FMNR Is Now a Widely Scaled-Up EverGreening Practice: A Robust Legacy of Tony Rinaudo's Career

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Introduction

Tony Rinaudo had an epiphany in Niger in the mid-1980s about the power of Farmer Managed Natural Regeneration (FMNR) to be a transformative practice for the African drylands. His journey to build on that epiphany, as described in the previous chapters of this book, was a powerful awakening – for him and many, many others. But it was, perhaps, not the most significant aspect of his journey—and of the impact of his work. What was most significant was his sheer determination and lifelong dedication to sharing the implications of that experience—initially in the pilot villages in Maradi, Niger, and then far and wide in Africa and around the world. This is what has made that 'discovery' so globally important today. Tony has made it his life's work to inspire thousands of farmers, and hundreds of fellow professionals, about the potential of this transformative practice; such that today, FMNR is generally recognised as a foundational practice for a more productive and sustainable dryland agriculture in countries throughout Africa, Asia and the tropics worldwide. It was that perseverance which made all the difference.

FMNR is a practice that directly confronts the conventional paradigm of agriculture: that crops ought to be produced in clean, treeless fields. He has fought for a new paradigm: That farming can be much more productive and sustainable when trees and shrubs are integrated into food production. And that FMNR is a very low-cost and scalable way of doing that. But such a new paradigm must be based on a very sound validation—by farmers' experience and by science. That validated knowledge base has been accumulating in the decades following the epiphany in Niger.

The evidence base is growing rapidly. There is now a solid documentation of the millions of families around the world that are successfully practising FMNR on their farms, and in their community forest and grazing lands. And there is also a growing body of research literature that has validated farmer observations about the multi-dimensional benefits of this practice. This chapter delves further into both topics. It asks 'What does the science tell us about why the practice has such widespread potential?' And 'What does the record of accelerating FMNR uptake in many countries tell us about its potential for future adoption around the world?'

It also provides an update on how the successes achieved so far have inspired the launch of a global effort to mobilise massive scaling-up efforts, through the Global EverGreening Alliance, and through the launch of a Global EverGreening the Earth Campaign to '*Green up to Cool down*' the entire planet.

The Context

Interest in the development of the African drylands has increased in recent years. This has been driven mainly by the recognition that these areas have been the target of considerable humanitarian aid over the last three decades, as agriculture has failed to provide adequate food security for hundreds of millions of people. Currently, the land degradation processes that Tony observed in Niger have become the cause of even greater concern – as they have created widespread social and political insecurity, and have fostered extremist elements to instigate brutal conflicts that have caught millions in the crossfire.

So far, comparatively little effort has focused more resources on suitable types of rural development that increase rural people's resilience in these countries, and to address the insecurities and dependency on aid. The reawakening interest in these challenges has only just begun to translate into support for livestock and crop-based development pathways, and into efforts to foster land restoration investments that will create more productive, sustainable and resilient farming livelihoods. Such efforts, however, will be of limited impact without attention to a broader systems approach, which builds on the synergies that trees can provide in these systems, as Tony has argued above.

Dryland peoples and their communities have acquired, through the millennia, considerable resilience to overcome the challenges that they face. This enables them to recover following droughts, and other nature-induced shocks like floods and fires. However, the recent very high rate of human population growth in the drylands, along with the increasing frequency and intensity of droughts, are seriously undermining the resilience of both the land and the people.

In the agricultural domain, production of the most important dryland crops is already typically associated with dispersed trees in the farm fields. This form of land use is referred to as agroforestry parklands in the Sahelian context (Boffa 1999). Variants of the parkland system are also common in the Eastern and Southern Africa drylands (Dewees 1995).

Often, trees in these systems directly provide an important product such as wood, gum, oil or fruit. In addition, they provide an input into the production of other major products, such as foliage used as nutritious fodder for meat and milk production, or tree nectar for honey, or tree leaves as bio-fertilisers for improved soil health and crop production. There is a great number of well-recognised tree species and products provide these benefits in the African drylands. These include the baobab tree (Adansonia digitata), which provides nutritious fruits and leaves; the shea tree (Vitellaria paradoxa) that provides oil used in cooking and in chocolate as well as cosmetics; gum arabic (Acacia senegalensis) that provides an emulsifier that is used in many beverages and food items; and the acacia tree Faidherbia albida, that enriches soils and provides valuable pods and foliage for livestock fodder. The environmental services derived from trees on farmlands provide another great stream of benefits, such as soil and water conservation, watershed protection, enhanced biodiversity and a more favourable microclimate for crops to withstand wind, heat and drought stress.

Tree-based systems provide regenerative and restorative effects that are useful, both on the farm and at a landscape scale. These systems include an enormous range of species and practices that enrich the quality of the land resource. The natural regeneration of trees can be applied across the entire range of land use types, including farmlands, forests, woodlands and rangelands. Restoration at scale has already been achieved through the efforts of millions of rural residents across many countries. Examples include the evergreening of the farmlands in Niger, Mali, Senegal, Tanzania, and Malawi, as well as in large-scale watershed rehabilitation efforts in Ethiopia.

Farmer Managed Natural Regeneration and Assisted Natural Regeneration

Farmer Managed Natural Regeneration (FMNR) of trees on agricultural lands, and Assisted Natural Regeneration (ANR) of forests on community lands, provide the most cost-effective way of achieving a widespread increase in vast numbers of valuable, adapted, and diverse trees. These practices have a common characteristic: That people (individual farmers or entire communities) are actively influencing the natural biological regeneration processes – and doing so to achieve tree numbers and patterns that better suit their needs.

On agricultural lands, farmers identify naturally regenerating tree seedlings or sprouted stumps or rootstocks in their fields. They protect and manage them to provide various benefits (for direct products or to enhance crop or livestock production). On community lands, local groups may adopt the same practices, and they may also introduce grazing management systems at the community level that are designed to allow successful tree regeneration in the targeted areas. Under both systems, they protect the young trees, by weeding around them and by pruning them as they grow to help them survive and flourish.

In recent years, FMNR has gained in popularity in many dryland areas in western, eastern and southern Africa. FMNR can expand rapidly through farmer-to-farmer and village-to-village diffusion, because it requires very little or no cash investment, The case of FMNR in Niger, that Tony Rinaudo initially spearheaded, provides the most dramatic example of how quickly and how extensively the practice can spread (Reij et al. 2009). But Niger is just the tip of the iceberg. A recent study carried out in Niger, Mali, Burkina Faso and Senegal has found that almost all farmers in the entire region are now actively regenerating trees on their farms (Place and Binam, 2013).

Opportunities to reduce vulnerability and increase resilience

It is important to distinguish between systems that are based on tree regeneration practices and those that are based on the purposeful planting of trees. The natural regeneration of trees leads to the culture of a diversity of indigenous species that generate a range of products and services. In the drier areas of sub-Saharan Africa, natural regeneration accounts for an overwhelming majority of the trees that are being managed by farmers (greater than 90%).

