementation of the borehole in terms of access to water for various needs, including drinking, domestic, irrigation, and livestock watering. The interview guide will also cover questions on the current water supply situation since the implementation of the solar-powered borehole. We would also like to know how the borehole maintenance is managed.

Please note that your participation in this process is voluntary, and we totally understand if you feel unable to.

We value your participation and appreciate you sharing with us your experiences using this solar-powered borehole.

IMPLEMENTATION PHASE

Community Engagement Prior to Borehole Implementation

- To begin with, I would like to hear how the planning for the borehole was initiated before it was implemented. Kindly walk me through this process.
    - How was your community initially contacted and communicated to about the implementation of the borehole?
- Did you and other community members have input in the planning process for the borehole?
- How did you and/or other community members participate in the planning process for the implementation of the borehole?
    - Community meetings
    - What agreements did you make within the community and with people that were implementing the project?
    - Did the community obtain authorisation to use the land from local leaders or the government where the borehole and its reticulation system is implemented?

Borehole Implementation Phase:

- I would now like to hear how the planning for the borehole installation and putting up of pipes was done.
    - How did you agree on sites where the borehole is implemented?
- Did you or the contractor conduct surveys to understand whether the sites selected for the implementation of the borehole were suitable or not?
- Did plans change at any point from what was proposed in terms of developing the water infrastructure? If so, what changes did you observe and how were they addressed?
- Were there any challenges faced at the time of drilling the borehole? How were encountered challenges addressed during drilling, and how were they addressed?
    - Theft of some parts etc.
    - Resistance from some stakeholders?
    - Failure to comply with government regulations, e.g., ….?
- Was the borehole drilled at a depth that was agreed up?
- How was the water yield?
    - Was the water yield from the borehole as initially desired during the planning for the borehole?
- How was the quality of the water after drilling?
- Did you have any concerns regarding the borehole implementation?
    - What were the concerns from the community, and how were they addressed?

Cost and Funding:

- Would you know the total cost for the installation of the borehole?
    - What was the total cost of the borehole installation?
- How was the project funded?
    - Has the financial support continued after the borehole was implemented?

- Was there an agreement where the community agreed to make some contributions for sustaining the borehole in furture, during the planning phase?
    - If so, how much was committed?
    - How much do you pay now?

POST IMPLEMENTATION: BOREHOLE USE

Impact Assessment:

- Does the borehole yield still provide enough water for community uses?
- Comparing the situation before the borehole was implemented and now, what major changes have you observed in access to water for the community?
    - For livestock watering
    - Gardening – field irrigation, if any
    - Drinking
    - Other domestic uses
    - Other productive uses
- How many households are benefiting from the borehole use? Could you approximate the number of people accessing water from the borehole for various uses?
    - For livestock watering
    - Gardening – field irrigation, if any
    - Drinking
    - Other domestic uses
    - Other productive uses
- Have you made any modifications to borehole pipes and taps, as well as the general installation of the borehole, to meet the required demand?
- Have there been any improvements in your life and the life of other community members since the implementation of the borehole?
    - Access to clean water, food, nutrition, income in the rainy and dry season?
- How would you rate the overall performance of the borehole in terms of yield?
    - Is the water yield enough to meet all water needs in the community?

Levels of Satisfaction:

- Have you received any feedback from people using the borehole about how it is performing?
    - If yes, what kind of feedback did you receive? Both positive and negative.
- Are all community members happy with everything surrounding the borehole?
    - If there are some that are not happy, what are some of the issues that have caused them not to be happy?
    - As a community, how do you plan to ensure that all people within the community are happy with the borehole?

Lessons Learned:

- What are some of the lessons that you have learned from this borehole project?
- Is there anything you feel should be done differently if a similar project were implemented in the future?

Annex 3: FGD Interview Guide for the Water Committee Members

INTRODUCTION

Thank you for joining us for this interview. As you already know, the ClimBeR project implemented a solar-powered borehole in this community last year for various purposes. We want to evaluate how the borehole has impacted your lives since its installation.

We have developed an interview guide with specific questions that will cover the situation before the implementation of the borehole in terms of access to water for various needs, including drinking, domestic, irrigation, and livestock watering. The interview guide will also cover questions on the current water supply situation since the implementation of the solar-powered borehole.

