The importance of Campos ecosystem as a world food producer and as a provider of ecosystem services

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Abstract

The Campos ecosystem represent one of the largest grassland areas on the world, with great biodiversity in plants and animals. It contributes to improve world food security, based on ruminant livestock production, providing animal protein to feed more than 160.000.000 people. The research agenda for Campos ecosystem demands attention on the productivity and increasing variability phenomena, overgrazing, biodiversity standards and water contamination among other factors. It provides services including genetic resources, carbon storage, control of soil erosion, nutrient recycling, water production with low nutrient concentration and pest control. Overall, there is available technology to improve long-term livestock productivity and preserve current environmental indicators and improve sustainability, contributing to supply increasing world food demand.

Introduction

More than a decade ago, the IGC-IRC agenda held in Hohhot - China 2008 emphasized some emerging issues associated to global warming, the growing population, quality and welfare food, social stability, alternative energy sources, protection of environment and resources among others. The multifunctional use of grasslands introduced a new prospective from potential opportunities provided by grasslands over the world. By 2050, an increase of 34% in world´s population is expected reaching 9.8 billion people (OCDE/FAO, 2017). Currently, the dilemma still in to meet the increasing food demand, preserving biodiversity and ecosystems services and minimizing negative environmental effects. The Rio de la Plata Grasslands region (750.000 km^2) in southern South America is one of the largest areas of temperate rangelands over the world. The Pampas and Campos biomes are being affected by the intensification impacts. Despite that, these grasslands feed 42.1 million heads of cattle and 11.9 million heads of sheep, making a significant contribution to global food security (Socioeconomic Atlas, 2018; MAGP-SENASA, 2019; DIEA, 2020).

Impacts, at ecosystem scale, have been driven mainly by agriculture and forestry expansion during the last two decades. In the southern portion of South America, the area of summer crops (mainly soybean) and "double crops" (wheat-soybean within the same paddock) increased by 62% and 52% respectively (Volante *et al.,* 2015). Most of these changes occurred at the expense of perennial crops (mainly cultivated pastures) and natural habitats. These transformations occurred in 14.2% of the rangelands of the Rio de la Plata (Baeza & Paruelo, 2020). In consequence, livestock production systems are being reoriented to increase their profitability. In extensive systems, feed resources are mainly supported by native grasslands, small improved areas and strategic supplementation. Native grasslands increase productivity if improved management practices are applied at global scale. Intensive systems combine introduced pastures in rotation with crops, use of crops residues, cover crops, hay or silage, mainly for finishing animals. Associated synergies contribute to speed up from calf-cow to finishing processes.

Materilas and Methods

The Campos region is situated between 24^0 S to 35^0 S, covering approximately 500.000 km^2 of north east of Argentina, south of Brazil and the whole of Uruguay. This area is extended to

approximately 750.000 km^2 when transitional areas and the pampas region is included (Soriano, 1991; Pallares *et al.,* 2005). It is one of the largest grazing lands in the world for livestock production. The climate is humid subtropical to temperate, with four defined seasons. Rainfall ranges from 1200 to 1600 mm approximately, with a decreasing gradient in temperature from north to south (Oyarzabal *et al.,* 2019). These grasslands are bordered by deciduous xerophytic forest to the west, and deciduous tropical and subtropical humid forests to the north (Overbeck *et al.,* 2007; Andrade *et al.,* 2018; Oyarzabal *et al.,* 2018). Grasslands co-dominated by C3 and C4 species are the most abundant physiognomic type, combined with shrubs and forests (Boldrini, 1997; Overbeck *et al.,* 2007; Perelman *et al.,* 2001, 2017; Oyarzabal *et al.,* 2018; Lezama *et al.,* 2019) Winter is the period with lowest herbage growth rates (5-10 kg/ha/day of DM), contributing with around 10% of annual biomass produced (Bermudez & Ayala, 2005, Baeza *et al.,* 2010). In some conditions, the promotion of C_3 grasses is an alternative to improve pasture growth and seasonal distribution (Bendersky & Pizzio, 2013).

Results

Forage productivity and variability

Biomass production is affected by soil conditions, fertility, water accumulation, vegetation types. As a reference, annual productivity of native grasslands in the basaltic is 2.9 ± 0.8, 4.5 ± 1.0, 3.8 ± 1.0 to 8.1 ± 0.5 t DM/ha/yr in shallow, black and two deep soils respectively over 15 years (Berretta, 2005; Rodriguez Palma & Rodriguez, 2017). On the granitic areas in the easter region of Uruguay biomass production reaches 1.4 ± 0.6, 1.1 ± 0.5 and 3.7 ± 1.0 t DM/ha/yr in hill, shallow and rolling areas respectively (Mas *et al.,* 1997; Bermúdez & Ayala, 2005). In general, productivity of native grasslands varies from 2.5 to 5.0 t DM/ha/yr, with extreme values of 1.5 to 6.5 t DM/ha/yr under extreme drought or rainy conditions (Ayala *et al.,* 2011). The variability in herbage production between and within years affect pasture management and animal performance in terms of liveweight gains to reproductive performance of herd in extensive systems, demanding adjustments in stocking rate (Cardozo et. al, 2015), strategic use of improved pastures or supplementary feed (Modernell *et al.,* 2016). For those areas of Uruguay dominated by native grasslands, the PSN was around 760 MJ.ha-1.yr-1 or, in meat equivalents, 77 kg.ha-1.yr-1. This represents a forage-to-meat conversion efficiency of 1.17% (Gutierrez *et al.,* 2020). The control of grazing control, generating adequate sward structures, allows to increase animal productivity, soil quality and water infiltration (Nabinger *et al.,* 2011).

