# Evaluation of the contribution of forest rangelands in the forage balance in the western part of the Central Middle Atlas: Case of the forests of Azrou, Jbel Aoua South and Sidi M'guild

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***Abstract—*** *Range management in Morocco is based on traditional practices where the land is used by a community for grazing by sheep. In the Atlas Mountains rangelands and forest lands are extensively used by grazing animals and even if the vegetation is abundant the cover is ongoing degradation especially in summer. The forest as a rich ecosystem where the plant community is constituted by Quercus and Cedrus sp. where overgrazing has an negative impact on the vegetation inducing degradation. The bred of sheep is Timahdit a bred which is adapted to the high mountain cold of the winter. The range is overgrazed by sheep and undergoes profound mutation with major degradation due to higher pressure by the increasing number of animals of the community which have the right to use the herbaceous cover. This study have the objective to determine the contribution of the range to meet the needs of the animals in the occidental region of the atlas mountains and determine the difference between the potential of the range and the need of the grazing sheep. The results showed that the herbaceous cover is over used by high numbers of animals. So a more rational use of the range is necessary to stop the degradation and sustain the production potential of the forest. The participatory method which includes the population in the decision making will allow better use of the range and sustain the resources and the forest by stopping degradation and a rational use of the range.*

***Keywords— Rangeland, overgrazing herbaceous cover, Atlas Mountains.***

## I. INTRODUCTION

Livestock breeding represents a significant share of Morocco's agricultural GDP (26 to 32% depending on the year) and 20% of agricultural employment. It generates significant income for the rural population. Furthermore, it is the best way to enhance pastoral areas. It contributes to the income of more than 80% of the rural population [1]. Rangeland is the primary source of animal feed in Morocco. They contribute on average 36% [2] of annual forage production, or about 3.4 billion forage units (FU). Extensive livestock breeding is the most used type in Morocco, which takes place on collective rangelands or in forest lands. Forest areas contribute to 17% of the national fodder balance [3], support 10 million head of cattle grazing there, and 45% of the national herd [4]. These sylvopastoral ecosystems remain subject to multiple technical, climatic, pastoral and social obstacles. These constraints weigh heavily on the management of this pastoral area and most often hamper the development processes undertaken there. Generally, pastoral ecosystems are very diverse and their level of production does not reflect the real potential of the environment. This situation can be explained by an overexploitation of the sylvopastoral resources: overgrazing, ecimage and delimbing of the tree and arborescent stratum during periods of drought. These repeated practices lead to the opening up or even gradual disappearance of these multiple-use formations, to the threat of soil erosion and consequently to the regeneration and sustainability of sylvopastoral resources, on which the survival of most user populations depends, is compromised. The pastoral mountains of the Middle Atlas constitute a region privileged by the existence of abundant sources and by a favorable tiering of climatic conditions. Extensive livestock breeding in this region is based on Timahdit sheep. The pastoralists of the region who, through a type of life and adapted habitats, use alternately the resources of the mountain in summer, the green oak groves of the Dir in spring, and the pastoral space offered by the Azarhar in winter: seasonal exploitation of these areas between which transhumance is played out, and within each of these areas use the different collective or private complementary paths of the forest. However, the scale of population growth in these areas, the sedentarization of pastoralists, the growth of the market economy and the recurrence of droughts, the ways and practices of using rangelands have undergone profound changes which induce major imbalances

between pastoral supply and demand. Overgrazing is considered the main cause of rangeland degradation. It is a direct consequence of an increase in herd numbers, as rangelands are their main source of nutrition. It is in this context that our study takes part. Indeed, the objective of this article is to estimate the forest potential in forage units and evaluate the impact of rangelands in terms of overgrazing in the study area.

## II. MATERIAL AND METHODS

### 2.1 Presentation of the study area

To evaluate the impact of rangelands in the Middle Atlas area, our investigations have essentially focused on measuring the annual needs of the livestock in forage units, and evaluating the forage potential of forest rangelands in the study area. Indeed, this task was essential to identify indicators of rangeland degradation. Taking into consideration that the Middle Atlas region occupies a considerable surface, our work on the ground was carried out in its western border of the province of Ifrane, encompassing three forests strongly recognized by a very remarkable pastoral activity, namely, the forest of Jbel Aoua South, Azrou and Sidi M'guild (Figure 1).

