Community Mobilization for Improved Livelihoods through Tree Crop Management in Niger

Article *in* GeoJournal · October 2008

DOI: 10.1007/s10708-008-9228-7

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Community mobilisation for improved livelihoods through tree crop management in Niger

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Abstract:

Effective natural resource management requires interrelated technical practices and social arrangements that are appropriate to a region's biophysical characteristics and that address protection and sustainable management of resources. This is illustrated from our experience in the Republic of Niger, West Africa. In 1980 barren plains, infertile soils, drought, dust storms, severe fodder shortages, and agricultural pest outbreaks were normal occurrences in Niger's rural regions. In general, despite large investments of time and funding, conventional reforestation efforts had little impact. However by 2008 over five million hectares of once barren land had been transformed through wide adoption of an agroforestry method known as 'Farmer Managed Natural Regeneration' (FMNR), introduced in 1983.

In the Aguie Department, the practice of FMNR was formalized through the Desert Community Initiative (DCI), addressing interrelated technical and social issues in resource management. New governance structures, which include marginalized groups, implement monitoring and enforcement systems enabling communities to manage land and regenerating trees. These, together with technical solutions that build on local knowledge and skills and use previously undervalued indigenous tree species, have generated a sustainable fuel-wood market for the first time. Increased linkage and compatibility between institutions at local and national levels and strengthened social capital have been crucial to these impacts. Food security and community resilience to drought have been markedly enhanced and local incomes have increased. The experience provides important lessons for approaches to

addressing environmental degradation and poverty in other semi arid areas and facilitating the spread and adoption of new agroforestry systems.

Key words: Agroforestry; community based natural resource management; desertification; poverty alleviation; revegetation; Sahel; participatory approaches.

Introduction

Seventy four percent of rangelands and 61% of rain-fed croplands in Africa's drier regions are damaged by moderate to very severe desertification (Tolba et al 1993 pp. 138-139). In some African countries deforestation rates exceed planting rates by 3,000% (Nana-Sinkam 1995). Agroforestry has the potential to change this situation. Woods (2003) cites five enabling conditions for spontaneous adoption of agroforestry enterprises by resource poor households: ease of access to markets; economic and other benefits that are higher than from alternatives; a viable production technology that is available and known to farmers; access to sufficient areas of land with security of tenure; and farmer confidence in being able to control risks, such as fire, pests and theft. Other reviews have emphasised the importance of expanding market opportunities (Russell 2004), while Godoy (1992) notes that even though output prices play the key role in smallholder commercial tree cultivation, tenure, information, credit, technology, government policies and labour availability are also important.

While appropriate and replicable technical solutions are critical to attaining successful land and tree cover rehabilitation, they will not bring lasting results by themselves. Byron (2001) notes that assistance schemes for farm forestry have often failed to address the complexities of smallholder decision making, or to explicitly recognise interconnections between production, markets and policies. More broadly, as Reynolds et al (2007, p. 847) note for drylands: "Ecological and social issues are fundamentally interwoven, and so are the options for livelihood support and ecological management."

Effective rehabilitation thus requires interrelated technical practices and social arrangements that are appropriate to a region's biophysical characteristics and that address protection, maintenance and sustainable management of resources. Arid regions and their people

typically struggle for political attention and external investment (Stafford Smith 2008). This reinforces the need to value options that engage local resources. However, development practitioners face challenges in identifying which local resources have most potential value and how to utilize them. They must address the barriers that led to previous underutilisation and identify the institutional changes needed to enhance the prospects of local ownership of innovation and sustained engagement in rehabilitation.

Experience in the Republic of Niger illustrates the consequences of focusing only on technical solutions for rehabilitation. Following severe droughts in the early 1970s, large scale reforestation efforts were undertaken in a number of Sahelian countries using exotic tree species, particularly Neem (*Azadirachta indica*) and River Red Gum (*Eucalyptus camaldulensis*). Despite millions of dollars spent on nurseries and planting, weeding, fencing and guarding seedlings, few projects made any lasting impression. In Niger it is estimated that some 60 million trees were planted in a twelve year period and that less than 20% survived (C. Reij, pers. comm. 2008).

After decades of top down approaches, non government organizations (NGOs), agencies such as USAID, and some Nigerien Forestry Department staff realised that community members, their ideas, knowledge, experience and enthusiasm were the greatest resource available to address land degradation while alleviating poverty. This paper draws on the authors' experience over more than 15 years of facilitating effective community-based processes of livelihood improvement through the practice termed 'farmer managed natural regeneration' (FMNR). FMNR has had substantial positive impact on farmers' livelihoods, as we describe in this paper. It has also impacted significantly on regional vegetation cover. Herrmann et al. (2005), in exploring temporal and spatial patterns of vegetation greenness and rainfall variability in the Sahel, note that increases in vegetative cover, including in the Tahoua and

Maradi regions of Niger, are greater than could be explained by rainfall alone. It would appear that at least some of this vegetative increase is due to the adoption of FMNR (UNDP et al 2008).

In this paper we first outline the environmental and social context of Niger and the obstacles to successful land restoration using conventional forestry approaches. We then describe the emergence and spread of FMNR, an approach to re-afforestation that draws on local resources, and the features that account for its progressive and now widespread adoption. We present experiences and lessons from the Desert Community Initiative (DCI) in Aguie Department in the Maradi region of southern Niger, where FMNR is being managed through new inclusive community based governance structures. As we establish below, success of that initiative potentially provides a platform for development of more complex and productive agroforestry systems. Finally we discuss how this experience from development practice in Niger illustrates the role that inclusive local institutions and cross scale linkages have in rebuilding resilience of linked social and ecological systems.

