Flora et Vegetatio Sudano-Sambesica 11, 17-24 Frankfurt, December 2008

Impact of Protected Areas and Land Use on Regeneration of *Acacia* Woodland's in Eastern Burkina Faso

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Reçu: 01.10.2007; accepted: 01.03.2008

Summary: Regeneration success, persistence strategies (seedlings vs. coppicing), and population trend of *Acacia* spp. were tested under two land-use regimes in eastern Burkina Faso: (i) protected areas shielded to livestock grazing pressure, to logging, and using early annual fire as a management system; (ii) areas with high human impact (heavily and extensive livestock grazing, harvesting for wood and for medicinal plants).

Generally, a good regeneration rate of *Acacia* species was observed in protected areas and a poor regeneration rate in areas with high human impact. Nevertheless, some species affiliated to the subgenus *Aculeiferum* as *A. dudgeoni* and *A. polyacantha* showed a good regeneration under both land use regimes. Juvenile plants less than 25 cm height of *A. dudgeoni* and *A. gourmaensis* increased by 116 to 50 % in areas with human impact as compared to their populations in protected areas. With SCD slopes varying from –0.40 to -0.70, the protected *Acacia* woodland displayed a stable population structure due to abundance of recruitment, and coppicing persistence (more common in the subgenus *Aculeiferum*) favoured by early annual fire. Consequently, the protected areas are favourable for *Acacia* woodland regeneration. Conversely, SCD slopes are positive or close to zero in areas of anthropogenic regime and showed a declining population, especially more marked with the subgenus *Acacia* due to permanent seed and seedling removal by livestock grazing. Nevertheless, the number of seedlings of some species was higher in areas under human pressure than in protected areas, especially for the subgenus *Aculeiferum*, improving the genetic variability and thus the long-term maintenance of the population.

Key words: *Acacia*, early fire, land use, sudano-sahelien zone

L'impact des aires protégées et des utilisations anthropogènes du sol sur la regeneration des terrains boisés à *Acacia* dans l'est du Burkina Faso

Rèsumè: Le statut de la régénération, les stratégies de persistance et la dynamique des *Acacia* spp. ont été évalués suivant deux modes d'utilisation dans la région est du Burkina Faso: (i) les zones protégées soustraites du pâturage extensif et de la coupe du bois, mais sont parcourues annuellement par des feux précoces ; (ii) les zones à forte impact anthropique (fort pâturage extensif, exploitations humaines diverses).

En général, les zones protégées montrent un taux de régénération élevé des *Acacia* spp. alors que les zones anthropogéniques présentent une faible régénération. Néanmoins, certaines espèces affiliées au sous genre Aculeiferum comme *A. dudgeoni* et *A. polyacantha* montrent une bonne régénération dans les deux modes d'utilisation des terres. La population juvénile de moins de 25 cm de hauteur des espèces tel que *A. dudgeoni* et *A. gourmaensis* est 116 à 50 % plus élevée dans les zones anthropisées que dans les zones protégées. Avec des pentes de régression variant entre -0.40 à -0.70 dans les zones protégées, les populations présentent une structure stable due à l'abondance des plantules, et des rejets de souches maintenues par les feux précoces (plus fréquent dans le sous genre Aculeiferum). Par conséquent, les zones protégées sont plus favorables à la régénération des formations d'*Acacia*. A l'opposé, les pentes de régression sont positives ou proche de 0 dans les zones anthropisées montrant des populations peu stables particulièrement pour le sous genre *Acacia* à cause du prélèvement des semences et des plantules due au pâturage extensif. Néanmoins, les plantules issues de la germination de certaines espèces du sous *Aculeiferum* sont plus nombreuses dans les zones anthropisées que dans les zones protégées et pourraient améliorer la variabilité génétique pour la conservation à long termes des peuplements.

