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***Access to land, livestock production and ecosystem  
conservation in the Brazilian Campos Biome:  
the natural grasslands dilemma***

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# Access to land, livestock production and ecosystem conservation in the Brazilian Campos biome: the natural grasslands dilemma

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## Topic of discussion

Policies and practices for securing and improving access to land by the poor and promoting agrarian reform to alleviate poverty and hunger.

## Summary

How to improve access to land and livestock production in synergy with ecosystem conservation? The paradigm occurring in natural grasslands of the Southern Brazilian Campos biome is used to illustrate the dilemma. This paper aims to contribute by addressing the technical bases being used by legislations concerning access to land and incentive to production and their consequences for natural grassland systems. Current policies have a production-oriented focus trying to promote livestock productivity by setting **minimum stocking rates** to be applied in grasslands. The unexpected results are overgrazing and reduction of natural grasslands, so the dilemma production *versus* conservation emerges. There is a need for adapting access to land legislations to the new environmental functions expected for natural grasslands, which warrant a conservation-oriented approach according to their multifunctional role (livestock production, food security, ecotourism, conservation of biodiversity, etc.). Integrated measures are proposed, which could be helpful in resolving the conflicting compromises regarding the inducement of production and the promotion of natural resources conservation. Its follow-up would: i) stimulate policy makers' sensibility to promote measures to decrease the current trends in reduction of natural grasslands; ii) foster the dialogue among parties, helping in the advance of the political commitments; and iii) provide discussion for a FAO E-Conference, preceding a Campos tri-lateral workshop (Brazil, Uruguay and Argentina) aiming to build an international project on rural development and sustainable management of Campos natural resources.

## Introduction

The natural grasslands are facing contradictory pressures in developing countries. There is a demand to be productive, contributing to the country development, and the concern to be preserved, since lessons learned worldwide showed the huge social and economical implications in restoring degraded ecosystems. This dilemma reached a crucial point in Southern Brazil, and the need in coordinating efforts between production and conservation-oriented policies in the Campos biome should be examined.

## The Campos biome

The Brazilian part of Campos (Annex 1) is called "Campos Sulinos" and represents 2.07% (176,496 km<sup>2</sup>) of the national territory. Its subtropical natural grasslands represent about 90 % of the grasslands in Rio Grande do Sul State. It is the most important forage source for almost 13 million cattle and 5 million sheep. This natural grassland system is under threat, decreasing at a rate of 135,000 ha per year (Figure 1).

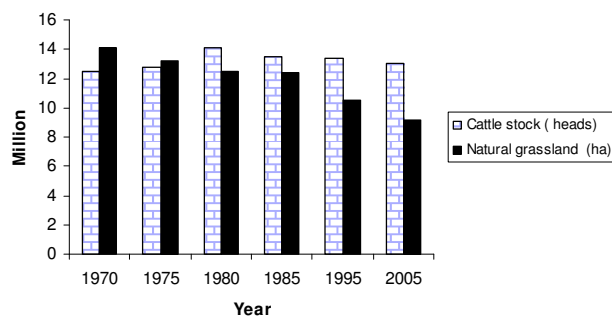


Figure 1. Evolution of natural grassland area and cattle stock between 1970 and 1995-1996 (IBGE, 1996). Data from 2005 was estimated. The decreasing area together with the maintenance of actual livestock numbers results in an increase in the stocking rate in natural grasslands.

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The expansion of the agricultural border (mainly cash crops, reforestation and cultivated pastures) together with overgrazing are the most frequent phenomena threaten the Brazilian part of Campos, as concluded by a tri-lateral study carried out by Argentina, Brazil and Uruguay (Bilenca & Miñarro, 2004). The consequences of biome degradation were estimated, such as: landscape fragmentation, loss of biodiversity, biological invasion, soil erosion, water pollution, land degradation and heavy use of chemicals. From the 14.078 million ha with natural grasslands in 1970, only 10.524 million ha survived in 1996 (IBGE, 1996). Current estimation sets natural grasslands in about 9 million ha (Dall'Agnoll, 2006 - pers. com.). The harmful effect for Campos Sulinos is the loss of biodiversity and ecosystem services<sup>2</sup>.

