

## Chapter 4

# How to practise FMNR

## Summary: How to practise FMNR

- FMNR generally involves three practices:

### 1. Select species and stumps

- a. Generate a preferred species list with the community based on required uses of regenerated trees, local species availability and possible restrictions, to inform tree species selection.
- b. When regenerating from tree stumps, base your selection on individual and community goals. For each stump, choose a number of the tallest and straightest stems to leave.
- c. Where there is bush encroachment, select the desired trees and species to be managed and cut out the rest. When dealing with dense thickets, you may need to make decisions as you go, because many trees will not be accessible until you have removed some of the unwanted ones. (For more information, see 'FMNR in woody thickets' on page 52.)

### 2. Prune and manage

Remove unwanted stems and side branches, leaving only the strongest and straightest stems. Protect the remaining branches from livestock, fire and competing vegetation or weeds.

### 3. Maintain and utilise

Periodically return to the trees and cull emerging new stems and prune side branches from time to time.

- The way these practices are undertaken will depend on what individual land users would like to achieve through FMNR, and how the community has agreed to manage it.
- FMNR can be successfully combined with other development practices, whether to provide a sustainable foundation of natural resources for further agricultural or environmental initiatives, such as water conservation, or in conjunction with other social or economic development activities, such as disaster risk reduction, water, sanitation and hygiene, savings groups or value chain development.

## Resources

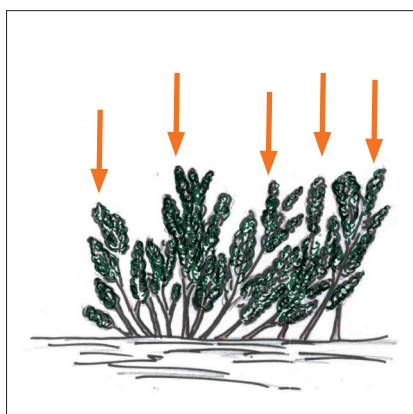
- In this chapter a range of technical terms are used. Please refer to the [Glossary](#) for explanations of any unfamiliar terms.
- Tree species information sources include:
  - [Agroforestree Database](#)
  - [Vegetationmap4africa species selection tool](#)
  - [Promising Agroforestry Tree Species in India](#)
  - [Annex 10](#) contains tools to record information about each plot and the tree species present.

Because the work of FMNR is undertaken by individuals using a few simple tools they already own, as well as the work of their hands, FMNR in practice is extremely versatile. It can be as simple as a family working to increase trees on their land for firewood, or it can be used to restore large areas of forest. In general, FMNR starts by understanding what challenges a family or community is facing, and what the causes are around the deforestation or land degradation that underpins these challenges.

The previous chapters described how to assess what a community's priorities and objectives are for FMNR. From this foundation, the basic steps of FMNR can be adapted through experimentation to determine what practices best meet the needs of the people managing the trees, in their own contexts.

## The basic practices of FMNR

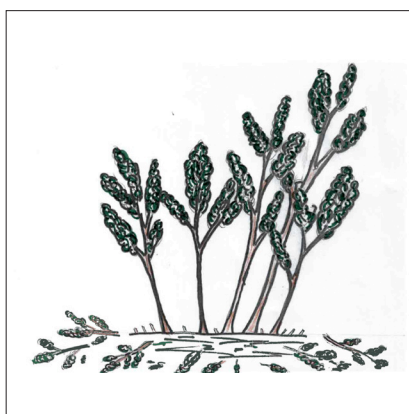
### 1. Select species and stumps or trees



**Step 1.** Survey land for sprouting stumps or seedlings and identify what species of trees are present.

**Step 2.** Select the species and stumps to be regenerated.

### 2. Prune and manage

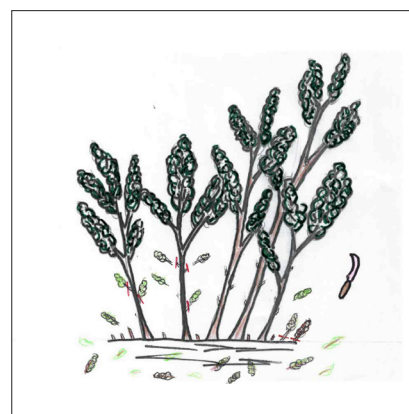


**Step 3.** For each stump, select three to five stems to keep and prune away the unwanted stems.

**Step 4.** For each remaining stem, prune off side branches up to halfway up the trunk.

**Step 5.** Protect the stems while they are growing.

### 3. Maintain and utilise



**Step 6.** Prune unwanted emerging shoots every two to six months as needed.

**Step 7.** Utilise tree for planned purposes; harvesting branches, portions of wood or the whole tree as necessary.

Depending on the land user's management style and goals:

- **a tree may be maintained** with unwanted trimmings used for fertiliser, fodder or fuel wood;
- **portions of wood may be harvested periodically** once the tree is large enough to continue to grow;
- **the entire tree may be harvested** once large enough and regenerated from the stump, repeating the cycle; or
- **the entire tree may be preserved**, as in the case of protected forest restoration.

The objectives of each FMNR project will impact the practices used significantly. For example, if the objective is to restore a biodiverse forest for habitat conservation, the types and numbers of trees selected, as well as the amount of pruning and ongoing management required, will be very different to an FMNR project practised on cropping land, as part of an agroforestry system. As discussed in [Chapter 5](#), it's important land users discuss their FMNR objectives and plans with others in the community, and preferably enact bylaws to ensure trees are not damaged by people unaware of why they're being protected.

## Who can do FMNR?

As the process of FMNR is very simple, nearly any man or woman can manage trees; even older girls and boys can learn the basics of pruning, as long as they are supervised when using sharp tools.

Because the current FMNR movement began with farmers, it's easy to think of farmers first when considering whether to use it. But anyone with access to living tree stumps or encroaching bush can adopt the practice, especially if they want to improve their land. This includes herders, foresters, students, teachers and shop keepers.

FMNR nearly always works best on land with individual owners. Land owners or land users who control the process – and the proceeds – are highly motivated to do the work when convinced they will benefit from it. Community FMNR only works well where there are very strong leadership structures, or where there are incentives for people to work towards a common goal, such as payments through a carbon credit scheme.

**When the land is individually owned**, then FMNR is best managed by the land user or owner. This allows them to ensure they keep the number and types of trees that best suit their needs.

**On communal land**, the whole community, or those with a stake in the land, should jointly manage FMNR. This ensures that everyone understands why it's important to protect the trees, and that everyone can benefit from FMNR work. On communal land in Tanzania, for example, FMNR practitioners have very successfully formed groups of around 15 members to manage sections of land. In Ethiopia and Rwanda, community volunteer days are often used to contribute to pruning and management of communal land areas.

[Chapter 7](#) provides more ideas around how to work with different members of the community.

## When and where to practise FMNR?

FMNR can be practised at any time of the year. Physiologically, there may be times that better suit plants for pruning than others, however in practice FMNR is usually determined by when land users have time to do it.

Many land users prune during the dry season, when there is not as much farm work to do and labour is more plentiful. Insects and disease are also less likely to damage freshly cut bark. The downside of pruning too early in the dry season, especially on farmland, is that newly pruned stems are more vulnerable to livestock, at a time when little food is available.

FMNR can be practised on any land with living tree stumps capable of resprouting, as well as self-sown trees or encroaching bush. The biggest determining factor to success – more important than climate, geography or even presence of tree stumps – is the attitude of communities and individuals, and their commitment to succeeding. If the community is committed to FMNR and willing to make the changes necessary, then amazing results, even under extremely difficult conditions, are possible.

## Practice 1 – Select species and stumps

Tree species selection is a critical part of the FMNR process. The land user should be responsible for selecting the tree species of most use to them and their family. FMNR specifically works with native species naturally occurring in the targeted area, helping to improve biodiversity and conservation of local environmental ecology while also meeting land users' needs.

In many situations, tree stumps of useful and desirable non-native species may be present. The same principles of thinning and pruning can be applied to these species as well if the land users wish.

Tree species identification and selection is often a mutual learning process on the part of both the land user and development workers<sup>1</sup>, as well as other external experts who may be involved. As the names, uses and values of certain indigenous species may not be known to the same degree by all in the community, it will be important to consult elders, women, local experts or vegetation specialists and reference material to learn what trees are in your FMNR site, and what useful services they may provide. To assist in collecting this information, a 'preferred FMNR species list' can be developed, based on which species are locally available, what benefits they have for the communities' priority needs, or restrictions for use. Once this information is available, it is up to the community (on communal land) and each land user (on individual land) to select what species from this list, and how many of each they wish to regenerate.

### Step 1: Survey land for sprouting stumps and identify what species are present

This is the first step to take when establishing an FMNR site. Look for stumps, shoots and seedlings available for regeneration. How many different species are there?

What are they, and how many are present?



**Figure 1** A sprouting tree stump, Ethiopia (2014). Photo: S. Sainovski



**Figure 2** Community FMNR agents surveying a site for stumps. Marigat, Kenya (May 2018). Photo: A. Muller

<sup>1</sup> As development practitioners, we are often taught that we are the experts and must know everything to help those we seek to serve. However, the very act of admitting ignorance and showing reliance on land users' knowledge and experience is a strength, not a weakness, in our behaviour, as it sends a powerful message to the land user that their views are respected and they have something to offer, instead of being treated as passive recipients or beneficiaries. This means so much to people's dignity, and it is this act of eliciting their contribution that sows the seeds of true 'farmer-managed', or 'farmer owned and internally motivated', natural regeneration.





### Will you remember how it was in the beginning?

While you are surveying the site, record some details about the land to be treated with FMNR. This information will help with monitoring and evaluating your activities to learn what is working and what is not (see [Chapter 10](#) on monitoring and evaluation for FMNR). These notes will also be a powerful reminder of what conditions were like before FMNR to highlight the changes that have occurred.