Key words: *Acacia*, feux précoces, pâturage, utilisation des terres, zone soudano-sahélienne

1 Introduction

Acacia woodlands represent one of the most widespread vegetation types of dryland ecosystems. In the sahelian region of West Africa, *Acacia* species often predominate (Wittig et al. 2004). These forest resources have a great ecological and economic importance in agro-ecosystems of arid and semi-arid land (Wickens et al. 1995, Vassal et al. 1998, Wiegand et al. 2000). These areas are characterized by their instability, exhibiting non-equilibrium dynamics due to several factors such as irregular rainfall and human disturbance including grazing pressure (Wiegand & Jeltsch 2000). Many studies in these areas (Akpo & Grouzis 1996, Lykke 1998) showed that human impact is a determinant factor in vegetation dynamics. If *Acacia* woodland seemed to be resilient in dryland ecosystems, many authors (Mwalyosi 1990, Ward & Rhoner 1997) demonstrated that population structure is instable in some area. More?ver like other forest resources, it is sensitive to overexploitation and mismanagement (Argaw et al. 1999). Heavy and extensive grazing as well as selective human logging throughout the year characterize the anthropogenic areas. In contrast, under still growing human impact natural forest reserves (protected areas) were designed to preserve in situ species diversity. The Convention on Biological Diversity encourages management and special measures to be taken for biodiversity conservation in protected areas. In Eastern Burkina Faso, these hotspots of biological diversity are shielded from land pressure and are distinguished by low to moderate wild grazing, and by annual early fire as a management system.

According to many authors (Barnes 2001a, Midgley & Bond 2001), herbivory grazing and fire represent controversly factors acting on *Acacia* woodland dynamics. The seed dispersal modes of some *Acacia* species (zoochory) illustrate the important role of herbivory in regeneration of *Acacia* species, particularly on sexual reproduction. If this reproduction mode contributes to improve genetic species variability over vegetative propagation, grazing could prevent the further growth of seedlings caused by the browsing effect. According to Vellend et al. (2006), herbivory simultaneously enhances plant migration rate via seed dispersal, and decreases it via a negative effect on population growth. The fire effect on regeneration tends to increase vegetative reproduction relative to sexual reproduction of species and limited input of genetic variation (Hoffmann 1998, Setterfield 2002).

In connection with these considerations, diversity conservation of *Acacia* species requires prospective evaluation of their regeneration under the two-land use regime widely spread in the sudano-sahelien zone. Accordingly, we have tested three main factors: regeneration success, persistence strategies of species and population dynamics. The following questions are discussed: (i) Are protected areas more improving regeneration success and population stability than areas with high human impact? (ii) Are the regeneration persistence strategies of species different under the different land-use regimes? (iii) Could taxonomic differences of *Acacia* species help to explain the regeneration persistence and strategy following these land use regimes?

2 Sites

Following a climatic gradient, the selected sites are located in the Subsahelian, the northern Sudanian and the southern Sudanian sectors, according to the phytogeographical classification of Fontes & Guinko (1995). In this area, the annual rainfall ranges from 500 to 900 mm. The distribution of *Acacia* woodland selected in this study is illustrated in Figure 1.

Acacia woodland typology is distinguished by six dominants species located in Cambisol and Vertisol: The subgenus *Aculeiferum* is represented by A. dudgeoni Craib ex Hall. , *A. gourmaensis* A.Chev., *A. laeta* R. Br ex Benth, *A. polyacantha* Willd., and the subgenus *Acacia* by *A. hockii* De Wild., *A. seyal* Del.

Wind and herbivories realize the seed dispersal for the subgenus *Acacia*, whereas wind represents the single dispersal agent for the species belonging to the subgenus *Aculeiferum* (Vassal 1998, Danthu et al. 2003). According to Arbonnier (2000), fruits and leaves of these species gladly eaten by goat and sheep (leaves only for *A. polyacantha*) as well as by cattle for *A. laeta* and *A. seyal*.

