

Full Length Research Paper

The use of the pasture areas by the cattle and the goats in the Sahel region of Burkina Faso

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The traditional systems of stock breeding in the Sahel are mainly based on the valorization of the fodder resources on the pasture areas. To know about the way they are used is a preliminary to the development and management actions in order to minimize the availability problems related to the reduction of pasture areas, their impoverishment and the increasing number of animals these past years. A diagnosis of the way they are used by the flocks of cattle and goat has been done during an annual cycle on two lands characterizing the Sahel of Burkina Faso. The investigations have enabled to appraise the differences in seasons that characterize the use of the pasture areas and to have details of the specific behaviors of the species on their units. In all the systems, the low grounds, the farms and the glacis and are areas that are more pastured by the cattle (36%, 21%, 35% respectively) whereas the goats essentially go to the low grounds and silt laden glacis (53% and 35% of pasture respectively). The food behavior confirms a dependence of the first on herbaceous fodder (71% of pasture time) and the seconds on woody plants (65% to 72%). The solutions to the feeding problems would essentially be in the optimization of the comparative advantages and its differences through the improvement of the productivity of the pasture areas by organizing the access to them. Further investigations concerning the evaluation of the fodder are meanwhile necessary to deepen these matters related to the food supply.

Keywords: *Pasture, Cattle, Goat, Food supply, Sahel, Burkina Faso.*

INTRODUCTION

In the Sahel area of Burkina Faso, stock breeding is the main economical activity and the most lucrative one of the primary sector. It is of the extensive type with some models of behavior of the cattle dominated by practices of exploitation of the food resources coming from the natural pastures and farms (Grouzis, 1988; Claude et al., 1991). The stock breeding has been characterized these past 10 years by an increase of the livestock number of 19.5%, 30% and 27.9% for the cattle, sheep and goats respectively, the main species that are bred, whereas in the same period, nearly 3.3% of the pasture areas are used for agriculture each year (MRA, 2004). The reduction of the pasture areas and their impoverishment in good quality fodder species these past years have not

actually been compensated for by a good pastoral management (Sawadogo et al, 2012). The increase in the number of ruminant species is still a threat for the pastoral resources (Kiema et al., 2007). The farmers and the cattle are developing behaviors to adapt themselves to these major changes, which above all expressed by the changes in having access to the pasture areas and the food behavior. But the consequences of these behaviors on the sustainability of the pasture areas could be harmful and detrimental to the whole pastoral ecosystem (Tezenas Du Montcel, 1990).

It is necessary to improve the animal production systems in the prospect to adapt better to the new conditions, to favor a management of the available resources that fight against the degradation and to channel the development actions at the level of the villages, communes and regions. Understanding the behavior of the flocks on the pasture areas and the

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Table1: Characteristics of vegetation types

Vegetation units	Katchari		Sambonaye	
	ha	%	ha	%
Rice fields	1155,2	12,6	4348,3	14,5
Bare soil and degraded lands	347,5	3,8	1287,5	4,3
Farmland and fallow land	4394,1	47,9	5365,1	17,9
Steppe (grassland and shrub)	2595	28,3	14404,7	48
Glacis gravillonnaires/out crop rock	352,2	3,8	4410,2	14,7
Stretch of water	320	3,5	184,2	0,6
Total	9164	100	30000	100

strategy of the shepherds contribute to this improvement (Semenye, 1998; Petit & Mallet, 2001; Cissé et al., 2002; Ouédraogo – Koné et al., 2006).

The aim of this study is to contribute to the best management of fodder resources by diagnosing the methods of exploitation. This work has consisted in analyzing the use of the fodder resources by cattle and goats in order to make proposals for their development. These two species are the more important in the breeding systems in the Sahel of Burkina Faso. In fact, they constitute alone, nearly 85% of the animal biomass (20% of goats and 65% of cattle) giving value to the natural resources that are offered on the pasture areas (DRED/ Sahel, 2003),

MATERIAL AND METHODS

Localization

The studies have been carried out in the villages of Katchari and Sambonaye, located in the Northern region of Burkina Faso, and belonging to the Sahel phytogeography sector (Guinko, 1984). Sambonaye is located between the 14°04' latitude North and the meridians' 0°02' longitude West and 0°12' of longitude Est. It is characterized by an intensive pastoral activity which takes care of a sedentary and transhumant livestock coming from other places. Due to these potentialities, it has been legally classified a pastoral area (PA). Katchari is rather an area of a high agricultural activity (AG). It is located between the 13°55' and 14°05' latitude North and 0°00' and 0°01' longitude West.

Cartography and study of the Vegetation

Cartography

The cartography of the two regions has based on the interpretation of the satellite images taken in the 2000's, and existing aerial maps and photos of the Area. It has been helpful in determining the vegetation units and their

acreage area respectively in Area AG and PA which are (i) the grassy steppes, shrubby (12.6 to 14.5%), (ii) the rice fields (28,3 to 48%), (iii) the farm growing soils and the fallow lands (47.9 to 17.9%), (iv) the grit area glacis (3.8 to 14.7%), (v) the degraded landscape (3.8 to 4.3%), (vi) lands that are suggested to flooding (3.5 to 0.6%) (Table1).

Herbaceous vegetation

The study of the vegetation has been based on the different units of pasture. In each case, 21 ecological stations of vegetation recording have been identified and allocated according to the spatial importance to characterize the herbaceous and woody vegetation.

The characterization of the herbaceous vegetation has been done in each ecological station by the method of lined up quadrat points of Daget and Poissonet (1971). The method enabled to calculate:

- The specific frequency (FS), the absolute value, corresponding to the proportion of species on the ground.
- The specific contribution (CSi) of each species is defined as the report between the specific frequency (FSi) of these species and by adding up the FSi of the species that have been counted on the 100 points that have been sampled

$$CS_i = \frac{FS_i}{\sum_{i=1}^n FS_i} * 100 \quad \text{With } n = \text{The number of species}$$

CSi and FSi are the contributions and the frequency of the species and n is the number of the species. CSi is the frequency value of the species i in the all the specific frequencies observed.