Notes to take during an FMNR site survey:

- a. Measure the area of the field.
- b. Is FMNR practised on the field in any way already?
- c. What is the field used for (cropping, grazing, forest, etc.)?
- d. What crops are grown on the field (if applicable)?
- e. Is there any erosion present, and what is the ground cover like?
- f. Note how many trees, stumps or shrubs are available for regeneration and what species are represented.
- g. Take **at least two photographs from fixed points** of the field to monitor change over time. We recommend recording the location of the photos with GPS coordinates. See this [guide on taking photopoints](#) for help.

[Annex 10](#) includes an FMNR site and tree monitoring template to help you record this information.

## Step 2: Select the species and stumps to be regenerated

Species selection is an important step in FMNR. The mix of tree species present will vary from farm to farm, district to district and country to country. In Niger's Maradi Region, species available for regeneration include *Philostigma reticulatum*, *Guiera senegalensis*, *Combretum* species and *Ziziphus* species. However, further east in the Zinder Region, *Faidherbia albida* and *Adansonia spp* are the dominant species used. Meanwhile, the mix of tree species in Ethiopia, Uganda, Swaziland and Myanmar are very different from the mix used for FMNR in Senegal, Mali, Niger and Chad.

Some land users will focus exclusively on trees already present for regeneration, while others will introduce non-native trees as well. Many land users regenerate a variety of tree species, while others focus exclusively on one kind, or just a few.

What tree and plant species are selected will strongly influence the outcomes of FMNR activities. Selection will depend on a number of factors, including what species are naturally occurring; their coppicing ability and uses; the local beliefs and values ascribed to each species; and characteristics such as thorniness, competitiveness with crops and growth rate.

Ultimately it is up to the land user to decide what species best meet their own needs, but often advice is sought about what species are good to prioritise, and what values they can offer. The following steps will help a community identify what species should be on their preferred FMNR species list. Going through this process also allows for additional information and knowledge that may not be widely known, so all land users have the best chance of maximising their FMNR outcomes. They might also feel encouraged to regenerate a larger number of species than initially considered.

## Developing a preferred species list

### a. Identify primary uses of regenerated trees

Refer back to the taking stock assessment completed with the community and expand upon their identified priority needs. Consider what urgent needs the regenerated species should work to address. Should they improve soil fertility for crops? Increase fodder, fuel wood or income? Act as a buffer for strong winds or provide shade? The template in [Annex 5](#) may help to collect this information.

Also consider what characteristics trees require to provide these needs and fit within the current farming system; for example, leaf palatability, bark and pods, deep tap roots that avoid competition with crops, valuable fruit and termite-resistant timber. Some typical tree characteristics for different uses are summarised below. Make sure to adapt these to the local area if necessary.

**Table 1** Primary tree uses and characteristics of appropriate trees<sup>2</sup>

Primary use of trees	Common characteristics of useful trees
<b>Intercropping with food or cash crops</b>	<ul style="list-style-type: none"> <li>- Deep roots that avoid competition with crop root zone</li> <li>- Open canopy for light shading (can also be managed through pruning)</li> <li>- High-nitrogen leaves for mulch</li> <li>- Nitrogen-fixing nodules on roots</li> <li>- No allelopathic characteristics, ie. does not suppress the growth of other plants</li> <li>- Root structures that provide 'hydraulic lift', drawing up deep water from the soil profile and releasing it for other parts of the tree, as well as other plants</li> </ul>
<b>Boundaries/living fences</b>	<ul style="list-style-type: none"> <li>- Dense or bushy habit</li> <li>- Thorns to deter livestock or intruders</li> <li>- Useful for fodder</li> <li>- Neutral or beneficial for crops grown in neighbouring plots</li> </ul>
<b>Timber and firewood</b>	<ul style="list-style-type: none"> <li>- Strong wood/high energy content for firewood</li> <li>- Withstands pruning of large branches and stems</li> </ul>
<b>Honey</b>	<ul style="list-style-type: none"> <li>- Flowers preferred by bees</li> <li>- Flowering occurs at different times throughout the year, particularly when alternative food sources are not available</li> </ul>
<b>Fodder</b>	<ul style="list-style-type: none"> <li>- Leaves, bark or pods palatable and nutritious for livestock</li> <li>- Quick to reshoot</li> <li>- Withstands regular pruning or grazing</li> </ul>
<b>Fruit and non-timber tree products</b>	<ul style="list-style-type: none"> <li>- Produces fruit or non-timber tree products useful at home, or valued for sale at accessible markets (may include tree seed from superior quality 'mother' trees)</li> </ul>

<sup>2</sup> Additional information can be found in this FAO publication: [fao.org/docrep/006/u4375e/u4375e08.htm#TopOfPage](https://www.fao.org/docrep/006/u4375e/u4375e08.htm#TopOfPage).

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**Forest restoration and biodiversity conservation**

- Rare or less common indigenous species of trees, shrubs and grasses
  - A high density of stumps should be selected for regeneration
  - Species valuable for habitat and food sources for native wildlife to encourage their return to the area
  - Species that provide fruits, medicines, honey or firewood to increase the value of the forest area for local communities
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**Land stabilisation/erosion control**

- Deep roots to stabilise soils
  - Fast growing to act as pioneer species, and provide improved conditions for additional species to be established in the future
  - Stumps or seedlings that are located along terraces or bunds to assist in slowing the rate of surface water run-off and encourage infiltration
  - Species that provide value to the local community such as for firewood, medicines, honey production, etc. are more likely to be successfully regenerated, especially in communal areas
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**Pasture land/communal grazing land**

- Fast growing or able to grow large enough to withstand speedy browsing or grazing
  - Thorns, which may help a tree be more resilient to browsing pressure during its establishment
  - Nutritious leaves, pods or bark for supplementing livestock diets in times of grass shortages
  - Open canopy for dispersed shade and maximum grass growth (or tolerant of pruning to manage shading)
- 

**Water conservation<sup>3</sup>**

- Root structures that provide 'hydraulic lift' by drawing up deep water from the soil profile and releasing it for other parts of the tree, and other plants, during dry spells
  - Heavy mulching, which provides organic matter to the soil to improve its water-holding capacity
  - Deep roots, which provide greater water infiltration opportunities through improvements in soil structure and reduction in compaction
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<sup>3</sup> [The Botanic Gardens of South Australia website](#) summarises the eight roles of trees and forests in the hydraulic cycle. For a complete handbook on how to manage water in the landscape, including through trees, see the [Green Water Management Handbook](#).



## b. Develop a local tree species list

With the community, make an exhaustive list of what tree species occur in the area and any current and potential uses, including economic, social and environmental. Local knowledge can be supplemented with information from reference books, forestry or parks department personnel, forest researchers and knowledgeable individuals. Often, elders in the community, particularly women, are knowledgeable about what trees occur and what their uses are. Try to record both the local and scientific names for each species if possible, along with any defining characteristics that may help in their identification. The template in [Annex 6](#) may assist to organise this information.

## c. Understand possible restrictions

Review your list and make note of any pertinent rules for each species listed. These could include the species' government protection status, cultural taboos and beliefs<sup>4</sup>, or restrictions to their use by different groups of people (eg. women, men, etc).

Some rare or very valuable trees may have government restrictions around harvesting, and for some this is a deterrent. Other trees may have no restrictions, which could also be a deterrent if the land user does not want people coming onto their fields to cut down trees. It is also important, especially on communal land, that no group of people is restricted from using or benefiting from the tree species selected for regeneration.

## d. Generate a preferred FMNR species list

Identify all the trees from the local species list that:

- have characteristics that meet the priority needs for the community;
- have the right mix of characteristics to be incorporated into the local land-use system; and
- do not have unreasonable restrictions on their use.



From this list, ensure there is maximum diversity of species, since every native species provides some ecosystem service or benefit. Many species also provide inclusive benefits for the community. Cross-check your list. Are there any land users excluding certain trees from it? Why? Are there any land users regenerating trees not on the list? Why?

If the FMNR site is managed by a group or is on communal land, it is important that all those involved in the site are able to contribute to the species selection process. Get people to participate in a voting process such as the 10-stone method<sup>5</sup> to prioritise which trees in the preferred FMNR species list they will focus on, while always encouraging them to leave as many different species as possible for enhanced biodiversity.

<sup>4</sup> Certain trees may be seen to bring good or bad luck, or harbour evil spirits. For example, in Niger it was believed that if you owned more than one baobab tree you would die. Other trees may be associated with some blessing or benefit; certain trees are said to indicate water is close to the soil surface.

<sup>5</sup> This method gives each person 10 stones (or seeds, leaves or any other locally available item). Each person puts their stones against their preferred species. They can allocate as many stones of their 10 to each species as they like. For example, they may vote for 10 species, with one stone each, or six species, with three stones for their most favourite, two stones for the next two favourites, and a single stone for the remaining three preferred species. It is important that each person in the group gets an equal number of stones/votes. Participants should be allowed to vote anonymously. At the end of voting the species with the most stones are the most preferred by the community.

### e. Select and mark the individual stumps and trees to be regenerated and managed

Each land user can now use the preferred species list to select the most appropriate stumps and trees to meet their needs, based on the mix of tree species and their location in the field.

Trees and stumps can be marked with coloured fabric, ribbon or tape as a sign that these plants are being managed.

#### How many tree stumps should be selected?

Almost universally, farmers are reluctant to leave trees on farmland. All their lives, they have been taught this is bad practice. In most places, the cultural norm is to clear all trees from farmland. Conventional western approaches, which have influenced global farming practices, favour monocultures and the removal of trees on agricultural landscapes. An FMNR promoter should expect resistance and work wisely to introduce this radical change to accepted norms.

On cultivated land, farmers tend to begin very conservatively, often leaving only five to 10 trees per hectare. In Niger, after farmers saw there were no negative effects and many benefits to leaving trees on their land, the number was soon increased to 20, then 40 trees per hectare. Today, some farmers are leaving more than 100 trees per hectare on their lands and, because of the way they manage the trees, they are still experiencing better crop yields than the treeless fields of their neighbours. On grazing land, it may be possible to exceed 100 trees per hectare while still increasing fodder yield. On forest land, all stumps and species would ideally be encouraged to regrow, using thinning and selected pruning to aid tree growth, while also providing local communities with benefits such as firewood. Across all land types, the number of tree stumps left to grow will vary with climate, tree species and objectives.

