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Case #4:

The hidden forest: farmers tend regenerating trees in African Drylands

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Contents

In Brief

Overview

Vast areas of the Maradi and Zinder regions of Niger were transformed from severely degraded farmland to agroforests through farmer-managed natural regeneration (FMNR). In the 1970s and 1980s, Maradi and Zinder faced an ecological crisis. Multiple droughts, rapid soil degradation, and famine left fuelwood, building materials, and fodder scarce, and agriculture nearly untenable. Because FMNR improved agricultural yields and was relatively easy to implement, it spread through external interventions and farmer-to-farmer exchange. More than 90% of Maradi's population now encourages selective trees to grow on farms. FMNR transformed 5 million ha from wasteland to agroforest as individual farmers invested in trees.

Exemplary practices

In the mid 1980s, FMNR was introduced in Maradi via a "Food for Work" program—farmers agreed to encourage natural regenerating trees on their land in exchange for food aid. FMNR also arose organically when migrant farmers returned home from work elsewhere too late to clear their fields from emerging woody species and found that crop yields were higher in treed fields than fields cleared of trees. A weakening national forest service department increased the control that farmers had over trees on their land, which was later formalized through policy reforms. Peer-to-peer learning was critical—many farmers switched from burning and clearing to protecting on-farm trees once they saw the agricultural benefits, which included increased agricultural yields, tree-based foods (especially important in times of famine), and fuelwood (which dramatically reduced the burden on women). The case showed that restoration does not always require large investments or financial support from governments or NGOs. FMNR was successful in large part because it met the needs of farmers and improved agricultural production with minimal investment. Listening to the farmers and understanding local needs was crucial. Now FMNR is practiced in many other countries, in Africa and beyond.

Key lessons learned

- *Flexibility and adaptability are key: had practitioners dictated to farmers exactly how to do FMNR, it is unlikely to have developed such widespread appeal.*
- *Desperate times can lead to restoration: In the face of a lack of viable alternatives, farmers were willing to change their practices and incorporate on-farm trees.*
- *Seeing is believing: Having a farmer see firsthand and exchange experiences directly with fellow farmers living and working under similar conditions is the easiest way forward and helps explain how FMNR spread so widely and quickly.*
- *Restoration based on FMNR takes the support of a village. In places where social cohesion was lower, FMNR was not adopted as widely.*
- *Engaging farmers is critical for widespread restoration using FMNR.*

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Niger

Farmer Managed Natural Regeneration

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Restoration narrative

Background and context

The Maradi and Zinder regions are flat and arid, located between 300–650 masl and receiving 100–500 mm of highly variable rainfall per year. Soils contain little organic material (Haglund et al., 2011; Sendzimir et al., 2011). Maradi (42,000 km2) is the region of Niger with the longest history of practicing farmer-managed natural regeneration (FMNR). Neighboring Zinder (145,000 km2) also has a long history of FMNR in the densely populated southern parts of the region (Figure 1).

Forest clearing and land use conflicts

Historically, vast savanna forests expanded over much of Maradi and Zinder. “The forests were so rich in wildlife that women were reluctant to venture out of the villages on their own” (Pye-Smith, 2013, p. 8). Forest clearing and land degradation accelerated in the 1960s and 1970s, driven by agricultural expansion encouraged by the government and rapid population growth that increased demand for firewood and wood products (Wouterse and Badiane, 2018). Trees were removed from farmland because people believed they would compete with crops.

Maradi has always been one of Niger’s most agriculturally productive areas (Haglund et al., 2011). In the 1920s, French colonialists dismantled traditional negotiations around land-use practices and in 1935 nationalized all of the natural resources in Niger. This action reduced the rights of local people to manage their land in customary ways, enforce land use rules and regulations, and share knowledge, which ultimately generated new conflicts among neighbors (Sendzimir et al., 2011). Even after the country gained independence in 1960 these legacies continued and persist today in many parts of the country.

Colonialism led to severe conflict between herders and farmers. Traditionally, farmers let herders' livestock into fields after harvest to fertilize them (Sendzimir et al., 2011). But colonialism separated the two groups into "nomadic" and "sedentary" zones, leading to conflict when herds entered farming areas or when herders harvested trees for fodder (Tougiani et al., 2009). In the 1950s and 1960s, above average rainfall encouraged farmers began to move northward from densely populated areas in southern Maradi and Zinder to settle in lands reserved for herding communities. The resulting conflict led to a sense of crisis around agricultural production and land use (Wouterse and Badiane, 2018).

