



Mathenge / Promi / Mrashia

Prosopis juliflora

Field handbook – Identification, impacts & management

The socio-economic and environmental impacts as well as the sustainable management of *Prosopis juliflora* in Eastern Africa has been the focus of the Woody Weeds project (2015 – 2021) and of several follow-up projects in Kenya and Tanzania.

This field guide builds upon the scientific outputs of those projects and includes principles and materials that are used by the project team to inform diverse stakeholder groups when designing integrated landscape management plans.

The research and implementation of the projects, as well as the development and the printing of this field guide have been financially supported by the Swiss Agency for Development and Cooperation, the Swiss National Science Foundation and the Darwin Initiative.



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Introduction

Prosopis juliflora, known locally as Prosopis, Mathenge, Promi, Mrashia or other, is a tree originally from Central and South America that is one of the most harmful invasive species in the world. It already dominates tens of millions of hectares in Eastern Africa and continues spreading rapidly.

In the beginning, when Prosopis just establishes in a new area, it can have some benefits, but when it becomes abundant, it negatively affects the environment and peoples' lives. It strongly reduces the availability of many natural resources used by local communities, such as water and grazing land. Therefore, people in areas where Prosopis is abundant want it managed or removed.

This field guide provides information on the identification of Prosopis, its impacts as well as management strategies and practices that can be implemented by people in areas where Prosopis has already established, or in areas that are at risk of becoming invaded by Prosopis.

Biological invasions

Woody plant species (i.e., shrubs and trees) have been introduced in many parts of the world to provide benefits, such as soil stabilisation, re-greening, shade, windbreaks, availability of wood or fodder. However, some of those species are among the worst invaders, causing widespread economic and environmental damage. Among the reasons for the spread and large impacts of such species is the absence, in the areas where they have been introduced, of natural enemies (insects and fungi) that feed on them. In the region of origin of these species, such natural enemies contribute significantly to the control of the spread and growth of the plants.

Prosopis was introduced in Eastern Africa in the 1960s, mainly as a windbreak in degraded habitats and to provide wood and timber. Nowadays, it is widely established and causes loss of grazing land and of water. Livestock, human activities, and water contribute to spreading *Prosopis* seeds to new areas, and there are no native insects or fungi in Eastern Africa that help to slow down its spread.

How to identify prosopis

Prosopis from a distance

Prosopis juliflora is a thorny tree or shrub that has leaves all year round (evergreen), with branches that bend down towards the twigs, often forming a drooping canopy.

By contrast, native *Acacia* (*Vachellia*) species have branches that are either horizontal or growing upward, allowing to see the stem where the branches are attached.

Prosopis trees usually have several stems and often grow together as dense bushes that can cover a large area.

Prosopis reaches up to a height of 3 – 5 meters (old trees can be 10 – 15 meters tall) and is typically found in dry grassland or in *Acacia* savanna, but also in other habitats such as agricultural land, wetlands or settlements.



Typical appearance of Prosopis trees and shrubs. Branches droop and the attachment to the stem is hidden.

Details of Prosopis

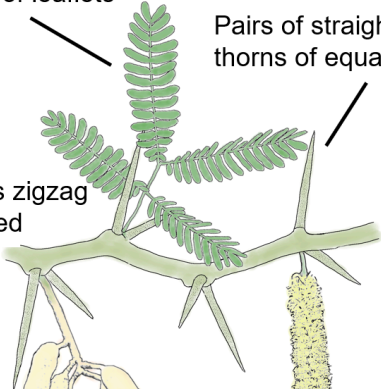
- More leaflets per leaf than African Acacia species, often more than 15 pairs;
- Pairs of straight spines that are equal in size;
- Young shoots tend to zigzag between nodes where leaves and spines grow;
- Flowers are longer than most native close relatives;
- Pods are glossy and shinier than most native species.



Often more than 15 pairs of leaflets

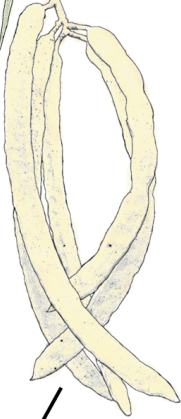
Pairs of straight thorns of equal size

Twigs zigzag shaped



Longer flowers than most native species

Glossy and shiny pods



Which species look similar?