#### What if there are not enough sprouting stumps?

If there are no living stumps remaining in an area, or there are not enough stumps to meet the land user's needs and goals, then trees can be nurtured through naturally sprouting seeds. These should be protected from damage by animals and humans, so they can grow large enough to start pruning and managing. While they won't have the advantage of mature root systems to give them the fastest start, land users can prune and protect them to ensure the best possible outcome.

Zai holes (planting pits containing compost) and half-moons (semi-circular water harvesting structures) can also be used to start growing trees. In Figure 6 seeds were introduced inadvertently through the manure placed in the pits.



**Figure 3** Pruned and marked trees in Niger, 2011. If marking with ribbon, attach this loosely to a side branch. Photo: World Vision



**Figure 4** Community FMNR agent identifying stumps for regeneration in Marigat, Kenya (May 2018). Photo: A. Muller



**Figure 5** Half-moon micro-catchments are used around acacia trees (*Senegalia senegal*) for water retention at a landscape restoration site near the village of Loga, Dosso Region, Niger (September 2017). Photo: Rodrigo Ordonez/GLF<sup>6</sup>



**Figure 6** Zai pits have been dug and will be filled with organic matter, including animal manure, before crop planting. Often, manure contains tree seeds that will germinate in the zai pit. Maradi District, Niger (c. 1985). Photo: T.Rinaudo

<sup>6</sup> First published by Landscape News (October 2017). See the original article, '[How do you stop the desert? Niger may have the answer](#)', for more information around half-moons and other landscape restoration methods.

If there are no naturally occurring tree stumps or seedlings available, it is also possible to raise trees in a nursery, plant out and manage them using FMNR techniques. This is more labour intensive and costly than practising FMNR with existing root stock, and may not be as successful, but the principles of pruning and protecting will provide the same benefits to nursery trees as they do to wild seedlings. When seedlings are planted, or seeds are directly sown in zai holes near half-moons, the chances of successful tree establishment increase, particularly in more arid environments.



**Figure 7** Thinning dense vegetation to allow for more productive use of land, such as better grass production and access for grazing livestock. Marigat, Kenya (May 2018). Photo: A. Muller

### What if there are already lots of trees?

Some FMNR sites may not require more regeneration, but instead may focus on the better management of existing trees, shrubs and even grassland. The same process of species surveying, prioritisation and selection still applies; land users can choose which trees and shrubs they would like to manage, and what management needs to occur to help them reach their desired goals.

Tree management may include pruning techniques, such as thinning and pollarding, or harvesting of branches or leaves. For shrubs with multiple stems, three to five stems may be selected and pruned to encourage the shrub to grow to a larger tree form.

Regeneration of grasslands can be encouraged by thinning dense shrubs that may be competing with grasses, reducing the grazing pressure from livestock through rotation or short-term exclusion, introduction of improved grass seeds, and implementing soil and water conservation practices that reduce water run-off and increase infiltration into the soil.

Refer also to the section on page 52 on FMNR in woody thickets.



### Feel like you don't know enough about tree species and how to identify them?

Remember, information on how to identify different tree species and their uses can be collected through:

- local knowledge gathered through meetings, focus groups, site visits, taking stock workshops and local expert experience;
- literature, reference material, tree manuals and guides such as the [Agroforestry Database](#), the [Vegetationmap4africa species selection tool](#) and [Promising Agroforestry Tree Species in India](#);
- observations of where you see trees growing naturally. Consider what is noteworthy about them. Do they appear to suppress grass growth? Do they harbour pests? Do they harbour beneficial organisms?;
- expert knowledge from researchers, forestry and agroforestry experts, extension staff and experienced individuals; and
- FMNR champions and trainers from other FMNR projects in your country, or beyond – check in with the FMNR Hub.

## Examples of common FMNR species

There are some species commonly found in FMNR sites around the world. While these specific trees may not be available on your site, you might find alternative local species with similar characteristics and values, which would also make them valuable for FMNR.

As you will see from the following list of popular trees, the species that land users select are not always the ones you would expect. For example, not all are nitrogen fixing, and some grow a heavy canopy that shades nearby crops. Others have shallow root systems, which can limit crop growth. However, a unifying thread is that they all serve a useful purpose, or purposes, important to the land user.

If any of these species are available on your FMNR site and meet your community's priority needs, they may be a good place to start.

### *Ziziphus mauritiana*

*Ziziphus mauritiana* is a medium-sized tree that grows vigorously and has a rapidly developing taproot. It is a popular FMNR tree in many parts of the world, and can be found throughout the tropics. *Ziziphus* has multiple uses for its durable wood, leaves for fodder and thorny branches for fencing. The fruit of wild growing *Ziziphus* are very small and have low or no market value. However, improved varieties are available and can be top grafted onto the regenerating trees. The fruit has high value in the fresh fruit market or for juicing. A case study of one farmer's experience with this fruit, 'the apple of the Sahel', can be found on page 58.

### *Prosopis cineraria*

*Prosopis cineraria*<sup>7</sup> is a widely grown agroforestry tree in India, where it is intensively managed for fodder production. It is also widely found in arid areas of the broader southern and western Asia region and into Southeast Asia. In many parts of India's Thar Desert, *P. cineraria* pods are used as a vegetable in the dried and green form. The sweetish bark has also been ground into flour and made into cakes during periods of food scarcity. Leaves are used as dry fodder, while the tree itself is an excellent fuel, providing high-quality charcoal. The tree is also used for timber, gum and tanning, as well as for some medicinal purposes.

### *Acacia* species

Many of the thousands of *Acacia* species existing in the world are useful FMNR species, often providing fodder, light, shading and nitrogen fixation for soil fertility, among other benefits. Many *Acacia* species are thorny, which may deter some land users, however these thorns can also become valuable living fences and help protect young regenerating plants from livestock. Specific species such as *Acacia tortilis* and *Acacia senegal* are often regenerated in low-lying savanna fields, and provide multiple products including fodder and gum. *Acacia nilotica* is found in South Asia and East and Southern Africa, and is particularly popular as a place where bees forage as well as a source of fodder for livestock during dry periods.

### *Cordia africana*

*Cordia africana* is a popular cropland tree in Ethiopia, even though it doesn't appear to be nitrogen fixing and is broad-leaved, capable of casting heavy shade. However, its popularity may be attributed to its many useful products, including edible fruits, fodder for livestock, nectar and pollen for bees, firewood and reasonably termite-resistant timber. In addition, its thick canopy is used in coffee plantations to provide shade, while leaves that fall during the dry season provide a heavy mulch. The trees grow quickly and are often managed through pollarding and coppicing.



**Figure 8** *Acacia nilotica* is commonly used for fodder. Bark, pods and leaves provide valuable sources of food for livestock in dry seasons and the flowers are important for honey production. Marigat, Kenya (May 2018). Photo: A. Muller

<sup>7</sup> Another *Prosopis* species, *Prosopis juliflora*, has been used effectively to address severe land degradation. In some areas, due to its resilience, it has become highly invasive and dominant, as in Kenya's Baringo County. Unlike *P. cineraria*, this species is not palatable by livestock, but it is an excellent fuel as firewood or charcoal.



### ***Faidherbia albida***

*Faidherbia albida* is perhaps the queen of agroforestry trees, with a number of unique qualities which have made it a popular farm tree across large parts of Africa.

*F. albida* is most valued for its nitrogen-fixing properties and reverse phenology. Unlike most trees, it sheds its leaves during the rainy season, so it's well suited for growing among crops. It doesn't compete with crops during the main growing season, and provides light, and beneficial shade during the hot dry season, where it can reduce air temperatures by up to 10 degrees Celsius and soil surface temperatures by as much as 35 degrees, providing crops with better growing conditions. The leaves from this legume tree are high in nitrogen and can double yields in maize crops when added to the soil.

The flowers provide valuable food for bees at the close of the rainy season, when most other plants are not flowering. Pods and foliage are highly regarded as livestock fodder and can be collected and sold in markets. However, while the wood is used for carving or other uses in some places, it is not a high-quality firewood.

### ***Pilostigma reticulatum***

*Pilostigma reticulatum* is the most common FMNR tree in south-central Niger. It's a broad-leaved shady tree with deep and shallow roots, known for its nitrogen-fixing properties. The tree is used for firewood, timber, fodder, medicine, fibre, dye, famine food and shading. After drawing up deep water from the soil profile, it 'leaks' through its shallower roots, enabling nearby crops to thrive even in drought time through hydraulic lift.<sup>8</sup> Despite the heavy shade provided by the tree, crops do very well right up to the base (see Figure 10). Farmers can control how many trees they leave on a field and how they prune them to manage the shading of crops.

### ***Guiera senegalensis***

*Guiera senegalensis* is a very popular FMNR tree in Niger and across the Sahel in cropping land. The species uses 'hydraulic lift', where water is brought up by the roots from deep in the soil profile. The tree has multiple uses, including edible gum, medicines, fodder, firewood and timber for light construction poles, and is found across the Sahel.



**Figure 9** *Faidherbia albida* - young trees in a field in Tigray, Ethiopia. Photo: T. Rinaudo



**Figure 10** *Pilostigma reticulatum* in a field in Malawi (2015) Photo: T. Rinaudo



**Figure 11** *Guiera senegalensis*. Photo: Marco Schmidt/Wikimedia Commons

## **Tell us about your favourite FMNR species**

The species listed above are only a small selection of species regularly regenerated by land users through FMNR. We would like to know more about what species are being regenerated, as well as where and how they are being used. This information can also be very helpful for beginners to FMNR.

<sup>8</sup> [This paper](#) explains more about some of the beneficial properties of *Pilostigma reticulatum*.

