

# Farmer-Managed Natural Regeneration Enhances Rural Livelihoods in Dryland West Africa

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**Abstract** Declining agricultural productivity, land clearance and climate change are compounding the vulnerability of already marginal rural populations in West Africa. ‘Farmer-Managed Natural Regeneration’ (FMNR) is an approach to arable land restoration and reforestation that seeks to reconcile sustained food production, conservation of soils, and protection of biodiversity. It involves selecting and protecting the most vigorous stems regrowing from live stumps of felled trees, pruning off all other stems, and pollarding the chosen stems to grow into straight trunks. Despite widespread enthusiasm and application of FMNR by environmental management and development projects, to date, no research has provided a measure of the aggregate livelihood impact of community adoption of FMNR. This paper places FMNR in the context of other agroforestry initiatives, then seeks to quantify the value of livelihood outcomes of FMNR. We review published and unpublished evidence about the impacts of FMNR, and present a new case study that addresses gaps in the evidence-base. The case study focuses on a FMNR project in

the district of Talensi in the semi-arid Upper East Region in Ghana. The case study employs a social return on investment analysis, which identifies proxy financial values for non-economic as well as economic benefits. The results demonstrate income and agricultural benefits, but also show that asset creation, increased consumption of wild resources, health improvements, and psycho-social benefits created more value in FMNR-adopting households during the period of the study than increases in income and agricultural yields.

**Keywords** West Africa · Agroforestry · Ghana · Land restoration · Semi-arid · Social return on investment (SROI) · Farmer-managed natural regeneration (FMNR)

## Introduction

In dryland West Africa, a quiet movement appears to be defying the trends of declining agricultural productivity and to be alleviating the decades of pressure on soil resources and tree cover. This phenomenon is ‘Farmer-Managed Natural Regeneration’ (FMNR, or *Régénération naturelle assistée*—RNA—in French), an approach promoted by environment and development NGOs for arable land restoration and reforestation. Proponents of FMNR claim that it reconciles the needs for sustained food production, conservation of soils, and protection of biodiversity. It is seen as a major contributor to the ‘re-greening’ of a region famed for desertification and degradation. In concrete terms, the approach is centred on an agroforestry practice that seeks to achieve the regeneration of woody plant cover in farming and mixed land use areas. Specifically, FMNR projects work with farmers to protect regrowth from live stumps in their fields that would

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otherwise be cleared each year (Rands and Rinaudo 1990; Rinaudo 2007; Taylor and Rands 1991, p. 49; WRI 2008; Samaké et al. 2011).

From the beginning, 30 years ago, many claims have been made about the benefits of FMNR for re-greening landscapes and restoring rural livelihoods. Yet, arguments for the approach's utility and effectiveness remain patchy, often relying heavily on promotional claims, theoretical modelling, or anecdotes. To date, published original research has focussed on either economic indicators or tree-counting as quantitative proxy contributions to human wellbeing (e.g. Haglund et al. 2011; Larwanou and Saadou 2011). Other studies have merely described other qualitative benefits (e.g. McGahuey and Winterbottom 2007; Tougiani et al. 2009). Thus, to date, no study has provided a measure of the aggregate livelihood impact of community adoption of FMNR.

As a result, we sought to provide new evidence to quantify the broad livelihood and environmental outcomes of FMNR for subsistence farming households in a new study area in northeast Ghana. The study employs a research methodology called social return on investment (SROI), which entails conceptualising proxy monetary values for social benefits of an initiative (Lingane and Olsen 2004). SROI is advantageous to this topic because many of the benefits claimed about FMNR relate to non-market outcomes that have no direct economic measure. SROI allows us to determine individual and aggregate values of perceived changes upon the livelihoods of households from the adoption of FMNR. Before presenting these results, however, we situate the approach in the broader literature on environment-development challenges in West Africa, and systematically review the published and unpublished evidence about the impacts of FMNR. Together, our paper demonstrates that community-wide adoption of FMNR made a distinct contribution to rural household wellbeing, particularly in terms of increased assets (tree stocks, healthy livestock), increased availability of wild resources (food and construction), improved psycho-social wellbeing, and improved soil fertility and crop yields.

## Background

FMNR has principally been developed in the drylands of West Africa. These are the bioclimatic zones that separate the Sahara desert from West Africa's humid coastal equatorial zone. They range from the arid Sahelian zone in the north, with highly variable rainfall totalling 250–500 mm/year to the sub-humid Sudanian zone in the south, with up to 1000 mm/year (UNCCD and CFC 2009). Typically, agriculture in this zone is smallholder

pastoralism and seasonal rain-fed crop farming for subsistence and market purposes (Darkoh 2003).

A number of dynamic pressures are transforming agriculture in West Africa's dryland belt (Mortimore 1998). In general, African agricultural production is declining per capita and productivity per hectare is lower than any other major region of the world (FAO 2009). Drivers include high population growth and neoliberal market reforms that have, among other effects, undermined the capacity of states to provide agricultural services (Moseley et al. 2010; Sanchez and Swaminathan 2005). In addition, land disputes have increased (Bugri 2008), while promotion of certain agricultural projects, markets, and techniques has led to the neglect of biodiversity, soil health, and water infiltration (Colchester 1993; Mortimore and Turner 2005). Land clearing for agriculture contributes to habitat conversion and exposed soils. The Sahel lost 28 % of its natural forest between 1961 and 2002, perhaps contributing to regional rainfall reductions (Taylor et al. 2002). Over the same period, exposed bare land is said to have doubled, and three quarters of all arable land have been affected by soil degradation (Montpellier Panel 2013; Woomey et al. 2004). For farming households whose livelihoods are closely tied to rain-fed agriculture and reliance on natural resources, the deterioration of ecosystems services—such as loss of wild foods, deteriorating soil fertility, and the threat of increased climate variability—elevates their vulnerability and undermines their coping mechanisms (UNDP 2011). Almost 6 million people were estimated to be experiencing severe food insecurity in the region in 2012 (CILSS et al. 2012).

Agroforestry is promoted as a farm and landscape management adaptation to these pressures. Agroforestry seeks to reconcile environmental goals and agricultural productivity by deliberately incorporating and managing trees and shrubs in farmlands or pastures (Simons and Leakey 2004). While such practices have long historical antecedents, formal research in and promotion of agroforestry as an alternative to high-input single-crop fields only began in the 1980s and gained acceptance globally in the 1990s (Leakey et al. 2005). In practice, agroforestry is often adopted to rehabilitate degraded farmland (Bae et al. 2013).