Native *Acacia* species have branches that either grow horizontal or upward, which allows one to see the stem where the branches are attached. Spines do not occur as pairs of equal length, but either not as pairs or as pairs of unequal length. In some species the spines are curved. Flowers are shorter and pods are not as shiny. With few exceptions, native *Acacia* (*Vachellia*) trees do not grow in thickets.

Ambatch (*Aeschynomene elaphroxylon*) seedlings and larger plants look similar to *Prosopis*, but the flowers are large and simple and the branches have small spines. The underside of the central stalk of each leaf has small hooks and the leaflets do not occur as pairs. Ambatch grows along or in standing water.



Many native tree species have branches that either grow horizontal or upward, which allows one to see the stem where the branches are attached. With few exceptions, native Acacia (Vachellia) trees do not grow in thickets. The pictures above show trees that resemble Prosopis, but that are not Prosopis.



Flowers of native *Acacia* (*Vachellia*) species such as *A. nilotica* (gum arabic tree), *A. tortillis* (umbrella thorn acacia) and *A. xanthophloea* (fever tree) are round, while the leaves and spines are different from *Prosopis juliflora* too. Ambatch (lower right) has single, large flowers, spines distributed on the stem and leaflets don't appear as pairs.

Image sources: Ambatch Wikipedia: J.-N. Labat, *Vachellia xanthophloea* :Wikipedia: Amada44, *Vachellia nilotica*: Wikipedia: Varinder Naturaphile, *Vachellia tortillis*: Wikipedia: Dinesh Valke

Biology and ecology of Prosopis

Prosopis can grow in very dry areas as a result of its deep tap root that allows it to access deep ground water. The dominant Prosopis species in Eastern Africa, *Prosopis juliflora*, is evergreen.

The trees **coppice** easily after aboveground parts are cut, for example for making charcoal, and the new shoots can flower and set seed within less than a year.

Prosopis can be spread by humans, animals and water. **Humans** may sell seeds or plant young trees, which can lead to the establishment of Prosopis in areas where it didn't occur before.

Animals often eat pods, which contributes to the spreading of the species when seeds are defecated; this can lead to new infestations along pathways of animal movement (including along roads and livestock and wildlife migration routes) or re-infestation of land that has been cleared of Prosopis. **Flooding**, for example due to changes in water levels of lakes or heavy rain, can spread the seeds over a large area, resulting in new infestations.



Livestock and humans can spread Prosopis seeds. If aboveground parts are cut, the trees coppice easily.

Impacts of Prosopis

Prosopis increases the availability of wood and honey production, which benefits some people in the community. However, there are many negative impacts of Prosopis on the environment and rural livelihoods. The negative impacts become increasingly severe as the species spreads and grows denser. Negative impacts include:

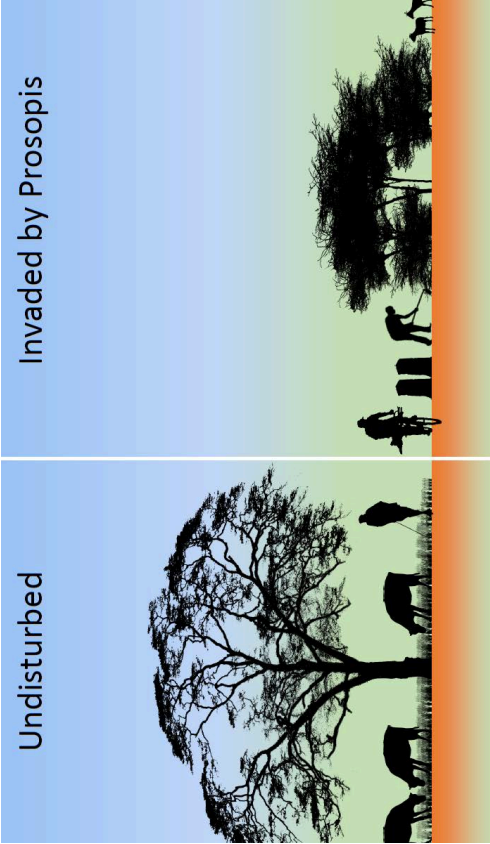
- Prosopis displaces native grasses, flowering plants and trees;
- Prosopis reduces availability and accessibility of grassland and fodder for livestock;
- Prosopis consumes a lot of water throughout the year because it is evergreen and has deep roots. It can consume up to 36 litres of water per stem per day, which strongly reduces the availability of water and lowers the groundwater table;
- Prosopis thickets block access to surface water and grazing land and offer hiding places for predators;
- The reduction of fodder and water lowers the number of cattle per household that the landscape can sustain;

- The loss of grazing land (particularly dry season grazing land) leads to conflicts among land users;
- The presence of Prosopis increases the cost of cultivating land for agriculture;
- Prosopis increases the density of malaria-transmitting mosquitos.

