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**Title:** Fifteen years of forest community management in Niger: from a technician's dream to social reality.

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**Abstract:**

Community forestry is based on the premise that local management by a community appropriating the resource on a delimited space guarantees a sustainable management.

In the 1990s, the Niger provides a favorable context for such governance: the great droughts have raised concerns about ecosystems degradation and the forest administration has too little means to ensure the control of forest exploitation. Thus, the Energy II project introduces rural markets (RM). Their aim is to ensure a regular supply in wood energy of urban centers and a sustainable management of forests. Each RM is characterized by fixed points of sale, a delimited "village-forest" and a local structure of management that ensures the sale of wood and the control of exploitation rules.

Fifteen years later, a study of two types of RM in Niger illustrated how villagers have translated the technical rules proposed by the project technicians. Despite different regulations, the practices are quite similar in these two villages. Although woodcutters observe changes in resource quality, they do not respect the technical rules (forest limit, plots, quota ...). They also note an improvement of their living conditions and wish to maintain this activity.

Wood exploitation, as conceived in the framework of RM, constitutes a new practice for farmers. In their actual form, we can estimate that RMs are an effective tool for resource valorization but not yet for sustainable forest management. To reach this ultimate goal, focus should now be on redefining technical rules for them to be more adapted to local conditions and easier to control.

**Key words:** Niger, Community Management, Forest Resource.

## INTRODUCTION

Degradation of tropical forest is a major concern in environmental policies. To face this problem, some southern countries have developed policies of devolution of forest management from state to local stakeholders (Bertrand, *et al.*, 2007, Cuny, *et al.*, 2006, Gautier, *et al.*, 2008). This strategy postulates that local management and an appropriation of forest resource by local stakeholders insure sustainable management. In Niger, during 1980's, state became aware of failure of policies that aim to exclude rural stakeholders from forest. This acknowledgement of failure favored the emergence of community forestry (Bertrand, *et al.*, 2006, Montagne, *et al.*, 2006). Community forestry in Niger resulted in the creation of forest cooperative since 1981, and then the creation of firewood Rural Markets (RM) since 1992. The creation of Rural Markets (RM) aims sustainable management of forest ecosystems and sustainable supplying of towns with firewood. Devolution of forest management rests on acknowledgement of the rural stakeholders' capacities to manage their resources (Montagne, *et al.*, 1997). However, technical rules that local stakeholders have to follow in order to reach the objectives of sustainable management were defined by the forest administration helped by forest experts of projects. These technical rules resulted from ecological and socio-economic studies done during different projects in Niger (Ichaou, 2005, Noppen, *et al.*, 2004, Peltier, 1994, Projet IDA/FAC/CCCE, 1988). In 2010, RMs have been applied for twenty years. With the benefit of hindsight, we can now assess the consequences of these technical and political choices at middle course. Our analysis implied two aspects. First, we assessed if technical rules are applied and respected. Then, we assessed the consequences of practices on sustainable management of forest supplying Rural Markets. Our results could help forest policy makers improve technical rules for more sustainable forest management in the context of Rural Markets.

The RMs of Ñinpelima and Tientiergou are among the first RM created in Niger in 1993. The Project Energy II (PEII, box 1) has come along their creation and defined technical rules to reach sustainable management of harvested forest ecosystems.

### Box 1: The Project Energy II (PEII)

Forest administration in Niger implemented the **Project Energy II** from 1989 to 1998. They were helped by the World Bank and were financed by DANIDA (Danish cooperation). This project aims:

- To organize firewood supplying of Niamey;
- To think and enforce the edict number 92-037 that creates firewood rural markets and that defines a new tax system for firewood trading;
- To bring the conditions of sustainable management of forest ecosystems by the mean of the creation of 200 rural markets.

All these actions would contribute to the implementation of the **Domestic Energy Strategy** in Niger.

## CONTEXT

In Niger, Rural Markets of firewood (RM) have been recognized in 1992 by the edict number 92-037. This edict defines RM as "places where organizations are set up for commercial exploitation of firewood outside big towns". A forest is delimited for each Rural Market. A "*Local Structure of Management*" (LSM) undertakes to sell the wood and to check out woodcutter practices.

### A. Location

The Rural Markets of Ñinpelima and Tientiergou are in the Southwest of Niger, in the rural councils of Torodi and Say respectively, in Say Department, Tillaberi Region (Figure 1).