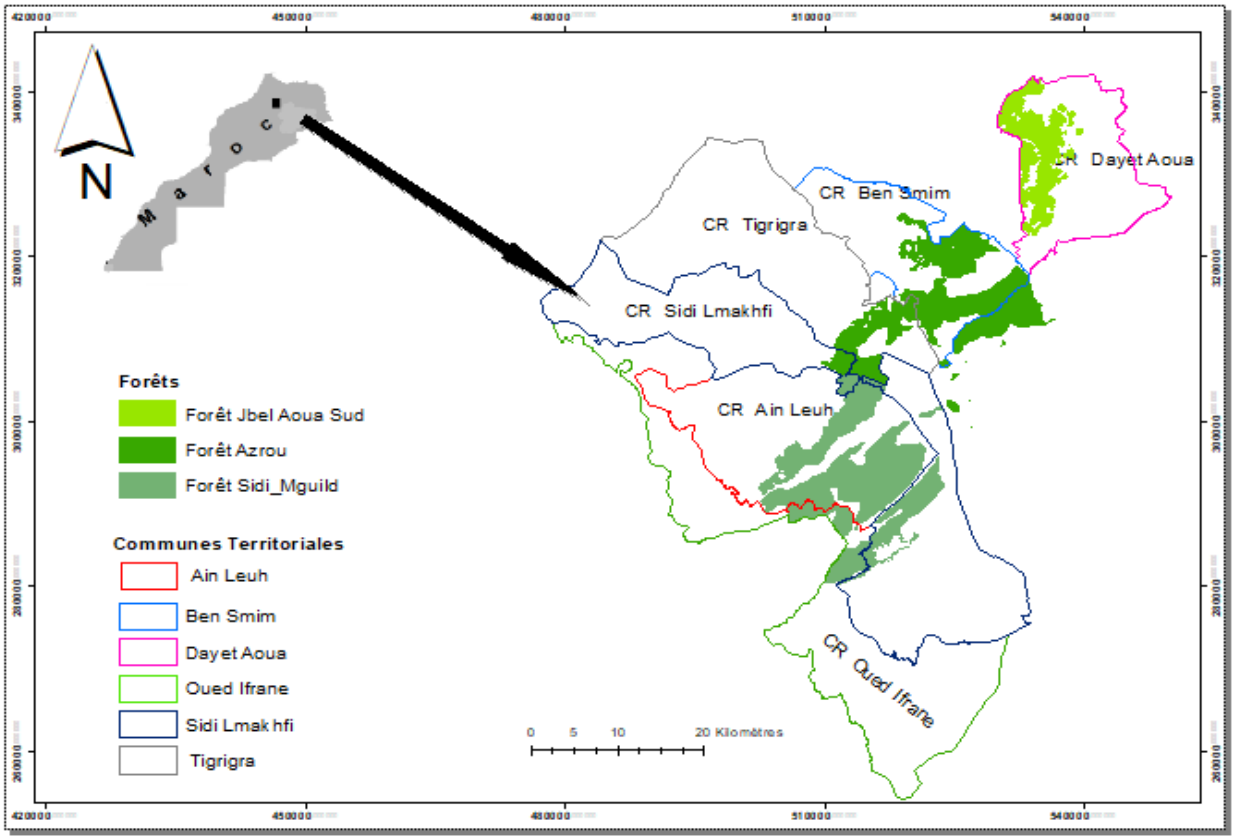


**FIGURE 1: Location map of the study area**

### 2.2 Methodological approach

In order to draw up a forage balance in the forest rangelands in the study area, our investigations focused on the determination of forage supply and demand. Thus, data collection from a field surveys and from their previous studies.

#### 2.2.1 The forage offer

The collection of information concerned:

- An in-depth bibliographical study of previous forest management plans in the province of Ifrane;
- A pastoral study carried out by the Ifrane National Park;
- Collection and analysis of population and housing census data (RGPH 2014) by commune and by terroir and other demographic data available at the provincial level.

### 2.2.2 Feed demand

To determine the forage requirements of the livestock breeding in the study area, the following data were collected and the following documents were reviewed:

- Collection of agricultural statistics, in particular agriculture and livestock breeding: general agricultural census: data by commune, vaccination statistics for livestock breeding in 2005 and 2016, other reference systems and survey results available at ONSSA level, etc;
- Consultation of associations and rural organizations concerned with forests in the area.