Agroforestry practitioners and researchers make a number of claims about the value of increased diversity and density of on-farm species. Greater tree densities reduce vulnerability to soil erosion (Brecht et al. 2009). Reintroducing indigenous and selected exotic trees into farmland improves soil nutrients and soil organic matter and attracts grazing animals that deposit manure (Franzel 1999). Trees also help increase water infiltration into soil, reduce soil evapotranspiration, and reduce soil temperature, which improve annual crops' tolerance of hot

and/or dry spells, especially in rain-fed agriculture (Brown et al. 2011). Increased densities of indigenous trees and shrubs can lead to greater wildlife diversity, including animal, bird, and insect species (Cunningham and Abasse 2005). For livestock, greater tree density can supplement grass fodder and reduce labour requirements for accessing feed during scarcity (Place et al. 2009). For humans, increased tree cover reduces wind speeds, airborne dust and provides cooling shade (Cunningham and Abasse 2005). In combination, these effects can stabilise and protect farming households' livelihoods (Thorlakson and Neufeldt 2012), diversify income into timber and non-timber tree products (Reij et al. 2009) and improve household resilience to droughts or pests (Brown et al. 2011).

Whereas the broad concept of agroforestry often implies the *planting* of tree seedlings, the key distinction of FMNR is the absence of planting. FMNR relies on regrowth from live stumps. The already mature roots of previously felled trees' stumps ensure regrowth is more resilient to dry periods and more rapid than planted tree seedlings (Rinaudo 2012; Taylor and Rands 1991; Tougiani et al. 2009). Conventionally, in agricultural fields, regrowth is slashed or burned down before each crop-planting season. Under FMNR, as regrowth emerges, the strongest, straightest stems are preserved and pollarded (Fig. 1). Other stems are culled. Stumps are selected for species type, spacing, and vigour. The basic techniques require no special inputs, are easily learned and passed on between farmers and can be adapted to each practitioner's own context and purpose. By contrast, conventional tree-planting requires seedling nurseries, transport, special tools and supplementary watering (Rands and Rinaudo 1990; Rinaudo 2007) (Fig. 2).

The technique that became known as FMNR was first developed in 1983 to protect the livelihoods of poor farmers in the drylands of rural Niger. At that time, a major drought—driven by climatic cycles (Bader and Latif 2011) and following on the heels of the disastrous 1968–1973 drought—contributed to failed crops, wind erosion, and chronic hunger. Because of widespread ideas linking desertification and drought with tree cover, policymakers and environmental managers had, since the 1930s, sought to prevent tree-cutting and encourage the planting of belts of trees (Mortimore 1998). Earlier campaigns of tree-planting in Niger had low seedling survival rates, while agriculture intensification projects had failed to improve food security and incomes. The initial FMNR attempts in Niger were touted as the first sustainable and self-replicating exercise in reforestation in that country. Its success was due to farmers deriving benefits, using farmers' own farm management, and the natural stock of living under-ground tree roots to ensure vigorous regrowth (Rands and Rinaudo 1990; Sendzimir et al. 2011). FMNR is one of a number of land management innovations to emerge from West Africa

over recent decades, which include 'zai' planting pits and stone bunds (Reij et al. 2009).

## Methods

Evidence of FMNR's broad livelihood outcomes has been assembled in two ways. Initially, we reviewed previous assessments of FMNR. In addition to the scientific literature, we assembled unpublished reports by NGOs and multilateral research or development organisations. These were sourced through organisational websites, referral by peers, publication alerts and document repositories of World Vision Australia, World Agroforestry Centre, Africa Re-greening Initiative and the World Resources Institute.

Next, we sought new empirical evidence through an innovative end-of-project evaluation of a FMNR project in Talensi District, Upper East Region, Ghana in 2012 (we describe the project and its context in the results section). We measured changes in farming practices against baseline data and applied a SROI analysis. The latter approach offers a novel contribution to filling identified research gaps. SROI is an approach to measure and account for value created by a project intervention or a policy (Wright et al. 2009). The approach is similar to cost–benefit analysis, but enables decision-makers to interpret social and environmental as well as economic value creation (Lingane and Olsen 2004; Wright et al. 2009). Building on practices from health and environmental economics, it establishes proxy monetary values for non-monetary and non-market outcomes of an initiative, then compares these with costs incurred to create those benefits. The approach also facilitates the recording of qualitative and quantitative changes expressed by a project's primary stakeholders, regardless of its original objectives and targets (Nicholls et al. 2012; Wright et al. 2009).

Data were collected using qualitative and quantitative methods. First, we convened twelve focus group discussions. These comprised five male farmer groups, five female farmer groups, and two youth groups. A total of 55 women, 59 men, 10 girls, and 10 boys participated in discussions. Second, key informant interviews were undertaken with two local officers of the Ministry of Food and Agriculture, a community chief and traditional land custodian, a secretary of a community FMNR group, a FMNR group treasurer, the chief researcher from the National Forestry Research Institute, and key World Vision Ghana personnel. Third, we surveyed 400 households (HHs) about project impacts. Respondents were split into three groups. Lead households ( $n = 104$ ) had at least one member of the household who had directly participated in project activities as a member of a FMNR Group.



**Fig. 1** A well-pruned FMNR regrowth from a stump in fallow field in Balungu village in the wet season (Photo: lead author, 2012)