Due to these negative impacts, people in invaded areas are willing to pay for the management of Prosopis, especially because they are aware of the impacts on grazing and water resources.



People make charcoal to compensate for loss of traditional income sources in invaded land.



As a result of prosopis invasion people's major income source shifts from livestock and agriculture to wood products.

Prosopis management on a landscape scale

Biological invasions are dynamic: invasive species density increases over time, and they invade new areas. Therefore, management objectives and related practices need to consider the current distribution and the possible spread of Prosopis:

Prevention measures are needed to protect areas where Prosopis is not yet present. This is the cheapest and most cost-effective intervention as it reduces the spread of Prosopis to unaffected areas, for example through livestock, humans or water.

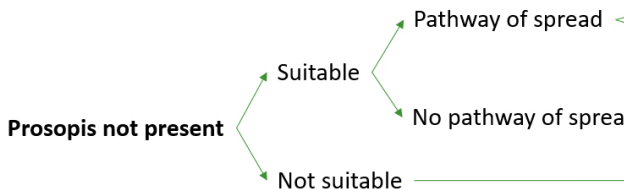
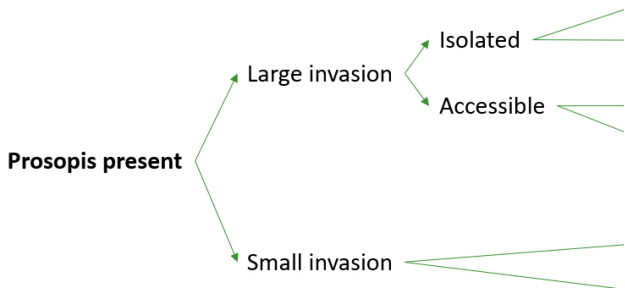
Early detection and rapid response (EDRR) is advisable in areas where Prosopis has already established, but only at low densities. The objective is to detect Prosopis early and remove all trees so that the area is cleared from Prosopis. In such cases, it is important that management practices (see below) kill the trees. Emergence of new seedlings must be monitored as seeds may survive in the soil for several years. EDRR is also cost-effective as it clears newly invaded areas from Prosopis when only a few trees have established.

Control is recommended in areas where Prosopis

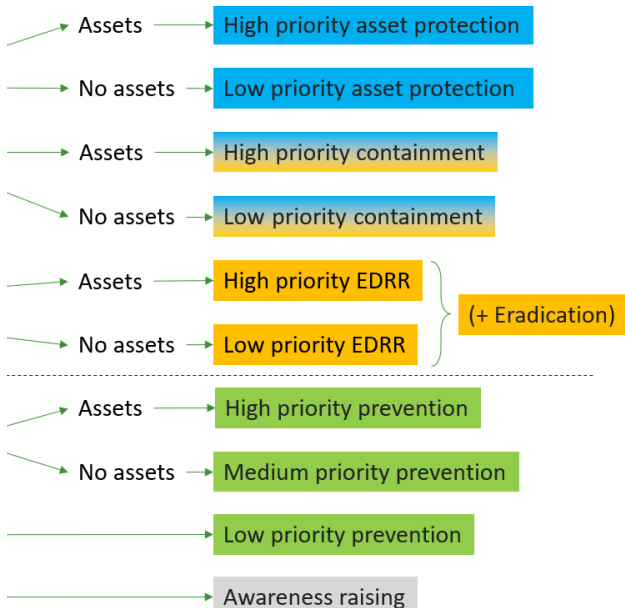
is already widespread and abundant. In such areas, it is impossible to remove *Prosopis* completely, but control helps at least to protect valuable assets such as dry season grazing land, watering points, and others. Control is often very costly, as it requires a lot of labour and/or equipment (for example, heavy machinery, or chemicals). Control practices must ensure that the trees being treated are killed.

Containment of *Prosopis* spread is needed when the removal of all *Prosopis* trees is no longer possible, but its spread to other areas should be prevented. Containment is more labour-intensive than other strategies. It is important that the containment practices being used kill the *Prosopis* trees. Milling seeds for flour to kill them, or using biological control, are important options to reduce the spread of *Prosopis* to new areas.