The analysis of the data collected made it possible to evaluate the potential in forage units, taking into account all forest formations. Indeed, the areas in question provide forage units with different productions (Table 1).

**TABLE 1**
**FORAGE PRODUCTION BY TYPE OF FOREST VEGETATION**

| Forest Vegetation | Forage Production (FU/ha/year) |
|---|---|
| Cedar | 300 |
| Mixture of Cedar, Holm oak and Zeen oak | 450 |
| Mixture of Cedar and Holm oak | 450 |
| Holm oak | 420 |
| Zeen oak | 320 |
| Holm oak mixed with the Thuriferous Juniper | 410 |
| Cedar mixed with the Thuriferous Juniper | 410 |
| Mixiture of Cedar, Holm oak and the Thuriferous Juniper | 370 |
| Mixture of maritime Pine, Cedar and Holm oak | 320 |
| Mixture of maritime Pine and Holm oak | 310 |
| Reforestation | 394 |
| Assylvatic vides | 394 |

The livestock's forage requirements were estimated on the basis of a maintenance ration of 300 FU/year per UPB [5].

## III. RESULTS AND DISCUSSIONS

### 3.1 Evolution of livestock numbers in the study area

The livestock breeding sector offers inescapable assets which enable it to occupy, with pride, the first rank in terms of agricultural turnover in Morocco and more particularly in the Central Middle Atlas [6]. Indeed, the territorial communes of this zone are traditionally considered as lands with a route, characterized by the presence of herd of all kinds confused with different proportions from one commune to another. Between 2005 and 2016, the number of UPB staff showed a positive and significant variation, averaging 28%, with a maximum variation rate recorded in the territorial commune of Sidi El mekhfi (+70.31%), and a minimum rate of (+3.61%) in the commune of Ain Leuh. In terms of numbers, sheep dominate the herd in all the territorial communes concerned. Indeed, the average number of sheep registered in the area is 96 833 against 11 333 goats and only 4 333 cattle in 2016. The average number of UPBs is around 127,567. An analysis of the changes recorded between 2005 and 2016 in the number of UPBs shows excessive growth in livestock numbers, especially in the territorial communes of Sidi El Mekhfi and Bensmim. Indeed, the weaknesses of the area's production systems have encouraged households to focus on livestock breeding activities, and have given concrete form to the abundance of herds to be kept in the forest (Table 2) and (Figure 2).

**TABLE 2**
**EVOLUTION OF THE HERD NUMBERS IN THE AREA BETWEEN 2005 AND 2016**

| Territorial municipality | Nature of Herd | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sheeps | | Cattles | | Goats | | Total of UPB | | |
| | 2005 | 2016 | 2005 | 2016 | 2005 | 2016 | 2005 | 2016 | Variation (%) |
| **Oued Ifrane** | 85521 | 89000 | 1600 | 3500 | 20500 | 15000 | 109921 | 118500 | 7,80 |
| **Sidi El mekhfi** | 115499 | 185000 | 2500 | 7050 | 13690 | 20500 | 138951 | 236650 | 70,31 |
| **Tigrigra** | 82000 | 97000 | 8100 | 8900 | 5500 | 8500 | 126900 | 148300 | 16,86 |
| **Ain Leuh** | 78683 | 83000 | 633 | 1500 | 16519 | 10000 | 95063 | 98500 | 3,61 |
| **Dayet Aoua** | 39483 | 38000 | 900 | 2600 | 11851 | 7000 | 53464 | 56600 | 5,86 |
| **Bensmim** | 58000 | 89000 | 1200 | 2450 | 4000 | 7000 | 67200 | 106850 | 59 |