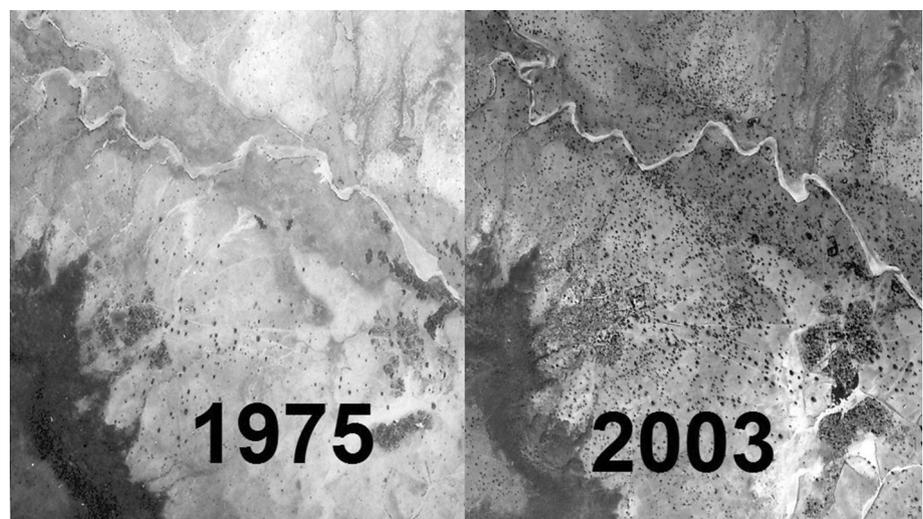
Neighbouring households ( $n = 154$ ) also lived within the project area, but did not participate actively in the project. Comparison households ( $n = 142$ ) live outside the project area but within the same district, geo-climatic, ethnic, and economic zone. Lead HHs were purposely selected; Neighbour HHs and Comparison HHs were randomly selected using transects originating from the approximate centre of the community. The survey tool included several open questions that could record a wide diversity of potential responses. The survey results were compared to a baseline survey conducted 3 years earlier (Ditto 2009). For some outcomes, proxy financial indicators were not obtained from the focus groups or surveys due to time limitations or because the extent of the impact only became apparent during analysis. These were the values of improved respiratory health, improved aesthetics, carbon sequestration, and a number of voluntary uses of people's

time to achieve a desired result. In these instances, we applied revealed preference techniques, estimating valuations based on prices of market-traded goods with similar benefits (Nicholls et al. 2012).

Data on tree cover were acquired for both community-managed reforestation reserves and for farmers' fields. For the former, monitoring of tree densities, heights, girth and species/biodiversity counts in four community reserves was provided by the Ghanaian National Forest Research Institute (Akpalu 2012), complemented with pre-project photography of conditions at these sites. Regarding farmers' fields, the household survey asked each respondent to report the area of fields managed by that household and number of trees regrown in the last 3 years.

Data analysis focused on calculating the values of the diverse benefits and costs identified by respondents. The value of each identified cost or benefit was calculated for one household and multiplied by the number of households reporting that benefit. To avoid the risk of over-claiming, discount factors (Lingane and Olsen 2004; Nicholls et al. 2012) were used to constrain the values of individual social returns. These are based on five factors. *Deadweight* refers to what probably would have happened anyway, if the project did not take place. In most cases, deadweight values were drawn from data gathered from the Comparison group. *Displacement* refers to negative outcomes transferred outside the project area. The only transfer effect detected that may be taking place is avoided deforestation. *Attribution* accounts for other non-project drivers of the documented changes. *Drop-off* estimates the future risk of participants abandoning or losing their benefits. We used discount rates of 0–20 %, depending on the benefit in question. Rates were low in part due to the importance of the benefits described by participants, the institutionalisation of changed practices and in part due to the short period

**Fig. 2** Satellite image of landscape surrounding Galma Village, Niger: Population and Tree cover has increased over 30 years (Reproduced with permission of the copyright holder: the U.S. Geological Survey, EROS Center)



of forecasting of returns of 4 years after the project. *Duration* considers how long the outcomes are likely to last. Outcomes from similar projects in Ethiopia (Kabore 2010) and Niger (Reij et al. 2009) suggest that, once farmers adopt FMNR and related practices, they rarely abandon them. Consequently, social returns were calculated for three time periods: immediately after close of project activities; 4 years after project; and 10 years after the project. *Discount Rate for net present value* We used a discount rate of 8.9 % p.a., which is Ghana's predicted inflation rate for 2012–2017 (IMF 2012). The values for each social impact were aggregated into a single total value, and divided by the total cost of project inputs to arrive at a SROI ratio for each of three time periods.

## Review of FMNR Evaluations

The majority of publications about FMNR in Africa are not based on original research (e.g. Garrity et al. 2010; Pye-Smith 2013; Reij et al. 2009) but draw on ten studies published either as journal articles or in agency reports (Table 1). Most focus on FMNR in Niger since the 1980s and highlight three major themes: the impact on tree cover, the impact on income, and the impact on-farm yields.

Below, we review the major research conclusions of each of these publications grouped according to theme.

### Theme 1: Increased Tree Cover

Tree density and cover has increased substantially in parts of Niger where FMNR was adopted by farmers since the 1980s. Two reports prepared for the U.S. Agency for International Development (USAID) in different parts of Niger were among the first to counter popular perceptions that the Sahel's vegetation was universally degrading (Larwanou et al. 2006; McGahuey and Winterbottom 2007). Based on focus groups, field visits, remote sensing, and other techniques, they suggested that large tracts of Niger's drylands had been re-greening over recent decades, with tree cover increasing on millions of hectares due to the adoption of FMNR. The scientific literature appears to confirm the trends. A remote sensing study of vegetation trends in the Sahel overlaid normalised difference vegetation index (NDVI) and rainfall estimates and suggested that while the climate cycle could explain the increase of some increased vegetative cover, some non-rainfall related re-greening had taken place through the efforts of human management (Hermann et al. 2005). The study points to Niger as a prime example where FMNR was a likely contributor to this phenomenon. Tougiani et al. (2009) report that, in the Aguié department of Niger, after 6 years of a NGO/Government project, farmers had converted

130,000 ha. of treeless land to FMNR, containing between 103 and 122 trees/ha. Larwanou and Saadou (2011), based on a tree vegetation inventory, suggest that FMNR had increased biodiversity and availability of harvestable timber: they state that "in all sites, it was obvious that wood shortage... was alleviated" (Larwanou and Saadou 2011:199). Finally, Sendzimir et al. (2011) develop a dynamic systems model to account for the observed reforestation. Their analysis points to targeted interventions like FMNR, together with political changes like local land management autonomy and a decline in centralised government interference, as the driving forces of 'regreening' within the broader context of a relatively favourable climate cycle (Giannini et al. 2008; Mortimore and Turner 2005). It should be noted that many of the above studies do not distinguish between types of vegetative cover; while FMNR in principle favours native biodiversity, the increases in tree cover could in some cases be from single agroforestry trees.