## Practice 2 – Pruning and management

Once the preferred species and stumps, trees or seedlings to be regenerated have been selected, it is time to start pruning and managing the trees to allow them to grow tall and reach their full potential. The pruning technique described below is the basic approach used in most situations. Over time, land users may adapt their techniques to maximise the particular outcomes they are looking for.

In addition to pruning, managing threats to the trees such as livestock, weeds, pests and disease is also necessary to give them the best chance to regenerate.

### The three golden rules of pruning

While the act of pruning itself is not difficult, there are three golden rules to keep in mind to prevent trees becoming diseased or damaged:

**1) Use sharp tools.** Sharp saws or secateurs are ideal pruning tools, since they provide a clean cut. If you don't have these tools, then machetes, harvesting knives, axes and even hoes will work fine as long as they are kept sharp.



**2) Wherever possible, cut upwards not downwards.** Cutting upwards causes less damage to the bark, so the tree will recover faster. Because this technique is less damaging, it also reduces the risk of disease and insects entering the wound where the tree has been cut.

**3) Don't prune stems too high.** Pruning too high up the stem may make the stem too fragile or top heavy to survive wind or animals brushing against it.



On small stems, it is best to prune no more than halfway up the trunk.



On established trees over two metres tall, prune no more than two-thirds of the way up the trunk.

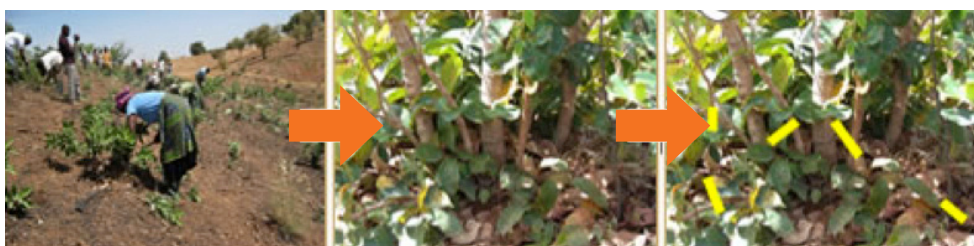
Note: Pruning for habitat creation in a forest setting may be much lighter than what is demonstrated above.



### Step 3: For each stump, select three to five stems to keep and prune away the unwanted stems

After selecting the stumps, the land user now decides how many stems will be allowed to grow on each one, based on his or her needs, the species selected and the ultimate objectives of the area. In general, it is advised to start by leaving three to five stems per stump.

The middle photo below shows multiple stems sprouting from a tree stump. In this case, we would suggest keeping up to five of the tallest, straightest, most vigorous stems, and pruning away the smaller, crooked and weaker ones.



If possible, tag the stems you are keeping with a coloured rag or paint. This helps identify the stems you want to keep and, after pruning, it tells others this tree is being managed and needs to be left alone. It's important to avoid tying a tag on the main stem, because as the stem grows it will be 'choked' by the tag. Instead, tie it on a side branch.

While it is possible to leave and manage only one regenerated stem, it's usually better to keep three to five, at least initially. This is because:

1. More than one stem allows the land user to harvest some of the regenerated wood in the short term, while still leaving a main stem to mature into a tree. Surplus stems can be harvested each year for firewood, stakes or poles, while leaving the main stem to continue to mature. A new sprout should be allowed to grow every time a stem is harvested.
2. Keeping multiple stems allows the land user to tie them together when they are young, to help protect them from livestock and strong winds. Several stems tied together are harder to break than single stems.
3. If one or multiple stems are damaged by animals or strong winds, some will remain to grow into maturity. If you only have one stem to start with and it gets damaged, it will take longer for a new shoot to emerge and replace it.

### Step 4: For each remaining stem, prune side branches up to halfway up the trunk.

Under normal pruning practice, side branches are cut flush with the stem. However, in most areas where FMNR is practised, there is no fencing to deter livestock from trees. To help protect new growth, it is possible to cut the side branches 10 to 15 centimetres from the stem as a slight deterrent to livestock. After a year or so, when the tree is more robust to resist damage, these short side branches can be pruned right back to the trunk.



**Figure 12** Lightly pruned trees are able to withstand livestock grazing, Niger (2011). Photo: T. Rinaudo



### Record what FMNR has taken place

This is a good time to record some details about the **trees and stumps** being managed with FMNR. This information will help with monitoring and evaluating your activities to learn what is working and what is not (see [Chapter 10](#) on monitoring and evaluation for FMNR for more details), as well as serving as a powerful reminder of how much the trees you are managing have grown. While FMNR success does not require taking measurements, collecting this data will better inform you what is happening, contribute to the growing body of FMNR knowledge, and shape the way FMNR is implemented in the future.

After each FMNR attempt, remember to:

1. Record the species and number of trees and stumps being managed with FMNR.
2. Take a picture of the site after pruning from established photo points. If possible, activate geolocation functions on your camera or smartphone to record the GPS coordinates.

If you wish to track the growth of the trees over time, you can:

3. Measure the diameter at breast height (DBH) in centimetres for any tree greater than 1.3 metres.
4. Note any other management practices being used, such as stock exclusion.

See [Annex 10](#) for tools to record information about the trees that are present.

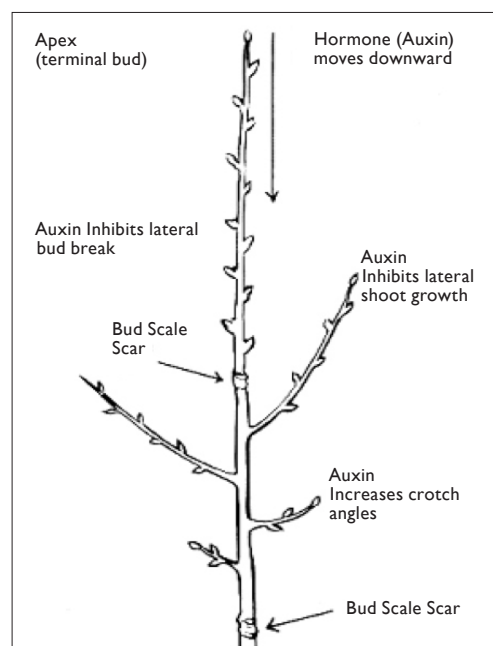
### Apical dominance: a plant's response to pruning, and why we prune!

Often the purpose of pruning a plant is to encourage it to grow taller, with larger stems. However, pruning stems and leaves away can seem counterintuitive to helping a tree grow bigger.

But plants, like humans, only have a limited amount of energy available to put into growing. If we can encourage them to channel this energy into growing certain stems, in certain directions, we can make plants taller and stronger.

Plants create a hormone called auxin at the topmost bud or growing tip of each branch. This hormone prevents any side branches from shooting too close to the tips. Plants that produce a lot of auxin generally have fewer stems and longer/taller habits. Plants that produce less auxin may have more branches and a thick, dense habit.

To encourage more vertical growth, it is important to prune away side branches, and not the topmost growing bud (also called the apex or terminal bud). This is why, although we retain a certain number of stems when pruning in FMNR, we always cut away the lower branches. (You can also choose to prune just the terminal bud of the lower branches, leaving a short stem for a level of protection from animals, at least in the short term.) By removing the terminal bud, the plant restricts its growth to a few stems – helping to grow them tall and strong – and doesn't waste energy growing multiple smaller stems. We don't remove all side branches, because this would result in the loss of leaves, which convert energy from sunlight into sugars used by the growing tree. Pruning is a balance between focusing tree growth and ensuring there are enough leaves left to fuel the growing plant.



**Figure 13** Parts of a tree or branch where growth occurs, or growth is hindered during pruning. Image: SickTree.com

## Step 5: Protect the stems while they are growing

Once you've done the work of selecting, pruning and maintaining trees, it's important to ensure your trees will not be damaged. FMNR regrowth is harder than transplanted seedlings, so reforestation using FMNR may succeed even without excluding livestock. However, if it is possible to exclude livestock from FMNR areas for six months to a year, this will give trees their best chance to become tall and strong enough to withstand grazing pressure. If you can't exclude livestock completely, don't let that stop you. There are still ways to protect your trees, such as:

1. Pruning side branches to deter stock slightly (see Figure 12 on page 46).
2. Setting aside a small portion of land each year to regrow trees away from livestock. In the second year, grazing is allowed among the first group of trees, and a new location is selected for excluding livestock and practising FMNR. This method is easiest for individuals practising FMNR on their own land, but can be performed on communal land as well, provided there is good communication and accepted bylaws.
3. Tying any thorny prunings around the stems to be regenerated, to discourage livestock.
4. Tying multiple stems together to make it harder for livestock to damage them.

### Social fencing

Protecting trees doesn't need to be laborious or expensive. Using thorn branches is one traditional method of protection, but these are often difficult and labour intensive; in fact, traditional fencing techniques can involve the cutting down of thousands of thorny trees to protect large parcels of land, increasing deforestation. Other options, such as wire fencing, are very expensive and beyond the reach of most land users. Reforestation projects often use paid guards, which is unlikely to be sustainable once funding ceases. In some cases, initially employing some guards may be necessary. However, even in these cases, the ideal intention would be to steer the community towards ownership of and responsibility for the sustainable management of trees.

When we talk of protection, what we usually mean is 'social fencing'. That is, an agreement between everyone using shared natural resources (in this case, land and vegetation) to follow a jointly developed set of bylaws on how to manage these resources. In practical terms, this includes self-imposed regulations on livestock movements, use of fire and harvesting of trees.

When these bylaws are embedded in traditional legal structures, they can be just as or even more effective than wire fencing, which after even a short period can be no match for resourceful, hungry goats. In Timor-Leste, communities were encouraged to revive aspects of their largely abandoned traditional legal system, *Tara bandu*, to great effect. *Tara bandu* can be simplified as a system of local rules set by different communities, including limitations on how, when and by who trees can be cut.

## Practice 3 – Maintain and utilise regenerated trees

### Step 6: Prune unwanted emerging shoots every two to six months as needed

New branches and stems will continue to emerge, so every two to six months it is best to return and prune away new growth. This will produce straighter stems and help the selected stems grow quickly.