The establishment of the number of observations has been done by calculating the confidence interval from the accrued number of the contacts of the dominating species line by line over the accrued number the contacts registered by the whole of the species (Boudet, 1991).

$$IC = \pm 2 \sqrt{\frac{n(N-n)}{N^3}}$$

«N» is the accrued number of the contacts the whole of the species,

«n» the accrued number of the contacts of the dominating species.

The pastoral value (VP) which determines the overall indication of the quality of the pastureland has been calculated from the floristic composition and the value related to the species established on a listing scale from 0 to 5. These values enable to make very instructive comparisons between the vegetation units of the same region (Daget and Poissonet, 1971).

$VP = 0,2 \sum CS_i * IS_i$; where 0,2 is a coefficient that enable to expres VP in %.

The herbaceous phytomass has been established in the same stations by the integral harvest method of Levang (1978). It has consisted in cutting short the phytomass contained in a metallic square of an area of 1m², representing the sample unit. On each harvest date, 10 squares have been sampled at random per ecological station of study.

The observations have been made at the end of the rainy season (September), in the cold season (January) and at the end of the dry and hot season (May). On each harvest date, the harvested Phytomass has been selected according to the species that are available which were classified into four categories, the gramineous plants, the leguminous plants, *Cassia obtusifolia* (due to its importance on the pasture areas) and other species.

The assessment of the agricultural production has been established by the square method of the yields of the farms. For each land twelve famers have been subjected to a survey. The establishment of the yields squares for each farmer took into account three speculative species which are *Pennisetum typhoides* (Millet), *Sorghum bicolor* (Sorghum) and *Vigna unguiculata* (bean). For each farm, three squares of 5m × 5 m have been selected for various measurements of the phytomass per speculative species. The residues of the harvest have been assessed at the same period.

The water content has been determined in 1 to 3 samples for each category of phytomass of 0.500 kg after drying till a constant dry weight of 105 °C.

The Theoretical Carrying Capacity (CC) has been established from these phytomass (Boudet, 1991).

$$CC = \frac{\text{Biomass production (Kg of DM/ha)} * K}{6.25 * \text{utilization period (Day)}}$$

K (%): utilization coefficient (1/3); DM: dry material; UBT: Tropical Cattle Unit.

Comparing this carrying capacity of the lands two systems of production with their real animal weight enable to estimate the fodder report. The number of animals of the cattle has been obtained from an overall

inventory of the cattle in the villages. A total of 222 cattle have been counted 178 at Sambonaye and 44 at Katchari. The equivalents in Tropical Cattle Unit (UBT) have been estimated by considering that an African Cattle is equal to 0.8 UBT and the Sheep and Goat to 0.12 UBT (Boudet, 1991).

BF= CCh+ CCr- The real weight of the lands

BF= fodder report; CCh= Herbaceous weight capacity;
CCr= Weight capacity of the residues of the harvest; CR= Real weight on the lands

Woody vegetation

The composition and the rate of covering over of the woody vegetation have been studied through the circular hectare method in the stations. The delimitation of the hectare has been done from a metric ribbon of 56.43 m (Radius of an acreage area of 1 hectare). The report has consisted in making an exhaustive floristic inventory by indentifying the plants, the strata (0 to 1m; 1 to 3m; 3 to 5m; 5 to 7m; >7m). The establishment of the covering rate has been done through the indirect method which has consisted in estimating the surface of the crowns by measuring the medium diameters of a representative sample of plants. The medium diameter has been established from measuring the two extreme dimensions of the wreath following a perpendicular axe. The average of these two measures gives the medium diameter the crown. The covering measure has been established in two repetitions for each species and by stratum on each inventory station. The covering rate has been established by making the report between the surface of the crowns and the surface of the plot of land considered. The report is brought back in 100 to obtain the covering rate in percentage.

Study of the food behavior

The observation sample is composed of six herds of cattle and six flocks of goats distributed as followed: four flocks of each species at Sambonaye and two of each at Katchari (because the size of the terroir). The flocks have been chosen half of them are the small size and the other half of are tall. In each case, the choice of the area approach has been done in order to obtain the maximum of representativeness (Table 2)

Every flock has been followed in an interval of time of 21 days along the annual cycle. Over the twelve months of the year, 5063 observations have been done: 2492 for cattle and 2571 for goats (Table 3). The observations have concerned (i) the spatial following of the animals on the pasture areas, (ii) their rhythm of activity, (iii) and their food behavior. In the practice, the flocks have been followed along their pasture areas between the departure and their arrival in the pen for the goats, and in the night park for the cattle. The localization of the animals has

Table 2. Numbers of herds followed in the villages of Sambonaye (pastoral area) and Katchari (agro pastoral area) according farming systems

Villages	Number of cattle		Number of goats	
	Great herd	Littleherd	Great herd	Littleherd
Sambonaye	70	17	30	15
	80	27	131	26
Katchari	28	12	33	15
Mean	59 ± 28	19 ± 8	65 ± 57	19 ± 6

Table 3. Number of observations by season and species

Seasons	Months	Number of observations	
		Cattle	Goat
Rain	June, July, August, September	867	947
Post harvest	October, November	472	450
Cold	December, January, February	663	677
Hot	Mars, avril, mai	490	497
4	12	2492	2571

been done in an interval of time of 15 min. with a GPS (Global Positioning System) for the recording of the geographical coordinates and determining the distance made during this period.

The study of the food behavior has consisted in making close observations on the targeted animals (generally the oldest females of the flocks two targeted animals per flock, chosen at random and identified by the color of the collar it's wearing on the neck or a wither) to determine the species that were absorbed and to estimate the pasture time.

Determining the rhythm of the activity consisted in registering the time the targeted animals spent on the various activities on the pasture areas. The recorded parameters were (i) the pasture time, (ii) the time they spent moving, (iii) the time they spent drinking and (iv) the time they spent resting with or without rumination.