Environmental and social context

Niger is a landlocked nation that spans the boundary of the Sahara and sub-Saharan regions (see Figure 1). The terrain mainly comprises plains and sand dunes, with flat to rolling savannah in the south and hills in parts of the north. Niger's subtropical climate is mainly very hot and dry with a short rainy season of three to five months and dry season of seven to nine months (Bationo & Buekert 2001). Average annual precipitation in Maradi region ranges from 250 mm to 500 mm on a north-south gradient (World Trade Press 2007) with high inter-annual variability.

Figure 1. The Republic of Niger, showing regional centres

Niger's population is 13.2 million. The growth rate is very high at 2.9% (IndexMundi 2008). On average women bear eight children. Niger is ranked the poorest country in the world with the worst health and development problems of all 177 countries included in the United Nations Human Development Index (UNDP 2008).

Over 90% of Niger's labour force is engaged in agriculture or livestock production. Significant constraints to rain-fed agricultural production include soil erosion, very low soil fertility, low water use efficiency, drought, shortages of animal fodder, poverty and an inefficient distribution of the labour force throughout the year. In spite of low soil fertility, average annual artificial fertilizer use in Niger is only 5 kg/ha. Low and irregular rainfall and outbreaks of crop pests make Niger highly vulnerable to recurring famine. Land degradation

and desertification are at the same time consequences of inappropriate pressure on land and contributors to poverty and malnutrition.

By the early 1980s, land in southern-central Niger that had been open woodland 30 years earlier had become a barren windswept plain because of increased land clearing for farming and increasing demand for firewood (see Figure 2). Further, government extension staff and NGOs were encouraging farmers to 'modernize' by removing all tree stumps to allow oxen-drawn ploughs and planters to be used. The rate of environmental degradation accelerated during a period of serious drought and famine from 1973 to 1975. Another serious drought in 1984 left little vegetation to clear within 100 km of major population centres.

Figure 2. Typical barren landscape, Maradi Region, Niger, circa 1984.

This is farmland, used to grow millet, during the dry season and before sowing. The area has been cleared of all vegetation and crop residues have been completely removed increasing vulnerability to wind erosion and creating a hostile environment for plant growth. Yet, even here living tree stumps and seeds were actually present in the soil, which has made it possible to use FMNR to quickly and cheaply revegetate the land.

Severe scarcity of fuel wood, building timber and fodder resulted. Women walked long distances daily to find fuel wood. Construction timber had to be sourced by middlemen from plundered forests in Nigeria. Even in wetter years, natural woody vegetation cover continued to diminish due to land clearing for cultivation. Malnourishment of livestock became common for much of the year with high rates of morbidity and mortality when severe fodder shortages occurred. Conflict was exacerbated as nomadic herders and farmers competed for scarce resources. Without tree protection from strong winds and high temperatures, farmers needed to re-sow failed crops three to five times each season. With the loss of habitat for natural predators, pest numbers escalated. Famine quickly ensued when drought led to crop failure, as in 1984 and 1988, compounded by the absence of an intact environment to provide alternative foods and services. Many people migrated to urban centres or immigrated to neighbouring countries to find food and jobs.

In the 1970s, the Niger government and international NGOs had made considerable efforts to address land degradation and desertification through tree planting. These efforts largely failed to produce significant or lasting results. Nor were they self replicating. In the authors' experience most forestry consultants dismissed indigenous tree species as 'useless bush'. Government forestry agents and farmers believed, falsely, that indigenous trees grew extremely slowly. These mindsets often led to existing indigenous vegetation being cleared in order to plant exotics, all undertaken in the name of 'combating desertification'!

Tree planting also faced many technical obstacles. During Niger's dry season, air temperatures can exceed 40^{o}C which means that seedlings require daily watering (see Figure 3). Access to water is difficult with well depths typically between 20m and 60m. The greenery and moisture in nurseries attracted termites, frogs, birds and lizards which caused damage.

Seedlings required transport to the planting site, care after transplanting and protection from a range of hazards including drought, termites, trampling or browsing by livestock, locusts, sand blasting, competition from crops and deliberate destruction by people. If follow up was not timely, heavy losses were incurred. The whole process was costly and not easily replicated at a village level. Thus farmers were dependant on a 'project'. Even where individual and village nurseries were established, these proved to be unsustainable. This experience indicated that a significant, sustainable impact on desertification was unlikely to be made using conventional forestry methods. These had failed to capture the hearts and minds of the people and consequently failed to stimulate a mass movement.

Figure 3. Village nursery in barren landscape, Maradi Region, Niger, circa 1983.

Before FMNR was adopted the Niger government and NGOs made considerable, but largely unsuccessful efforts, to address desertification by planting trees. At that time, the top-down approach of government forestry agents, shown here in para-military uniform, discouraged voluntary tree management by farmers.

Farmer-managed natural regeneration

Although much of southern Niger appeared to have been stripped of trees by the 1980s, with only small bushes left, a vast 'underground forest' existed, consisting of live stumps of indigenous tree species with the capacity to coppice profusely (Rinaudo, 2001). Farmers

slashed and burnt the coppice regrowth annually in preparation for farming such that these trees appeared to be short bushes to the casual observer. The strong belief that a good farmer was a 'clean' farmer, who removed this regrowth, was reinforced by extension and project staff who promoted 'modern' farming methods. Farmers also recognized that slashing and burning coppice regrowth added valuable nutrients to the soil.

