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Technical Note #65

Farmer Managed Natural Regeneration

Exceptional Impact of a Novel Approach to Reforestation in Sub-Saharan Africa

What's Inside:

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Halidu from Gangara, Niger Republic, proudly displaying new shoots being groomed to sequentially replace older growth (left) as they are harvested.

For many years, conventional Western forestry methods have been applied, and exotic tree species promoted in Sahelian countries in order to combat desertification. Large and small projects were commissioned to curtail the assumed southward movement of the Sahara desert, but few made any lasting impression.

Little thought was given to the appropriateness of these methods. Indigenous species were generally dismissed as "useless scrub." In misguided efforts to establish forests, many projects even cleared the "useless scrub" to make way for exotics. Often exotic species were simply planted in fields containing living and sprouting stumps of indigenous vegetation, the presence of which was barely acknowledged, let alone seen as important.

This was an enormous oversight. In fact, these living stumps constitute a vast "underground forest," just waiting for a little encouragement to grow and provide multiple benefits at little or no cost. These live stumps may produce between 10 and 50 stems each. During the process of traditional land preparation, farmers treated these stems as weeds, slashing and burning them before sowing their food crops. Under this management system, the stems rarely grow beyond 1.5 m tall before being slashed again. The net result is a barren landscape for much of the year with few mature trees remaining. To the casual observer, the land appears to be turning into desert and most would conclude that tree planting is required to restore it.

Farmer Managed Natural Regeneration (FMNR) is the systematic regeneration of this "underground forest." Tentative steps to introduce FMNR began in 1983, in the Maradi Region of Niger. Twenty-seven years later, the results have been amazing, with FMNR being practiced in one form or another across Niger and beyond.

A social, rather than a technical breakthrough, has been achieved. The greatest barriers to reforestation were neither the absence of an exotic super tree nor ignorance of best practice nursery and tree husbandry techniques. The greatest barriers were the collective mindset which saw trees on farmland as "weeds" needing to be cleared and inappropriate laws which put responsibility for and ownership of trees in the hands of the government and not in the hands of the people.

With the aid of the Maradi Forestry Department, which unofficially relaxed laws on tree harvesting, farmers stopped seeing this tree regrowth as a weed problem. Trees suddenly became a legitimate cash crop with multiple benefits. Once farmers' perceptions were changed, the revolution began, moving slowly but surely from farmer to farmer and eventually across the nation, sometimes aided by various development agencies (in the early stages at least), and sometimes occurring seemingly spontaneously.

Guidelines on how to practice FMNR were given, but *a key factor to its widespread appeal and success is that farmers themselves controlled the process.*

Because FMNR can become a grass roots movement, large areas of land can be "re-treed" rapidly and for little or no cost, resulting in increased bio-diversity and benefits to people (such as firewood and building material for household use or income generation). As explained in more detail below, the benefits of FMNR were also seen to extend to the environment, soils, crops and livestock.

At a time of unprecedented forest destruction and increased demand for agricultural land, FMNR has much to offer not only Africa but also the world. Development practitioners, government and non-government bodies concerned with the environment, agriculture and/or forestry and farmers themselves would do well to study the Niger experience outlined in this paper, and consider if FMNR could be applied to their particular situation. This Technical Note is not designed to give hard and fast rules. Rather, it lays out the history of FMNR and serves as a guide for its implementation. If the principles outlined are followed and adapted to local needs and conditions, great environmental, economic and social benefits will result.

Background

Missionaries with SIM began working on forestry interventions with local farmers in Maradi Region immediately after famine relief activities in 1975. The Maradi Wind Break and Woodlot Project eventually became the Maradi Integrated Development Project (MIDP) funded predominately by the Canadian International Development Agency.

It was very evident in 1975 that, if large-scale famines were to be averted in the future, something needed to be done to reverse the staggering tree loss and severe environmental degradation which had been exacerbated by drought (Figure 5.1). However, SIM's early attempts at reforestation were small scale and did not impact the environment at large. Nor did these efforts capture the hearts and minds of the community. Consequently little was attempted beyond prescribed project activities. This was a common pattern witnessed by most government and non-government forestry projects at the time.

Figure 5.1: *Photos illustrating the challenge of establishing planted trees on degraded lands. The photo on the left shows the pruning of transplanted tree seedlings on deforested land. The sheer scale of deforestation almost guaranteed that conventional methods of reforestation were doomed to fail. Even with enormous budgets and manpower, most large projects were proving unsustainable and they failed to gain significant acceptance from the communities meant to benefit from tree planting. Typical farm land (pre-FMNR) was cleared of all vegetation. In fact, a good farmer was considered a "clean" farmer who axed, burnt and swept his fields clean! The photo on the right is of a bush nursery with barren landscape in the background, symbolizing the futility fo combating desertification by this means alone.*

Travelling in any direction from the project base, one was struck by endless windswept plains, stripped of practically all woody vegetation. The fatalistic outlook of those most affected, who declared that it was God's will and there was nothing man could or should do about it, compounded the difficulty of restoration.

Women bore the brunt of the crisis, having to walk many kilometers in search of wood. As supplies diminished, they turned to poorer quality fuels such as millet stalks and dung. Occasionally one came upon fences made in the past—large logs placed in the ground side by side along a compound perimeter; however, many homes had no fence at all, and where fences existed, most were falling down (Figure 5.2).

