Evolution of referential methods for grazing management on dynamic, heterogeneous rangelands: the case of the Regional Park of Massif des Bauges in the northern Alps, France

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Workshop

A shift in natural resources management paradigm: from resource sufficiency to functional integrity?

28th and 29th June, 2008

Agenda of the Workshop
Concept Note
Abstracts of the presentations

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Agenda of the Workshop

28th June 2008

- 8h30 – 9h00 : Introduction
- 9h00 – 10h30 : Presentation of 3 case studies
  - ✓ North Western China(Quinghai)
  - ✓ Tropical South American Grassland/Rangelands
  - ✓ North Western China (Gansu)
- 10h30 - 10h50 : Break
- 10h50 - 11h20 : Discussion on the 3 case studies
- 11h20 - 12h30 : Floor Discussion

- 12h30 - 14h00 : Lunch

- 14h00 - 15h30 : Presentation of 3 case studies
  - ✓ Andean Highlands
  - ✓ African Sahel
  - ✓ Mongolian Steppes
- 15h30 - 16h00 : Break
- 16h00 - 16h30 : Discussion on the 3 case studies
- 16h30 - 17h30 : Floor Discussion

29th June 2008

- 8h30 – 10h00 : Presentation of 3 case studies
  - ✓ French Haut-Languedoc hills
  - ✓ French Alpes Mountains
  - ✓ North American Prairies
- 10h00 - 10h30 : Break
- 10h30 - 11h00 : Discussion on the 3 case studies
- 11h00 - 12h00 : Floor Discussion
- 12h00 - 12h30 : Conclusion of the Worskhop

XXI Grassland / VIII Rangeland International Congress - Hohhot (China)

Workshop (28th-29th June 2008)

A shift in Natural Resources Management Paradigm: from Resources Sufficiency to Functional Integrity?

Concept Note

An enlarged heuristic framework to rethink sustainable management of natural resources

Agricultural sciences generally consider natural resources as a fixed capital –or stock- limited and renewable to a lesser or greater extent. When one of the elements that compose the agricultural system capital is judged to be insufficient to guarantee the sustainability of the system the solutions proposed in light of declining resources are a decrease in the rate of consumption, an increase in the efficiency of the system or a substitution with other resources. As far as rangeland management is concerned a similar reasoning is applied as can be seen in a number of technical recommendations on rangeland use and stocking rates (in regard to 'carrying capacity') based on the introduction of improved and more productive pastures or an increase in the production of biomass through external inputs, fertilizers etc. As stated by the philosopher P.Thompson, this kind of approach based on the notion of "resources sufficiency" focuses on the quantitative estimation of available resources and the measurement of rates at which resources are used in production, distribution and consumption of food (Thompson, 1997).

Such approaches and reasoning where limiting factors are treated in a hierarchical manner do not suffice for sustainable management of complex systems such as traditional and extensive pastoral systems or mixed farming systems. This is where the notion of functional integrity comes into the picture. Functional integrity does not focus on a particular component or resource but instead focuses on the systemic interactions between the various components of a system such as for instance interactions between production practices and ecological and social renewal processes. This notion could be illustrated in the case of extensive livestock farming. The diversity of resources that are mobilized (cultivated areas, diverse natural areas), the diverse functions of the system (production of meat, milk, wool, leather; animal labour; fertility transfers) and the diversity of services provided (biodiversity, landscape conservation, …) exhibit complex interconnections. The limiting factors or key elements of this complex and dynamic system are regenerated over time at a rate that depends not only upon previous states of the system but also on the dynamics of non biological factors (climate change) and different living communities interacting within the system. This regeneration of the key elements is indeed possible during a long period of time. Certain crises can however erupt suddenly (or with a substantial time lag) as a consequence of critical alterations in the regenerative capacity of any single element. These alterations could be the result of human practices and their evolution or due to inability of existing practices to adapt to external changes that affect the regenerative capacity of the elements that compose the system. According to this approach, resources cannot be dissociated from the practices that mobilize them and hence from the values, the references and the norms that underline these practices. It presumes that these norms, references and values are as such also components of the agro-ecosystems

To summarize, resource sufficiency assumes that agro-ecosystems wholes are simply the sum of resource transformation and consumption parts that make them up, or assume that such relationships are sufficiently stable and thus can be ignored. However, it is precisely these system level dynamic and changing interrelationships that are the primary objects of study for functional integrity., A sustainable management of resources thus depends on the successful identification of appropriate strategies that help resources preserve their capacity for regeneration and resilience as well as those that prevent irreversible effects capable of driving the system into states from which reproductive processes cannot recover.. All of this in a context of high uncertainties linked in part to the dynamics of external, economic, social and climatic factors.

