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Rangeland improvement and management options in arid environment of Central and South Tunisia

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RESUME – "Amélioration des parcours et options de gestion en milieu aride dans le Centre et le Sud de la Tunisie". Les parcours doivent affronter divers problèmes concernant leur gestion institutionnelle, sociale, économique et technique. Cet article est axé sur l'amélioration et la gestion des parcours dans les zones arides de la Tunisie. Une profonde mutation du statut foncier a eu lieu lors des cinquante dernières années, ayant de forts impacts sur les aspects techniques et socio-économiques. Cette mutation est due à la privatisation des parcours collectifs et à la mise en culture subséquente des meilleurs pâturages avec plantation d'arbres. Différentes pratiques de gestion des parcours sont passées en revue et analysées en utilisant des résultats d'évaluations rurales succinctes, d'enquêtes auprès des foyers et d'analyses économétriques de 5 échantillons de communautés représentatives du Centre et du Sud du pays. Les systèmes de production animale sont discutés et analysés eu égard aux différentes options de gestion des parcours, ainsi que l'utilisation actuelle des terres, et la distribution du revenu provenant ou non de la ferme. Finalement cet article révisé les principales options techniques pour l'amélioration des parcours en milieu aride, en particulier la mise en défens temporaire, le réensemencement, la plantation d'arbustes, et l'application de fertilisants. La plupart de ces techniques semblent être inefficaces en milieu difficile et la solution la plus prometteuse reste probablement de mettre au point des instruments de gestion appropriés faisant participer les usagers/communautés, et encouragés par les institutions locales.

Mots-clés : Privatisation, déstructuration, systèmes de production, gestion, techniques, revenu, institutions.

Introduction

Tunisia covers an area of 16.4 million hectares. The rangelands occupy about 5,5 million hectares, 87% of which are located in the arid and desert areas (45% and 42% respectively). The remaining rangelands are in the semi-arid (9%), humid and sub-humid (4%) zones. Depending on the year, these rangelands contribute nowadays between 10 to 25% to livestock needs, compared to 65% in 1960 (World Bank, 1995).

This regression is due to the decline of the rangeland area and the increase of livestock numbers. In fact, during the last four decades, the livestock has increased from 1.3 to 3.9 millions female units for sheep and from 250,000 to 750,000 heads for goats. About 72% of sheep numbers and 81% of goats' numbers are found in the Center and the South of the country (World Bank, 1995).

Rangelands are classified under various land tenure status:

- Forest rangelands	970,000 ha
- <i>Stipa tenacissima</i> based rangelands	743,000 ha
- Collective and state rangelands	2,500,000 ha
- Private rangelands for joint ownership	85,000 ha
- Private rangelands	1,200,000 ha

The rangelands are facing several problems with regard to their institutional, social, economical and technical management. They are managed in different ways and are, in most cases, used collectively. Different institutions, depending on the land status intervene, directly or indirectly in their improvement and management.

This contribution will focus on rangelands improvement and management in the arid areas of Tunisia. These areas are subject to severe land degradation and erosion of agro-biodiversity. The climate is highly variable with a quasi-permanent feature of low rainfall, high occurrence of drought, and water scarcity leading to uncertainty and low productivity. This arid environment is often perceived as marginal environment where economic activity is marginal.

Problematic

Problematic of rangelands improvement and management in arid zones of Central and South Tunisia are related to several issues: land tenure, socio-economic problems, ecological (environmental) problems, and technical problems.

Land tenure & rangeland users

Deep mutation of land tenure status occurred during the last fifty years with strong impacts on technical and socio-economical issues. This mutation is due to collective rangeland privatization and consequent cropping and tree planting of best pastures.

Indeed, collective lands (tribal collective lands or lands of "arouchs") represent 3 million hectares in 1956, i.e. around 1/5th of the national territory and 1/3 of the cultivated lands (Nasr et Bouhaouach, 1997). These lands are basically located in the Center and the South of the country. They were used for cereal crops and as grazing lands for the flocks of the collective communities.