Figure 5.2: *Sand dune engulfing a compound fence during the 1984 drought. By this time, few compounds had fences made with logs. Even the small stakes used to hold up millet stalks or grass mats had become extremely difficult to obtain.*

Due to the lack of wood, grain silos and huts were often in need of urgent repairs. As scarcity of wood increased, poorer and poorer quality materials were used, and structures needed repairs and replacement more frequently. At funerals in some districts, the bereaved turned to using bricks as a cover for the corpse, instead of wood. Ironically, rural people who once supplied towns and cities with wood began travelling 50 km or more to buy it. As trees disappeared from fields, emerging crop seedlings took the full force of winds which reached up to 70 km/hour. Millet seedlings were often desiccated after being sand blasted (Figures 5.3 and 5.4) or they were simply buried by sand. Consequently, farmers increasingly found themselves replanting their precious seeds six to eight times in a season. This in turn contributed to diminishing crop yields and increased hunger.

Figure 5.3: *Abraded and partially buried millet seedlings. Due to strong winds, farmers plant much more seed than is needed to ensure the survival of some. This clump of seedlings will be thinned back to just three plants.*

Reforestation projects in Niger were typically based on ideas developed in temperate climates and in societies and cultures entirely different from those in West Africa. Large, costly tree nurseries were established to produce exotic species, particularly eucalyptus (*Eucalyptus camaldulensis*), neem (*Azadirachta indica)* and *Prosopis juliflora*. Unfortunately, some projects appropriated land from communities without adequate consultation. Plantations were either fenced at great expense, or protected by paid, armed guards. This expensive, top-down approach often alienated rural communities and could never be replicated by them.

In belated efforts to achieve popular ownership and participation in tree planting, community- and individually-run nurseries were introduced. However, few formally trained project personnel could comprehend the sheer difficulty of raising, planting and caring for trees in this hostile environment. It was expected that farmers would be happy to draw water by hand for 3 months. During the dry season, when seedlings are grown, temperatures can exceed 40°C. Well depths range between 20 and 60 m in many villages. Nurseries became small green oases in a sea of brown which usually attracted termites, frogs, birds and lizards capable of doing great damage to seedlings. Water is so scarce in some villages that usage for tree nurseries is not practical. Once seedlings are planted out, a plethora of hazards await them, including drought, termites, trampling or browsing by livestock, locusts, sand blasting, competition from crops, and even deliberate destruction by humans.

Project staff members often ignored, or were quite unaware of, the considerable resentment harbored by communities. Government forestry agents enforcing tree laws often fined and, at times, even imprisoned offenders. The law required farmers to obtain a permit to clear trees on their own land. This system was open to abuse, and was very impractical for farmers living in remote regions. Sometimes thieves would cut and steal trees and the innocent landowner would be fined. Not surprisingly, farmers determined that the fewer trees on their farms the better.

Beliefs play a big role in determining actions. Farmers believed that trees would compete with crops and depress yields. They also believed that trees grew very slowly and there would be no benefit to themselves to prune and protect trees in their fields. Little wonder they saw trees as nuisance weeds which should be removed.

Quite needlessly, Maradi Region had its own dust bowl experience. The consultants of one large project aimed to "modernize" agriculture through promotion of modern inputs and animal-drawn implements, complete with the total removal of trees—roots and all! The severe damage from this ill-advised project is still evident on large tracts of land today. One of the subtle consequences was the reinforcement of the old adage "a good farmer is a clean (i.e., treeless) farmer."

Figure 5.4: *A woman battles wind and dust as she returns home from the well. The almost complete removal of trees resulted in increased wind velocity at ground level and an increased severity of dust storms.*

Even if people made the connection between the destruction of the environment and the decline in food supplies, few were in a position to change their behavior. Tradition expected them to clear the land. "Modernization" efforts reinforced tradition, making people feel foolish if they did not completely clear their land. On top of all this, severe poverty and hunger forced people to cut the few trees remaining in order to survive.

It has been estimated that over a 12 year period, some 60 million trees were planted in Niger, with less than 20% surviving. Despite the millions of dollars spent on the forestry sector, results have been disappointing. In addition to widespread ineffectiveness, some projects left communities hardened and less likely to attempt reforestation activities themselves.

When attempting to solve a difficult problem, it is critical to know what the root cause of the problem is. It is also important to analyze the assumptions held about it.

Niger is just one country on a vast continent. Some 34% of land in Africa is threatened by desertification, and each year 2.3 million ha of open woodlands are harvested or cleared for new farmland. In reality, the damage is greater than this when one includes farmland tree degradation; overharvesting of branches for fuel and fodder; and continuous browsing, stripping and trampling by livestock (Weber and Stoney, 1986). In some African countries, deforestation rates exceed planting rates by 30:1. Therefore, because destruction is occurring on such a large arena in Niger, as in the whole of Africa, conventional methods of reforestation are not and possibly never will reverse the trend of tree loss and desertification.

Foresters generally assumed that:

- Droughts and population-driven demand for firewood were causing deforestation.
- Trees had died or were completely removed by people.
- Indigenous species grew slowly and were of no economic importance.

In fact:

- While drought and firewood demand contributed to deforestation, destructive farming methods, cultural norms and inappropriate tree laws were the main causes.
- While above-ground parts of trees were removed, the stumps remained alive, with the ability to regenerate.
- Indigenous species can grow rapidly, and while most do not provide millable timber, they meet a wide range of basic needs and constitute a significant economic resource.

Simply planting thousands of trees did not make an impact on the deteriorating environment. Millions of dollars could have been saved if the real problems were understood and if common assumptions were tested. Incredibly, some projects actually cleared indigenous trees, considered to be "useless," before planting exotics. They were allegedly useless because they did not grow straight or tall, were assumed to be slow growing, were often knotted and forked and could not be milled.

It was not until a “useless bush” study was conducted that it was realized just how useful these plants were. They provided timber, firewood, fodder, fibers, medicines, fruits, edible leaves and nuts, dyes and many environmental services.