### Theme 2: Increased Crop Yields

Two of the evaluations of FMNR calculated its impact on crop productivity. Comparing FMNR-adopting households in Maradi Region to matched non-adopters, Haglund et al. (2011) calculated that the adopters' crop production values were almost 60 % higher. Place and Binam (2013) found crop yields of FMNR adopters in four West African dryland countries were between 15 and 30 % higher than non-adopters. In addition, an overview publication (Reij et al. 2009) estimated that the soil restoration effect of FMNR's spread across Niger has resulted in at least 500,000 additional tonnes of grain produced per annum, which they equate to the consumption needs of 2.5 million people.

### Theme 3: Household Income and Local Economic Value

Previous studies imply that adoption of FMNR improves cash incomes through improved agricultural yields and timber sales, as well as through the sale of firewood and of carbon credits. Cunningham and Abasse (2005) provide a case study of the NGO 'Serving In Mission's' (SIM) Maradi Integrated Development Project in Niger that began in 1983. They show that wood sale income for farmers intensively applying FMNR to their land was almost nine times higher than that of non-adopting farmers (Cunningham and Abasse 2005:4). Reflecting on his experiences in that same project, Rinaudo (2012) estimates that a FMNR-adopting household would be earning an additional USD 140 per year by rotationally harvesting timber poles from just 40 stumps. Haglund et al. (2011) also focussed original research on the case of Maradi, finding that FMNR

**Table 1** Summary of contents of publications containing original research (including practitioner experience) about FMNR, in chronological order

Authors	Peer reviewed?	Location	Type of benefit	Quantification?
Cunningham and Abasse 2005	No	Maradi, Niger	Increased income, via sale of wood, based on farmer testimony	Farmers intensively applying FMNR were earning 150,000 CFA francs compared to the average of 17,465
Larwanou et al. 2006	No	Three departments in Zinder Region, Niger	Tree cover expansion in 3 Regions; benefits to Household revenues, environment, agriculture, livestock, food security, and nutritional intake	Over 1 million ha regreened by FMNR Household revenues not quantified
McGahuey and Winterbottom 2007	No	Three regions of Niger: Tillaberi, Tahoua, and Maradi	Raised optimism; increased crops and natural resources; soil and water conservation; income and food security; benefits to women, widows and landless	Not quantified
Tougiani et al. 2009	Yes	Aguie Department, Niger	Reduced vulnerability in years of national food shortage	Not quantified
Haglund et al. 2011	Yes	Maradi, Niger	Increased income Increased crop yield Higher return on labour investment	Av income among FMNR Adopters: 86,104 CFA francs versus 62,996 among non-adopters ( <i>difference of 23,108 CFA francs: USD 46</i> ) Crop values of 71,333 CFA francs versus 45,580 among non-adopters ( <i>difference of 25,753 CFA francs: USD 51</i> )
Brown et al. 2011	Yes	Humbo, Ethiopia	Attract carbon revenues	USD 726,000 of income for the resident community over 10 years (initially)
Larwanou and Saadou 2011	Yes	Three regions in Niger	Greater tree species diversity; more trees; timber shortage alleviated	Around 100 trees per ha. where previously there were virtually none
Sendzimir et al. 2011	Yes	Two regions in Niger	Modelling secondary data to confirm the central role of FMNR promoted by NGOs in re-greening a large portion of Niger	5 million ha reforested
Rinaudo 2012	No	Maradi, Niger	Increased local economic value Increased household income	Estimated USD 17–21 million per year At least USD 140 per year
Place and Binam 2013	No	Several sites in Burkina Faso, Mali, Niger, and Senegal	Increased value of firewood harvested consumed and sold Increased income from sale of non-timber tree products consumed and sold Increased yields Reduced vulnerability to food shortages	<i>Firewood:</i> Burkina: additional USD 56–170 per year Mali: additional USD 102–180 per year Niger: USD224–256 per year. <i>Non-timber tree products:</i> Mali: average increase of USD 237 per year Yields: On average 15–30 % higher

adopters earned around 30 % more income than matched non-adopters. They report that FMNR-adopting households reported increased wood supply (98 % of respondents), improved soil fertility (98 %), improved crop yields (92 %), healthier animals (81 %), increased revenues (78 %) and improved food security (73 %).

Evidence from elsewhere in Africa supports the Maradi case. With native parkland trees contributing strongly to household income in rural areas (Faye et al. 2010), the expansion of tree resources due to FMNR can increase income. Place and Binam (2013) demonstrate that FMNR practitioners across four West African countries had higher

sales of firewood and non-timber tree products (see Table 1). Sales of FMNR timber and other tree products resulted in participating villages avoiding “...tragedy and reliance on famine relief” (Tougiani et al. 2009, p. 385). Finally, and perhaps most dramatically, in a new development related to the creation of carbon emissions offset markets through the Kyoto Protocol’s Clean Development Mechanism, a 2728 ha. community-managed FMNR site in Ethiopia is forecast to generate around USD 726,000 for the community over the initial 10 years (Brown et al. 2011, p. 329).

### What Gaps Exist in FMNR’s Evidence-Base?

FMNR is considered useful because it generates livelihood benefits for poor land users. However, livelihood security is not just linked to income, but to a much broader set of relationships, conditions, and physical factors. Livelihood has been described as assets, capabilities and activities to provide a living (Scoones 1998:5), or as ‘five capitals’: human (skills, knowledge, and health), physical (shelter, transportation, energy, and communications), social (including networks, associations, relationships of trust, and access to social institutions), financial (such as savings, access to credit, remittances, or pensions), and natural (stock of available natural resources including land, water, forests, indigenous plants, animals, and insects) (Haglund et al. 2011; Scoones 1998). The studies reviewed above primarily emphasise financial capital (such as household cash incomes and crop yields) and some aspects of natural capital (especially changes in tree cover). Thus, we may conclude that researchers either have not prioritised non-economic livelihood benefits or have not identified methodological tools to measure such outcomes. Many of the above studies made reference to a wider number of livelihood outcomes, but did not measure their impact (Brown et al. 2011; Cunningham and Abasse 2005; Haglund et al. 2011; Larwanou et al. 2006; Place and Binam 2013). The resultant undervaluing of non-market livelihood benefits of FMNR has been acknowledged by a number of authors (Faye et al. 2010:429; Fifanou et al. 2011:2; Reij and Smaling 2008, pp. 417–419). In order to fill this gap and present a more comprehensive measure of the impact of FMNR adoption on sustainable rural livelihoods (Scoones 1998), we used the SROI approach. SROI lays aside predetermined outcome indicators in order to record, quantify and value what participating households perceived as of most value to them. In so doing, economic, social, health and environmental impacts of FMNR have been valued in a way that allows comparison or aggregation despite their intrinsic differences.

