Module 2: Management options for exclosures

This module of the training material presents the proposed management options and discusses the benefits and recommended steps; social, environmental, institutional, and economic considerations; stakeholders; opportunities and assumptions; costs and timing of each management option.

2.1. Constructing physical SLM measures within exclosures and integrating them with other biological measures

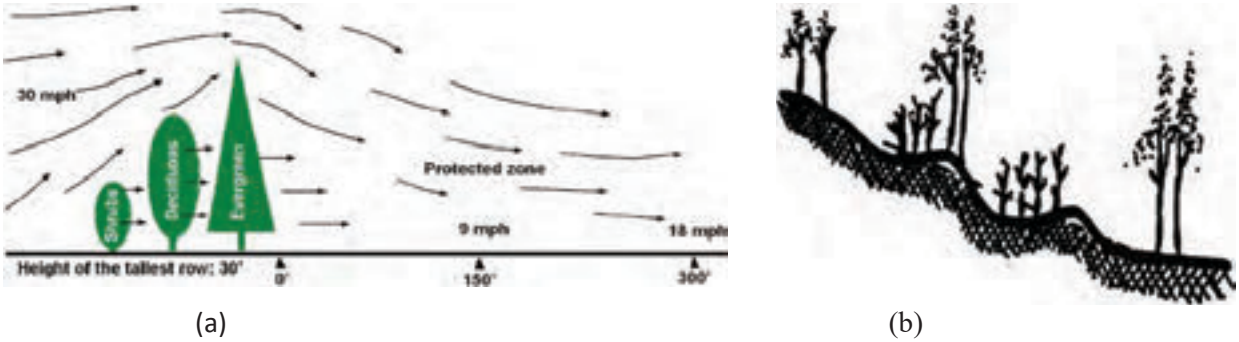
2.1.1. Benefits and recommended steps

Constructing physical SWC measures, such as terraces, trenches, and soil and stone bunds within exclosures can support the regeneration of native plant species (Fig. 4). These can improve the quality and quantity of livestock feed that can be harvested from the exclosure (Fig. 5). This, in turn, improves livestock production and increases the benefits obtained by local communities.

Figure 4: Physical SWC measures implemented in agricultural landscape (***Photo***: Wolde Mekuria).

Figure 5: Regeneration of grass species following establishing exclosures (***Photo***: Wolde Mekuria)

Physical SWC measures can be made more effective by integrating them with biological conservation measures, such as by sowing grasses and planting forage trees on banks of bunds. In this line, the fourth livestock development project in Ethiopia considers the integration of grass and fodder trees within soil and water conservation as one of forage and pasture development strategies (Alemayehu 2006). This practice or strategy can also support to stabilize existing physical SWC measures and provides several positive contributions. For example, fodder trees planted in the banks of SWC measures serve as wind breaks and control soil erosion (Fig. 6), stems and branches gives us fuelwood and timber (Fig. 7) while roots, leaves, flowers and bark are used as drugs. Also, some trees, known as leguminous trees, improve the soil by fixing nitrogen from the air, making it available to livestock. For livestock farmers, the tree's most important role is the use of leaves, flowers, tender twigs, seeds, fruits and pods as feed or fodder for the animals (Fig. 8), and food for the farmers themselves. In dry tropical areas, the case in CRV of Ethiopia, where rainfall is low and therefore grasses for feeding animals are seasonally scarce and low in quality, you can sometimes feed your animals almost entirely on fodder trees.



(a) (b)

Figure 6: Trees serving as wind break (a: credit: Bijay Tamang) and controlling soil erosion (b: Smith 1995)

Figure 7: Leaves and stems of trees serving as a source of fuelwood (Smith 1995)

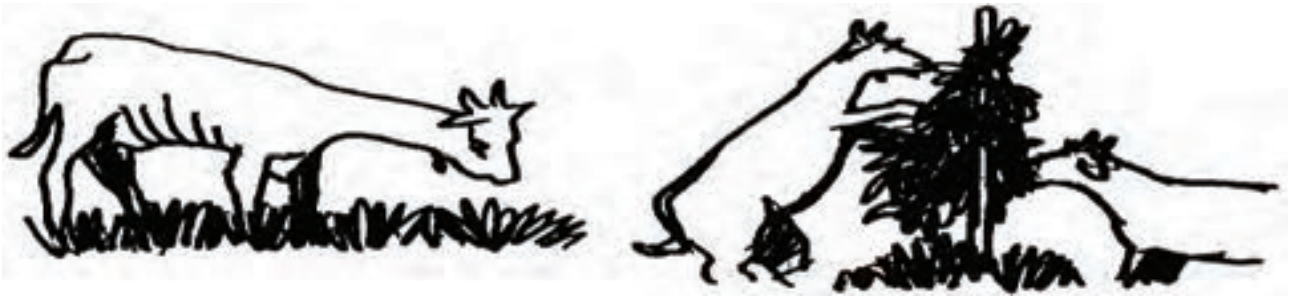


Figure 8: Animals feeding tree fodder together with grasses (Smith 1995)

To implement this management option, first construct the physical SWC measures within exclosures and in agricultural landscapes, then plant grasses and trees on the banks of bunds (Fig. 9). Other necessary steps include identifying grass varieties and fodder trees appropriate for the area, raising seedlings of fodder tree species, sowing grass species and planting fodder trees. Figure 10 summarizes some common criteria and sub-parameters within a criterion for selecting grass and multipurpose fodder trees. Grasses and forage trees that are tested in the fourth livestock development program of Ethiopia (Alemayehu 2002) and found successful are summarized in Table 6. This information provides smallholder dairy farmers an opportunity to use these materials as a useful starting point for improved forage programs because of their adaptability and proven forage value (Alemayehu 2002; Lukuyu et al. 2007).