Land users may find this easiest to do this during the dry season, when there are lower labour demands, but pruning can be performed any time that works well for those managing the trees.

Once regrowth reaches **two metres or more**, it should be safe to prune side branches **up to two-thirds of the way up the stem**. However, the more branches you leave, the more leaves will be photosynthesising and fuelling tree growth. Crop farmers tend to over prune trees because they want to minimise shading of crops. A healthy compromise is to avoid over pruning, while keeping shade to a minimum.



## Case study

### Timing pruning and livestock exclusion in Niger

In Niger Republic, 240 million trees have been regenerated – without fencing. FMNR practitioners pruned regrowth on tree stumps before the onset of rains and the busy crop-planting season. Once crops were sown, livestock were automatically excluded from cultivated areas, giving the emerging FMNR trees a five- to six-month window of opportunity until harvest to grow free from livestock damage.

There is no doubt that some damage occurred once livestock returned to the fields, especially when large herds and flocks passed through. However most of that damage was so mild or localised that it did not affect the overall spread of FMNR, or the growth of the majority of trees.

### Step 7: Utilise trees for planned purposes

FMNR trees can be managed for a wide range of purposes, depending on the land user's needs. Often, many of the traditional uses of trees will be known by someone in the community, and may have been identified during the FMNR species selection process (see Step 1). Resources such as the [Agroforestry Database](#) provide advice on how different tree species can be used, if these uses are not already known by someone in the community. Most FMNR practitioners have found ways of using prunings as well, whether for fodder, firewood or mulch.

Using the pruning system described above, land users are encouraged to harvest one stem per year over a four- to five-year cycle, always allowing a new shoot to replace the harvested stem. Ideally, in the fifth year, the largest stem will have attained tree stature and, when there is a need, land users are encouraged to harvest up to a third of the tree's branches in any one year. This way, there is no danger of replacement branches being damaged by livestock (they are too high), the tree recovers quickly, and the land always has a measure of protection from the standing tree.

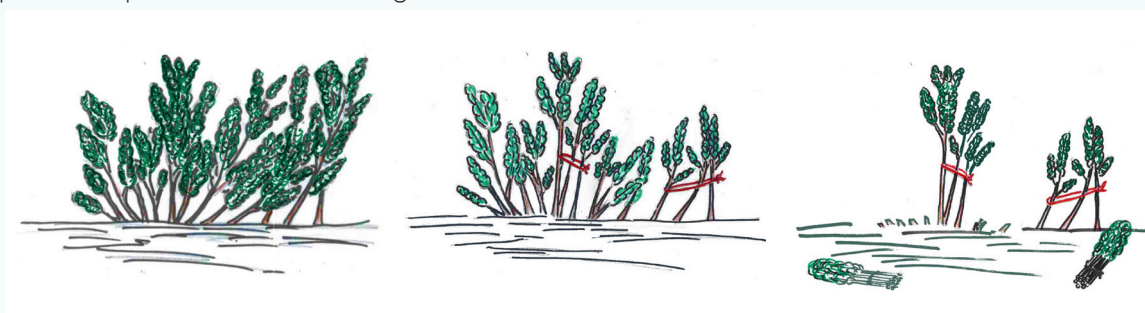


## Case study

### Combining pruning with fodder collection by children

In Niger Republic, FMNR-practising land users were getting very discouraged because children collecting fodder would regularly break off all the stems left to regrow.

In such cases, a win-win solution is to host a community meeting and announce that, from now on, any stems the land user wants to keep will be marked in some way – with paint, or a cloth or tied together. Rather than pruning away the remaining stems during the normal FMNR pruning period (prior to the onset of rains in Niger), land users will leave them for children to harvest. The success of this tactic relies on strong community leadership, careful messaging, capacity building, advocacy and, where possible, supervision and monitoring.



1. Select sprouting tree stump.
2. Desired stems have been pruned and 'marked', in this case by tying them together.
3. Children harvest the remaining 'unwanted' stems for fodder and kindling.



### A final word on pruning

Different species may require different pruning techniques; depending on the intended uses of each tree, some ways of pruning may be more useful than others. That's why FMNR can never be prescribed as 'one right way'. Rather, the right way must be determined through experimentation and observation, with land users empowered to do what is most effective for their needs and goals.

## Examples of common FMNR systems

The FMNR practice varies from context to context and even from individual to individual, however the principles of thinning, pruning and managing regrowth are constant. The basic steps are simple, but the ways FMNR is practised are nearly as varied as the people who practise it.

Here are a few examples of how land users are practising FMNR around the world. (Undoubtedly you will come across something new before long.)

### FMNR in cropland

Almost universally, farmers think trees on farmland will reduce crop yields. However, there are many examples where farmers have experienced no detrimental effects at all; some studies in Southern and West Africa have shown harvests to double or triple in fields with trees. This is possible where trees with the right characteristics are selected. Examples include nitrogen-fixing trees such as *Faidherbia albida* and species such as *Guiera senegalensis* and *Pilostigma reticulatum*, which draw water from the soil through hydraulic lift and disperse it within reach of crop roots. Many species also have mycorrhizal associations on their roots, which make more water and nutrients available to crops.

In FMNR systems, farmers can help control how much shading of crops occurs by the severity of pruning undertaken, and by the number of trees regenerated. To reduce competition during the growing period, some regenerated shrubs are routinely coppiced (pruned back heavily to just above ground level) as crops emerge, but are left to grow and provide ground cover when the crop is harvested. Trees also may be pollarded (all branches except the main stem removed), for the same benefits.

Many land users don't follow a particular pattern when regenerating trees in their fields, while others only regenerate trees that fall into a pattern they prefer, such as along the edges of fields, or arranged to protect crops from harsh sun or wind. In one district in Mali, for example, FMNR practitioners only leave trees that are growing approximately in straight lines, where they will also transplant naturally occurring seedlings. They grow most of the trees as bushes, slashing them to ground level each year except for single stems roughly 12 metres apart, which are allowed to continue growing into trees. The reasons for this are:

- so that the trees do not interfere with their ploughing;
- because they require low windbreaks in their fields to combat severe wind erosion; and
- because soil infertility is a major problem, and they can address it by mulching with the pruned branches.

Sometimes farmers choose FMNR species they know will have a detrimental effect on crop yields, but are prepared to allow this because of the value of the tree or tree products, such as fruit, medicine or fodder:



**Figure 14** Trees regenerated with FMNR can be seen interspersed across cropping fields. Malawi (2015). Photo: T. Rinaudo



## FMNR with *Faidherbia albida*

*Faidherbia albida* is a very popular fertiliser and fodder tree across much of Africa. Transplanting *F. albida* is expensive and tricky, as it develops a long tap root early in its life and can suffer shock during transplanting. However, where *F. albida* occurs naturally, there will nearly always be an abundance of naturally occurring young trees growing from seed, stumps and even from roots. Characteristically, young trees are multi-stemmed and multi-branched. With this species, it is preferable to leave just one main trunk and cull the remaining stems.



**Figure 15** Young *Faidherbia albida*, regenerated in a teff field through FMNR. Tigray, Ethiopia (2010). Photo: T. Rinaudo



**Figure 16** The value of revisiting pruned trees can be seen in this photo, where new shoots have sprouted from the tree's base. These should be removed before they grow too large. The side branches have also grown; at this stage, these could be shortened. Ethiopia (2010). Photo: T. Rinaudo

## FMNR in woody thickets

Forest clearing and annual burning has resulted in bush encroachment in many subtropical and tropical regions, and some semi-arid tropical ones. When this happens, dense, impenetrable thickets of multi-stemmed bushes, thorn trees and vines grow to dominate the landscape after clearing, effectively turning them into 'green deserts'. These provide little benefit to either wildlife or humans (see Figure 17).

When FMNR is applied to woody thickets, branches are pruned and the thicket is thinned. This allows access for wildlife and livestock, increases fodder availability and reduces competition between trees, allowing them to reach their full size in a shorter time. Depending on the project's objectives, FMNR can also be nuanced to leave pockets of dense growth, which may be preferred by certain bird and animal species.



**Figure 17** Bush encroachment after forest clearing (left). This thorn thicket is impenetrable by most wildlife and livestock. Effectively, a 'green desert' has been created. In the photo on the right, FMNR has been applied to an area of bush encroachment. Photos: T. Rinaudo (2013)

## FMNR for forest conservation

FMNR can be successfully used to regenerate degraded forests. In forests that have been disturbed through clearing or over harvesting, there may be low species diversity or bush encroachment, leading to poor forest structure. Forests that can provide sustainable benefits, such as the provision of medicines, fruits and firewood, are more likely to have the support of the surrounding community, making them easier to conserve.

FMNR practices of thinning and pruning in a forest setting reduce competition and allow light to penetrate the canopy. While the ultimate goal is to create a biodiverse, natural forest, multiple stems can be left on each tree stump to meet short- and medium-term needs of the communities now managing and utilising the forest.

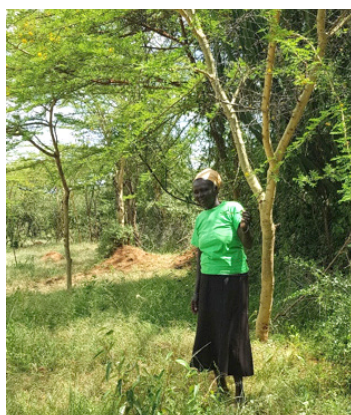
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**Figure 18** Forest restoration through FMNR. These photos are taken of the same hillside in 2005 (left) and 2017 (right). Humbo Community Forest Restoration Project, Ethiopia. Photos: T. Rinaudo

## FMNR in pastoral land

Because pastoral lands are used for grazing livestock, the focus for FMNR in these areas is the plants that grazers and browsers feed on. These include trees and shrubs as well as grasses. Leaves and sometimes the bark of many species are eagerly sought after by sheep and goats, making regeneration in these areas challenging at times. This can be managed by excluding or limiting the access of livestock to regenerating areas, until the trees are large enough to withstand some grazing. Another option is to leave more branches and stems than desired until the tree has grown beyond the reach of livestock. Thorny species will also offer some degree of protection.



