



# Methods and Costs for Pond-Catchment Rehabilitation on the Borana Plateau

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## Research Brief

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### Abstract

*The Borana Plateau is an important rangeland for Ethiopia. One key limitation for people and livestock is lack of drinking water. Hundreds of ponds are important water sources for most of the year. Pond catchments are poorly managed because livestock access is uncontrolled. Catchments are stripped bare of vegetation due to trampling and heavy grazing, and unprotected soil is prone to erosion. When the rains come the ponds quickly fill with sediment. Sedimentation reduces pond holding capacity and much labor is required to clean them out. As part of a pilot research project we rehabilitated four ponds and their immediate catchments using a combination of: (1) Perimeter bush-fencing to confine livestock access to a few narrow corridors leading to the water's edge; (2) erosion control using dams and trenches to capture sediment prior to it entering the ponds; and (3) pond de-sedimentation using human labor. In tandem these methods have completely renovated the four sites in less than two years and could be adopted by the pastoralists. Here we report how we implemented each method as well as estimate the total cost of rehabilitation. Overall, the average cost to rehabilitate one seven-hectare pond catchment was 283,045 Ethiopian Birr (or USD \$14,152) including cash and in-kind sources. Costs were almost entirely labor. The largest outlay was for de-sedimentation at 87 percent of total costs on average, followed by erosion control (9 percent) and bush fencing (4 percent). If all 162 ponds in our study area were rehabilitated the cost could exceed 46 million Birr; this might be defrayed if communities can donate some of the labor. The high cost of rehabilitation illustrates that poor catchment management has major economic consequences that undermine system sustainability. Cost data also reveal that a small investment in preventing sedimentation via bush-fencing, grazing management, and erosion control would yield high returns in terms of reducing the need for regular, and expensive, de-sedimentation via manual labor.* 

### Background

The Borana Plateau is home to some of the most important rangelands in Ethiopia. The region has supported pastoralists for hundreds of years and livestock are currently sold to domestic and export markets. The Borana pastoral society, however, endures many hardships. The people suffer from high rates of poverty and they are also challenged by poor access to public services as well as degradation of the rangeland environment.

When we began our research project in late 2012 we were tasked with finding opportunities here to improve forage and livestock productivity. We knew this would be difficult because the plateau is overpopulated with people and has been heavily stocked with animals for decades. We decided to use participatory methods to learn what the pastoralists felt were their most important problems and go from there.



*A large sieve-dam structure in a gully on the central Borana Plateau. (Photo credit: Bedasa Eba)*



## Lack of drinking water for people and livestock is the biggest problem

It was clear from participatory assessments that limited access to drinking water, for both people and livestock, was by far the most important problem perceived by the residents of the four Pastoral Associations (PAs) we worked with (i.e., Dikale, Harweyu, Denbala Bedana, and Medecho). Given that we wanted to focus our research on the people's priorities, we searched for ideas to tie together water, forage, and livestock. The answer was ponds.

The central portion of the Borana Plateau is a severely water-limited environment. It does not have rivers, streams, or lakes. The people and livestock depend on two main sources of water: (1) Deep (tula) wells where ground water is lifted by chains of people passing leather buckets to troughs near the surface during dry seasons; and (2) rain-fed ponds accessed for variable periods each year during and after wet seasons. Water quality for human consumption is particularly bad with regards to the pond water. People share pond water with the animals; the livestock stand in the water and drink it directly, while the people collect it in plastic containers. There is no evidence that pond water consumed by people in the pastoral villages is boiled or otherwise treated. This has negative implications for human health.

## Management of pond catchments can be improved

There are hundreds of ponds across the central plateau. They vary in capacity and the catchments are poorly managed. Livestock access to ponds is traditionally uncontrolled and the catchments in the immediate vicinity of the ponds are typically stripped bare of herbaceous vegetation due to intense trampling and heavy grazing. Unprotected soil surfaces then become prone to soil erosion. Then, when the rains come the ponds quickly fill with sediment. Pond holding capacity is markedly reduced by sedimentation and considerable labor is required to clean them out. The sedimentation also impairs water quality for human and livestock consumption. In sum, it is a system that can be much better managed.