Statistic analysis of the data

The data were analyzed using Statistical Package Software for Social Science (SPSS®). ANOVA test was used to a classification criterion in order to test the effect of the various types of activities and the pasture land site on the dynamic of the behavior of the flocks. The test of Scheffé (1959) has been used to identify the averages that differ significantly at the threshold of 5%.

RESULTS

Characteristics of the fodder resources on the pasture areas

The two lands have been characterized by and herbace-

ous vegetation composed of 52 and 54 species at Sambonaye and Katchari respectively, and can be divided into four main families (gramineous plants, leguminous plants, sedges and rubiaceae and a group of various other species). The number of species is less varied on damaged lands (10 to 14), and higher on grassy steppes and the low grounds (35). In total, 7 species are common to all the vegetation units at Sambonaye and 3 at Katchari. The vegetation is dominated by the grain plants the importance of which varied according to the units: 81% to 90% on the steppes and the grit glacis, 62% on the rice fields and only 41% on the farms and fallow lands. On these last two units, the leguminous plants are more important with respectively 34% and 29% of the contribution. The highest contributions of cypress plants are recorded on the farms and fallow lands (16%). The rubiaceae represent low specific contributions (less than 5%). Just like the floristic composition, the pastoral value of the vegetation units are similar between the pastoral area (58% to 65%) and the agro pastoral area (58% to 64%), but very variable between the vegetation units. The steppes have the best values (64%) and the rice fields have the lowest (58%).

The number of woody species is more important in the agro pastoral area than in the pastoral one. The covering over of the vegetation is in the average higher in the agro pastoral area than in the pastoral one. It is less high in the grit glacis (5%) and higher in the rice fields (21%) in the pastoral area, whereas in the agro pastoral area, these changes are respectively of 4% and 5%.

As far as the availability of the phytomass is concerned, there is a statistical difference between the season and the system of production (Table 4). At the end of the rainy season, the available phytomass are more important in the fallow lands with respectively 2669

Table 4. Dynamics of phytomass in kg of DM ha⁻¹

Systems	Seasons	Types of fodder	Types of pasturage					
			Grassy Steppes	Shrubby Steppes	Silt laden glacis	Degraded soil	Fallow lands	Fields/Fallows
Agro pastoral (Katchari)	Rains	Gramineae	461,2	347,1	741,2	411,3	621,3	492,6
		Legumineae	920	93,0	2,2		127,9	339,1
		<i>Cassia obtusifolia</i>	142,2	653,6		2,0	435,9	4,4
		The others species	3,0				242,4	131,2
		Total	698,4	1093,7	743,4	413,3	1427,5	967,2
	Cold	Gramineae	556,4	658,3	520,0	311,8	466,0	336,0
		Legumineae				0,4		128,3
		<i>Cassia obtusifolia</i>	63,4	359,0			449,5	0,7
		The others species		3,3				
		Total	619,8	1020,6	520	312,2	915,5	465
	Hot	Gramineae	129,4	128,7	205,0	108,3	116,8	45,7
		Legumineae				0,5		
		<i>Cassia obtusifolia</i>	16,4	97,0		0,5	197,0	2,3
		The others species						
		Total	145,8	225,7	205,0	109,3	313,8	48,0
Pastoral area (Sambonaye)	Rains	Gramineae	901,8	929,7	536,5	500,0	1511,7	270,8
		Legumineae	1,9	51,4		8,1	101,4	554,4
		<i>Cassia obtusifolia</i>	41,6	0,4	1,5	8,2	1045,4	23,7
		The others species	0,5		26,1	4,5	10,8	77,5
		Total	945,8	981,5	564,1	520,8	2669,3	926,4
	Cold	Gramineae	685,5	680,8	381,3	382,1	525,3	181,5
		Legumineae	10,2	18,0		0,3		79,5
		<i>Cassia obtusifolia</i>	7,4	0,5	1,3	3,0	419,0	2,5
		The others species	0,9	1,0		0,7	0,3	
		Total	704,0	700,3	382,6	386,1	944,6	263,5
	Hot	Gramineae	386,6	441,4	145,6	201,0	241,8	63,5
		Legumineae		0,5				1,5
		<i>Cassia obtusifolia</i>	4,0	0,5		2,7	201,3	0,5
		The others species						
		Total	390,6	442,4	145,6	203,7	443,1	65,5

and 1427 Kg DM ha⁻¹ on the PA land (pastoral area) and AG land (pastoral area). This unit produces in the average two times more than the other types of natural pasture areas. The farming residues phytomass and the adventitious plants are very important: respectively 2746 and 2417 Kg of DM ha⁻¹ an⁻¹. In a specific way, the weight contribution of the phytomass of the various categories of fodder remains very variable between the systems and the vegetation units. The grain plants are more important in the PA area than in the AG area where all the units except in the fallow lands and the farms, represent contributions above 95%. The contributions of the leguminous plants are important both lands with respective rates of 30% and 60% for the AG land and PA land. *Cassia obtusifolia* is a leguminous plant the contribution of which is particularly important in the AG

area: 20% on the herbaceous steppes, 31% on the rice fields and 60% on the shrub steppes. In the PA area, its production is only interesting in the fallow lands. The various other species are more important in the farms (8% in the PA area and 14% in the AG area). The rate of disappearance of the whole phytomass according to the seasons is very variable in accordance with the vegetation units. It is more important for the harvest residues the most part of which is (more than 90% of the production) is either collected and stocked for consuming in the dry season, or consumed before the cold season. The decrease proportions of the total phytomass are less important in the PA area (69% at the end of the season) than in the AG area (78% at the end of the season). It is more severe for the rice fields (respectively 65% and 36% from the cold season) and the farming lands (more

Table 5: Fodder balance of terroir

Parameters	Units	Terroirs	
		Sambonaye	Katchari
Area	ha	30000	9164
Annual production of phytomass herbaceous	T MS/an	49749	13835
Carrying capacity	UBT/an	7269	2022
Real carrying of animals biomass	UBT/an	3996	638
Fodder balance	-	+3274	+1384

than 96% at the end of the season). Generally speaking, these rates are very high at the end of the seasons no matter the units; they go beyond 60% of the assessed productions, explaining then the severity of the food deficit for the herds/flocks.