The process of collective lands' privatization in Tunisia started as early as the first years of the protectorate by the delimitation of these lands. Later on, (Decree of 01/14/1901) a right of ownership of these lands by the tribes was acknowledged. Then, the Decree of 11/23/1918 has acknowledged the tribes' right of ownership as a preliminary condition to the right of collective lands ownership in the military areas of the South-East (tribes lands of Ouerghemma). Finally, procedures of assigning plots of reclaimed collective lands had started (Decree dated 12/28/1918 and 1/7/1935) (Hamdi, 1996).

Since the independence, important reforms have affected the land structures with the aim to proceed to collective lands' partition « habous » etc. Thus, the ancient regulations related to collective lands have been formulated and adapted to the new conditions of Independent Tunisia. The privatization conditions of the reclaimed collective lands have been clarified in Law N° 59-83 dated 07/21/59. Hence, the acknowledgements of the change of the ownership rights of collective lands, which have lost their range function because being cropped.

The collective lands' privatization process was accelerated after the "collectivization period". The assignment was carried out to the benefit of collectivities members represented by elected "Management Committees". Law 79-27 dated 11/05/1979 later boosted the privatization process. The issue of individual ownership titles has been accelerated to allow farmers to have access to credits.

Finally, at the end of 1980s, a decentralization process had been set in order to facilitate and accelerate the partition of collective lands. Thus, the Law n° 85-5 dated 02/08/1988 completes the Law 64-28 dated 06/04/1964 mainly in the matter of the decentralization of the land attribution activities through the establishment of a local "tutelage council" in each district (where collective lands exist) and a regional tutelage council at the Governorate level. The main purpose of the new law is to speed up collective land's privatization. Thus, after almost one century of land privatization and partition; about 1.3 million ha of collective rangelands were privatized, 0.6 million ha were submitted to forestry regime, and 1 million ha of identified and delimited collective rangelands remain un-managed (Nasr and Bouhaouach, 1997).

As a result, during the period 1971-1992, the regression of pastoral areas reached one million of good rangelands that have been converted to tree planting and cereal cropping. Meanwhile, along with this regression, the livestock number continued to increase.

Socio-economical issues

Important mutations of livestock production systems

Livestock production systems undergo deep mutations as the disappearance of traditional rules of rangeland management and transhumance in particular, and the « destructuration » of the traditional

social organization (tribal rules). Besides and due to factors developed above, the use of supplements by small ruminants increased from 0 to 80% in 3 decades (Fig. 1).

Two main changes occurred with livestock production systems, in the Center the pastoral system changed to agropastoral system, and in the South the pastoral system with large transhumance shifted to an extensive agro-pastoral system.

Thus, in Central Tunisia, collective lands privatization is boosted by the development of tree planting sector and irrigated perimeters together with the sedentarization of the nomads and semi-nomads. As a result the flocks' size decreased sharply with more integration of livestock and crop sectors accompanied by the increasing replacement of fat tail sheep by the Algerian sheep breed.

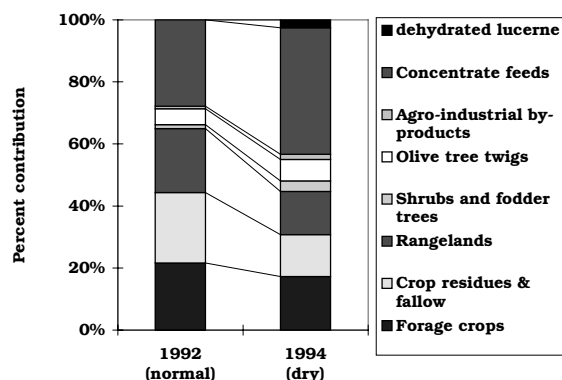


Fig. 1. Percent contribution of feed resources to cover livestock requirements in Tunisia in a good year (1992) and dry year (1994) (Nefzaoui, 1997).

