An Analysis of Institutional Supports for Community-Based Land Management Systems with Carbon Sequestration Potential in Mali

Carla Roncoli (SANREM CRSP-University of Georgia[1], Keith Moore (Office of International Research, Education, and Development, Virginia Tech), Abou Berth (Institut de l'Economie Rurale-Sotuba), Salmana Ciss (Institut de l'Economie Rurale-Mopti), Constance Neely (SANREM CRSP-University of Georgia), Carlos Perez (SANREM CRSP-University of Georgia)

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Abstract

This paper analyzes the role of institutional factors in the adoption and implementation of land management technologies with carbon sequestration potential among rural communities of the Sudan-Sahel region. The technologies in question are a contour tillage system for cropland to retain water and nutrients in planted fields tested in southern Mali and a
open range rotational grazing system tested in north-central Mali. The two case studies provide a basis for comparative analysis of institutional frameworks that can facilitate the adoption, implementation and scaling up of these technologies. First, we focus on the institutional factors that shape the configuration of resource endowments available to households and communities, access to training and technical services, organizational capacities and supports, and information channels and networks that enable technology adoption. Secondly, we examine the role of supra-local institutions that can support coordination of aggregate or collective land use decisions and represent communities in carbon trading negotiations.

Introduction

The vulnerability of Sudan-Sahelian livelihoods to environmental degradation and climate variability and climate change warrants a consideration of the potential of carbon sequestration and trading among West African crop and livestock producers. The region's potential for sequestering carbon in soils is not high, given its low annual rainfall rates and high mean temperatures (Batjes 2001). But sustainable management of its drylands can contribute significantly to carbon cycling by reducing carbon releases due to deforestation, land clearance, and nutrient mining. This underscores the need for improving the productivity of cropland and grasslands, by the adoption of yield-promotion practices
that increase organic matter as well as soil and water conservation measures and regeneration of vegetative cover (Batjes 2001:138). In addition to the obvious economic and environmental benefits of increased productivity and sustainable resource management, the demonstrated ability of these practices and technologies to contribute to carbon cycling could enable West African communities and countries to profitably participate in carbon trading as envisioned by the Clean Development Mechanism (CDM) proposed under article 12 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

But implementation of carbon sequestration projects in West Africa remains hindered by unanswered questions regarding its operationalization in a context where land management is the result of decisions made by myriads of small holders or the outcome of informal negotiations surrounding common property, which makes accounting and verification difficult. This paper synthesizes preliminary findings from the social science component of an interdisciplinary project that seeks to address some of these questions. As social scientists we focus on the role of institutional mechanisms that can facilitate aggregate adoption (to a scale relevant for carbon trading) and that can represent rural producers in carbon negotiations, rather than on the technical aspects of carbon sequestrations.

Th
e Carbon from Communities project (2001-2004) is funded by the National Aeronautics and Space Administration (NASA) and is jointly implemented by the USAID-funded Sustainable Agriculture and Natural Resource Management (SANREM) and Soil Management (SM) Collaborative Research Support Programs (CRSPs) and the USDA Agricultural Research Service, with the Institut de l��conomie Rurale (IER), the national agricultural research system of Mali. The technologies in question are a land management system, developed and implemented in southern Mali by IER scientists at the Centre Regional de Recherche Agricole (CRRA)/Sotuba in collaboration with CIRAD and the SM CRSP, and a open range rotational grazing system being tested in north-central Mali by collaborating scientists in the SANREM CRSP and IER at the CRRA /Mopti.

The first technology, known as *Am*[illegible] *nagement* [illegible] *Courbe de Niveau* (ACdN) incorporates most functions identified as crucial to reducing carbon loss and improving carbon sequestration potential, such as increased crop residues, prevention of erosion and nutrient runoff, water management and conservation, and expansion of vegetative cover (Gigou et al. 1997)**.** This technology has also the advantage of having been the object of systematic research for almost 10 years and having met considerable interest among farmers who tested it. ACdN consists of tilling along the contour, building ados (semi-permanent earth ridges) and waterways to channel water runoff, and, possibly, adding organic an/or inorganic fertilizer to increase soil fertility. Most fields can be managed with three ados (of a width ranging between 0.50 and 1.00 meter) per hectare. Ados may be planted with *Andropogon* grass or, more often, weeds are left to grow in order to stabilize them.

The tillage and the construction of ados and drainage can be done by farmers provided that they have the necessary training and equipment (oxen and plows). But the technology package, as currently implemented, calls for a skilled technician
to carry out the initial diagnostic survey, to measure and mark the ados, and to advise farmers on maintenance during the first three years (until ados become stabilized). Experiments in the study sites have been conducted since 1994 and have shown that yield increases of 30% to 50% (respectively without and with fertilizer application) can be obtained within the first few years of implementation.

[illegible]

The second technology consists of a system of open range planned grazing based on the segmentation of pasture area into parcels that are grazed in succession. This system diverges from conventional rotational grazing technologies in that the decision relative to the appropriate time for the herd to move on to the next parcel is triggered by empirical observations of the potential for pasture regeneration rather than on a pre-determined schedule based on some fixed carrying capacity estimate (Savory with Butterfield, 1999). Village-based and transient herds are combined and pastured on a single parcel at a time and shifted to the next parcel when the forage is grazed down to a level that permits regeneration. This allows other parcels to regenerate their annual and perennial grass cover before receiving the herd. The duration of the rotation is a function of time the animals are on a specific parcel in a given period. Movement of animals is based on the recovery needs of the most severely grazed grass, forbs, or shrub and the focus is on minimizing overgrazing while maximizing the benefits of animal impact. Grazing is mostly conducted during the rainy season, ending at some point during the dry season when regeneration stops due to lack of water.[illegible]Rainfall levels during the rainy largely season determine this threshold.
This system diverges from conventional rotational grazing technologies in that the
overgrazing is understood as a function of time rather than numbers of animals. The decision relative to the appropriate time for the herd to move on to the next parcel is triggered on the basis of an empirical monitoring of the potential for pasture regeneration rather than on a pre-determined schedule based on some fixed carrying capacity estimate.[2] Another key differentiating factor is that this approach explicitly recognizes and seeks to capture, and integrate into the grazing rhythm, the regeneration potential of the trampling effect of animal hoofs as they break up the surface and push seed into the ground.

An even more significant difference is that this approach to pasture management moves beyond a purely technical level of intervention, by integrating a host of institutional development supports at the community and Commune

level. While ACdN can be practiced by individual farmers, the feasibility of this rotational grazing system hinges on a concerted effort by stakeholders groups, which include local farmers and transhumant herders as well as key actors of local level government. The provision of NRM planning and facilitation skills and the establishment of an institutional mechanism for collective decision
-making and conflict mediation (such as the commune-based Natural Resource Management Advisory Committee, see below) are therefore an essential component of the intervention package. The rotational system is monitored and managed by village-based environmental monitors who are trained in both technical and negotiation aspects and work in collaboration with community and Commune leaders. Village NRM User Groups facilitate communication flows between communities and Commune level decision making bodies and ensure involvement of local stakeholders.

Pilot projects implemented in other parts of the Sudan-Sahel region (Chad, Senegal) indicate that the system has potential for increasing overall biomass and species diversity (Bingham 2002). However, a scientific assessment of this potential (especially on a longer term basis under various rainfall conditions) has yet to be carried out. While the Madiama experiment seek to test the feasibility of the rotational grazing system as entirely managed by local communities, IER researchers and technicians are also working alongside environmental monitors to collect data on pasture quality and quantity (dry matter, vegetative cover, dominant species, etc.) and document biophysical soil processes, including carbon cycling.

The study sites

ACdN in southern Mali [3]

The three southern villages are located near Fana, Kati, and Koutiala and represent a diversity of agro-ecological conditions, livelihood systems, technology adoption, extension frameworks, and institutional capacity. Two of these villages are situated in the cotton growing zone, which have received inputs, credit, and training by the cotton parastatal *Compagnie Malienne pour le D*[illegible]*veloppement des Textiles* (CMDT), and one is located in the zone of operation of the *Office de l*[illegible]*Haute Vall*[illegible]*e du Niger (OHVN),* a state development agency, which receives funding from USAID and European countries.
The project sites are located in the 800-1000 mm rainfall zone of southern Mali, and are Siguidolo (
near Konobougu), Sougoumba (near Koutiala), and Fansirakoro (near Kati, northwest of Bamako), and In all three sites ACdN have been introduced and continue to be extended in the context of IER research activities (in collaboration with CIRAD or the Soil Management CRSP).[illegible] Farmers in Siguidolo were among the first to be exposed to the experimental technology, which is in its 8th year of implementation, and practice is common (29 out of 39 households are reported to have established ACdN). ACdN technology was introduced by a joint IER-CIRAD research team (access to these villages was facilitated by CMDT). The IER research program and on-farm trails continue, and this provides impetus to adoption and implementation in this site. Introduction in Sougoumba and in Fansirakoro/kura is more recent (respectively 1997 and 1999) and scope of adoption is more limited. In Sougoumba, ACdN were also initially introduced by research but then extended by an NGO service provider. In Fansirakoro/kura ACdN were also introduced in the context of research.[illegible] As was the case in the two CMDT sites (Siguidolo and Sougoumba), the main extension and development organization operating in the site (OHVN) was not directly involved.