In both lands, the fodder report is all the same positive and shows that theoretically, there is no over pasturing. But actually this report does not consider several very important factors involved in the rational use of the pasture areas as (i) the variation of the availability of the fodder, (ii) the abundance of the transhumant herds/flocks and the bordering regions, (iii) the selection in the use of the phytomass by the livestock (particularly the stalks and the straws of some species). Meanwhile, this estimate enabled an overall assessment of the report between the needs and the available dry material in the villages (Table 5).

Seasonal and daily rhythm of activity of the animals

Observations concerning the rhythm of activity have been distributed into the food, movement and simple resting time, rumination and drinking time. We observe then a great variability of the daily calendar between the cattle and the goats and this, in relation with the seasons. The feeding time of cattle has been rather important in the afternoons where cattle are busy between 80% to 60% of the time of the livestock from the rainy season to the dry hot season whereas that of the goats has been more or less well distributed the whole day. Besides, the feeding time of cattle has been completed with night grazing the duration of which is very variable in relation with the periods of the year but which is between 9 p.m. and 6 a.m., nearly 9 hours. The results indicate that the traditional systems of the animals' behavior exploit in a maximum the daily time.

The feeding time includes the gathering that is the picking up of leaves fruits that have fallen on the ground, the grazing or picking up the leaves on the tree or other organs and the pasture of the natural herbaceous and the residues of harvests. The cattle's average feeding time (42%) has been significantly more important than all the other activities, but it is variable according to the seasons: 55% in the rainy season, and 30% in the dry hot

season. The other activities as the movement/walk (25%), resting (18%), and rumination (14%) have been variable and important in the daily time. The feeding time of the goat (61%) has been 1.5 times higher than that of the cattle (night pasture not included). The intensity of walking (23%) has been similar to that of cattle. Times that have been spent for resting (8%), ruminating (7%), for drinking (0.5%) have been variable but 2 to 3 times lower than those of cattle (Table 6).

As a general rule, in the daily rhythms of activity of the shepherds, the actual time they spend behind the livestock does not cover more than 50% of the time the animals spend on the pasture area during the day time. But there are strong changes among the shepherds in relation with the family labor force available for the management of the livestock. From the observations that have been carried out, we can mention that the time spend in overseeing and drinking vary not from one period to another but also from the distance between the pasture area and the watering place and also the nature of the watering source. To sum up, during the cold and the hot time, the most frequent behaviors in these two lands are: the part time behavior and the free pasture generally with the goats.

Exploitation of the pasture areas by the animals

As indicated in table 7, the food times have presented the significant differences at the threshold of 5% between the systems and the vegetation units. The fallow lands have constituted the vegetation units that have been attended more in the year, by cattle (36%) and goats (53%) and this no matter the animal breeding system; they are followed by silt laden glacia at the rate of 34%. The contribution of the farming lands has been more important with the cattle (21%) than the goats (11%). If we consider the exploitation systems, we observe that the feeding time cattle is practically 3 times higher for the agro pastoral system (38%) than that of the pastoral system (13%). The gap is less important the Goats: 15% and 9% respectively for the agro pastoral system and the pastoral system.

In fact the attendance of the vegetation units is in relation with plant species that are in face, and the

Table 6. Activity rhythm of herds by main production systems and seasons (values in % of time of presence of the herds on the route)

Production system / activities	Rainy (June to September)		Post harvest (October to November)		Cold (December to February)		Hot (March to May)		Mean of the year	
	Cattle	Goat	Cattle	Goat	Cattle	Goat	Cattle	Goat	Cattle	Goat
Agro pastoral area										
<i>Pasture time</i>	50,1 ^c	61,4 ^c	39,7 ^c	45 ^c	36,6 ^d	59,2 ^e	28,2 ^c	58,4 ^c	39,6 ^c	57,5 ^c
<i>Moving time</i>	23,4 ^b	17 ^b	30,7 ^{bc}	31,4 ^{bc}	24,2 ^{bc}	22,9 ^{bcd}	23,1 ^b	24,1 ^b	25,1 ^b	22,3 ^b
<i>Resting time</i>	10,8 ^{ab}	10,9 ^{ab}	16,6 ^{ab}	15,4 ^{ab}	22,1 ^{abc}	9,5 ^{abcd}	29,1 ^{ab}	12,4 ^{ab}	19 ^{ac}	11,6 ^{ab}
<i>Rumination time</i>	15 ^{ab}	10,3 ^{ab}	12,5 ^{ab}	7,8 ^{ab}	16,4 ^{abc}	8,3 ^{abcd}	18,2 ^{ab}	4,5 ^{ab}	15,5 ^a	8,3 ^a
<i>Drinking time</i>	0,7 ^a	0,4 ^{ab}	0,5 ^a	0,4 ^a	0,7 ^a	0,1 ^a	1,3 ^a	0,7 ^a	0,8 ^a	0,4 ^a
Pastoral area										
<i>Pasture time</i>	57,4 ^c	67,5 ^c	39,4 ^c	55,8 ^c	35,4 ^d	57,8 ^e	31,3 ^c	64,7 ^c	43,3 ^c	62,3 ^c
<i>Moving time</i>	25,1 ^b	19,6 ^b	32,3 ^{bc}	31,2 ^{bc}	24,2 ^c	25,3 ^{cd}	19,9 ^{ab}	22,1 ^{ab}	25,2 ^b	23,7 ^b
<i>Resting time</i>	8,3 ^{ab}	6,5 ^{ab}	17,7 ^{ab}	3 ^{ab}	21,7 ^{abc}	9,9 ^{abcd}	30,3 ^{ab}	6,8 ^{ab}	17,7 ^a	6,9 ^a
<i>Rumination time</i>	8,8 ^{ab}	6 ^{ab}	10,2 ^{ab}	9,5 ^{ab}	17,6 ^{ab}	6,5 ^{ab}	18 ^{ab}	5,8 ^{ab}	13,1 ^a	6,7 ^a
<i>Drinking time</i>	0,5 ^a	0,4 ^a	0,5 ^a	0,6 ^a	1 ^a	0,5 ^a	0,5 ^a	0,6 ^a	0,6 ^a	0,5 ^a
Average of the test										
<i>Pasture time</i>	55,3 ^c	65,3 ^c	39,5 ^c	52,1 ^c	35,8 ^d	58,3 ^e	30,3 ^c	62,7 ^c	42,1 ^c	60,6 ^c
<i>Moving time</i>	24,6 ^b	18,7 ^b	31,7 ^{bc}	31,3 ^{bc}	24,2 ^c	24,5 ^{cd}	21 ^{ab}	22,8 ^{ab}	25,1 ^b	23,2 ^b
<i>Resting time</i>	9 ^{ab}	8,1 ^{ab}	17,3 ^{ab}	7,2 ^{ab}	21,9 ^{ab}	9,8 ^{abcd}	29,9 ^{ab}	8,6 ^{ab}	18,1 ^a	8,5 ^a
<i>Rumination time</i>	10,6 ^{ab}	7,5 ^{ab}	11 ^{ab}	8,9 ^{ab}	17,2 ^{ab}	7,1 ^{abc}	18,1 ^{ab}	5,4 ^{ab}	13,9 ^a	7,2 ^a
<i>Drinking time</i>	0,5 ^a	0,4 ^a	0,5 ^a	0,5 ^a	0,9 ^a	0,4 ^a	0,8 ^a	0,6 ^a	0,7 ^a	0,5 ^a