In 1983, staff of the Maradi Integrated Development Project[1] (MIDP) 'discovered' the underground forest of coppicing trees. They realized that proponents of tree-planting schemes were wrong in their assumptions about the local indigenous vegetation. In fact, fields in southern Niger were not devoid of trees; many species of indigenous trees actually grow very rapidly; and indigenous tree species are very valuable in the local economy, having multiple uses. With these realisations, land restoration became easier, faster and cheaper.

The process of managing the existing indigenous vegetation to address desertification and land degradation became known amongst NGOs as Farmer-Managed Natural Regeneration (FMNR). FMNR was promoted vigorously from 1983 by MIDP and gained initial exposure in over 100 villages through 'food-for-work' programs during famines in 1984 and 1988. From these small beginnings FMNR spread from farmer to farmer and through field visits and workshops. MIDP provided training and exposure visits to various NGOs and Peace Corps volunteers, first in Maradi region and later across Niger (Rinaudo 2007).

FMNR involves the systematic selection, pruning and protection of stems sprouting from living tree stumps and natural seedling regeneration. The practice includes:

- selection of tree stumps and seedlings to be protected
- selection of stems to be pruned and protected on each stump
- removal of unwanted stems and side branches

- ongoing removal of emerging new stems and pruning of surplus side branches.

The major species used in FMNR in Maradi region include *Bauhinia reticulata, Guiera senegalensis, Combretum spp., Faidherbia albida, Ziziphus spina* and *Z. mauritiaca. Faidherbia albida*, in particular, is highly prized. It is known to fix nitrogen and is recognized by farmers as beneficial to crop yield and as an important source of fodder.

Benefits and reasons for the spread of farmer-managed natural regeneration

FMNR is now practiced to some extent on an estimated five to six million hectares in Niger, comprising over 50% of cultivated land (B. Winterbottom, pers. comm. 2007). No survey of FMNR potential on the remaining land has been undertaken, but we assume that at least a further five million hectares have potential for FMNR in Niger alone[2]. Beyond Niger, a number of organizations in Senegal, Mali, Burkina Faso (C. Reij pers. comm. 2007), Chad and Ethiopia are now promoting FMNR.

Key features favouring the spread of FMNR include:

- tangible benefits, from the first year: firewood, fodder, mulch, wind breaks and habitat for predators of pests
- ease, rapidity and low cost of replication, wherever coppicing tree stumps exist
- enhancement of, rather than competition with, cropping and grazing systems
- flexibility, which allows the method to be tailored to individual needs
- it is led and undertaken by farmers, and benefits them directly, including through sale of tree products.

Had MIDP dictated to farmers exactly how to do FMNR, it is unlikely to have developed such widespread appeal. Farmers decide where and when to practice FMNR, how many trees to

manage, their spacing - taking account of the number and species of regenerating stumps- and how to prune them. Initially MIDP recommended 40 trees/ha. Many farmers feared that crop yields would be severely compromised at such densities. However crop yields increased, even with higher tree densities, and densities on some farms now exceed 150 trees/ha. (see Figure 4).

Figure 4. Typical farmland in Maradi region, Niger, in 2005.

Previously cleared land with three to four year old *Bauhinia reticulata* regrowth from stumps, protected and pruned for pole production. Smaller bushes of *Guiera senegalensis*, commonly used for firewood, are visible in the foreground. Inclusion of trees in farming systems has made it possible for farmers to leave crop residues on farmland.

The flexibility of FMNR gives farmers freedom to respond to felt needs. Thus, in Niger's variable climate, a farmer whose main concern is food security may decide to maximise the number of trees in the knowledge that trees are drought resistant, can be harvested and cashed in at any time, and will provide a certain income in any year. Alternatively, a farmer whose

priority is to maximise annual crop production may reduce the number of standing trees, or prune them heavily. Farmers who want early wind protection for emerging annual crops may leave large numbers of regenerating stems, reducing them once crops are established. Farmers may harvest all their trees every two to three years for firewood production, or prune regrowth to produce a harvest of poles, a higher value timber product, every three to four years.

FMNR also results in significant gains for livestock production through increased availability of tree browse and shelter. Before FMNR the major dry season fodder source was millet stalks which have low organic matter digestibility, low contents of metabolizable energy and crude protein and were in demand for other purposes (Hofs 1992, Reed et al 1992, Lameers et al. 1994). Under FMNR, tree leaves and pods provide complementary, higher protein fodder sources, particularly during the dry season. This increases millet stalk digestion (Le Houerou 1980, Hofs 1992). In addition, more millet stalks are available for fodder because FMNR has allowed farmers to return to using wood for cooking and fencing.

Increased crop yields under FMNR can be attributed to transfer of nutrients from trees to crops through leaf, fruit and flower drop and decomposition, with additional nutrient inputs from dust deposition on tree leaves, bird excretions (Soumare 1995) and manure from livestock browsing on and sheltering amongst trees (Buerkert & Hiernaux 1998). Increased shading reduces temperatures and may reduce heat damage to crop meristems[3] (Buerkert & Hiernaux 1998). In addition, mulching with crop residues is possible where FMNR is practiced. This is widely reported to give large increases in crop yields on acid Sahelian soils (Bationo et al.1995). In these ways trees create ‘islands of fertility’ which benefit adjacent crops.