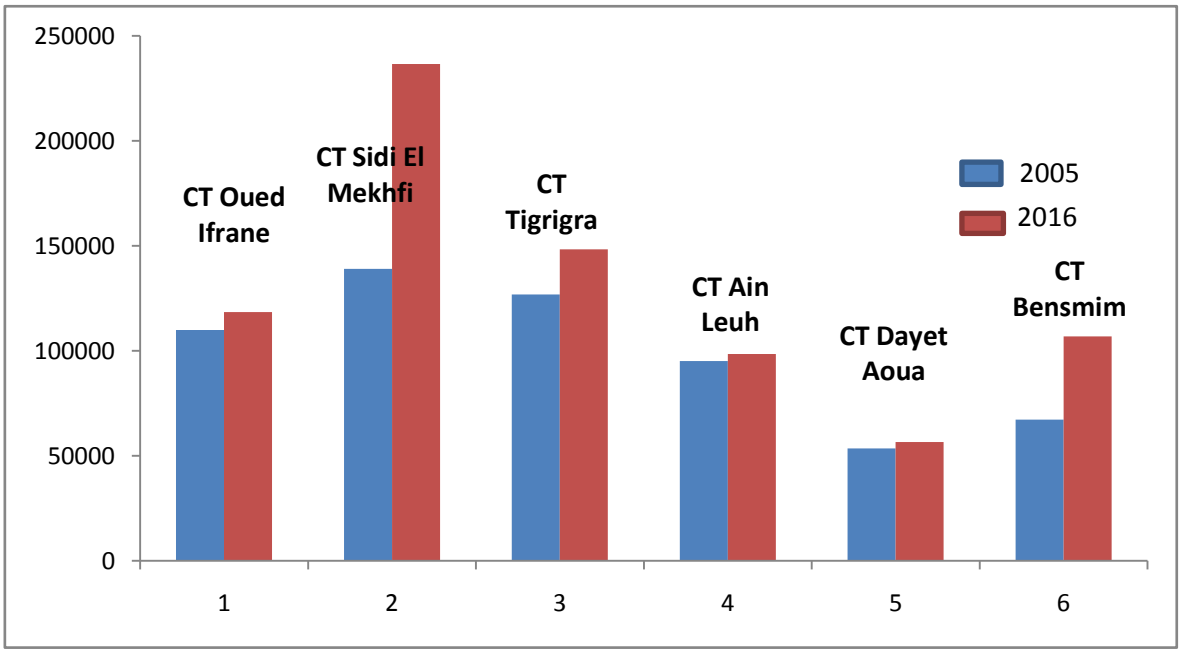


**FIGURE 2: Evolution of Livestock Numbers In the Area between 2005 And 2016**

### 3.2 Animal forage requirements in the area

From the data collected from the departments concerned, as well as the average forage requirement per head, we were able to deduce the demand formulated by the entire grazing livestock in the study area. The forage requirements in all the communes concerned amount to 229 620 000 FU/ha/year, with a maximum recorded in the commune of Sidi El Mekhfi: 31% of the forage demand in the study area. For the six municipalities, the needs of sheep represent the major part, these needs are of the order of 75.5% on average, followed by those of cattle representing 17%, on the other hand goats, need only 7.5%. These needs are mainly drawn from forest rangelands whose potential remains below existing capacities, which contributes to overgrazing and strong pastoral pressure in the forests of Sidi M'guild, Azrou and Jbel Aoua South characterizing the area under study (Table 3).

**TABLE 3**
**LIVESTOCK FORAGE REQUIREMENTS IN THE STUDY AREA ON 2016**

| Territorial municipality | Herd | Number of Herd | Number of UPB | Forage requirements (FU/year) | % |
|---|---|---|---|---|---|
| **Oued Ifrane** | Sheeps | 89 000 | 89 000 | 26 700 000 | 75,10 |
| | Cattles | 3 500 | 17 500 | 5 250 000 | 14,77 |
| | Goats | 15 000 | 12 000 | 3 600 000 | 10,13 |
| | **Total** | **104 000** | **118 500** | **35 550 000** | **100** |
| **Sidi El mekhfi** | Sheeps | 185 000 | 185 000 | 55 500 000 | 78,17 |
| | Cattles | 7050 | 35 250 | 10 575 000 | 14,90 |
| | Goats | 20 500 | 16 400 | 4 920 000 | 6,93 |
| | **Total** | **212 550** | **236 650** | **70 995 000** | **100** |
| **Tigrigra** | Sheeps | 97 000 | 97 000 | 29 100 000 | 65,41 |
| | Cattles | 8 900 | 44 500 | 13 350 000 | 30,01 |
| | Goats | 8 500 | 6 800 | 2 040 000 | 4,58 |
| | **Total** | **114 400** | **148 300** | **44 490 000** | **100** |
| **Ain Leuh** | Sheeps | 83 000 | 83 000 | 24 900 000 | 84,26 |
| | Cattles | 1 500 | 7500 | 2 250 000 | 7,62 |
| | Goats | 10 000 | 8 000 | 2 400 000 | 8,12 |
| | **Total** | **94 500** | **98 500** | **29 550 000** | **100** |
| **Dayet Aoua** | Sheeps | 38 000 | 38 000 | 11 400 000 | 67,14 |
| | Cattles | 2 600 | 13 000 | 3 900 000 | 22,97 |
| | Goats | 7 000 | 5 600 | 1 680 000 | 9,89 |
| | **Total** | **47 600** | **56 600** | **16 980 000** | **100** |
| **Bensmim** | Sheeps | 89 000 | 89 000 | 26 700 000 | 83,30 |
| | Cattles | 2 450 | 12 250 | 3 675 000 | 11,46 |
| | Goats | 7 000 | 5 600 | 1 680 000 | 5,24 |
| | **Total** | **98 450** | **106 850** | **32 055 000** | **100** |