The values with the same letters on the column (of the two villages) are not significantly different to the 5% threshold.

Table 7. Intensity of exploitation of vegetation units by season (times pasture in %)

Production system / seasons	Types of pasturage							
	Grassy/ Shrubby Steppes		Fallow lands		Fields/ Fallows		Silt laden glacis	
	Cattle	Goat	Cattle	Goat	Cattle	Goat	Cattle	Goat
Agro pastoral area								
<i>Rainy</i>	57,3 ^b	57,1 ^c	38,3 ^{abc}	39,7 ^{abc}	1,1 ^a	2,2 ^{ab}	3,2 ^a	1 ^a
<i>Post harvest</i>	51,6 ^b	52,8 ^{ab}	1,9 ^a	6,9 ^a	46,5 ^{ab}	40,1 ^{ab}	0 ^a	0,2 ^a
<i>Cold</i>	21,1 ^{ab}	14,1 ^a	5,6 ^{ab}	54,7 ^{abc}	69,7 ^b	31,2 ^b	3,7 ^a	0 ^a
<i>Hot</i>	12,7 ^a	25 ^a	16,6 ^{abc}	74,6 ^c	66,3 ^b	0,4 ^a	4,4 ^a	0 ^a
<i>Total</i>	39,8 ^{ab}	38,7 ^{ab}	18,8 ^{ac}	46 ^{abc}	38,5 ^{ab}	14,8 ^b	2,9 ^{ab}	0,4 ^a
Pastoral area								
<i>Rainy</i>	34,4 ^{ab}	42,1 ^{bc}	61,7 ^c	57,1 ^{abc}	2,1 ^a	0,7 ^a	1,7 ^{ab}	0,2 ^a
<i>Post harvest</i>	52,5 ^b	39 ^{ab}	1,8 ^a	23 ^{abc}	45,8 ^{ab}	36,5 ^{ab}	0 ^a	1,5 ^a
<i>Cold</i>	28,4 ^{ab}	23,2 ^{ab}	25 ^{abc}	65,1 ^{bc}	18,6 ^{ab}	11,5 ^{ab}	28 ^b	0,1 ^a
<i>Hot</i>	25,4 ^{ab}	27,4 ^{ab}	58,9 ^c	71,8 ^c	4,5 ^a	0,8 ^a	11,2 ^{ab}	0 ^a
<i>Total</i>	34,9 ^{ab}	33,8 ^{ab}	43,7 ^{ac}	57 ^{abc}	13,1 ^{ab}	9 ^{ab}	8,3 ^{ab}	0,3 ^a
Average of the test								
<i>Rainy</i>	40,4 ^{ab}	47,2 ^c	55,6 ^{bc}	51,2 ^{abc}	1,8 ^a	1,2 ^a	2,1 ^{ab}	0,4 ^a
<i>Post harvest</i>	52,1 ^b	43,1 ^{ab}	1,8 ^a	18,3 ^{ab}	46 ^{ab}	37,6 ^{ab}	0 ^a	1,1 ^a
<i>Cold</i>	25,7 ^{ab}	20,1 ^a	17,8 ^{abc}	61,5 ^{bc}	37,6 ^{ab}	18,3 ^{ab}	18,9 ^{ab}	0,1 ^a
<i>Hot</i>	21,4 ^{ab}	26,7 ^{ab}	45,8 ^{abc}	72,6 ^c	23,6 ^{ab}	0,7 ^a	9,1 ^{ab}	0 ^a
<i>Total</i>	36,4 ^{ab}	35,4 ^{ab}	36 ^{ac}	53,4 ^{abc}	21 ^{ab}	10,9 ^{ab}	6,6 ^{ab}	0,4 ^a

The values with same letters on the column are not significantly different to the 5% threshold.

season. Therefore, we can observe a continuous decrease of the attendance of the grassy/ shrubby steppes from the rainy season to the hot season. In the contrary, as far as the fallow lands are concerned, the important decrease observed from the rainy season to the beginning of the dry season (the post harvest period) for cattle (56% to 2%) and goats (51% to 18%), is followed by a raise of the attendance during the dry hot season (46% for the cattle, and 73% for the goats). The attendance of the farming lands has been practically high from the post harvest period to the dry hot season for the cattle, whereas the presence of the goats in this unit has been high only during the post harvest period and the dry cold season. The cattle have regularly attended the silt laden glacia (7%), particularly the PA area (8%, against 3% in the AG area). This unit is particularly attended during the cold seasons (19%) and the hot seasons (9%) and very few during the rainy seasons (2%).