Unclear land tenure and laws restricting local control over trees also accelerated forest clearing and discouraged its recovery. Trees were a source of conflict with the government. Forestry officers had a large degree of control over on-farm trees, which discouraged farmers from using trees in farming systems. "Without release from the often corrupt control of forestry officers, a quasi-paramilitary force that on occasion could perversely interpret the law so as to extract prohibitive fines, farmers saw trees more as sources of conflict than as resources. Feeling helpless to change the power structure, farmers often cut trees to avoid trouble" (Sendzimir et al., 2011, p. 6).

"When I was a young man, the relationship between us and the forest agents was like the relationship between cats and mice," recalls Idi Daouda, a farmer in Dan Saga, Maradi. "The forest agents used to come here every week hoping to catch people who had done something wrong, such as cutting branches for firewood or fodder from the trees that grew even on our own farms. If you were caught, you risked a heavy fine or being sent to jail" (Pye-Smith, 2013, p. 26).

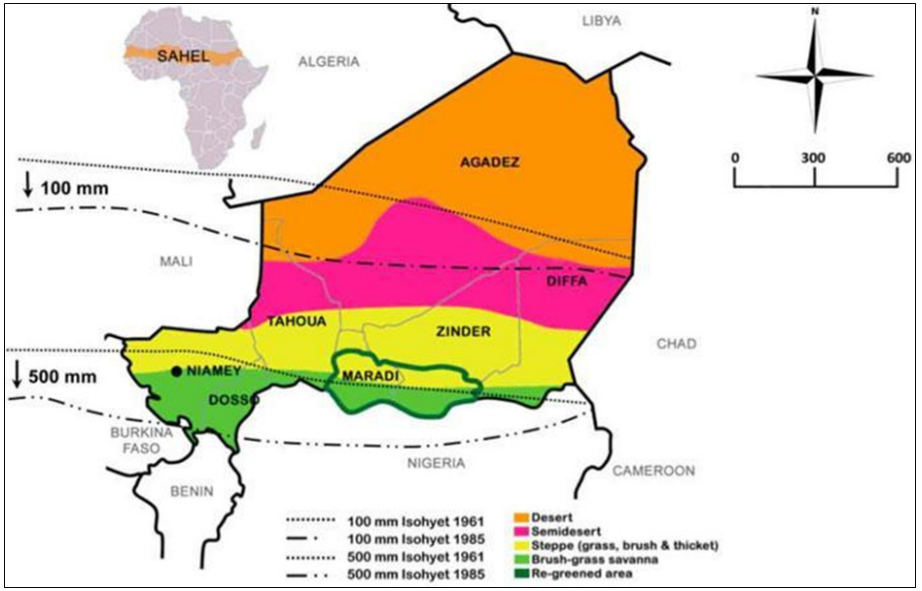

Figure 1. Niger, West Africa. The green outline shows an estimate of the area re-greened in the Maradi and Zinder regions. The hatched lines show the southward shift of the 100 mm and 500 mm rainfall during the drying trend from 1970 to the late 1980s. Source: Sendzimir et al., 2011

Baseline conditions

Between 1910 and 2010, Niger suffered five severe droughts, seven famines and three locust outbreaks (Sendzimir et al., 2011). Prior to initiating FMNR, environmental conditions were extremely poor in both Maradi and Zinder. “It was a disaster,” says Chris Reij, long time researcher and practitioner. “The situation was so bad, especially for women, who had to walk two and half hours a day to collect firewood. Population densities were high and for years people cut natural vegetation, which was their only source of firewood, so very little was left. There was essentially wall-to-wall agriculture.” Removing almost all woody species from farms was also common practice: during the colonial era, a farmer was considered modern if he cultivated a single crop on completely cleared land, and this legacy persisted.

Many people had experienced prior restoration efforts that failed to deliver benefits. Reforestation efforts in the 1970s used fast-growing exotic species (e.g., Neem (*Azadirachta indica*), River Red Gum (*Eucalyptus camaldulensis*). Local communities were not systematically engaged, and lacked rights to trees (Tougiani et al., 2009; Pye-Smith, 2013). Programs were widespread, costly, and involved extensive monitoring and maintenance programs, but survival rates were low: of 60+ million trees planted in Niger throughout the 1970s and early 1980s, less than 20% survived.