To help ensure equal benefit sharing and to prevent conflicts, it is recommended that the CWT determine the total amount of yield, the total number of beneficiaries, the amount of yield per beneficiary, and the schedule for harvesting and distributing yields.

Figure 9: Forage trees have been planted on the banks of a soil bund to help stablize it and increases access to livestock feed (***Photo***: Wolde Mekuria).

Biomass yield	Amount of leaves and soft twigs per cutting
Ease of propagation	Easy to propagate by seeds, seedlings, and cuttings; Easy to collect seeds and raise seedlings; Labour requirement
Adaptability	Easy to grow on wide range of soil types, fertilities and moisture regimes; Drought resistance
Growth and re-growth potential	Growth rate after establishment; Re-growth potential after frequent cutting or looping
Feed value	Palatability by animals; Improvement of body condition, growth and milk production; Improvement of intake of straw diets; Improved health of animals
Multi-functionality	Use for Timber, poles and other constructions; Fuel wood; Fence; Medicinal value; Shade tree; Source of honey; Farm implements
Life span of the tree	Ability to stay for many years after planted under recurrent cutting
Compatibility	Do not compete with crops on available soil nutrients and moisture; Improve soil fertility; Improve growth of below canopy annual and perennial crops

Figure 10: Criteria for selecting grass and multipurpose fodder trees (Abebe 2008).

Table 6: Forage crops that can be grown in Ethiopia and suitable climatic and soil characteristics for their cultivation (Alemayehu 2002; Lukuyu et al. 2007)

Types of Forage	Rainfall (mm)	Altitude (m)	Planting material
• Napier or Elephant grass (Pennisetum purpureum)	• Over 1500	• Up to 2000	• Cuttings
• Rhodes grass (Chloris gayana)	• Over 250	• 600 to 2000	• Seed
• Buffel Grass (Cenchrus Ciliaris)	• Below 2000	• Above 250	• Seed
• Guinea Grass/Panic (Panicum maximum)	• Below 2000	• Above 600	• Seed
• Setaria (Setaria sphacelata)	• Below 2000	• Above 800	• Seed
• Phalaris (Phalaris aquatica)	• Below 2400	• Above 400	• Seed
• Lablab (Lablab purpureus or Dolichos lablab)	• 200 to 2500	• Up to 1000	• Seed
• Siratro (Macroptilium atropurpureum)	• Below 2000	• Above 500	•
• Axillaris (Macrotyloma axillare)	• Below 2400	• Above 500	•
• Verano (Stylosanthes hamate)	• Below 2400	• Above 500	•
• Seca (Stylosanthes scabra)	• Below 2400	• Above 500	•
• Cook (Stylosanthes guianensis)	• Below 2400	• Above 600	•
• Wynn Cassia (Cassia rotundifolia)	• Below 2400	• Above 400	•
• Cow pea (Vigna ungulculata)	• Below 2400	• Above 350	•
• Common vetch (Vicia dasycarpa)	• 1500 to 3000	• Above 400	•
• Native clover (Trifolium species)	• Above 2000	• Above 500	•
• White clover (Trifolium repens)	• Above 2000	• Above 500	•
• Maku Lotus (Lotus pedunculatus)	• Above 2400	• Above 600	
• Greenleaf/silverleaf desmodium (Desmodium intortum/ Desmodium uncinatum)	• 850 to 1500	• 800 to 2500	• Seed and cutting
• Lucerne or Alfalfa (Medicago sativa)	• 500 to 1000	• Up to 2400	• Seed
• Trichandra (Leucaena trichandra)	• 1100 to 2000	• 200 to 2500	• Seed
• Diversifolia (Leucaena diversifolia)	• 1500 to 3500	• 500 to 2500	• Seed
• Pallida (Leucaena pallida)	• 500 to 1500	• 800 to 2500	• Seed
• Leucaena (Leucaena leucocephala)	• Above 600	• Up to 1000	• Seed
• Sesbania (Sesbania sesban)	• 500 to 2000	• 100 to 2300	• Seed
• Griricidia (Griricidia sepium)	• 600 to 3500	• Up to 1200	• Cuttings
• Tagasaste or Tree Lucerne (Chamaecystisus palmensis)	• 350 to 1600	• Up to 1000	• Seed
• Pigeon pea (Cajanus cajan)	• Below 2400	• Above 250	

Note: Most of the forage trees grow in a wide range of soils but requires well drained, deep, and fertile soils for optimum production. For details please see SNV (2017): Forage production and management: Training packages for extension workers.

2.1.2. Social, environmental, institutional, and economic considerations

Local communities should participate in selecting grass and fodder tree species to be planted on the banks of physical SWC measures. To maximize the benefits, the CWT should work closely with district agricultural offices to decide when to harvest grasses and fodder trees planted on the banks of bunds. The CWT should also consult experts at the district agricultural offices to learn how to manage fodder trees, including when and how to prune fodder trees and when and how to harvest fodder and feed the livestock. Close collaboration between the CWT and experts at district agricultural offices will help ensure better management of fodder trees planted within the exclosure and maximize the benefits. Some practical tips on growing Leucaena, one of the commonly used fodder trees in Ethiopia and usually planted on the banks of SWC measures, as outlined by Smith (1995) are summarized in box 6.