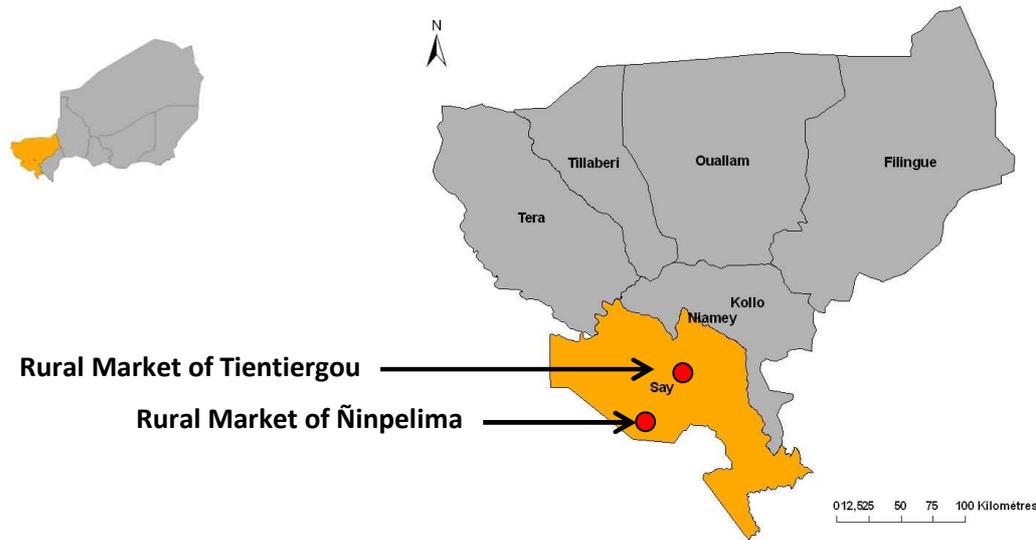


Figure 1 : Rural Markets of Ñinpelima and Tientiergou in Tillaberi Region.

### ***B. Agro-ecological conditions***

In the Southwest of Niger, climate is soudano-sahelian with a long dry season (from October to May) and a short rainy season (from June to September). Landscape alternate plateaus with superficial lateritic soil, valleys with deep ferruginous soil and slopes between plateaus and valleys with sandy soil (Ichaou, 2000). Between 13° and 15° north latitude, vegetation on plateaus is organized in a particular way (Ambouta, 1997). This kind of vegetation, called “tiger bush” is made up of bands covered by dense woody vegetation and bands without woody vegetation. Water runoff on bands without vegetation and it is accumulated on bands with dense vegetation. This process allows vegetation to resist under scarce rain conditions. It is difficult to grow on plateaus as their soil is not deep enough. Therefore, plateaus are either not farmed at all, either they are farmed for a short period. Most of the valleys are farmed. Slopes can be farmed but they need to be lain fallow or to be fertilized.

In the village of Torodi, 50 km north from Ñinpelima, annual rainfall is 588 mm (average rain for 30 years). Annual rainfall in Ñinpelima may be higher than in Torodi. In the area of Ñinpelima, there is a little surface of plateaus. In these latitudes, the “tiger bush” structure in bands tends to attenuate. The structure alternates with vegetated and bared areas but it is not organized in bands (‘speckled bush’; Ambouta, 1997). Most of the valleys are cultivated with sorghum. Some of the fields in valleys are lain fallow during short period (five years maximum). A part of the slopes is cultivated with millet (Montagne, 1997).

In the area of Tientiergou, annual rainfall is 600 mm (average rain for 40 years). There is a large surface of plateau with rare area of slash-and-burn cultivation. The tiger bush is organized in patches (‘spotted bush’; Peltier, *et al.*, 1994).

### ***C. Human conditions***

In the RM of Ñinpelima, the ethnic groups of villagers are *Fulani* and *Gourmantché*. *Gourmantché* people have been in this area for 400 years. Their ancestors came from Bilanga, Burkina Faso. Because of the population growth, this group has expended on 14 villages including Ñinpelima. The 14 villages are under the authority of the same customary chief. The customary chief has the power over land tenure and deals with the collection of state tax. The *Fulani* arrived in this area later. They have their own traditional chief who is in charge of resolving conflicts between farmers and breeders. The *Gourmantché* people are traditionally farmers. They have developed breeding for over 50 years. The *Fulani* are traditionally cattle breeders. They have developed agriculture since they were settled in this place. Before the creation of the RM, some *Gourmantché* men were woodcutters and worked for traders. Since the RM was created, the woodcutters' number has increased. Yet, no of Fulani has become woodcutter.

In the RM of Tientiergou, the ethnic group of villagers is in majority *Fulani*. This group is made up by noblemen called *Fulbe* and by their former slave called *Rimaïbé*. The main activity of *Fulbe* people is breeding whereas the principal activity of *Rimaïbé* people is agriculture. The customary chief exercises his authority for the clearing of the land of Tientiergou. Each chief in this area has identified the land of his village. Before the creation of the RM, some *Rimaïbe* men sold wood along the road to traders. However, woodcutter was seen as a caste profession. With the creation of RM, this sense of the profession disappeared. Accordingly, woodcutters' number has increased, particularly among *Rimaïbé* people. Their enrichment has modified social hierarchy between *Fulbe* and *Rimaïbe*.