Diet

The cattle exploit nearly 47 plant species composed of the herbaceous (23 species), the woody (19 species) and the harvest residues (5 species). At the level of goats, 60 species divided between the woody (29 species), the herbaceous (27 species) and the various speculations (4 species) have been counted. The importance of the number of species decreases between the rainy seasons (39 species for the cattle and 35 for the goats) and the dry hot season (5 species identified for the cattle and 24 for the goats). Furthermore, the observations indicate that the farms, the shrubby / grassy steppes and the fallow lands are the most supplied with appetite species (Table 8). The food compositions, no matter the specie, vary in accordance with the vegetation units and the seasons.

Fallow lands

The cattle have been more interested in the herbaceous and the woody species on the fallow lands (respectively 89% and 11%). The main grain plants consumed have been *Panicum laetum* (35%), *Schoenefeldia gracilis* (23%), *Echinochloa colona* (14%), and the main woody species, *Mitragyna inermis* (5%) and *Balanites aegyptiaca* (1.5%). These grain plants have been important during all the seasons except the post harvest period. During this one, the woody species (29%) have become the most important species in the consumption of food with the abundance of the leaves of *Balanites aegyptiaca* (28%). At the same time, the leguminous plants and various other herbaceous species were taking important proportions: *Cassia mimosoides* (25%), *Cassia obtusifolia* (8%) and *Cucumis melo* (7%). For the goats, the exploitation of this unit has been rather characterized by a high consumption of the woody species (64%).

Specifically, the main woody species were composed of *Acacia raddiana* (19%), *Acacia seyal* (6%), *Balanites aegyptiaca* (17%), *Ziziphus mauritiana* (7%), *Mitragyna inermis* (4%), etc. A high consumption of the leaves and the pods of *Cassia obtusifolia* has also been observed during the rainy seasons (5%), the post harvest period (48%) and the cold seasons (14%) whereas the grain plants were weakly represented by *Schoenefeldia gracilis* (7%) and *Panicum laetum* (7%).

Farmlands

On the farming lands, the harvest residues intervene a lot in the consumption of food of the cattle (47%). This one is essentially composed of stalks of millet (33%) and sorghum (8%), and the hay of bean (5%). The residues are filled up with the herbaceous species (45%) essentially composed of *Panicum laetum* (13%), *Schoenefeldia gracilis* (8%), *Eragrostis* (5%), *Aristida* (5%). In the post harvest season, it is the harvest residues that prevail in the consumption of food (56%), associated with high consumptions of leguminous herbaceous (12%) and the woody species (12%) mainly composed of *Alysicarpus ovalifolius* (8%) and the pods of *Acacia raddiana* (4%). During the other periods, the most consumed herbaceous are especially *Panicum laetum* (22%) and *Schoenefeldia gracilis* (15%) the contribution of which reaches more than 50% in the animals' diet.

At the difference of cattle, in this unit, the woody species (63%) coming from the new growth plants and those that have been spared during the farming have constitute the most exploited resources by the goats. This contribution is mostly important the first three seasons (from the rainy to the cold season). The contribution of the harvest residues to the consumption of food of the goats has varied from 21% to 26% during the post harvest period to the cold period. Specifically the main species that have been consumed by the goats are *Acacia raddiana* (22%), *Ziziphus mauritiana* (22%), the straw of millet (13%), the pods of *Cassia obtusifolia* (7%), the straw of sorghum (5%), the tops of niébé (5%), *Balanites aegyptiaca* (3.9%), *Acacia seyal* (3.5%), *Borreria radiata* (3%), *Bauhinia rufescens* (2.7%), *Schoenefeldia gracilis* (2%).

Grassy / Shrubby Steppes

The grassy / shrubby steppes have been the main pasture units of cattle and on which were essentially exploited the herbaceous species (91%). Apart from the dry hot season where the contribution decreases at 65%, during all the other seasons, its remains above 83%. The most wanted species are *Schoenefeldia gracilis* (46%), *Panicum laetum* (25%), *Chloris pilosa* (4%), *Aristida spp* (4%), and *Dactyloctenium aegyptium* (3%). The woody

Table 8. Contribution of the different types of pasturage at the diet of animals in the year