Attitudinal change

In spite of these advantages, adoption of FMNR in Niger was slow initially. Deeply held beliefs about trees competing with crops meant that poor and often hungry farmers in particular would not risk growing trees. Theft of trees and associated conflict were additional strong disincentives. Further, government ownership of all trees discouraged farmers taking responsibility for tree protection or sustainable use. Government agents who enforced the forestry code were rarely skilled or interested in capacity building or education, and they did not encourage farmer participation. Farmers disliked these forestry agents because of their policing role and widespread corrupt practices. Farmers who left trees on their farms risked being fined if a tree was felled, whether or not they had felled it themselves. Many preferred to keep their farms free of trees, denying benefits to thieves and reducing the risk of fines.

Initially, individuals who practiced FMNR were ridiculed. However the multiple benefits of FMNR and the perseverance of MIDP staff led to a paradigm shift. The prevailing attitude changed from farmers seeing trees as 'weeds' to recognizing trees as an economic crop in their own right.

Governing farmer-managed natural regeneration: the Aguie Desert Community Initiative

Effective management of natural regeneration to address poverty and land degradation needs to include social measures, notably in respect to the control of access to managed trees (Fortmann & Bruce 1988, Arnold & Perez 2001). The Desert Community Initiative[4] , located in the Aguie Department of Niger, has actively addressed social issues through new organizational approaches to agroforestry development.

Farmers took a central role in managing DCI project activities and in planning, organising and evaluating their own actions. Field work was piloted in three villages in 2001 and focussed on three key activities:

- forming new organizational structures, task groups and associations
- capacity building of communities, groups and individuals to initiate and lead research and development activities, and to value and promote traditional knowledge, skills and the sharing of ideas
- promoting an enabling environment for open dialogue and exchange to facilitate the adoption of new ideas.

By 2007 170 villages were involved and 53 village committees had been established, each encompassing three or four villages. Some 130,000 ha was being managed under FMNR and fields which were practically treeless in 1984 were covered with 103 to 122 trees ha^{-1}.

Various committees, inclusive of all stakeholders, were formed to deal with specific tasks:

- village committees plan new activities and supervise the work of four sub-committees
- agricultural sub-committees monitor crop experiments and seed production activities.
- environment sub-committees supervise implementation, monitoring and FMNR policing
- social sub-committees manage cultural activities
- income generation sub-committees facilitate small enterprise activities.

These new organizational structures have approval from government and traditional authorities. A number of stakeholders are working together for the first time: farmers, herders, men and women, researchers and Aguie Departmental and government services and International Fund for Agricultural Development (IFAD) project staff. Communities are fully involved in programming, implementing, monitoring and participatory evaluation of their

own natural resource management activities. The success of the Aguie village committees, as described below, has resulted in national extension services staff promoting this concept across Niger.

Inclusive governance structures

Inclusion of all stakeholders in decision making has been pivotal to the successful adoption and spread of FMNR. Committees comprise both women and men, village residents and sedentary Fulani herders living outside the villages. Membership is decided through a vote by all community members. Inclusion of women and herders started at project inception and was a bold step given Niger's cultural context.

Women have not usually played a role in decision making processes affecting the whole community. They are amongst the greatest harvesters and utilisers of wood and other tree products and, along with children, are charged with the daily task of firewood collection. In the past it was not unusual for conflict to arise between men who managed trees and women who harvest them.

Fulani herders are traditionally nomadic and constantly on the move with their livestock but desertification and other factors have now made this more difficult. Now some Fulani herders are sedentary: they live in permanent settlements, cultivate crops and maintain livestock herds when they are able to do so. If herds are large enough and pasture is scarce, the young men may walk their livestock to distant grazing reserves while women and children and older family members stay at home. During the eight month dry season, when pastures are largely depleted, some herders have sustained their livestock by lopping tree branches, particularly those of *Faidherbia albida*. This practice can severely damage trees and is at odds with sustainable tree management. Herder-farmer conflicts have occurred regularly in this region,

resulting in injuries and sometimes death, and relations between the two groups have often been strained.

Sedentary Fulani herders were included in the committees after they were brought together with villagers to debate and discuss problems in a way that allowed all points of view to be heard. Under the new decision making structures all members, whether farmers or herders, must act in a way that is mutually beneficial. For example, it is more beneficial to harvest seed pods for livestock year after year than to lop branches that will not be ready to harvest again for two to three years.

Fulanis that continue to live as nomads tend to move in a regular pattern which means that it is also possible for them to form mutual agreements with the sedentary peoples they come in contact with. However nomads have too often allowed their stock to enter crops before they are harvested and farmers have extended their fields into grazing reserves. Mutual distrust and competition for scarce resources has made it difficult for agreements to be made. As a result nomadic Fulanis are not included in the management committees. Nevertheless FMNR does seem to have lead to a reduction in conflict between nomadic herders and farmers. One study, albeit with a small sample of villages, indicates the number of conflicts between nomadic herders and farmers has reduced by about 80% in villages which had invested in FMNR (Baoua 2006). This is not surprising because FMNR has expanded the natural resource 'cake'. More fodder, and in some cases more water, means that there is more to share.

Operations and impact of new governance structures

The role of the new committees was formalized publicly when they were established to ensure that all community members, most of whom are illiterate, were informed and to add

legitimacy to the office. Committee members were equipped with a uniform and badge as a symbolic mark of their authority.

Each week sub-committees collect information in their respective spheres of influence. The various sub-committees meet together each fortnight to share information. Finally, each month there is a village level general assembly, attended by village elders and the chief, in which all information from the sub-committees is fed back to the villagers, including women and Fulanis. Decisions and action plans are based on this information.

Rules for management of FMNR have been established by environment sub committees in consultation with all stakeholders. All community members are fully informed of the rules and of fines for infringements. Each committee member monitors a specified area and is responsible for reporting on infringements.