#### **Why policies try to motivate production but promote unexpected overgrazing ultimately?**

Access to land and production are foster by several initiatives, including the expropriation of non-productive lands (Annex 2). This later process gave rise to unexpected results by setting requirement levels of productivity to natural grasslands, in which a concept based on stocking rate<sup>3</sup> (converted in animal units) is used to address productivity<sup>4</sup>. The dilemma arises from the consequences on grassland management. The required stocking rates reflect averages of grassland systems with different livestock products and levels of intensification. Therefore, it was set too high for extensive natural grasslands, as demonstrated by the scientific community (Annex 3). Since ranchers have constraints to be considered productive, they are forced to overgraze or use cultivated pastures. They also turn into agriculture (mainly by land leasing) or even sell their land to cash crop farmers.

Despite the decrease in natural grasslands areas being a common consequence of agricultural intensification (Gibon, 2005), and overgrazing a global concern (Annex 4), the current production-oriented policies supporting access to land could accelerate this trend, which is not in harmony with conservation-oriented policies. This addresses the question about the use of the stocking rate in policies related to grasslands.

#### **Stocking rate and carrying capacity as a management tool to base policies**

Legislators from different countries are trying to face overgrazing (Box 1) by establishing levels of sustainable grazing ecosystem use. The carrying capacity<sup>5</sup> is the concept that has been used attempting to define the stocking rate in which the grazing pressure is supposed to be sustainable (Dikman, 1998). The basic principle is that each ecosystem has a potential to produce a certain amount of forage, and this amount defines the stocking rate which could be fed. It has been used by policy makers aiming to prevent the overgrazing in communal lands. In Southern Africa, policies have been oriented on de-stocking incentives aiming to control land degradation and increase individual animal performance (Benjaminsen *et al.*, 2005). De Haan (1997) proposes a conservative management in these cases, where a flexible destocking and restocking strategy could be desirable to conserve natural resources. African (e.g., Benjaminsen *et al.*, 2005) and West Asian (e.g., Kawamura *et al.*, 2005) initiatives are within the consensus that range degradation is caused or enhanced by overgrazing, and **stocking control is assumed to be a measure of conservation**.

European legislation is based on similar reasoning (e.g., the nitrate directive – 91/676/EEC). After decades of promoting the intensification of agricultural systems and specialisation in land use, the long-term effects of production-oriented policies proved to be deleterious to the stability of the land and water resources and biodiversity (Lemaire *et al.*, 2005). European legislation is currently facing the consequences of the attained level of livestock intensification by fixing maximum stocking densities (Tamminga, 2003), driven mostly by its consequence in increasing pollution and the aim to

#### **Box 1: Anthropogenic intervention leading to overgrazing**

*In the wild, herbivore populations are in a dynamic equilibrium with vegetation, fluctuating according to climate and forage availability. Animals reproduce when abundant feed is available, and die as a consequence of deficits. Humankind altered this equilibrium by the intervention on natural grassland systems (fencing, supplementing, mobility, subsidies, forage conservation, inputs of fossil energy, etc.) and the natural controlling process is buffered. Consequently, the animal population density is artificially maintained above ecosystem capacity.*

<sup>2</sup> Ecosystem services are the many essential goods and life-support services that human societies derive from natural ecosystems (Daily *et al.*, 1997).

<sup>3</sup> According to The Forage and Grazing Terminology Committee (1992), stocking rate refers to “the relationship between the number of animals and the grazing management unit utilized over a specified time period”.

<sup>4</sup> According to Briske & Heitschmidt (1991), the productivity of grasslands systems is measured in terms of primary productivity (plant growth/area/time) and secondary productivity (animal production/area/time).

<sup>5</sup> Carrying capacity refers to the maximum stocking rate that will achieve a target level of animal performance, in a specified grazing method, that can be applied over a defined time period without deterioration of the ecosystem (The Forage and Grazing Terminology Committee, 1992).

decrease the nature and the amount of nutrients recycling in the biogeochemical cycles.

Compared to other regions of the world, Campos Sulinos appears to facing a singular situation in which a **minimum stocking rate** is set by production-oriented policies, aiming to promote productivity in biodiversity-rich natural grasslands. Since the **stocking control is assumed to be a measure of production**, it addresses the question about the relationship between stocking rate and productivity.