Siguidolo is near of the Niger River floodplain, with lateritic uplands alternating with
gentle slopes and lowlands. The village counts 39 households, of which three fourths are said to be practicing ACdN in one form or another. About two thirds of the households have access to animal traction (one or more operational sets), while one third have less than a complete set (i.e. only one oxen and plow). The village looks relatively prosperous, due to production of cotton and watermelon, which the area is renowned for. It does not have a school and few farmers are literate, but there is Koranic instruction at the local mosque.

The landscape surrounding the village of Sougoumba is characterized by large
rock outcroppings and many deep gullies and ravines. Some fields are plagued by severe erosion and violent runoff, which farmers try to contain by digging waterways and blocking ravines with millet stocks, branches, rocks and vegetative strips. The village comprises 78 households, of which 40 actually reside in the separate hamlet of Oumarbougou, located on the main road

from Koutiala to the border with Burkina Faso. The hamlet is situated on the side of the road and was established about 15 years ago by junior households from Sougoumba village in need of additional farmland. Most resident households have access to animal traction. Sixteen of the 78 households in Sougoumba are said to be practicing ACdN, most of which (14) are from Oumarbougou. The village appears wealthier than the other two villages, having benefited from its long history of cotton production and from its proximity to the international route. There is a primary school and many farmers are literate and some understand French.

Fansirakoro is surrounded by steep hills
, which are farmed by the inhabitants. Upland areas are undergoing severe erosion due to excessive surface runoff, while lowlands are degraded because of continuous cultivation. The lowlands have been farmed permanently and there is no room for further expansion. The settlement includes two villages, old Fansira (Fansirakoro) and new Fansira (Fansirakura), which are less than 1 km apart. The two villages manage the same territory but most inhabitants of the old village farm on one side, and those of the new village farm on the other. There are 37 households in old Fansira and 53 households in new Fansira.[?] Only three households in Fansirakoro are practicing ACdN. Old and new Fansira appear much poorer than the other two sites. Sale of firewood, which contributes to deforestation of hill slopes, is a major source of revenue, along with vegetable crop production. Farmers complain about water scarcity, as wells dry up early in the dry season. There are no local organizations, and no school: very few farmers are literate or understand French.

In Siguidolo and Sougoumba farming systems revolve around rainfed cultivation of cotton and
cereal grains. Cotton is more prevalent in Sougoumba than in Siguidolo, where it covers an estimated 40-60% of arable land. In Fansirakoro/kura, only a few farmers cultivate cotton in lowland fields. Major food crops in all sites are millet, sorghum, and maize. Farmers also grow peanut, Bambara nut, cowpea, sesame, soja, and calabash. Some households have access to valley bottom fields, where they can grow rice. In Siguidolo, watermelon, tomatoes, and other vegetables (lettuce, cabbage) are also grown for the market. Dry season gardening is also a significant component of local livelihoods in Fansirakoro/kura, whose farmers travel to a nearby area where a small reservoir provide water for small vegetable plots.

Expansion of cultivation prompted by the growing population and by the cotton boom of the 1980s has led to a shortage of farmland, which limits severely farmers[?] ability to fallow land (reduced fallow is still practiced on hillside fields in Fansirakoro/kura). To manage fertility, farmers rotate crops, apply manure, crop residues, household waste, and compost. But some farmers are unable to do so because of lack of labor and of transport equipment, shortage of water to assist in the decomposition of compost, and, especially in Fansirakoro/kura, insufficient numbers of animals to produce manure. Chemical fertilizer is purchased
on credit through CMDT and applied to cotton and maize fields.[4]

The increasing shortage of land provides farmers with a clear incentive to intensify land management through systems, such as ACdN that retain water and nutrients, although expansion of ACdN has been constrained by availability of labor, animal traction equipment, and technical support services. In Siguidolo and Sougoumba, fields under ACdN range between 2 ha and 21ha per farmer (the median holding was 3 ha). Farmers with larger holdings tend to be the earlier adopters. Most fields under ACdN were planted with millet and/or sorghum,
a few with cotton, either alone or in association with cereals. Preponderance of cereal crops is explained by the fact that these crops are usually grown in the less fertile, more eroded fields, which are also those that are more in need of management by ACdN.

Rotational grazing in north-central Mali [5]

The Commune of Madiama is part of the Niger Delta region and comprises 10 villages.[illegible] It belongs to the *Cercle* of Djenn[illegible] and the Mopti Region, and it is located on the national highway that links Segou and Mopti, about 20 km from the town of Djenn[illegible]. The population of the Commune was 7,973 inhabitants in 2001
. The climate is characterized by mono-modal and erratic rainfall with high radiation loads and temperatures during the growing season. Rains begin in May-June and last till late September-early October. The annual average from 1950-69 was 636mm and from 1970 to 2000 was 482mm (Badini and Dioni 2001).

The principal crops are millet, sorghum and rice, followed by cowpeas, peanuts, hibiscus, fonio, watermelons, and okra. Crop production is extensive in nature, with low levels of purchased inputs. Introduction of animal traction (which is practiced by 50-80% of local farming households) has enabled farmers to expand acreages to feed a growing population and compensate for declining fertility and rainfall. This expansion has been led to encroachments of pasture and cattle corridors which fuels tensions between farmer and herder group. Livestock (cattle, sheep and goats) is a key component of local production systems. Extensive livestock management is practiced by all ethnic groups, but approximately 70 % of animals are managed by Peul herders. Land under crop production has been expanding to the detriment of pasture and livestock corridors. Only 20 percent of the land is currently
under useable pasture, so that resources are insufficient even for some of the local livestock, which must seek water and pasture outside of the Commune boundaries for at least part of the year.

In addition to local livestock, Madiama lies across the path of traditional transhumant herding, whereby livestock moves between the dryland plains exploited during the rainy season and wetland grazing areas in the inner delta of the Niger exploited during the dry season. The transhumant herds, some coming as far as Burkina Faso, cross the territory in a southwest to northeast direction in October-November to return from the delta to the dryland plains in June-July. Direction and destinations vary according to the nature of the rains and state of the pastures in any given year. It is during these passages, but especially at the end of the rainy season when crops are still in the field ready for harvesting while herders are eagerly waiting to cross the Commune territory to bring their livestock to the delta wetlands, that many conflicts between pastoralists and agriculturalists arise (Moseley et al. 2002).

Two study sites have been established
in[illegible]two villages in the Commune of Madiama, Siragourou and Torokoro, which volunteered for the experiment and which control most pasture land in the Commune.[6] Both village territories straddle the major north-south highway linking different regions of Mali. They are inhabited by a majority of Marka (Bambara) farmers. The pasture of Siragourou contains 99.4 hectares and has been divided into 7 parcels. The pasture of Torokoro is 105.2 hectares divided into 6 parcels.

Implementation is still in its early stages (rotations began in August 2002)
and[illegible]the exceptionally low rainfall in 2002 did not allow for the expected level of pasture regeneration of the parcels as they had been delimited before the onset of the season.[7] Moreover, it became evident that the parcellization of the Siragourou pasture had not taken into account the need for livestock to be able to access water points without disturbing pasture regeneration in [illegible]resting[illegible] parcels. This underscores the need for long-term monitoring of performance in diverse rainfall conditions and for integrating annual variability in water availability and access in the experimental design. Water access is key to the ability to use pastureland and, and it has quality as well as quantity dimensions. The quantity dimension is a function of time, most water points dry up a few months after the end of the rainy season (the number of months depending on the level of annual rainfall). The quality dimension is a function of labor, that is the amount of work that different types of water points require for animals to avail of the water (i.e. an open access pond and a deep well from which water must be manually drawn impact the viability of the pasture differently).