#### **D. Technical rules**

The project Energie II has come along the creation of RM. In order to guarantee a sustainable management, project experts established technical rules for wood harvesting. Two types of RM were created ("oriented" and "controlled"); each one of those was characterized by different technical rules.

The Rural Market of Ñinpelima is an "Oriented" RM (ORM). The edict number 92-037 states that RM are "oriented" when "they are supplied by areas delimited but not managed" (Article 10). When the RM of Ñinpelima was created, a forest was delimited and an exploitation quota was fixed. All stakeholders (Forest administration, project, woodcutters, and traders) agree that ORM have to exploit only dead trees, although this rule is not mentioned in legal text.

The RM of Tientiergou is a "Controlled" RM (CRM) which "is supplied by areas delimited and managed". When it was created, a forest was delimited and divided into six plots. Each plot has to be exploited during one year. A quota was fixed for the harvesting of dead and live trees. Woodcutters are allowed to harvest four species (*Combretum glutinosum*, *Combretum micranthum*, *Combretum nigricans* and *Guiera senegalensis*). Forest technicians recommended a minimum diameter cutting limit of 6 cm for *Combretum micranthum* and *Guiera senegalensis* and a minimum diameter cutting limit of 8 cm for *Combretum glutinosum* and *Combretum nigricans* (Peltier, et al., 1995).

## **MATERIALS AND METHODS**

The studies in the two types of RM were compared to assess the effect of different technical rules on effective management. These two RM are among the first in Niger and they allow benefits of insight for such analysis. We collected data in 2009 in the RM of Ñinpelima and in 2007 in the RM of Tientiergou. Both study used vegetation inventories, interviews and observations. The study of the application of technical rules was based on interviews and observations. The study of the effects of practices on vegetation was based on inventories, observations of stocked wood and qualitative assessment by villagers.

### **A. Interviews**

For each study, two series of semi-directive interviews was made. The first one was intended to the officers of forest administration at local and national scale. The second series was intended to villagers.

In Ñinpelima, about 50 interviews were made with villagers. In Tientiergou, about 30 interviews were made.

### **B. Inventories**

In Ñinpelima, the effects of wood harvesting on vegetation were assessed by a comparison between inventories done in harvested and inventories done in non harvested plots. The inventories were made on 18 plots of 100 m<sup>2</sup> (10 X 10 m). Random sampling was guided by soil occupation. Villagers helped us to identify plots which have never been cultivated. Among them, we choose harvested and non harvested plots. We avoided choosing plots in bared areas. We attempted to choose plots in similar ecological formation; the majority was on slopes. For each stem, we noted the species, the height, and the diameter at 20 cm high. All ligneous species were inventoried.

In Tientiergou, the effects of wood exploitation were assessed by a comparison of results of inventories made in 1990 with those made in 2007. The inventories of 2007 were made on 100 plots of 100 m<sup>2</sup> (10 X 10 m). A systematic sampling was made on three tracks located from the road, one kilometer away from one another. On each track, plots are 100 m away one from one another. In each plots, number of stems higher than 4 m was measured, and the species and the diameter at 1.30 m high of those stems whose diameter was bigger than 3 cm. Only harvested species were inventoried (*Combretum glutinosum*, *Combretum micranthum*, *Combretum nigricans* and *Guiera senegalensis*).

## **RESULTS**

### **A. Practices**

#### **1. Space management**

In Ñinpelima, the forest was delimited with the help of the Project Energy II. The RM includes five villages. Woodcutters recognized they do not respect forest limits. They were harvesting in the forest of neighboring RM and woodcutters from neighboring Rural Markets were harvesting in the forest of Ñinpelima RM. When Rural Market was created, they respected limits because dead trees were

abundant. A SLG member said that “*At the beginning, we had not this problem, there was wood everywhere and we do not feel delimitation because we were able to stay in our village*”. The non respect of limits had confronted the SLG managers to a problem since exploitation of live trees had begun. Woodcutters from neighboring RM came to Ñinpelima forest to harvest live trees whereas Ñinpelima’s SLG forbid his woodcutters to cut live trees. When dead trees were finished and live trees harvesting was generalized above all woodcutters, the problem of non respect of limits disappeared. Ñinpelima’s Local Structure of Management (LSM) and neighboring Rural Markets LSM accepted that forest limits were not respected because dead trees were finished and local harvesting practices were the same for all woodcutters. For the managers of Ñinpelima’s LSM, it was obvious that a woodcutter of a neighboring RM was allowed to harvest in their forest if the wood was finished in his forest. They said “*In Mossipaga [a neighboring RM] forest is finished. They are forced to come in our forest.*” With regard to woodcutters from Niamey, LSM members considered that they were not allowed to harvest firewood in their forest. For other uses (leaf, fodder), foreigners were allowed to harvest in the forest of the RM of Ñinpelima.