We have been aware of a practice used by the Boran for several decades to reserve fodder for calves and sickly livestock during dry seasons. Areas several hectares in size are typically bush-fenced and the forage is allowed to grow unhindered inside for most of the year. The protected sites are referred to as *kalo*. By the time the warm dry-season occurs the general forage availability is very poor outside of *kalo* and livestock must travel long distances to find fodder. Inside the *kalo*, however, forage is abundant and helps vulnerable animals survive, whether by light grazing, hay making, or cut-and-carry methods.

We decided to apply the *kalo* concept to the pond sedimentation problem. The idea was simple: Why not protect the catchments in the immediate vicinity of ponds with bush-fencing that excludes animals from most of the area? Low-impact animal access to the water's edge could still be accommodated using bush-lined corridors. We suspected that the vegetation in the protected portions of catchments surrounding the ponds would quickly recover given that the landscape collects moisture and nutrients. More vegetation would then greatly reduce pond siltation and improve water filtration and hence water quality. The fodder inside the protected zone could be lightly used in dry



*Laborers erecting a bush fence around a pond catchment in Dikale Pastoral Association. (Photo credit: Bedasa Eba)*

seasons in the manner of how *kalo* are already used. The main challenge would be convincing the people to maintain the site protections even during droughts and other times of production system stress.

In previous research briefs we outline the: (1) Ecological effects of site protection on vegetation recovery, as well as (2) our technical experiences in gully repair. Readers are advised to consult these briefs for further information, and they are listed in the back of this publication.

In general, the effects of bush-fencing on vegetation recovery of protected pond catchment areas were impressive. Plant cover increased dramatically and plant species diversity greatly improved; in some cases this occurred after only a few months of protection given that seasonal rains were adequate. It is important to note that the plant recovery was entirely via native species; exotic forage materials have not been necessary in the ecological recovery process.

For erosion control the challenge has been to find techniques that are effective, sustainable, and use local materials at a low cost. We found that sieve dams constructed of local plant materials are especially effective for gully repair, but effort must be made to position sieve dams nearer to where gullies begin on a landscape so that a process of sediment re-deposition can be sustained. Larger gullies can channel massive volumes of water, and the force can easily destroy sieve dams located in the lower reaches of a large gully. Effective gully repair requires a thoughtful approach that starts at the landscape level.

## The three steps of pond catchment rehabilitation: Approaches and estimated costs

Each of the four PAs we worked with nominated one pond catchment for rehabilitation. The rehabilitation process can be broken down into three steps, namely: (1) Fencing the perimeter around the immediate pond catchment and allowing vegetation recovery to occur; (2) digging

out the accumulated sediment in the pond; and (3) repairing gullies and controlling other sources of erosion in the catchment. Each step is briefly described below:

**1. Fencing the pond-catchment perimeter.** Most of the central plateau is well-endowed with noxious bush species because of bush-encroachment processes. This provides a ready source of fencing material, as bush can be felled with hand axes and arranged with the crowns pointed inwards toward the pond to form an almost impenetrable shield that excludes livestock. We employed local laborers (men and women) to bush-fence each site; the effort involved from 200 to 250 person-days of work per catchment. The size of the protected areas of catchments varied from 2 to 20 hectares (Table 1).

Laborers constructing a bush fence, as well as a schematic diagram showing the fencing in relation to livestock access corridors, are illustrated. People can readily access pond water in fenced catchments by simply having “bush gates” or other human-entry points at various intervals along the fence line. Livestock access is allowed via one or more corridors where livestock use is concentrated and controlled by herders. Typically, livestock corridors were situated in areas where environmental impact could be minimized; in cases where soil erosion in access corridors is still a problem “soft pathways” could be “hardened” via placement of stones.

Livestock corridors are important primarily because they prohibit animals from wandering throughout the protected zone and impeding vegetation recovery. Corridors are also necessary because they can restrict animals to a small portion of the pond edge when they drink and this limits the scope for animals to urinate or defecate in the pond. This reduces the likelihood for further contamination of water that people also consume.