## Talensi Case Study and Results

### Location and Context of the Project

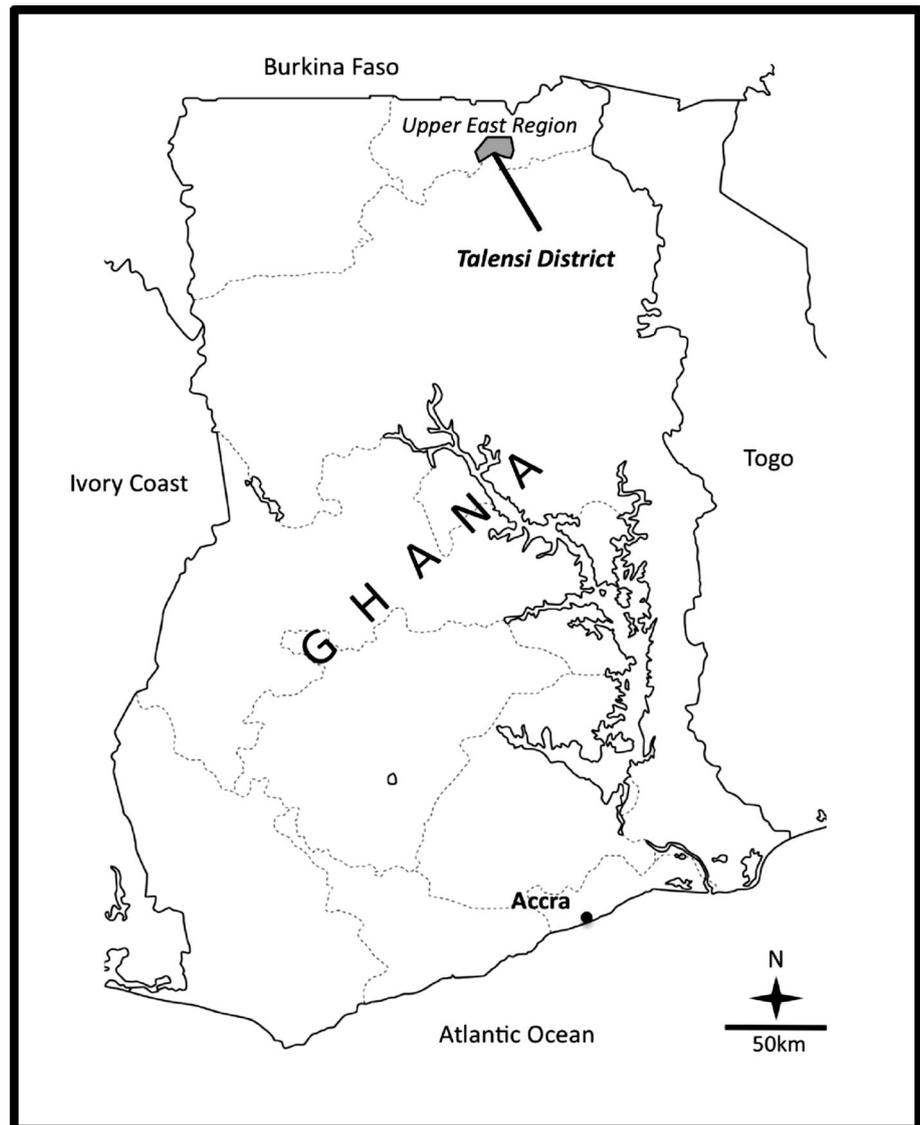
The northernmost region of Ghana has a semi-arid tropical dryland climate. Rainfall, which averages 950 mm per year, is highly variable and concentrated in the period between May and October (Dietz et al. 2004; MoFA 2011). The Upper East administrative division is relatively densely populated, at 200 people/km<sup>2</sup> in some places. The economy is predominantly agricultural, though there are trends of livelihood diversification and migration remittances in response to economic transformations. Important crops include millet, sorghum, maize, rice, groundnuts, and cotton; and livestock such as cattle are also prominent. Longer term trends in land use in northern Ghana include the extension and intensification of farming of bush areas due to population pressure and market opportunities, as well as the increased cultivation of low lying areas, facilitated by tsetse fly eradication, ox-plough adoption and irrigation projects (Dietz et al. 2004; Laube et al. 2012; Yaro 2006).

In this region, livelihood challenges such as poverty, drought and resource scarcity have been a reality for decades (Agyemang 2012). These challenges have been compounded by land degradation. In the baseline survey for the project we review (detailed below), farmers reported problems of loss of soil fertility, declining yields and reduced availability of wild foods and other natural resources. These assessments are corroborated by other studies (Bugri 2008; Damnyag et al. 2012; Ditto 2009; Wopereis et al. 2006; WVG 2008). These problems were caused by expanding charcoal production, logging and agriculture, the loss of traditional long fallow periods, and lack of tree ownership rights. Recovery of natural resources was hampered by bushfires and traditional beliefs that discouraged planting of trees: specifically, the belief that planting a tree was akin to defying Nature, and would result in death (Agyemang 2012; Bugri 2008; Weston and Hong 2013b).

To reverse this situation of resource degradation, the humanitarian and development NGO World Vision implemented an FMNR project in the Talensi District<sup>1</sup> in the Upper East Region of Ghana, bordering Burkina Faso (Fig. 3). Talensi District covers around 500 km<sup>2</sup>, of which around 27,000 ha is cultivated (WVG 2008). The project started in July 2009 and ran for 3 years. It worked with nine out of the district’s 69 communities, having a

<sup>1</sup> Previously ‘Talensi-Nabdram’ District, which was divided into two separate districts in 2012. Note also that the area was the site of well-known ethnographic work by Meyer Fortes in the 1930s (Parker 2013).

**Fig. 3** Location map of study site



population of 11,920 in 1472 households (Weston and Hong 2013b) (Fig. 4).