In Tientiergou, woodcutters said that the limits of forest are respected. However, we could see that there was wood with large diameter at the selling point whereas such wood was finished in their forest.

The division of forest into plots has been introduced only in Tientiergou. Interviews and observations showed that this share out was not respected. Woodcutters were exploiting wood in the whole forest without a turnover.

## 2. Practices of trees harvesting

In both RM, our studies showed that woodcutters were exploiting live trees. They did not make a difference between protected and non protected species. However, in Ñinpelima, woodcutters avoided to harvest species which produces edible fruits (*Vittelaria paradoxa*, *Parkia biglobosa*, *Tamarindus indica*, *Ficus sp*, *Diospiros mespilliformis*). Woodcutters protected these species because they are useful. Observation of wood stacks revealed that these species were just harvested in low quantity. In Tientiergou, these species disappeared from the plateaus.

When the RM was created, Ñinpelima’s and Tintiergou’s woodcutters harvested only dead trees. In Ñinpelima, the beginning of harvesting live trees was said to have started four years ago by woodcutters. They harvested the species that traders asked for. Consumers preferred wood from *Combretum nigricans*. However, this species was in short supply and that favored harvesting of other species. Main was *Combretum micranthum*, *Guiera senegalensis*, *Combretum glutinosum*, *Anogeissus leiocarpus* and *Piliostigma reticulatum*.

The minimum diameter of harvested wood was assessed by interviews and observations of wood stacks. In Ñinpelima, a minimum diameter of three centimeter was revealed by both information sources. In Tientiergou, woodcutters declared a minimum diameter of 6 cm but our observations showed smaller stem. In both RM, woodcutters’ strategy consisted in mixing small with medium wood.

In Ñinpelima, the quota was exceeded mostly each year since 1995 (Figure 2). During the first years, the non respect of quota was decided in agreement with the officers of forest administration. They agreed that dead trees would be destroyed anyways by termites if it was not harvested.

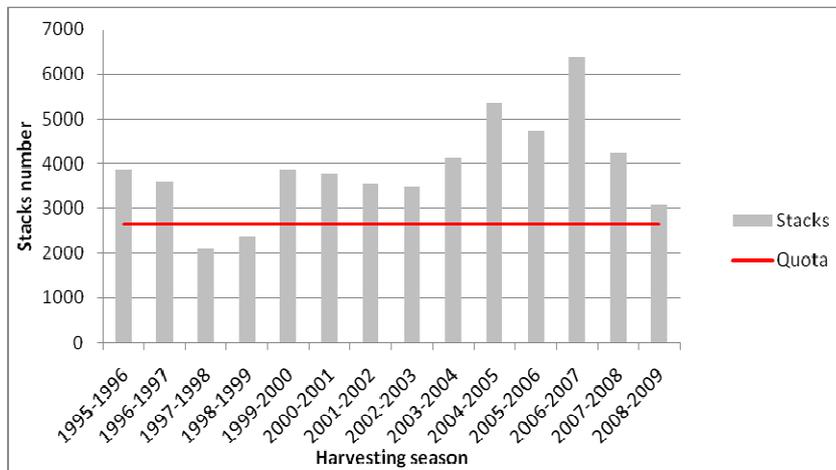


Figure 2: Quota and number of harvested stacks by year in Ñinpelima's RM

## B. Ecological and Socio-economic changes

### 1. Ecological changes

Table 1 shows the results of inventories done in Tientiergou forest.

| Species                           | Stems number<br>3<d<6cm | Stems number<br>6<d<10cm | Stems number<br>d>10 | Total stems<br>number<br>d>3cm |
|-----------------------------------|-------------------------|--------------------------|----------------------|--------------------------------|
| <i>Guiera senegalensis</i>        | 113                     | 36                       | 1                    | 150                            |
| <i>Combretum micranthum</i>       | 350                     | 136                      | 5                    | 491                            |
| <i>Combretum glutinosum</i>       | 5                       | 8                        | 7                    | 20                             |
| <i>Combretum nigricans</i>        | 12                      | 27                       | 5                    | 44                             |
| <b>Total for the four species</b> | <b>480</b>              | <b>207</b>               | <b>18</b>            | <b>705</b>                     |
| Percent of stems with d>3 cm      | ~68%                    | ~29%                     | ~2%                  | 100%                           |
| Dead trees                        | 1                       | 8                        |                      |                                |

Table 1 : Repartition of stems by diameter class and species in Tientiergou forest on 1ha (100 plots of 100 m<sup>2</sup>) (d = diameter at 1.30 meters high)

Table 2 and 3 shows the results of inventories done in Ñinpelima forest in harvested and not harvested plots.