These regenerative practices include both Farmer Managed Natural Regeneration of trees (FMNR) in croplands and Assisted Natural Regeneration (ANR) that rehabilitates rangelands or woodlands. They are based on the local selection and management of a diverse range of tree species that are well adapted to the local conditions, and they entail very low establishment costs because tree planting is not necessary. They are currently being expanded on large areas throughout the arid and semi-arid drylands, They are now seen as foundational systems for application throughout these agro-ecosystems (Cervigni et al, 2016).

It is important to emphasise that the regeneration of trees on farms may occur throughout the farm, including in crop fields as well as on field boundaries. The result is a mosaic of trees that are integrated into land uses such as cropping, pastures, woodlots, and fallows.

The purposeful planting and management of certain types of tree species, that can produce economically valuable products and services, is also important. Tree planting complements natural tree regeneration through FMNR or ANR. Tree planting is particularly widespread in the more sub-humid and humid zones of Africa and the tropics, where rainfall is higher and tree survival from planted seedlings is more successful. In these zones, there is less risk of poor seedling survival, or of losing more mature trees due to drought. The productivity of individual planted trees is also higher. This compensates for the higher costs of establishing them, by planting from nursery-raised seedlings, compared to FMNR.

Tree-based systems for natural resource management

The products and services farmers get from FMNR vary a lot from location to location. This depends on the tree species that are present in the area, and those that are most valued by them. In the Sahel, more than 100 different woody species are being managed by farmers through natural regeneration. These trees provide a very important contribution to the livelihoods of local people (Place and Binam, 2013). They contribute more than USD 200 per household per year of products for human consumption. Crucially, they also provide fodder for livestock consumption during the late dry season, when other sources of green forage are virtually exhausted. They also have positive effects on the yield of annual crops — accounting for roughly 15–25% increased productivity of millet and sorghum food crops, the staple foods of people in the region.

The trees also provide many environmental services, watershed protection, soil health enrichment, and capture of atmospheric carbon. These services can be generated either through FMNR, ANR, or by purposeful tree planting. All trees store carbon in a relatively stable proportion of about 50% of their dry weight. Tree growth is slower in more arid environments. The annual above-ground carbon storage in a typical field with regenerated trees may be around 1 tonne per hectare in the semi-arid regions, with an additional 0.3 tonnes accumulated below ground. These systems also supply tot he soil a large amount of additional nitrogen, which benefits crop production without any cost. They also enhance the fertility of soils in many other ways, such as soil carbon build-up and improved aeration, which also benefit the associated crops.

A livelihood is classified as sustainable when it can cope with, and recover from, various stresses and shocks. In addition, sustainable livelihoods need to maintain or enhance family assets and capabilities, both now and in the future, while not undermining the natural resource base (DFID 2000). Livelihoods in the drylands are affected by a number of natural hazards. Repetitive drought is the most prominent one. Others include severe floods, as well as animal and human diseases that are often triggered or intensified by droughts or floods.

Other factors—such as weak institutions and inappropriate policies—are human-induced hazards. These exacerbate the impacts of the natural hazards. Conflict is another shock that is increasingly common in dryland areas: witness the prolonged quarter-century of conflict in Somalia, the widespread insecurity in the northern regions of Mali and Niger, in north-eastern Nigeria, and throughout the Central African Republic. Drylands are also prone to economic risks that are felt primarily by shortages of food and fodder, as well as price spikes for food and inputs during periods of stress.

Vulnerability is often the result of extreme poverty, especially where poor people have limited options to sustain their livelihoods. It is also due to exposure to hazards that affect the primary livelihoods of the poor. A typical example from the drylands is when a long-term drought pushes up food prices, worsening the condition of pastoralists' or agropastoralists' livestock, or even causing the death of the animals. Rural people in this situation may find themselves unable to sell their excess stock to buy food and to guard against future hunger. Or they find that livestock prices have collapsed because many other people are disposing of their herds simultaneously. Then they find themselves locked into a massively deteriorating livelihood crisis.

Resilience is a desirable condition, often regarded as the converse of vulnerability, where people have the means to protect themselves from such hazards. But complete protection from exposure to drought, flood and other eco-physical factors is not possible.

Trees reduce exposure to shocks

In the drylands of Africa, there is relatively little that individual households can do to reduce their exposure to shocks, short of moving away from the affected area. If a household is located in a place that is affected by a weather or price shock, it will be exposed. However, many households acting together through collective action can achieve landscape-level effects that do in fact reduce exposure.

An example of this is the reduced incidence of weather-induced dust storms in south-central Niger. That has occurred due to the widespread regeneration of trees in the agricultural landscapes with FMNR. The dust storm frequency and intensity has declined markedly after the communities created a contiguous tree cover over an immense area through FMNR. Farmers also testify that in the absence of tree populations on their fields they were often forced to replant their crops multiple times because high winds early in the crop season often buried or killed the emerging crop seedlings. But with regenerated tree populations the wind speeds in the fields are dramatically reduced. planting more than once is no longer necessary.

At the regional level, recent modelling studies have demonstrated that tree-covered landscapes, which have higher evapotranspiration rates, have a tendency to increase rainfall in the landscapes downwind from them (Ent et al., 2010). This reduces their exposure to drought.

Trees reduce sensitivity to shocks | Trees can play an important role in reducing household sensitivity to shocks. Although trees are not impervious to climate change, their deep rooting systems can access deeper sources of water in the soil. This make them less vulnerable than annual crops to seasonal rainfall reductions. This robustness enables trees to play a particularly important role in reducing sensitivity to at least three important types of shocks: Weather-related, climate-related and health-related shocks (Place et al., 2016).

Reduced sensitivity to weather-related shocks | The dominant weather-related shocks are droughts that are unusually severe, frequent or prolonged. Trees in crop fields directly and significantly ameliorate the severity of drought effects on annual crop performance by creating a more favourable microclimate. Crops in the vicinity of trees experience a higher level of humidity in the crop canopy. This reduces plant desiccation.

Trees also slightly shade the crops, thus reducing the crop's exposure to too much sunlight, which damages the crop plants.. Trees also dramatically increase the infiltration and storage of rainfall in the soil by reducing surface run-off (Ilstedt et al., 2016). The additional foliage that trees provide increases the soil organic matter. This enhances both soil moisture storage capacity and nutrient availability to the crops. Moreover, there are circumstances in which some trees effectively transfer water from lower depths in the soil, bringing the moisture up close to the soil surface through their root systems, and making such water available to nearby crops. This is called 'hydraulic lift' (Bayala et al., 2014). Together, these phenomena reduce the rate of onset of crop water stress, enabling crops to more successfully withstand periods of drought during the growing season.