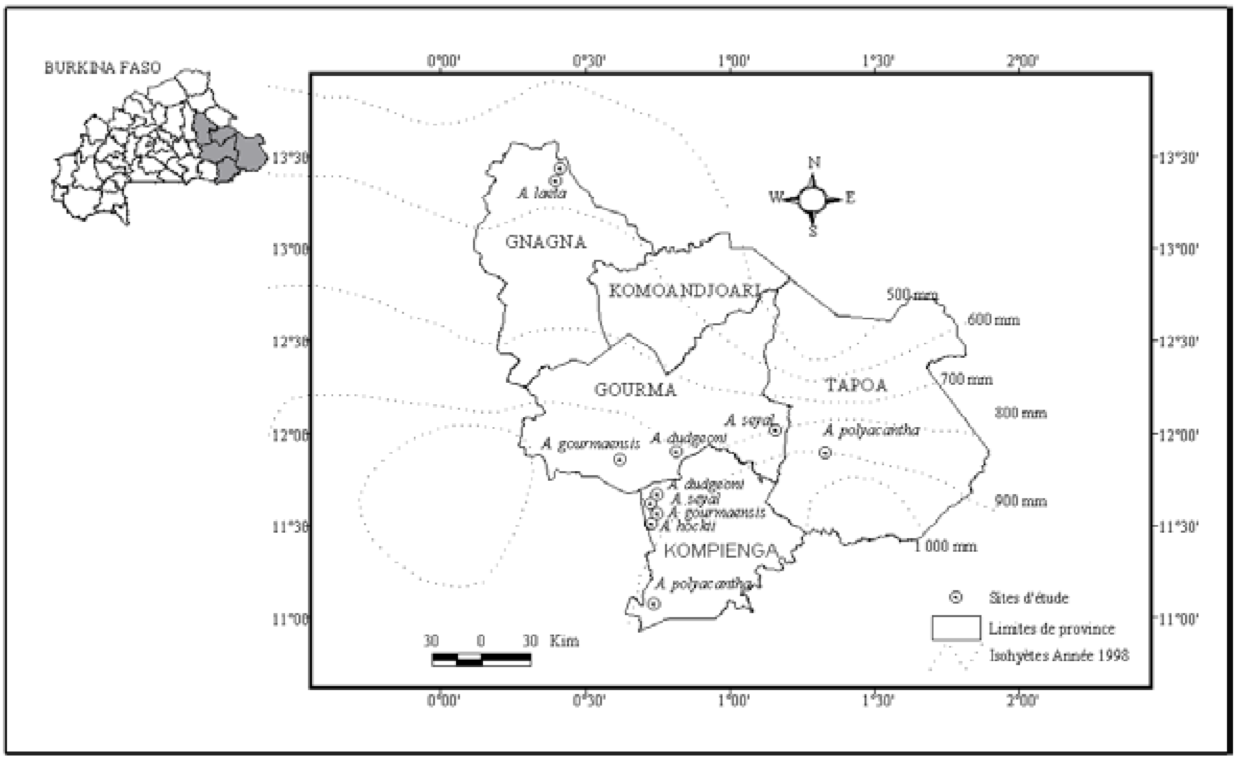

Figure 1: Location of the sites in eastern Burkina Faso
Figure 1: Localisation des sites à l'est du Burkina Faso

The protected area is characterized by the absence of land pressure during the last 15 years (natural vegetation, old fallows) and by early annual fire as a management tool. High-intensity and extensive livestock grazing mainly by goat, sheep, cattle and selective human logging (medicinal use and fuelwood) for the last tens years define the anthropisized area.

The selected sites of *Acacia* woodlands represented in both land-use regimes have mature plant densities greater than 30 individuals/ha. These sites present the similar soil and climate typology under the two land-use regime. Table 1 presents the biophysical characteristics of the sites.

3 Methods

3.1 Sampling and inventory

Regeneration inventory was conducted during the first months of the rainy season (June, July). In each Acacia woodland, the sampling method was based on a random stratified design with each main plot (representing each land use regime) containing twenty subplots (10 m x 10 m), randomly selected. The height measures, more sensitive to grazing impact, were recorded instead of diameter measures (Wiegand & Jeltsch 2000).

In each plot, the height measures for regeneration and mature plants were recorded. Individuals with height less than two meters were classified as regeneration plants grouping in juvenile plants (less than 50 cm height) and saplings (more than 50 cm height). Mature plants were those individuals greater than two meters in height. With juvenile plants less than 50 cm high, the regeneration modes distinguished seedlings originating from germination versus coppicing originating from vegetative propagation. When the regeneration mode was difficult to determine, the individuals were not classified.

3.2 Data analysis

Pearson correlation was used to evaluate the relationship between mature and regeneration plants under the two land use regimes as well as between the two methods used to determine population dynamics.