| Species                     | Stems<br>number<br>d<2cm | Stems<br>number<br>2<d<4cm | Stems<br>number<br>4<d<6 cm | Stems<br>number<br>d>6 cm | Total Stems<br>number |
|-----------------------------|--------------------------|----------------------------|-----------------------------|---------------------------|-----------------------|
| <i>Guiera senegalensis</i>  | 176                      | 11                         | 0                           | 0                         | 187                   |
| <i>Combretum micranthum</i> | 54                       | 7                          | 2                           | 0                         | 63                    |
| <i>Combretum nigricans</i>  | 199                      | 42                         | 4                           | 0                         | 245                   |

|                        |            |           |          |          |            |
|------------------------|------------|-----------|----------|----------|------------|
| <b>All species</b>     | <b>493</b> | <b>62</b> | <b>6</b> | <b>1</b> | <b>562</b> |
| Percent of total stems | ~88%       | ~11%      | ~1%      | ~0%      | 100 %      |

**Table 2 : Repartition of stems by diameter class and species in Ñinpelima forest on harvested plots of 100 m<sup>2</sup> (average on 11 plots). (d = diameter at 0.30 meters high)**

| Species                     | Stems number<br>d<2cm | Stems number<br>2<d<4cm | Stems<br>number<br>4<d<6 cm | Stems number<br>d>6 cm | Total Stems<br>number |
|-----------------------------|-----------------------|-------------------------|-----------------------------|------------------------|-----------------------|
| <i>Guiera senegalensis</i>  | 136                   | 9                       | 0                           | 0                      | 145                   |
| <i>Combretum micranthum</i> | 57                    | 24                      | 6                           | 0                      | 87                    |
| <i>Combretum nigricans</i>  | 77                    | 24                      | 10                          | 1                      | 112                   |
| <b>All species</b>          | <b>314</b>            | <b>63</b>               | <b>18</b>                   | <b>2</b>               | <b>397</b>            |
| Percent of total stems      | ~79%                  | ~16%                    | ~5%                         | ~0%                    | 100 %                 |

**Table 3: Repartition of stems by diameter class and species in Ñinpelima forest on non harvested plots of 100 m<sup>2</sup> (average on 7 plots). (d = diameter at 0.30 meters high)**

Ecological changes were also assessed by interviews with villagers. In both RM, woodcutters assessed that wood to harvest was decreasing. The stems they exploited had a diameter shorter and shorter. Moreover, they noticed the difficulty to found wood from *Combretum nigricans*. They assessed that this species had not a well regeneration. Some woodcutters noticed that a tree harvested at the end of dry season would regenerate easier. However, the majority of harvesting was on beginning of dry season because weather is milder. Woodcutters also noticed that dead trees finished (for four years in Ñinpelima).

In Ñinpelima, a lot of woodcutters were worried by the decreasing of wood. “*Bush is finished*” was a frequent sentence in the speech of villagers. All *Fulani* people wanted that harvesting was stopped. *Fulani* people and some *Gourmantché* people noticed the decreasing of woody species used to provide feed for cattles.

The observations of stacks on the selling points in both RM confirmed these results. The majority of stems had a diameter smaller than 8 cm. In Ñinpelima, stems from *Combretum nigricans* had a diameter smaller than 6 cm. The most important species on stacks was *Combretum micranthum* and *Combretum nigricans*.

## 2. Socio-economical changes

In both village, RM provided means by two ways. On the one hand, a part of the taxes collected from wood transport is intended to the Local Structure of Management. On the other hand, wood provided a lot of incomes for woodcutters.

The transport taxes provided means for the LSM, which had financed community investments. In both villages, this money was employed to build schools and wells, and to vaccination campaign. In Ñinpelima, villagers decided to finance a villager garner in order to provide cereals cheaper than in the market during the gap between two harvests.

For woodcutters, the most important change was the improvement of their incomes. According to Ñinpelimas' woodcutters, the price of stacks evolved from 400-600 Fcfa<sup>1</sup>/stacks in 1989 to 1200-2000 Fcfa/stacks since RM was created. Moreover, since RMs were created, all incomes are intended to villagers and no one woodcutter from Niamey came to harvest in their forest. In Tientergou, each woodcutter earned in average 80.000 Fcfa/year and some woodcutters could earn up to 300.000 Fcfa/year. In Ñinpelima, one woodcutter could earn up to 400.000 Fcfa/year. In Ñinpelima, the first use of wood incomes cited by woodcutters was the marriage. Incomes were employed by men to finance their own marriage (dowry for the wife family may reach up to 400.000 Fcfa) or to contribute to friends or family marriage (minimum contribution of 5000 Fcfa). The second use of wood incomes cited by woodcutters was the cereals. Before RM was created, they were obliged to sell sheep or cattle when the harvests were not sufficient for supplying the family during all the year. Since RM was created, when the harvests were not sufficient, they sold wood. The last uses of wood incomes cited by woodcutters were the purchase of stockers and the purchase of cycle or motorbike. Moreover, in both villages, since RM were created, a lot of new economic activities was developed (store, motorbike selling, cycle fixer). These incomes benefited particularly the men in both RM and particularly the *Gourmantché* men in Ñinpelima. In Tientergou, 43% of the women thought their incomes had not increase. In Ñinpelima, a lot of women did not feel that RM improved their life conditions. They said that *"For women, there is not change since RM was created."* The majority of *Fulbe* (men and women) felt only negative consequences of the creation of RMs.