Reduced sensitivity to climate-related shocks | Global temperatures are increasing as a result of climate change. Average temperatures in the Sahel have already increased by about one degree Celsius during the past 40 years (UNEP 2011). Periods of extreme day-time temperatures are now more frequent and severe. Most annual crops experience a reduction in their yield potential as a result of higher temperatures. This is due to two processes: They have higher respiration rates, which burns up more of their energy, making less of it available for grain filling. And they shorten the crop maturity period (fewer days between flowering and maturity) which reduces the size and weight of the grain.

Trees spaced throughout a crop field significantly reduce the temperatures in the crop canopy and at the soil surface. This curtails the crop's exposure to high temperature shock, particularly at midday. The aggregate effect across the growing season is to reduce the shock of a shortened crop maturity period. This enables the crop to photosynthesise longer during the daytime, and to increase the total length of the grain-filling period -- enhancing the ultimate yield (Sida et al., 2018).

The sum of these effects of reduced shock sensitivity is a more stable crop yield during drought years in fields with trees than in fields without them. Surveys in Niger, comparing the crop performance in drought years between villages and households, with and without the practice of Farmer Managed Natural Regeneration of trees, have provided farm-level evidence that higher tree populations reduce the drought effects on crops (Reij et al., 2009).

Reduced sensitivity to human health shocks | Tree-based systems may reduce a family's sensitivity to health shocks during seasonal or prolonged drought-induced hunger periods. Fruit and vegetable foods from trees are obtained from the farm or from the forest during these periods (Place and Binam, 2013). These products assist in sustaining and improving nutritional levels, particularly of children. For example, the fruits and leaves of baobab are highly nutritious in vitamins A and C, which are lacking in staple foods (Orwa et al., 2009), or are unavailable from other sources during the dry season.

Trees help to cope with shocks

A diverse portfolio of trees on the farm can enhance a household's ability to cope with stresses. The fruits or edible leaves from different species are available at different times during the year. The leaves from many tree species are available as sources of vegetable protein throughout the year, for human food or for livestock nutrition (e.g. baobab, moringa and others).

In the Maradi and Zinder Regions of Niger, where Tony Rinaudo worked and where 1.2 million households now sustain medium-to-high densities of tree populations on their farms, tree branches are cut on a continuous cycle for household fuel-wood supplies and for sale. Some of the mature trees are also cut down and sold in local wood markets for poles and construction materials. Export markets are now active in buying and shipping farm-grown wood south into Nigeria. During prolonged drought periods, these tree assets may be gradually liquidated to supply the household with cash for food purchases. This process was observed to be an important source of coping capacity for households during the prolonged drought (Reij et al., 2009).

Trees are important to the livelihoods of dryland households, and they contribute in many ways to resilience. Income from wood and non-wood tree products can make a significant contribution to rural households' budgets and their food security. The services that trees provide for crop and livestock systems are in many cases even more important and of higher value than their direct products alone. Building resilience and improving livelihoods requires an integrated approach. Investment in scaling up FMNR should be seen as an essential component of a basic set of technological options for supporting dryland livelihoods.

During drought years farmers survive on trees because they provide different sources of income. Yamba and Sambo (2012) surveyed in two districts (Kantché and Mirriah) in the Zinder Region of Niger, each with high population densities and high on-farm tree densities. Niger's estimated food deficit in 2011/2012 was 600,000 tonnes. Surprisingly, the Kantché district, with 350,000 people, had produced a grain surplus of almost 14,000 tonnes in 2011, which was a major drought year. The district had produced significant grain surpluses since 2007. These surpluses were attributed to the wide-scale adoption of FMNR.

FMNR and soil fertility

Trees of all types have some properties that are beneficial for soil conservation and soil fertility, chiefly through their root systems, which help to hold the soil in place. But the their falling leaves provide tons of mulch to enrich the soil. Their roots die back periodically, and provide additional organic matter. These sources of organic matter nourish the micro and macro fauna in the soil, that recycle these nutrients tot he crops. Many farmers have known and appreciated these properties for generations.

At the same time, trees can compete with crops for nutrients, water and light. So, farmers weigh the benefits and costs in associating trees with crops, and they make careful choices on the appropriate tree species to cultivate, the optimum densities of these trees in their crop fields, and the type and severity of pruning that they employ to reduce competition with crops. Trees in crop fields may also interfere with animal ploughing operations, by imposing additional time and costs during tillage operations. Thus, 'cultivate your crops in clean fields without trees' has often been the message that extension agents have conventionally conveyed to farmers (Smith, 2010).

But this message is much too simplistic. And it ignores the great benefits that trees can provide, when managed appropriately in cropping systems. Many tree species have been found to offer significant benefits to soils with relatively little competition with crops. However, the real kingpin for the African drylands is Faidherbia albida (formerly Acacia albida). This unique species fixes atmospheric nitrogen, has a deep rooting system, a relatively sparse, open canopy, and it drops its nitrogen-rich leaves onto the soils right as the rainy season begins. These characteristics give *Faidlherbia* great compatibility with crop production, making it a highly desirable component of farms throughout the continent of Africa. The many other useful species for soils are also beneficial as livestock fodder as well (such as many of the *Acacia* species).

A meta-analysis of studies on the effects of fertilizer trees on maize yields found that they often have quite significant positive effects—generally, a doubling of yields or more (Sileshi et al., 2008). However, results to vary, and the choice and management are critical factors, as are the local environmental conditions. Two recent studies (Glenn, 2012; Place and Binam, 2013) examined the crop yields and profits from FMNR in Malawi and the Sahel, respectively. In both cases, Faidherbia was a common species, and in the case of Malawi, the dominant species. Both studies found positive effects on yields from the trees, and on profits as well, due to the low labour requirements associated with the trees. The millet/sorghum yield effects of FMNR were between 16–30% in Mali, Burkina Faso and Niger, controlling for other inputs and conditions (Place and Binam, 2013). In Malawi, Glenn (2012) found that Faidherbia trees increase maize yields by 12–16%. The limited evidence suggests that while the fertilizer tree systems cannot completely shield crops from some yield losses in droughts, they provide higher yields than when trees are absent in both drought years and in normal conditions (Akinnifesi et al., 2010).

The extent of FMNR adoption

A key objective of Farmer Managed Natural Regeneration is to create a vegetative cover that is commonly referred to as an agroforestry parkland system. Parklands are landscapes in which mature trees are scattered in cultivated fields (Pullan, 1974; Sautter, 1968, cited in Raison, 1988). The parkland system is the dominant land use system across the entire West African semi-arid and sub-humid zone. In these agroforestry parklands, the composition and density of the woody vegetation is altered by humans in order to optimise its use. Most often, parklands development reflects a continual process of tree species selection, tree density management and tree pruning to optimise the benefits.

Parklands with FMNR are not limited to the Sahel and Sudanian zones of Africa. FMNR is wide-spread in parts of Ethiopia (Hadgu et al., 2011), Malawi (Dewees, 1995; Kundhlande et al., 2017), Tanzania (Monela et al., 2005), Kenya (Muriuki, 2013; Oginosako et al., 2006) and Zimbabwe (Campbell et al., 1991). There is considerable evidence that farming households in Malawi actively encourage the regeneration of trees in their crop fields and around their households (Dewees, 1995). Recent surveys show that more than 85% of Malawian farmers protect a wide variety of trees that are regenerating on their land (Nyoka, 2013; Kundhlande et al., 2017).