### 3.3 Forage supply produced in the study area

The forage potential available in the forest rangelands in the study area is estimated at 17 067 302 forage units per hectare per year (Table 4), with intermunicipal and interforest variability. Indeed, the forest of Sidi M'guild offers 8 766 176 FU/ha/year (51.36%), followed by the forest of 5 142 142 FU/ha/year (30.13%), and finally the forest of Jbel Aoua South offers only 3 158 984 FU/ha/year (18.51%). This variability is essentially due to the composition of forest species with significant potential offered by holm oak and cedar forests. Certainly, this value is relatively important in comparison with others found by [7] in the forests of Tafechna and Reggada in the Middle Central Atlas which are of the order of 221 FU/ha and 259 FU/ha respectively. This improved production could also be linked to the favorable climatic conditions in the Ifrane area, which receives more than 1000 mm of rainfall annually, which conditions a favorable water balance in the soil and significant foliation of trees. The high density of the stand studied also contributed to the improvement in this forage value [8].

**TABLE 4**
**FORAGE SUPPLY FROM FOREST RANGELANDS IN THE AREA**

| Territorial municipality | Forest concerned | Forestry Vegetation | Area open for the grazing (ha) | Forage Production (FU/ha/an) | Forage potentiel (FU/an) |
|---|---|---|---|---|---|
| Oued Ifrane | Sidi M'guild | C+CV | 2487,38 | 450 | 1 119 322 |
| | | CV pur | 81,97 | 420 | 34 430 |
| | | CV+Gt | 52,25 | 410 | 21 423 |
| | | C+CV+Gt | 2,13 | 370 | 790 |
| | | VS | 436,95 | 394 | 172 160 |
| | | **S/total** | **3060,68** | | **1 348 125** |
| Sidi El Mekhfi | | C+CV | 723 | 450 | 325 353 |
| | | CV pur | 55,06 | 420 | 23 126 |
| | | CV+Gt | 572,20 | 415 | 237 465 |
| | | C+Gt | 143,33 | 415 | 59 485 |
| | | C+CV+Gt | 764,29 | 430 | 328 645 |
| | | Gt | 340,74 | 410 | 139 704 |
| | | VS | 1302,43 | 394 | 513 160 |
| | | **S/Total** | **3901,05** | | **1 626 938** |
| Ain Leuh | | C+CV | 8093,44 | 450 | 3 642 048 |
| | | C pur | 350,81 | 300 | 105 243 |
| | | CV pur | 1654,13 | 420 | 694 736 |
| | | CV+Gt | 714,57 | 415 | 296 546 |
| | | C+CV+Gt | 49,35 | 430 | 21 223 |
| | | Gt | 33,85 | 410 | 13 882 |
| | | VS | 2414,13 | 394 | 951170 |
| | | Cl | 139,62 | 320 | 44 678 |
| | | Rb | 54,79 | 394 | 21 587 |
| | | **S/Total** | **13504,69** | | **5 791 113** |
| Dayet Aoua | Jbel Aoua South | C+CV | 2008 | 450 | 903 600 |
| | | CV pur | 3484 | 420 | 1 463 280 |
| | | C pur | 17 | 300 | 5 100 |
| | | CV+Pp | 1509 | 310 | 467 790 |
| | | C+CV+Pp | 196 | 320 | 62 720 |
| | | Rb | 51 | 394 | 20 094 |
| | | VS | 600 | 394 | 236 400 |
| | | **S/Total** | **7865** | | **3 158 984** |
| Tigrigra | Azrou | C+CV | 1062,19 | 450 | 477 985 |
| | | C pur | 453,4 | 300 | 136 020 |
| | | CV pur | 1621,12 | 420 | 680 870 |
| | | CZ pur | 44,14 | 320 | 14 124 |
| | | CV+CZ | 92,48 | 450 | 41616 |
| | | C+CV+CZ | 79,95 | 450 | 35 977 |
| | | C+CZ | 8,62 | 450 | 3879 |
| | | Cl | 131,75 | 320 | 42 160 |
| | | Rb | 26,16 | 394 | 10 307 |
| | | VS | 336,34 | 394 | 132 384 |
| | | **S/Total** | **3856,15** | | **1 575 322** |
| Bensmim | | C+CV | 3994,72 | 450 | 1 797 624 |
| | | C pur | 644,89 | 300 | 193 467 |
| | | CV pur | 1999,08 | 420 | 839 613 |
| | | CZ pur | 40,92 | 320 | 13 094 |
| | | CV+CZ | 55,32 | 450 | 24 894 |
| | | C+CV+CZ | 27,89 | 450 | 12 550 |
| | | C+CZ | 9,74 | 450 | 4383 |
| | | Cl | 98,9 | 320 | 31 648 |
| | | Rb | 65,06 | 394 | 25 633 |
| | | VS | 1663,78 | 394 | 655 529 |
| | | **S/Total** | **8600,3** | | **3 566 820** |