Box 6: Some practical tips for growing Leucaena

- Establish many fodder trees that you need to feed your animals by planting seeds directly, or by using seedlings that you first need to raise your- self.
- If you plant from seeds or seedlings, you will first need to obtain the seeds. It is possible to produce seeds on a small portion of your land, for your own use, or to sell or give to other farmers. For Leucaena, for example, fence a small portion of your land and plant the seeds in rows (2 x 2 metres).
- For trees such as Leucaena, you can leave the pods to mature on the tree. Harvest when yellow, not when too mature and dark brown, to reduce seed losses through shattering and insect damage.
- Your Leucaena plant may flower after nine months and produce mature pods about eight months later. The pods contain 15-25 seeds each. If you collect 1 kg of pods, you will get about 20 000 seeds.
- If you do not plant seeds immediately after collection, you need to store them properly, so that they are not damaged by insects and moulds. The first thing is to make sure they are properly dried: dry your seeds for three to five days in the sun.
- Then store them in airtight containers such as glass bottles or plastic bags. First put some material in the container that can absorb water, like dry wood, ash, charcoal, lime, newspaper, dry rice hulls, etc., then fill the rest of the container with the seeds, in order to leave no space for air.
- Remember that when you plant fodder trees, either by direct seeding or through seedlings, you must take care of them just like your food crops.
- After clearing the land, sow seeds 2-3 cm deep in shallow furrows in individual holes.
- If you take good care of your trees, you will get a lot of fodder for feeding your animals for many years. However, insects and other pests may attack your trees. Treating the soil or trees with insecticides may remove these insects. Planting different types of trees is also a good way to make sure all your trees do not get destroyed by insects. For example, the jumping lice that attack Leucaena will not destroy Gliricidia or pigeon pea, so these trees are safe when Leucaena is attacked.

2.1.3. Stakeholders

District agricultural offices and the CWT can be expected to be the lead stakeholders, while local communities, the bureau of agriculture (BoA) and NGOs should also participate. District agricultural offices have mandate to raise seedlings of forage trees and provide seeds of different grass varieties. The CWT is responsible for mobilizing local communities when sowing grasses and/or planting forage trees on the banks of bunds. Local communities can provide unpaid labor to plant forage trees and protect conservation measures from the interference of people and domestic animals. NGOs can be expected to be keen to provide technical and financial support, while the BoA has mandate to coordinate the support provided by local and international NGOs.

2.1.4. Opportunities and assumptions, cost, and timing

Information on available grass species and fodder trees can be obtained from the BoA or from respective district agricultural offices. Facilities for raising seedlings of fodder trees are also available in each district (Fig. 11), which could make this option practical and effective.

Figure 11: Nursery for raising seedlings in North-western Ethiopia (***Photo***: Wolde Mekuria).

The costs of implementing this option could be low, as bund stabilization with grass and fodder trees costs about US$40 per kilometer of bund (i.e. the costs for labor and seed, Mekuria et al. 2017). This option can be implemented immediately or starting one year after the establishment of the exclosure, depending on the availability of resources and other logistics. Results can be expected in the short term.

2.2. Enrichment plantation of economically important plant species

2.2.1. Benefits and recommended steps

Conducting enrichment plantation of economically important plant species such as fruit trees and trees that can be used for fuelwood (e.g. Acacia decurrens, Fig. 12) could help improve the short-term benefits of the exclosure. Allowing communities to harvest for example fruits and fuelwood (charcoal) can contribute to increasing their incomes and diversifying their livelihoods.

Figure 12: Charcoal production from Acacia decurrens plantation in Awi zone, Amhara region, Ethiopia (***Photo:*** Wolde Mekuria).

The effectiveness of this option depends on environmental factors, such as rainfall, and quality of soil and land and habitat management practices. Thus, this option requires regional agricultural bureaus, district agricultural offices as well as local and international NGOs to regularly provide support for and follow up on management of planted trees and estimation of total amount of yield.

To implement this option, identify economically important plant species, raise seedlings, plant seedlings, and carry out intensive cultivation during the first year. Table 7 presents some tips on managing tropical fruit crops. The contributions or suitability of exclosures for producing high value crops such as fruits are also summarized in Box 7.

Table 7: Tips on managing tropical fruit crops.

Tips on managing fruit crops	Major field operations for fruit crops include nursery site preparation, propagation (by seed and vegetative means), pit digging for planting, intra-and inter-row cultivation, fertilizer application, irrigation, tree canopy management, plant protection, harvesting, handling, packaging and transport.
	Having the right tools and knowing how to use them are essential factors which can affect horticultural operations and production profits in several ways (Bello 2012). Among the different tropical fruits, Banana, Pineapple, Papaya, Mango and Guava are the major tropical fruit crops widely grown in Ethiopia (SNV 2019).
	Fruit plants may be propagated directly from seeds or by vegetative means. Several vegetative propagation methods are used to multiply tropical fruit crops. Some of these include grafting, budding, cutting, layering, micro propagation or tissue culture. Although their basic requirements remain the same, tropical fruit saplings differ in their needs for soil type (nursery substrate), light, temperature, and moisture requirements (Bose et al. 2001; Chanana 2008). They also require protection from the sever heat of the Sun, heavy rain, drought and variety of pests and diseases.

Box 7: Contribution or suitability of exclosures for producing fruit trees

» Exclosures can be used to increase the production of high-value fruit species. Exclosures reduce grazing pressure, contribute to the recharge of groundwater, improve soil moisture content and moderate local climate, which would increase the potential for fruit production, especially when SWC structures such as terraces, trenches, bunds and micro-basins are built (Anwar et al. 2016).

» Experience from the Amhara, Tigray and Oromia regions of Ethiopia shows that farmers are producing high-value irrigated crops and fruits in a watershed where exclosures are established (Gebregziabher et al. 2016). Cultivating fruit trees in exclosures will have multiple benefits, such as diversifying local livelihoods, producing high-quality fruits for local and export markets, stabilizing SWC structures and, ultimately, ensuring that exclosures are sustainable by increasing the short-term economic benefits they deliver.