In the South traditionally livestock was based on the use of large rangelands and transhumance to Central regions and even neighboring countries (Algeria, Libya). Large size flocks of more than 500 heads, rather frequent in the past, become rare but still present in the large steppic rangelands of the South. The herds are of medium size and a large proportion of farmers own less than 20 heads. According to the importance of the flock size, its composition, and importance of the family labor, farmers use several systems of shepherding alternative as guardianship by the family, recruitment of a shepherd, association agreement or "Khlata (Nasr, 1995 for the Dahar; Nasr *et al.*, 2000 for El-Quara).

Characteristics of current livestock production systems

Currently three livestock production systems are predominant, the pastoral, agro-pastoral and intensive system (Table 1). The pastoral system is decreasing in importance and where supplementation is increasingly important during rainy and dry years. The agropastoral is increasing with some integration and where supplementation is still practiced at quite high level. The intensive system is limited to irrigated areas where supplementation is quite low (use of fodders and crop residues instead of concentrate feeds) and where fat tail sheep is replaced by thin Algerian type. The sustainability of this production system depends of the water availability.

Table 1. Main characteristics of current systems (Nefzaoui, 1997)

Systems	Characteristics	Supplementation		Importance
		Good year	Normal year	
Pastoral	Rangeland based	xxxx	xxxx	Decreasing
Agro-pastoral	Crop/livestock integration, new breeds	xxx	xxx	Increasing
Intensive	Irrigated areas, new breeds	x	x	Limited, sustainability?

Current rangeland management options

In a recent study conducted within the framework of Mashreq/Maghreb project, five different options of range management are prevalent in Tunisia (Elloumi *et al.*, 2001), the “cooperative”, the “private”, the collective non improved, the collective improved, and the forestry regime type.

In order to study and analyze different options of rangeland management being used in Central and South Tunisia, rangeland sites were selected taking into consideration both the various land tenure systems and management options. The sites selected were:

- Bir Amama (Bir Lahfay, Sidi Bouzid) where a private rangelands, improved by spineless cactus plantation was selected as a case study of private rangeland.

- In the ancient “Habous” or “Enzels” land tenure system, we have chosen the area of El- Khaima (Mezzouna, Sidi Bouzid). The rangelands belong to the Haouchine Community. It is under forest legislation and covers about 500 hectares. This rangeland was improved by native fodder shrubs species (well adapted to aridity, but slow growing).

- For collective land tenure system, the following cases were considered:

- § Collective rangelands not subject to forest legislation: 300 hectares of Ouled Zid, Guettis sector (Gafsa).
- § Collective rangelands of 650 hectares under forest legislation and planted with *Acacia cyanophylla* and spineless cactus (Ouled Farhane, El-Makarem, Governorate of Sidi Bouzid).
- § A rangeland of 46,000 hectares in the Dahar of Béni Khédache (Medenine Governorate) subject to the forest legislation and provided, mainly with basic infrastructure (trails and water points). This case is referred to as “tribal improved”.
- § A rangeland in the Dahar of Tataouine, not subject to forest legislation and not managed; “tribal non improved”.

- In the former WFP (World Food Program) cooperatives, the site of Ouled Zid (Guettis sector, Gafsa) was chosen. This rangeland (300 ha) was improved by spineless cactus plantation together with *Acacia ligulata*.

Land use distribution and flock size

Economical, political and institutional issues related to these different management options were investigated, using rapid rural appraisals and household surveys as well econometric analysis.

Results showed clear discrepancy between sites located in the Center and those in the South (Table 2). Sites located in the Center experienced important diversification of production systems, while in the South production systems remained dominated by pastoral and/or agropastoral systems. Data on pluri-activities obtained from off-farm income confirmed this statement (Table 2). In fact, data from Guettis site differ from others because of the absence of off-farm income, while for other sites; the proportion of families that have off-farm income is high and may reach 65% at Béni Khédache and 88% at Bir Amama. Household income analysis confirms these results.