The realization that, by using conventional reforestation methods, MIDP would have minimal impact, even if it ran for a decade with a large budget, weighed heavily on me. In 1983, while on route to a village, I stopped the car and looked out over the barren landscape and said a silent prayer, asking for wisdom and a breakthrough. Then, for the first time, I “saw” what had been there all along—a sea, not of insignificant desert shrubs, but a sea of felled trees, the stumps of which were resprouting. In other words, an underground forest just waiting to be discovered!

Each year multiple shoots sprouted (Figure 5.5). However, they were not given the opportunity to grow to their full height because of the standard slash-and-burn practice. Consequently, low-lying shrubs were all that were visible. As a result, forestry agents did not recognize that these shrubs were actually felled trees with the capacity to regenerate. The fact that the true nature of this vegetation was not realized led to the coining of the term “the underground forest.”

Discovering the underground forest totally changed our approach to reforestation (Figure 5.6). There was no longer a need to run an expensive nursery. The extreme difficulties of tree establishment could simply be bypassed. The battle lines for reforestation could now be redrawn. Reforestation was no longer about technical concerns such as species choice and planting techniques. The new battle was more about social issues—how to change the belief system of communities that accepted land clearing as a necessary component of farming. It was also a battle with the legal system, whose workings ironically resulted in the destruction of the very trees it meant to protect.

Figure 5.5: *FMNR is based on the existence of resprouting tree stumps and roots and germinating seeds.*

Figure 5.6: *Even here in this seemingly treeless field, an underground forest is present.*

All that needed to be done now was to convince farmers to allow a number of the tree stumps in their fields to regenerate. Over time, farmers’ hearts and minds were won, and they adopted “Farmer Managed Natural Regeneration” as normal practice. Fears that trees in fields would compete with crops were overcome as farmers experimented with FMNR and fine-tuned it to meet their individual needs. FMNR also took on a life of its own as farmers themselves began to spread the new technique. Allowing the underground forest to grow through FMNR proved to be a highly successful way of rapidly reforesting large areas of land at minimum cost.

FMNR: What it is and how it evolved

The practice of FMNR has evolved since its introduction in 1983. Farmers have the flexibility to modify the technique to meet their own needs. It is important that farmers be free to choose the number of shoots per stump and per hectare, the length of the rotation and the method of pruning (see Figure 5.7 for an example). Any form of enforcement of FMNR “norms” was avoided by MIDP. The basics of FMNR are very simple:

- Desired tree stumps are selected.
- For each stump, a decision is made as to how many stems will be chosen for growth.
- The tallest and straightest stems are selected and side branches removed to roughly half the height of the stem.
- The remaining stems are then culled.
- Returning regularly to prune any unwanted new stems and side branches attains best results.

FMNR is not a new idea. It is a form of coppicing and pollarding (see glossary)—techniques which have been practiced for centuries in Europe. Over 1000 years ago, Europeans managed their woods as a renewable resource by coppice-farming naturally occurring woodlands. Without destroying the trees, they produced poles, wood for fences and construction, and firewood. Ash stands still exist that have been repeatedly cut and allowed to resprout on a regular rotation for at least 500 years (National Academy of Sciences, 1980). What was possibly new about FMNR is that this method of tree management was carried out on farmland—land which was normally completely cleared of other vegetation.

In 1983, the thought of leaving trees in crop fields was seen as ludicrous by farmers brought up with the belief that cleared fields were essential for realizing good crop yields. Not surprising, adoption of FMNR was very slow. The few individuals who tried it were often ridiculed. Wood was extremely scarce and valuable, and theft of rare stems left in fields was a discouragement to the few who gave it a go. Even if the aggrieved knew the perpetrator, it was culturally unacceptable to report him to the chief.

Figure 5.7: *Pruned stems of* Calotropis procera *attained a height of over 2 m in just 1 year. Contrary to popular belief of both farmers and foresters, indigenous tree and shrub species can grow very rapidly, especially when growing from a mature stump.*

However, in 1984, radio coverage of an international conference on desertification, held in Maradi, greatly increased peoples' awareness of the link between deforestation and drought. The message was strongly reinforced when the disastrous subsequent drought of 1984 caused almost total crop failure resulting in widespread starvation. MIDP operated a Food for Work program in 95 villages and FMNR was one of the activities. Farmers in a whole district were asked to leave trees on their farms. Having the whole population leave trees over a wide area helped break some of the stigma experienced by the earlier FMNR pioneers. Now, through firsthand experience, farmers in the district could see for themselves that their crops actually grew better amongst the trees. Another benefit included having extra wood for home use.

Unfortunately, during this exercise most farmers had only reluctantly practiced FMNR in order to receive food. At the end of the Food for Work program, an estimated two-thirds of the 500,000 trees left to grow were cleared. Even so, the seeds of a new idea were sown in over 95 villages for a 12-month period, and for some, fears of ostracism and tree-crop competition were alleviated. Ironically, those who cleared their trees soon experienced a recurrence of their old problems: shortage of firewood and light poles, burial and sand blasting of emerging seedlings, high temperatures, and absence of pest predators in crop land. Even though stealing occurred during the 1984 campaign, most farmers who practiced FMNR were able to harvest something and benefited to some degree from having their own trees. Post 1984, a gradual change occurred, as more and more farmers began practicing FMNR. Today, it is impossible to count the number of trees present on the once barren landscape, but estimates suggest that there are over two million trees standing in the MIDP working area. The success of FMNR has been acknowledged through an InterAction 2010 Best Practices and Innovation Award in natural resources and agroforestry (see web URL in bibliography).

Today, FMNR, in one form or another, is a standard farming practice. In fact, an indicator of the extent of the change that has occurred is that a farmer is much more likely to be ridiculed today for not practicing FMNR than for practicing it. The logic behind this is that everybody needs wood, and if you are not growing your own and you are not rich, then you must be stealing or begging from others!