2.2.2. Social, environmental, institutional, and economic considerations

The local community, in consultation with the district technical staff, should decide which tree species to plant in the exclosure. To ensure control of soil erosion and to meet the diverse needs of the community (e.g. for fuelwood, construction materials, fodder, medicine, food, etc.), it is recommended to establish a mixture of tree species, which have been selected to ensure short-term benefits of the exclosure.

For the first year, intensive management is needed to enhance the survival chances of economically important plant species. The CWT should work closely with experts at district agricultural offices to get technical advice, while managing and harvesting products. The CWT should consult the beneficiaries to decide on benefit-sharing mechanisms, and the interest of the majority of the beneficiaries should be respected. To maximize the benefits, it is crucial to match economically important plant species with the agroecological specifics of the site, such as soil quality, expected rainfall, etc.

2.2.3. Stakeholders

District agricultural offices and the CWT can be expected to be the lead stakeholders, while local communities, the BoA, private sector actors and NGOs should also participate. District agricultural offices and NGOs have mandate to raise seedlings and provide technical and financial support; the CWT can mobilize local communities and follow up on activities week-to-week; and local communities can take care of planted trees. Local communities and private sector actors could also be involved in raising seedlings.

2.2.4. Opportunities and assumptions, cost, and timing

Information on available economically important species and their environmental requirements can be obtained from the BoA or respective district agricultural offices. Facilities for raising seedlings are also available in each district, which could make this option practical and effective. This option has varying initial and operational costs. For example, pit preparation and plantation might cost US$300-400 per hectare, while the first and subsequent years of cultivation might cost on average about US$200 per hectare (Mekuria et al. 2017). This option can be implemented starting one year after the establishment of the exclosure, as at least one year is needed to identify appropriate economically important plant species and raise seedlings. Results can be expected in the medium to long term.

2.3. Beekeeping

2.3.1. Benefits and recommended steps

Integrating beekeeping within exclosure is another way to create short-term economic benefits for communities. Giving members of the community the opportunity to sell honey and related products can increase their incomes and resilience. The key beneficiaries are landless youth and women (Fig. 13).

Figure 13: Landless youth organized to engage in beekeeping in Gomit watershed, north-western Ethiopia (***Photo:*** Wolde Mekuria).

To implement this option, consult the local community on whether they prefer managing modern beehives on an individual basis or in a group. Train community members on beekeeping, and approach local and international NGOs to mobilize financial support for purchasing beehives, such as in the form of long-term credit.

Finally, establish a formal agreement between the government, the individuals, or groups of people to be engaged in beekeeping and the entire group of beneficiaries or members of an exclosure. This agreement should clearly describe the size of land within an exclosure allocated for beekeeping, duration of the contract, benefits of all members or beneficiaries, benefits sharing mechanisms in case of groups, etc.

2.3.2. Social, environmental, institutional, and economic considerations

Integrating beekeeping with an exclosure can be appropriate for areas where plant communities generate sufficient bee forage. Landowners and land managers are very aware of the need to provide forage for insect pollinators. One way to do this is to plant seeds of wildflowers. In addition to planting seeds, it is the cutting or grazing regime which determines the diversity and number of wildflowers in exclosures or grazing areas. Furthermore - and this is important - if you are lucky enough to have an area of established unimproved grassland (e.g. exclosures established on degraded lands), with a management regime and native species mix which dates back many years, then you should not plough and seed with introduced species. Maintaining the value of these areas depends on implementing an appropriate cutting and/or grazing regime. Principles that govern the cutting or grazing regime is summarized in Box 8.

Box 8: Principles of cutting

- Do not cut when the flowers are growing, flowering and seeding.
- Do cut often enough to discourage scrub such as bramble and tree saplings (unless that is what you want).
- Remove the cut vegetation in order to reduce the fertility of the site because this discourages prolific grass growth, and so gives a wide variety of wildflowers the chance to thrive and provide pollen and nectar to pollinators.
- Cut on a high setting to allow plants with spreading, low habits to keep on flowering.

To this end, communities and households could invest in planting the vegetation preferred by bees in exclosures on degraded landscapes (Babulo et al. 2006; Gebremedhn et al. 2017). Gebremedhn et al. (2017) observed that exclosures in Tigray support the successful regeneration of one of the most important honeybee floras (i.e. Hypoestes forskaolii or Vahl). It is also argued that beekeeping is sustainable when the interactions between humans and bees maintain healthy populations of locally adapted indigenous (where possible) bees, living in the wild and in the apiaries of beekeepers, bringing benefits to people and to biodiversity. Further, creating market opportunities for the local communities is crucial to realizing the benefits of honey production. Some relevant good beekeeping practices (GBPs) as outlined by FAO (2020) are summarized in Table 8.

Table 8: Good beekeeping practices (FAO 2020).