The term 'agroforestry parkland' emphasises the multiple forms and purposes of these systems. They differ considerably in terms of three variables: the density of trees and shrubs per hectare, the diversity of tree species, and the age of individual trees. Together, these shape the economic benefits that can be generated today and in the future. A healthy agroforestry parkland system would include both mature trees that provide benefits today, along with some younger trees to replenish the system in the future. However, demographic, economic, environmental and social developments during the past 40 years have put serious pressure on the traditional land-use systems of the Sahel. Modern Sahelian forest laws banned the cutting of trees on farms without a licence. This discouraged farmers from engaging in optimum parkland management practices. And it led to the major degradation of the parklands across the region (Boffa, 1999).

The loss of trees and the land degradation was particularly serious in Niger. During the 1970s and 1980s, Nigerien farmers faced massive tree losses from drought (affecting particularly the young trees). Meanwhile, the rapid rate of human population also caused wide-spread desertification of the agricultural landscape.

After conventional reforestation projects failed, as Tony Rinaudo noted in the earlier chapter, he initiated pilot projects during the mid-to-late 1980s to promote FMNR. These were followed by larger development projects that began to emphasise FMNR as a much better way to re-establish useful trees in the desertified agroecosystems of southern Niger (Tougiani et al., 2009). They generated a range of benefits, including a supply of dry-season fodder for livestock, firewood supplies, and fruit and medicinal products that farm households could consume or sell. Moreover, several species were excellent in enhancing soil fertility and increasing crop production (Barnes and Fagg, 2003).

Interest in FMNR was further stimulated in the 1990s when the successful experiences of several pilot projects were shared with government policymakers. This encouraged the government to relax the restrictive forestry regulations (*Code Forestier*) that had severely discouraged farmers in cultivating their own trees. FMNR began to spread rapidly across the landscape. In 2004, the Government of Niger formally recognised the trend by revising the national forestry laws to eliminate the onerous restrictions on the freedom of farmers to manage the trees that they cultivated on their own land.

As a result, tree densities and tree cover in Niger have dramatically increased in recent decades. Analysis of high-resolution satellite images, acquired during 2003 to 2008, showed that in the Maradi and Zinder Regions of Niger alone, about 4.8 million hectares of farmlands were regenerated by 2008 through FMNR (Reij et al., 2009). An estimated 1.2 million households were engaged in managing these FMNR systems through their own independent efforts. Many villages now have 10–20 times more trees than they did 20 years ago, and the agricultural landscapes of southern Niger now had more than 200 million more trees than they did 30 years before. Reij et al. (2009) estimated that this transformation resulted in an average of at least 500,000 tonnes of additional food grain produced per year, enough to cover the requirements of 2.5 million people. A more recent mapping of tree cover on farmlands has revealed that FMNR is now being practised on over 7 million hectares in Niger (G. Tappan, 2016, pers. comm.) This is an astonishing transformation that has impressed development professionals around the world.

The scaling-up of Farmer Managed Natural Regeneration has also been spreading to other countries in the Sahel, inspired by the Niger experience. The US Geological Survey recently mapped 450,000 hectares of young, contiguous FMNR on the Seno Plains of eastern Mali (Reij, 2012). This had evolved through a similar process as in Niger. It had accelerated during the previous 15 years, after the enforcement of forestry laws that had discouraged FMNR were relaxed.

What has happened since 1994 on Mali's Seno Plains illustrates the importance of forestry legislation. In 1991, Mali's president was toppled by a popular uprising. During that period, many forest agents were thrown out of the villages and some were even killed. They had managed to make themselves very unpopular, for instance, by starting bushfires themselves, while later accusing the villagers of having done so. Since the practice of burning was against the law, the forest agents were subsequently able to impose unjustified fines on the people.

In 1994, a new forest law was adopted, which regulated the rights of farmers to on-farm trees, on the condition that the land was not left fallow for more than 10 years. This policy encourages farmers to reduce the number of years that they leave their land fallow and to protect on-farm trees. Due to the high and rapidly growing population on the Seno Plains, most farmers have to cultivate their land permanently, in any event.

A radio station in the small town of Bankass on the Seno Plains, which was funded by the NGO SahelEco, decided to broadcast the contents and implications of the new forest law. The reaction of villagers was: "Does this mean we can refuse access to those who cut our trees with a permit of the forestry service?" The answer was 'yes', and it was also broadcast by the radio station. From that day, farmers refused access to woodcutters and began protecting their on-farm trees (Reij and Garrity, 2016).

It took until 2011 before the scale of the new agroforestry systems on the Seno Plains was fully uncovered. Local staff estimated that they had spread over 16,000 hectares. However, Gray Tappan, of the US Geological Survey's EROS Data Center in South Dakota, used satellite images and to map the area under medium and high-density agroforestry in the area. He found that it had expanded to almost 500,000 ha. Until 2011, the scale of this re-greening process was unknown and unappreciated. Field visits have shown that 90% of the trees are less than 20 years old, corresponding tot he time when the changes occurred in the forestry regulations.

FMNR is now also prominent in northern Burkina Faso. Interestingly, some farmers there are managing FMNR in more standard row patterns in order to avoid interference with ploughing operations (R. Bunch, 2012, pers. comm.).

In Senegal, the Serer people have sustained a medium-to-high density of mature Faidherbia albida trees in parklands that cover 150,000 hectares of farmlands, during at least the past several generations. This excellent FMNR system was an excellent model of how the land could be managed more sustainably. But unfortunately, severe degradation of the tree and land resources had occurred across much of the rest of the country. This was, to a considerable degree, caused by government programs that promoted mechanisation and the complete removal of trees from farmlands in the interests of "modernisation". However, that effort failed because it accelerated massive land degradation on the fragile, sandy soils of Senegal.

Fortunately, the Government recently has revised its agricultural strategy to promote agroecological farming with FMNR. This has led to over a dozen FMNR pilot projects that are providing the technical and institutional experience to enable the widespread adoption of re-greening practices (Sanogo, 2010; Rinaudo, 2012; Herrmann et al., 2013). World Vision's FMNR project in the Kaffrine region has enabled the adoption of 70,000 hectares of new FMNR. And farmers throughout the central and northern parts of the agricultural zone of Senegal have begun to regenerate millions of trees on their farms.

Recently, there has been a resurgence of interest by the Heads of State of the Sahelian countries to create a Great Green Wall across the continent. At the 1st African Drylands Conference (Dakar, June 2011), scientists presented evidence underpinning the value of an approach based on a participatory engagement of the local rural populations in order to expand the farmer-to-farmer dissemination of FMNR region-wide. This was supported by the World Bank and the Global Environment Facility, which are now collaborating with each of the Sahelian countries to invest a pool of USD 1.8 billion to implement land regeneration projects based on these community-based natural resource management systems and other restoration methods.