Role of institutional factors shaping technology adoption and implementation

Two processes that have been at work during the past decade constitute an important background that must be taken in consideration in an assessment of the potential of various institutional frameworks for extending and coordinating aggregate adoption of NRM practices and for mediating between farmers and external actors involved in carbon trading. In the economic arena, since the mid-1980s the process of structural adjustment has triggered a thrust towards liberalization and privatization of the agricultural sector, including removal of price controls, liberalization of input markets, disengagement of the state from service provision, devaluation of the CFA Franc, etc. Donor pressures have also contributed to reforms to ensure greater efficiency and transparency of state agrarian institutions. In the political arena, a process of democratization begun in the early 1990s has given birth to a radical readjustment of the relationship between rural communities and the central government. Since 1999 the process of decentralization has redefined local level politics, by transferring power from nationally appointed administrators to elected local representatives.

The cornerstone of the decentralization process is the Rural Commune, which replaces the former *arrondissement* as the main local politico-administrative structure above the village level [8]. The crucial difference is that Communes have elected governments while the *chefs d*[illegible] *arrondissements* were appointed by the Ministry of Interior. Communes are governed by a Commune Council[illegible] formed of elected representatives. The Commune Councils have jurisdiction and responsibility over organization of agricultural activities, infrastructure development and maintenance, development of land use plans, environmental conservation and land use disputes. The Communes are expected to fund these operations from locally mobilized resources.[illegible] (Moseley 1999).

Resource endowment

ACdN in southern Mali

The willingness and ability to invest in land improvement is a function of the land manager[illegible]s assessment of the need for and effectiveness of such intervention, the significance of the land for his/her income and livelihood, and the means at his/her disposal. In all three sites farmers were deeply aware of problems of soil erosion, loss of soil fertility, and poor water retention in their fields, but they varied in whether they perceived ACdN to be a viable solution. Farmers in Sougoumba, for instance, believed that ACdN were inadequate against the violent runoff that plagued their fields and unsuited to sandy soils or sloping fields. But even when motivated to adopt, resource constraints may hinder establishment of ACdN in farmers[illegible] fields.

Labor was often mentioned by farmers as a key constraint.

ACdN must be built at the beginning of the rainy season, when the first rains soften the hardened soil, but at this time farmers are also busy tilling and planting, so that there is no time to devote to additional work. A delayed onset of the rain, a frequent occurrence in the last 20-30 years, exacerbates the pressure on labor resources by shortening the viable time for planting. Early planting is particularly crucial for viable cotton production, which has a growing cycle of about four months and is very sensitive to water deficits. To establish ACdN farmers must mark the contour and the ado first, then build the ados and proceed to tracing ridges parallel to the ado, following the contour line. The work is particularly hard if the farmer must reorient the ridges from parallel to perpendicular to the slope. Assessments of labor inputs varied with conditions of oxen and equipment as well as of the terrain (many of the fields being irregular in terms of topography). One farmer assessed that measuring and marking 3 ados in 1 ha field takes two people about 3-4 hours. Two people about with a team of oxen and plow can then build them in one or two days depending on the strength and skill of the oxen. Ridging a 1 ha field also takes one or two days. During the first two or three years, heavy rains and runoff may damage the ados, requiring repairs and reinforcements. Maintenance and repair may entail 2-4 hours twice during the season the first year and 1.5-4 hours once during the season the second year.

Most of the work for establishing and maintaining ACdN (as well as most other farming tasks) is done by household

members. Women participate in all farm work on household fields in Fansirakoro/kura and, to a lesser extent than men, in Sougoumba. On the other hand, married women do not work in the fields in Siguidolo, where Islamic influence is stronger. In addition to household labor, some farmers participate in labor exchange groups, whose members work on one another's fields according to a pre-determined cycle that ensure that all members benefit from the group's work and reciprocate the help received. Youth groups or women's groups also hire themselves out to earn money to fund their activities. Wealthier households may host hired laborers for the season, usually young men from other villages[10]. Local men who have smaller farms may also work as day laborers, especially for weeding and cotton harvesting[11]. But these forms of extra-household labor are generally unavailable during at the onset of the season because everyone is busy planting their own fields.

Because labor is such a critical resource, labor-saving technology such as animal traction is key to farmers' ability to establish ACdN in their fields in time for planting. Notably, all households who have adopted ACdN in Sougoumba (and the few in Fansirakoro that did) have animal traction. In Siguidolo (where IER assists under-equipped farmers who participate in their trials), two thirds of households that practice ACdN own at least a complete set of animal traction equipment and a team of oxen. Access to animal traction (ownership of one or more pairs of oxen and plow) in the southern Mali sites was relatively high among the villages in the cotton growing areas (93% in Sougoumba and 64% in Siguidolo), where CMDT has provided extension services and credit for farm equipment. In Fansirakoro, on the other hand, only one third of households had animal traction, and two thirds had no oxen and plow at all.

Because of the low availability, hiring animal traction services is relatively rare in Fansirakoro/kura, and can only be obtained at a later, less favorable, time, when the owner has finished plowing his own fields.[12] Hiring is more common in Sougoumba, where more oxen and plows are available (and the larger size of holdings means that even households who do have animal traction set may need additional help to ensure timely land preparation and planting). With the withdrawal of CMDT (and other government agencies) from provision of agricultural inputs and services, farmers groups may still apply to banks for credit to purchase farm equipment, but they will be subject to collateral requirements and interest at commercial rates.

But while animal traction is a key enabling factor for the establishment of ACdN, it signifies more than a technological fix and, as the Sougoumba case suggests, it is not, by itself, a determinant of adoption. Degree of access to animal traction is rather a proxy for household wealth status, productive capacity, and dependence on rainfed agriculture for livelihood. For instance, CMDT classifies households based on availability of animal traction in order to assess their ability to repay debts incurred for purchasing productive inputs.[13] The fact that the majority of households that have adopted ACdN have more than one operational animal traction set suggests that wealthier households are more willing or able to invest in the technology by virtue of greater labor capacity and availability of cash for technical services as well as ownership of animal traction (wealthier farmers may also be given precedence by technicians who provide the contour measurement services). Farmers who have more than one animal traction set are also likely to be those who are more reliant on rainfed agriculture for their livelihood and, therefore, more motivated to invest in land improvements (hence the higher adoption levels in Siguidolo rather than in Sougoumba, where trade and migration also contribute to livelihoods, and in Fansirakoro/kura, where households also derive revenues from fuelwood sales and dry season gardening).

Land scarcity also plays a role in shaping adoption, as a motivating rather than limiting, factor, since it is becoming increasingly difficult for household to fallow their fields to restore fertility or to open new fields when soil becomes depleted.

But ambiguities in the land tenure situation may discourage the implementation of permanent land improvements, especially on borrowed fields (for instance, land-owners firmly oppose tree planting in fields they have lent to others because borrowers may use it to establish claims or demand compensation when the land reverts back to the owner). In most of the countryside (except for irrigated schemes and peri-urban areas), access to farmland is regulated by customary tenure. A "*chef de terre*" (who may be the same or a different individual from the village "chief" recognized by the administration), from a founding ancestral lineage, may have ritual responsibility for the land. In some areas, there are two customary chiefs, the *chef de terre* and the *chef de brousse*, who have ritual oversight respectively on cultivated and uncultivated land. But in daily practice, farm

rights are held by families who first cleared and farmed certain tracts of land and are inherited patrilineally. These families can transfer land to newcomers: the rights thus allocated are also inherited so that, over time, the land cannot be retrieved by original owners without grave reason. Household heads manage household fields and allocate land to male and female subordinates for individual fields. Borrowing of fields is relatively common, but more so individual fields rather than household fields (which is more difficult for the owner to reclaim).

********** *Rotational grazing in north-central Mali*

Social relations between transhumant Peul herders and resident Peul agropastoralists and Marka (Bambara) farmers mediate access to the Madiama territory and to the water points, pasturelands, and corridors it contains. Pasture resources normally fall within a particular village territory and, as such, they fall under the jurisdictional authority of the village chief. They are generally treated as an open-access common pool resource, but village chief (whether he is Marka or Peul) exercise some control over timing and order of access by transient herds. Decisions as to when animals can access the pastures within the Madiama Commune have formally been regulated by the *chef d* *arrondissement* , but decentralization has devolved to the Communes the formal jurisdiction over NRM in their territories, so that now the Mayor makes these decisions in consultation with local chiefs and pastoral leaders.