The management objectives outlined above must be selected depending on (a) the abundance of *Prosopis*, (b) the presence of pathways of spread, and (c) the presence of important assets. The diagram on the next pages may aid decisions about management aims for a defined part of a landscape. Stakeholders in charge of implementing management practices, must participate in the identification of management objectives.



The selection of appropriate management objectives depends on the presence and abundance of Prosopis in an area. Whether an area is suitable for Prosopis may change if the climate changes and large or small invasions are defined by the ability to remove Prosopis entirely from



the area. Management objectives related to Prevention, Early Detection and Rapid Response (EDRR) and Control (including asset protection and containment) are indicated with green, orange and blue boxes. Multi-coloured boxes are situations with a combination of objectives.

Effective Prosopis management practices

Various concrete management practices are available to achieve the management objectives outlined above (Prevention, EDRR and Control). When selecting a practice, consideration should be given to the management objective, the feasibility with respect to the size of the area to be managed, the costs and benefits of the practice as well as the availability of required resources, including funds, labour force, tools and skills. In most cases, a combination of practices is needed to achieve a particular management objective.

Surveillance can be a regular, systematic checking of an area to spot new Prosopis seedlings or trees as quickly as possible and remove them as long as it is still easy to do so. People engaged in other activities, e.g., livestock herding or wildlife conservation, can be trained in finding and recording new occurrences of Prosopis. Ideally, surveillance is conducted by people who are living in or regularly travelling within the area. For that reason, awareness creation and capacity building

among these people are key for surveillance to be successful. The following steps are needed to set up surveillance:

- Define the area to be constantly surveyed, e.g. dry season grazing land or community conservancy. Also consider surveillance of pathways of spread into the selected area (e.g. along roads, livestock routes, wildlife migration corridors, or rivers);
- Agree on who will survey (rangers, pastoralists and/or community members). Agree to whom any suspected cases of Prosopis establishment should be reported;
- Train people who will remove Prosopis in how to identify Prosopis and how to permanently remove seedlings and trees;
- Repeatedly visit sites where trees have been removed and timely remove newly emerging seedlings. The best period is when the soil is moist, because at least 30 cm of the roots must be removed to permanently remove a seedling.

Prosopis abundance

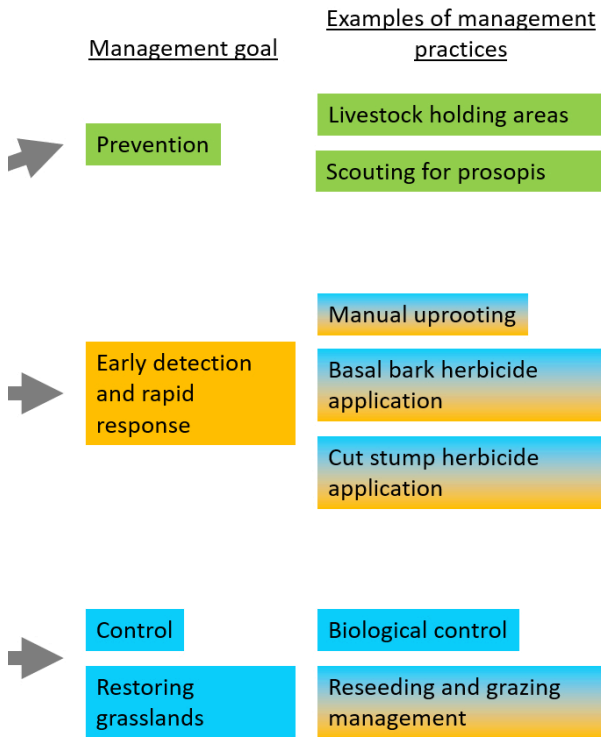
Not present

Few trees, sparse

Many trees, dense



Selection of management practices for identified goals depends on the presence and abundance of Prosopis in an area. Prevention (green), early detection and rapid response (orange), and control and grassland restoration



(blue) can be achieved through different management practices, indicated with the same colours. Practices with a colour gradient are suitable for early detection and rapid response as well as for control and grassland restoration.