Other differences between agrarian systems of studied sites are related to cropping pattern and livestock production systems. The first significant difference between Center and South is the importance of fruit trees and the level of land development and use. Thus, for sites located in the Center, trees represent 28 to 64% of the total agricultural surface and even 71% for the site of El Kheima. This result confirms the history of land appropriation through olive tree planting and to differences in agro-ecological conditions. Harsh climatic conditions of the South explain the poor level of agricultural development in this region. It is worth indicating that farmers from the Center classify non-cropped lands as fallow land, while in the South, they are used mainly as rangeland or as impluvium for the jessours.

Finally, irrigation opportunities available in Ouled Zid (Guettis) site constitute another parameter difference cropping systems of targeted sites. At Ouled Zid, availability to irrigate allows vegetable cropping. This advantage has a beneficial effect on the whole production system.

Table 2. Land use distribution, flocks size and off-farm income in the different sites (Elloumi *et al.*, 2001)

	Cooperative	Forest	Private	Tribal Improved	Tribal non Improved	Total
Total agricultural surface	44	17	21	20	36	26
Rate of land use,% *	34	89	74	12	17	35
Flocks size in sheep equivalent	52.8	25.8	15.6	82	33.6	47.4
Off-farm income, %	3	49	88	65	42	48

* This percentage has been obtained for each farm by adding the land really used during the current year.

The impact of land tenure restructuring process is perceived in different ways according to sites. In the sites located in the Center, farms sizes are quite homogenous and development through promotion of tree planting is quite well advanced. Thus rangelands management is shifted from a pastoral type to private status with better crop/livestock integration.

For all the samples, livestock size varies greatly in spite of the presence of collective or private rangelands. Thus the average flocks size is 38 sheep and 3 goats, but ranges from 0 to 400 sheep and from 0 to 50 goats. In the Center and because of collective lands privatization, the trend is toward the reduction of flocks' size and to more integration of livestock and crops.

The average flocks size ranges from 15.6 in Bir Amama to 62 goats in Douiret (Table 3), but again there are very large variations.

Table 3. Farms distribution according to flock sizes, % (Elloumi *et al.*, 2001)

Flock size	Cooperative	Forestry regime	Private	Tribal improved	Tribal non improved
0	0.0	10.3	18.8	0.0	1.5*
0 to 10	0.0	21.8	50.0	14.5	32.4
10 to 20	6.7	38.5	12.5	10.1	20.6
20 to 50	53.3	23.1	12.5	31.9	29.4
50 to 100	33.3	5.1	6.3	17.4	8.8
> 100	6.7	1.3	0.0	26.1	7.4

* This situation is cyclical because some breeders had sold their herds following successive dry seasons.

So, we have sites where the distribution of livestock is relatively balanced with a majority having herds ranging between 20 and 100 (in the case of Guettis) while in other sites this distributions is less balanced with livestock ownership varying widely as in the case of Dahar rangeland (Table 3).

Rangeland management option effect on income generation and allocation

The level of income varies within and between range management practices (Table 4). This variation results from differences between farm and off-farm income sources and their contribution to the household total income.

Thus, except for Guettis (Cooperative system), income is generated both from farm and off-farm sources. Because of aridity and climatic harsh conditions, off-farm income contributes in a large proportion into income of the majority of households.

With regard to the agricultural production, figure 2 shows the contribution of crops and livestock to the gross product. Because of water availability for irrigation, Guettis site is different compared to other studied sites.