Pasturage	Optimum period of grazing	The Diet (Number of species and time of grazing in % between parenthesis)		
		Herbaceous species	Woody species	Residue_of cropt
Cattles				
Fallow lands	season rainy, cold and hot	-number of the grazed species (5 to 15) -herbaceous species (71 to 100%), - <i>Panicum laetum</i> (8,9 to 42,5%) - <i>Schoenefeldia gracilis</i> (19 to 39%) - <i>Echinochloa colona</i> (0 to 17%), - <i>Aristida adscensionis</i> (0,5 to 16%), - <i>Cassia obtusifolia</i> (0 to 8%)	-number of the grazed species (0 to 13) - Woody species (0 to 12%) - <i>Mitragyna inermis</i> (0 to 6,5%) - <i>Balanites aegyptiaca</i> (0,7 to 28%)	- residue (0,0)
Farmlands	season post harvest to hot	-number of the grazed species (4 to 15) - herbaceous species (32 to 69%), - <i>Panicum laetum</i> (1 to 34%) - <i>Schoenefeldia gracilis</i> (6 to 15%), - <i>Aristida adscensionis</i> (0,5 to 18%), - <i>Eragrostis</i> (0 to 5,4%), - <i>Alysicarpus ovalifolius</i> (0 to 8%)	-number of the grazed species (0 to 12) - Woody species (0 to 12%) - <i>Acacia raddiana</i> (0 to 2,3%), - <i>Prosopis juliflora</i> (0 to 3%), - <i>Balanites aegyptiaca</i> (0 to 1,2%)	- number of the grazed species (1 to 5) -residue (31 to 56%) - stalks of millet (31 to 37%), - stalks of sorghum (0 to 13), -Tops of bean (0 to 10%)
Grassy / Shrubby Steppes	all the seasons	-number of the grazed species (3 to 17) - Herbaceous species (87 to 100%) - <i>Panicum laetum</i> (0 to 30,7%) - <i>Schoenefeldia gracilis</i> (42 to 54%) - <i>Aristida adscensionis</i> (0,8 to 23%) - <i>Alysicarpus ovalifolius</i> (0 to 2,5%)	-number of the grazed species (0 to 17) - woody species (0 to 13%) - <i>Balanites aegyptiaca</i> (0 to 2,2%) - <i>Acacia raddiana</i> (0 to 2,2%) - <i>Ziziphus mauritiana</i> (0 to 2,2%)	-residue (0,0)
Silt laden glacis	Season_cold and hot	-number of the grazed species (3 to 5) - herbaceous species (0 to 100%) - <i>Panicum laetum</i> (0 to 27,1%) - <i>Schoenefeldia gracilis</i> (35 to 62%) - <i>Aristida adscensionis</i> (0 to 29%)	-number of the grazed species (0 to 1) - woody species (0 to 3%) - <i>Balanites aegyptiaca</i> (0 to 3,4%)	-residue (0,0)
Goats				
Fallow lands	all the seasons	- number of the grazed species (4 to 19) - herbaceous species (22 to 48%), - <i>Panicum laetum</i> (0,7 to 13,8%) - <i>Schoenefeldia gracilis</i> (1 to 10%) - <i>Echinochloa colona</i> (0 to 5,4%). - <i>Cassia obtusifolia</i> (0,9 to 48,1%)	- number of the grazed species (14 to 19) - Woody species (53 to 78%) - <i>Acacia raddiana</i> (7,3 to 26,5%), - <i>Acacia seyal</i> (5,7 to 8,4%) - <i>Balanites aegyptiaca</i> (6 to 38%) - <i>Ziziphus mauritiana</i> (1,8 to 13,1%), - <i>Mitragyna inermis</i> (0,3 to 8,2%)	- residue (0,0)

Table 8. Continue

Farmlands	season post harvest and cold	- number of the grazed species (7 to 8) - herbaceous species (0 to 32%), - <i>Borreria radiata</i> (2,9 to 3,7%) - <i>Cassia obtusifolia</i> (6,9 to 7,4%), - <i>Schoenefeldia gracilis</i> (0,6 to 3,2%)	- number of the grazed species (14 to 15) - Woody species (12 to 66%) - <i>Acacia raddiana</i> (18,5 to 24,3%), - <i>Acacia seyal</i> (4 to 4,8%), - <i>Balanites aegyptiaca</i> (2,5 to 6%), - <i>Bauhinia rufescens</i> (2,7 to 2,9%), - <i>Combretum</i> (0,5 to 2,2), - <i>Acacia nilotica</i> (0,8 to 2,2%), - <i>Ziziphus mauritiana</i> (20 to 25%)	- number of the grazed species (3 to 4) - residue (21 to 26%) - stalks of millet (8 to 16%), - stalks of sorghum (4 to 7), - Tops of bean (5%)
Grassy / Shrubby Steppes	all the seasons	- number of the grazed species (3 to 9) - herbaceous species (20 to 39%) - <i>Cassia obtusifolia</i> (1,4 to 24,7%), - <i>Chloris</i> (0 to 4,9%), - <i>Panicum laetum</i> (0,2 to 10), - <i>Schoenefeldia gracilis</i> (2 to 12%).	- number of the grazed species (11 to 14) - Woody species (61 to 80%) - <i>Acacia raddiana</i> (16,1 to 58,3), - <i>Acacia seyal</i> (2,7 to 9,4), - <i>Balanites aegyptiaca</i> (2,7 to 28%) - <i>Mitragyna inermis</i> (0 to 3,7%), - <i>Ziziphus mauritiana</i> (0 to 3,7%).	- residue (0,0)
Silt laden glacis	season rainy and post harvest	- number of the grazed species (1 to 4) - herbaceous species (0 to 49%) - <i>Cassia obtusifolia</i> (1,5 to 14%) - <i>Chloris</i> (0 to 20,8%) - <i>Aristida adscensionis</i> (0 to 20,8%), - <i>Schoenefeldia gracilis</i> (0 to 6,2%)	- number of the grazed species (2) - Woody species (51 to 86%) - <i>Acacia raddiana</i> (46,2 to 80,2%) - <i>Balanites aegyptiaca</i> (5,8 to 83,3%)	- residue (0,0)

species are mainly exploited during the rainy seasons (13%), the post harvest period (5%), and the dry cold season (5%).

Over the whole year, the pasture times of the woody species by the goats are superior to 60%. The herbaceous species have contributed only 33% with the highest level of 39% during the rainy season. *Cassia obtusifolia* has been important in the consumption of food with 12% in the average and the highest levels of 25% and 16% respectively during the post harvest period and the cold period. The dry hot season has particularly been a gathering period during which the dead litter not specifically determined has contributed at the rate of 12%. Specifically, *Acacia raddiana* (45%), *Balanites aegyptiaca* (8%), *Acacia seyal* (3%), *Ziziphus mauritiana* (2%), *Schoenefeldia gracilis* (8%), *Panicum laetum* (6%) and *Chloris* (3%) are the species that have been well appreciated by the goats.