As farmers became confident with FMNR and began to profit from it, it became possible to promote progressively more intensive forms of tree management. There were three main training phases:

1. *Modern land preparation*

Farmers graduated from completely clearing and burning all tree regrowth on cropland, to selecting and pruning about 40 stems, (one stem per stump) per hectare.

This modest step into FMNR required a lot of courage by early adopters. Their neighbors often ridiculed them. Some had their young trees stolen or deliberately damaged. Many feared a reduction of food crop yields.

As confidence grew and farmers became convinced of the benefits, and as negative peer pressure diminished, a more intensive form of FMNR was promoted. Even so, "modern land preparation" remains the most commonly practiced form of FMNR.

2. *Next-step land preparation*

Instead of only leaving one stem per stump, five or even more stems were left (Figure 5.8). The intent was that one stem would be harvested each successive year, and each year, a replacement young stem would be encouraged. The longer a stem is left to grow, the greater its size and value. Stems on 50-100 stumps/ha were pruned in this way. This was the ideal taught by MIDP, but actual practice varied from farmer to farmer.

Figure 5.8: *Five or more stems are left and pruned on each selected stump.*

A very significant change in mindset and practice was occurring. Trees were no longer considered as weeds needing to be chopped down. The majority of the population was now seeing trees as valuable cash crops in their own right. Where force and appeals to save the environment failed, the sheer economic benefits of farming trees began to bring about radical changes in farming practice. It was then time to introduce a third modification.

3. *Profit from every stump*

For a significant part of the 8 month dry season, woody vegetation continues to grow and has the potential to provide benefits to the farmer and the environment. Farmers were encouraged to leave and prune five stems on every stump growing on their land for at least the duration of the dry season.

Some fields contained in excess of 200 stumps. So with this method, farmers could effectively manage a young forest for the duration of the dry season. Prior to sowing crops, farmers could harvest stems, leaving only the number of trees that they required or that suited their crops. Stems produced over one dry season are still relatively small and of less value than those left for 1 or 2 years, but they are of greater value than unpruned stems, which were normally slashed and burnt at the end of the dry season.

Apart from the economic benefits, there are environmental gains. Extra vegetation in the fields results in greater deposition of rich, wind-blown silt. Livestock spend more time in fields with increased tree cover, and leave their manure as fertilizer. The soil is enriched with greater quantities of organic matter from leaf-fall and trimmings. Predators of crop pests find habitat, food and shelter. Practicing “profit from every stump,” FMNR allows idle land to become a productive resource during an otherwise unproductive 8 month dry season. While this is a sound practice, it has not been adopted very widely.

However, those who promote FMNR should not become obsessed with specific methods. Perhaps one of the major reasons for widespread acceptance of FMNR is that it represents a departure point from hard science (with replicate trial plots) and instead emphasizes farmer innovation, with its infinite variations, towards what works and what is practical in the field. The emphasis is, and always has been, on the “Farmer Managed” part of FMNR. And it is precisely this freedom of choice that a farmer has to meet his/her own specific needs, using the free materials at hand (e.g., stumps of existing mix of tree species) and responding according to their understanding and specific conditions (e.g., climate, soils and crop combinations) at the time of implementation. FMNR is not a fixed practice, but varies from region to region and even from farm to farm. I recently heard of farmers in Burkina Faso who only leave and prune trees which are growing approximately in straight lines. They even move self-sown seedlings from where they are not wanted and plant them within these lines. Within the rows, the trees are grown as bushes slashed to ground level during the rainy season, except for single stems that are allowed to grow about every 12 m. They choose to do this because they do not like interference with their plowing, and they can address the major issue of soil infertility by mulching with the pruned branches (personal communication, Roland Bunch).

In the Maradi region today, some farmers are still leaving very few (10-20) to very many (150) trees/ha. Many of these farmers only leave a single stem to grow from a stump; they can harvest it when they have a need, or at an optimum time for them. Others leave multiple stems, successively harvesting one each year. Others still allow a single stem to grow into a tree, and then they only harvest say 1/2 to 1/3 of the branches per year (i.e., pollarding), always leaving the tree. They discovered pollarding provides larger wood harvests and regrowth is more rapid.

The bulk of FMNR in Niger is generated from live tree stumps. However, in the Tahoua Region, where there were few tree stumps remaining, FMNR became possible only after farmers dug zai pits and half moons. It appears that droppings placed in the zai and half moon structures contained tree seeds that germinated, resulting in the revegetation of over 250,000 ha (Chris Reij, Personal communication). In the Zinder region, the 1 million or more ha of *Faidherbia albida* trees have at least partially been generated from the roots of mature trees.

In Niger, FMNR is practiced by individual farmers on their own land. However, as I promote FMNR in other countries, such as Ethiopia and Uganda, there are ample opportunities to not only practice FMNR on farmland but also in degraded forests through community management.

Finally, farmers have many different objectives in mind when they practice FMNR: soil fertility; wind breaks; firewood and building poles for home consumption and sale; fruits; edible leaves; fodder; erosion control; reversal of land degradation; aesthetics; medicines; income generation; and social acceptance. Ultimately, the farmer's mix of objectives is what determines the type of FMNR practiced.

As I run workshops in different countries, it is very interesting to me that NGO and forestry personnel invariably ask for specifications like, "What species, how many, when and how to prune...," whereas farmers ask questions such as, "How can I possibly leave trees on my field since they will shade the food crops and reduce the yields?" When I explain to the farmers that they are the experts, that they will learn through experimentation which trees to leave and how to prune, and it is them who will make the choices, they relax, and the atmosphere in the workshop changes. I believe that it is at that point that they begin to embrace FMNR. This is very, very important. If a farmer's objective is to increase food production, he does not want to be forced to do something that "he knows" will reduce yields. Effectively, in the workshops I am assuring them that ultimately, they are in charge, and they will decide what to do, not the (often mistrusted) forestry officer nor the NGO extension agent (whose livelihood does not depend on the advice he gives).