**Figure 19** This area has been managed with FMNR to increase grass production for livestock. Kenya, (2017). Photo: A. Muller



**Figure 20** Pasture land managed with FMNR (left of fence) in Senegal. Photo: beershebaproject.org

Alternatively, prunings of branches and stems can be tied around remaining stems. This makes it harder for livestock to browse emerging new growth. Side branches can also be used to protect young FMNR plants from livestock, by truncating branches and tying pruned branches back against the tree.

The density of vegetation regenerated in pastoral areas is often managed to maximise grass growth, where low shading from light canopy cover can reduce evaporation and encourage grass growth. Often FMNR in pastoral areas is combined with the regeneration of grass species and ground cover.

## FMNR for water management

Increasing the number of trees in critical locations across a landscape can help address issues such as erosion, land instability, salinity and depleted groundwater resources in catchments or watersheds. Trees on hillslopes and upper catchment areas can assist in slowing the rate of surface run-off, allowing more time for water to infiltrate and recharge groundwater reserves. There are many examples of FMNR sites where long-absent natural springs have returned in great volumes. See the case study on Abreha Weatsbha in Ethiopia later in this chapter.

In areas where water tables are too high, bringing salts to the surface, trees can be used to absorb water and allow these minerals to recede.

Trees and vegetation restored in wetlands and riparian zones (along waterways) are important for ensuring water quality. As well as filtering sediments and impurities, trees can also reduce excessive evaporation and high temperatures, which may affect water quality and availability.

By increasing shading and ground cover on farmland or grazing land, FMNR can reduce the loss of soil moisture through evaporation, making more water available for crops and grasses to grow. Trees can also be regenerated along soil and water conservation structures such as bunds and terraces to help stabilise these structures and boost their ability to conserve water.

### **FMNR on communal sloping or degraded land**

Usually, any non-agricultural sloping land is communal land. To implement an FMNR program on these slopes, it is necessary to work through community groups. This often requires a lot of advocacy, awareness raising and patience. If communities do not have exclusive or predominant access rights to the area, then it is important to engage with authorities to ensure they have legal user rights. Without reasonable assurance that they will benefit from any improvements they make to the communal land, communities are unlikely to persevere with FMNR beyond the life of a project or intervention from external parties. Local development of bylaws and enforcement procedures is also required for ensuring the shared natural resource base is managed in a way that enhances the environment and provides optimal benefit for the community.

FMNR on communal land provides a number of valuable goods. These include fodder, traditional medicines, firewood, timber and wild foods, as well as ecosystem services such as groundwater recharge, increased crop pollination (through increased pollinating insects), increased crop protection (through increases in birds and insects), improved nutrient cycling and soil fertility, plus reduction in erosion, flooding and even landslides. Potential negative effects include an increase in wild animals, which may be perceived as threats to crops or livestock.

### **FMNR along fence lines**

Sometimes, and especially when FMNR is a new concept, farmers just can't bring themselves to restore tree cover on their valuable crop or grazing land. At the very least, they should be encouraged to practise it on the farm borders: along footpaths, in gullies and on rocky outcrops and hilltops. Restoring trees along farm borders can provide many beneficial goods and services. Not only can trees act as a windbreak and shelter belt for livestock, but farmers can harvest various products from them, such as firewood, wild foods, traditional medicines, dyes, resins, honey and fodder – depending on the species present. The trees also provide critical habitat for birds and wildlife, acting as wildlife corridors and increasing biodiversity.

Farmers also gain experience from managing trees and will make observations on the impact various species are having on crops and pasture. Practising FMNR along farm borders may be a stepping stone for farmers to eventually adopt the practice on more of their land.

## **Combining FMNR with other practices**

The comprehensive benefits of FMNR make it a foundational practice for sustainable development. Increasing tree density and biomass has positive benefits for soil fertility, water availability, biodiversity and other ecosystem functions performed by a healthy environment. Without a strong, functioning environment, it is very difficult to achieve food security, economic development and resilience to shocks. FMNR is a foundational and complementary intervention that is rarely promoted as a standalone activity.

When planning FMNR interventions, it is important to address key limiting factors to sustainable livelihoods in order to take an integrated approach. Are water shortages, food insecurities or a lack of income-earning opportunities contributing to deforestation and land degradation? Unsustainable use of forests or trees on farms – such as excessive harvesting for charcoal or fodder – is a common detrimental coping strategy when people are desperate.

Finally, sometimes the short-term reduction in productivity as trees grow, and the mid-to-long term return on investment, can be seen by communities as a barrier to implementing FMNR. This is especially the case for the most vulnerable people, who prioritise immediate return on investment to cover all their daily needs. Combining FMNR with other livelihood options that provide short-term benefits, such as poultry, bees and market gardening, increases the likelihood of FMNR adoption.

Because of this, it is common to see FMNR interventions combined with other practices such as soil and water conservation, improved livestock management, climate change adaptation, disaster risk reduction or management,



economic development, irrigation and improved farming techniques. In fact, as long as communities are not overwhelmed with too many interventions simultaneously, FMNR is much more likely to be adopted when there are a range of benefits and entry points with which to engage them.

## Building on the FMNR foundation

FMNR complements and improves the productivity of most agricultural practices, and many other forestry and natural resource management practices. When choosing complementary practices to be combined with FMNR, it is always wise to use the most locally adapted and climate-smart practice available to increase the long-term success of farming, herding or forestry.

Many interventions that complement FMNR, such as market gardening, beekeeping, fodder production and animal fattening, will also provide short-term benefits while the trees are growing and not yet providing an income. Such activities help land users commit to FMNR by providing essential short-term benefits.

The forestry, agriculture, environment and development practices that benefit from and complement FMNR are too many to name here, but these are some key practices often found in FMNR projects.

## Beekeeping

Beekeeping and honey production benefit from an increase in trees, and can be a beneficial source of food and income. Beekeeping can also provide a valuable source of income during the short 'start-up' period of FMNR, when new trees are being protected but not yet contributing economic benefits. In fact, in East and Southern Africa, beekeeping in combination with FMNR is at the same time a major economic driver of the uptake of FMNR and an incentive to protect trees. Land users will go to great lengths to protect their considerable investment in beehives, as well as the resource base that makes honey production and the resultant profits possible: nectar-producing trees.



## Case study

### Beekeeping in Somaliland

An excerpt from: **From desperation comes hope: FMNR in Somaliland, April 2016**,  
by Silvia Holten, World Vision Germany

The landscape in Somaliland is barren and desolate. Here and there, there is still some greenery, but it is mostly an invasive thorny tree called mesquite (*Prosopis juliflora*), that is beginning to overrun thousands of hectares of land. During 2016, drought conditions affected large areas of the Horn of Africa, leading to widespread livestock deaths and weakness, that affected the largely pastoralist communities dramatically.

But even for a dry region like Somaliland there is hope for a better life and as bad as the drought is, it is also an opportunity for people to think of alternate livelihood strategies. Many pastoralists are now ready to settle down and grow fruits and vegetables. Farmer Managed Natural Regeneration (FMNR) has been used by some communities and despite the drought and barren soil, there are astonishing results. An FMNR pilot project, which was fenced to protect regenerating trees from livestock, has shown successful results. The head of the community, Haybe Ismail Buni told us that many trees have now grown well – from 90cm in 2014 to now 1.90cm. The trees – mostly indigenous acacias – provide shade, fuel wood and fodder. They help to build soil fertility and to prevent erosion. Meanwhile, because of the emerging forest, the community has started bee keeping. Already three harvests have been made with a total value of 1,450 USD. Because of the success of this pilot, neighbours are beginning to copy it, and current group members are practicing FMNR outside of the pilot area.



**Figure 21** Beekeeping in FMNR sites in Somaliland is a profitable exercise (2015). Photo: M. Badoreck

## Fodder production

Leaves and seedpods of many trees are highly nutritious, while the regeneration and management of trees in pastoral areas contributes to an increase in grass growth. When trees are still being protected, fodder from grass in the field or tree prunings can be collected and carried away to supply animals. As the FMNR trees become established, animals can graze in regenerated areas, or a cut-and-carry system can be used in combination with holistic or rotational grazing systems (see below for more information). Fodder can also be dried and stored as dry or cold season feed.

In East Africa, land users are reporting increased stocking rates and milk production through FMNR of between 200 to 500 percent. Trees can also act as a standing fodder reserve, which is drawn on during times of drought and fodder shortage. In this way, land users not only manage to feed their animals during drought, but they also avoid devastating stock losses that are very difficult to recover from.

As grass-growing conditions improve through the effects of FMNR, it also becomes more viable to invest in grass seed varieties that provide high-value fodder. The collection and sale of valued pasture grass varieties can also be a lucrative income source for families.