### Stocking rate and its relationship with productivity

This animal-pasture relationship is complex and was discussed by several authors (e. g., Hodgson, 1990; Heitschmidt & Taylor, 1991). As stocking rate is increased, individual animal performance decreases, while production/unit-area increases to some maximum and then declines as a result of concurrent process controlling plant production and utilisation by the grazing animal (Figure 2).

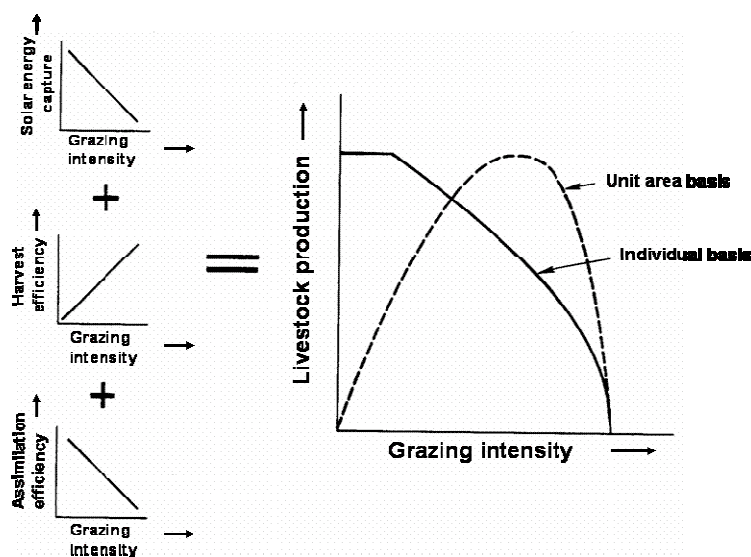


Figure 2. Livestock production per animal individually and per unit area in response to grazing intensity (from Briske & Heitschmidt, 1991).

Increasing grazing intensity<sup>6</sup> decreases plant solar energy capture because of the negative impact on leaf area index. The harvest efficiency is increased with increasing grazing intensity because the forage intake per unit area is increased. Conversely, with increasing the number of animals, the competition for forage decreases the individual animal intake, which diminishes the assimilation efficiency. From the nature of these relationships the so-called **fundamental ecological dilemma** encountered in grazing systems emerges (Briske & Heitschmidt, 1991), where the same stocking rate can not optimize simultaneously the individual animal performance and production per unit area. Forage plants need leaves to capture solar radiation, and animals need the same leaves to be fed. The consequence of these competitive processes is that proper stocking rates depends on production goals and when prioritizes individual animal performance or the stock production per unit area.

According to Conner (1991), because of temporal and spatial variation in quantity and quality of forage produced in grasslands, as well as different economic goals, there is not a single optimal stocking rate to maximize production. As a result of uncontrollable factors, desirable stocking rates vary widely with sites, seasons, years and within and among geographical regions (Heitschmidt & Taylor, 1991). Moreover, as stocking rate is increased beyond a moderate level, profit levels begin to decline because production costs generally increase at a somewhat faster rate than the rate of increase in gross returns (Conner, 1991). Thus, as stocking rate is increased beyond a moderate level, profit levels begin to decline. Consequently, stocking rate is limited to support production-oriented policies.

### Can we improve livestock production being concerned with ecosystem conservation?

De Haan (1997) described several policy measures to mitigate the negative effects and to enhance positive effects from the production *versus* conservation dilemma in grazing systems. His adapted

<sup>6</sup> Grazing intensity refers to the amount of animal demand in relation to available forage and is used to illustrate the stocking rate/livestock production relationship. Stocking rate is not as precise to describe animal-pasture relationships. For example, the same grazing intensity can be obtained with different stocking rates (e.g., 1 animal unit/ha with 1,000 kg of herbage mass/ha or 2 animal unit/ha with 2,000 kg of herbage mass /ha).

approach can be useful to start discussions on measures that could be taken. Since ownership of biodiversity is extremely important, the **property measures** could determine that access to grazing and water resources should be conditioned by the attaining of conservation responsibilities. The establishment of protected areas can be advanced, but the nature of Brazilian land tenure determines that incentives to invest and conserve biodiversity in private farms should be obligatory discussed. Access to land in natural ecosystems should be prioritised by conservation-oriented policies, and not by productive-oriented ones. **Financial measures** could promote conservation in farms where good conservative practices have been adopted. The creation of environmental debt titles could provide financial resources to indemnifying landowners who keep part of their lands as natural grasslands. Obviously, the definition of these practices and types of financial aid constitute a vast subject. For example, the provision of financial incentives by decreasing taxes, which fall over the land ownership or livestock product being produced in such areas, could be an incentive measure. In the same sense, agri-environmental schemes have been implemented within the European Union to compensate farmers financially for any loss of income regarding environmental policies (Kleijn & Sutherland, 2003).

