

Water-harvesting Technology Using Micro Dams: A Case Study of Same District, Tanzania



In Tanzania, it is estimated that 60% of the country is semi-arid or arid. These areas receive short-interval rainfalls and experience long dry spells with high evapotranspiration rates and erratic temporal and spatial distribution of rainfall (Liwenga *et al.*, 2012). Often, long dry spells occur during the growing season to the extent that crop and pasture production becomes poor even when total seasonal rainfall amount is high.

Same District in Kilimanjaro region of Tanzania experiences semi-arid condition, which is characterized by low, erratic, and unreliable rainfall with upstream users enjoying more rain

than downstream users. The average annual rainfall ranges from 500 mm/a in the lowlands to 800 mm/a in the upper areas. This rainfall is distributed over two crop-growing seasons, with the farmers predominantly growing maize (crop water requirement is 500 mm/season) (FAO, 1998).

The onset and duration of rainfall in semi-arid areas are inherently stochastic, and the probability of occurrence of acute dry spells during a growing period is high (Mahoo *et al.*, 1999). Such a situation makes farming in semi-arid areas a risky venture with a very high likelihood of production failure (Hatibu *et al.*, 1999). There is general water scarcity, which is

partly a result of climatic change and variability and partly a result of increased competition for the limited resource. Climate change and abstractions over the past decades have reduced in-stream flows from several hundred cubic meters to less than 40 m³/s in rivers such as Pangani River (IUCN, 2003).

Water harvesting is highly considered in areas where rainfall is heavy during storms of considerable intensity, with short intervals compared with no-rainfall periods. It requires adequate provision for the interception, collection, and storage of the water. The effectiveness of these tasks depends on the catchment characteristics and location, whether it is on the field or runoff from upstream catchments.

Agricultural practices, in turn, are highly dependent on rainfall, either directly or indirectly, through traditional irrigation systems (including *ndiva*). The farmers in the Pare mountains have resorted to supplementary irrigation in order to increase crop yield. Supplementary irrigation is necessary in order to realize crop yield and thus support smallholder rainfed rural livelihood. The highlands provide an almost perennial source of inflow into the micro dams (DAICO, 2014). More than 157 micro dams have been established to supply water for crop growth during dry-spell periods and in the mountainous area where they can even irrigate crops during the dry season.

Micro dams for water-smart agriculture

A micro dam (*ndiva*) can be defined as a small traditional water storage structure which involves the modified furrow irrigation method. The structure is incorporated at suitably selected points in the system. Storage is usually done during day and night. Most of the existing *ndiva* have sizes ranging from 200 m³ to 2000 m³ (DAICO, 2014).

Ndivas are traditional water harvesting and storage technologies used in most of the Pare areas. In Same District, the use of this technology dates back to early 18th century. Irrigation started as a way of getting water for crops during dry seasons. This was indeed the early method of adaptation to climatic change. Crops grown during dry season were mainly root crops, which were the staple during periods of famine.

Ndivas are built in the upper part of a catchment. These micro dams receive water from a diversion canal from the main river and supply areas ranging from a couple of hectares to about 400 ha. Most farmers are connected to furrow systems, often combined with a small reservoir. The micro dam is communally managed by a group of farmers within the irrigation zone served by the micro dam. Usually, within the catchment area are several systems. The micro dam intercepts runoff from perennial or seasonal streams, which otherwise would have been lost. There are no external incentives to maintain the micro dams. Farmers organize themselves in groups to manage and maintain the *ndivas*. Through participation in a group, a farmer gets access to his ration of water (WHaTeR report, 2011).

Due to erratic rainfall and the resulting high degree of variability and unpredictability, smallholder farmers have resorted to supplementary irrigation by using *ndiva* in order to reduce the impact of dry spells and to store water when they need to irrigate. The existence of *ndiva* is of great importance as it impounds water with low discharges to create high discharges that can be used during periods of high demand, reaching farmers far down the command area.

Supplementary irrigation in these areas can be traced back to the pre-colonial era in Tanzania. In Ndolwa and Vudee villages, irrigation furrows started before the Germans arrived. In Bangalala, it started during British colonialism. Taking into account that 90% of the population in the Pare Mountains live in the highlands, 80% depend directly or indirectly on agriculture (Mwamfupe, 1999).

However, unimproved micro dams have some disadvantages, which lead to poor performance. These include water losses due to seepage, evaporation, leakages, unstable walls of the structure, poor conveyance systems, and poor management.

On the other hand, improved micro dams are more efficient as there is very little or no water loss through seepage and leaching. Water stays longer in the reservoir. Canals that convey water from the source to the micro dam and those that convey and distribute water into the farmers' fields are lined, helping reduce water losses. Also, the collection chambers are redesigned (e.g., grit chamber and screens) to ease the collection and removal of

sediments and other debris that come along with water from the source. Improved micro dams have been a very useful source of irrigation water for most farmers in the district.