Variables	Description
Site selection	Ensure proper selection of apiary sites. Suitable sites are away from sources of pollution such as intensive agriculture and industries, and provide sufficient bee fodder all year round. In addition, beehives should be sheltered from humidity and cold winds (Fig. 14). In this line, exclosures can be considered as a suitable place for practicing bee-keeping (Fig. 14).
Selection of suppliers	Ensure careful selection of suppliers of bees and beekeeping equip-ment, and verification of the health status of newly acquired swarms, colonies, and queen bees.
Hive identification	Identify each hive with a unique numerical code.
Keeping record	Keep a record of each hive visit, colony productivity and resistance to illness. Verify the health status of the colonies regularly during the year. The frequency of hive inspections will depend upon the time of the year. For example, under unfavorable weather conditions, opening the hives should be limited to a strict minimum.
Renewing	Renew honeycombs regularly (every 2 years) and replace queens reg-ularly (every 1–2 years). Preference should be given to queens showing disease resistance, hygienic behavior, docility, low tendency to swarm, and high productivity.
Balance colony strength	Maintain balanced colony strength within the same apiary; ensure that hive capacity is sufficient to discourage swarming; and prevent robbing by removing heavily diseased or weakened colonies from the apiary, as these are more liable to be attacked and “sacked.”
Maintenance	Undertake regular maintenance of hives to maintain them in good con-dition. Undertake regular maintenance of the apiary, for example, mowing the grass in front of the hives
Feeding	Avoid the use of honey to feed bees. Provide candy or glucose/fructose syrup. Verify origin and wholesomeness of feed provided to the bees.
Smoking	Use the bee smoker appropriately, respecting the bees’ welfare, and avoid using toxic material that may contaminate the honey and harm the bees.
Toxic materials	Avoid the use of toxic substances such as disinfectants or chemical treatments for wood and toxic paints for hives.
Transferring honeycombs	Avoid transferring honeycombs from one colony to another if the health status of the colony is unknown. Diseased colonies should be removed from the apiary and destroyed, if necessary.
Cleaning	Keep beekeeping equipment clean and in good order. When necessary, renew the materials.
Consultation	Consult an expert in the event of anomalies.

Figure 14: Shades for placing beehives within exclosures (***Photo:*** Wolde Mekuria).

2.3.3. Stakeholders

The BoA can be expected to be the lead stakeholder, while district agricultural offices, local communities and NGOs could also participate. The BoA, in collaboration with district agricultural offices, has mandate to form landless youth and women's groups, which are the main intended beneficiaries for this option. NGOs can be expected to be keen to provide financial and technical support.

2.3.4. Opportunities and assumptions, costs, and timing

It can be assumed that this option will receive strong support from government and local administrative bodies because it benefits vulnerable and marginalized groups. The initial costs of implementing this option can range from low to high, depending on the approach used to provide beehives (i.e. individual or group) and types of beehives (modern ones cost about US$80-90 per beehive, transitional ones US$40-55 per beehive and traditional ones US$20-30 per unit). Providing beehives to groups of landless youth and women's groups could help ensure that more people benefit from this option. This option can be implemented starting two to three years after the establishment of the exclosure, provided that bee forage has already been established in the exclosure. Results can be expected in the short to medium term.

Group exercise or discussion one:

Title: Importance of bee keeping in a society.

Task: discuss the importance of beekeeping & explain the importance of each bee product or service.

Type: Group discussion

Materials: Flip chart, markers, etc.

2.4. Cut-and-carry fodder system

2.4.1. Benefits and recommended steps

In many regions of the tropics, fodder can be produced on the farm as grazing land or as grass or tree crops used for cutting. While grazing requires less labour than shed feeding, more land is needed and appropriate measures to keep the animals away from other crops must be undertaken. Grazing may lead to a lower productivity (milk, meat) but usually is the more favourable option concerning health and welfare of the animals. Shed keeping, however, has the advantage that the dung can be easily collected, stored, or composted and applied to the crops or used as a source of fuelwood (Fig. 15). Whether grazing or shed feeding is the more suitable option will mainly depend on the agroclimatic conditions, the cropping system, and the availability of land. A combination of shed feeding and grazing in a fenced area may be an ideal combination of high productivity and animal friendly husbandry.

Figure 15: Animal dung collected at the homestead (***Photo:*** Wolde Mekuria)

In a cut-and-carry fodder system with exclosures, local communities harvest grass within the exclosure and carry it to their homestead areas where livestock is kept (Fig. 16). A cut-and-carry fodder system increases the quantity and quality of fodder, limits livestock movements and reduces grazing pressure. In addition, keeping livestock out of the exclosure will enable the regeneration of indigenous tree species, which have ecological and economic importance, and will protect physical or biological SWC measures. However, the success of this option requires strict protection of the exclosure from the interference of livestock and unsanctioned users.

Figure 16: Harvesting of grass produced within exclosure (***Photo:*** Wolde Mekuria).

To implement this option, harvest grass after the seeding stage, starting two to three years after exclosure establishment.The main reason for postponing grass harvesting is to restore the soil seed bank.

This option is most suitable for highland and midland agroecological zones, as lowland areas are mainly inhabited by pastoral and semi-pastoral communities. These communities usually move from one place to another, depending on the availability of resources such as water. Thus, a cut-and-carry system might not be suitable for these communities, unless resources such as water are available throughout the year, allowing them to settle in one place.

2.4.2. Social, environmental, institutional, and economic considerations

Successfully implementing and sustaining a cut-and-carry system depends on establishing the right governance frameworks. It is recommended that appropriate government bodies allocate or strengthen communal usufruct rights over the exclosure by considering existing community practices, grazing land use dynamics and local negotiations to reduce conflicts over resource uses. At the community level, bylaws should be created to govern (a) harvesting procedures and harvesting of grasses, (b) harvesting schedules including period and frequency of harvesting and (c) quotas for harvested grass and sharing of the harvested grass.

2.4.3. Stakeholders

The CWT and local administrative bodies can be expected to be the lead stakeholders, while district agricultural offices, the BoA and NGOs should also participate. The CWT and local administrative bodies have mandate to identify beneficiaries, arrange harvesting schedules and ensure that harvested grass is shared equitably. The main roles of the BoA and NGOs will be providing inputs such as seeds and harvesting equipment.

2.4.4. Opportunities and assumptions, costs, and timing

It can be assumed that this option will receive strong support from government and local administrative bodies. This option also hinges on the assumption that NGOs are willing to supply improved seeds of different grass varieties. This option does not have costs, except salary for guards who protect the exclosure from the interference of people and domestic animals. The costs for guards are estimated at US$400 per hectare per year. This option can be implemented starting three years after the establishment of the exclosure. Results can be expected in the short term.