Local empowerment and decentralization are important for sustainable grazing resource conservation, so partnership and collaborative agreements between federal, state and municipal institutes and civil society is vital. These **institutional measures** could be significant for a country such as Brazil, where it is difficult for a central service to dictate and react to local specificities. Finally, **information measures** to monitor ecosystem trends and conservation initiatives should provide qualitative and quantitative information to support policies measures. The dialogue with all concerned stakeholders in a continuous working group is necessary for a continuing reaction to market and land use pressures. Environmental education and training in local populations should be viewed as crucial to a long-term programme aiming to promote sustainable development practices and rural development.

#### **Final comments**

The new environmental functions expected for natural grasslands (Hervieu, 2002) should be taken into account by policy makers in reviewing and adapting relevant legislations. This is a challenge for developing countries, where natural grasslands are viewed as extensive systems, and intensification is the main focus on research, development and policies implicated. A sound judgment and coordination are the postulation to policies in balancing the production *versus* conservation dilemma.

Unexpected results from the current approach are the stimulation of overgrazing and reduction in natural grasslands. In this sense, two different approaches can be discussed. The first one could be the reduction in the set stocking rates for natural grasslands (e.g., between 20-30 %), considering data supported by research. It would be palliative, only partially addressing the overall problem, but still crucial. The second one, more complex, would need the changing of current focus. Access to land in natural grassland sensitive areas and all policies related to this natural resource should be adjusted by conservation-oriented initiatives. In this case production should be a reward, and not a target.

#### **Points to discussion at the ICARRD Conference**

The need in coordinating efforts between production and conservation-oriented policies address the following questions to be discussed at the ICARRD Conference:

- i) Change set stocking rates or change approach?
- ii) Which nature of access to land should policies determine in sensitive grasslands areas?
- iii) How much of the natural grasslands (and where) should be kept in its "natural" condition?

#### **Points to be discussed by the E-Conference (or even at the ICARRD Conference):**

- i) How other countries, considering legislation and other initiatives to promote productivity and/or conservation, address the stocking rate which should be used in grasslands?
- ii) How other legislations address the agrarian reform in grassland livestock areas?
- iii) Which initiatives have been taken into account to preserve natural grasslands?
- iv) Is this conflict between production-oriented and conservation-oriented policies occurring in other countries and what are the consequences and measures being taken?

#### **Follow-up: An International Project**

The Campos biome in Brazil, Argentina and Uruguay is facing the same threat at different levels. It is desirable that measures should be discussed and implemented jointly, analysing impacts, processes, mechanisms and the actors involved. Monitoring seems vital to determine and quantify ecosystem trends, aiming to support political interventions which assure biodiversity conservation and the revitalization of local rural communities. The international project concerning the rural development for the Campos biome would promote the tri-lateral dialogue, discuss conservation-oriented technologies and build local capacities to promote a sustainable management of natural resources.

### Annex 1: the Campos biome

The Campos Biome comprises 500.000 km<sup>2</sup> (latitudes 24° and 35° S) of Uruguay, Northern Argentina, Southern Brazil, and part of Paraguay (Pallarés *et al.*, 2005). Campos refers to a vegetation cover comprising mainly of grasses (notoriously *Andropogonea* and *Panicea*) and herbs (small shrubs and trees are occasionally found) which feed more than 65 million ruminants (Berreta, 2001). Livestock production is one of the main economic activities, as natural grasslands cover about 95% of the region. Beautiful scenes of animals grazing natural free ranging pastures in vast open spaces all year round confer a remarkable appeal to natural livestock products and ecotourism. These domestic herbivores were first introduced by European settlers in the seventeenth century (Bilenca & Miñarro, 2004). As natural vegetation has a low grazing history, high grazing intensities in this region can produce negative impacts on biodiversity (Soares *et al.*, 2003).