Each collaborating village has agreed to make payments to support the DCI. These payments, together with fines, are paid to a fund whose uses reinforce social unity and support work undertaken by the committee. The fund is used for agreed purposes such as medical supplies for local dispensaries, digging wells, or raising tree seedlings in nurseries. While members of village committees are volunteers, villagers have typically decided they should receive a very small remuneration from this fund to encourage their participation. The fund also pays for fuel to enable the Forestry Department to help resolve conflicts between villagers and nomadic herders, and to support partnerships between extension services and villages.

The Land Tenure Commission, researchers, traditional chiefs and the new governance structures formed a partnership, supported by IFAD, for participatory research that takes needs identified by farmers themselves into account. One outcome has been the provision of

training in areas of identified need, which are diverse including literacy, tree pruning and nursery techniques.

Increased productivity of the trees is reflected in an increase in both domestic consumption and sale of tree products. One bundle of firewood sells for around US$ 6 and the annual per capita income to villagers from wood sales alone ranges between US$ 46 and US$ 92, a significant contribution to household budgets given that the average annual income in Niger is less than US$ 200 per person. Sale of firewood and non-timber tree products in 2005, when over one third of Niger's population suffered from famine induced by drought and locust attack, meant that farmers involved in the DCI avoided tragedy and reliance on famine relief.

With increased confidence in their committees and the dramatic increase in wood available for home use and sale, villagers want to establish rural wood markets. They aim to increase local control and reduce exploitation by middlemen who pay low prices. In 2007 a number of pilot wood markets were started for up to four villages, administered by one village committee. Currently wood is sold to larger towns and cities within the Maradi region. Village committees are planning to transport surplus wood to neighbouring Nigeria and to the larger Nigerien cities to capitalize on higher prices.

FMNR and agro-pastoral-forestry area management have become standard land management practices in Aguie Department as a result of the effectiveness of the new governance mechanisms. There has also been a positive change in community attitudes and behaviour towards the environment. Community members know the high cost of environmental degradation in terms of human suffering and poverty. They are now benefiting first hand, economically and socially, from their environmental restoration efforts. Illegal tree cutting, which was an enormous disincentive and threatened the success of the project initially, has

practically ceased in the whole area. As knowledge and confidence have grown, community members have progressively adopted new practices. For example, in response to strong interest by farmers, the DCI has begun to facilitate development of 'living fences' around individual agroforestry and pastoral plots. Emphasis is placed on the selection and use of local species for short, medium and long term outcomes.

The DCI has increased social capital and equity through giving women and sedentary Fulani herders a voice in decision making and by facilitating inter and intra village dialogue. Through promotion of FMNR and providing an enabling environment for its maintenance and expansion, this initiative has enhanced community resilience to adverse conditions.

Extending the impact of the Desert Community Initiative

The Farmer Managed Agroforestry Farming System (FMAFS) (Rinaudo and Cunningham 2007) represents an incremental gradation into a more complex farming system which offers many more benefits than FMNR alone in terms of enhanced food security and reduced vulnerability to famine. FMAFS retains and promotes the strengths of FMNR, and also those of the Sahel Eco Farm agroforestry system (Pasternak et al. 2005). It is an alley cropping, agro-pastoral-forestry system which incorporates a wide range of annual and perennial, indigenous and exotic plant species and livestock. The diversity in its design makes it flexible enough to meet individual farmer's varying needs and priorities.

Building on the success of FMNR and farmers' existing knowledge was important since adoption of innovation can be very slow. The success of the DCI had indicated that its organizational framework would provide an effective platform to promote the new agroforestry systems represented by FMAFS. Nigerien farmers had gained up to 20 years

experience growing indigenous trees on crop land and become very familiar with the benefits and the various management options open to them. Farmers experienced with FMNR are now willing to put in the substantial extra effort required to raise, plant and protect trees with economic or food value.

In FMAFS, farmers determine the density and layout of tree plantings and annual crops and the types of indigenous and exotic trees. In Maradi region World Vision and MIDP are providing training, regular follow up and assistance in developing markets for FMAFs products, three ingredients that experience in this region suggests are essential to the successful adoption of new farming systems.

In FMAFS the foundations laid by FMNR are complemented by the introduction of other species including a range of high seed and wood producing Australian acacias (*Acacia colei, A. torulosa, A. tumida, A. elachantha*). Acacias are planted along farm borders and in rows within the farm, providing human and animal food, firewood, timber, mulch, environmental restoration and crop protection. Australian acacias have high tolerance to drought and low susceptibility to most African crop pests and diseases. They were first introduced into Niger by the government Forestry Department in the 1980s, primarily for windbreaks, woodlots and land rehabilitation. When MIDP staff learnt that the seeds were edible, collaborative work started with the Australian research organisation CSIRO to test the safety of the seed for human consumption and to choose the most suitable species and provenances for Maradi region (Harwood et al. 1999, Rinaudo et al. 2002). While certain Australian acacias are weeds in some other regions, the species being promoted have not become weeds in the Sahel.