The regeneration status was assessed through plant renewal rates (R/M) determined by the ratio between the numbers of mature (M) and regeneration plants (R). These rates are ranked in three classes: (i) $R/M < 0.5$ expressed a very poor plant renewal, (ii) $0.5<R/M< 1$ indicated a poor plant renewal, and (iii) $R/M >1$ expressed a good plant renewal. In addition, a one-way ANOVA test with LSD model was used to compare regeneration status between the land use regimes. Significance level was expressed at $P< 0.01$ and $P<0.05$

The dynamic pattern of *Acacia* woodlands in both land use regimes was categorized by the analysis of size class distributions (SCD) proposed by Condit et al. (1998). Eight classes of distribution were used between 0 and 1300 cm (with the following intervals: 0-50, 50-100, 100-200, 200-300, 300-500, 500-700, 700-1000, 1000-1300 cm). Square linear regression was calculated with size class midpoint (hi) as the independent variable and the average number of individual in that class (Ni) as the dependant variable. The size class variable was logarithmically-transformed (ln), and the average number of individuals was transformed by ln (Ni+1) because some classes had zero individuals. SCD slopes were used as an indicator of population structure and their interpretation was based on the type of SCD described by Everard et al. (1995) and Lykke (1998).

Table 1: Characteristics of the selected sites in eastern Burkina Faso
Tableau 1: Caractéristiques des sites sélectionnés dans l'est du Burkina Faso

Woodland sites	Land use regime	Annual rainfall (mm)	Soil type (FAO; 1998)	Grasses cover (min-max %)
A. dudgeoni	- Protected areas	800-900	-Skeletic-Cambisol	40-80
	- Anthropogenic areas	800-900	-Skeletic-Cambisol	30-50
A. gourmaensis	- Protected areas	800-900	-Vertic-Cambisol	40-70
	- Anthropogenic areas	800-900	- Vertic-Cambisol	40-50
A. hockii	- Protected areas	800-900	-Eutric-Vertisol	70-90
	- Anthropogenic areas	800-900	-Eutric-Vertisol	30-70
A. laeta	- Protected areas	500-600	-Lithic-Leptosol	50-70
	- Anthropogenic areas	800-900	-Vertic-Cambisol	30-40
A. polyacantha	- Protected areas	900-1000	--Eutric-Vertisol	60-70
	- Anthropogenic areas	900-1000	- Eutric-Vertisol	30-40
A. seyal	- Protected areas	800-900	-Gleyic-Cambisol	70-80
	- Anthropogenic areas	800-900	-Gleyic-cambisol	30-60

4 Results

The regeneration status of *Acacia* woodlands showed a significant variability of regeneration status dependent on species phylogeny and land-use regime. A strong, significant correlation was established between regeneration and mature plants only in protected areas (r2 =0.70). In anthropogenic areas, regeneration plants were not correlated to mature plant densities (r2 =0.02). Highest regeneration under anthropogenic regime occurred in sites with mature plant densities less than 100 individuals/ha. In this regime, the regeneration is not proportional to the density of canopy individuals (mature plants).

Table 2 shows the regeneration variability under the two land-use regimes. Except for *A. polyacantha* and *A. dudgeoni*, the regeneration of *Acacia* species was considerably reduced in anthropisized areas.

Plants renewal rates in *Acacia* woodlands ranged from 1.16 to 3.00 in protected areas and from 0.37 to 1.60 in anthropogenic areas (Table 2). These values demonstrated a good renewal rate of Acacia species (R/M>1) in protected areas regime. *A. seyal* and *A. gourmaensis* showed a strong renewal rate in this land use regime. In anthropisized areas, *Acacia* species showed a poor renewal rate (R/M<1) except for *A. polyacantha* and *A. dudgeoni*, which still showed a good renewal rate (R/M>1).

The comparison of *Acacia* species' regeneration between land use systems by distribution classes suggests that land-use intensity has an influence on all distribution classes. The most sensitive to anthropogenic impacts concerned the lowest classes of regeneration (Tables 3 and 4). For the juvenile plants less than 25 cm in height, *A. dudgeoni* and *A. gourmaensis* regeneration increased by 116 to 50 % in anthropogenic areas compared to their populations in the protected areas. However, the regeneration of *A. hockii*, *A. laeta* and *A. seyal* was almost equal in anthropisized and protected areas. In the 25-50 cm height classes, the frequency of juvenile's plants decreased significantly by 80 to 99 % in anthropogenic areas (except *A. polyacantha*) as compared to protected areas.

As the lowest height classes of juvenile plants, saplings showed a higher regeneration regression in the anthropisized areas compared to protected areas. The number of saplings of *A. dudgeoni*, *A. gourmaensis*, *A. hockii*, and *A. laeta* between 50 and 150 cm height decreased significantly from protected areas to anthropisized areas. The number of saplings was reduced by 60 to 100% for 50-100 cm and 100-150 cm height classes, and by 60 to 80% for 150-200 cm height class. Then, the juvenile plants (less than 50 cm heights) were more affected by land use intensity than saplings. *A. laeta*, *A. polyacantha*, and *A. seyal* saplings did not vary significantly between the two land use regimes (Table 3).