Steps in FMNR (Figure 5.9)

Step 1

Do not automatically slash all tree growth. Instead, survey your farm, noting how many and what species of trees are present.

Step 2

Select the stumps which will be used for regeneration.

Step 3

Select the best five (or so) stems to prune, and cull unwanted ones. In this way, when a farmer wants wood, he/she can cut the stem(s) that are needed and leave the rest to continue growing. These remaining stems will increase in size and value each year, and will continue to protect the environment as well as provide other useful materials and services (e.g., fodder, humus, habitat for useful pest predators and protection from the wind and sun). Each time one stem is harvested, a younger stem is selected to replace it. Tag selected stems with a colored rag or paint. Work with the whole community to draw up and agree on laws that respect each person's rights while protecting the trees being pruned. Where possible, include government forestry staff and local authorities in planning and decision making.

Figure 5.9: *Photos showing steps 1 (left), 2 (middle) and 3 (right) of FMNR.*

Species used in FMNR

The mix of tree species will vary from farm to farm, district to district and country to country. In the Maradi region, the species regenerated include *Piliostigma reticulatum*, *Guiera senegalensis*, *Combretum* spp (firewood, poles and fodder) and *Ziziphus* spp (fruit, fodder and firewood). In Zinder region, *Faidherbia albida* (fodder, nitrogen fixation) and *Adansonia* spp (edible leaf and fruit) are the dominant species used. 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.

Selection will depend on a number of factors including:

- which species occur naturally
- coppicing ability of each species
- local beliefs and values ascribed to each species
- uses of each species
- characteristics such as thorniness, competitiveness with crops, and growth rate

> A principle of FMNR is to use whatever is available. As a starting point, document existing species and their importance in the local culture. There may well be a niche for exotics, particularly fruit trees, but the great potential of what is already present should not be ignored.

Pruning tips (Figure 5.10)

There are very few basic rules to FMNR. In practice, each farmer adapts this system of agroforestry to his or her own needs and situation. Different tree species may require different pruning techniques, something that can be determined by experimentation and observation.

1. Ideally a handsaw should be used for pruning side branches of young shoots. However, most farmers do not own a saw and they must use what they have on hand, usually an axe or machete. Simple rules of pruning are: a) always sharpen your axe / machete; and b) always cut upwards, carefully.
2. When cuts are made downwards, the tree can be easily damaged through splitting or the bark may be stripped from the stem. Excessive damage will set back the plant's ability to regrow and may become an entry point for disease and insects.
3. If too many side branches are pruned from the main stem it may be easily broken by livestock or strong winds. Ideally, stems should be pruned up to half way up the trunk while small, and up to two-thirds of the way up, once they are over 2 m tall.

Figure 5.10: *Illustration of pruning tips 1 (left), 2 (middle) and 3 (right).*

Benefits of FMNR

Firewood and building timber

Before FMNR, rural people had to travel to Maradi to buy firewood and building materials (which had mostly been brought from remnant forests on the Nigerian border). Women had no choice but to travel long distances in search of wood. As it disappeared, they substituted crop residues and dung for firewood. Today, FMNR meets domestic demand, and a significant surplus is sold. For example, in 1984 barren plains surrounded the village of Sarkin Hatsi. Today, lightly wooded fields surround the village which boasts a thriving wood market (Figure 5.11). Merchants come twice weekly to buy wood for resale in Maradi.

Figure 5.11: *Land Rover taking a load of firewood to the city market*

FMNR contributes to land reclamation

A significant spin-off from FMNR is the restoration of otherwise unusable, hardpan sites and nutrient-depleted, sandy soils without financial expenditure.

On hardpan sites, harvested branches are left in a pile for a period of time, This results in:

- *Termite activity.* In search of food, termites burrow through the hard soil crust, breaking it up in the process.
- *Better water infiltration.* Rainwater can now penetrate the broken crust instead of washing off.
- *Silt deposition.* Turbulence caused by winds passing over the woodpile causes deposition of silt rich in organic matter. Topsoil deposits 30 cm deep have been recorded.

In this manner, farmers restored hundreds of hectares of hardpan sites, which had been idle for decades. They did this free of charge, and independent of any NGO or government program.

Similarly, practicing FMNR rejuvenates farmland that has been depleted of nutrients. The trees draw nutrients from deep in the soil profile, returning them to the soil surface and depositing organic matter through leaf fall. Trees cause winds to drop their load of nutrient-rich silt and provide perches, nesting sites and food for birds, which deposit their droppings. The shade and edible leaves and pods also attract livestock, which enrich the soil. Sites treated in this manner are suitable for cropping again within 2 years.

FMNR positively impacts crop yields and animal production

Browse (e.g., leaves, twigs, branches) from trees and shrubs are critical to livestock production in the Sahel. For much of the dry season grasses are in very short supply. Vast areas are completely bereft of vegetation due to continuous high stock carrying rates and manual harvesting of grass (Figure 5.12). Among the few foods available are dry millet stalks, which have a very low nutritional value. Before the introduction of FMNR, it was common for oxen to be too weak to plow fields at the end of the dry season. Suckling lambs and calves were severely malnourished because their mothers had insufficient milk. But now, tree species being regenerated in Maradi produce nutritious pods which are eagerly eaten by livestock (Figure 5.13). Additionally, some farmers now earn extra income by collecting and selling pods of *Faidherbia albida*.