Campos Sulinos is recognised as containing a rich biodiversity. It is the habitat for 3,000 vascular plants, 385 species of birds and 90 terrestrial mammals (Bilenca & Miñarro, 2004). Despite advances in legislation<sup>7</sup> and conservation initiatives, only 2.23% of Campos Sulinos surface is being officially protected in seven conservation units comprising about 375,000 ha (Bilenca & Miñarro, 2004). Campos Sulinos, among Brazilian biomes, has received little attention compared to its counterparts (e.g., the Amazonian biome, which is a source of global concerns). Consequently, this biome has not the same level of concern and until now its threatening status has not been sufficiently recognized.

However, there are many symptoms of ecosystem degradation and loss of biodiversity in Campos Sulinos. More than 50 forage species, 16 mammals and 38 birds, among others, have been classified recently in different levels of threat by mismanagement of natural resources (Boldrini, 2005 - pers. com., MMA, 2005). Another example is the desertification process occurring in the western part. Considered as a natural phenomenon, it strongly increased in the second half of the twentieth century by non sustainable agricultural practices, reaching 5,200 ha in ten different micro-regions (Suertegaray *et al.*, 2001). Overgrazing and conventional agriculture based on inappropriate tillage systems are considered the main factors responsible for this phenomenon. Concerning the natural grasslands, probably the most important degradation process currently in course is the biological invasion by *Eragrostis plana*, a South African perennial tufted grass that has low palatability, prolific seed production and exhibits allelopathy. It was accidentally introduced around 1940 (Ziller, 2005). Its expansion is impressive, reaching 20,000 ha in 1978, 400,000 in 1993 and now estimated at an expansion rate of 14,000 ha per year, now covering almost 2 million ha. This process is being strongly increased by overgrazing of the natural pastures because the higher grazing intensities decrease diversity, vegetation cover and increased grazing pressure on preferred plants (Carvalho, 2005), favouring the spread of *Eragrostis plana*.

The expansion of agriculture (Box 2) is another concern to this ecosystem. Annual crops increased to about 5 million ha from 1985 to 1995-1996. It was estimated that soybean spread to 250,000 ha (primarily over natural grasslands) only in 2002. In 2005, the cellulose industry announced investments, expecting to reach 1 million ha of *Eucalyptus* spp. and *Acacia* spp. in the next years. A recent census indicates that Campos natural grasslands are decreasing in all countries at 3.6, 7.7 and 11.9%, respectively for Argentina, Uruguay and Brazil (Bilenca & Miñarro, 2004).

#### Box 2: the Brazilian agricultural modernization

Brazil has 851 million hectares from which 527 million hectares are potentially useful for agricultural employment. The country enters the new century as being one of the most important countries in the global trade of agricultural products. Brazil produced 112.715 million tons of grains in 2005, harvested from 45.114 million ha; particularly soybean, maize, rice, beans and wheat (Carvalho, 2006). This status was obtained by a strategy of agricultural modernization and land colonization carried by successive governments. The last century public initiatives generated policies of land colonization, and were oriented to the strategy of agricultural modernization (Guivant, 2003), providing incentives for expansion of agricultural and cattle-ranching frontiers. This changed some regions in a remarkable way, the Cerrados biome being the best example. Up until 1960 the Cerrados was exploited extensively, with a few farmers using natural pastures for cow-calf operations and many small farmers cultivating cassava and beans, mainly along river margins for subsistence. This changed drastically with government investments in highways and railways or direct agricultural incentives. Monocultures of cash crops or cultivated grasses spread to 40% of this system, and the population quadrupled. Export products, such as soybean, have increased notably. Commercial, large-scale, mechanised and capital-intensive farming has replaced small farmers, who have decreased by 1 million at the end of the twentieth century (in all regions concerned) (Carvalho, 2006).

<sup>7</sup> Brazil has developed an outstanding National Biodiversity Policy legislation to protect and preserve biodiversity (Brazil, 2004). For example, the land use legislation states for the concerned region of Campos that 20% of each farms' surface should be kept in its natural condition (*Medida Provisória* nº 2.166-67, 24 August 2001).

While in some biomes (e.g., the Amazonian) the discussions about conservation are based on preservation, Campos Sulinos has a clear economic function, and feeding grazing herbivores is its ecological vocation. Therefore, all conservation initiatives should take into account that sustainable livestock farming in the region is the *modus operandi* of conservation.