The regeneration mode was influenced by land use regimes (Fig. 2). Coppicing represented the predominant form of regeneration for *A. laeta* in both land use systems. This persistence form increased in protected areas and became predominant (more than 50%) for the subgenus *Aculeiferum* (*A. dudgeoni*, *A. gourmaensis*, *A. polyacantha*). Conversely, seedlings were a dominant regeneration form in anthropisized areas for *Acacia* species (except *A. laeta*). The seed germination represented more than 75 % of juvenile plants for species as *A. dudgeoni*, *A. gourmaenis*, *A. hockii*, *A. seyal*.

The dynamic pattern of *Acacia* woodland was different under the two land use regimes (Fig. 3). The regression coefficient of SCD was high (r2>50) and the slopes are strongly negative in the protected areas (Table 5). Except *A. polyacantha* and *A. dudgeoni*, the slope of SCD under anthropogenic regime was close to zero. Only the *A. hockii* woodland showed a positive slope under anthropogenic land-use. Based on slope value and regression coefficient, *Acacia* woodland in the protected areas displayed inverse J distribution and had SCD slopes between –0.40 and –0. 70. The high SCD slope value of *Acacia* species in the protected areas regime were a consequence of the abundance of juvenile

Table 2: Regeneration and status of the mature plants of *Acacia* spp. under two land use regime. Mean ± 95 % confidence interval (n=20)

Tableau 2: Statut de la régénération et des individus adultes des formations des *Acacia* spp. entre les deux modes d'utilisation des terres. Moyenne ± 95 % de l'intervalle de confiance (n=20)

Woodlands	Protected areas			Anthropisized areas		
	Regeneration (R)	Mature (M)	Ratio (R/M)	Regeneration (R)	Mature (M)	Ratio (R/M)
A. dudgeoni	11.88±2.55	8.00±2.1	1.48	10.74±2.1	6.70±1.37	1.60
A. gourmaensis	8.50±1.45	2.83±0.43	3.00	2.05±1.42	4.70±0.55	0.44
A. hockii	24.47± 3.71	21.07±2.65	1.16	4.33±0.95	11.83±1.60	0.37
A. laeta	7.00±2.39	4.83±1.8	1.44	2.20±2.00	4.00±1.24	0.55
A. polyacantha	6.11±1.35	4.89±0.98	1.25	6.38±2.02	5.31±1.12	1.20
A. seyal	7.53±1.66	3.27±0.77	2.30	1.63±0.44	3.25±0.39	0.50