Australian edible seeded acacias have great potential for combating hunger in semi-arid lands (Thomson et al 1994, Harwood et al. 1999, Rinaudo et al. 2002). The seeds have a long

storage life and are tasty, safe to consume and nutritious: protein, carbohydrate and fat contents are 17-25%, 30-40% and 14-16 % respectively (Brand & Cherikoff 1985, Adewusi et al. 2003). In West Africa, the seeds ripen when labour demand is low. Being perennial plants with extensive root systems, mature acacias can take advantage of out-of-season or poorly distributed rains that would be ineffective for annual crops. Acacia seeds are easily harvested and processed into flour, using simple and existing local technologies, for incorporation into local dishes and 'non-traditional' foods such as spaghetti, bread and biscuits. The seed also has great potential as a food supplement for livestock. No indigenous species used in FMNR has all these characteristics. Including more than one species of acacia in FMAFS increases the likelihood of realizing a seed harvest each year (Rinaudo et al 2007).

In recent years villagers have started eating acacia seed and enthusiasm for this new food is growing strongly. An Australian company, Kalkardi Pty Ltd, has been purchasing small quantities of acacia seed in Maradi region annually since 2003 which has greatly stimulated interest in planting acacia trees. Seed that is not sold is being avidly consumed, fulfilling the original motivation for promoting acacia planting.

Other valuable agroforestry species are also used in FMAFS such as Pomme du Sahel (*Ziziphus mauritania*), Tamarind (*Tamarindus indica*), Boabab (*Adansonia digitata*) and Moringa (*Moringa oleifera*). The latter is unproductive for much of the year in this dry region but is highly valued locally for the edible and nutritious leaves it sprouts as soon as humidity increases, at a time of critical food shortage. Annual cash crops such as millet, sorghum, cowpeas, peanuts, hibiscus, sesame and cassava are planted in rotation between the tree rows, providing food and fodder and income. Crop residues are used as mulch for soil improvement and protection.

FMAFS provides significantly increased farm income compared to traditional millet farming or to FMNR alone, and more diversity in income sources. Farm labour inputs and income are also spread much more evenly across the year instead of being concentrated within a four month period. As with FMNR, the biomass produced by the trees counters the impact of low soil fertility and water stress by providing mulch and soil organic matter as well as protection from winds and fuel for firewood and income generation.

Implementation of FMAFS results in greater insurance against total crop loss during adverse events such as drought, insect attack or storms because not all species and products will be equally disadvantaged by the same event in a particular year. The biologically diverse farming system also tends to offer a range of habitats for beneficial predators of crop pests. Hence FMAFS assures a minimum income every year, even in seasons when annual crops fail. As well as the above benefits, factors which seem to be driving farmer willingness to adopt FMAFS are that it builds on the widespread adoption of FMNR and the long standing promotion of acacias by MIDP.

Explaining the impact of the Desert Community Initiative

A Latin American development agent, Eliaz Sanchez, said “you have to be able to grow cabbages in your head before you can grow them in the ground” (Smith 1994). The various development actors involved in FMNR in Niger shared a belief that poverty and famine were not inevitable. They believed that a better way of managing the natural resources and organizing people could result in better conditions for all. They worked to bring this idea to reality even though many others from NGOs, the Niger Forestry Department and donor organisations who had supported earlier reafforestation methods said it was impossible.

DCI's impact is not due to its technical innovation alone but in large part to the participatory methods employed that value local knowledge and experience, and to innovation in governance. These elements have facilitated the creation of an enabling environment for development. The open consultation, cooperative behaviour and local accountability that now characterises villages participating in the DCI stands in stark contrast to the competitive climate of mutual mistrust and hostility that is common between stakeholders in many other situations in Niger.

Increasing the links and compatibility between institutions at local and national levels and building social capital have been crucial to DCI's impact. In many other situations analysts have drawn attention to the false assumptions behind 'top-down' policy for natural resource management and to the importance of effective locally based governance. In particular Elinor Ostrom (eg 1999) has established from experimental evidence and extensive research in field settings that resource users can and do cooperate to overcome common problems of overuse and degradation of natural resources and that centralised authority is not required for resource users to change their behaviour. Ostrom's work also establishes that the design of effective rules for sustainable self-governing institutions for natural resources is a complex task requiring experimentation and feedback mechanisms such that resource users learn from the consequences of their actions and adapt their behaviour. The conditions for effective experimentation are best established when resource users have the authority to craft the rules governing access to resources, to monitor and enforce the rules and to change rules that are not working.

The impact of the Aguie DCI is explained by its attention to such factors. It has built on the centrality of the village unit for decision making, using this in a coordinated approach to solving the enormous environmental and social problems faced by the population. Before the

initiative was established, each village and ethnic group worked in isolation from each other and marginalised groups were not included in village decision making. The inclusion of women and Fulani herders in consultations and as members of village decision making bodies provided a basis for addressing conflict and managing access to regenerating trees. In the context of scarcity, of food and wood for example, it is extremely difficult for a single community to address issues of deforestation, land degradation and declining food supplies in isolation of the wider needy population. By bringing villages together through village committees representing three or four villages, common district wide problems have been tackled and solutions found collaboratively. Working on a district level means that all stakeholders can be informed, have an opportunity to provide input and be involved in the solutions. Consultation facilitates consensus about the nature of problems, how they will be tackled and how infringements will be dealt with.

Cross scale linkages have been further strengthened through the involvement of national agencies in the initiative. Reynolds et al. (2007) highlight the importance of strengthening cross scale linkages amongst the multiple scales at which dryland social-ecological systems are coupled. These linkages are often particularly weak in drylands because populations are relatively sparse and remote from economic and policy centres. Through facilitation of exchanges, individuals and villages are now being linked with each other and with government extension services, researchers, and project staff from NGOs and IFAD. Experimentation is encouraged and an enabling environment is created in which local knowledge and experience is discovered and valued. This knowledge and experience is then applied in the collaboratively designed programs which are promoted in the wider community, typically through appropriate structures and by-laws, ensuring successful adoption.