Figure 5.12: *Grasses have disappeared due to drought. With no fodder-bearing trees, animals go hungry.*

Figure 5.13: *Pods of* Piliostigma reticulatum *are highly sought after by livestock.*

As trees were nurtured with FMNR, animals spent more time in the shade of trees and in search of falling tree pods. As a result, their dung and urine increased soil fertility on treed fields. Trees protect crops from extreme weather conditions: high temperatures; strong winds, which may exceed 70 km/hour; and high evaporation rates. By contrast, in the absence of shade, plants experience increased heat and water stress with soil temperatures that may exceed 60ºC .

Before FMNR, all crop residues were removed from fields for use as cooking fuel and animal fodder. The production of firewood from trees, along with the benefits animals receive by accessing tree pods, has enabled farmers to leave crop residues on the field for the first time in decades, leading to increased crop yields (Figure 5.14). In the past, limited availability of crop residues was a major constraint to their application as surface mulch (Buerkert & Hiernaux, 1998).

FMNR increases biodiversity and reduces dependence on pesticides:

As habitat disappeared with the widespread loss of trees, so did wildlife. By the early 1980's, apart from certain bird species, wildlife was rarely sighted. Foxes, wild cats, ground squirrels, hedgehogs, lizards, rats, mice and frogs were the main species remaining, though not in large numbers. As the trees returned, wildlife also began to return. Heavily-treed sites saw the return or at least visit of monkeys, wild guinea fowl and rabbits. Predators of insects, including birds, lizards and other insects such as wasps and praying mantids (Figure 5.15) began to find shelter and places to breed, making a positive impact on crop yields by reducing insect pests. This lifted a great burden from farmers who could not afford pesticides.

Figure 5.14: *This bumper millet harvest both surprised farmers and helped to convince them of the value of FMNR – that selected and well managed trees could happily co-exist with annual crops.*

Figure 5.15: *Praying Mantis egg sacs on tree branches. I only ever saw praying mantis egg sacs on tree branches – never on grasses or annual crops. Thus, the presence of praying mantises (and the crop protection afforded by them) tended to be greater in fields with more trees.*

FMNR contributes significantly to the local economy

In a 12 year period, it was conservatively estimated that US$600,000 worth of wood was sold as a result of practicing FMNR in Maradi (1994-1997 MIDP Summary Report). By 2008, total gross income in the region had increased by between 17 and 21 million dollars per year due to FMNR (Haglund et. al, 2009).

From the first year of practicing FMNR, light firewood is collected from pruned branches. From the second year on, cut branches can be sold. As wood availability increases, value-added products such as hut roofs and tool handles can be made and sold for additional income.

Conservative values for income generating potential can be easily calculated:

Area:	1 ha
No. trees protected:	40 trees/ha
No. stems pruned per tree:	5 stems/stump

If the farmer prunes five stems on each of 40 stumps/ha and harvests only 1 stem/stump/year, always encouraging a replacement, by the 6th year, she/he could have an assured annual income on the order of US$140/year. Table 5.1 below accounts for the fact that, over time, as the stems grow larger they also increase in value.

Table 5.1: Increase in value of tree stems over a six year period.

Year 1	40 stems x 0.10 cents	$4.00
Year 2	40 stems x 0.70 cents	$28.00
Year 3	40 stems x $1.50	$60.00
Year 4	40 stems x $3.50	$140.00
Year 5	40 stems x $3.50	$140.00
Year 6	40 stems x $3.50	$140.00
Total		$512.00

Thus, over a 6 year period, a farmer could earn over US$512, and US$140/year/ha each year after that. This may not seem like much, but in context, most families have a total income that is only about twice that—and most of their "income" is eaten.

The Figures used in the calculations are deliberately low and account is not made of other benefits of FMNR such as increased crop yield (at least two-fold yield increase), wood trimmings used for home consumption, fodder value of leaves and pods, and food items. When wood is converted into hut roofs or tool handles, the monetary value is higher than that of firewood. Additionally, leaving 40 stems/ha is a minimal amount. Some farmers are leaving up to 200! They may not leave all 200 stems for the duration of a 6 year period, but they do benefit from the harvest and sale of a larger volume of wood each year (Figure 5.16).

Some farmers may not have much land at their disposal. My observation in West Africa is that there are many millions of hectares of "common land" and grazing land that are gradually degrading and becoming less and less productive. With a participatory approach that includes all stakeholders (farmers, nomadic herders, men, women, youth, etc), what might be possible on such vast areas?

Figure 5.16: *Income from the sale of wood has risen to the extent that farmers are now in a better position to buy food during stress periods without selling assets.*

Using satellite imagery, researchers at the United States Geological Survey have been able to identify where tree densities and tree cover in Niger have increased over time and where these changes are likely attributable to FMNR. Estimates from high-resolution images acquired from 2003 to 2008 peg FMNR at nearly 5 million ha (Reij et. al, 1999).

The spread of FMNR is even more spectacular when you consider that in 1983, much of the area was completely cleared of trees. In Maradi, only 12 farmers were tentatively practicing FMNR on as many hectares. In 1984, due to famine, some 500,000 trees were managed through FMNR in approximately 100 villages. This increased to about 2,000,000 trees in 1988 through a second food-for-work program. Since 1988, FMNR has taken on a life of its own and has spread across the country, through other NGOs, farmers' groups and Peace Corps workers, as well as through MIDP staff and farmers visiting new areas across the country and sharing their experience.

FMNR contributes to the quality of life

Wind velocity at ground level and the incidence of irritating dust storms have been reduced. Shade is now available, giving protection from 40°C and higher temperatures. Trees reduce the reflection of light from white sand, greatly reducing eyestrain. The once barren landscape is now more relaxing and pleasing to the eye.

A number of tree species being regenerated are a source of edible leaves and fruit. Some of these foods are only eaten during times of food shortage, but even so, they fill an essential gap that was previously missing. Other kinds of leaves and fruit are sought after eagerly, and eaten whether or not regular foods are available. During recent famines, fruits and leaves from regenerated FMNR trees were the only foods standing between the people and starvation.