The declaration of the 2nd African Drylands Week, convened by the African Union in August 2014, urged that the drylands development community commit seriously to achieving the goal of enabling every farm family and every village across the drylands of Africa to be practising Farmer Managed Natural Regeneration and Assisted Natural Regeneration by the year 2025.

Due to the continued expansion of agricultural land in the drylands, FMNR is all but assured to play an ever more important role in overall tree management. It can indeed be considered a 'foundational practice' that is relevant for virtually all farming systems in the semi-arid and dry sub-humid dryland zones. It has such a wide recommendation domain because establishment costs are very low.

Natural regeneration has a high success rate due to the vigorous growth from rootstock and self-seedling establishment. And it is based solely on indigenous species that are well adapted to each site -- environmentally and climatically. This practice can be integrated with the full range of traditional and improved crop and soil management systems. Other tree-based systems that involve the planting of trees can then be built around the basic FMNR practice, further enriching the species portfolio on the farm. Tony Rinaudo refers to this process as FMNR+.

By contrast, tree planting has much more limited possibilities in the drylands. It is more suited to the sub-humid and humid zones, where rainfall is higher, and where there is access to dry season water to support tree nurseries (e.g. proximity to low-lying wetland areas). Tree planting is further encouraged where there are attractive commercial opportunities for specific tree species suitable to the drylands (e.g. Melia volkensii for high-quality timber in the drylands of Kenya).

Environmental services from FMNR practices

In addition to the private benefits from FMNR restoration and regeneration practices to the farmers who apply them, the broader environmental services that they produce are also provided to other stakeholders across the landscape or the region. These services may attract payments to farmers and communities to help compensate for their investment in introducing them on their land.

Carbon is accumulated and stored as trees grow, mainly in the wood of the tree but also in the root system. As the landscape fills up with more trees, and that tree cover continues to increase over the decades, the carbon stored in the landscape increases. In the drylands, tree growth is slower than in humid areas, and the density of trees in the landscape is less than in more humid areas. One might expect an average of around 1 tonne of carbon accumulation in above-ground biomass per ha per year in FMNR systems, (Beedy et al., 2014).

Trees can add to soil carbon through their roots and leaves. However, while there is a straightforward relationship between above-ground woody biomass and carbon, it is much more difficult to assess soil carbon build-up. Moreover, soil carbon stability is susceptible to change due to tillage and cropping practices. Thus, in terms of the ability of dryland farmers to benefit from carbon finance schemes, the above-ground carbon sequestration through woody biomass is likely to be the primary opportunity for them.

Given a typical carbon value added of 1 tonne/ha, this will generate up to USD 10–15 per tonne of carbon dioxide offset value given current prices. However, due to high transactions costs, only a portion of this amount would make its way to the farmer or community. There are several examples of programmes to compensate local people for protection of existing woodlands that are operating in the drylands (e.g. the Humbo Project in Ethiopia, and other projects in the UN REDD+ programme); but projects that seek carbon sequestration as a major goal generally favour more humid areas, where biomass growth is faster on a per hectare basis.

Restoration and temporary land enclosures also provide water and watershed services to communities downstream. Many of these effects are localised, such as spring and river rejuvenation, and enhanced groundwater supply for the valleys nearby. But the benefits may be felt even further downstream, such as in erosion and sedimentation control for hydropower dams, and for aquifer replenishment that enhances the provision of clean water to towns and cities. A study of woodlands in semi-arid and arid areas has found that a canopy cover of even just 3.5–6% would suffice for conferring the necessary surface run-off regulation benefits of the woodlands for the rest of the landscape (Shivdenko at al., 2005).

Increased tree cover in the dryland communities reduces wind speeds and dust loads. African drylands contribute over 50% of the total global atmospheric dust circulation. They have dust concentrations in the air that are considerably higher than in any other region on earth (Engelstaedter et al., 2006). High child mortality is associated with respiratory illnesses, especially in Africa. And this has been partly attributed to over-exposure to high concentrations of dust in the air (Romieu et al., 2002; Smith et al., 1999). Communities in Niger that have succeeded in creating medium-to-high density agroforests across their farmlands through FMNR report that they experience much lower dust in the air, and that they are much less affected by dust storms as well.

Finally, biodiversity benefits have been clearly identified and quantified by tree restoration in the agricultural landscape. More trees on farms creates a multitude of niches for all kinds of other flora and fauna to inhabit the land. This also brings with it a wide range of insect predatos, that enhance natural management of pests and diseases. These enhanced pollination and pest regulation services are well known, but their economic value needs to be better quantified.

Costs of FMNR establishment and scaling up

By definition, FMNR neither requires the effort to acquire tree seeds, or to propagate stem cuttings, or to nurture them into seedlings in tree nurseries, or to plant them out in the field. These operations are serious constraints for individual farm families, and they present huge costs for large-scale tree planting programs. In contrast, the cash cost of regenerating a tree seedling or root sprout via FMNR, that is already established in the field, is essentially zero. New trees emerge from the soil without the need for any initial nurturing or protection. However, further protection and maintenance may be required for them to thrive once the farmer has selected them for cultivation in the farm.

The most important establishment costs for FMNR seedlings are the protection of the desired trees—either in the form of micro-protection of individual trees or the protection of larger areas—mainly using barriers or fences—and the removal of other trees that are not desired. Maintenance costs may include weeding and pruning. Weeding is primarily for trees emerging from seed, but it is not generally needed for those emerging from coppices and roots -- because these grow quite rapidly.

Pruning and other forms of management of the canopy size and shape is often necessary. This is one of the more demanding labour needs for FMNR, especially as the trees mature—but pruning is also the source of supply for family fuel-wood and the foliage provides livestock fodder.

Although the scaling up of FMNR in the Sahel has been labelled as farmer-driven, with little external support, a number of development and extension programmes are now supporting the scaling-up of FMNR. These programmes are spending resources on enhancing farmer awareness of the benefits of FMNR, building farmer tree management skills, organizing landscape control of grazing and fire to protect the young trees, and helping to develop tree product markets. They are also supporting policy reform, particularly to modify forest code regulations to encourage rather than discourage farmers to establish trees on their farms. More productive and sustainable woodland management is also getting much more attention, not as an alternative to FMNR on farms, but rather as a highly complementary activity (Shumba et al., 2010; Mayaux et al., 2004).

Rural development projects in Niger since 1985 have invested significant resources in the promotion of re-greening by farmers. A part of the 7 million ha of adoption has occurred is the direct result of these interventions, but a much larger part has been the result of farmers spontaneously adopting the practice, because they have observed the benefits and do not need any external support in getting started on their own. And the consequent spread of the practice from farmer-to-farmer and village-to-village.