Deforestation led to low crop yields. Soil degradation, reduced or eliminated fallow periods, and an increase in agricultural pests caused lower cereal yields and food insecurity (World Bank, 2013). For example, pre-FMNR crop yields were estimated at 400–500 kg/ha and declining, and some places produced as little as 250–300 kg/ha of millet and sorghum. Fields were often scorched and windswept, and farmers sometimes had to replant crops several times when young plants were knocked down by strong winds laden with sand. Droughts in 1984 and 1985 exacerbated existing problems and led to severe food shortages. Something had to change. Crisis became the mother of invention.

The turning point

Farmer managed natural regeneration improves agriculture by training farmers to identify and care for regenerating trees and stumps. The practice arose in different locales throughout Maradi and Zinder at about the same time—in some areas, FMNR was catalyzed by external interventions, while in others it spread spontaneously. Practitioner Tony Rinaudo of World Vision "accidently" discovered the spontaneous emergence of trees from living roots in seemingly barren farmland in the Maradi region (Tougiani et al., 2009). During the 1980s famine, FMNR was included as part of a Food for Work program, where farmers were given food aid in exchange for leaving portions of land uncultivated for natural tree regeneration. This program was implemented in 95 villages and reached an estimated 80,000 to 100,000 farmers.

Farmers were initially hesitant to participate. Historical conflicts with the national forestry service over managing trees on farmland and the perception that trees compete with crops were major barriers to adopting the practice (Tougiani et al., 2009). But the crisis around food shortages and agricultural decline left many people more open to experimentation. Results were evident within a couple of years

Figure 2: Typical farmland in the Maradi region in 2005 on land that had been previously completely treeless (Tougiani et al., 2009).

of project inception. From that point on, FMNR began to spread spontaneously, without external support, as farmers observed results and shared techniques. "It was a revolution," Rinaudo says, "without planting a single tree, simply by recognizing what was there, literally at our feet, caring for it, nurturing it, allowing it to grow, 200 million trees came back into that landscape over a 20-year period. Because of the improved soil conditions and microclimate, an additional 500,000 tons of grain were harvested every year, which is enough to feed two and a half million people in the poorest country in the world." After a couple of years, when implementers stopped

providing food aid, about half of the farmers returned to customary practices of removing trees from fields. But farmers who persisted continued to have higher yields, and observing this, many other farmers reinstated FMNR.

Adopting FMNR was not always linked to external intervention. In the Maradi town of Dan Saga, Nigeriens returning home from migrant work arrived too late one year to clear the green shoots from their fields. They decided to plant crops regardless and discovered that crop yields were higher on farmland where young woody plants had not been cleared. They experimented with allowing more regeneration, with positive outcomes. Farmers in the densely populated parts of the southern Zinder region implemented FMNR after learning about it from other farmers, without external intervention. A nearly continuous agroforestry park landscape emerged, dominated by *Faidherbia albida*.

FMNR is not found in all villages in Maradi, perhaps because of conflicts or a lack of social cohesion in those villages. Collective decision-making around trees makes the protection and management of regenerating trees feasible.

Drought and famine created crisis conditions that left farmers open to new solutions like FMNR, but concurrent changes in government and policy further facilitated its adoption and spread (Reij and Garrity, 2016). For FMNR to work, farmers and communities need to be autonomous land managers. But prior to 1985, the national forestry service controlled how farmers managed on-farm trees with strict rules, fines, and observation (Sendzimir et al., 2011). Two events coincided to change these policies. First, in 1984, a national meeting in Maradi on controlling desertification in Niger emphasized empowering farmers. Second, in 1986, the highly esteemed president Kountché passed away, sending the country into a long period of political turmoil and economic crisis. This crisis weakened the forestry service, giving farmers increased control over their trees—a key enabling condition for FMNR. Farmers felt the ownership and freedom to experiment with, discuss, and organize around FMNR practices (Sendzimir et al., 2011). Today, the government at all levels recognizes the success of FMNR and provides support, from forestry extension agents up to the highest-level ministries.

Actors and arrangements

The Society of International Ministries (SIM) was the first organization to promote FMNR as part of a Maradi Integrated Development Project (MIDP) in 1983, managed by Tony Rinaudo, The goals were to promote sustainable development and poverty alleviation in the region. In the 1990s, other organizations began to support the implementation and spread of FMNR at larger scales. These included World Vision but also the International Fund for Agricultural Development (IFAD), an agricultural development bank of the United Nations which funded FMNR in Maradi's Aguie Department. The IFAD-funded project helped develop local institutions for the protection and management of FMNR.

International NGOs (especially SIM) played a key role in promoting adoption by helping to connect local communities with the regional government services. They worked with the Ministries of Agriculture and Environment to help establish the legitimacy of the local committees. Importantly, this helped erase some of the long-standing uncertainty about who controls the local natural resources.