Water points such as ponds and watercourses are also considered common property and can be openly accessed by residents and strangers alike. Wells are owned by the families or lineages that built them, who might have priority of use but, if available, water is shared with all those who ask in consonance with customary pastoralist conventions of resource utilization that dispose that neither pasture or water can be denied to those in need. But right of use may be limited to a certain amount of time and to the maintenance of good relationships, and may be curtailed in case of contagious illness or extreme scarcity (de Brujin and van Dijk 1995). User fees are becoming a more frequent method of regulating water use rights in the case of water points that required significant investments or that can serve large numbers of animals (as a way a of limiting the potential damage to surrounding farmland or pasture).

A certain degree of plurality and fluidity in resource access arrangement has been relatively functional in the past, being well adapted to a pastoral production systems that depend on flexibility and mobility to cope with the vagaries of uncertain rainfall. However, in the last two decades, increased climate variability and pressure on resources and the imposition of formal regulatory systems contributed to exacerbate competition and tensions (de Brujin and van Dijk 1995). The challenge for the rotational grazing experiment is to be able to manage, and therefore improve, pastureland without exacerbating latent tensions. For instance, Nerekoro, which is the main Peul village in the Madiama Commune, was unable to participate in the rotational grazing experiment because of a dispute with the village of Madiama over boundaries of their pasture areas. The dispute is the result of gradual encroachment by the Madiama village, which is the seat of the new Commune administration as well as of residence of a cluster of locally prominent families, into the territory of neighboring villages.

********** ***Organizational framework***

ACdN in southern Mali

Mali has a long-standing tradition of strong rural organizations that have played an active role in development. Bambara farming communities have traditionally been organized around cohort associations (the *tonw*), which included the village elders that assisted the chief in decision-making as well as young men and women's collective labor groups. Colonial and post-colonial administrations have sought to capture this vibrant associational life to mobilize rural populations for various economic and political purposes. The village association or AVs (*Associations Villagoises*) were revamped by CMDT in 1977 to facilitate the distribution of inputs and credit, marketing of cotton and other crops, and the investment of cotton revenues into community development. Through the AVs CMDT intervened not only in cotton production and marketing but in all areas of agricultural production, including sorghum,

millet, rice, cowpea, and livestock, and all aspects of rural life, including agricultural extension, infrastructural development, environmental conservation, and literacy programs. The same model of AV has been used by OHVN and in other areas.

The AV is still the essential legal structure of rural development, including all heads of resident households (but not those households who are not considered "resident", such as the Peul living in the bush surrounding the village). But in recent years, especially since the fall of world prices for cotton in the second half of the 1990s, the viability of AVs has been eroded by internal tensions, because surplus from successful farmers had to be used to repay loans of defaulting members. As a result many village associations splintered into several different AVs (this is the case in Sougoumba which counts 15 AVs). To remedy the problem CMDT is now promoting a new model of producer association, the *Association Producteurs de Coton* (APC), based on the voluntary association of a more limited and more homogeneous groups of producers [15]. Unlike AVs, which included all households in the village, APCs are constituted by persons who share social bonds (of kinship, affinity, neighborhood, etc.) and can refuse membership to those considered untrustworthy. Their scope and functions are much more circumscribed, compared to those of the AVs, being limited to support for cotton production and marketing. This shift has obvious advantages in terms of ensuring better repayment rates and easing tensions, but has the disadvantage of eliminating CMDT support for literacy and other training which has been a key support for village-wide mobilization.

The AV have been instrumental in the promotion and extension of improved land management practices, such as diguettes and compost production, through their "*quipes techniques* (technical teams), groups of 5-7 literate lead farmers who are charged to act as intermediaries between extension, development, and research institutions and the community. Members of the "*quipes techniques* received specialized trainings in agricultural and NRM technologies they were to demonstrate and extend to other farmers and participated in field trials and data collection. Some of the first farmers to test and adopt ACdN were members of "*quipes techniques.* It is yet unclear how the shift to APCs will affect the viability of "*quipes techniques,* except that supervision will be more difficult because of the larger number of APCs compared to AVs.

[KMM4]

"""""""""""" *Rotational grazing in north-central Mali*

Unlike the southern sites, the prominent organizational framework for the rotational grazing experiment in north-central Mali is rather a supra-village entity whose development has been fostered in the context of the SANREM CRSP institutional development activities in Madiama. The decentralization process devolved responsibility for the management of land resources in the Commune to the Mayor and the elected Commune Council. In 1999, a Natural Resource Management Advisory Committee (NRMAC) was created with assistance from the SANREM CRSP and its partners IER and CARE to advise the Mayor and the Council on NRM issues.

The NRMAC derives legitimacy from both administrative and customary spheres of governance by adhering to formal institutional procedures while at the same time deferring to local chiefs in community affairs. This is a delicate balancing act, given the history of relations between the chieftaincy and the state, and given the contrasting agendas represented in village and Commune governance. There is also tension between the workings (and demands) of the formal legitimacy that is conferred by the civil authorities and documented in public records, and the support of traditional leaders, which is contingent on personal relations and verbal agreements, and thus more subject to shifting perceptions and alliances, although also essential in mobilizing communities and enforcing agreed-upon decisions.

The NRMAC achieved legal recognition as a non-governmental organization in October 2001 by deliberation of the Prefect (the government representative) of the Cercle of Djenn" and upon fulfillment of legal prerequisites, such as approval of by-laws by the judicial authorities. Its development was supported by the Mayor, who saw an opportunity to fulfill the Commune"s NRM mandate (promoted but unfunded by the new decentralization stipulations). This support is particularly notable given that the President of the NRMAC belongs to a political party in opposition to that of the Mayor: their willingness to collaborate is to be partly ascribed to their participation in conflict mediation trainings. Likewise, some village chiefs were initially reluctant to participate (and thus lend legitimacy to

the committee), fearing mayoral or administration interference in their community affairs, but have subsequently embraced the initiative since they understood that lack of participation could lead to exclusion from potential benefits and information channeled through the NRMAC.

Efforts were made to ensure a relatively balanced ethnic and gender representation, although the result still reflects, to some extent, existing configurations of power. Yet, given that, consistently with local styles of collective decision making, most NRMAC deliberations are based on consensus rather than majority rule.
Numerical representation consequently does not determine outcome, enabling some degree of influence and negotiation. The NRMAC members were elected during a General Assembly of delegates from the ten villages that make up the Commune of Madiama. Five village delegates to the general assembly were appointed by the village chief of each village, in consultations with other village elders, from the Village NRM User Groups, whose role is to interface between the NRMAC and village residents. Members of such groups were also selected by the chief from among the representatives of traditional associations and salient social groups (but not transhumant herders). In three villages, where the World Bank-Funded *Programme Gestion Ressources Naturelles* (PGRN) program had already formed villages committees, the latter assumed the functions of the Village NRM User Group.

The NRMAC is comprised of 18 members, of which 6-7 are from the central village of Madiama (on account of its larger size but also the social prominence of four major lineages, which are represented on the committee) and 1-2 from each village in the Commune. The committee is still predominantly Marka, with 3 or 4 Peul members, including a representative of the Nerekoro Herders Association.
[17]
Despite the dominance of Marka, it is generally perceived by local leaders as relatively sympathetic to herders. Upon request by the partners, about one third of the committee is made up of women, of which 3 are from Madiama and a few others make up an additional representative from the other villages. All NRMAC members were recently voted by the General Assembly for a second three-year term during a session presided over by the Mayor and the Sub-Prefect. This new term of office will be monitored by a commission of peers composed of a representative from the Commune Council, the village chiefs, other customary/religious leaders, and other relevant stakeholders (IER, CARE, and other NGOs working in the area).

The NRMAC bridges between technical specialists and community by advising on NRM research agendas and actions, such as tree planting and protection, on-farm trials, inter-village resource use agreements and conflict resolution. For instance, the NRMAC has been assisting the Mayor in facilitating meetings with village chiefs and pastoral leaders to coordinate the passage of herds through the Commune after harvest. The
open range rotational grazing experiment is designed to articulate with this system, thereby prolonging the herbaceous growth in some of the pastures.