Table 4. Rangeland management option impact on income structure, in TD (Elloumi *et al.*, 2001)

	Cooperative	Forest	Private	Tribal Improved	Tribal non Improved	Total
Total income (1)	22940	1170	1312	2416	2165	4267
Agricultural income	22907	-165	-950	663	242	2764
Off-farm income (3)	33	1335	2262	1753	1923	1503
(3)/ (1) in %	0.1	114.1	172.4	72.6	88.8	35.2

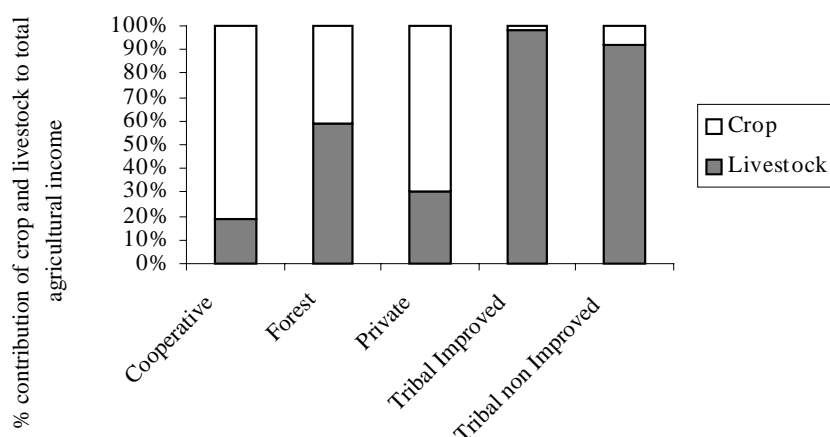


Fig. 2. Contribution of crop and livestock to the total agricultural product.

To conclude this analysis, we highlight the following:

- Importance of off-farm activities and income for the surveyed production systems, except for Guettis site where availability of water for irrigation helped to alleviate the agricultural development constraints.

- The decrease in herd size resulting from land privatization and rangeland cropping in Center of the country (Sidi Bouzid, Gafsa). This decrease has not always been accompanied with greater integration of livestock and crop production. Moreover, livestock production systems remain strongly dependent on purchased feed.

- The collective lands privatization of the Center resulted in the intensification of tree planting. This development may also have happened before privatization process because olive tree planting was used as a way of land appropriation.

Environmental issues – management

It is difficult to assess the impact of rangeland management options on rangeland degradation and environment issues in general. The absence of long term monitoring of rangeland resources (soil and vegetation) does not allow a coherent assessment. Nevertheless, the free access to collective rangelands and the trends of rangeland area and livestock number will let us assume that rangelands natural resources are submitted to strong pressure and are in process of degradation.

Also as a result of the privatization process, the general trend was the decrease of rangelands area and productivity generated by the increase of livestock number and pressure. Indeed the livestock number increased 2 to 3 folds artificially through import of feeds, feeds subsidies and feed transfer from favorable areas to unfavorable areas (Fig. 3).

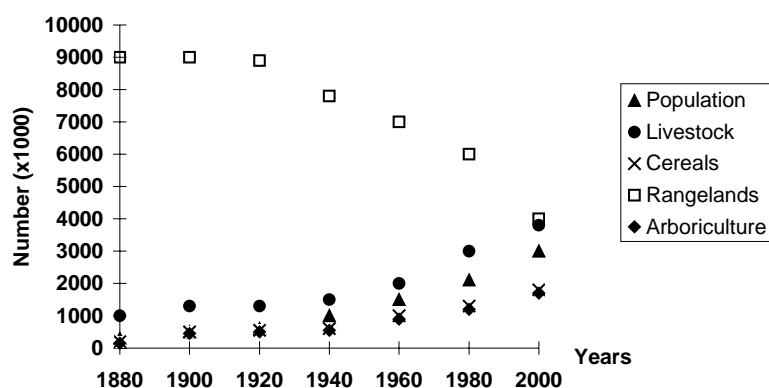


Fig. 3. Human and livestock pressure on rangelands (Nefzaoui, 1997).

Technical problems

Supplementation, transhumance and shepherding according to management options

Relationship between livestock production systems and rangeland management options

The main difference in livestock production systems between surveyed sites is transhumance, expressed here in terms of km. It appears that transhumance is extensively practiced in Dahar sites, even when water is made available, as in case of Beni Khedache. For the sites of the Center, herders of Guettis still practice some transhumance. They move towards the zone of "segui" of M'dhila where they are allowed to graze. This is done through an agreement between Ouled Zid and rangeland owners of Segui (Table 5).