The Talensi FMNR project promoted the restoration of multi-purpose trees in two different landscape forms: farmland and community-managed forests. Farmlands are family-owned crop fields under a customary tenure system, averaging 1.3 ha per family (Weston and Hong 2013b). Community-managed forests are protected by community by-laws and managed by community members who benefit from harvesting wood, grasses and other resources. The promotion of FMNR was complemented with training on anti-erosion techniques, bulk composting, field mulching, suppression of bushfires and field burning, fuel-efficient wood stoves, formation of income-generating groups, and formation of savings groups (Weston and Hong 2013b). The project also

facilitated the planting of 40,000 fruit trees. Extension was carried out via the formation of community FMNR Groups, made up of each community's most dynamic farmers. These 'lead farmers' (90 men and 90 women) were trained in FMNR practices and were pivotal in mobilising other community members to learn and experiment (Weston and Hong 2013b).

A small number of other organisations had provided some agricultural assistance to the communities in the past. In previous years, the NGOs 'Action Aid' and 'Techno-Serve' had delivered short-term assistance in the form of donated agricultural inputs. One private national firm is providing some philanthropic support to the farming community through donated tree seedlings. The Ministry of Food and Agriculture (MoFA) is also active in the area, but charges a fee-for-service for many of their supports, such

**Fig. 4** Comparison photos of hill overlooking Yameriga village. **a** February 2010. (Photo: Paul Akaribo, WV Ghana). **b** April 2014. (Photo: Anne Crawford, WV Australia)



as tractor ploughing, seeds and mineral fertiliser, which must be repaid at harvest time.

The end-of-project evaluation (Weston and Hong 2013b) found that community members used FMNR to restore 161 ha of community-managed forest (with an average density of 2343 trees/ha) and 336 ha of crop land (with an average tree density of 57 per ha.). These contrast with baseline tree density in both lands of 5 trees/ha. These managed forests now contain around 567,000 trees of which 377,000 can be counted as additional due to the project. On farmland, 547 households, or 37 % of all households, adopted FMNR in their crop fields. Focus groups consistently estimated that even the trees previously in the area would have disappeared within 5–6 years in the absence of the project. Reforestation on forest and farmland was reinforced by the project's mobilisation of community volunteer fire brigades. These collective efforts to suppress fires created time for regrowth to reach grassfire resistant heights (Darkoh 2003; Samaké et al. 2005). In a survey of FMNR adopters, 94 % reported an increase in soil fertility (against 26 % among the comparison group); 66 % reported improvement in soil erosion (against 17 % in the comparison group); and 46 % thought that the FMNR practices had generated more wild food (fruits, nuts, rabbits and partridges). The evaluation documented that 157 households have adopted fuel-efficient stoves (90 were distributed by the project and the remainder were spontaneous adoptions), and that 42 % of all FMNR lead farmers and 10 % of neighbouring households learned and adopted the improved, bulk compost method (over 94 %

of those who learned the technique went on to apply it to their farmlands). Finally, in terms of natural resources, the annual field surveillance (Akpalu 2012), focus group discussions, and household survey (Weston and Hong 2013b) also documented that the return of natural tree coverage increased overall biodiversity.

### SROI Analysis of Project Inputs and Outcomes

The SROI analysis estimated proxy monetary values for the social benefits of the FMNR project, many of which are non-market outcomes that have no direct economic measure. It compares project inputs against outcomes.

Regarding project inputs, World Vision Australia funded activities using private donations and a grant from the Australian Government. USD 306,392 covered all costs associated with World Vision Ghana staff time, material inputs and contractors. Australian technical and monitoring support was valued at approximately USD 17,424.<sup>2</sup> We calculated the value of in-kind contribution from Talensi community members to be approximately USD 90,871. Each of the 180 lead farmers contributed an average of 78 volunteer days per year, some for 2 years, some for 3 years. 315 community members contributed time as fire brigade volunteers. This time was valued in terms of the district's average adult labourers' daily wage of GH¢ 4

<sup>2</sup> Finance figures sourced from World Vision Australia financial database and timesheet records.

(USD 2.1). Thus the total value of project inputs was USD 414,686.

The value of project outcomes was based on data collected in focus group discussions and the household survey. The benefits identified by the community participants and their calculated values are presented in Table 2. Some additional project outcomes were mentioned by stakeholders but not included in the SROI calculation. This was due to lack of identifiable quantifiable or proxy value. These outcomes include, on the positive side, a reduction of time required by boys to herd cattle and, therefore, freed to attend classes or recreation; women's increased participation in educational activities and attending to their families' health due to time saved from collecting firewood; and the protective effect of trees reducing damaging wind speeds and storm impacts. A negative outcome that was raised but not incorporated was an increased fear of snake bites while pruning shrubs. This concern was raised by 9 % of lead households in the survey, but no actual bites were recorded and the concern did not appear to result in changed behaviour.

By the end of the project, GH¢ 3,835,000 (USD 2 million) of value had been created. Assuming that the FMNR techniques become more widely shared, as has happened in FMNR experiences cited earlier, and estimating the number of trees expands by 16 per cent per year, which is very conservative compared to the Niger experience (Reij et al. 2009; Rinaudo 2012), the project is forecast to generate GH¢ 10,304,000 (USD 5.5 million) of net present value by 2016. The net social return on direct investment by World Vision, after accounting for discounting factors, is thus, a SROI ratio of 6:1 by the end of the project, 17:1 4 years after the project, and 43:1 10 years after project closure. When we factor in the value of in-kind contributions, the SROI ratios become 5:1, 13:1, and 34:1, respectively.

#### *Sensitivity Analysis*

SROI calculation places emphasis on avoiding the risk of over-claiming by erring on the side of undervaluing estimations (Nicholls et al. 2012). Nevertheless, calculations based on estimations and subjectivity of participants are prone to error. A sensitivity analysis was conducted to test the robustness of the SROI ratio by testing the effect of certain variables, such as the magnitude of discounting factors and the valuation given to important outcomes (Table 3). By running various scenarios, we found that the three ratios (end of project, 4 years after project and 10 years after project) had low sensitivity to changes in individual discounting factors. Discounting factors such as deadweight or attribution had to be increased to 80 % before the social return approached a 1:1 ratio. The most

sensitive variable was the value of timber stored in the additional young trees.