To equip NRMAC members and other community leaders in these functions, series of trainings have been provided on Holistic Management and NRM conflict mediation, as well as literacy and numeracy, financial planning, and the laws and codes of decentralization. NRMAC members themselves have also conducted training on some of these topics in their own villages, sometimes using theatre and other forms of popular representation. The conflict management approach hinges o n consensus building process that stresses inclusive participation, social learning, critical analysis of potential outcomes, and identification of the changes of values and behaviors required for optimal outcomes to occur (Goebel 2003).[18]

An example of NRMAC-led resolution of conflicts over pastoral resources occurred when a herd of cattle trespassed before the set date to access water points located just across Commune boundaries. This caused remonstrations by Peul agropastoralists from a village within the Commune, who also had herds waiting to enter the territory but no accessible water points. Tensions erupted so that villagers were on the verge of summoning the law enforcement, but NRMAC intervened by applying the conflict mediation techniques

acquired during their training and was able to diffuse the confrontation
. This incident is important as it highlights how attempts at regulating resource use can engender social tensions and how crucial it is to ground such attempts in a viable institutional framework that enables communication and negotiation among all stakeholders.

Bambara villages in north-central Mali maintain traditional cohort associations, but they do not have functioning legally-recognized Village Associations as found in the cotton growing areas.[20]

Herders are organized in the Nerekoro Herders Association, whose membership is predominantly Peul, but also include some Marka livestock owners. Despite its name, which refers to the main Peul village in the Commune, the association has supra-local functions. Its president is a prominent Peul chief (*joro*) who is very influential on decisions regarding herd movements across the strategic territory of the Commune. He is a member of the Commune Council (politically aligned with the Mayor) and a significant player in the regional political arena. His support of the principles and objectives of the NRMAC and the rotational grazing experiment has been instrumental to securing the cooperation of the pastoralist community in the Commune.

Technicity requirements

ACdN in southern Mali

Technical services for measuring and marking the contour are provided by IER technicians in Siguidolo and in Fansirakoro/ kura and by an NGO (run by a former IER technician) funded for this purpose in Sougoumba. Farmers interested in establishing ACdN in their fields submit pay 5,000 Fr CFA/ha for the diagnostic and measurement services provided by the technician (the fee can be paid in cash or in kind at the time of service or after the harvest). But

the viability of this system is limited by the small number of IER technicians or other extension agents available and capable to respond to farmers demands. In addition to technical skill, experience is particularly crucial during the diagnostic phase, during which technician and farmer analyze the hydrological characteristics of the field and draw a land management plan.

Until recently, agricultural and NRM extension services have been conducted by parastatal institutions (formerly known as *Op rations de D veloppement Rurale*) established in the 1960s, including la *Companie Malienne de D veloppment des Textiles* (CMDT) and Office de l Haute Vall e du Niger (OHVN). These institutions fall within the jurisdiction of the *Minist re du D veloppement Rurale et de l Eau* (MDRE), which contracts with them to provide those services. In areas not covered by the ODR, MDRE directly provides extension services, according to a World Bank supported T&V approach. CMDT has been active in promotion of NRM in the past through the *Projet Lutte Anti-Erosive*, originally funded by Dutch foreign assistance and later subsumed under the PGRN program. Improved NRM has also been one of OHVN four intervention priorities, funded by various donors, including USAID and GTZ. But under pressures from the World Bank and other donors, both agencies have been undergoing a radical restructuring, withdrawing from development and environmental interventions and privatizing many of the services they previously offered.

The disengagement of CMDT agents from village level extension service had already begun in the 1980s with the creation of *quipes techniques* within AVs and the establishment of *Zone d Animation et Expansion Rurale* (ZAER), clusters of 8-10 villages, as the basic outreach unit. Because of the large number of villages they cover and because their functions will be increasingly focused on cotton production and marketing, CMDT agents are unlikely to play a direct role in ACdN extension and service provision. The relationship of CMDT agents with the communities is also affected by the sometime charged climate of farmer-CMDT relationships (Bingen 2000).

Generally CMDT agents are better equipped and better remunerated than OHVN agents, and are employed on contractual basis while OHVN agents are government employees, conditions that may affect performance in various ways (motivation and initiative on the agents part, continuity of presence and interaction with the community). As

contractual workers, CMDT agents are under greater pressure to perform, but such performance is likely to be assessed in terms of the company's interest, so that OHVN's extension approach tends to be more responsive to farmers priorities than CMDT (Kelly, personal communication).

NGO field agents may be in a better position to provide NRM extension and services. Many NGOs intervene in community-based NRM and generally have high credibility with both communities and donors. However they are disadvantaged in that their territorial coverage and involvement in communities are limited by project cycles, which lead to lack of continuity, inconsistency of approaches, and high staff turnover. They also lack the leverage (i.e. to enforce payment or compliance with guidelines) that CMDT or government agents may have. The three sites visited differ considerably in terms of NGO involvement. There are no NGOs working in Fansirakoro. Siguidolo benefits from assistance by several NGOs that operate in the domains of NRM, micro-credit, health and sanitation, literacy, etc. Only one NGO intervenes in Sougoumba, that is AMED (*Association Malienne d Ev illement et D veloppement*) which was founded by a former IER technician specifically to respond to demand by farmers of the area for ACdN services. This NGO extends the same technological package introduced by IER, but since are paid for contour marking on the basis of number of hectares measured, there is little incentive for them to spend time doing a thorough diagnostic or to return to the farmer's field to monitor implementation. Currently they have discontinued intervention in Sougoumba because several villagers defaulted on the fee payment.[21]

The increasing withdrawal of the state from the provision of rural services may also require solutions that go beyond traditional extension structures and approaches. Private sector operators may also play a key role, if appropriately trained, especially where there is no coverage by extension or NGOs. However there should be some oversight by farmers representatives and/or public sector institutions to ensure that profit consideration to not prevail over environmental viability. Provision of technical services could provide a source of revenue and, therefore an incentive for their community service, for members of *quipes techniques* or farmers involved in research trials. Another potentially viable option would be to train young people who are school leavers and reside in rural areas, many of whom are now unemployed, so that they can perform these services (possibly activating the model of traditional young people's associations (*demisenw tons*).

Rotational grazing in north-central Mali

There are two dimensions for the implementation of open range pasture rotational grazing. One is largely technical, involving the capacity to monitor pasture conditions and make the management decisions to move the herds from parcel to parcel before all pasture is grazed down so that it can regenerate. The second dimension is organizational and involves establishing relations and facilitating communication among the wide range of pasture users who agree to adhere to the principles of rotational grazing in exploiting the pasture.

Management and monitoring of the open range rotational grazing system hinges on the role of community-based environmental monitors. Two monitors per village were designated by the village chiefs and trained in the technical aspects of open-range rotational grazing as well as in the necessary facilitation skills to prepare them to work with the different stakeholders. In addition to technical monitoring and management decisions, the volunteers are responsible for informing herders about the pasture management and for monitoring of compliance with its regulations. They are assisted in these functions by a sub-committee of the NRMAC, including a representative from the villages in question and a herder representative. Monitors have been provided by the SANREM CRSP with bicycles for transportation, but no other compensation has been envisioned other then the community-wide benefits of improved pastureland.

The community volunteers monitor the grazing parcels based on observations of pasture regeneration potential and make decisions about when it is time to move herds to the next parcel and which parcel is ready to receive the herds. The parcels were delimited prior to the rainy season by the monitors and IER technicians by marking rocks and trees with paint, and will subsequently adjust the repartition on the basis of empirical observation of regeneration capacity of different parcels.

The open range rotational system hosts the locally owned livestock that stays in Madiama during the rainy season as well as the transhumant herds that cross the Commune at the onset and at the end of the rainy season. Local animals may continue rotate through the parcels for a few months in the dry season as long as grass and water are available. Due to the influx of additional, pressure on the system is much greater in June-July and in October-November. At these times careful decisions will have to be made about when and where to move the animals. Because decisions are empirically rather than prescriptively made and the project is still in its early stages of implementation, the limits of the systems have not yet been tested.

Significantly the two villages that are participating in the experiment are mostly populated by Marka (Bambara) farmers, and, consequently, their environmental monitors are also Marka farmers. This is hardly surprising since it is the Marka who tend to have control over the land in the Commune. Marka farmers also own cattle, although they are far less skilled and involved than Peul herders in livestock and pasture management. The project is currently exploring how to integrate the traditional knowledge and experience of Peul herders in its environmental monitoring, not only to better ground the technology in the specificity of the local landscape but also to continue building bridges among the two ethnic communities.