Sustainable management of natural resources in terms of functional integrity calls for research that focuses on a better understanding of the limiting factors themselves, the different elements that compose the system and the systemic interactions between the elements that allow the system to regenerate or adapt. Ecology, ecosystem modelling, and systems analysis as well as agricultural, human and economic sciences are essential for understanding this approach that reinforces the importance of interdisciplinary. In addition, the complexity of the problems and the challenges faced requires an approach that promotes dialogue between the different actors and draws on different sources of knowledge ranging from academic scientific methods to local empirical knowledge.

A workshop associating scientists and practitioners

The aim of this workshop entitled "A shift in Natural Resources Management Paradigm: from Resources Sufficiency to Functional Integrity?" that will be held during the IRC/IGC Congress at Hohhot is to promote dialogue and discussions between scientists and practitioners on the thematic of functional integrity and sustainable management of natural resources in livestock systems.

A frame of reference for social and technical changes

The frame of reference that we would like to propose is based on three factors crossed with three induced dynamics.

Three principal categories of factors that affect the sustainability of the system are:

- Reconfiguration of markets, at both local and global scales ;
- Change in environmental factors, particularly those linked to climate change;
- Evolution of public policies that could affect the role played by the State, market regulations or the importance given to environmental issues

These above mentioned factors are clearly present in all the regions of the globe albeit to a greater or lesser extent. They influence the livestock systems and drive them into a dynamic that can affect:

- Institutional set up and arrangements inside of which these systems are organized (social structures, modalities of the use of space)
- Modes of collective actions, bundles of rights, and reconfiguration of identities (linked to the profession, cultural values, locality etc.)
- Re-qualification of resources, practices and areas (forage intensification, innovative systems of pastoral resources management, breeder skills, sedentarization etc.)

Organization of the workshop

The workshop is divided into three half day sessions with three case study presentations in each session. The case studies presented during this workshop will focus on the above mentioned three categories of factors that affect the sustainability of the system. The aim is to illustrate the consequences of each of these factors on the three types of dynamics that they induce. Each half day session will comprise of presentations on experiences and case studies (three per half day) in a diversity of situations illustrating the transformations of livestock systems in some of the most emblematic geographic zones.

These various experiences will be highlighted and viewed through the eyes of a scientist, belonging to a particular discipline, and a person from the field, breeder or development agent. The goal is to try and understand how the notion of functional integrity can help in moving towards sustainable management of natural resources.

Each presentation will be commented upon by a discussant and analysed through the discussants' point of view and put into perspective of the two other case studies of the session.

The discussants' analysis will be followed by a general floor discussion.

The first half day session (28th June 8.30 am – 12.30 pm) will comprise of presentations that have a macro approach and which are centred around the major dynamics of livestock systems in three regions of the world: North Western China (Quinghai), Tropical South American Grasslands/Rangelands and North Western China (Gansu). The second half day session (28th June 2.00 pm – 5.30 pm) will focus on the viability of livestock framing which is at stake in certain regions such as Andean Highlands, African Sahel and Mongolian Steppes. The third and the last half day session (29th June 8.30 am – 12.30pm) will focus on livestock farming that is in mutation in French Haut Languedoc hills, French Alps and North American prairies.

The floor discussion and the resulting debate that will follow the last session could lead to the identification of certain key issues that constitute gaps in knowledge which research to a certain extent could contribute to resolving. This workshop could also be the starting point of future collaborations between interested research teams and their partners.

The workshop will lead to a publication in the form of a book in which significant importance will be given not only to the presentations but also to the discussions that follow the presentations and above all to the recommendations resulting from the workshop destined for researchers, practitioners and decision makers.