Possible constraints in adopting FMNR

Absence of live tree stumps

Ability to practice FMNR is dependent on the presence of live tree stumps of useful species that can be coppiced. Where these are not present, it is sometimes possible to broadcast seeds of indigenous species and use the ensuing trees as the basis for FMNR. In this case, more time will be required between seed sowing and first harvest, and high mortality rates can be expected during the establishment phase. Trees established in this way are eventually managed in the same way as regrowth from tree stumps.

Distance to markets

There is a severe wood shortage in most districts in Niger. Even when farms are not close to markets, the benefits of FMNR make this activity worthwhile, though farmers closer to markets will realize greater financial gains from sale of wood and other tree products. Though prices are lower in remote areas, wood is always marketable due to severe wood shortages.

Respect for private property

In order for people to widely adopt FMNR, the general population must respect private property. It is common in Niger to treat all land as common property once the harvest is in, since there is free access to farmland during the dry season. Farmers initially received little sympathy from village chiefs if they complained that someone had cut their trees down. In any case, farmers were unlikely to report theft because it was considered anti-social to inform on others. This prevented many from even trying FMNR. MIDP staff worked hard to introduce the idea that it is just as big an offense to steal someone's trees as it is to enter someone's home and steal his belongings.

Ridicule

It was common for those who did things differently to become the butt of jokes. For many, this negative pressure was too great and they were discouraged from trying anything new. MIDP encouraged innovation and tried to create an environment in which it was safe to experiment and in which failure of an experiment would not result in embarrassment.

Deeply ingrained attitudes

Language may give clues to negative attitudes about trees. For example, in the Hausa language, the word for tree (*itce*) is the same as the word for firewood. This may indicate that trees are given no intrinsic value of their own, apart from their utility as firewood. Much can be done to teach community members about the value of trees and to change deeply ingrained attitudes, as shown by the effect of the International Conference on Desertification.

Pride in the history of a people group may be a hidden factor that shapes attitudes. As with any society, children in Niger are brought up hearing the stories of their forebears. In the Maradi Region, it is only within the last century that Hausa families moved from the Maradi River valley to the heavily treed sand plains north of the city. The current generation is proud of the pioneering spirit displayed by their forebears, who cleared the land and made it possible to farm. Project staff members need to be careful how they portray those who clear land. In this situation, it may be helpful to link the pioneering spirit of those practicing FMNR with that of those who settled the land.

History and tribal interactions

An understanding of the history of the various tribes and their interactions is invaluable. Fulani cattle herders equate chopping and selling wood with the lifestyle of their traditional enemies, the settled farmers. A study of actions and characteristics of the "model" person in a given culture goes a long way towards understanding why people do or don't do things, and gives insights into harnessing the power of culture to introduce change.

Critical mass

Wherever possible, it is important to convince the majority of a given population of the value of FMNR. When only a few individuals practice FMNR for the first time, they may be completely discouraged by their peers through ridicule and theft.

Climatic factor

Trees that are regenerated are indigenous and generally have mature root systems, so drought should not significantly affect growth rates. Deep-rooted perennial species used in FMNR in Maradi not only survive but also continue growing even when rainy seasons are poor. Regrowth of trees in lower rainfall areas that receive less than 200 mm annually will be slower and the harvest rotation period will be longer than in higher rainfall areas. The potential for FMNR in the 800 mm plus rainfall areas of Southern Chad and Southern Ethiopia is enormous.

Insect pests

There are no recorded accounts of significant insect damage on indigenous species used in FMNR. Even when locust attack occurs, indigenous species usually recover after the locusts have moved on.

Reasons for the successful spread of FMNR in Niger

Conducive legal environment

When people have no legal right to own or even utilize trees there is no incentive for them to sustainably manage them. When trees belonged to the government, in the minds of the people, they belonged to nobody; hence, everybody had the right to cut them down! Unfortunately, to this day, the government in Niger still officially owns trees and has the authority to fine individuals for cutting trees without a permit. Even so, FMNR has flourished because, from the mid 1980's, there was a weakening of the states' ability to police wood cutting and a "perception" arose in people's minds that they did in fact own the trees. In addition, local forestry authorities granted informal approval for farmers to be able to reap the benefits from protecting trees on their own land. Ironically, once farmers had the assurance that they would not be prosecuted for cutting trees managed by them on their own land, they did everything in their power to protect them! Without this sense of ownership, FMNR could never take hold and spread.

It is only because of an informal guarantee that they would benefit from their labors that farmers continued to practice FMNR, even after the food for work program phased out. The practice even spread by simple word of mouth, from farmer to farmer.

As I promote FMNR in other countries, one of the first recommendations I make to government authorities is that if they want reforestation to occur rapidly, they must ensure either secure tree ownership rights, or secure tree user rights.

Severe wood shortages resulted in a desperate situation

Rural people had to go to the city to buy wood. Buildings were collapsing for lack of durable building material. Women were walking long distances to collect fuel. The substitution of millet stalks and manure for firewood resulted in competition for these scarce resources. This serious need cultivated a climate in which change became possible.

Timing of international attention to the problem

The International Conference on Desertification was followed by severe drought and famine and then MIDP's Food for Work Program promoting FMNR. The combination made a big impact on attitudes. Perhaps for the first time, a link was made between the disappearance of trees and drought and famine. People began to comprehend that they were partly responsible, but also that they could do something about it.

Trust

MIDP staff and their SIM predecessors worked for many years in the district building friendships and trust. They were responsible for benefits including wells, famine relief and agricultural development. Even though the message of FMNR was strange, the messengers were trusted, greatly facilitating its adoption. Community members also needed to be able to trust each other and to trust the legal system they have access to (either traditional or government).