Table 5. Flock management methods (Elloumi *et al.*, 2001)

	Cooperative	Forest	Private	Tribal improved	Tribal non improved	Average
Purchased feed costs TD/ewe equivalent	101.3	48.1	64.3	40.6	50.3	51.8
Distance covered in Km	18.5	1.8	0	40.1	45.5	26.1

The implementation of the surveys following two years of drought explains the importance of feed purchase in all sites. However, at some sites feed costs are higher than the common average (Table 4). It is the case in Guettis sites where despite the existence of an intensive production system, the high feed cost is due to unusual drought that affects the area and the construction of Sidi Yaich dam which halted the use of floodwater by the community. Meanwhile in the southern sites, farmers are able to reduce the feed costs by moving on wide rangelands spaces of Dahar.

Feed costs in dry years are related to strategies used to limit the drought effect, which may vary from one site to another, going from selling young animals to reduction of the flock size.

The use of shepherds depends also of the rangeland management option (Table 6). For the tribal rangelands, the extended spaces require the presence of specialized shepherds, aware of resources distribution in time and in space. For rangelands located in the Center, which are of smaller size and where agricultural activity is more or less integrated to livestock, shepherders almost disappeared and are used only for the rare transhumance of flocks towards the North part of the country. For this purpose, flocks are grouped with one shepherd.

Under unfavorable climate conditions, especially drought, the main strategy of farmers is to reduce the flock size, which is true in two thirds of the sample studied. For the remaining cases, it is either the purchase of feeds or the total absence of clear strategy. Here again the Southern areas adopt this

strategy (sale of reproductive units), due to the absence of forage and the high sensitivity of rangelands to drought (Table 6).

Table 6. Flock management methods (Elloumi *et al.*, 2001)

	Cooperative	Forest	Private	Tribal improved	Tribal non improved
Use of shepherd %	16.7	43.7	0	56	82.6
Reduction of flock %	16.7	65	25	84.6	81.7

Finally, the analysis of the production systems confirms the results of the analysis related to the land tenure structures and the relationships between the privatization process of collective lands and the orientations of the production systems. In the Southern area, flock management is dependent on grazing rangelands with dominant use of shepherds, even though supplementation during drought years is frequent. In Central rangelands the flock management is more and more independent of rangelands' resources.

Availability & efficiency of techniques to increase/sustain rangelands productivity

Several techniques were investigated to increase rangeland productivity. They include, deferment grazing, shrubs planting, reseeding, fertilizer application, scarification, etc. Some of these techniques show significant results under favorable conditions. But under arid environments most of these techniques failed and meager results are reported here and there. Table 7 summarizes the conditions and the assumptions for positive results of the main techniques available at this stage.

Table 7. Availability & efficiency of techniques to increase/sustain rangelands productivity

Techniques	Level of degradation			Assumption for positive results
	(-) -----		(+)	
Deferment grazing (rest)	X	XX	0	Available seed bank in the soil
Shrubs planting		X	X	Water availability (associated with water harvesting facilities); availability of adapted species/ecotypes
Reseeding		X	X	Sufficient soil moisture and availability of appropriate seeds
Fertilizers	X	0	0	Soil moisture
Scarification		X	X	Availability of soil seed bank, appropriate for crust soils

Deferment grazing for 2 to 3 years and even sometimes for one grazing season only might give good results if there is sufficient soil moisture and sufficient seed bank. This technique is not efficient if the range is highly degraded. At the moment this is probably the most indicated technique for arid zones rangelands and must be synchronized with rainy season.