### **Annex 2: Access to land by a production-oriented legislation**

The Brazilian legislation promotes production within the scope of the agrarian reform, which was proposed by the law nº 4,504, sanctioned in 1964. The praiseworthy objective was to promote social justice and increasing productivity in the countryside by better distribution of lands. The agrarian reform was based in a stated-centred model by expropriation of lands which were not attaining their social function. It states that land is accomplishing its social function when: i) contributes to the welfare of owners and workers; ii) maintains satisfactory levels of productivity; iii) assures the natural resources conservation and, iv) observes the legal work legislation between owners and workers. The current legislation (*Instrução Normativa* nº 11, 4 April 2001) states two basic indices to define the land social function<sup>8</sup>: the land utilization rate and the exploitation efficiency rate. Consequently, from the complex definition of the land social function, in practice, it is the level of land utilization (or production) which determines consequential measures.

All grasslands, natural or cultivated, are included in the same orientation. While all the main agricultural products have defined levels of productivity which takes into account the type of the product (rice, soybean, coffee, banana, etc.) and the potentialities of the regional natural resources, establishing indices according to different regions, the legislation is not as precise for grassland areas. The same stocking rate level required in a certain region is suppose to refer to the productivity of different livestock products, such as calves, meat, milk, wool and animal genetics, for example. As crops have more identifiable and measurable products to estimate productivity (e.g., tons of grains per unit area in a wheat field), grasslands systems are more complex and, consequently, legislation become limited in the definition of productivity. The difference between well-fertilised cultivated grasslands and extensive natural grasslands, for example, is not considered. Consequently, the complexity of grasslands systems makes ambitious the setting of required levels of productivity by a single variable as stocking rate.

### **Annex 3: How do we know set stocking rates are too high?**

Universities and research institutes in Rio Grande do Sul have a large experience in natural grassland research. There is a consensus among Federal Universities, EMBRAPA (National Research Institute), FEPAGRO (Local Research Institute), etc., that legislation requirements are set too high for natural grasslands. From the vast bibliography available on the subject, some contributions were selected based on their relevance for this discussion<sup>9</sup>.

A long-term study on the effects of grazing intensities on natural grasslands was established in 1985-1986 by the Federal University of Rio Grande do Sul, supported by FAO. Twenty-year data shows that moderate stocking rates can duplicate the current regional livestock production. To maximize individual animal performance in Campos natural grasslands it is necessary to offer to the animals, on a daily basis, an amount of forage at least 4 times greater than its consumption potential (Figure 3).

The study uses variable stocking rates to maintain a stable relationship between herbage production and stocking rates. In this respect herbage growth is continuously monitored and stocking rate fluctuates according to pasture production. The graph consists of the averages (from 5 years) of livestock production (growing steers) during the growing season (220-240 days). The stocking rate in the best management fits well with the legislation requirements for the concerned region (0.8 animal unit/ha). However, to maintain the acquired animals' weight, the stocking rate should be reset to 180 - 200 kg live weight/ha (0.4 animal unit/ha) during the rest of the year (Maraschin, 1998). The maintaining of warm season stocking rates during winter, according to legislation requirements, provokes intense loss of weight (Maraschin, 1998).

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<sup>8</sup> A farm exploiting grasslands is considered productive if attaining simultaneously a land utilization rate equal or superior to 80 % (calculated by the relationship between the areas of land effectively being used in relation to that potentially usable) and a land exploitation efficiency rate equal or superior to 100 % (calculated by the total animal units in the stock in relation to minimum animal densities to be attained in five different zones).

<sup>9</sup> Maraschin (2001) provided detailed discussions about natural grasslands production potential at the XIX International Grassland Congress held in Brazil -2001.