Inclusion of the atmospheric benefit of regrowing trees may be questioned by some who might argue the benefit is too indirect to the target community, or that double-counting has taken place by recording the latent timber value of the trees as an asset and the carbon sequestered by the same trees. We argue that the inclusion is legitimate for three reasons: the scientific reality of the carbon removal from the atmosphere; project participants' testimonies of the positive value of knowing their trees are making a healthier atmosphere; and that the same trees provide two distinct benefits of timber income and carbon sequestration (if the timber is not burnt it continues to stock carbon). However, we also ran a sensitivity analysis to see what happens when carbon sequestration and emission reductions from fuel-efficient stoves are removed. Under this scenario, the SROI 4 years after project closure decreases from 17:1 to 16:1, and the immediate (end of project) remained relatively unchanged at 6:1.

#### *Value Created by the FMNR Project per Household*

SROI was developed to measure the magnitude of community benefit against project inputs, not to communicate a project's or technology's contribution to individual households' wellbeing. Yet, the nature of the data analysis lends itself to interpreting the average value of benefit accrued by households of different stakeholder groups. The SROI calculation estimated the total value of social, health, environmental and economic benefits for 180 lead farmer households to be GH¢ 366,000 at the end of project, GH¢ 938,000 4 years hence, and GH¢ 1,826,000 10 years hence. To these direct benefits, we may add a pro-rata proportion of the community commons benefits. This brings the aggregate value generated by the project for lead households collectively to GH¢ 599,193 at the end of project and GH¢ 2,386,071 4 years hence. Therefore, by the end of the project, the value created per household equates to GH¢ 3328 over 2 years or GH¢ 1664 (USD 887) per year. Applying the same formula to neighbouring households arrives at a created value of GH¢ 1228 (USD 654) per household per year. These values to households are substantial in a country where the gross national income per capita is USD 1410 (World Bank 2013).

## **Discussion**

To date, research on FMNR has emphasised economic incomes and agricultural yield values. This case study contributes additional evidence that supports these claims. However, this case study also found that, as far as participating households are concerned, increased incomes

**Table 2** Outcomes per stakeholder group and their proxy financial values. Adapted from Weston and Hong 2013a

Stakeholder	Outcomes or benefits	Individual outcomes	Year 3: end-of-project value in GH¢	Year 7: 4 years after project close (before discounting for NPV)	Percentage of total value per stakeholder group
Lead farmers' households ( <i>n</i> = 180 households)					
	Increased household resources and income	Wild resources for cash, utilisation, and purchase substitution	60,000	179,000	19
		Improved livestock and economic tree assets	151,000	354,000	38
		Increased soil fertility and crop yield	15,000	75,000	8
		Savings on traction expenditure, small loans, and fuel-efficient stoves	26,000	63,000	7
Improved health		Improved respiratory health due to fuel-efficient stoves	5000	14,000	1.5
		Reduced accidental burns due to fuel-efficient stoves	200	500	0.1
		Improved health due to improved food accessibility	43,000	130,000	14
Psycho-social		Increased optimism towards future	4,000	8,000	1
		Enhanced leadership roles (especially for women) and community solidarity	62,000	115,000	12
	Total		366,000	938,000	100
Neighbouring households ( <i>n</i> = 1292)					
	Increased household resources and income	Wild resources for cash, utilisation, and purchase substitution	271,000	494,000	16
		Improved livestock and economic tree assets	1,016,000	1,613,000	54
		Increased soil fertility and crop yield	31,000	221,000	9
		Savings on traction expenditure and fuel-efficient stoves	35,000	97,000	4
Improved health		Improved respiratory health due to fuel-efficient stoves	71,000	181,000	6
		Reduced accidental burns due to fuel-efficient stoves	1000	2000	0.1
		Improved health due to improved food accessibility	70,000	210,000	7
Psychological		Increased optimism towards future	18,000	46,000	1.5
		Enhanced leadership roles and community unity.	47,000	105,000	4
	Total		1,561,000	2,969,000	100
Community commons ( <i>n</i> = 1472)					
Economic		Tree stock assets for community	1,607,000	6,512,000	84
Psychological		Change in attitudes towards environmental protection	58,000	174,000	2
		More beautiful and comfortable existence	159,000	477,000	6

**Table 2** continued

Stakeholder	Outcomes or benefits	Individual outcomes	Year 3: end-of-project value in GH¢	Year 7: 4 years after project close (before discounting for NPV)	Percentage of total value per stakeholder group
	(Global) environmental	Reduction in carbon dioxide through fuel-efficient stoves	8000	21,000	0.2
Carbon dioxide sequestration through reforestation		75,000	619,000	8	
Total		1,907,000	7,803,000	100	
Grand total of value created (2012 GH¢)			3,835,000 (US\$ 2 m)	11,710,000 = 10,304,000 (US\$ 5.5 m) net present value	
Value of all inputs (GH¢)			779,808 (US\$ 414,686)	779,808 (US\$ 414,686)	
SROI ratio			5:1	13:1	

**Table 3** Effect of various calculation adjustments upon the SROI ratio, to test the sensitivity of results (Weston and Hong 2013a)

Adjusted variable	Adjusted scenario at end of project	Adjusted scenario 4 years after project	Adjusted scenario 10 years after project
Default scenario: social return on funds invested:	6:1	17:1	43:1
Increase all Deadweight values from between 2 and 10 % to:			
20 %	5:1	14:1	35:1
50 %	3.3:1	9:1	22:1
80 %	1.3:1	3.5:1	9:1
Increase all attribution values from between zero and 20 % to:			
20 %	5:1	14:1	36:1
50 %	3.4:1	9:1	22:1
80 %	1.3:1	3.6:1	9:1
Increase all drop-off values from between zero and 20 % to:			
10 %	6:1	15:1	29:1
20 %	6:1	13:1	21:1
30 %	6:1	12:1	16:1
Reduce the value of carbon per tonne from USD 12 to:			
USD 4	6:1	16:1	42:1
Adjust the timber value of young trees from USD 2.1 to:			
USD 1	5:1	12:1	30:1
USD 6	11:1	34:1	92:1

and crops yields are not the most important benefits of adopting FMNR. In lead, neighbour and community commons stakeholder groups, the most valuable change was the increase in value of assets in the form of tree stocks and livestock. The livelihood implication of these benefits comes from their contribution to household resilience against periodic shocks (Thorlakson and Neufeldt 2012; Walker et al. 2006). Shade and perennial sources of leaf and grass fodder have made livestock more resilient in the dry season. The increase in tree cover on each managed

plot has increased households' stocks of 'timber' assets that can be monetized in difficult times, and can be replenished later by regrowing (Fig. 5).