Silt laden glacis

For the cattle, the silt laden glacis essentially supply grain

plants the whole year with an average of 98%: *Schoenefeldia gracilis* (39%), *Aristida adscensionis* (22%) and *Panicum laetum* (21%). This unit has not been exploited during the post harvest period by this specie.

In the other hand, the goats exploit there the woody species (67%) essentially composed of *Acacia raddiana* (58%), *Balanites aegyptiaca* (7%), and *Acacia seyal* (3%), the herbaceous species (33%), particularly *Aristida adscensionis* (12%), *Chloris pilosa* (12%), and *Cassia obtusifolia* (6%), *Schoenefeldia gracilis* (3%).

DISCUSSION

The various changes observed showed that the valorization of the pasture areas by the livestock in the traditional systems of stock breeding is complex; the investigations have shown the use of the various vegetation units are subjected to the seasons, and this use is very influenced by the stock breeding systems (Richard et al., 1991). In fact, it appears that in the agropastoral system, the exploitation of the farming lands are more important than in the pastoral system. This kind

of use has been observed the whole dry season on the AP lands at more than 50% of the pasture time, whereas in the PA village the exploitation has rather been important only during the post harvest period (46%), and less than 19% during the other seasons. This variation is equally controlled by the quality of the fodder resources. The importance of the attendance of the fallow lands, the steppes and the glacis remains very variable among the seasons. In the strategies of use and management of the pasture areas and the fodder production, it appears owing to the observations to deepen the knowledge acquired on the comparative advantages regarding to the vegetation units and particularly to the impact of the farming lands. The vegetation units presenting the best assets as far as animal production is concerned should have been studied in order to define the type of development that can be done.

The specific behavior of the animals on the pasture areas has a strategic interest in the management of the pasture areas (Tezenas Du Montcel, 1990). The observations show that the use of the pasture areas is very variable according to the species. In practice, cattle feed only 42% (during daytime) of the time they spend on the pasture areas compared to 61% for the goats. But the feed consumption during the night is important complementary time for cattle; the goats don't feed during the night. The use of the various pastoral units is therefore strongly influenced by the shepherds who guide the herd/flock and decide for the feeding time depending on the plant species. The exploitation of the pasture areas is for this reason controlled by the experience and the skill of the shepherd who decides about the strategies. The specific behavior of the animal species may also be subjected to the vegetation units and the seasons. The goats essentially feed in the fallow lands whereas the cattle attend in addition to this unit the farms and all the glacis. The large majority cattle in all the units is characteristic and confirm the complementarity of the species described by the various actors but above all its capacity to valorize a more higher number of the vegetation units (Guérin et al., 1991). During the dry season, the role of the shepherd in the exploitation of the units is weak, the caretaking of the animals being in reality very relaxed.

The observations have not permitted to perceive a kind of organization as far as the exploitation and the management of the available resources was concerned. The study effectively reveals that the fodder resources of the vegetation units are rather exploited according to their availability. There is no management of the space as such. It did not appear in the strategy at the level of the villages for the organization of the access to the fodder resources taking into account their preservation. The access to pasture is free; community based on the maximization of the valorization of the units by the animals. The fodder resources which are variable control the behavior of the animals and the shepherds (Kiema et

al., 2007). The inventories of the vegetation have well shown the weakness of the diversity of the fodder resources, the production of the biomass and the importance of the damaged species on both lands. The proposals for the improvement must take into consideration the techniques of improvement of the pasture areas. The new techniques like the stony cordon, scarification, the filtering barriers, etc., permitting to increase the diversity, the pastoral value, the covering over of the soil and the fodder production (Hien, 1995; Kiema, 2008). To these improvements, it might also be added the definition of the objective production of the producers in the herds/flocks and the organization of their movements to increase the efficient use of the available resources. The management and the improvement of the pasture areas must above all show the will of the community of the rural populations in particular the shepherds. According to Derrier, (1991), this will power must be organized around well stated objectives. Various aspects of the improvement of the pasture areas must be taken into account for the sustainability of their use. Among the main considerations, it is important to notice: (i) the improvement of the traditional exploitation practices through the control of the real weight on the vegetation units and the access times, to forbid or regulate the access to the pasture areas, to organize the movement of the livestock, to improve the performance of the herds/flocks by eliminating the animals that are less productive and by intensifying the production of animals; (ii) the development of degraded lands or lands of low fodder productivity but by protecting them temporarily which will enable them to regenerate progressively from the expected vegetation like it has been highlighted during the formal studies of Kessler et al. (1998) and Kiema and Sanon (2006). While exploiting, the conditions for a sustainable use of the plots of lands must be met in order to avoid a new degradation of the restored species and bring people to their preservation.

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CONCLUSION

The study of the pasture areas and their valorization by cattle and goats on AG and PA lands show the diversity of the situations that control the practices of the traditional systems of stock breeding. The fodder resources depend on the soil and seasonal characteristics very affected which explain the livestock's behavior on the pasture land. The various variations

observed indicate that the valorization of the pasture areas by the cattle in the traditional systems of stock breeding is complex. This study suggested the necessity to define a community based strategy of exploitation based on the characteristics of the pasture units, the seasons and the exploitation systems. The use of the various pastoral units can be managed by the shepherd who guides the herd/flock and decides about the time spent on the pasture area according to the animals' species. The various periods and vegetation units define values and the availability of the food following a calendar to be exploited to valorize the cycle of animals productions. It indicates the necessity to associate the development to the present use of the pasture areas (according to various techniques) to improve the animals productions. The point will be to (i) select the various types of performing development in accordance with the vegetation units and the establishment of controlled exploitation models (hay and/or seasonal pasture), (ii) develop and intensify new exploitation and development techniques of the pasture areas, (iii) secure the pasture areas by consensual delimitation of farming and pastoral areas at the scale of the lands, (iv) intensify the trainings on the exploitations techniques of the fodder resources, (access to the pasture units, exploitation of the woody species) at the level of the shepherds, (v) initiate internal and consensual rules of access to the pasture areas (in accordance with the vegetation units).

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