Impressive results are obtained with fast growing shrubs planting (*Acacia cyanophylla*, *Atriplex nummularia*, *Opuntia ficus-indica*) in Central Tunisia where average rainfall is 200-300 mm per year (Table 8). The water requirement of these species cannot allow them to be used to improve rangelands of the South, since average rainfall is around 100 mm and even less. But in certain "niches" and in association with water harvesting techniques, *Opuntia* and *Atriplex* may be suggested. Still in this case it is recommended to use native shrubs, as *Rhus tripartitum*, *Periploca leavigata*, *Retama retam*, etc. which are better adapted to harsh climates. These native species are slow growing and their productivity is much lower than the introduced ones, which represent a real constraint for adoption by rangeland users. In both cases, serious investigation is needed to assess technical, social and economical efficiencies of both alternatives.

Results of reseeding in association or not with scarification are quite mitigated and remain

dependent of soil moisture and availability of seeds. Good results are obtained under favorable conditions but there is not a success story for harsh environment.

Table 8. Average productivity of rangelands in the studied sites (Elloumi *et al.*, 2001)

Rangelands	Improvement technique	Productivity (FU/ha)
Private (Bir Amama, Sidi Bouzid)	Spineless cactus	700
Submitted to the Forest Regime (Ouled Farhane, Sidi Bouzid)	Spineless cactus and Acacia cyanophylla	800 – 1000
Submitted to the Forest Regime (El Khima, Sidi Bouzid)	Rhus tripartitum, Periploca leavigata	300
Cooperative (Guettis, Gafsa)	Spineless cactus and Acacia ligulata	400 – 500
Tribal non improved (Dahar, Tataouine)	None	35 – 50
Tribal improved (Dahar, B. Khedache	None	35 – 50

Fertilizer, mainly phosphorus, is appropriate only when average rainfall is higher than 300 to 400 mm depending of soil type.

Conclusions

In view of the above analysis, rangeland development and management problematic is complex and diversified. They are related to the agro-ecological conditions and the socioeconomic context. Therefore, conclusions drawn from this study are to be used with precaution. Indeed, they give a good clarification of the current situation; but their use for identification of best options of rangelands management must be done with precaution. In fact, the diversity of the situations requires the development of technical options, management options and specific development project for each site or at least separately for the Center and the South of the country.

In spite of this large diversity, a set of common problems is identified. These problems are related to technical issues, to management options and/or to the potential role of users.

- The increasing demographic and livestock pressure on a decreasing rangeland have led to a breakdown of the balance between production and take-off.
- The poor farmers participation and the need to organize them in a body able to be erected as a partner for rangelands development and management.
- The need for Government intervention to support rangeland development and to draw together with users the main orientations.
- The absence of a unified framework of public authorities/administration.
- Management issues were often neglected in earlier development rangeland projects.

In addition to these common problems depending of the management method being implemented and the agroecological conditions, other constraints are specific to each site/region.

Thus, for Central Tunisia rangelands are residual plots of pasturelands where privatization was difficult to conduct. The main problems faced by this region are:

- The unbalance between current “technical projects” and farmers’ strategies reflected by the emergence of “subsidies captors”.
- The under-use of the generated feed resources from improvement action has a detrimental effect on the sustainability of rangelands.
- The overgrazing of rangeland resources had contributed to the degradation of plant cover.
- The unequal access of users to rangelands resources, which is caused by their production system orientation and by the availability of their means.

Rangelands located in the South are different of those of the Center.

- Livestock is the main agricultural income (90%) and the situation may collapse if rational methods of management are not applied.

- Confused land tenure status, especially for collective rangelands.
- Confused right of use and claimants "ayant droit" of rangelands (intra and inter communities conflicts).
- Lack of efficient and operational institutions representative of the population and able to participate in decision making for the development and the management of rangelands.

In view of these problems and constraints that need to be alleviated before implementing any intervention; some general orientations can be drawn to establish rangeland management options strategy.

- Delimitation of grazing lands and clarifying of their land status.
- Definition of claims and modality of access to rangelands.
- Need to organize users as partners in decision making for rangeland development and management.
- Need to unify all actors and administrative bodies dealing with rangelands around a clear policy and sound development projects.

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