Livestock holding areas are used to make sure that livestock that has been in an invaded area does not spread Prosopis seeds into uninvaded areas. Seeds might take up to 7 to 10 days to transit the animals' digestive system before being defecated. Here are a few recommendations for the setting up of livestock holding areas:

- Holding areas can be set up in areas identified by a grazing committee;
- To keep livestock together and/or protect it from predators, mobile or permanent bomas can be established;
- Prosopis seedlings must be removed continuously from the holding area;
- Plan for availability of water and fodder for the livestock kept in holding areas.

Manual uprooting is a labour-intensive practice to remove Prosopis. Therefore, it can only be performed for relatively small invasions unless a large number of labourers is available. A few aspects to consider when implementing this practice:

- Prosopis seedlings or young plants, up to a height of 1 metre, can be removed using a “tree popper” or tree puller, which uproots the plants;

- Larger plants (higher than 1 metre) need to be removed using a machete. At least 30 cm of the rootstock needs to be removed to kill the plant;
- Any seedlings emerging following removal of the trees must be removed, ideally just after the rains when the soil is moist;
- Areas where Prosopis has been uprooted should be visited after subsequent rain seasons to check for new plants.



Removal of Prosopis, especially of individual trees or small infestations, can be achieved by mechanical and chemical means. These include manual uprooting, the use of a “tree popper” to pull small trees from the ground, or cut stump and basal bark application of herbicides.

Burning can lead to some 60-70% mortality of Prosopis trees. Prosopis is quite fire-resistant and can survive if there is not enough grass underneath that fuels the fire. However, communities in Eastern Africa have developed methods that increase the impact of fire on Prosopis:

- Cut stems at ground level and expose the rootstocks by removing the soil down to ca. 50 cm;
- Fill the hole around the rootstock and cover rootstocks with dry branches or other flammable material. Light a fire;
- Maintain fire by adding wood to the rootstock.

Chemical control is a faster and less tedious practice and can therefore be used for larger invasions. There are two types of chemical control: (1) Basal bark treatment, where an herbicide is applied to the base of each stem (from 0 to 75 cm above ground and around the entire circumference of the stem) with a brush or a knapsack sprayer. (2) Cut-stump treatment, where stems are cut using a chainsaw and the stumps are painted with an herbicide immediately after the cutting. Recommendations for chemical control:

- Use appropriate personal protective equipment and follow the instructions provided on the

pesticide label for rates of application and re-entry intervals after application;

- Select suitable herbicides, use the correct application method, identify the correct time of application, and make sure to conduct the required follow up actions after spraying;
- Persons recruited to aid management efforts must be trained on the safe use of specific herbicides designated for management and control of Prosopis;
- If chemical control is happening in your area, inform your neighbours to stay away from the location while the herbicide is being applied to Prosopis stems or rootstocks.

Biological control consists of releasing natural enemies (mainly insects) that only attack the invasive Prosopis trees. Some insects feed on the seeds, which reduces its ability to spread. Other insects are tying the leaves together, which reduces the plant's photosynthesis, growth and seed production. Biological control is very efficient and does not require tedious labour. Therefore, it is the only option to manage very large invasions. Biological control of Prosopis has been approved



Cutting stems to immediately apply herbicide to the stump and herbicide application to the entire bark at the base of trees are effective, safe methods to kill Prosopis.

by several national governments, with clear impacts reported in Australia. Steps for biological control:

- The national government evaluates the needs for biological control;
- If additional research to that done in Australia and South Africa is needed, the government will conduct research, or ask experts to do so. The government can then take an informed decision on whether a biological control agent should be released or not;
- Once the biological control agent has been approved for field release by the government, it will be released at different locations; the biological control agent will establish, multiply and damage the invasive Prosopis trees;
- In contrast to other management practices, local stakeholders do not have to invest time or labour in biological control, because biological control agents can multiply and spread by themselves.

Restoration of grassland or cropland is a very important follow-up measure after any control practice. In the case of grassland, a well-designed grazing management plan, including rotational grazing, is required to prevent damage due to overgrazing. In those cases where the rangeland



Good grassland restored on land that was invaded by Prosopis after the trees were killed using basal bark and cut stump herbicide treatments (upper and lower images).

has been degraded for a long time, reseedling with native species may be needed. On cropland, Prosopis seedlings should be removed regularly and livestock should not be allowed in, except when coming out of a holding area as described above, to avoid introduction of new Prosopis seeds. Recommendations for restoration or rehabilitation:

- Rangeland restoration should be based on a carefully designed grazing management plan which is adopted by all users of the rangeland;
- Seeding of native species should be done before the onset of rains to ensure good establishment;
- Prosopis seedlings should be removed regularly;
- To restore a dense vegetation, heavily degraded rangeland may need some time (e.g., 1 – 2 years) to recover either with no or with very limited grazing;
- Immediately after restoration of the grass and herbaceous layer, the grazing management plan should be enforced;
- Prosopis seedlings should be removed regularly to avoid establishment.