The second greatest change for both lead and neighbouring households was the increase of consumable wild resources: especially wild foods (plant and animal) and construction materials (timber poles and thatch for fencing and roofing). Some association exists between increased wild resources and incomes, with households describing the sale of some wild products, like shea fruit (Fig. 6).



**Fig. 5** Yameriga village. Firewood bundled next to 1-year-old FMNR regrowth in community-managed forest (Photo: Lead author)



**Fig. 6** Shia village. Shea nuts harvested for processing into butter (Photo: lead author, after Weston and Hong 2013a)

However, for the most part, the main value was in the form of consumables at household level that never entered the cash economy. This finding is consistent with the point that, especially in drylands, populations that retain access to wild food plants fare best in times of drought (Darkoh 2003). Closely associated with these benefits is the stated health benefits related to increased and diversified diets (Golden et al. 2011; Jamnadass et al. 2011; Powell et al. 2011).

The third most significant improvement perceived by target stakeholders is a cluster of psycho-social benefits consisting of joy and peace-of-mind from the enhanced beauty and comfort of the now greener landscape, enhanced leadership confidence and experience for women



**Fig. 7** Wakii village. Residents shade from afternoon sun in community-managed FMNR reserve (Photo: lead author)

and men who took part in FMNR groups, improved attitudes towards environmental management and greater optimism for the future of their farms and communities (Fig. 7). Literature related to climate change adaptation suggests that, whereas environmental degradation has a major negative effect on people's mental wellbeing (Fritze et al. 2008; Maginness and Stephens 2008) and stifles cognitive ability to adapt to changing economic and climatic conditions (Van Haaften and Van der Vijver 2003), hope gives rise to optimism, which gives rise to better mental health and a greater mental energy to pursue adaptation (Fritze et al. 2008). Presenting viable and affordable adaptation options, such as FMNR, markedly improves cognitive ability to cope with such stresses (Grothmann and Patt 2005). Furthermore, according to the focus groups, community collaboration necessary to share FMNR farmer-to-farmer and to establish collective protocols among land users improved social capital in Talensi, which can also enrich and secure the livelihoods of individual households (Collier 1998; Woolcock 1998).

The value of outcomes calculated in Talensi District using SROI is consistent with findings elsewhere. Haglund et al. (2011) calculated increases in crop yield and diversity and timber production from FMNR adoption in Maradi Region, Niger, 20 years after the introduction of FMNR is between USD 17 and 21 million per year. Taking into consideration that the effects of FMNR in Talensi are early and have not yet spread widely beyond the target communities, these magnitudes seem consistent with our finding of USD 2 million at the end of the project. At the household level, Haglund et al. (2011) calculated that FMNR-adopting householders in Niger are earning around USD 51 per year more in crop yields, and Place and Binam (2013) estimate that from firewood sales earn FMNR adopters in West African drylands up to an additional USD

256 per year. Therefore, combined, we might assume that, in Sahelian West Africa, FMNR adopters are up to USD 300 better off on strictly economic terms. The Talensi SROI calculation found that asset accumulation, increased consumption of wild products, increased health, and psycho-social benefits as well as yield and income were worth USD 655–887. The overall Talensi SROI calculation found that non-economic outcomes added more value than changes in income and yields. Therefore, a total estimate of all benefits that is two to three times higher than incomes estimated by other studies appears consistent also. We should bear in mind that we cannot make a pure comparison between studies. The Ghanaian economy is growing faster and average prices likely to be higher than in Niger. The Talensi FMNR project promoted not only the FMNR technique, but other complementary sustainable agricultural techniques that are likely to have contributed to outcomes, particularly for direct participant households.

## Conclusion

Previous studies on FMNR make claims about diverse social, health and environmental as well as economic benefits. Yet, to date, all published original research has focussed on economic indicators, and/or tree-counting as an assumed contribution to human wellbeing. Many of these studies also reported evidence of social, health or environmental benefits, though have not quantified their values. Thus, to date, no study has provided a measure of the aggregate livelihood impact of community adoption of FMNR. This study has attempted exactly this by documenting and valuing what outcomes were of perceived importance by stakeholder households of a FMNR project. SROI methodology was used to identify proxy financial values for each outcome and these outcomes were aggregated to calculate the total value created in target communities by the project. The study found that the total value of the social return for stakeholders was many times greater than the project costs and in-kind contributions.

This study gives us a clear understanding and measure of the diversity of livelihood impacts that FMNR adoption can contribute to vulnerable rural communities in dryland zones of Africa. The study validated the importance of economic outcomes of increased crop yields and incomes found by previous studies. However, non-market benefits were found to generate greater value to stakeholder households. For the Talensi community in Upper East Region of Northern Ghana, the most valuable outcome categories were (1) increased assets in the form of tree stocks and improved livestock; (2) increased wild resources (especially wild foods and construction inputs) for house-

hold consumption and sale and associated dietary health benefits; (3) improved psycho-social wellbeing as a result of a more aesthetically pleasing and comfortable community and work environment, enhanced leadership capacity of FMNR group members, and a more positive outlook; and (4) improved soil fertility and crop yields. The value of carbon sequestered by increased tree cover was also identified by stakeholders as important and validated by carbon calculations, which contributed to the overall value created by the FMNR project.

Estimating the livelihood impact per household revealed that the social, health, environmental and economic values created by this FMNR project were between USD 655 and USD 887 per annum. These figures are two to three times greater than other studies' calculations that are based only on the economic returns of FMNR. This is consistent with this study's finding that non-economic outcomes generated more value than the economic benefits of the project. This highlights that, though FMNR is often introduced on the grounds of improving arable soils for crop production, such gains may be secondary to the livelihood contribution of natural assets and consumables restored to the landscape.

The project's outcomes were the result of FMNR adoption, landscape fire suppression and the promotion of complementary sustainable agricultural techniques. This serves to emphasise that, while FMNR is a field and forest restoration technique, the concept is also an embodiment of rural landscape management that empowers land users and creates space for ecological dynamics to restore soil and natural resources. Across Africa, as well as many other regions of the world, agricultural land and production is threatened by erosion, soil depletion, and loss of biodiversity. If African agriculture is to adequately feed future generations, it must not only increase productivity, but also restore already degraded lands and reduce small-scale farmers' exposure to climatic vulnerability. FMNR is a valid contribution to achieving these objectives.

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