From you as the water committee, we would also like to know how the borehole maintenance is managed. We also want to know the plans that you have to sustain the water infrastructure so that it stands the test of time.

Please note that your participation in this process is voluntary, and we totally understand if you feel unable to.

We value your participation and appreciate you sharing with us your experiences using this solar-powered borehole.

Roles of the Water Committee

- What is the role of the water committee in relation to this borehole?
  - What are some of your specific tasks?
- How many people are part of the committee?
- How did you end up being a member of the committee?
- How have you ensured that all water needs are met, including drinking and domestic water, gardening and livestock watering?
- How do you ensure that people follow the set rules in using the borehole infrastructure?
- Are there any forms of sanctions for people or households that do not follow rules of using the borehole?

Sustainability:

- What measures have you put in place to ensure that the borehole is sustained for many years to come?
- Are there any requirements for maintaining the borehole since its implementation?
  - What are some of those requirements?
- Based on your assessment, how long do you think this borehole will last?
- Do you currently have a plan in place to ensure that the borehole is maintained regularly? Does this include regular repairs?
- Has there been any training on the maintenance and operation of the borehole?
  - If not, are there plans for the community to be trained on how to maintain and sustain the borehole?

Challenges of the Water Committee

- Do you face any challenges as a member of the borehole committee?
  - What are some of the challenges you face, particularly in day to day running of the borehole?

• Annex 4: Key Interview Guide for the Local Authority in Monze District

INTRODUCTION

Thank you for taking the time to conduct this interview with us. The ClimBeR project implemented a solar-powered borehole in Hanzila community last year which is used for various purposes. We are now in the process of evaluating the what has happened since the implementation of the borehole.

However, we are also aware that you have a responsibility to support the development of rural water supply in communities. We have visited you, therefore, to see what your role is as a local authority in supporting rural water supply projects, both those implemented by external donors and those implemented by the government.

We have developed an interview guide with specific questions that we would like to use to understand these details and learn from you if there are any opportunities for scaling up such water projects that support the livelihoods of rural communities.

We value your participation and appreciate you sharing with us your experiences using this solar-powered borehole.

Responsibilities of the Local Authority

What are the main responsibilities of the local authority in managing rural water supply?

Are there specific water supply infrastructures that you oversee as a local authority (e.g., wells, pipelines, treatment facilities)?

How do you prioritise and select areas for infrastructure development or upgrades?

What key policies or regulations guide the local authority's approach to rural water supply?

How do such policies guide your mandate?

How do you develop and implement long-term plans for rural water infrastructure?

Do you have adequate budget allocated for developing infrastructure for rural water supply,

How are budgets determined?

Are there any specific funding sources or grants available for rural water projects?

Community Participatory Planning for Water Supply Projects

How do you ensure that you engage with rural communities in planning and decision-making for water supply?

Are there any programs or initiatives to raise awareness and educate community members about water infrastructure management?

Do you also do this for projects not directly initiated through the local authority?

Collaboration with NGOs in Developing Rural Water Supply

Do you coordinate with other governments, NGOs, or agencies to provide water services?

How does the local authority coordinate with other government agencies or organisations to provide water services?

Was the local authorority involved in the implementation of the solar-powered borehole supported through the ClimBeR initiative? What was the role of the local authority?

How do you ensure that projects such as the ClimBeR project borehole are implemented according to the guidelines of the local authority and that such projects should meet government-set standards?

Do you have plans to support the maintenance of the boreholes outside what was directly initiated by your office?

What are the processes for maintaining such water supply systems, e.g. the ClimBeR borehole?

Do you handle repairs related to water supply?

Scaling Up

The ClimBeR project borehole used what we are calling a step-wise participatory planning process to develop the solar-powered borehole. This involved engaging communities to understand the challenges and communities they faced in relation to water access and allowing communities to come up with their own suggested solutions that they felt would improve their water access. They were also involved in siting the location until the construction of the borehole. Do you see this as something that the local authority can use as a scale-up? What benefits or challenges do you perceive from such a process?

How can the local authority enhance people's resilience to impacts of climate change by replicating developing a solar powered borehole as achieved through the ClimBeR borehole initiative?

Challenges

What are some of the significant challenges you face as a local authority in providing rural water supply?

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