Local control

MIDP encouraged established community-based regulations on trees. The village chief, and not a distant forestry agent, now dealt with theft. Difficult cases were referred to the district chief. Once farmers gained confidence that their rights would be respected and defended, FMNR began to flourish. MIDP, with support of district chiefs, encouraged farmers to break with tradition and act against offenders, whoever they were.

Simplicity and cost-effectiveness

FMNR is easy to practice, does not require significant extra work beyond normal land preparation, and is cheap, requiring no financial outlay.

Accessibility

Anybody—male or female, rich or poor—who has land containing live tree stumps can practice FMNR.

Profitability

FMNR is extremely profitable and utilizes a renewable resource.

Compatibility and complementarity with essential activities

FMNR has a positive effect on crop yields and livestock. If there were negative impacts, it would be unlikely that poverty-stricken farmers who regularly face hunger would adopt FMNR. FMNR also increases the possibility of mulching farmland. Pre-FMNR, all crop residues were utilized for firewood and fodder. Today trees are the main source of firewood, and they make a significant contribution to fodder supplies. Thus crop residues can be left on the fields as mulch, and leaf litter from trees also makes a contribution to the availability of mulch.

Self-replicating

FMNR spread from farmer to farmer by word of mouth. It did not depend on large projects or proclamations of government or NGOs.

Perseverance

The MIDP staff persevered in the face of many obstacles and setbacks including prejudice and handicapping laws. It took at least 5 years for FMNR to become acceptable, and around 8 years before it was established enough to not require ongoing project encouragement. Note: now that the impact is well documented and there are a number of working examples it should not take 5 years for FMNR to be accepted in a new community.

Tony's responses to several questions by ECHO staff:

Q. You had such success because there were so many resprouting stumps. But over how much of West Africa would such a situation exist?

A. I have traveled in Benin, Nigeria and Niger and most farms that I have seen have large numbers of living tree stumps in them which are slashed each year. My guess is that this is the norm and FMNR could revolutionize agroforestry practice in the whole region where traditional crops are still planted. Districts where tree stumps have been uprooted and regions where trees have died would require replanting or direct sowing of trees.

Q. You mentioned that species not seen in years are reappearing. What are some of those species?

A. Most of them are fast growing, hardy "survivors," used mostly for wood (e.g., *Bauhinia reticulata* and *Guiera senegalensis*). Species not seen for some time in the district but making a comeback through FMNR, include: Monkey Orange (*Strychnos spinosa*), a much sought-after orange-like fruit; Custard Apple, (*Annona senegalensis*), which produces an edible fruit, wood used for tool handles, and seeds used as an insecticide in grain storage; Zoure, (*Boscia salicifolia*) is today very rare and produces a quite tasty leaf; and Ciciwa, literally "eat, eatable" (*Maerua angolensis*), which produces a highly sought after edible leaf. Species which are not rare, but are making a come back due to FMNR, include jujube species *Ziziphus mauritiaca* and *Ziziphus spina christi*.

Other species originally in the area apparently do not regenerate so well and so are only found occasionally. These include edible plum (*Ximenia americana tswada*); Mother of Medicine (*Securidaca longipedunculata*), used in medicine (and sorcery); Hanno (*Boswellia dalziell*), bark used for dysentry; Yadiya (*Leptadenia lancifolia*), a highly sought after perennial vine with an edible pod similar to okra and edible leaves that stay green well into the dry season.

Conclusion

Desertification and land degradation continue to expand on a massive scale around the world. Despite enormous expenditure of funds and manpower, traditional forestry approaches have failed to stem the destruction. Expensive, and often inappropriate, approaches rarely capture the hearts and minds of the communities most affected.

FMNR relies on local management of existing indigenous tree and shrub species. Where practicable, it should be considered as a rapid and cost-effective approach to reforestation. FMNR is easy to adopt and adapt to local needs. It is cheap to implement and has the potential to quickly increase tree cover on a large scale. FMNR benefits soils, crops, livestock, the environment and local communities. Once grasped by the community, it has the potential to become a people movement that spreads by word of mouth, from farmer to farmer, without ongoing project intervention.

In describing the benefits of FMNR, this paper is not discounting the value of tree planting schemes. In some regions, there are no live tree stumps in the fields that can be regenerated. A number of tree planting projects have been very successful (e.g., CARE International's windbreak project in the Maaja valley of Niger). For some tree species, such as fruit trees and

valuable rare or exotic species, a nursery may be the only way of propagation. However, for rapid, cheap and ongoing reforestation beyond the life of the project, FMNR should be given high consideration.

FMNR's potential to reverse desertification and land degradation while positively impacting the welfare of communities is enormous (Figure 5.17), yet it is little known or appreciated. Wherever conditions are appropriate, foresters, agriculturalists, project planners and farmers can benefit from the practice of FMNR.

Figure 5.17a: *Circa 1984, before FMNR was introduced in the village of Sarkin Hatsi, this type of land preparation was considered normal.*

Figure 5.17b: *Sarkin Hatsi today. FMNR has become standard practice.*

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Glossary

Browse: leaves, small twigs and shoots of shrubs, seedling and sapling trees, and vines available for forage for livestock.

Coppice:

1. A method of cutting certain species of trees to encourage them to regrow from the remaining stump. A tree that coppices readily does not require frequent replanting and is, therefore, useful for producing fuel and poles.
2. Shoot developed from a dormant bud on a main trunk.
3. A small wood regularly cut over for regrowth; also called a "copse."

Maradi: Maradi Region is one of seven regions within Niger Republic. The capital of Maradi Region is Maradi, a city of approximately 100,000 people.

Pollarding: cutting back, in more or less systematic fashion, the crown of a tree but leaving a main trunk to 1.5 m or so, with the object of harvesting small wood and browse, and of producing regrowth beyond the reach of animals.

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