Information dissemination

ACdN in southern Mali

The relatively high level of technicity required for viable implementation of the technology underscores the importance of good communication and understanding. But these hinge on a clear definition of what the ACdN technology package entails and how it differs from other approaches. One issue relative to communication that emerged in the course of interviews, with farmers as well as extension agents and institutional representatives, was the relative confusion surrounding the definition of ACdN. In some cases, farmers claimed to be practicing ACdN if they ridged their fields perpendicularly to the slope, even without the ados or any other structural modification. Often, and especially in areas that had been targeted by the PGRN program, ACdN was used in reference to any kinds of land management technology, such as ridging or diguettes (in fact, ACdN is translated in the local language (*Bamanan*) as *lab*[illegible] , which applies to any anti-erosive intervention). Defining ACdN is important not only to promote good comprehension and accurate implementation, but also for the accounting of carbon gains and, eventually, the distribution of benefits from carbon trading.

There seems to be also some misunderstanding as to how and by whom technical services can be obtained. In the sites where IER has a presence, the IER technician convokes household heads to a meeting, inviting them to submit a list of names of farmers interested in practicing ACdN. Applications are taken until the end of April, when he begins making rounds for contour marking. But access to information about these meetings is mediated by the designated channels of communication, the AV leadership and the chief and his elders as well as predicated upon being present in the village at the time. Interviews show that Siguidolo some farmers were confused about eligibility. One farmer [KMM5]believed the technology was only extended to contact farmers who participated in the IER trials. Another farmer, who would have liked to adopt ACdN on his personal field, having observed the benefits on his father[illegible]s fields, hesitated because he believed that services were only available for household heads (that is family fields).

Village meetings are a common mechanism of information dissemination in rural West African communities but, despite the appearance of general mobilization, participation may not be open to all or information may not percolate to all sectors of the population, especially women and the youth. On the other hand, as literacy plays an increasing role in organizational life, the authority of elders may be counterbalanced by greater participation of younger men, who are more often literate and Francophone. Literacy is a prerequisite for eligibility for positions of responsibility within AV (and now APCs), and therefore enables literate villagers to exert greater influence on the management of community resources, distribution of credit and agricultural inputs, access to technical services and training opportunities, and relationships with outside institutions and interventions.

In the past CMDT
(with World Bank funding) has provided literacy and numeracy training to members of village associations to enable them to keep records and accounts relative to agricultural inputs and credit and the marketing of cotton. Siguidolo and, even more so, Sougoumba have several "neo-literates", farmers who are graduated from the CMDT trainings for members of the AV. Although OHVN also implements literacy programs in some of its areas of intervention, Fansirakoro has not had a literacy program and has very few literates and, consequently, has not had a village association, since it requires a quorum of literate members to serve as officers.

Of the three
study villages in southern Mali, only Sougoumba has a school, in the other two villages children have to walk several kilometers. There is Koranic instruction in Siguidolo. Government efforts to promote rural education and school construction during the last two decades have centered on the role of the AV, but as cotton revenues decline and development-oriented village-wide AV turn into more socially fragmented and production focused APC, the ability to mobilize village resources for education is dwindling. Whether the rural Communes will have the necessary resources take up those functions is not yet clear. Among the study sites only Siguidolo had an NGO (AMAPROS) that provides literacy training.

Numbers of literates in the village and existence of associations is also a criteri
on whereby some NGO chose areas where to intervene. For instance, this is how USAID-funded CLUSA, which operates both in OHVN and CMDT areas, targets its trainings in entrepreneurial skills. CLUSA has also been successful in inducing banks to accept loan applications in *Bamanan*, therefore making it easier for literate farmers' groups to apply. Training in literacy and numeracy, financial planning, banking procedures, and market analysis was also emphasized as key capacity building supports for the promotion of sustainable NRM by a recent institutional analysis carried out in OHVN zones (Kelly 2000).

The written media is relatively rare in rural areas, so farmers rely on radio broadcasts for news and information.[22] In terms of dissemination of NRM programs in Siguidolo and Sougoumba farmers can tune in the National Radio as well as local radio programs in local language, broadcasted from nearby towns. About a dozen households in Sougoumba have TVs. Private
FM radio stations are more popular than National Radio and have been able to proliferate relatively freely in the last several years, as the country embarked on a course of economic and political liberalization. Radio programs and communiqu's are a key mechanism for promoting community mobilization and information dissemination, having the advantage of relatively widespread coverage, but they are limited in that they do not allow for practical demonstration and question-and-answer (in contrast to local learning modes, which tend to be interactive and experiential. Information passed on the radio tends to be fleeting (condensed in a short time and repeated only once) and time of broadcast may not be known to farmers, who thus fail to tune in at the appropriate time.

Rotational grazing in north-central Mali
The rotational grazing project maintains multiple communication interfaces. At the Commune level, the NRMAC is the interface between local government and external services associated with NRM on the one hand and the community on the other. Being at the crossroads of administration, technical services, and community puts the committee in a privileged position to access information about local governance, technical innovation, and resource management.

The committee meets monthly in Madiama, and occasionally more often to organize specific activities. The Mayor or his representative participates as an ex-officio member. Village representatives report on the discussions and decisions to their chiefs and to
Village NRM User Groups, who are then responsible for disseminating information in the community. Inevitably, information dissemination efforts have not remained unaffected by the political and social context in which they

occur. In fact, communication problems remain one of the most formidable challenges to the overall effort to decentralize local government. A recent survey indicates that information relative to NRMAC activities does reach village chiefs, but it is not equally distributed across all sectors of the community, particularly where the latter are fragmented by factionalism based on lineage or ethnicity.[23] In some cases, the ability of some NRMAC members to operate as communication nexuses is limited by low educational levels. To address these problems, the NRMAC has leveraged additional funds from the *Fondation de France* for technical assistance in developing an improved communication strategy.

In the field, environmental monitors are responsible for explaining the principles and agreed-upon regulations of rotational grazing to herders using the pasture. Training workshops in holistic management and conflict mediation training has equipped them with tools to carry out these functions. The monitors derive legitimacy from having been appointed by the village chief and delegated to their task by their communities. But social identity issues may present challenges in ensuring communication across social groups, particularly in the case of delicate negotiations surrounding resource use. For instance, the fact that monitors tend to be younger (as young men are more likely to be literate and at ease dealing with project personnel may weaken their clout vis-à-vis elders. Morevoer, most of them are Marka and do not speak *Fulfulde* (the Peul language). Although many Peul residents do speak *Bamanan*, transhumant herders may not. This may complicate communication across ethnic lines, particularly in the case of delicate negotiations about resource access and rule enforcement. This further underscores the need to continue efforts to ensure Peul participation in monitoring and management as well as in the utilization of the pastureland.

In addition to interpersonal communication, the NRMAC has also led efforts to disseminate information on NRM issues by radio which, given the low literacy rates, is by far the most efficient media to reach rural populations. Four radio programs, covering the Circle of Djenn, have been conducted so far on topics ranging from protection of *Acacia albida* to local agreements for *bougouti* re regeneration, to issues relative to decentralization. A program on rotational grazing is being prepared. Most broadcasts are in *Bamanan*, with occasional interventions in *Fulfulde*.

Role of institutional factors in scaling up technologies and representation of beneficiaries

While the two technologies considered, ACdN and rotational grazing, differ in terms of the essential unit of adoption (the decision resting at the farmer/household level in the case of ACdN and at the village level in the case of rotational grazing), in both cases scaling up calls into play supra-local organizational frameworks. Participation in carbon trading will entail the consolidation of households (or clusters thereof) and villages into aggregate blocks, the accounting of investments made and compensations due, and the entrusting of negotiation powers to a representative legitimate structure. Recent developments in the political and economic arena point to various structures that can provide accountability and representation, although several areas of ambiguity and imbalance remain, particularly in relations to the rights of minorities and disadvantaged groups.

Local level

Given its salience in terms of resource management and popular representation at the local level, the Commune is likely to play a key role in the process of coordinating and accounting for implementation of land use technologies with carbon sequestration potential. The NRMAC model intends to build on this potential, although it is for now limited to a pilot project in one Commune (although lessons may be scaled up via inter-Commune linkages such as the Mayors Association of the Cercle of Djenn).

The upward connections and regional linkages of key pastoral leaders such as the President of the Nerekoro Herder Association can also provide a vehicle for scaling up technology adoption and lessons learned.