Conclusion

The principles embodied in the DCI are important to facilitating the spread and adoption of promising new agroforestry systems such as FMAFS. They also have wide application in other contexts where people need to work together to solve common natural resource management problems.

The importance of recognizing and starting with what you already have, and building from this, is clearly demonstrated by the unprecedented success of FMNR as a method of revegetation under harsh and impoverished conditions in Niger. The bio-physical resources available in Niger had long been ignored by most experts and community members alike. But after closer examination it became apparent that the unique flora of the region and the capacity of the people to change, given an enabling environment, were the keys to reversing desertification and attaining sustainable rural livelihoods through diversified production systems. After decades of failure with costly and ineffective conventional reforestation methods, farmers in large parts of Niger are now turning the tide against desertification by managing indigenous tree regeneration. Local knowledge and skills with the inputs of development agencies have fostered an appropriate 'hybrid' (Reynolds et al. 2007, p. 849) of scientific and local environmental knowledge and new governance structures that engender cooperative behaviour. The DCI has succeeded largely because it was inclusive of all stakeholders. It has built on local knowledge, skill and experience and generated a consultative and cooperative climate which has overcome fear of failure and subsequent ridicule amongst innovative farmers.

Acknowledgements

The authors wish to express their appreciation for the extensive editorial assistance of Jocelyn Davies and helpful comments of Mark Stafford Smith and two anonymous reviewers. We also thank the people and organisations involved in FMNR and FMAFS: the Desert Community Initiative is being implemented with the support of the International Fund for Agricultural Development (IFAD); the Maradi Integrated Development Project is managed by Serving In Mission personnel and continues to play a pivotal role in the development and promotion of FMNR and FMAFS across Niger and beyond; World Vision Niger and World Vision Australia are actively promoting FMNR in Niger and across a number of Sahelien countries respectively.

References

Adewusi, S.R., Olumuyiwa, S.F. & Harwood, C. (2003). Chemical composition of *Acacia colei* and *Acacia tumida* seeds: potential food sources in the semi-arid tropics. *Food Chemistry, 80*, 187–195.

Arnold, J.E. & Pérez, R.M. (2001) Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics, 39*, 437-447.

Baoua, I. (2006) *Analyse des impacts des investisements dans la gestion des resources naturelles sur le secteur élevage dans les régions de Tahoua, Maradi et Tillabéry au Niger. Etude Sahélienne.* (Niger: Center for Research Evaluation and Social Assesment.)

Brand, J.C. & Cherikoff, V. (1985). The nutritional composition of Australian Aboriginal food plants of the desert regions.(In G.E. Wickens, J.R. Goodin & J.V. Field (Eds.), *Plants for arid lands*. (pp. 53-68). London: George Allen & Unwin)

Batiano, A & Buekert, A. (2001). Soil carbon management for sustainable land use in the Sudano-Sahelian West Africa. *Nut. Cycl. Agroecosystems, 61*, 131-142.

Bationo, A., Buerkert, A., Sedogo, M.P., Christianson B.C., & Mokwunye, A.U. (1995). A critical review of crop residue use as soil amendment in the West African semi-arid tropics. (In J.M. Powell, S. Fernandez-Rivera, T.O. Williams and C. Renard (Eds.), *Livestock and sustainable nutrient cycling in mixed farming systems of sub-Saharan Africa. Volume II, Technical Papers. (*pp. 305-322). Addis Ababa: International Livestock Centre for Africa.)

Buerkert, A., & Hiernaux, P. (1998). Nutrients in the West African Sudano-Sahelian zone: losses, transfers and role of external inputs. *Z. Pflanzenernahr.Bodenk., 161*, 365-383.

Byron, N. (2001). Keys to Smallholder Forestry. Forests, *Trees and Livelihoods, 11*, 279-294.

Dogett, H. (1988). *Sorghum*. (Singapore: Longman, 2nd edn.)

Fortmann, L. & Bruce, J.W. (1988). *Whose trees? Proprietary dimensions of forestry*. (Boulder and London: Westview Press.)

Godoy, R.A. (1992). Determinants of smallholder commercial tree cultivation. *World Development, 20*, 713-725.

Harwood, C. Rinaudo & A. Adewusi, S. (1999). Developing Australian acacia seeds as a human food for the Sahel.*: Unasylva, 196*. Retrieved August 4, 2008 from *FAO corporate Document Repository:* http://www.fao.org/docrep/x0963e/x0963e0c.htm

Herrmann, M.S., Anyamba, A., & Tucker C.J. (2005). Recent trends in vegetation dynamics in the African Sahel and their relationship to climate. *Global Environmental Change, 15,* 394-404.

IndexMundi, (2008). Niger population, Retrieved September 24, 2008 from http://www.indexmundi.com/niger/population.html

Lameers, J.P., Michels, K., & Vandenbeldt, R.J. (1994). Trees and windbreaks in the Sahel: establishment, growth, nutritive, and calorific values. *Agroforestry Systems, 26,* 171-184.

Le Houerou, H.N. (1980). Agroforestry techniques for the conservation and improvement of soil fertility in arid and semi-arid zones. (In Le Houerou H.N. (Ed) *Browse in Africa: The current state of knowledge*. (pp 433-435). Addis Ababa: International Livestock Centre for Africa.)

Nana-Sinkam, S.C. (1995). *Land and environmental degradation and desertification in Africa: the magnitude of the problem*. Retrieved November 26, 2007, from FAO corporate Document Repository http://www.fao.org/docrep/X5318E/x5318e02.htm

Ostrom, E. (1999). Coping with tragedies of the commons. *Annual Review Political Science, 2*, 493-535.