Although woodcutters saw an improvement of economical conditions, they were worried by the decrease of their harvesting activity. In Ñinpelima, they noticed that the diameter of the majority of the stems they sold evolved from 8-10 cm when RM was created to 3-6 cm in 2009. Some *Gourmantché* men got involved in others activities (truck farming, breeding) to face the decrease of woodcutter's activity.

## DISCUSSION

Community forest management postulates that sustainable management follows the appropriation of natural resource. In Niger, the process of devolution of forest management was followed by the identification of technical rules by forest technicians. These technical rules set a harvesting dynamic in a space that already has its own dynamic, with a specific property rights and a spatial organization. Effective management of Rural Markets results from the interactions between these two dynamics and it may be sustainable or not.

In this section, we first describe how technical rules were transformed into effective management in order to judge whether they will ensure sustainability. Then, we analyze the consequences of effective management for ecological and socio-economic dynamics to assess the relevance of RM for sustainable management.

### ***A. A gap between the technical rules and the effective management***

In Ñinpelima and Tientergou Rural Markets, although the technical rules differ, the wood harvesting practices are quite similar.

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<sup>1</sup> 1000 Fcfa ≈ 1,5 € ≈ 2 \$ USD

## 1. Non respect of limits and resource appropriation

In the context of RMs, the state allocates a delimited forest to the Local Structure of Management (LSM). This is intended to ensure the appropriation of forest resources. In Tientiergou, woodcutters may recognize the limits but the contradictions between the responses we obtained in the interviews we conducted and what we observed in the forest limits our ability to draw conclusions. In Ñinpelima, it is obvious that woodcutters do not recognize forest limits. One possible explanation is that the RM forest is located in a larger space which is controlled by one traditional chief. This space includes 7 RMs whose woodcutters and LSM managers come from the same family and share the same cultivation area. Since the creation of forest cooperatives in Niger, project experts have regularly brought up the problem of delimitation. For the cooperatives, the limits of the forests were defined by forest technicians and were based on the surface area of the forest massif. The forest covered a very large area. For example, Faïra forest, where a cooperative was created in 1988, had a surface area of 8,020 ha (Projet IDA/FAC/CCCE, 1988). Assessment by the Energy II Project revealed three major problems. First, the number of villages within the cooperative reduced social cohesion and favored conflict between villages. Secondly, the distance between the villages and the plots to be harvested undermined the woodcutters' desire to harvest and increased the cost of plot supervision. Finally, villagers were not involved in the identification of the limits defined and, as a result, they did not recognize them. In order to overcome these problems, in RMs, forest technicians chose to define the forest limits in collaboration with the villagers and to base the limits on the "zone of villagers influence" (Peltier, *et al.*, 1994). Forest areas for RMs are thus less extensive and are based on natural limits recognized by the woodcutters.

The change in the identification of forest limits did not apply in Ninpelima RM. The same result was observed in other RMs belonging to Torodi rural council (Oumarou, 2007). Does the lack of recognition of forest limits imply that villagers do not appropriate forest resources within these limits?

This question requires first defining what appropriation means. The term refers to property. Control theory defines five rights linked with property (Le Roy, *et al.*, 1996): right of access, right of withdrawal, right of management, right of exclusion and right of alienation. With the creation of Rural Markets, the state gave LSM members exclusive rights to harvest firewood in their forest (Article 11 of the edict number 92-037). The right of exclusion was applied *de facto* to woodcutters from Niamey. Since this RM was created, woodcutters from Niamey have no longer come to this forest to harvest. However, the right of exclusion was not applied to woodcutters from neighboring RMs. For these stakeholders, not respecting the limits of the forest was acceptable provided the practices were the same for all woodcutters. For other forest resources, the exclusion right was not applied. In spite of fact that the right of exclusion did not apply to all stakeholders and did not concern all forest resources, members of LSM delivered rights to stakeholders they themselves selected. These results suggest that there is a form of appropriation of forest resources. However, further studies should be conducted in several RM to state such analysis.