Costs for bush fencing were entirely labor and varied from 10,000 to 15,000 Ethiopian Birr (ETB) per enclosed catchment area. Overall, it cost an average of 1,724 ETB (USD \$86) to simply protect one hectare of catchment land; costs per hectare dropped markedly as the size of the protected catchment area increased (Table 1).

**2. Removing accumulated pond sediment.** It is typical—given the lack of pond catchment management—that ponds are packed with sediment. Sediment can be removed by hand labor or heavy machinery. Increased local access to heavy machinery such as bulldozers, backhoes or excavators has occurred as a result of infrastructure development projects. This is an option especially where ponds are sited near roads or towns.

Human labor is the more common approach, however, and laborers are often available. One challenge is the general lack of suitable hand tools such as high quality shovels, picks and wheelbarrows for laborers to use. It is often observed that the pastoralists will rely on

**Table 1. Various characteristics associated with pond-catchment rehabilitation on the Borana Plateau. Cost estimates are in Ethiopian Birr (ETB)<sup>1</sup>**

Site	Catchment Size (ha) <sup>2</sup>	Costs for Bush Fencing <sup>3</sup>		Costs for Sediment Removal <sup>4</sup>		Costs for Erosion Control <sup>7</sup>	Total Cost
		Total	Per ha	Total <sup>5</sup>	Per cubic meter <sup>6</sup>		
Dikale	20	15,000	750	300,000	111	38,590	353,590
Harweyu	2	15,000	7,500	300,000	114	20,540	335,540
Denbala Bedana	4	10,000	2,500	217,000	135	15,560	242,560
Medecho	3	10,000	3,333	167,000	167	23,490	200,490
<b>All</b>	<b>29</b>	<b>50,000</b>	<b>1,724</b>	<b>984,000</b>	<b>124</b>	<b>98,180</b>	<b>1,132,180</b>

<sup>1</sup>Where 20.00 ETB = 1.00 USD.

<sup>2</sup>Estimates based on expert opinion.

<sup>3</sup>Estimates based on 50 laborers per day at a pay rate of 50 ETB per person per day. It took five days each to bush fence the Dikale and Harweyu catchments and four days each to bush fence the Denbala Bedana and Medecho catchments. This equates to 250 person-days each for Dikale and Harweyu and 200 person-days each for Denbala Bedana and Medecho. Variation in cost per hectare is attributable to differences in local environments; the cost per hectare enclosed goes down as the size of the fenced area increases.

<sup>4</sup>Estimates based on 102 laborers working 26 days at Dikale, 94 laborers working 28 days at Harweyu, 70 laborers working 23 days at Denbala Bedana, and 45 laborers working 20 days at Medecho. All days based on a 9-hour schedule. Work includes digging as well as transporting the sediment away from the immediate vicinity of the pond. Estimated volume of sediment removed was 2,704 m<sup>3</sup> (Dikale), 2,632 m<sup>3</sup> (Harweyu), 1,610 m<sup>3</sup> (Denbala Bedana), and 1,000 m<sup>3</sup> (Medecho; includes silt and rock). The percent of total sediment removed was 95 percent (Dikale and Harweyu) versus 100 percent for Denbala Bedana and Medecho. The volume of sediment removed per person per working day was approximately 1 m<sup>3</sup>.

<sup>5</sup>The project paid for 30 percent of all labor costs while the remainder was donated by the communities (the project had insufficient funds to cover all labor costs). The figures here thus estimate the total cost if all labor had been paid for.

<sup>6</sup>The overall average of 124 ETB per cubic meter is comparable to the figure of 200 ETB from expert opinion (Demisachew Tadele, 2014). The figure will vary with the type of sediment; clay and stony soils will require more effort than loamy or sandy soils. The figure is also subject to community negotiation.

<sup>7</sup>See Table 2 for details.