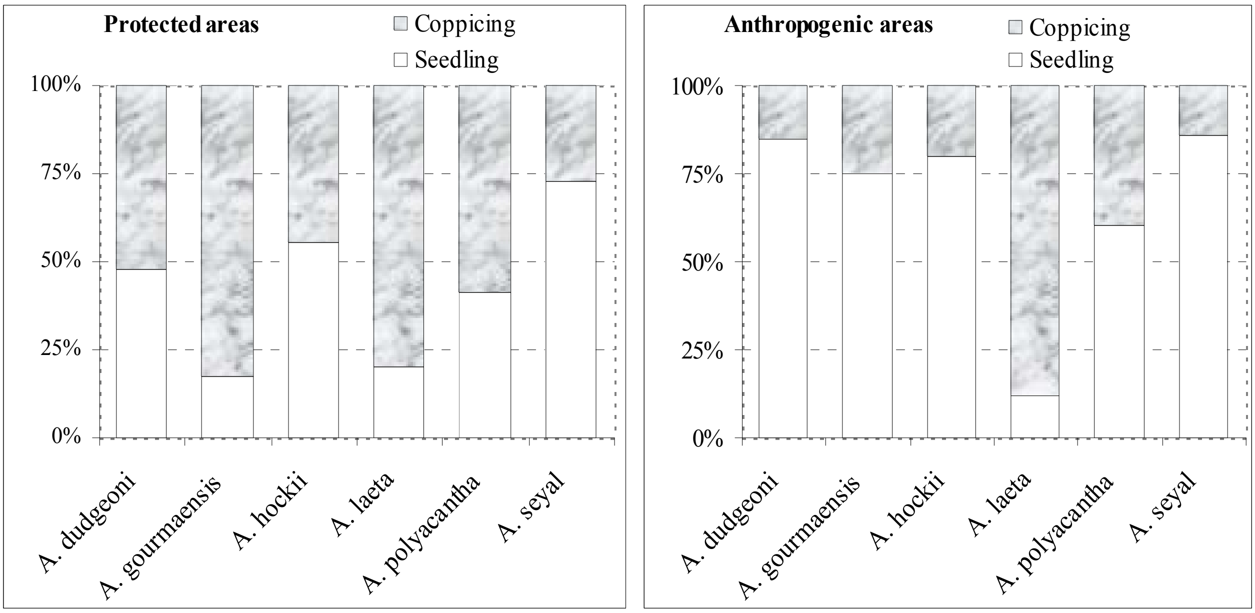

Figure 2: Comparison of the regeneration mode of *Acacia* spp. in protected and anthropisized areas
Figure 2: Comparaison des modes de régénérations des *Acacia* spp. dans les zones protégées et anthropisées

Table 3: Status of the juvenile plants (height less than 50 cm) of *Acacia* spp. in protected and anthropisized areas. Mean ± 95 % confidence interval (n=20)

Tableau 3: Statut des plantes juvéniles (classe de hauteur inférieure à 50 cm) des *Acacia* spp. entre les zones protégées et anthropisées. Moyenne ± 95 % de l'intervalle de confiance

Woodlands	height (cm)	Protected areas	Anthropogenic areas	LSD test
A. dudgeoni	-25	4.59±1.03	9.96±2.62	**
A. gourmaensis	-25	1.33±0.54	2.00±0.43	NS
A. hockii	-25	0.93±0.47	0.08±0.08	**
A. laeta	-25	0.27±0.16	0.00±0.00	**
A. polyacantha	-25	4.33±1.21	4.31±1.53	NS
A. seyal	-25	4.27±1.67	0.38±0.18	**
A. dudgeoni	25-50	4.24±1.23	0.26±0.19	**
A. gourmaensis	25-50	5.33±2.45	0.05±0.05	**
A. hockii	25-50	10.60±3.2	1.00±0.40	**
A. laeta	25-50	3.17±1.23	0.60±0.40	**
A. polyacantha	25-50	0.78±0.64	1.00±0.80	NS
A. seyal	25-50	2.60±1.06	0.50±0.40	**

NS: Means insignificantly different
* Means significantly different (P<0.05) | ** Means significantly difference (P<0.01

Table 4: Status of the saplings of *Acacia* spp. in protected and anthropisized areas. Mean ± 95 % confidence interval (n=20)

Tableau 4: Statut des jeunes plantes (classe de hauteur entre 50 et 200 cm) des *Acacia* spp. entre les zones protégées et anthropisées. Moyenne ± 95 % de l'intervalle de confiance (n=20)

Woodland	height (cm)	Protected areas (P)	Anthropogenic areas (A)	LSD
A. dudgeoni	50-100	1.24±0.57	0.04±0.04	**
A. gourmaensis	50-100	0.83±0.29	0.00±0.00	**
A. hockii	50-100	4.80±1.54	0.83±0.45	**
A. laeta	50-100	1.83±1.20	0.60±0.40	*
A. polyacantha	50-100	0.22±0.15	0.08±0.07	NS
A. seyal	50-100	0.20±0.10	0.25±0.16	NS
A. dudgeoni	100-150	0.76±0.34	0.04±0.04	**
A. gourmaensis	100-150	0.50±0.22	0.00±0.00	**
A. hockii	100-150	3.80±0.82	0.75±0.29	**
A. laeta	100-150	0.67±0.50	0.20±0.20	**
A. polyacantha	100-150	0.11±0.10	0.08±0.07	NS
A. seyal	100-150	0.13±0.09	0.12±0.11	NS
A. dudgeoni	150-200	1.06±0.40	0.43±0.30	*
A. gourmaensis	150-200	0.50±0.22	0.10±0.10	*
A. hockii	150-200	4.33±1.28	1.67±0.74	**
A. laeta	150-200	1.17±0.43	0.80±0.48	NS
A. polyacantha	150-200	0.67±0.55	0.92±0.46	NS
A. seyal	150-200	0.33±0.74	0.38±0.48	NS

NS: Means insignificantly different
* Means significantly different (P<0.05) | ** Means significantly difference (P<0.01

plants (Fig. 4). In contrast, the SCD slopes in the anthropisized areas were flat and deviated from the reverse J-shape (except *A. dudgeoni* and *A. polyacantha*, which conserved reverse J-distribution). This flat SCD characterized a poor regeneration of *Acacia* in anthropisized areas. The positive slope of *A. hockii* was typically characterized by the absence of regeneration with many canopy individuals (mature plants).