## 2. The need of division into plots

From a technical point of view, the division of forest into plots has three major advantages. First, the pressure of harvesting is spread out over the whole forest. Second, ecological monitoring is easier. Third, control is also easier for forest administration officers and also for the villagers (Peltier, *et al.*,

1995). For these reasons, some authors consider that “controlled” RMs are better than “oriented” RMs (Djibo, *et al.*, 1997).

However, in our study area, practices are in fact the same in the two types of RM. Forest technicians have been discussing the question of plots in forest management for several years. In Faïra cooperative forest management plan, forest technicians identified fifteen 530 ha plots with a five-year turnover. Lack of knowledge on the annual growth of harvested species justified this turnover (Projet IDA/FAC/CCCE, 1988). In the forest management plan of RM, with the decrease in total forest area, the number of plots was also reduced. This reduction was justified by the difficulty involving in identifying the limits of the plot and by the woodcutter’s harvesting practices which consists in only cutting stems that have reached harvesting diameter. This method allows a plot to be harvested more often than with a clear cutting method. The assessment of this theory in experimental conditions showed that six years are sufficient to regenerate a forest selectively harvested in this way (Ichaou, 2000). As a result, in Tientiergou, the forest management plan defined six plots with a 6-years turnover. However, a later study showed that in a context of limited control, a 6-year turnover leads to a decrease in the diameter of the trees harvested (Ichaou, 2005). The author suggested extending the turnover to 9 years. He also suggested a turnover on three plots each harvested for a period of three year in order to avoid increasing number of plots.

These thoughts deal with plots number and turnover. Woodcutters’ constraints were integrated with the decrease of plots. However, division into plots, whatever the plots number, follows a space organization which is very different from the one of villagers (Karsenty, Marie, 1998, Rossi, 1998). With a limited control by forest administration, it is difficult to achieve this rule. Aiming to tackle these difficulties, we examined the need of forest division into plots in order to ensure sustainable management.

In a hypothetical case where rules are achieved, we affirm that plots and quota are redundant rules. We imagine two types of management plans. The first one is characterized by a minimum diameter of cutting and an annual harvesting quota. During the first year, woodcutters will harvest in priority trees around the village. When annual quota will be finished, they will stop harvesting. During the second year, woodcutters will harvest trees in another area. Vegetation around the village will regenerate until stems will reach the minimum diameter cutting. The second management plan is characterized by a minimum diameter of cutting and a division of forest into six plots. During the first year, woodcutters will harvest in plot 1. When stems with minimum diameter will be finished, they will stop harvesting. During the second year, woodcutters will harvest in plot 2. Vegetation in plot 1 will regenerate for six years. Quantitative limit of harvested wood to ensure regeneration is given by stacks number in the first case (quota) and by space restriction in the second case (plots). In each type of management plan, woodcutters are obliged to let forest areas without harvesting to allow the regeneration of stems. The choice of the type of management plan will depend on the capacity to control the achievement of technical rules. In Niger, forest administration has very few means for harvesting control. The control of plots needs heavy means to travel all over field. The control of quota and minimum diameter of cutting can be done at the selling point or along the road. Accordingly, we consider that division into plots is not necessary in the context of RMs. This solution of management plan without plots was proposed by project experts when RMs were created but it was not followed (Mazoyer, 1992). Fifteen years later, different studies showed the turnover on plots is not achieved. This observation allows forest experts to think up new technical rules for RM. In a

recent project, they proposed a kind of management without plots called “harvesting with a unique possibility” (Ichaou, 2009). It consists in harvesting a delimited forest during 9 years following a one-way. This rule may be easier to achieve for woodcutters. However, this rule still defining a space organization (one-way) which may be too restrictive for villagers. With only quota and minimum diameter of cutting, harvesting will be divided out the space and organized according to the moving choice of woodcutters. The objective of vegetation regeneration will be achieved even so plots of regeneration are not put together in a geometrical structure.

### **B. Sustainable management**

The Ministerial Conference on the Protection of Forests in Europe defines sustainable management of forest as “the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems”. This definition implies an ecological and an economical sustainability. In Rural Markets, the principal function searched is the production of firewood supplying towns. A lot of studies were conducted in Niger to define management plans which allows a good regeneration of forest (ecological sustainability) and a constant production of wood which quality (species, diameter) is appreciated on the market (economical sustainability). The application of these technical rules will ensure a sustainable management. However, the reverse is not true. The implementation of technical rules is only one indicator of sustainable management. Our assessment of the consequences of effective management showed that this management is ecologically sustainable but it may not be economically sustainable.

#### 1. The forest is regenerating

In both RM studied, wood harvesting changes the structure of harvested forests.

Inventories and woodcutters interviews showed that dead trees finished. In both cases, dead trees were harvested in priority. In Tientiergou, although live trees harvesting was allowed, traders preferred buy dead trees. The abundance of dead trees when RMs were created may be the result of the droughts of 1974 and 1984. The vegetated area of tiger bush had reduced and provided a lot of dead trees. Since 1990, the pluviometry is more favorable and mortality could decrease.