Costs, funding, and other support

FMNR costs little compared to other restoration techniques, like tree planting, because the main input is labor (Garrity et al., 2010; Haglund et al., 2011; Larwanou and Saadou, 2011; Weston et al., 2015; Reij and Garrity, 2016). The estimated external investment costs are most likely less than US $20/ha (Reij et al., 2009). The labor requirements for protection and management of FMNR are modest. This observation-based estimate has been critiqued for not including opportunity costs to land (Chomba et al., 2020) but given levels of degradation, there is little other viable use for this land. Outsiders who have not visited this large-scale FMNR sometimes assume that the costs of fencing are overlooked, which leads to an underestimation of the costs of FMNR. However, farmers generally do not use physical fences, instead practicing "social fencing," wherein communities collectively protect and manage their new tree capital from grazing and illegal cutting.

Planning, implementing, and adopting FMNR

"FMNR is now spreading to other parts of Niger, beyond Maradi and Zinder. If you travel from the capital to Maradi, which is about 720 km, you'll see young trees emerging on many fields in the bigger villages along the entire stretch of 600 km along the border with Nigeria."

— Chris Reij, long time FMNR practitioner, champion, and scholar

FMNR is not centrally organized, and instead gains traction only where community leaders and farmers invest time and effort. "In Niger, transformation was achieved on 5 million hectares because of decisions made by individual farmers to invest in on-farm trees, with no landscape planning" (Reij et al., 2020, p. 22). None of the major players that helped to promote FMNR practices had the resources to support FMNR long-term (Reij et al., 2009). Rather, farmers adopted and shared the techniques with each other, recognizing the long-term benefits. FMNR can be practiced by even the poorest farmer and yields better results with fewer resources than conventional ways of reversing desertification (e.g., tree planting) (World Vision, 2012).

Because FMNR originated in different locales simultaneously, implementation varied. In Maradi, for example, SIM technicians trained individual farmers and local associations in FMNR techniques. Once local people and groups became familiar with it, they were trained to teach others. As Chris Reij described: "Tony Rinaudo worked for Maradi Integrated Development Project in training farmers how to correctly prune trees. That certainly helped. But now you have farmers who have become such experts that they've organized themselves into groups. Some of them will help train other farmers themselves." FMNR has developed into a self-sustaining activity by farmers and for farmers.

The degree of community engagement varied from region to region, depending on the implementer/funder and the time period, and some regions required external intervention more than others (Reij and Garritty, 2016). An example of an implementation process is the Desert Community Initiative (Tougiani et al., 2009) in the Aguie Department in the Maradi Region (Box 1). FMNR was adopted by a wide range of households. Those with secure land tenure—who had inherited or purchased land rather than leased it—were more likely to adopt. Inheritance confers full rights to manage and access the land (Binam et al., 2015).

Major technical methods included caring for and pruning regenerating trees and protecting them from grazers and fire. FMNR generally involves protecting and managing regenerating trees on farmland by selecting existing tree stumps and seedlings, pruning stems, and protecting regenerating seedlings (Chomba et al., 2020; Tougiani et al., 2009). FMNR requires pre-existing, living roots or stumps of previously-felled trees which play a role in what will regenerate and how much, as do the seeds of woody species stored in the topsoil (Reij and Garrity 2016; Reij et al., 2009).

Farmers typically identify stumps and seedlings of desirable species to protect, and then choose several (five or more) of the strongest stems (Pye-Smith, 2013). Over-pruning early on was a common problem as farmers were initially concerned that trees would compete with their crops and trimmed all side branches. This can weaken trees and leaves them vulnerable to damage.

Thinning accelerates the growth of trees and allows for crops to grow in and around trees. Farmers are trained how to choose the stems to remove and protect the selected stems against livestock. Pruning is often indispensable for developing a proper trunk and canopy. Pruned branches are often used as firewood.

Box 1

Desert Community Initiative in the Aguie Department of the Maradi Region

The Desert Community Initiative (DCI) was initiated by the International Fund for Agricultural Development (IFAD) in 1997, then further funded through 2001–2008. The Initiative supported forming new organizational structures, capacity building in communities, and idea sharing among farmers and between farmers and implementers. The development of multi-stakeholder committees which were recognized by government and traditional authorities allowed for the community to be fully involved in programming, implementing, monitoring, and evaluating the management activities they were undertaking. Committees focused on agriculture (e.g., monitoring crop experimentation and seed production), environment (e.g., monitoring FMNR implementation), social issues (e.g., managing cultural activities) and generating income (e.g., facilitating enterprise activities). Committees included men and women, village residents, and herders living outside the village (Tougiani et al., 2009). Collaborating villages made payments to support the DCI for agreed-upon purposes such as procuring medical supplies, digging wells, and helping resolve conflicts with herders. By 2007, 170 villages were involved and 53 village committees had been established, each encompassing three or four villages. Estimated area covered 130,000 ha of FMNR with average on-farm tree densities as high as 103–122 trees/ha.