5 Discussion

The regeneration of species is a complex process, integrating the morphological and physiological characteristics of plants to support environmental constraints (Fenner 1987). In any case, regeneration status is closely related to plant density (Louda 1989). This relationship was altered in anthropisized areas suggesting disturbance of regeneration processes related to seeds and seedlings. In general, the current investigations showed that regeneration was greater in protected areas than in anthropisized areas under conditions of similar plant density, climate and soil. These results obtained were comparable to those of Gampine & Boussim (1995) for *Combretaceae* and *Caesalpiniaceae* woodlands in protected and open areas. The plant renewal rate confir-

Table 5: Regression slope of size-class distributions of *Acacia* spp. in protected and anthropisized areas
Tableau 5: Pente de régression des différentes classes de distributions des Acacia spp. dans les zones protégées et anthropisées

Species	Protected areas			Anthropisized areas		
	Slope	r^2(%)	t-value	Slope	r^2(%)	t-value
A. dudgeoni	-0.56	60	-2.13	-0.55	27	-1.07
A. gourmaensis	-0.70*	80	-3.41	-0.17	07	-0.49
A. hockii	-0.40*	81	-3.62	+0.19	61	2.20
A. laeta	-0.45*	94	-7.17	-0.02	07	-0.48
A. polyacantha	-0.47*	51	-2.54	-0.42*	48	-2.37
A. seyal	-0.60*	56	-2.27	-0.07	17	-0.92

med a poor regeneration of species with intensification of land use. The anthropogenic causes were linked to the impact of high intensity of grazing and browsing. In fact, Acacia was considered to be a genus with high palatable species (Arbonnier 2000, Wickens 1995, Breman & De Ridder 1991) and was favored year round (Owen-smith & Cooper 1987). If the browsing effect at low intensity could stimulate biomass production and coppicing (Oba 1998, Sawadogo et al. 2002), the intense browsing limited growth and increased mortality of plants (Barnes 2001b). The juvenile plants and saplings were more exposed than adult plants due to the higher palatability explained by the higher nitrogen content of their leaves. According to Argaw et al. (1999), in areas subjected to high grazing it was estimated that 69% of the plants in *Acacia* woodlands (Rift Valley of Ethiopia) were damaged by browsing.

The intensity of land-use affected all distribution classes of regeneration plants, but was more pronounced in the lower class than in upper classes. However, the juvenile population of *A. gourmaensis* and *A. dudgeoni* less than 25 cm height thrived better in anthropisized areas versus protected areas. This distribution class demonstrates the new seedlings recruitment (from seed germination) and also shows the probable difference of soil seed bank viability between the two land-use regimes. According to many authors (Tybirk 1994, Walter & Milton 2003), the production of *Acacia* seed is very important and regeneration of species depends on their viability and dispersal agents.

Acacia species frequently have hard, impermeable seminal integuments that ensure dormancy and adaptation to dispersal strategies (Vassal 1998). Livestock grazing and annual early fire contribute differently to *Acacia* seed viability following the taxonomic characteristics of species. In protected areas, the early annual fire could have a negative effect on seedling recruitment, particularly for the subgenus *Aculeiferum* due to several contributing factors. Depending on *Acacia* species phenology, annual early fire (running in September-October) could destroy the recent seedlings exiting from seed germination during the rainy season (June-August) or alter the annual soil seed bank. According to Danthu et al. (2003), fire does not encourage in situ germination of different *Acacia* species and in effect, increases seed mortality particularly for species belonging to the subgenus *Aculeiferum* that are characterized by their lack of integument inhibition. Indeed, the recruitment of juveniles plants in the lower class for some *Aculeiferum* subgenus (*A. dudgeoni*, *A. gourmaensis*, and *A. polyacantha*) was weaker in protected areas than in areas of high-intensity of land-use.