What kinds of activities have been funded by donor and government-supported projects? One key activity was the organisation of study visits among farmers and among communities. Letting farmers (men and women) who don't yet use the practice visit those who have gained experience with it, has proven to be one of the most effective ways of spreading the practice widely.

The International Fund for Agricultural Development (IFAD) recently calculated the costs of farmer-managed re-greening in the Maradi Region of Niger. The costs amounted to 9,000 CFA/ha, which was USD 14 per hectare at current exchange levels (USD 1 = CFA 607) (Reij and Garrity, 2016).

The impacts of FMNR on household income and food security

The three main sources of private household benefits for practising FMNR are through direct human consumption of tree products, indirect benefits on crop production, and increased benefits through enhanced livestock production.

In terms of direct consumption benefits from trees, the major products are foods (fruits, nuts, oils and leaves) and wood (construction and fuel-wood). A recent four-country study, across 1,000 farms in the Sahel, found that all households harvested tree products for their consumption, and in many locations, the quantity and value was quite high (Place and Binam, 2013). The average harvested value per household ranged from a low of about USD 110 in Senegal to about USD 250 in Niger. Only a minority of harvested products were sold by the households for income—the highest being about 35% in Burkina Faso, and the lowest being about 4% in Niger. Burkina Faso households benefit from the presence of a wide distribution of Vitellaria paradoxa (shea butter) which has a large and expanding global market.

Crop yield improvement is the 2nd major benefit pathway of trees. It is important to note that in the Sahelian countries chemical fertiliser use is low, both in terms of percentage of farmers (25–30%) and the amounts applied. Manure is a much more common input (55–80% of farmers). Trees are found throughout all farms, but the density and age profile of those species with known beneficial effects on soils (ie. 'fertiliser trees') varies across sites. Both the number of trees per hectare and the age oft he trees are important, for it is the older trees, which produce the greatest volume of foliage, that have the most significant effect on yields.

In Niger, the average number of mature fertiliser trees per hectare was 32, while in Mali and Burkina Faso it was lower, at about five per hectare. The mature fertiliser trees increased cereal crop yields by 15–30% in Niger, Mali and Burkina Faso, after controlling for other effects (rainfall, soil type, seed density, area, manure, fertiliser). Furthermore, the study found that more trees were cultivated per hectare in crop fields, the more manure and fertiliser were applied. Farmers tend to apply more manure and fertiliser on fields with more trees, probably because they find that their crops respond better to these inputs because the trees have restored a healthier soil environment. Trees and fertiliser inputs (organic and inorganic) behave synergistically to enhance production.

Haglund et al. (2011) undertook a study of more than 400 farmers in Niger, comparing those who practise FMNR with those who don't. Their figures indicated that the gross value of crop production for farms practising FMNR was USD 138, compared to USD 88 for those that were not practicing it.

Reij, Tappan and Smale (2009) conservatively estimated that average grain yields had increased by 100 kg/ha on the 5 million ha of new agroforestry parklands that they had mapped in Niger. They also assumed that the yield increases were higher on the farms that were dominated by Faidherbia albida trees. They calculated that the regreening by farmers with FMNR was contributing an 500,000 tonnes per year of additional grain production to the families that had created these FMNR agroforestry parklands. This is enough grain to feed 2,500,000 people.

FMNR also contributes in other ways to household food security. Many tree species produce nutritious fodder with a high protein content. This enables smallholder farmers to raise more livestock for mil and meat. In Niger, livestock now depends on tree fodder for sustenance during about half of the year. More livestock means that farmers have more ‘cash on the hoof’ which they can sell in drought years. During those drought years, farmers sometimes literally survive by their trees. They cut down some of them trees and sell the firewood or construction wood to generate cash. This enables them to buy enough cereal grain to feed their families during these years when crop yields are reduced due tot he drought (Reij and Garrity, 2016).

The sale of vegetable tree leaves, and of fresh or dried fruit, generates important income for women. One mature baobab (Adansonia digitata) tree can generate an additional annual income of USD 34–75 for a family. This level of revenue allows a family to purchase 70–175 kg of grain on the market. As many as 75 baobab trees may be found growing on 1 ha in some parts of the region (Yamba and Sambo, 2012).

Income from the sale of firewood has an estimated average annual value in the Sahel of USD 127–154 per household. The sale of non-timber products, such as fruit, provides an additional return of USD 237 per year, or an additional value of USD 0.66 per day per household (Place and Binam, 2012, quoted by Francis and Weston, 2015).

Individual farmers can protect and manage the trees that they regenerate on their farms, but it is more effective, and a lower risk, to each family if the village community organises itself to practice FMNR across the entire landscape. To do this successfully, enforceable by-laws for protecting and managing the trees are enacted and enforced locally. The process of supporting such village institutions was pioneered by a project in the Maradi region (Reij and Garrity, 2016) that was funded by the International Fund for Agricultural Development (IFAD). Men and women farmers, and representatives of the livestock herders, were members of the management committees. These committees convene meetings with the surrounding villages (an inter-village organisation) to foster cooperation on tree protection. They developed rules and set fines for the illegal cutting of trees. And these rules are enforced. This provided confidence to each farm household that their efforts to regenerate trees on their croplands would pay off, since the danger of stray livestock destroying their efforts would be minimised. That stimulated an enormous increase in tree density across the villages.

Can an increase in rainfall in the Sahel explain the emergence of agroforestry parklands?

It has been argued in some quarters that the major cause for the large-scale re-greening observed in Southern Niger was a general increase in rainfall in the Sahel. Indeed, the average rainfall in the Sahel has increased since the mid-1980s, after a prolonged cycle of drought years during the previous decades. And it is true that this increase in rainfall has had a positive impact on natural regeneration and on the growth of woody species. But if rainfall were the determining factor for re-greening, then the on-farm tree densities in northern Nigeria should be higher than than in southern Niger, since both areas, which are adjacent to each other, have similar population densities, similar soils and the same ethnicity. But northern Nigeria has more rainfall, yet it has much lower on-farm tree densities than southern Niger. Thus, increased rainfall can certainly facilitate the regeneration of trees in the landscape, but it is the deliberate human choices and management of naturally regenerated trees that is a more important determining factor of success in creating robust FMNR parklands.

New evidence is emerging that confirms the positive effects of forests and trees on rainfall (van Noordwijk *et al* 2015). This suggests that the large-scale development of the new agroforestry parklands in southern Niger may have had a positive impact on rainfall in the region, particularly in areas downwind of the extensive parklands in the Zinder and Maradi regions. However, the historical rainfall data for this region have not yet been fully analysed to test this possibility.

Why does such large-scale natural regeneration by farmers fly under the radar?

The examples from Niger and Mali show that the significance of even large-scale FMNR can go unrecognized and unheralded at the national and regional levels. This has also proven to be the case in Malawi, where farmers had also protected and managed natural regeneration on millions of farms across the country. But scale and significance of this phenomenon was also revealed only quite recently.