The conclusions of this workshop will be presented by Dr Bernard Hubert during the IRC/IGC 2008 in the C3 "Land use change and Grassland/Rangeland tenure" morning session that will be held on Tuesday July 1st from 10am till 12.30 pm. *(Conference room : to be confirmed).*

Thompson, P. (1997) "The Varieties of Sustainability in Livestock Farming," in *Livestock Farming Systems: More Than Food Production*, J. T. Sørensen, Ed. (Wageningen, The Netherlands: Wageningen Pers) pp. 5-15.

North-western China: looking for sustainable ways of subsistence

Public policies oriented towards economic development and environmental protection impact on social organisation, cultural values, resources management and agricultural practices.

By Li Sandan[1], Luo Peng[2], Gao Yanming[3], Sylvie Dideron[4]

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Since the late 1970's, China has witnessed rapid economic growth accompanied by a sustained increase in farmers' income. However, this development process did not benefit much to the "Great Northwest". This vast mountainous semi-arid area remains poor, with increased disparities between urban and rural areas, and people suffering from low per capita income, poor social and education services and difficult accessibility.

Northwestern China is also an "environmentally" sensitive area. The intensive on-going erosion of the loess plateau results in the accelerated accumulation of sediments in the lower part of the Yellow River basin, increasing risks of flood and threatening the densely populated Central Plain of China, a major economic and industrial pole of development.

The economic development of North-western China is one of the government priorities and, during the last decades, enormous budgetary efforts have been dedicated to support the implementation of large-scale and ambitious programs in the area. The objective of the public policies targeted to the North West is actually two-fold: to compensate the development discrepancies with other regions by supporting infrastructure construction and the industrial sector, and to control the erosion process going on in the Yellow River basin.

Agricultural activities- cultivation of marginal land on slopes and extensive grazing- are often considered as a major source of soil erosion. To control erosion public policies aim at stopping cultivation of marginal land, reducing extensive grazing practices and encouraging reforestation. However, in the region, a major part of the population relies on agricultural activities for their subsistence. Therefore, by reducing agricultural activities, there is a risk of increasing the precariousness of the farmers' economic situation. Unless other sources of income are generated for farmers. The government strategy relies on two assumptions: off-farm employment opportunities will continue to increase for unqualified or low qualified labour, and more productive agricultural systems will be established that will compensate the loss of arable land and the decrease in livestock numbers.

Public policies clearly set-up measures giving direction for changes of the agricultural systems in North-western China. Two case studies will illustrate the impact of the public policies in terms of sustainability of the livestock and agricultural systems, with an in-sight on three dynamics: institutional set-up and arrangements, social and traditional identities, and re-qualification of resources.

Herding systems on the Tibetan plateau:

Public policies influence nomadic herding activities through measures aimed to promote the settlement of nomadic herders at least in winter, restrict the area dedicated to pastureland through subsidies for giving-up pastureland, and limit the herds and flocks size through allocation of quotas per pastureland. This bunch of measures result in a shift from a nomadic pastoralist system to a semi-settled individual family livestock system, inducing major changes in:

- Traditional institutions and decision-making processes;
- Land rights (from commonly managed access to land in time and space to individual rights) and cultural values linked to herding (multi-function of traditional herding system: utilisation of animal products for everyday's life, living in tents versus houses, diet); and
- Modalities of access to and utilisation of resources as well as technical practices. Technicians propose new techniques meant to increase the livestock productivity under the restricted conditions of access to natural resources such as forage intensification (oats for hay cultivation), rotational grazing, improved breeds, settlement etc. These techniques are not always easily and widely adopted and do not fit the socio-economic conditions of all types of herders. A necessary adjustment of the husbandry practices is going on.

Mixed farming systems areas.