Figure 3. Region in Maradi before and after adopting FMNR. Upper: Typical barren landscape, Maradi region, 1984. This millet field has been cleared of vegetation and crop residue. Lower: Typical farmland in Maradi region, 2005. Larger trees (Bauhinia reticulata) grew from stumps 3–4 years prior and are used for poles. Bushes (Guiera senegalensis) in foreground are used for firewood. Source: Tougiani et al., 2009

Regenerating trees often require protection from livestock, but wire fencing is too expensive for farmers. "'Social fencing' is much more effective than wire fencing. It occurs when a community develops and enforces by-laws governing when and where livestock can be allowed to graze. This sometimes involves community scouts and fines per animal" (World Vision, n.d., p.3). Fire can be a major threat to regenerating trees. Although not a major issue in Maradi and Zinder, it is important to note that where traditional agricultural practices involve burning pastures and cropland in the dry season, controlling fire through raising awareness and providing training is key for forest regeneration.

Villages also organized to overcome other challenges. In Dan Saga the village chief set up a general assembly and villagers agreed to set up surveillance committees to avoid tree theft (Pye-Smith, 2013).

Bringing farmers who haven't used FMNR to farmers who are experienced in FMNR methods and keen to share their knowledge is one of the best ways to stimulate adoption (Figure 4). Technical training during such visits focused on the importance of thinning, and how to prune woody species by making "clear cuts" with local tools that minimize damage to the trees.

Figure 4. A woman farmer from Maradi's Aguié district (Sakina Mati) shows other farmers how to thin Guiera senegalensis. Photo credit: Chris Reij

"It was a revolution," says FMNR pioneer Tony Rinaudo. "Without planting a single tree, simply by recognizing what was there, literally at our feet, caring for it, nurturing it, allowing it to grow, 200 million trees came back into that landscape over a 20-year period. Because of the improved soil conditions and micro-climate, that equated to 500,000 more tonnes of grain being harvested every year, benefitting two and a half million people in the poorest country in the world."

Biophysical outcomes:

The most remarkable change was a dramatic increase in trees on the landscape. As early as 2008, a reported 5 million ha of land were transformed through FMNR. Farming practices changed significantly to include trees, which produced a dramatic "regreening" effect on their landscape (Figure 3). Contrary to what is commonly found in agricultural regions, the highest tree densities are found in areas with higher rural population density (Reij et al., 2009). As of 2010, more than 90% of Maradi's population practiced pruning trees on their farms (Haglund et al., 2011). By 2007, in the Aguie department of the Maradi region, 130,000 ha was under FMNR, and fields which were practically treeless in 1984 were covered with over 100 trees/ha.

Tree density on farms increased. Before FMNR was implemented in the Maradi area, in many places tree density was just 2–3 trees/ha (Reij and Garritty, 2016). Now, 100–150 trees/ha are common (Reij and Garrity, 2016; Chomba et al., 2020), although some studies estimate that the positive effect of on-farm trees is maximized at 40 mature trees/ha (Binam et al., 2017; Glenn, 2012; Reij and Garrity, 2016). However, farmers in many areas are keen to have high densities of species which improve soil fertility (*Faidherbia albida*) or of species which produce fruits or leaves which are readily sold on the market.

Tree diversity also increased (Haglund et al., 2011). Species diversity from FMNR is relatively high (many tree planting projects across Africa focus on just a few species) and tend to be indigenous species (Chomba et al., 2020) (Table 1). *Faidherbia albida* trees were an especially common choice to retain as they are nitrogen-fixers in a poor-nutrient landscape and shed their leaves during the rainy season which decreases light competition with crops (Reij and Garrity, 2016).