2.5. Livestock fattening or dairy production

2.5.1. Benefits and recommended steps

This option can further underpin the benefits of a cut-and-carry system and reduce free grazing. Optimizing the use of produced feeds can improve livestock productivity and smallholders' income, thereby further incentivizing farmers to adopt and sustain exclosures. The contributions of exclosures to promoting livestock fattening is summarize in Box 9.

To implement this option, identify women and men to be engaged in livestock fattening or dairy production (Fig. 17 and 18) and consult them on whether they prefer to carry out the activities individually or as a group. Then mobilize financial resources for purchasing improved livestock breeds from government and non-governmental organizations.

Financing could be sourced from NGOs in the form of long-term credit. This option could be more effective in midland agroecological zones, as livestock lose only minimal energy on adapting to weather conditions.

Box 9: Contributions of exclosures for livestock fattening

- Exclosures can help support livestock fattening by providing space to increase the quantity and quality of feed (Ibrahim 2016; Hailu 2017). Exclosures without mitigation measures effectively decrease access to livestock feed by reducing the grazing land area, which in turn forces farmers to reduce the size of their livestock herd (Mekuria et al. 2017). Therefore, the integration of improved feed harvesting in exclosures would encourage local community support for exclosures, and provide at least a short-term economic incentive to reduce free grazing and support land restoration measures (Tekalign 2010; Mekuria et al. 2017). However, improved fodder has the most significant impact on the productivity of improved livestock breeds. Therefore, interventions to introduce improved cut and carry fodder varieties in exclosures should also include the introduction of improved livestock breeds in the area.
- Exclosures can contribute to conserving soil moisture and recharging groundwater, both of which are important for livestock feed production. Descheemaeker et al. (2010) demonstrated that exclosures could also contribute to improving livestock water productivity, defined as the ratio of beneficial outputs from livestock to the water depleted in producing them.
- (3) According to MoARD (2009), about one-third of the country is suitable for practicing livestock fattening with improved feed, suggesting that there is good potential for integrating forage production in exclosures.

Figure 17: Oxen fattening in Birakat watershed, north-western Ethiopia (***Photo:*** Wolde Mekuria).

Figure 18: Sheep fattening in Alekt-Wenz, north western Ethiopia (***Photo:*** Wolde Mekuria)

2.5.2. Social, environmental, institutional, and economic considerations

It is recommended that this option be supported by continuous training, follow-up and technical support. If groups of people carry out these activities, a clear description of the responsibilities of each member is required. Also, a signed agreement on benefit sharing mechanisms is necessary.

2.5.3. Stakeholders

The BoA can be expected to be the lead stakeholder, while district agricultural offices, local communities, the CWT and NGOs should also be involved. The BoA, in collaboration with district agricultural offices and the CWT, has mandate to identify groups or individuals interested in this activity. Also, the BoA is responsible for coordinating the financial support from local and international NGOs, who can also provide technical support.

2.5.4. Opportunities and assumptions, costs and timing

This option may receive strong support from the government and local administrative bodies. This option also hinges on the assumption that NGOs are willing to provide financial support, for example in the form of long-term credit. The implementation cost of this option is estimated at US$800-1,200 per head of livestock for improved breeds. This might be high, considering the financial capacities of farmers. To reduce cost and ensure wider implementation, strategies for revolving funds could be explored. Such strategies could involve the distribution of initial animal stock to a number of individuals or groups, who are selected according to criteria determined by the community. These individuals would then be required to give the first offspring from their animals to others in the community, and so on, until full distribution throughout the community has been achieved. This option can be implemented starting four years after the establishment of the exclosure. Results can be expected immediately or in the short term.

2.6. Woodlots

2.6.1. Benefits and recommended steps

A woodlot is a section of a woodland or forest capable of small-scale production of forest products such as firewood, timber, and non-timber forest products. When establishing woodlots in the exclosure, the focus should be on serving local communities by providing income diversification mechanisms and alleviating problems that arise due to exclosures, such as shortages of fuelwood and construction materials.

Establishing woodlots requires a multi-step process. First establish small user groups, no larger than the typical number of households in a village and demarcate an area for the woodlot within the exclosure. Then, members of the group need to agree on the purpose of the woodlot, whether timber management, firewood production or wildlife habitat. Once the purpose has been agreed upon, identify appropriate tree species, and establish a nursery. Finally, prepare a management plan that includes information on nursery establishment and management, planting, harvesting, marketing, and different silvicultural practices, before establishing the woodlot. The overall activities related to woodlot establishment is summarized in Figure 19.