## Case study

### Fodder production in Kenya

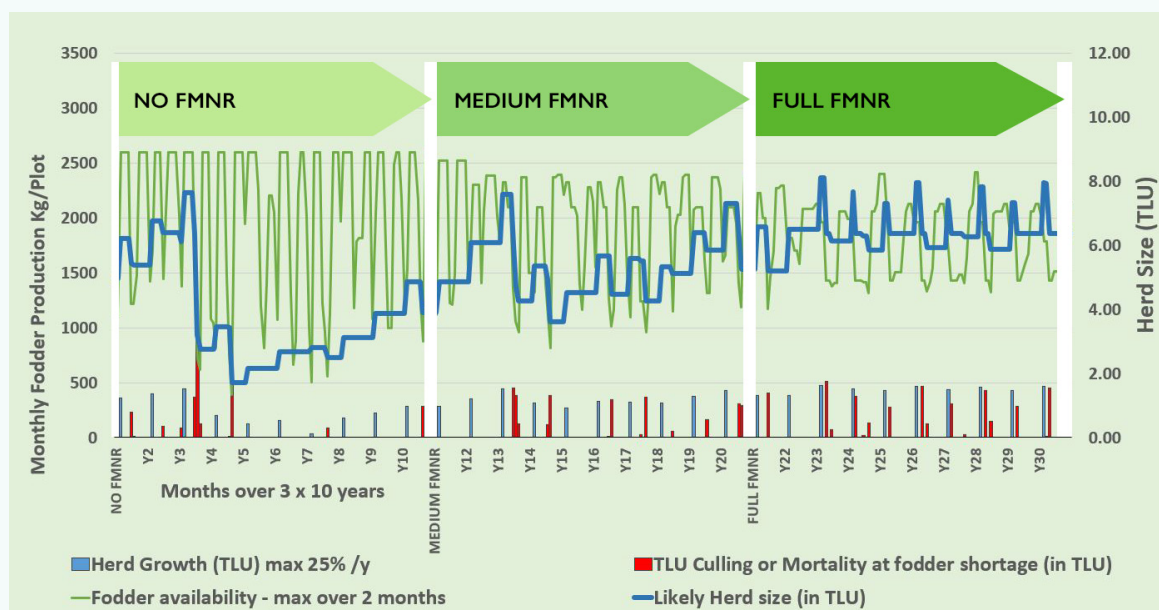
Nancy, a farmer in Baringo, Kenya, has been using FMNR to foster tree regeneration on her land. In the past, the dry season each year would reduce the grass so much that her cows would have nothing to eat and in dry years many died. Since regenerating trees in her pasture land however, Nancy has had no cows die, even in years where neighbours' cows have succumbed. Nancy believes this is thanks to FMNR.

When there are no trees on the land, rain and sun reach the soil directly. This leads to more and more dense grass during moist seasons. After one month without rain, grass stops growing. A cow can survive only two months without fodder. On land with carefully pruned trees the growth of the grass is sufficient throughout the dry season. No cows will die of malnutrition. Nancy says: "trees make grass grow". This picture shows it: the grass is darker around the trunks.

What is the best ratio between trees and grassland? Nancy knows. Her neighbours grow few trees, and their cows died last dry season. An economic modelling tool was developed (called FarmTreeTool) to try to answer this question. The ideal ratio of trees to grass on land such as Nancy's was developed. The graph on the next page shows Nancy's observations are reflected in data about the interactions between the trees and grass cover.



**Figure 22** Nancy is using FMNR to increase her grass production. Kenya (2016).  
Photo: F. Schoubroeck



The left side of this scheme shows a plot without trees, only grass. The situation is very uncertain. In wet periods, grass production is high – but during drought, fodder shortages wipe away almost a complete herd. It takes years to rebuild a lost herd. In the middle you see what happens if you allow local trees to grow on the grassland spontaneously and you prune them according to regulations: grass will endure the dry season longer. Still, the situation is not stable in the first few years. To retain enough water in the soil, you need sturdy, well pruned trees with open space for grass. On the right-hand side of the scheme you see the ideal situation. Mortality of cattle caused by drought is something of the past. Grass is growing less in wet months – but it grows year-round, feeding the cows. In times of scarcity dried bark can be fed to the cows. Goats will thrive on the tree leaves. The farm flourishes: cows may be sold or used for meat and milk at times the prices are high.

For more information about the FarmTreeTool see the [Farm Tree Services website](#).

### Small livestock, animal fattening and breed improvement

As grass, nutritious seedpods and leaves become more plentiful in FMNR sites, these can be stored by FMNR practitioners and used to fatten animals for profit. Now that additional feed and shelter is available, additional small livestock enterprises such as poultry or rabbits can also be introduced. These small breeds are of particular value to women, who can benefit from income, eggs and meat. This is another way to diversify incomes during the start-up period of FMNR, before trees are mature. Furthermore, once reliable fodder supplies are established, investments in improved breeds of livestock become more successful, and can be used to increase herd quality and productivity over time.

### Market gardening

Home gardens or crops made more viable by the practice of FMNR, through improved soil quality and micro-climate, can be used to not only provide greater nutritional diversity at home, but also a good source of income. High-value wild fruits or other non-timber tree products such as gums, resins or medicinal herbs can also provide additional income before the trees are ready to harvest.





## Case study

### How the apple of the Sahel is feeding families in Niger

On his farm, Yaouza practises FMNR with a range of indigenous trees for various purposes. But one of his favourites is a modified variety of *Ziziphus mauritiana*: pomme du Sahel or, as it's known in English, 'apple of the Sahel'. The hardy tree produces a delicious, apple-like fruit that not only sells well, but is high in vitamin A and C.



**Figure 23** Tree grafting. Photos: T. Rinaudo

Yaouza has grafted *Ziziphus* trees on his three-hectare, rain-fed farm to increase productivity and diversify his income sources, helping to enhance his family's livelihood and resilience.

The trees are pruned very hard each year, clearing the way for cultivation and resulting in vigorous regrowth. This is important, because the grafted trees grow fast. *Z. mauritiana* has a weeping willow shape and, if not pruned heavily, its thorny branches would seriously interfere with crop cultivation and harvest.

To protect his livelihood, Yaouza employs a man to stay on the farm and guard his 70 grafted trees. He pays him 40,000 francs (US\$72) per season.

In 2017, poor rainfall saw the failure of Yaouza's entire cereal crop. But thanks to good harvests from his *Ziziphus* trees, he still managed to bring in 200,000 francs (US\$360). From this sale, he invested half the profits into purchasing three sheep. These he sold for 395,000 francs (\$708), for a profit of 295,000 francs (\$530).

"With this profit I have invested in my household food provisions, children's education and health, and I support relatives," he said. "I [also] bought a motorbike."



**Figure 24** Yaouza (centre) is earning good profits by selling fruit produced by his grafted *Ziziphus* trees. Photos: T. Rinaudo and World Vision Niger

## Agroforestry, forestry and tree planting

Because FMNR can increase tree cover on both farm and forest land, it's not difficult to see how it can help forestry and agroforestry efforts. Through careful selection of the species and location of stumps to be regenerated, FMNR can be used to implement systems such as EverGreen Agriculture, alley cropping, woodlots and silvopastoral systems. FMNR can also provide both a social and physical foundation that increases the likelihood of planted trees surviving, if additional planted trees are desired. The authors have seen numerous instances in which FMNR practitioners, encouraged by the success of FMNR, have gone on to plant desired tree species and provide them with the necessary water and protection required to ensure high survival rates.

In some cases, tree planting is employed after FMNR and other methods have restored the soil and water to a point where planted trees have the best chance of surviving; essentially, after a more favourable micro-climate has developed. Tree or enrichment planting can also occur simultaneously with FMNR if there are not enough surviving stumps or self-sown seeds to meet a site's objectives. Land users may also choose to plant trees that are not native to the area, or not available through regeneration on their land, such as species valued for fruiting, fodder, fertiliser or timber.



## Case study

### Planting of high-value trees on regenerated land in Timor-Leste

Often FMNR is used to create a suitable environment to allow for the planting of alternative species to supplement what is naturally regenerated.

In Timor-Leste, Manuel practises FMNR on sloping land with native *Eucalyptus alba*. After stabilising erosion and improving the area's micro-climate, he plants more valuable species between his FMNR trees, such as cinnamon. Over time, he plans to reduce the number of FMNR trees while increasing growth of high-value tree species.

A similar strategy has been adopted by farmers in other parts of Timor-Leste with coffee plants and naturally occurring *Eucalyptus urophylla*. They groom the *E. urophylla* as shade trees for the coffee crop, which helps boost their harvests and increase their incomes.



**Figure 25** Manuel Mendes (left) with Manuel da Silva (centre) are harvesting pineapple on Manuel da Silva's farm where he implements FMNR. Timor-Leste (2016). Photo: Roni Pati Tpoi

### Farmer Managed Agroforestry Farming in Niger

A system of integrating planted trees with FMNR was developed by Peter Cunningham in Niger, called the Farmer Managed Agroforestry Farming system. In this system, Australian acacias are planted in a grid formation, with interspersed FMNR trees. The nitrogen-fixing acacia trees improve soil fertility, lower temperatures and wind speeds, while yielding nutritious seeds, firewood and small poles for construction.



**Figure 26** Australian acacias planted alongside FMNR trees. Niger (2007). Photo: T. Rinaudo

### Conservation agriculture with trees

Conservation agriculture is based on three principles:

- keeping bare land covered at all times;
- disturbing the soil as little as possible; and
- rotating crops.

This system works well with FMNR, where prunings and leaves can be used as ground cover and compost. Tree roots help to break up hard soil, avoiding the need for excessive tillage, while some trees produce natural fertiliser to boost soil fertility. As trees grow, they provide additional fodder and firewood. This reduces the need for families to use crop residues for fodder and fuel, and enables land users to leave the residues on the field, protecting the soil from erosion, building soil fertility, and reducing evaporation and water run-off.

### Permaculture

Permaculture is an integrated approach to farming in which production systems are designed to mimic or directly use natural ecosystems. Permaculture systems are fully compatible with the natural regeneration of trees. The trees are able to contribute to other components of the permaculture system by providing mulch, improved micro-climates for crop growth and fodder for livestock, etc, while also being a productive component in and of themselves.

### Conservation of soil and water, and erosion control

FMNR decreases the speed of wind and water run-off, while trees help to hold soil in place. Trees also allow more water to sink into the soil and recharge wells and aquifers. The organic matter from tree leaves being shed helps to improve the structure of soil, while fertiliser trees increase soil nitrogen.

FMNR is typically implemented to restore degraded land. Occasionally, land has been so degraded that there are few sprouting stumps or naturally sown seedlings remaining. In situations like this, soil and water conservation practices such as digging zai holes, half-moons and direct sowing of tree seeds may be implemented to bring the land to a point where FMNR can be practised. In locations with hardpan or compacted soil, digging zai holes and half-moons can be practised at the same time as FMNR is applied to existing tree growth. These methods increase the capture and infiltration of water, and concentrate fertility for crops and trees growing in the depressions. For more information, [refer to this tutorial on zai pits](#).