Conversely, the early annual fire in protected areas regime stimulates vegetation reproduction (coppicing) of *Acacia* species. We are in agreement with Barnes (2001b) that fire encourages coppicing regeneration of *Acacia* species and suggest that regeneration reliant to sexual reproduction is disadvantaged by frequent fire (Hoffman 1998, Setterfield 2002). However, the lack of seedling's production from sexual reproduction in the *A. laeta* woodland in both land use regime is probably a function of rainfall insufficiency (subsahelian zone less than 600 mm) that the frequency appears to be essential for germination and seedlings survival (Wilson & Witkowski 1998). Consequently, the coppicing of subgenus *Aculeiferum*, dominant in protected areas, demonstrates a survival status related to environmental constraints (e.g. annual early fire). Nevertheless, vegetative reproduction is not favourable to natural conservation of species, even if it contributes to short-population maintenance, because the lack of sexual recruits will limit the input of genetic variation (Setterfield 2002).

Conversely, the subgenus *Acacia* (*A. hockii*, *A.seyal*) showed a relative higher recruitment of juvenile plants in protected areas than in anthropisized areas regime. The regeneration of subgenus *Acacia* demonstrates the relative seed ability to survive after early fire in protected areas as seedlings were more abundant than coppicing. The poor regeneration in anthropogenic areas is partly due to seed removal and dispersal by livestock grazing as the *Acacia* subgenus seeds are adapted to endozoochorie (Danthu et al. 1996, Coe & Coe 1987). Seed dispersion by mammalian herbivores enhances seed viability by reducing seed infestations, scarifying the hard seed coat, and imbibing moisture (Or & Ward 2003, Witkowski & Garner 2000, Miller 1994). Livestock grazing in anthropisized areas contributes to dispersion of *Acacia* (especially *Acacia* subgenus) regeneration far from parental individuals and weakens regeneration under canopies.

The regeneration pattern in anthropisized areas highlights flat SCD of *Acacia* species (except *A. dudgeoni* and *A. polyacantha*) due to lack of regeneration due to disturbances factors, e.g. browsing damage and seed removal caused by livestock grazing. Growth suppression of plants caused by herbivory has an important factor shaping tree size distribution (Ruess & Alter 1990). However, this instability of population structure 'in situ' in anthropisized areas will be offset by the spatial extension of *Acacia* species due to dispersal mode (zoochory) of *Acacia* subgenus. The short-term population maintenance is threatened due to decline structure of *Acacia* woodland but the long term dynamic is favoured by genetic input.

The selective human harvesting for fuel and medicines represents a further factor able to cause irregular distribution of *Acacia* species in high land-use regime. Nevertheless, this factor affects more adult and sapling plants than seedling establishment.

The protected areas regime showed a stable plant structure with abundance of regeneration. This regeneration status is explained by coppicing probably stimulated by early annual fire especially for subgenus *Aculeiferum* and by 'in situ' seed germination for the subgenus *Acacia*. These factors supply a good plant renewal rate and modify the irregular distribution of *Acacia* highlighted in many areas (Rhoner & Ward 1999, Grice et al. 1994). The close and significant correlation between plant renewal rate and SCD slope (r2=0.70) demonstrates that the ratio regeneration and mature plants could be used to estimate the dynamic of plants population.

6 Conclusion

Two contrasting land-use regimes in eastern Burkina Faso differently influence the regeneration of *Acacia* woodlands. In both land-use regimes, the regeneration pattern is irregular due to environmental constraints for seedling development. As a result, the regeneration was confirmed to be superior in protected areas than in anthropisized setting. The active causal factors concern mainly the early annual anthropogenic fires in protected areas, and livestock grazing in anthropisized areas. The land-use regime influences persistence strategies of *Acacia* species. The protected areas hampered seedling establishment probably due to seed damages caused by annual early fire and conversely stimulated coppicing for the species affiliated to *Aculeiferum* subgenus. This change of regeneration mode could limit the genetic variability maintained by germination. The intense livestock grazing in anthropisized areas with an absence of annual fires impedes seedling development with browsing impacts, but also promotes seed viability and dispersal particularly for species belonging to *Acacia* subgenus. If the protected areas promote population stability, the long-term maintenance of *Acacia* species diversity requires the control and evaluation of annual early fire on population genetic performance.

Acknowledgments

Authors are grateful to African Academy of Science and Institut de l'Environnement et des Recherches Agricoles for financial support. We also thank the reviewers and editors for their contribution to improve the quality of this manuscript.

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