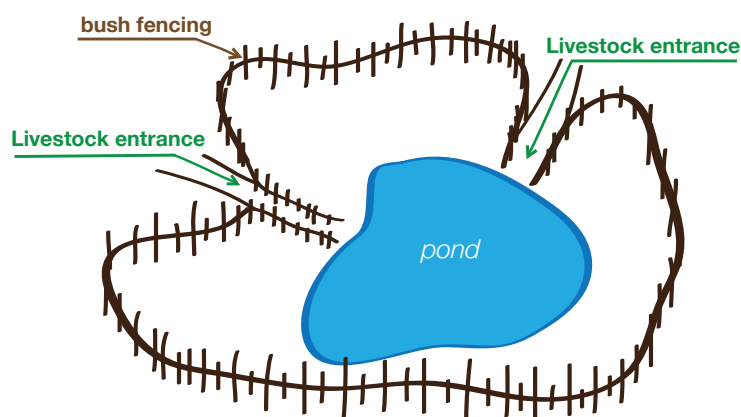
farming tools and their own hands to get the job done. We employed local laborers (men and women) to clear the sediment from each pond; the effort involved from 900 to over 2,600 person-days of work per pond. The volume of sediment removed varied from 1,000 to over 2,700 cubic meters (Table 1).

The very high costs of de-sedimentation via manual labor are shown in Table 1. Overall, one laborer using locally available tools could remove 1 cubic meter of sediment in a 9-hour workday, and on average this cost 124 ETB (USD \$6.20). Because the project had insufficient funds to cover all anticipated labor costs, communities ended up donating 70 percent of the required effort. Both cash and in-kind contributions, however, were added to yield the estimated total costs in ETB.

**3. Erosion control.** Both gully erosion and sheet erosion contribute to pond sedimentation. However, one or two large gullies can easily contribute the vast majority of sediment. Vegetation recovery attributable to the bush fencing can help mitigate sheet erosion in the protected zones; use of dams and trenches to control other forms of erosion constitutes other approaches.

Erosion control using dams and trenches is potentially the most complicated step in pond-catchment rehabilitation. This is simply because this step requires an inventory and assessment of all gullies and other erosion problems in catchments and then decisions must be made concerning which areas must be prioritized for attention. Then an approach for each must be decided upon as affected by the size of the problem area and landscape position.

Details concerning such assessments are found in other research briefs. On page 1 we will illustrate a large sieve dam, one of the primary tools to help repair gullies. An inventory of erosion control methods for each site is summarized in Table 2. Sieve dams are the most common intervention for the deep gullies. The cost for any one type of intervention is modest because only the labor of a few people



*Schematic diagram of a bush-fenced enclosure with corridors for livestock access to the pond edge. (Illustration credit: Bedasa Eba)*

is required over a short period of time. The materials used to pack sieve dams are the stumps, stems, and branches of abundant local plants hence the cost for materials is virtually nil.

Despite the complexities of such erosion-control interventions the costs are low when compared to the costs for de-sedimentation (Tables 1 and 2). Erosion control interventions are essential, however, for reasons previously noted.

## Conclusions

When the overall outlay is considered, it is remarkable that the average cost for catchment rehabilitation in the immediate vicinity of the ponds was 283,045 Birr (or USD \$14,152) including cash and in-kind sources. Costs were almost entirely for labor. The largest outlay was for de-sedimentation at 87 percent of total costs. This was followed by erosion control interventions (9 percent) and bush fencing (4 percent).

**Table 2. Estimates for various erosion-control interventions associated with pond-catchment rehabilitation on the Borana Plateau. Cost estimates are in Ethiopian Birr (ETB)<sup>1,2</sup>**

Site	Initial Size Of Fenced Catchment (ha)	Sieve Dams		Check Dams		Bench Terraces		Trenches		Grand Total Cost
		No.	Cost	No.	Cost	No.	Cost	No.	Cost	
Dikale	20	89	35,600	14	1,400	3	150	24	1,440	38,590
Harweyu	2	45	18,000	12	1,200	4	200	19	1,140	20,540
Denbala Bedana	4	38	15,200	0	0	0	0	6	360	15,560
Medecho	3	56	22,400	4	400	9	450	4	240	23,490
<b>All</b>	<b>29</b>	<b>228</b>	<b>91,200</b>	<b>30</b>	<b>3,000</b>	<b>16</b>	<b>800</b>	<b>53</b>	<b>3,180</b>	<b>98,180</b>

<sup>1</sup>Where 20.00 ETB = 1.00 USD.