Pasternak, D, Nikiema, A, Dougbedji, F. Ndjeunga, J. Koala, S. Dan Goma, A. and Abasse, T. (2005). The Sahel Eco-Farm. Retrieved August 4, 2008, from http://www.worldwidewattle.com/infogallery/utilisation/sehelian-eco-farm.pdf

Reed, J.D., Rittner, U., Tanner, J., & Wiegand, O. (1992). Nutritive value of leaves and fruits of Faidherbia albida and their use for feeding ruminants. (In R.J. Vandenbeldt (Ed.), Faidherbia albida *in West African Semi-Arid Tropics*. (pp. 43-49). Patancheru, India: International Crops Research Institute for the Semi-Arid Tropics and Nairobi, Kenya: International Centre for Research in Agroforestry.)

Reij., C. (2007, 2008). Consultant, VU University, Amsterdam. *Personal communication*.

Reynolds, J.F., Stafford Smith, D.M., Lambin, E.F., Turner, B. L., Mortimore, M., Batterbury, S. P. J., Downing, T.E., Dowlatabadi, H., Fernandez, R.J., Herrick, J. E., Huber-Sannwald, E., Jiang, H., Leemans, R., Lynam, T., Maestre, F. T., Ayarza, M., and Walker, B. (2007). Global desertification: building a science for dryland development, *Science, 316*, 847-851.

Rinaudo, A., Patel, P. & Thomson, L.A.J. (2002). Potential of Australian Acacias in combating hunger in semi-arid lands. *Conservation Science Western Australia, 4*, 161-169.

Rinaudo, T. (2001). Utilizing the underground forest: Farmer managed natural regeneration of trees. (In D. Pasternak & A. Schlissel. (Eds.) *Combating desertification with plants*. (pp. 325-336). New York: Kluwer Academic/Plenum Publishers.)

Rinaudo, T. (2007). The development of farmer managed natural regeneration. *LEISA Magazine, 23,* 32-34.

Rinaudo, A. & Cunningham, P. (2007). Australian Acacias as multi purpose agroforestry species for semi arid regions of Africa. *Muelleria, 26,* 79-85.

Russell, D. & Franzel, S. (2004). Agroforestry, markets and the African smallholder. *Agroforestry Systems, 61,* 345-355.

Smith, K. (1994). *The human farm: a tale of changing lives and changing lands*. (Bangkok: Kumarian Press).

Soumare, A. (1995). Utilisation des elements nutritifs par deux arbres du Sahel: Acacia seyal et Sclerocarya birrea. Dissertation, Institut Superieur de Formation a la Recherché, Bamako.

Stafford Smith, M. (2008). The 'desert syndrome' – causally-linked factors that characterise outback Australia. *The Rangeland Journal, 30,* 3-14.

Tolba, M.K., El-Kholy, O.A., McMichael, D.F., & Munn, R.E. (Eds.) (1993). *The world environment 1972-1992: Two decades of challenge.* (New York: United Nations Environment Program, Chapman & Hall).

Thomson, L.A.J., Turnbull, J.W. & Maslin, B.R. (1994). The utilization of Australian species of *Acacia,* with particular reference to those of the subtropical dry zone. *J. Arid Environments, 27,* 279–295.

UNDP. United Nations Development Programme. 2008. *Human development report 2007/08*. Retrieved August 4, 2008 from http://hdr.undp.org/en/statistics/

United Nations Development Programme, United Nations Environment Programme, World Bank, World Resources Institute. (2008). Turning back the desert. how farmers have transformed Niger's landscapes and livelihoods. (In World resources 2008: Roots of resilience - growing the wealth of the poor (pp. 142-150). Washington DC: World Resources Institute.) Retrieved September 25, 2008, from http://www.wri.org/publication/world-resources-2008-roots-of-resilience

Woods, P. (2003). Spontaneous agroforestry: Re-greening barren hills in Vietnam. Dissertation, University of Melbourne.

Winterbottom, B. (2007). Senior Manager/Forester, International Resources Group (www.irgltd.com), Washington, D.C. (*Personal Communication*.)

World Trade Press. (2007). Precipitation Map of Niger. Retrieved September 25, 2008 from http://www.bestcountryreports.com/Precipitation_Map_Niger.html

Endnotes:

[1] The Maradi Integrated Development Project (MIDP) was established by Serving in Mission (SIM), a Christian missionary organization, with funding from the Canadian International Development Agency. Following the 1973 – 1975 famine in Niger, SIM had some relief funds unutilized. In view of the widespread loss of trees and the impact of strong winds, soil erosion and high temperatures on crop yields, SIM decided to commence the Maradi Windbreak and Woodlot project. MIDP is an extension of this earlier project.

[2] This is based on cultivated land being located in the arid and semi-arid tropical climatic region in the vegetation band classified as 'tree steppe' (Yangambi classification), and on the practice that was normal prior to the introduction of FMNR of using hand tools to clear trees from farmland, such that coppicing continued.

[3] The high absolute soil temperatures in bare plots at the onset of the rainy season are often above 50^0C, a threshold reported to mark the beginning of protein denaturation in sorghum (Dogett 1988).

[4] The DCI was initiated by the International Fund for Agricultural Development (IFAD) whose involvement in the Aguie region started with a rural development project completed in 1997. This was followed by a two year community initiative promoting agroforestry. Good results from this second grant led IFAD to fund the DCI for six years (2001 to 2008).