For the whole live species, the diameter of stems is smaller after harvesting. In Tientiergou, other inventories were made in 1990 (Peltier, *et al.*, 1994). The inventories methods were lightly different than those of the inventories done in 2007. Only stems that presents diameter bigger than 4 cm on the ground were measured. We may consider that diameter 4 cm on the ground corresponded to 3 cm at 1.30 meter. In 1990, stems number that diameter is bigger than 4 cm was 920/ha (Peltier, *et al.*, 1994). In 2007, stems number that diameter is bigger than 3 cm was 705/ha. Although methods were different, we may conclude that the diameter of stems has decreased since the creation of RM. To confirm these results, inventories should be done using the method of 1990s inventories. In Ñinpelima, the comparison between harvested and non harvested plots showed that stems diameter was smaller in harvested plots. These results should be confirmed by increasing the sample. In spite of the limitations of these inventories, woodcutters’ perception confirmed that the diameter of stems was decreasing.

Among all species, we analyzed in particular *Combretum nigricans*, which is the most harvested species. In Ñinpelima, the part of stems of *Combretum nigricans* that diameter is smaller than 2 cm is of 81% in non harvested plots and of 69% in harvested plots. We may explain this difference by two factors. In one part, stems that have a large diameter were harvested. In other part, *Combretum nigricans* produces a high number of stool shoot after harvesting. Woodcutters noticed also that *Combretum nigricans* was the most impacted by harvesting. Apart from this species is the most harvested, it as difficulties to regenerate. In 1998, regeneration capacities after harvesting were assessed in Tientiergou (Giraud, 1998). The mortality rate of stems was 16% for whole species as against 31% for *Combretum nigricans*.

Although harvesting modifies forest structure, inventories showed that the dynamic of forest was provided. The vegetation regenerated as well as species harvested a lot as *Combretum nigricans*. Assessment of ecological sustainability depends on the conception of functioning of forest ecosystems. In ecology, perturbation theory cast doubt on approaches based on equilibrium concept (climax). The dynamic approach focuses on the resilience of ecosystems i.e. "their capacity to absorb shocks while maintaining function perturbations" (Folke, *et al.*, 2002).

Although harvesting is higher than previous by management plans, forest dynamic may be provided thanks to 'tiger bush' resilience (Peltier, *et al.*, 1994, Tongway, *et al.*, 2001). One explanation may be the capacity of soudano-sahelian species to regenerate by vegetative propagation (Bellefontaine, 1997).

## 2. For the time, economical conditions are improved

The creation of RMs has resulted in a real improvement of the life conditions of villagers in Ñinpelima and Tientiergou. Since traders and woodcutters from Niamey did not harvest in the forest of the villages, we observed a transfer of financial resources from towns to rural areas. The improvement of life conditions in rural areas is a major success of the process of devolution of forest management in Niger. This result was observed in several studies (Noppen, *et al.*, 2004; Oumarou, 2007). In this climatic area, farmers are subjected to climatic hazards. Years characterized by low harvests are frequents. Incomes from wood harvesting allow woodcutters and their family to face with famine during these years.

However, the decrease of the diameter of harvested stems suggests that the effective management conducted in the RMs of Ñinpelima and Tientiergou will not be economically sustainable. Although harvested species are able to regenerate following harvesting, they can not produce stems that have the most appreciated diameter. In a near future, traders would modify their area of purchase. In the Northwest of Torodi rural council, some RMs, which are farther than the road, still have a high quantity of trees from *Combretum nigricans* with large diameter. This area is under-harvested whereas the area of Ñinpelima is over-harvested (Projet Gesforcom, 2007). This observation brings up the question of scale of sustainability. At the scale of the rural council, the production of firewood is sustainable. At the scale of the RM, it may be not sustainable. In addition to studies at the scale of RM, further studies about the changes in purchase area of traders could allow a better analysis of the variation of sustainability between scales.

## CONCLUSION

Technical rules were defined by forest technicians in order to allow a sustainable management of the forest of the Rural Markets. Since RMs were created, forest technicians have modified some technical rules in order to take in account local practices. However, our study showed that these technical rules do not apply in two types of RMs in Niger. This can be explained by the difference between forest technicians' and villagers' perception of the organisation of space.

Forest regeneration in Niger is actually not affected by local practices but the quality of firewood sold on the market has decreased. Ecologically speaking, we conclude that local practices are sustainable in a dynamic approach, even if they do not respect defined technical rules. Economically speaking, such practices are not sustainable at the scale of RM.

To ensure sustainable management, we recommend modifying the technical rules to make them more adapted to woodcutters' practices and easier for forest administration to control.

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