Public policies aim to stop extensive grazing on collective land and to promote intensive animal husbandry practices: grazing is banned on slope land formally used in common as pastureland by villagers, huge areas on slope land are planted with trees or closed to any activities to allow forest natural re-growth. In four years time, the numbers of livestock and the cultivated area have been drastically reduced. This results in a disruption of the agricultural system and impacts on:

- Institutions: Various local administrations are involved in the implementation of these public policies. Each institution is responsible of the implementation of activities in its own field (forestry, animal husbandry, agriculture). However, the forestry sector plays a major role in the implementation of the present programs, especially regarding establishment of land use planning. The changes in agricultural systems induced by the public policies request coordination between government agencies. After several years of failure, implementers re-orient their approaches for an open dialog, and shared decision-making.
- Identities: this policy tends to go ahead with the policy initiated at the end of the 70's with de-collectivisation and establishment of private and individual rights and management systems, and turned towards profitability.
- Agriculture practices: Cultivation and livestock were previously closely linked, manure being utilised to fertilise crop fields and livestock being fed by two major sources, crops by-products and common grazing land. In this "zero-cost" system, expenditures were reduced as much as possible. On the contrary, the new system proposed is based on the intensive utilisation of animal feed, chemical fertilisers and pesticides. This change will necessitate the establishment of a dialog between technicians and farmers families in order to elaborate practices that can be adopted, taking into account local knowledge and technical innovations. Livestock rearing and tree plantation compete for the use of natural resources. Searching for a solution suitable for all implies a re-organisation of land and natural resources management: modality for allocation of land use rights, local regulations of access, management and utilisation of the common land (grazing land, forests).

South America, the new global center of food production

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At the beginning of the 21st Century, South America, and in particular the countries of the Mercosur, are food providers on a global scale, especially in the sector of livestock produce, i.e. meat and dairy products, as well as soy beans and cereals. The commercial links, formerly mainly with Europe and the United States, are now increasingly directed towards the emergent countries. The historical perspective shows that the export market has grown at the same rate as the South American bovine and ovine production. The market has always been the main driving force and it should continue to, know that the area has a strong potential for growth in food production.

The colonist and his herd replace the Indian and his game

From the historical and socio-spatial point of view, livestock breeding appears as one of the drivers of the colonization of the Amerindian lands in order to exploit the natural resources of its soil and subsoil. It led to the creation of new territories and offered a new perspective to the European and Asian migrants who were often excluded from the land system in their own areas and country of origin.

Apart from the llama and the alpaca in the Andean mountain range, pastoral breeding does not seem to have been a widespread activity in pre-Columbus societies. Hunting, fishing and farmyard animal breeding appear to have been the main source of animal proteins. It seems that the territory of hunting and fishing often merged with the community territory.

The market in pastoral history, as well as other major drivers

Social, cultural, identity and political factors, among others, have combined to have a complex influence on each other as well as on the market, which has often been put forward as the sole factor because it is more easily identifiable and quantifiable and thus able to be modified. As an example, a fine analysis of those responsible for deforestation in the Amazon show frighteningly successful land appropriation strategies. In the same way, the exploitation of the South American subsoil, rich in hydrocarbons and other ores, tends to direct the public policies towards the balance of the nation's economies.

The ox, spearhead of colonization, enters by savannah and is introduced into the forests

The herbaceous biomes of the Pampa in the south and Llanos in north were the first to undergo colonial pressure in the 17th century and became populated by herds in the hands of colonists who took possession of the land. From the 18th century, the Patagonian steppes became populated by sheep under the impulse of the British wool companies. At that time, the forest biomes were still little concerned with livestock breeding, with the exception of the Atlantic fringe which became arable land where the livestock was used for labour and transport, and also for the provision of animal protein for local populations. From the second half of the 19th century, the tropical forest savannas were gradually occupied by beef herds, and then zebus herds who were more adapted to the tropical conditions. The Mata Atlantica was the first transformed land. After crossing this barrier, it was the turn of Caatinga in north, Cerrado in the center and Chaco in the south. The process continues in the 20th century and has reached the Amazon. Today these biomes hold nearly 250 million cattle, which added to the more or less 50 million in the Pampa, account for approximately 20% of the world livestock.