Objectives

The main objective of this paper is to document and create awareness on the use and importance of micro dams (*ndiva*) as an effective and efficient water-harvesting technology to manage and use available water for supplementary irrigation in semiarid and arid areas.

Methodology

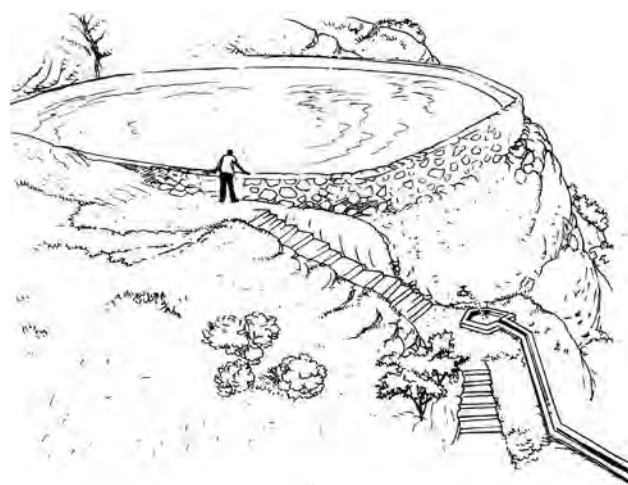
The methodology involved documenting field experience, conducting farmers' interviews, direct observation, and literature review. A literature review was done to gauge the existence and current use of water-harvesting techniques in Same District. The review covered the evolution of these technologies and their adoption in Same District. Both traditional and modern management systems of *ndivas* were described.

Through a participatory approach, village communities are enabled to prepare village agricultural development plans (VADPs). These plans later on became the basis of the district agricultural development plans. The most frequently identified problem is poor crop performance due to inadequate rainfall and hence less moisture in the soil for crop production. This has led to food shortages, progressively low income for farmers, poor contribution to development activities, and a low standard of living. Farmers identified the need to improve/rehabilitate existing irrigation infrastructure and build new ones. They also wanted interventions that will lead to efficient and effective utilization of available water in order to improve productivity.

Results and discussion

Key achievements

There are about 157 micro dams in the district (89 of them improved) and about 7,500 ha of land are under irrigation, getting the water from traditionally constructed and rehabilitated micro dams. In



The improved micro dam contributes to an efficient and effective use of available water for crop production.

In addition, about 3,400 farmers in the middle and lowland areas are producing crops as source of food and income (DAICO, 2014). The area under irrigation has increased as a result of increased water availability due to reduced water losses.

There is an increase in production of maize from 0.6 ton/acre to 1.2 tons/acre due to irrigation. This has led to improved productivity and thus improved food security among farmers. The micro dams have created an opportunity for other stakeholders and development partners to come together and solve other social and economic problems in the community.

There was reduced conflict between farmers and pastoralists, which was caused by competing for scarce water from different sources. Also, the time spent by women to look for water for domestic use has been reduced.

Key challenges and limitations

- ◆ Inadequate financial resources to support the construction and rehabilitation of micro dams, which result in many unimproved micro dams.
- ◆ Poor management of catchment areas and water sources that result in siltation in the water collection chamber and reservoirs.
- ◆ Conflict between water users/beneficiaries due to lack of an equitable distribution scheme for users downstream.

Overcoming the limitations

- ◆ The government, in collaboration with different development partners, is making efforts to improve and rehabilitate existing micro dams. So far, 89 micro dams have been rehabilitated. A good example is the Manoo micro dam, the oldest in the area (established in 1936). It serves farmers up to 3.5 km downstream of the dam. The micro dam was rehabilitated in 2003, resulting in an increase in capacity to 1,620 m³ thus benefitting 150 families over an area of 1,000 acres (400 ha) (SAIPRO, 2004).
- ◆ Farmers are advised to line canals that convey and distribute water into the farmers' fields. This is a better option to adopt to have rational use of water for agricultural activities.
- ◆ The district council and other development sectors are facilitating the formation of irrigator organizations to reduce conflicts among farmers. The irrigator organization has to design an efficient and equitable water distribution system.

Conclusions

The use of micro dams as a water-harvesting technology in semiarid areas is in line with the national irrigation policy that emphasizes the need to harness irrigation potential, along with improvement of irrigation schemes in both the highlands and lowlands. It is a water-smart technology as it serves as a storage facility for water that can be used when farmers need to irrigate. It intercepts runoff from perennial or seasonal streams, which otherwise would have been lost. Improvement in irrigation practices in potentially irrigable areas, together with a good package of extension services, may be one of the strategies to increase agricultural productivity.

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