Livestock production

The Campos region supports 11.9 and 42.1 million heads of sheep and cattle respectively (Table 1). The high proportion of sheep stock (55%) is settled in Uruguay and the cattle stock (43%) in Argentina. Meat and wool produced is exported in a high proportion to different countries.

Table 1: Cattle and sheep stock in the Campos region.

	Argentina1	Brasil2	Uruguay3	Total
Sheep (heads)	2.136.902	3.187.776	6.562.000	11.886.678
Cattle (heads)	18.113.945	12.561.431	11.411.000	42.086.376

Source: [1]MAGP-SENASA, 2019; [2]Socioeconomic Atlas, 2018; [3]DIEA, 2020

The slaughter rate of animals in the Uruguayan herd is 19 and 13% for cattle and sheep respectively (DIEA, 2020). Based on local indicators, outputs from Campos region are 4.1 and 0.95 million ton of meat of cattle and sheep respectively (Socioeconomic Atlas, 2018; MAGP-SENASA, 2019; DIEA, 2020.). Meat consumption rates vary among countries, but estimations of per capita meat consumption rates are 30 kg of cattle and sheep together (OCDE, 2017). Potentially, the region can provide meat to feed 168.000.000 million people. The 60-70% of produced meat is exported, contributing to feed more than 108.000.000 million people living outside region.

Biodiversity and Ecosystem Services (ES) supply

The region has a population of 3000 vascular plants, 450 grasses and 150 legumes with forage value, 385 species of birds and 90 terrestrial mammals (Berretta, 2001; Bilenca and Miñarro, 2004; Pallares *et al.,* 2005; Boldrini, 2007). The great diversity of species makes it a center of origin of germplasm. From the prospective of herbage production, native grasses and legumes are adapted to intensive and frequent grazing and to variations in climate conditions and the occurrence of extreme phenomena (drought -wet, cold-hot, poor fertility-high fertility). There are

opportunities for the domestication of native species as well as the use of existing genetic variability for the development of new cultivars of those species of forage value. Local genetic resources provide feed source, ornamental, aromatic, nutraceutic or cultural use. Actions of prospection, characterization and conservation are required (Ayala *et al.,* 2011), especially in areas under risk by the agriculture pressure. Based on biodiversity analysis that integrates species richness (plants, animals) together with soil and water status at paddock scale Blumetto *et al.,* (2019) built an integrity ecosystem index (2017), a tool to evaluate the sustainability of productive systems operating on Campos ecosystem according to economic, social and environmental dimensions. Paruelo *et al.,* (2016) presented a synoptic index on the supply of regulating and supporting ES based on remotely sensed data. The Index was tested to evaluate the level of degradation of grasslands areas (Staiano *et al.,* 2020). State and Transition Models were generated for the main grasslands' communities and geomorphological regions of Uruguay (Altesor *et al.,* 2019, 2020). The Basaltic Cuesta region, in the North-central part of the country presented the best-preserved grasslands.

Outputs from Campos region

The intensification process on livestock production is expected in the next decades based on the increase in world population and food demand, affecting the ecosystem services supply from Campos biome and the conservation status (Paruelo *et al.,* 2016; Modernell *et al.,* 2016; Tiscornia *et al.,* 2019; Baeza & Paruelo, 2018; Texeira *et al.,* 2019; Rivero *et al.,* 2021).

Intensification alternatives to increase meat production and maintain/improve ecosystems services supply must consider the following:

1. Effects on biomass production: productivity, overgrazing, floristic composition
2. Effects on livestock production: growth rate, reproductive processes, feed conversion efficiency
3. Effects on renewable resources: soil health, water requirements and quality
4. Effects on environment: erosion, nutrients cycle, greenhouse gas emissions, carbon stock, climate change
5. Effects on population: lifestyle, heritage, consumer preferences, human health

Series of topics related with intensification are in the research agenda of different institutes and universities on the region Campos. The "Grupo Campos" is an organization (see www.grupo-campos.org) with actors involved in research, teaching and transfer actions to promote sustainable livestock production systems. Regularly, meetings allow to see the focus of these group of institutions.

In table 2 there is a list of research topics presented in Proceedings of Grupo Campos during 2017 and 2019 conferences. The 14% of total reports refers to emerging topics such as nutrients cycle and gas emissions. Clearly, topics like biomass production, pasture management and utilization and plant ecology and physiology represent the main focus of the reports (52%). The design and study of production systems and animal performance account for 25% of the list of reports.

A network of approximately 15 universities, 3 research institutes and 3 extension service units are active in the region.

Table 2: Number of research communications topics on "Grupo Campos Proceedings" between 2017 and 2019.

Year	Genetic resources	Productivity Quality	Management Utilization	Ecology Physiology	Diseases Weeds	Nutrients cycle	Gas emissions	Production systems	Animal performance
2017	-	17	3	10	4	11	1	12	9
2019	6	13	6	14	1	4	1	5	4

Source: Grupo Campos (www.grupo-campos.org)

The biome Campos and Pampas in the south of South America have the potential to play an important role in food security for world human population. There is knowledge available to improve productive inputs, intensifying the pastures-based system based on process technologies. There is a regional network including universities, research institutes and extension services to adapt and develop technologies for future scenarios. At the same time, agriculture and forestry are competing for available grassland scenario for livestock but providing synergies as

sub-products to feed livestock or conditions to reduce negative effects of climate and improve animal performance. This region offers a series of ecosystems services, being necessary mitigate emissions, in a changing climate scenario, but maintaining or improving carbon stock inventory. To improve the feed conversion efficiency is critical in terms of improve resources efficiency and reduce contamination.

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