The ox adapts to the resource then transforms it to grasslands before sharing it with agriculture

South American pastoral space is not similar to how it was before the European arrival. Livestock breeding there today takes profit from a ready-made resource which is partly modified from what once existed, and partly created, having spent a few centuries in the presence of colonists. Submitted to the influence of man and the herds, tropical woody savannas evolved into grasslands, following the same process that the herbaceous steppes and savannas had experience some time before. Even if the fodder plants of African origin that were introduced predominated, decreasing the natural biodiversity, a good increase in the food value of this biodiversity took place, as well as a real adaptation of the breeding practices to these new contexts, in particular concerning the water resource. Thus, the places where the permanent habitat is located are the plains, which are grazed preferentially in the rainy season, and the hollows, where the herds concentrate in the dry season.

At the beginning of the establishment of livestock breeding, in parallel there was a systematic exploitation of the natural resources available: wood, non-wood forest products, animal skins, etc. Gradually, both to control its territory and stimulated by the market, society has intensified its modes of exploitation. The extensive breeding is substituted by export agriculture, supported with credits, mechanized and involving many

industrial inputs. The hilly areas remain the field of the pastoral activities. The breeding is not being eliminated, far from it. It keeps a dominant position in every landscape of every biome. Thus Cerrado, known worldwide for its production of soybeans and cereals, still remains mainly covered by grasslands. In addition, it has profited from the new context to move to intensification.

Environmental impact of dynamic agriculture in progress and its social externalities

The Amazon, with a deforestation of about 15 to 25%, according to different countries, is focused on by the media. At the same time, nobody mentions the Mata Atlantica, the Cerrado and the Chaco, which have nearly 95%, 70% and 50% of their surface deforested. However, these three biomes joined together cover a surface almost equivalent to the Amazon and present a biodiversity which is among the most remarkable on the planet.

The environmental impact also relates to the water cycle. The deforestation of Chaco, Cerrado and Mata Atlantica is directly responsible for the intense floods in the whole Plata-Parana-Paraguay basin, one of largest on the planet. The deforestation of the Oriental Amazon has resulted irregular water cycles with climatic consequences which are still little known but potentially major.

At a local scale, the establishment of livestock breeding often resulted in a random occupation of the available surface land without taking into account the potential of the above ground pre-existing ecosystems. Thus, in the woodland and forest ecosystems, the pasture was established in an ill-considered way along the riverbanks, the surroundings of the sources, as well as the steep slopes. The result is serious erosion resulting in the changing of courses, the silting of the streams and rivers, and the draining of the sources and ground water. The consequences were not as serious for herbaceous savannahs because of their gentle relief, which resulted in less erosion, and because of the original herbaceous cover.

In all the cases, a mining style exploitation of the natural resources resulted in a genuine waste of these resources, seriously damaging the environmental functions of the forest and herbaceous ecosystems concerned, although all the situations are not irreversible. Regarding the marginalization of most of the Amerindian population, livestock breeding was an important factor in producing social differentiation for the South American colonial societies.

Also, a transformation of the agrarian society has been going on during recent decades. The social function of breeding, which was the foundation of colonial societies are irrelevant for the management of the large ranches, which are real human deserts.

The battle for land possession is finishing and a way of sustainable management of the grazed agro-ecosystems is arriving.

In spite of the renewal of deforestation in the Amazon in 2007 for which cattle breeding is always regarded as one of the main driving forces, and the increase of biological fuels in the others biomes forests, one notes a real environmental awakening within the South American societies concerned. Even if the fight for the land at any environmental and social price is still likely to continue, in particular in the Amazon, it is not any anymore the more frequent scenario.

Cattle breeding will be regarded as the destroyer of the natural ecosystems for a long time. However, far from disappearing from the landscape of the intensification, it is integrated into it by adopting the new rules and international standards, i.e. less environmental impact, maintaining the soil fertility, respect for the surfaces of permanent protection which are the riverbanks, the sources and the steep slopes. Moreover, land valuation and productivity will pass more and more to tree planting within the fodder parcels, as has occurred during recent years for the perennial cultures, even if it is only because it is facing a lack of wood of value in the already exploited forests.