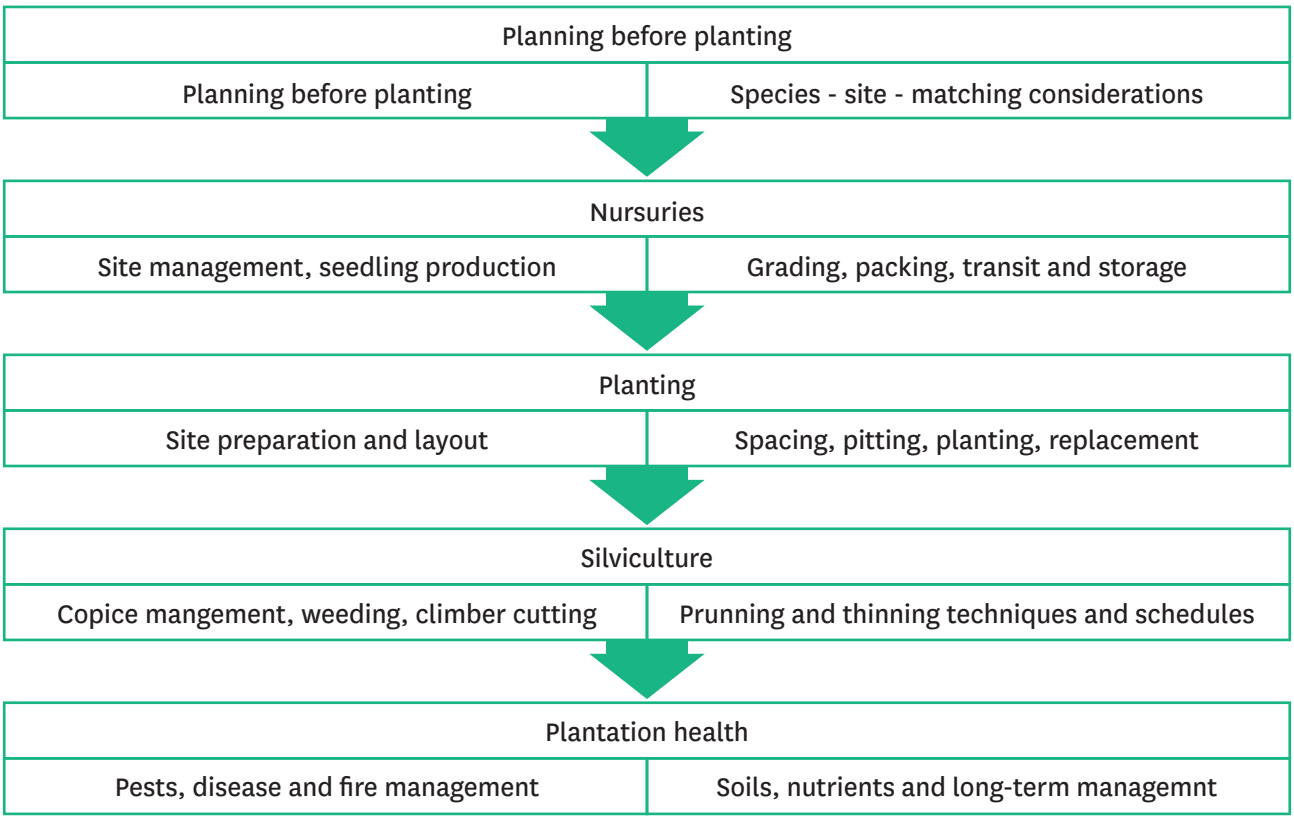


Figure 19: Key activities of woodlot establishment and management.

2.6.2. Social, environmental, institutional, and economic considerations

Once a woodlot is established and a management plan is prepared, it is recommended that the district agricultural office work closely with the CWT and beneficiaries to design benefit-sharing mechanisms. The benefit-sharing mechanisms should align with the agreed purpose of the woodlot and take into account the interest of the majority of beneficiaries.

2.6.3. Stakeholders

District agricultural offices can be expected to be the lead stakeholders, while the BoA, local communities, CWT, private sector actors and NGOs should also participate. District agricultural offices can be expected to lead the overall activities, while the CWT can facilitate discussions with communities to decide on the goals of woodlot. The BoA and NGOs can provide technical support. Private sector actors could provide financial support through contract farming mechanisms.

2.6.4. Opportunities and assumptions, costs, and timing

It is assumed that strong support can be obtained from the government, as this option can further the government's objective to sustain exclosures and restore degraded ecosystems. The implementation cost of this option could vary depending on the size and purpose of woodlots, but the estimated per hectare cost ranges from US$2,000-3,000. This option can be implemented starting one year after the establishment of the exclosure, and results can be expected over the medium to long term.

2.7. Habitat management

2.7.1. Benefits and recommended steps

The goal of habitat management is to improve the restoration of degraded ecosystems and regeneration of native plant species. This option could involve all kinds of forest management practices, such as thinning, pruning, taking care of planted seedlings, and constructing water-harvesting structures. It could also improve tree growth and productivity as well as curb adverse impacts of invasive species, as invasive species could be identified and removed while implementing the above forest management activities. Potential short-term benefits include increased supply of fuelwood and construction materials.

Before establishing a habitat, consider available scientific information on vegetation and wildlife in exclosures as well as site-specific conditions, letting this information guide your goal setting for managing the habitat. Similarly, consider a range of management strategies that meet such specific goals and use adaptive management to modify strategies to match objectives, aiming to maximize the benefits. Finally, manage invasive species to minimize unacceptable changes to the structure of the exclosure.

The concept of adaptive management has evolved in numerous directions, but all are centered around iterative learning about a system and making management decisions based on that learning (Stirzaker et al., 2011; Webb et al., 2017). The adaptive process is often represented as a cycle of plan, do, monitor, and learn and can guide informed decision-making while implementing activities related to habitat management and helps to address post-implementation trade-offs. The use of adaptive management usually helps to better understand the drivers and outcomes in the entire landscape. In this line, Stirzaker et al. (2011) argue that using real-life management of the system as a whole and turning it into an experiment by asking the right questions, implementing decisions, collecting the right data, and learning from the experience, is crucial to understanding the effects or outcomes of habitat management. The attributes of adaptive management, which make it distinct from the traditional trial and error approach, is so that it involves exploring alternative ways to meet management objectives. It forecasts the outcomes of alternatives based on the current state of scientific knowledge and it implements one or more of these alternatives. Adaptive management monitors impacts of management actions, updates knowledge, and adjusts management decisions (Haileslassie et al. 2020).

2.7.2. Social, environmental, institutional, and economic considerations

It is recommended that this option be supported by continuous training, follow-up and technical support.

2.7.3. Stakeholders

District agricultural offices can be expected to be the lead stakeholders, while the BoA, local communities, the CWT and NGOs should also participate.