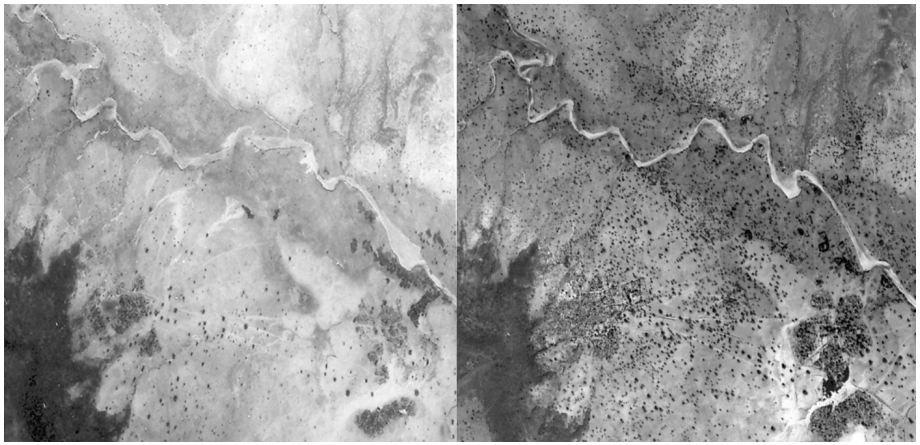

Figure 5. Aerial photographs over the village of Galma (Tahoua region, Niger) in 1975 and 2003 (left to right). The number of trees is much higher in 2003. Black dots are mature trees that have been restored through farmer managed natural regeneration. Source: Reij et al., 2009

Livelihood and wellbeing outcomes:

The benefits of FMNR to local livelihoods were overwhelmingly positive: increased yields, firewood availability, income, and production diversity. The diversity of farmer management preferences and farmers' own estimates about yields make quantifying impacts challenging, but general outcomes are described below (Reij, 2021; Pye-Smith, 2013; Chomba et al., 2020). A strength of FMNR is that other benefits are realized quickly; within the first year of adoption, farmers saw an increase in fuelwood (from thinning), fodder, and reduction of wind speed which leads to reduced soil erosion and seed loss (Tougiani et al., 2009; Sendzimir et al., 2011).

Many farmers saw an increase in crop yields after implementing FMNR—a conservative estimate puts the increase at about 100 kg/ha (Reij et al., 2009). How much yields increased depended on the species, the age, and the density of the trees: where trees are young and densities low, impacts are low. Where nitrogen-fixing trees (*Faidherbia albida*) dominate the agroforestry parkland, increases in crop yields are usually larger than an additional 100 kg/ha. Farmers practicing FMNR also tended to grow a greater variety of crops on their land, which can help improve farm resilience and diversify livelihoods (Haglund et al., 2011).

Villages with FMNR tended to be less affected by a regional famine in 2005, when there were serious deficits of grain yields across the Sahel. In areas with both high human densities and high tree densities, farmers had actually produced a cereal surplus. Farmers were able to consume more from their own farms, sell tree products, and often had larger stockpiles of supplies (Larwanou et al., 2006; Reij et al., 2009).

Only one year after implementing FMNR, farmers could use thinned shoots or early prunings as a source of firewood. After year two, firewood increased. One study found that the firewood sold from FMNR in 100 villages was worth about US$600,000 over 12 years (Pye-Smith, 2013). Some villages also established rural firewood markets where wood was collected at the roadside from farms and sold along the road crossing the village. The sale of firewood was regulated by village committees to prevent over-exploitation of the parkland.

FMNR generally had a positive impact on income by increasing crop yields, diversifying crops, and producing firewood. In Maradi, for example, adopting FMNR was found to increase annual income by about $US 50 per person per year, or about 20% of the farmers' existing income (Haglund et al., 2011).

People gained new food sources on their land from regenerating trees. These products helped to increase food security, especially during droughts and for poorer members of communities. Commonly protected trees with edible leaves and/or fruit include *Strychnos spinosa, Balanites aegyptiaca, Ziziphus* sp., and *Adansonia digitata* (the Baobab tree) (Pye-Smith, 2013). Many medicines can also be derived from trees on farms. "I see these trees as my pharmacy," says Laouali Dan Boula, a traditional healer in the village of Droum (Pye-Smith, 2013, p. 21).

With sources of firewood readily available, women no longer had to travel long distances or spend hours looking for firewood. Women sometimes also earned additional income from selling other tree products, including oils, fruits and nuts (Pye-Smith, 2013).

More trees mean more fodder for livestock, and livestock can remain closer to the fields thereby providing manure for the soil. Previously, most manure was used for cooking fuel, but an increase in fuelwood meant manure could be used to fertilize fields instead. Farmers were able to use fodder from regenerating trees, but because livestock were not confined to private land, benefits were realized at the community level—one of many reasons that having a large percentage of the community on board is key for the success of FMNR (Haglund et al., 2011). Increasing fodder availability locally decreased the need to move cattle over larger areas (Sendzimir et al., 2011).