In conclusion, livestock breeding, spearhead of the colonization of most of the South American continent, rested on the mining of the natural resources transforming the forests and savannas into pastoral space. The market demand for livestock products and the prospect of land accumulation has sustained the advance of colonization. After this first pastoral wave a second wave made up of vegetable productions, also boosted by the market, followed. The environmental impact added to the social impact leads those currently involved to imagine other modes of development of rural ecosystems which are less degrading, more respectful of their integrity and make it possible to recover part of the functions of these same ecosystems.

From a scientific point of view, facing incertitude and a growing number of stakeholders, the research community seeks to improve (i) its insertion in the social networks to construct shared perceptions with the potential of improving action. Also, and in a collaborative manner it is necessary to continue: (ii) the observation and monitoring of livestock systems changes underway throughout the whole region, (iii) understanding of these changes as a coupled human– environment system, (iv) spatially explicit modeling of the transformations ongoing and the associated changes in land change, and (v) assessments of system outcomes, such as vulnerability, resilience, or sustainability.

A peasant society in front of a globalized market: the Bolivian Altiplano, between immediate profits and an ecological dead end.

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At the beginning of 1980s, the arrival of tractors on the Bolivian Altiplano induced a rapid increase in cultivated areas. From 1990s, quinoa's market became international, with increased awareness of the importance of health-oriented diets in developed countries. This traditional Andean crop hence occupied a place of choice, not only because of its nutritional qualities, but also because its production is associated with more or less mythicized virtues of a traditional agriculture in communion with Nature. A horizon of apparently infinite development opened for the Bolivian quinoa, in particular for the quinoa produced by organic farming. Between the end of 1970s and 2006, the production tripled, the cultivated surfaces quadrupled, the annual exports passed from 150 to 8000 tons. Many farmers found in this market an exceptional economic opportunity. But is this way of development sustainable, when it questions profoundly the functional integrity of the Andean socio-ecosystem?

Traditionally, peasants cultivated small fields on hillsides. They chose the fields according to the risk of frost and the importance of the water reserve, linked to the lateral movements of water in the ground. After one year of quinoa crop, the field was planted with potatoes, and manure was brought every year to improve the soil fertility. The fields were then left lying fallow and grazed by the herds of llamas and sheep. The resumption of the natural vegetation and the fertilization by animals insured a progressive reconstruction of the fertility, authorizing a new cultivation cycle after six to ten years. This system, based on a profound knowledge of the environment, guaranteed the food supply of the family in a relatively sure manner. The major part of the monetary income was found in animal products (transport, wool, secondary meat and milk). The variety of productions and the valuation of the totality of the resources offered by the ecosystem (cultivable areas and rangelands) provided a relative stability in front of climatic risk.

Mechanization lead to the shift of the cultivation from the hills towards the level fields that are easier to plough. Because of the phenomenon of temperature inversion, the risk of frost is very high on the level fields (more than 270 days a year on the Southern Altiplano). Such conditions prevented potato cultivation and strongly compromised quinoa's harvest. They turned quinoa from auto-consumption (that needs to be ensured in all conditions) to a highly-risky monetary speculation. The non-agricultural and emigration incomes, which constituted more than ever the base of the family finance, were often used to compensate this risk. The products of breeding rarely played the same function, on account of their low prices. Herds represented savings in front of unforeseen events. But increasingly, this function could be ensured by the quinoa production and the non-agricultural work, to which the family's labour was preferentially allocated. This lead to the abandonment of breeding, which is very demanding in labour.

This exclusion of breeding is stressed as the increase of cultivated surfaces is accompanied by a considerable disappearance of rangelands. In the flat parts, the water supply for the plants is only provided by the rain. Currently these are generally insufficient: 250 to 400 mm / year, for plant needs estimated at 450/500 mm. To cultivate quinoa, it is thus necessary to depend on the multi-annual accumulation of water in soils. Every cycle of cultivation is thus followed by one or two years of bare fallow, whose function is the reconstruction of water reserves. Moreover, the main yields are 20% to 50% less in mechanized system than in hillside manual cultivation. On the other hand, these soils are hardly fertile and the yields run out very quickly. According to the interviews conducted with farmers and local experts, the main yield after three cycles of cultivation is a third of the first year after clearing natural vegetation. At the end of two or three cycles of cultivation-fallow, the yields are insufficient to justify the expenses. New fields are then cleared for cultivation, the former being abandoned. Around twenty years or more will be necessary before they become cultivable again. Indeed, due to the agricultural techniques and the climatic conditions, there is a delay in the reconstitution of natural vegetation. During long years, grounds remain almost bare, subjected to wind erosion, without any pastoral value. An evaluation made in six communities of Southern Altiplano shows a mean rate cultivated surfaces / cleared surfaces of less then 15%, abandoned and unusable lands representing some 60% of former cleared lands.