Classical biological control

Classical biological control aims to reduce the abundance and thus the impacts of invasive alien species by introducing insects or fungi from the region of origin of the invasive plant. Such biological control agents coexist with the target species in the region of origin, where they contribute to its control. This natural control does not occur in the introduced range because native insects or fungi do not attack alien species.

Release of biological control agents must be approved by national authorities. For approval to be granted, research using internationally accepted testing procedures must show that the biological control agents will only attack and survive on the targeted invasive plant. In these experiments, researchers test whether the insect feeds and survives on numerous plant species. Only insects that survive solely on the targeted species are selected as biological control agents.

Biological control of weeds is a safe, practical and low-cost method that is applicable especially in highly infested areas where other methods are not feasible anymore or prohibited. This method has been used hundreds of times worldwide and no

unpredictable or lasting damage to other plant species has been observed.

Several insect species have been released in South Africa and Australia to control *Prosopis*, including the seed-feeding beetle *Algarobius prosopis* and the leaf-tying moth *Evippe* sp. #1. The moth is a particularly interesting insect, as it contributes to limiting the spread and impacts of *Prosopis*.



The bruchid beetle Algarobius prosopis and the leaf tying moth Evippe sp. #1

Image sources: Algarobius: Bob Barber, Bugguide; Evippe: ARC-PHP (South Africa)

Myths and misconceptions

1. Utilisation of Prosopis is a (sustainable) form of management

Utilisation of Prosopis biomass has been promoted by governments and NGOs, but research has shown that it does not lead to reductions in spread or abundance of this invasive tree. This is largely due to coppicing of Prosopis if the utilisation does not kill the trees. Sustainable, lasting management requires killing of the whole Prosopis plants, including the rootstocks, through uprooting or targeted use of herbicides.

2. As we cannot eradicate Prosopis, we should make the best out of it

In areas where dense Prosopis occurs and can't be entirely removed, people will adapt by making money of the species. However, most stakeholders would prefer livelihoods without the impacts of Prosopis and it is impossible to eradicate Prosopis once it has become widely established. It is therefore important to prevent Prosopis establishing in uninvaded land and to remove sparse Prosopis where it is possible.

3. Prosopis is good for climate mitigation and carbon sequestration

Like all plants, Prosopis stores carbon from the air. However, research has shown that restored grassland stores as much or more carbon than Prosopis and carbon stored in Prosopis is released when charcoal is made. Moreover, grassland provides more benefits than Prosopis, including fodder for livestock, protection against soil erosion, medicinal plants and increased biodiversity.

4. Management of Prosopis should focus on areas with highest densities

People living in areas with dense Prosopis would prefer Prosopis removed from their area, but this is rarely possible and very expensive and the former land use benefits are unlikely to be restored. Thus, managing Prosopis through Prevention and Early Detection and Rapid Response (EDRR) is more cost-effective and protects existing benefits, livelihoods and culture that depend on uninvaded land.

5. Prosopis is poisonous and causes diseases such as Malaria and Leishmaniasis

Prosopis is not poisonous, but secondary infections associated with the injuries caused by their spines and their consequences can be serious. In addition, Prosopis invasion increases densities of insects which can transmit human diseases, such as Malaria or Leishmaniasis.

Find out more

This field guide builds upon the scientific outputs and information materials of the Woody Weeds project (2015 – 2021), as well as several follow-up projects in Kenya and Tanzania.

Partners:

Switzerland – CABI, Center for Development and Environment of the University of Bern (CDE)

Kenya – CABI, Centre for Training and Integrated Research in Asal Development (CETRAD), Kenya Forest Research Institute (KEFRI), Department of Land Resource Management & Agricultural Technology (LARMAT) of the University of Nairobi

Ethiopia – Water and Land Resource Centre (WLRC), Haramaya University

Tanzania – Tanzania Forestry Research Institute (TAFORI), Sokoine University of Agriculture, Tanzania Natural Resource Forum (TNRF), Community Research and Development Services (CORDS), Tanzania Wildlife Authority (TAWA)

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