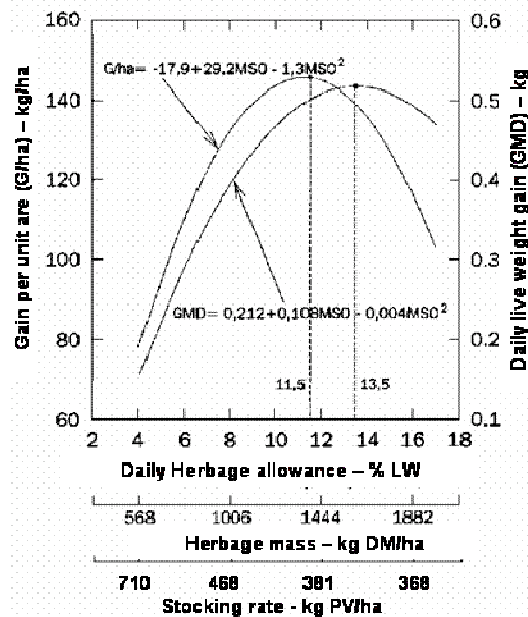


Figure 3. Livestock production per animal and per unit area in response to herbage allowance during the growing season (adapted from Maraschin, 1998).

In another trial, Fagundes *et al.* (2003) compared the stocking rate set by legislation (360 kg live weight/ha) with a conservative stocking rate (280 kg live weight/ha) in the context of cow-calf operations. The resulted pregnancy rate was 67.6 % (conservative) and 22.6 % (legislation), being the pregnancy rate a good indicator of the prevailing lowest feeding level in the stocking rate system defined by legislation.

Since conservative stocking promote higher herbage mass and vegetation cover, herbage growth is increased as well as different parameters associated with ecosystem sustainability (Figure 4).

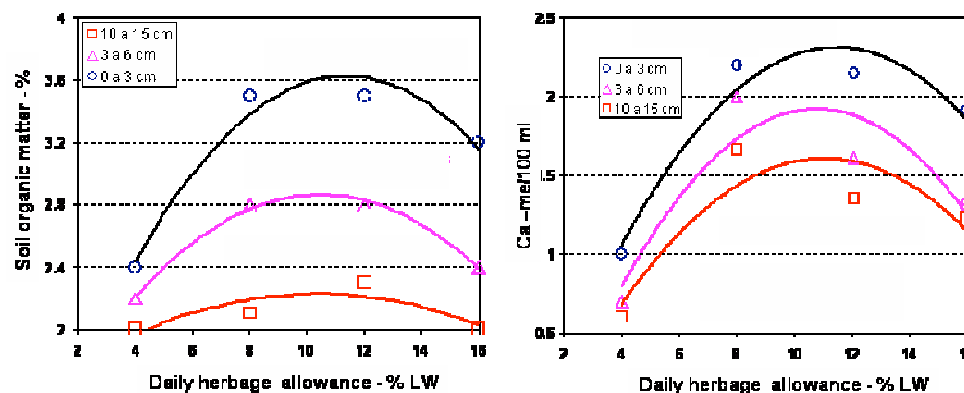


Figure 4. Parameters associated with sustainability in response to different levels of herbage allowance (adapted from Bertol *et al.*, 1998).

The herbage allowance in which livestock production is optimized is the same one which promotes range condition. Soares *et al.* (2003) demonstrated this strategy to offer 4 times the animal intake potential not only maximize livestock production, but also plant diversity. This is quite similar to suggested conservative stocking rates proposed for North American natural grasslands, where only a grazing efficiency<sup>10</sup> of 30 % is capable of increasing the most valuable forage plants, being  $\geq 50$  % the start of the overgrazing and degradation process (Holechek *et al.*, 1999).

#### Annex 4: Overgrazing and cattle asset value

Overgrazing is a global trend and reasons are complex reflecting biological, social and economical factors (Hanselka & Landers, 1993 and Kawamura *et al.*, 2005). Trying to explain the overgrazing

<sup>10</sup> Grazing efficiency is defined as the amount of forage consumed in relation to that produced.



behaviour of cattle ranchers from Central Brazil, Costa & Rehman (2005) studied ranchers' objectives and concluded that the cattle ownership sense (cattle asset value) and its benefits in terms of security and liquidity were the main reasons for overgrazing. Besides this most important reason, the objective of maintaining the ownership of land was significantly related to stocking rate decisions, illustrating the importance of this issue in determining the degradation of about 25 million ha of grasslands in Central Brazil (Costa & Rehman, 1999).

Recent stocktaking that focused on beef cattle operations in the Southern part of Campos concluded that the maintaining of the ownership of land is the most important factor taken into account by ranchers to manage pastures (Nabinger, 2005 – pers. com.). Therefore, the attaining of legislation requirements is almost the only management factor in place, reflecting in low production indices.

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