***C : Cedar, CV : Holm oak, CZ : Zeen oak, Gt : Thuriferous Juniper, Cl : Crategus, Rb : Reforestation, Vs : Assylvatic vides***

Compared to the needs of the livestock, the pastoral forestry potential exploited in the study area of the western edge of the Central Middle Atlas represented by the province of Ifrane therefore covers only 7.43% of the annual needs of herd in the forests in question. However, current pastoral practices are causing the vegetation cover to deteriorate in an increasing and worrying manner. At forest level, annual losses are estimated at 1000 ha/year [6]. Also, forest stands remain prone to delimbing and lopping, the products of which will be used as fodder for herd. These practices cause the physiological weakening of the trees leading in the long run to a reduction in density and forest cover in the Middle Atlas. Such a situation threatens the future of forest ecosystems and their equilibrium structures and the exposure of soils to various forms of wind and water erosion, without forgetting the effects of climatic hazards that aggravate this situation [9]. It is in this context that pastoralism researchers have recommended that the "Arbre-Herbe-Animal" balance is necessary to maintain and develop forest and sylvopastoral resources[10] Analysis of the results obtained shows that the forage potential of forest areas does not meet the forage needs of herd in the same terms. Needs far exceed supply in the study area.

On the other hand, the presence of these herds, often all year round in the forest, prevents any possibility of natural regeneration, through soil compaction and watering of young seedlings, which has a negative impact on the balance of ecosystem regeneration in the Central Middle Atlas, home to a forest heritage of great value.

## IV. CONCLUSION

The forest rangelands in the study area contribute only 7.43% of the forage requirements of the grazing livestock in this area. Thus, the degradation aspects resulting from overgrazing in the communes studied can be observed at several levels:

- The forage possibilities of the forest of Sidi M'guild, Azrou and Jbel Aoua South remain below the forage needs of the livestock in the area, resulting in remarkable overgrazing leading to degradation of the undergrowth and preventing any possibility of natural regeneration;
- In times of famine, in addition to the failure to respect the defended lands, the shepherds attack the trees by pollarding and delimbing, to draw additional forage units from the herds. This phenomenon largely contributes to injuries and is considered an aggravating factor in the decline and physiological weakening of trees.

The examination of this situation leads us to reflect on the possibility of pastoral improvement based on local species in order to be able to meet the needs of grazing livestock in the forest following the recommendations of the national sylvopasoralism strategy initiated by HCEFLCD in 2016, on the one hand, and to limit the pastoral load, to reserve sufficient pasture for the users' herds, on the other hand.

Consequently, an organization of the user population of these forests is essential for a sustainable use of pastoral resources, through the practice of participatory silvicultural practices (depressing by the population) allow these populations to benefit from the forage units that are necessary for their herd. As well as socio-economic development in the area which will alleviate pastoral pressure on natural resources, in particular through income-generating projects that will make it possible to move from a path of more productive and not dependent on forest areas.

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