Yet the legitimacy of the Commune as a representative territorial unit hinges on a clear definition of boundaries and sovereignty. A considerable degree of reorganization occurred as the existing 250 *arrondissements* were segmented into 700 *Communes,* the idea being that smaller units would have greater economic and social cohesion and ensure greater community participation (Rawson 2000). But, since Communes are now the main vehicle for access to state resources and services, the process of boundary delimitation has sometimes been charged with tensions, particularly around key resources and facilities, such as access to arable land, water points, and major roads. The process was complicated by the existence of "hamlets", seasonal or permanent settlements adjacent to a villages, established by either local or immigrant" families as land in the original village became scarce (Koenig 1998: 86-87). As the Communes were established, hamlets were included with the original "mother" village in some cases, while in others they were counted as separate villages.

Territorial definition and administrative autonomy remain charged issues in at least two of the three of the study sites in southern Mali. In Sougoumba, there have been violent confrontations with a neighboring Commune. The hamlet of Oumarbougou, which was established by young families that left Sougoumba to farm new land, is trying to define itself autonomously from its mother village, Sougoumba. Likewise, families from Fansirakoro split to found another village, within less than a kilometer from the original village. The new village, Fansirakura (new Fansira), is now larger than the former, and has its own village chief, tax rolls, communal Council representatives, etc. The two villages claim the same territory, although in practice a division has developed with most residents of Fansirakoro (old Fansira) farming on one side of the plain and farmers of Fansirakura (new Fansira) cultivating the other. In north-central Mali, a village neighboring Madiama and participating actively in its social and economic life, was assigned to a different Commune (in a different Region) and is now appealing to be transferred to the Commune of Madiama. Decentralized administrative structures can function as interlocutors in carbon negotiations and channels for benefits to communities, but whether they represent the interests of all sectors of the population remains an open question. The shift from government appointed to elected governance is likely to disadvantage pastoralists, not only because of the numerical or political dominance of farming populations, but also because it deprives them recourse to an occasionally favorable (sometimes corruptible) administrator that they might have had during past regimes. In terms of NRM there is also a contradiction between scales: while agricultural use can be managed at the level of Commune, pastoralism entails land management decisions at a much broader spatial scale (Moseley et al. 2002). The soon-to-be-developed Commune land use plans are likely to reflect the interests of farmers rather than those of pastoralists because political and legal authority is vested in territorial units rather than social (potentially mobile) units, such as those structuring herder communities.

In the course of an institutional analysis carried out in 1999, Moseley et al. (2002) found that most elected officials had little understanding of the rights and needs of pastoralists, while most pastoralists had limited knowledge of the workings of decentralization. The analysis highlighted the need for training in NRM decision making and conflict mediation, which indeed has been the core of the capacity building component of the open range rotational grazing. A recent survey indicates an increase in awareness of pastoralist issues among elected officials and community leaders in the Madiama Commune, although it is possible that the problem remains in Communes that did not benefit from these trainings (see footnote 23).

Another source of ambiguity and tension is the disjuncture between jurisdictions of customary authorities, elected bodies, and government control. Chiefs and their elder councils still decide on allocation of non-cultivated land within village territories and mediate land disputes among villagers, but authority over interstitial areas (between village territories) is less clearly defined and often contested. Inter-village conflicts or conflicts between agricultural and pastoral users are generally handled by the customary representatives of both groups. Those that cannot be settled at this level or that pertain to several villages are brought before the Mayor. If the dispute cannot be resolved, the parties will be convoked in the judicial courts, which have not been decentralized, and are therefore still under government"s control (Moseley 1999)." Although the state recognizes customary tenure, it also has formal ownership of all land that is not under private title. The state directly controls certain areas, such as registered forests (*for" ts class" es*) and protected territories (Jijkoop et al. 1991:32). The process of decentralization is placing more authorities in local

level elected decision-making bodies, but tensions remain between state control and local government in the elaboration of NRM plans, especially when they entail revenue generation (Agrawal and Ribot 1999). It is plausible that similar tensions will also arise as national government and community institutions define their decisional roles and scope of authority in the negotiation and allocation of revenues from carbon trading.

Regional/national level

Even if land management occurs at the local level, the scale dimension of carbon trading will require that community-based or Commune-based groups join in broader coalitions. The two simultaneous processes of decentralization and liberalization engender a crisscrossing set of trends having key implications for community self-representation. On the one hand, the replacement of community-wide AVs with multiple APCs eliminates a traditional structure of community mobilization and risks fostering specific kinship or class interests at the expense of community-wide solidarity. On the other hand, the decentralization of local governance and emphasis on participatory development is creating more opportunities for community-based organizations to be actively involved in NRM at the local level. New federative bonds are also developing among community-based groups, enabling them to have a voice in national level policy making and to tap into global networks of information and support. Being organized into a federation, would enable rural communities and associations to accumulate enough carbon credit to engage in trading and to negotiate more effectively with external partners. However, while these structures enjoy a higher level of credibility among rural populations than government agencies, they do not have a territorial representation and, consequently, may not have the legitimacy to enter agreements relative to carbon credits from land-based technologies.

A model of federative movement is offered by the *Association des Organisations Professionelles Paysannes* (AOPP), which included over 65 farmers' groups that joined together into a national organization in 1995. Their goal is to "professionalize agriculture", including facilitating access to means of production and technical services, training, and information. AOPP collaborates with IER, ICRISAT, and CIRAD in testing seed varieties and other technologies: its three-year strategic plan includes ACdN under the rubric of soil fertility conservation. Membership is open to all organizations whose members are farmers themselves rather than NGOs that work *with* farmers (as it is the case for the Comit' Coordination et Action des ONG, or CCA-ONG). It includes groups organized around sectors and commodity crops (including pastoral associations) as well as farmers' unions and village associations. This diversity enhances its links to the countryside but also represents a challenge because the various groups differ in terms of institutional capacities, management approaches, and organizational priorities, and have generally very circumscribed scope and goals.'

Politically, the AOPP intends to provide a framework for representing farmers in national-level negotiations, grounded in its ability to mobilize its rural constituencies. It also aims at brokering direct relationships between farmers and donors. The group is politically independent and participates in the *Assembl' P' rmanente des Chambres d' Agriculture du Mali* (APCAM), a consultative body that advises the government (MDRE) on agricultural policy, including CMDT restructuring. AOPP receives supports from European NGOs, including French, Swiss, and Italian NGOs. Within this framework of international cooperation, the group engages in farmer-to-farmer visits and exchanges with European farmers. A connection to international networks has been identified as a key factor that bolster the bargaining strength of marginal groups vis-'-vis powerful agencies.

An important form of rural social mobilization, that has emerged as a powerful political force representing farmers in cotton growing areas in the last decade, are the farmers' unions (*syndacats*) (Bngen 2000, Docking 1999). Farmers' unions have representatives at the district (*cercle*) level, and communicate with AVs through the AV Secretary. The first union, the *Syndacat des Producteurs de Coton et des Vivriers* (SYCOV) was created by CMDT contact farmers and AV leaders on the wake of the overthrow of the Traor' regime and the onset of a process of greater democratization of political expression. SYCOV is a member of APCAM and benefits from European funding. However, internal political divisions and differences of opinions with regards to relationship to CMDT and the proliferations of different unions for different regions and sectors has made it more difficult for unions to operate as a united front in policy and corporate circles (Bingen, personal

communications).

There is no corresponding structure that upholds the interests of pastoralists at national and regional level. However, in the context of decentralization, a national Pastoral Code is being formulated to guide the integration of needs and rights of pastoralists into the development Commune land use plan (Moseley et al. 2002).

Conclusions

This paper examines the conditions for aggregate adoption of land management technologies in order to understand the potential for carbon sequestration and trading.

Within and across the study areas considered (southern and north-central Mali), the villages in question differ in terms of agro-ecological conditions, production strategies, educational levels, and institutional capacities. History and extent of technology adoption also differ considerably within and across areas. In the ACdN case, experience ranges from long-term involvement in research trials (Siguidolo) to relatively recent, socially or spatially circumscribed adoption (Sougoumba and Fansirakoro). The open range rotational grazing experiment in north-central Mali has been implemented for less than a year, so that data collection and analysis are still in progress and the findings presented here should be considered preliminary.

Yet substantial learning has occurred. Both cases made a strong argument for community participation, capacity building, and incorporation of farmers' own experience as the centerpiece of technology generation and transfer. Rather than a lineal transfer of ready-made technology, we are proposing land management systems that serve as starting points for a dialogue between farmers, technicians, and scientists. In both cases the generation and transfer of technology is being blurred in the experimentation that is occurring at the local level, but how to extend adoption beyond pilot communities remains an open question. In the ACdN case, it essential to move beyond dependence on external technical services towards harnessing the learning and innovations that have occurred as farmers have adapted the technology to a variety of agro-ecological contexts. This may entail trade offs between optimal performance of the technology in limited controlled conditions on the one hand and feasibility at a greater scale and across social strata and consonance with broader household livelihood goals on the other. In the case of the open range rotational grazing, the next step is to identify ways to ensure the continuity and replicability of the NRMAC accomplishments over time and in areas that do not benefit from the external technical and financial support that Madiama has received. In other words, how the efficient and sustainable management of natural resources can help build social capital and create connections within and among communities.