Why is it that outsiders had not observed these developments and interpreted their great signifiance? Is it because it was the farmers on their own that had played the dominant role, and that no there were no project signboards that were put up to extol the support of outside organizations to drive the process? Was it not a case of 'hidden in plain view'?

Authorities are typically not expecting, or looking for, a transformative solution to come from uneducated farmers, especially when that solution flies in the face of conventional technological wisdom from the agricultural and forestry centers of wisdom and experience. And they certainly have not immediately recognized the FMNR solution as a valid, albeit unconventional, way of solving a pressing problem that has vexed and eluded the experts.

Fortunately, this is a situation that is gradually changing, as voices from such respected organizations as the World Bank, the GEF, FAO, UNEP, and other UN agencies, are now recommending FMNR as an important innovation deserving great attention in addressing the world's most serious environmental challenges in overcoming land degradation, addressing climate change and reversing biodiversity loss. And is it not likely that many more FMNR successes remain to be uncovered around the world?

Scaling up FMNR

There are several factors that limit the potential for FMNR to be massively upscaled that are related to social and institutional constraints. These include the attraction of setting fires annually on farmland and grazing lands in many countries, the tradition of allowing free grazing on farmlands during the dry season, and various rights and regulations related to the ownership over trees.

The use of fire does generate important benefits to some local people—it may stimulate fresh grass to grow, help to clear debris from crop fields and rangelands, and it may facilitate catching wild rodents for food. And free grazing systems offer a cheap mechanism for feeding livestock in the dry season.

It is challenging to deploy institutional reforms that can reconcile the interests of FMNR practitioners with the interests of others who benefit from setting fires and from free grazing. Such reconciliation needs consultation and engagement with all stakeholders in the community to work out solutions that can suit all parties. Fortunately, practices such as controlled fires, rotational grazing areas and the promotion of livestock corridors are some of the options that have been successfully implemented in the drylands in order to facilitate the scaling-up of FMNR. So we know that these challenges can be overcome.

A large percentage of Sahelian farmers feel that unreasonable forest codes are still a limiting factor (44%). They also identify other important constraints as the heavy-handedness on the part of forest officers (38%), uncontrolled cutting of trees by outsiders (31%) and animal damage (28%) from uncontrolled grazing (Place and Binom, 2013).

Forest regulations that disincentivize farmers from growing trees is a very widespread constraint in the developing world. The regulations that are unfit for purpose include bans on the felling or cutting of a number of tree species without obtaining a prior permit, at a fee. Violation of such regulations entails a hefty fine. Farmers will often remove young trees from their land to avoid having to adhere to these rules. Among such regulations, the adverse effects of the Sahelian forest codes have long been recognized (e.g. McLain, 1992). There have been many policy dialogues in the region to try and move reforms forward. The recent re-greening in Niger and Mali has been attributed to a significant extent by the relaxation of the enforcement of such policies (Rinaudo, this volume; Reij et al., 2009). A recent analysis of the forest codes and recommendations for further action was done by Yatich *et al.* (2013).

The existence (or not) of markets for tree products is another factor that impacts on farmers' incentives to establish and manage trees. The development of tree product markets has a stimulatory effect that encourages tree-based systems in general. For FMNR in particular, market development may have different effects. In general, as these markets develop, there is more incentive to maintain trees on farms, as the case of shea in Burkina Faso has demonstrated. There may be further incentives that influence the selection of tree species to retain in the crop fields, based on market signals, but only if market signals persist for a long enough period, since changes in tree species composition is a long-term evolutionary proposition in the drylands.

FMNR should be recommended in all geographical regions in Africa, particularly in the semi-arid and dry sub-humid drylands. There is a vast area of cropland between 400–1,000 mm of annual rainfall which includes large areas of the West African Sahel, the Horn of East Africa and much of Southern Africa (table 1). The key foundational agroforestry practice for these zones is Farmer Managed Natural Regeneration, for use on all farms in the zone, complemented by other improved farming practices as well as cropping and livestock systems. Place and Binam (2013) found that over 90% of trees on farms in the Sahelian countries were established by Farmer Managed Natural Regeneration.

There is growing political support for massively scaling up FMNR. The World Resources Institute, the German Development Cooperation (GIZ), the African Union, and a number of other organisations are now jointly supporting a process of engaging many countries in Africa to restore 100 million hectares of degraded landscapes by 2030. This AFR100 initiative has an audacious level of ambition that can only be achieved if FMNR, led by farmers and their communities, will be a dominant component of the effort. No other set of practices could possibly accomplish the job—given the enormous areas of land involved and the limited investment funds available.

The World Resources Institute recently published a report about how to scale up re-greening successes (Reij and Winterbottom, 2015). This report builds on and distils the re-greening experiences observed in the West African Sahel that were discussed above. The scaling strategy has six steps, and some activities under each of the steps.

Step 1: Identify and analyze re-greening successes

There are many small and large re-greening successes in Africa's drylands. As the examples from Niger and Mali show, re-greening by farmers is often overlooked. Each country should make an effort to identify its previous re-greening successes, because these can be sources of inspiration and training grounds for farmers who do not yet protect and manage their naturally regenerating trees.

Step 2: Build a grassroots movement

In most countries, donor-funded projects are already promoting some forms of participatory natural resource management, but they are not always working together. The challenge is to unite them in order to create synergies and stronger political leverage in collaboration with government and to expand enabling policies and legislation.

Farmer-to-farmer study visits are a very effective way of scaling up FMNR. In some regions, both women and men farmers have gained so much experience with the practices that they have become experts and can train others. These hubs provide the foundation for outward expansion. If it is true that practice precedes policy, then it is important to inform government about the successes and about the existing dynamics that can accelerate the process on-the-ground.

Step 3: Address policy and legal issues and improve the enabling conditions

Working at the grassroots level only is not sufficient to accelerate the scaling up of FMNR. The role of national governments is to create forestry legislation and agricultural development policies that induce land users to invest in trees. Current forest legislation tends to show some weaknesses. One of these is that they often do not recognise farmers' rights to own, manage and harvest the trees that are established on their land. For instance, in most Sahelian countries, farmers are allowed to exploit and also cut the trees that they have planted, but if they have protected and managed natural regeneration of indigenous tree species, they may need a permit from the forestry service in order to manage, prune or harvest the trees.

A major weakness that needs to be addressed is that Ministries of Environment tend to be interested in natural forests and in planting trees, but not in natural regeneration; whereas Ministries of Agriculture usually concentrate their extension efforts only on annual crops. However, as soon as funding for agroforestry projects becomes available, turf fights often emerge between both ministries. The Ministries of Environment then claim that agroforestry is about trees, which is their domain, while the Ministries of Agriculture, which have much stronger extension services—and usually have a much greater capacity to implement such projects—claim that it is all about farming systems. The solution is the development of inter-sectoral platforms that combine the strengths of both ministries in the accelerated scaling up of agroforestry.