<sup>2</sup>See other research briefs listed under “further reading” for technical details on gully interventions. Estimates assume a per-unit cost of 400 ETB for each sieve dam, 100 ETB for each check dam, 50 ETB for each bench terrace, and 60 ETB for each trench. These are crude estimates primarily founded on labor costs, as local construction materials are freely found by scavenging. Costs will vary depending on local labor negotiations as well as the relative difficulty in working different soil types and time needed to gather suitable construction materials in different environments.

The high cost of rehabilitation illustrates that poor catchment management has major economic consequences that undermine system sustainability. For example, the four PAs where this work was conducted have a total of 162 ponds (large and small ponds combined). If we assume the average, fenced catchment area and pond size is similar across our study area to what we dealt with on our project, the implication is that this would cost on the order of 46 million ETB or USD \$2.3 million overall.

Importantly, the data also reveal that a small investment in preventing sedimentation via bush fencing, grazing management and erosion control would yield very high returns with respect to negating the need for regular and costly de-sedimentation using manual labor. One might propose that use of heavy machinery could be a viable alternative to reduce de-sedimentation costs via labor, but this is unlikely.

Expert opinion (Demisachew Tadele, 2014) reveals that once costs for hourly equipment rental and the high rates of fuel consumption are considered, costs of de-siltation via labor and heavy machinery are broadly similar. In addition, reliable access to heavy machinery can be a problem and many ponds are distant from roadways. The local presence of heavy machinery also varies as major road-infrastructure projects come and go.

Although the costs of pond-catchment rehabilitation are daunting, the benefits of doing so are numerous in terms of enhancing human welfare and system sustainability. Perhaps the most realistic and financially viable approach is to undertake interventions whereby communities make major in-kind contributions to the process. It is conceivable that some communities could contribute half or more of total project costs via the provision of free labor.

A more serious constraint, however, is getting communities to commit to a fundamental change in their natural-resource management behavior. First and foremost, the integrity of bush-fenced catchment enclosures must be respected in all years—even during droughts when forage demand is high and forage supply is scarce. Recent observations suggest the people may be willing to do this, but the pastoralists and their leaders require consistent support and guidance from development agents and government to make such a transition a reality. 🐄

## Further Reading

Coppock, D.L., S. Tezera, B. Eba, J. Doyo, D. Tadele, D. Teshome, N. Husein, and M. Guru. 2014. Sustainable pastoralism in Ethiopia: Preliminary results from participatory community assessments on the north-central Borana Plateau. Research Brief RB-16-2014, Feed the Future Innovation Lab for Collaborative Research on Adapting Livestock Systems to Climate Change. Colorado State University, Fort Collins, CO, USA. <http://lcccrsp.org/wp-content/uploads/2011/02/RB-16-2014.pdf>

Eba, B., J. Doyo, D. Tadele, D. Teshome, A. Defar, S. Tezera, B. E. Norton, and D.L. Coppock. 2015. Enclosures for rehabilitating pond catchments and implications for grazing management on the Borana Plateau. Research Brief RB-23-2015. Feed the Future Innovation Lab for Collaborative Research on Adapting Livestock Systems to Climate Change. Colorado State University, Fort Collins, CO, USA. 5 pp. <http://lcccrsp.org/wp-content/uploads/2011/02/RB-23-2015.pdf>

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*Project: Sustainable Pastoralism on the Borana Plateau: An Innovation Systems Approach*

*Principal Investigator: D. Layne Coppock, Utah State University*

*This project is focused on the study and testing of best-bet land and livestock interventions that can move the Borana pastoral system back towards sustainability. These efforts will consider livestock herd diversification, improvements for forage production, changes in common-property management, as well as pastoral livelihood diversification. A partnership including Utah State University, the Oromia Agricultural Research Institute (OARI), Managing Risk for Improved Livelihoods (MARIL PLC), and other stakeholders will be forged to help meet project objectives.*



**Feed the Future Innovation Lab for Collaborative Research on Adapting Livestock Systems to Climate Change is dedicated to catalyzing and coordinating research that improves the livelihoods of livestock producers affected by climate change by reducing vulnerability and increasing adaptive capacity.**

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