2.7.4. Opportunities and assumptions, costs, and timing

It can be assumed that this option will receive strong support from the government. The implementation cost of this option might be low as maintenance, such as thinning and pruning, only has to be done every three to five years. Habitat management can be done in five-year intervals after the establishment of the exclosure. Results can be expected in the long term.

2.8. Alternative energy sources

2.8.1. Benefits and recommended steps

One of the main concerns local communities express regarding exclosures is that they reduce the availability of fuelwood and the number of useful tree and shrub species in the remaining communal grazing lands. This is a critical concern, as more than 90% of people in these communities depend on bio-energy sources, such as wood and dung,

for household energy demands. Therefore, providing alternative energy sources can help make exclosures more acceptable to communities, thereby making them more sustainable. Benefits of improved or energy conserving cooking stoves on biomass use and emission of carbon is summarized in Box 10. Also, providing women with alternative energy sources can improve their health and free up time previously spent collecting fuelwood, while reducing the encroachment into exclosures.

Box 10: Improved cooking stoves saved fuelwood and reduced emissions

A study in Ethiopia (Elisabeth et al. 2014) demonstrated that fuelwood savings of nearly 40% in injera preparation due to using improved cooking stoves compared to the traditional three-stone fire. This is translated to an annual savings of 1.28 tons of fuelwood per household. Considering the approximated share of fuelwood from unsustainable sources, these savings translate to 11,800 tons of CO_2 saved for 11,156 disseminated ECS, corresponding to the amount of carbon stored in over 30 ha of local forest. The study also indicated that stove efficiency increased with longer injera baking sessions, which shows a way of optimizing fuelwood savings by adapted usage of ECS. This study confirmed that efficient cooking stoves, if well adapted to the local cooking habits, can make a significant contribution to the conservation of forests and the avoidance of carbon emission from forest clearing and degradation.

When considering this option, first identify areas where women are facing critical fuelwood shortages and where exclosures are used as a means to restore degraded landscapes. Then consult them on whether they prefer to get energy-conserving stoves, biochar stoves or solar panels. Finally, mobilize financial resources for purchasing and introducing alternative energy sources, such as solar panels as well as energy-conserving and biochar stoves.

2.8.2. Social, environmental, institutional, and economic considerations

Support from NGOs and private sector actors, especially for financing, is required to implement this option. NGOs, for example, could offer women access to long-term credit.

2.8.3. Stakeholders

The BoA can be expected to be the lead stakeholder, while district agricultural offices, local communities and NGOs should also participate. The BoA, in collaboration with district agricultural offices and local communities, can help identify women in need of alternative energy sources. The role of NGOs would likely mainly be to provide financial support.

2.8.4. Opportunities and assumptions

It can be assumed that several NGOs working at the local level would be interested in such activities. The implementation cost of this option might be beyond the financial capacities of women and marginalized groups, and therefore support from for example NGOs is required. The costs for energy-conserving stove could reach up to US$25, while the costs for solar panels exceed US$100. This option can be implemented anytime (i.e., before or after) the establishment of the exclosure. Results can be expected in the short term.

Group exercise or discussion one:

Title: Natural resource management incetives that support the sustainability of exclosures.

Task: discuss on the different types of incetives (e.g. individual incentitves, group incentives, community incentives) and provide your opinion on the below questions:

- Which incentives benefit women the most?
- Which incentive benefit youth the most?
- Of all incetives provided in the watershed, which of them are income generating?.

Type: Group discussion

Materials: Flip chart, markers, etc.

2.9. Distribution of exclosure land to landless youth and women's groups

2.9.1. Benefits and recommended steps

Distributing some of the land that makes up an exclosure to landless youth and women's groups can help empower such marginalized groups. It can also create a sense of ownership over the management of the exclosure. Assigning land to marginalized groups can help them diversify their livelihoods and increase their incomes.

However, implementing this option requires caution and may only be a viable option in areas where none of the social groups customarily entitled to the exclosure exists, because it might otherwise create conflicts between competing claimants.

Prior to distributing exclosure land to landless youth and women's groups, conduct discussions with local community members to identify eligible claimants, based on hitherto tenure practices, and assign beneficiaries. Also, work with communities to determine the proportion of an exclosure to be allocated for these marginalized groups, the duration of the contract and any benefit-sharing mechanisms.

2.9.2. Social, environmental, institutional, and economic considerations

It is essential to develop a legal document that outlines the arrangements agreed upon by government agencies, landless youth and women's groups, and the community. Allocating exclosure land to landless youth and women's groups without consulting all members of an exclosure could erode the community's trust in the government, especially regarding the ownership arrangements of the exclosure. Failing to include local communities in the process may make them less willing to establish exclosures in the future. This option should be integrated with provision of incentives such as modern beehives and improved livestock breeds. Providing technical support to the groups is also key for the success of this option.

2.9.3. Stakeholders

A regional or sub-national environmental protection and land administration bureau can be expected to be the lead stakeholder, while the BoA, district agricultural offices, local communities, the CWT and NGOs should also be involved. The Environmental Protection and Land Administration Bureau can lead the overall activities and prepare appropriate laws and agreements. The BoA and CWT can provide support to effectively implement the day-to-day activities. NGOs can provide financial support.

2.9.4. Opportunities and assumptions, costs, and timing

Strong support from government and local administrative bodies can be assumed, as redistribution of agricultural land has been stopped due to land fragmentation. It is also assumed that NGOs can provide financial and technical support. The associated costs are related to the provision of incentives. Such costs are discussed under management options on beekeeping; livestock fattening and dairy production; and cut-and-carry system. This option can be implemented starting two to three years after the establishment of the exclosure. Results can be expected in the medium to long term.