As populations in the regions continue to grow, farmers are moving northward where rainfall is lower which makes the risk of crop failure higher and conflicts with herders more likely. Observations suggest less conflict in areas with FMNR, most likely because FMNR increased the resources available which makes conflict less likely. "In Tahoua, a region directly west of Maradi where parkland emerged via water harvesting techniques used to restore degraded land, I visited the sedentary nomads' section of the village of Batodi in January 2019. They said, 'Because we now have many trees in the village, we don't need to migrate with our livestock to Nigeria during the dry season as there is sufficient tree fodder for our cattle.' If true and if this is the case in more villages, this could potentially help to reduce clashes between herders and farmers in Nigeria" (Reij, 2021).

Key challenges

Initially, there were many barriers to adopting FMNR. These included the belief that trees would compete with and harm crops. The traditional practice of removing all woody species was overcome when farmers were able to see the impact of FMNR firsthand on the farms of early adopters. Food for Work programs also provided a strong incentive in the very early stages to try FMNR in parts of Maradi, which stimulated adoption and created many "demonstration sites."

Prior to 1985, the national forest service gave fines if trees on their land were felled, regardless of who cut them. This provided a strong disincentive to grow trees on farms (Tougiani et al., 2009). The state weakened the second half of the 1980s and in the 1990s, which reduced the impact of the Forestry Department to levy fines and patrol farms, allowing farmers more freedom to experiment with tree systems. Eventually, broad support for FMNR developed at all levels in the Ministry of Environment and a forestry decree was signed in July 2020 by the President of Niger in support of FMNR.

In some villages in the Maradi region, communities lacked the cohesion required for successful FMNR. As Chris Reij notes: "FMNR is not just about a simple technique; there are other components which are just as important. One of them is village organization—a social process that accompanies a technical one." This challenge remains unresolved in some areas, while in others, working with communities to resolve conflict and initiating culturally appropriate conflict resolution strategies improved adoption.

Once farmers had adopted FMNR, there were additional challenges to keep systems in place, including "exit strategies" and maintaining protection of regenerating areas. In the 1980s, after the Food for Work incentive ended, more than half the farmers cut their trees. But many resumed the practice once they were able to observe the yields of farmers who did not. Today, in most cases, once FMNR is adopted there is little regression as the results are overwhelmingly positive. Outsiders sometimes steal trees as the demand for firewood is high. Some villages successfully organized a "village police agency" to report offenders to the village chief.

How to protect young trees from livestock? FMNR has led to changes in livestock management. In some places, livestock such as goats are now tethered even after harvests, whereas they would typically only be tied up during the cropping season. Farmers also began to enclose livestock, which also allowed them to produce and use more manure on their fields. Growing more trees on farmland has led to more complex agricultural systems, which integrate agriculture, livestock, and trees.

Enabling factors and innovations

Although FMNR has led to the development of more productive landscapes at scale in densely populated parts of Niger, the success of restoration in Niger cannot be attributed to a single actor, policy, or practice. The spread of FMNR in Maradi and Zinder occurred because of interactions between a range of environmental and social conditions (Sendzimir et al., 2011).

"Most farmers will mention several reasons why they are pruning and conserving trees in their fields. These may vary from one village to another, but there are certain benefits which are common throughout Maradi and Zinder. Not surprisingly, in these regions with long and bitter experience of droughts and hunger, farmers are keen to highlight the impact which natural regeneration has on crop yields"

(Pye-Smith, 2013).

Although FMNR arose through different mechanisms in different places, all locales generally shared four common enabling factors that led to widespread adoption:

1. Environmental conditions (especially drought and soil degradation) threatened people's ability to produce food. Farmers were facing an environmental crisis which provided a strong motivation to try new techniques to improve production.

2. Trees produced quick, tangible on-farm benefits. FMNR produced tangible benefits in only a few years, and farmers quickly came to recognize trees as an "essential" component of their production systems. FMNR is not presented as an "environmentally friendly" practice but rather as a logical choice for agricultural systems, with concrete benefits that are readily available (Pye-Smith, 2013; Reij and Garrity, 2016).

3. Farmers gained more control over their trees. The transfer of state ownership and management of on-farm trees to farmers was initially an unintentional, de facto transfer of ownership brought on by a weakened national government.