## Case study

### More trees, more water

Scientists have proven that intermediate (moderate) tree cover can maximise groundwater recharge in the seasonally dry tropics. Where FMNR has been conducted at scale, such as in Niger and Ethiopia, there are documented cases of water tables rising, and springs which had long dried up flowing perennially again.

A number of factors can explain this. Most of the soils in the seasonally dry tropics have lost significant amounts of moisture-retaining organic matter. In addition, the removal of vegetative cover and continuous grazing has compacted these soils to the extent that they now shed water – in extreme cases, over 90 percent of the rain that falls does not soak in, but flows away, causing erosion and flooding in the process. Additionally, storms in the seasonally dry tropics tend to deliver large volumes of rainfall in a short period of time, further negatively affecting the ability of already compromised soils to absorb moisture.

The Tigray region is one of the most water insecure regions of Ethiopia. However, Tigrayan communities that have combined soil and water conservation measures with natural regeneration of trees on the hills and valleys have become the most water secure communities in all of Ethiopia. In Abreha Weatsbha, the community decided to no longer overexploit the vegetation on the hills, and trees soon began regenerating. In addition, they dug many kilometres of contour banks and converted deep gullies into dams.

More water began to soak into the ground recharging water tables. In the valleys the water table rose from a depth of nine metres to less than three metres from the surface in just two years. Community leader Aba Hawi calls this 'water banking'. He says, "We make our deposit in the hills, and withdraw it in the valley." This community, which had been threatened with relocation because conditions had become so dire, went on to dig over 600 shallow wells. In several places the water table has risen to such an extent that it is even coming out of the ground under pressure. Now even in drought years they grow two to three crops per year through irrigation by drawing on their 'deposit'.

Today, this community which was vulnerable to both drought and flooding, is not only food secure, but they produce a surplus. Flooding has stopped and their 'water deposit' ensures that they have nothing to fear during drought.

On Mount Damota, in southern Ethiopia, heavy deforestation had contributed to most of the springs drying up completely, or only flowing after rain. Within a few years of regenerating the trees on 500 hectares, 12 formerly dry springs 'returned' and one completely new spring appeared. Nine of these springs now flow permanently through the year.

The importance of these experiences and the scientific findings cannot be underestimated. Two of the most serious issues facing communities globally in the semi-arid zones are water and food shortages. Ironically, many of these very same regions are subject to seasonal flooding during the rainy season. By the simple act of restoring tree cover through FMNR, flooding can be greatly reduced and more water can be 'banked' for times of need. For the semi-arid tropics at least, more trees do indeed mean more water.



**Figure 27** A regenerated spring. Ethiopia (2016). Photo: T. Rinaudo



### **Rotational grazing**

Improved grazing management systems, also known as managed, holistic or planned grazing, are especially complementary to FMNR. This is because grazing livestock away from newly regenerating trees until they're large enough to withstand grazing pressure helps them to grow more quickly. FMNR in turn provides additional fodder, shade and shelter for livestock, and may contribute to increased water supply through groundwater recharge.

### **Fuel-efficient cookstoves and alternative fuel sources**

Programs introducing fuel-efficient cookstoves and alternative fuels are a natural fit for FMNR, as these interventions reduce demand for firewood and, as a result, the pressure on people to cut more trees. These interventions are frequent in disaster and refugee relief contexts, as well as in health programming.

### **Economic development**

Because so many people around the world make their living from the land and other natural resources, when they are able to improve the land, they can often improve their incomes too. As incomes increase, FMNR practitioners may want to build businesses, diversify their work, or increase their savings for the future.

Many communities practise FMNR in groups, giving people solidarity and mutual support as they implement FMNR and negotiate for change and collaborative partnerships with leaders and other stakeholders. Groups may include farmers' groups, women's groups, savings and loans groups and cooperatives. FMNR groups that function well are accustomed to working together and have built trust over time, so they can achieve other goals effectively as well.

#### **Savings groups**

Communities practising FMNR may choose to work together to achieve additional benefits. Savings groups allow community members to build their savings for future needs, learn financial skills, provide for emergencies and hard times, secure loans and support vulnerable members of the community. Both FMNR and savings groups build trust and cooperation skills, so they fit easily together.

#### **Local Value Chain Development**

Communities with improved land and increased income and savings may also want to consider small business and value chain development. These practices help people generate more sustainable incomes by building up their businesses, learning business skills and gaining better access to profitable markets. Like FMNR, these practices depend on groups of people coming together to support each other and collaborate for the benefit of the community.

## Case study

### From small bushes, big trees grow

Over the last decade, World Vision and partners have been working very hard to introduce FMNR wherever a receptive ear can be found. Uptake generally follows the following pattern.

First there is disbelief that this low-cost, simple technique can be beneficial. Deep-seated paradigms such as “trees are bad for crops, trees grow too slowly and indigenous trees have no value” are challenged, and so there is some pushback.

An enlightened few decide to pilot FMNR on a small scale. Within a short period, positive changes are self-evident: the landscape looks greener and now, with trees, is more pleasing to the eye. By thinning and pruning thorn tree thickets, light is allowed through to stimulate grass growth, and the trees themselves produce fodder. An improved habitat for natural predators results in fewer insect pests. Soil fertility increases. With lower temperatures and higher soil moisture holding capacity, when drought does occur, it has less impact.

As a result of these benefits, farmers are reporting more productive farmland, higher incomes, school fees paid on time and without stress. Children are spending more time in school and, along with their mothers, are spending less time foraging for firewood. Hope for a bright future is being restored. Confidence is growing and farmers are investing more in agriculture, because it pays to do so and because the impact of drought and flood are reduced, so there are less risks – allowing for new beehives, improved seed, fruit trees, haymaking and storage facilities. Incomes increase in line with these investments.

When farmers see their neighbours prospering and no longer toiling for little return, they in turn begin to take up FMNR, and what was an oddity very quickly becomes the norm. What was initially met with resistance quickly becomes a self-propelling movement.

### Musa's story of change: from meagre harvests to plentiful production

Musa's story is not atypical. Musa, from Kiambogoko district in Kenya's Nakuru County, was a struggling farmer. Musa's farm yielded meagre harvests even in good years. In 2009, he lost five head of cattle due to drought, despite desperately walking them long distances in search of fodder. In order to feed his family and pay school fees, Musa would leave home in search of day labour elsewhere. When he did find work, he was lucky to earn just 200 Kenyan shillings or about US\$2 per day, barely enough to be worthwhile, but he had to do it to pay school fees. Musa's wife, along with the other village women, would regularly walk 10 kilometres to the Eburu forest reserve to collect firewood and accelerate deforestation. This was exhausting work that prevented her from performing other more productive activities, and it had to be repeated time and time again. Musa did not see his farm as helpful for his situation, let alone a profitable enterprise.

The FMNR for Kenya project is a partnership between World Vision Australia and the Australian Department of Foreign Affairs and Trade. Thanks to the project, Musa learnt about FMNR in 2013 and volunteered to become an extension agent.



**Figure 28** Rhodes grass flourishes in an FMNR field in Kenya (2015). Photo: T. Rinaudo



**Figure 29** FMNR has resulted in plenty of fodder for Musa's cattle, and milk production has increased from seven to 12 litres per day. Kenya (2015). Photo: T. Rinaudo



*“FMNR has brought me far,” Musa says. “I have seen many changes here in my life. Before, I had many problems, especially for obtaining firewood and fodder and for paying school fees. I did not know that if you have a farm, you should take care of the trees, or that the farm could help me in my situation.”*

Musa has 2.4 hectares of land. Today, 1.4 hectares are under dense tree cover for grazing animals and the remaining hectare is reserved for crops, which are grown under lower density tree cover.

*“With FMNR the grass has grown and my wife and children no longer have to go beyond my farm to obtain firewood,” he says.*

Thanks to FMNR, Musa reports that temperatures are lower, the air is fresher and he has plenty of fodder, which he also sources from the nutritious bark of pruned indigenous acacias. Not only did he not lose any livestock during the 2014 drought, he didn't have to move his animals long distances in search of fodder. Today he does not fear drought, as he has plenty of grass, tree leaves and bark, even in the dry season.

*“I have so much grass that I'm thinking of building a hay shed. The fertility of my soil has increased.”*

Milk production from four cows has increased from seven to 12 litres per day. One litre of milk sells for 40 shillings (US\$0.40). Growing trees has also enabled Musa to increase honey production. He had beehives previously, but they only yielded eight kilograms annually per hive. Post-FMNR, the same hives are yielding 32 kilograms annually per hive. Honey sells for 200 shillings (US\$1.98) per kilogram and Musa has three hives, bringing total income from honey to 19,200 shillings (US\$190). Musa plans to increase the number of hives, but at the moment most of his earnings are going into school fees.

Grain yields have also increased. From less than 0.4 hectares, Musa would typically harvest just 20 kilograms of maize, but since beginning FMNR, average yields have increased to 180 kilograms of maize and 90 kilograms of dried beans. Musa says life is much better for his children.

*“I am no longer obliged to search for day labour far from home. I now stay home because FMNR has employed me.”*

Money earned from FMNR has enabled Musa to fence and subdivide his farm with barbed wire. Musa is also planting Rhodes grass, and plans to bale and sell hay in the future. One bale can sell for 400 shillings (US\$4) when there is high demand. Rhodes grass is notably greener and denser beneath Musa's pruned acacia trees than out in the open.

*“FMNR has opened my horizons to be a farmer and to adopt innovation,” says Musa. “Before, the farm wasn't much more than a place to live and it had low productivity. In fact, [it] was a liability, as I regularly lost my cows during drought. I did not see farming as a viable way to meet my family's needs. Today, I have a growing and thriving business which supports my family.”*

Because of his renewed confidence and the reduction of risk, Musa is investing in improving his farm's productivity even further.

The changes arising from FMNR have been so sweeping and significant that Musa and his neighbours have come up with a new catch-cry: *“melele FMNR, FMNR melele”* (forever FMNR, FMNR forever).