The case studies also demonstrate the importance of institutional factors for meeting the core challenges of sustainability and equity, which ultimately determine the societal impacts of NRM technologies. In absence of attention to these issues, the objectives of increasing productivity, reducing soil erosion, and increasing carbon sequestration may be met, but the overall goal of supporting sustainable communities and environments may fail.

For instance, if the technologies are adopted widely in the communities, they may ease pressure on land resources, by making it possible to intensify production in one area without encroaching into land that is already taken by other users. But at the same time, by intensification may trigger a solidification of tenure claims that could catalyze the eruption of latent tensions and enhance social conflict [sp7]. Rotational grazing may ease pressure by improving pasture quality and quantity but, in the short term, the imposition of regulations may exacerbate boundary conflicts. This underscores the need to move beyond conventional emphasis on technical solutions to improving land management towards approaches that also integrate institutional interventions to help develop local level capacity and frameworks for resolving disputes over rights and rules. It also indicates that research on soil fertility, soil erosion, crop productivity, and biomass change, must be complemented by sustained analyses of the pressures that threaten to erode the social fabric.

The equity challenge is particularly salient for the ACdN technology, since its feasibility is shaped by the household resource endowment, particularly land, labor, and farm equipment (the open-range rotational grazing pasture, on the other hand, is open to local and transient herders regardless of their herd size). It is also a function of a household's and a community's positioning with respect to

access to agricultural credit, inputs, and technical services, market and earning opportunities, and alternative uses of labor. The fragmentation of village-wide associations into smaller, more homogenous, producers groups may accentuate the gap between better-off and resource-poor households in cotton zones. As farmers obtain (and do acknowledge) returns to investments in terms of higher yields and reduced erosion, equity may be better served if returns from carbon trading were invested in community improvements that would benefit all households, including those who do not practice ACdN. This underscores the need for developing appropriate tools and frameworks for collective decision making at the community level, which articulate with the new elected bodies of decentralized governance at Commune level. [KMM8]

In the case of the open range rotational grazing experiment, the equity challenge is less a question of unequal resource endowments of individual household than of power imbalances between wider social units (although these may result in differential advantage for individual users). At this early stage of implementation, the main actual and potential challenges to equitable resource management appear to be the political dominance of Bambara farmers in decentralized governance, the influence of Marka (Bambara) chiefs over the village delegates and monitors, and the expansion of the central Madiama village and its prominent families. The elected status of the NRMAC and its formal recognition as advisor to the Mayor and the Commune Council may counterbalance these imbalances but only up to a point (for it was elected from a pool of delegates appointed by the village chiefs). It remains to be seen how salient social cleavages (i.e. between Marka and Peul villagers, residents and transhumant herders, chiefly and commoner lineages) will play out in shaping access to the controlled pasture and enclosed water resources, particularly in terms of optimal timing of access and quality of the resource (i.e. nutrition potential of pasture at different times, labor requirements associated with different water points). This point to the importance of fostering viable conflict management approaches and arenas as well as facilitating communication across ethnic groups and awareness of the institutional mechanisms protecting the rights of minorities among the latter and among elected officials.

Ultimately, it is essential to recognize that issues of sustainability and equity cannot be simply analyzed in the circumscribed arena of community or Commune boundaries. Interventions at the level of field or village territory cannot be isolated from the broader contexts of landscape ecology and regional economy. For instance, water management (control of water flows and reduction of runoff in the south, and integration of water access into timed open-range grazing in Madiama) emerges as a key component of both technologies, for which resolution may require mobilization and agreements that extend beyond the adoption unit (household or village). The implications of adoptions of technologies, such as ACdN or rotational grazing, by local households and communities must be also assessed in light of the entire range of resources and options that are utilized by agriculturalists and pastoralists in different seasons and in different years. These include the diversity of biophysical endowments (soil types, toposequences, etc.) available to farmers as well as the constellation of livelihood strategies that households can mobilize. The ebb and flow of trade and migration opportunities for communities near major roads or towns and access to education and salaried employment for young people also influence the degree of commitment to improved land management systems. Integration into the market economy and profitability of crop or livestock production are also key dimensions that define the level of incentive for investments in land improvements but that also reflect trends and dynamics in the wider arena of agrarian and development policy. An assessment of the potential for aggregate adoption of land management technologies and of societal implications of community participation in carbon trading must keep in perspective this broader context in which individual and institutional decision makers operate.

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[1] Corresponding author: Sustainable Agriculture and Natural Resource Management CRSP, University of Georgia, 1422 Experiment Station Road, Watkinsville, GA 30677, ph: (706) 769-3792, fx: (706) 769-1471, Email: carlaroncoli@yahoo.com. The opinions expressed in this report are those of the authors and do not reflect the official view of their respective institutions or of the funding agencies.

[2] See for instance the ODAM scheme described in de Bruijn and van Dijk 1995.

[3] These findings draw from: a) Participatory Rural Appraisals in villages of southern Mali (March-April 2002); b) In-depth interviews with representatives of relevant national-level institutions; and c) Review of key published materials and unpublished documents.

[4] ? The average does is 100 kg of NPK and 50 kg of Urea per hectare.

[5] These findings are based on SANREM CRSP research in Madiama from 1999 to date , see http://www.oird.vt.edu/sanremcrsp/sanremcrsp.html

[6] The other villages in the Commune participate in all capacity building activities and in other research activities, including soil fertility trials, small ruminant tethered grazing, and modeling of crop-rainfall interactions.

[7] Sigagourou registered 350mm and Torokoro 382.1mm? (data kindly provided by Omarou Badini, Washington State University).

[8] *Communes* are grouped into *Cercles* (districts), which are grouped into *R? gions*.

[9] Hiring a plow costs 4,000-5,000 CFA for a 4-5 hours day (including the two people who drive the oxen team), in addition to food for the workers.

[10] They are paid about 12,500 CFA/mo. plus room and board. They work for the hosting family six days per week, and have one day off, during which they may do additional day labor.

[11] They earn about 500-1000 CFA for a 4-6 hours day (higher pay and longer hours at times of peak labor demands).

[12] Hiring a plow costs 4,000-5,000 CFA for a 4-5 hours day (including the two people who drive the oxen team), in addition to food for the workers.

[13] For a discussion of this classification, see http://www.sanrem.uga.edu/carbon/htdocs/SiteCharacterization.htm

[14] Sigagourou registered 350mm and Torokoro 382.1mm (data kindly provided by Omarou Badini, Washington State University).

[15] A group of producers can form an APC if they are at least 10 households, have a collective production of at least 30 tons of cotton, have at least 5 literate members in their midst and a clean credit record.

[16] An exception is the Association of the Casier du Syn, that groups a limited number of farmers who produce rice in a perimeter managed by the Office Riz.

[17] But it must be noted that caste and lineage are crucial elements of social solidarity among the Peul, so that it cannot be assumed that Peul committee members equally represent all Peul Commune residents or transhumant herders.

[18] This consensus building methodology was developed by Bob Chadwick, see http://www.holistic-solutions.net/Articles/BuildTrust&Communication.pdf

[19] The conflict management training builds on the consensus building process developed by Bob Chadwick, see http://www.holistic-solutions.net/Articles/BuildTrust&Communication.pdf

[20] An exception is the Association of the Casier du Syn, that groups a limited number of farmers who produce rice in a perimeter managed by the Office Riz.

[21] The default was caused by an inconsistency in approaches to farmers contribution. ACdN were first introduced, in 1997, a Swiss NGO, ADP (*Environnement et D veloppement Paysan*) that intervened in Sougoumba within the framework of the PGRN program, subsidized half of the cost for contour marking. But a couple of years later it withdrew the subsidy, leaving farmers to pay the full amount, which they refused to do

[22] The *Division de la Formation Rurale* of CMDT publishes and distributes local language newspapers, produced in collaboration with the *Direction Nationale Alphab tisation Fonctionelle et Linguistique Appliqu e* (DNAFLA).

[23] The data, collected in February-March 2003 is still being analyzed.