Step 4: Develop and implement an effective communications strategy

It is possible to reach out to tens of millions of smallholders by using rural and regional radio stations to spread the messages about re-greening and by linking mobile phones with radio as well as ICT to make the web more accessible to rural people. The process can be enhanced by inviting national and international journalists to visit re-greening successes. However, at this moment most re-greening projects don't have a communications strategy, or if they have one, it is seriously underfunded. The challenge is to inform all land users in a country about what has been achieved and what they and their communities can do to participate. Land users themselves should be at the heart of FMNR communications strategies.

Step 5: Develop or strengthen FMNR tree product value chains

This is where the private sector has a major role to play. They can support the development of value chains around the agroforestry products from FMNR. This will put more cash into the pockets of smallholder farmers and induce them to expand their tree enterprises.

Step 6: Design research activities to fill gaps in knowledge about FMNR

We know enough to move into accelerated action on FMNR scaling up, but at the same time it is important to fill some important gaps in our knowledge. For instance, too little is known about the impact of landscape-level FMNR on surface and groundwater hydrology, or about the impact of re-greening on rainfall, on carbon sequestration in biomass or in soils and on nutrition as well as food security.

Conclusion

Seventy percent of the 700 million food insecure people in the world live on rural smallholder farms. These families are hungry because they cannot produce enough food to feed their families on their own land. This is usually degraded land. They also cannot afford to improve it to increase its productivity. Restoration of the productive quality of this land will increase food production and make it more resilient to droughts and other stresses. More food-producing trees, and more trees that produce products that the family can sell to buy more food: These are obvious opportunity to overcome food insecurity, increase incomes sustainably, and provide these families with dignity.

FMNR has great potential to enhance the lives and livelihoods of the poorest people in a very practical way. It reduces their vulnerability and increases their resilience to shocks, in the dryland regions of sub-Saharan Africa – and around the world. It can not only can restore degraded land. It can help restore the livelihoods, the dignity, and the local environment of the rural poor. And it is a practice, that is fully accessible to the poor. It can be implemented conveniently with their own resources, through their own efforts.

The potential of FMNR is enormous, but it is not appreciated nearly enough by those who command the resources to invest in restoration, climate mitigation, and poverty alleviation. Much work remains to be done to change the mindsets of policy-makers, development professionals and even technical specialists such as researchers and extension agents – in order to ramp up investments in working with poor communities, to share the evidence and build their own capabilities to spread the practice widely.

Unfortunately, for many leaders in agriculture and forestry, the idea of integrating trees with crops or pastures, or assisting the natural regeneration of forests, is still considered to be unconventional, even backward, and to be avoided: Even in the face of all of the experience, and scientific evidence, that has piled up during the past few decades, Yet, this growing body of evidence shows clearly that successfully integrating trees into farming and livestock-keeping systems can be extremely profitable, provided the appropriate species and management practices are used.

Tony Rinaudo's epiphany about FMNR in Niger back in the mid-1980s, and his steady persistence in building awareness and expanding training efforts across many countries, have inspired scaling-up efforts that we see taking root all over Africa -- and across the world. They set the stage for the development of an EverGreen Agriculture Partnership in 2012, that has now grown into a strong alliance of development NGOs and international organisations, governments, research and educational institutions and the private sector – joining up their efforts in amazing ways to foster the spread of FMNR and other evergreening solutions.

The Partnership (evergreenagriculture.net) championed all aspects of the scaling up of FMNR, as part of a vision to fully exploit the potential for trees to be integrated into agriculture, forest, and rangeland systems around the world. That Partnership laid the groundwork. It has now evolved into a global organisation – The Global EverGreening Alliance -- which is dedicated to marshalling the capacities of many more organisations, and attract much greater levels of resources, to scale-up restoration solutions on a much bigger scale. The Alliance now includes about 50 key organisations, and is continuing to grow rapidly.

The deep strength of this broad-based commitment has now led the Alliance to launch The EverGreening the Earth *'Green Up to Cool Down'* Campaign, at the New York Climate Summit in September, 2019. The Campaign is mobilising efforts to to capture and restore back to the land 20 billion tons of CO2 annually from the atmosphere by the year 2050. It aims to achieve this by landscape restoration that engages with the poorest rural families, first and foremost, to enhance their livelihoods by caring for the land.

It will restore degraded forest, agricultural and grazing lands, and draw down these vast amounts of carbon into regenerated landscapes, while ensuring the most valuable benefits redound to rural people, particularly the least well-off inhabitants of the drylands: For it is the dryland inhabitants who are by far the most vulnerable to the changes that are occurring as a consequence of this global warming emergency.

One of the unique features of the Campaign is its focus on achieving six targets that emphasise the capture of these large quantities of CO2 through the scaling-up of highly cost-effective evergreening solutions, including the assisted natural regeneration of forest lands, farmer-managed natural regeneration of trees on farmlands, the incorporation of leguminous shrubs into agricultural systems, and the regeneration of grazing systems with better silvopastoral practices. All of these solutions have already been demonstrated to be highly scalable across tens of millions of hectares -- and they are very effective in improving the livelihoods and resilience of the poorest people in the developing world.

The Campaign is being spearheaded by the Global EverGreening Alliance, which is composed of nearly all of the major development and conservation NGOs around the world (evergreening.org) involved in restoration. They have pledged their joint capacity to restoring hundreds of millions of hectares of degraded lands through the spread of tree-based systems. The Campaign draws inspiration from the large-scale successes that have in the drylands of Africa, including the millions of hectares of croplands that have been restored through the practice of farmer-managed natural regeneration in Niger and throughout the Sahel, and the several millions of hectares of watersheds and grazing lands that have been restored through assisted natural regeneration in Tanzania and Ethiopia, and elsewhere in eastern and southern Africa.

There are currently about one billion hectares burned annually in Africa. Burning is commonly implemented to regenerate pasture regrowth, but it reduces soil carbon reserves and it severely degrades the land over time. Burning can be replaced by more holistic systems of planned grazing that regenerate the health of the land, build up soil organic matter, and increase pasture productivity. Pastureland-managed natural regeneration will be deployed to restore a healthy balance of grass, trees, and bushes, enhance fodder production, and create a more moderate microclimate to improve animal welfare and productivity. The target is to regenerate 20% of the Africa's degraded pasturelands by 2050 by expanding the scale of these successful systems, and continue on to restore the remaining 80% during the second half of the 21st Century.

The Alliance is working closely on all this with the African Restoration Initiative. AFR100, an Africa Union Program that has mobilised nearly 30 countries to declare national restoration targets, adding up to over 116 million hectares. The Alliance has already developed several major multi-country evergreening programs that are being implemented in the drylands. These programs emphasise learning from, and scaling-out, the most inspiring successes that have already occurred on the ground in many countries.

The Alliance has now grown into a powerful global movement on land restoration. It supports national evergreening movements everywhere -- that are spreading the word about FMNR. That's a pretty significant legacy for a humble guy who stumbled unexpectedly onto a very big idea.