4. Policies adapted to support FMNR. Once the technique had proven successful at the grassroots level and was widely adopted by farmers, FMNR began to become recognized at the state level. The Rural Code was passed in 1993, which aimed to provide more secure tenure by integrating customary land tenure agreements into formal law, tasking "customary leaders" with resolving land and natural resource conflicts in locally appropriate ways and encouraging participatory natural resource management. The government further decentralized on-farm resource management in 2003 with the Rural Development Strategy, which gives local governments more control to manage natural resources. In 2004, a forestry law was passed mentioning on-farm trees, but it still had some ambiguities about formal ownership rights of on-farm trees. These ambiguities were removed in 2020 when a national decree was signed to formalize the legal arrangements around on-farm tree ownership. Combined, these policies are thought to have "contributed to the sense of ownership and economic incentives that the communities needed to participate in protecting the forests" (Nkonya et al., 2015, p. 75).

In addition, FMNR practice is *innovative* in that it offers flexibility, local control, and requires relatively few inputs. Sendzimir et al. (2011, Fig. 5) present a high-level overview of the feedbacks between biophysical and socio-political relations. “Farmers decide where and when to practice FMNR, how many trees they want on their farmland, their spacing—taking into account the number and species of regenerating stumps—and how to prune them” (Tougiani et al. 2009, p. 382). Surviving and overcoming challenges in a drought-prone, degraded environment requires a degree of innovation, ingenuity, and imagination. Rather than being prescriptive, FMNR can be used in multiple ways depending on local conditions and the needs and constraints of each farmer. Farmers thus feel empowered in their own management choices.

FMNR does not require financial investment, just an investment of time and in training. Whereas planted seedlings may need regular watering in extreme heat and have shown low survival rates in the region, trees regenerating through FMNR are adapted to local conditions and as their roots are already established in the soil, it increases their chances of survival. FMNR requires relatively few inputs compared to “green revolution” technologies. Farmers do not have to buy inputs to intensify agriculture. FMNR requires only labor for protection and management and time dedicated to establishing rules and guidelines. The quantity of labor is modest compared to other farm tasks.

Key lessons learned

- Flexibility and adaptability are key. "[Had we] dictated to farmers exactly how to do FMNR, it is unlikely to have developed such widespread appeal" (Tougiani et al., 2009, p. 382).

- Desperate times can lead to restoration. Farmers in this region were in a dire situation. In the face of a lack of viable alternatives, and in some cases with meaningful incentives in place, farmers were willing to change their practices around clearing their fields of green shoots as preparation for the rainy season.

- Seeing is believing: the value of being able to visit on-farm experience. In both cases where implementation was structured (e.g., the Maradi Food for Work programs) and spontaneous (e.g., adoption after "accidental" regrowth of woody species), seeing the results of the technique was vital. As Chris Reij (2021) put it: "When farmers see with their own eyes that it makes sense, they'll get into it; they are rational people. We've put farmers in busses to go and see firsthand and exchange experiences directly with fellow farmers living and working under similar conditions. That is the easiest way forward and it helps explain how FMNR spread so widely and quickly."

- Restoration based on FMNR takes (the support of) a village. In places where social cohesion was lower, FMNR was not adopted as widely. Individual farmers may be more likely to adopt restoration if their neighbors do—if it is seen to be culturally acceptable and as "what farmers do." The role of the outsiders has been to catalyze processes, but ultimately FMNR has and must become a farmer-driven process that requires only minimal external support.

- Farmers can motivate other farmers. Unless millions of smallholder farmers are mobilized to invest in improving agricultural systems by increasing the number of on-farm trees, land degradation will continue. Strategies to mobilize millions of farmers are key and informing them about what's been achieved by other farmers is one important way forward.

- We're not out of the woods yet. Although FMNR has transformed large areas in Niger, the country has the world's highest population growth rate. There is a huge need to accelerate and improve FMNR as a way of coping with this population growth, and there is still scope for improving agriculture systems. One way to do this is by increasing both the density and diversity of on-farm trees.

Learn more

Further information and resources

Media article: https://www.theguardian.com/environment/2018/dec/14/reforesting-world-australian-farmer-240m-trees

Blog: https://www.worldagroforestry.org/blog/2021/01/12/niger-formally-adopts-farmer-managed-natural-regeneration

FMNR Hub website: https://fmnrhub.com.au/

Video: https://www.youtube.com/watch?v=tBv7_K0PtZo&t=5s

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Acknowledgements

This case study is made possible by funding from the World Economic Forum and was edited and managed by Rebecca J Cole and ETH Zurich's Crowther Lab.

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