Henceforth, in some communities, the new lands to cultivate as well as the pastoral spaces are declining. Decline of the agronomic value of the soils; disappearance of husbandry, with their economic as well as agronomic functions; increased dependence on a unique production; tensions in communities around access to land, the reasons are numerous for questioning the sustainability of the current quinoa-based model of development.

The farmers and their organizations are conscious of these problems and are seeking solutions. They cannot count on the usual "receipts" of agricultural modernity. In the situation where markets are demanding organic products, they cannot resort to chemical inputs to resolve the loss of fertility, often seen as the main problem. Irrigation could allow cultivating for several years but there are more failures than successes in the already attempted experiments: water is rare and often salty; frost destroys irrigation devices; the culture of collective water management is absent.

The stake would seem to take up with the principles which based the traditional systems and insured their security in front of risks. It is an issue of rethinking a new balance between breeding and crops that ensures the indispensable transfer of fertility. It is an issue of rethinking cultivation techniques which do not end in a long term destruction of the resources. But the idea is not to go back to the ancient system, as changes in rural society are irreversible. The monetary needs of the peasant families are undeniably important. Labour availability for agriculture is too weak, due to the importance of off-farm work and emigration. It is unthinkable to give up the international market of quinoa, which remains extremely profitable. The disintegration of the agricultural spaces does not allow the former modes of coexistence between herds and crops any more.

It is thus advisable to reinvent everything, within the framework of a project of total development. The main peasant organizations of the Southern Bolivian are working on this. The first step in this process is the Protected Geographic Indication (PGI), "*Quinoa Real de Montaña*", according to European rules. It aims at an up-market niche; with high guaranteed prices, environment-friendly conditions of production that will facilitate insertion in fair trade networks. The ambition is to re-localize the fields on the hillsides, using a range of traditional varieties giving the best quality of grain, which are generally better suited to such conditions of cultivation. This project is possible only under some conditions: (i) facilities for the access to fields; (ii) appropriate light mechanization, limiting labour costs; (iii) restoration of collective rules guaranteeing fair access to land. In this case, higher and less variable yields and prices can justify the unavoidable limitation of cultivated area. Another advantage would be to take up with the traditional cognitive frame about quinoa, which appeared inappropriate to the “tractorized-system”.

But the key to success would be to restore the synergies between crop-husbandry. This is the main condition in order to ensure the indispensable transfers of fertility between rangelands and farmlands, which would allow high yields with limited durations of fallow. But, basically for labour reasons, it seems very difficult to reintroduce herds in the farms which abandoned animal production. An alternative suggestion would be the setting up of large breeding farms, using the still preserved rangelands. These farms would insure the production of manure, within an organized trade of fertility. But to be economically viable, they have to find profitable markets for the animal products. It can be obtained through micro-companies managed by a small number of breeder families, who transform products (dried meat of llama, weavings…) and lean on the same fair business networks as quinoa.

The implementation of such a project is far from being easy. Farmers hesitate to precipitate into such changes, while the economic efficiency of the PGI is still in the course of approval. The richest ones, who are often owners of tractors and entrepreneurs of agricultural works, are obviously reluctant to abandon a system from which they largely benefit. The development of micro-companies collides with problems of construction of markets and seed money. The cost of the necessary access facilities on the way back to hillsides is high for producers' organizations to bear alone, and the State is not currently able to factor in these costs. These reasons and some others make a fast transition difficult, which is nevertheless an essential condition for success.

This case study marks indeed a major shift in agricultural development thinking. It is not solely an issue of producing for the Market. It is an issue of contributing firstly to the construction of markets coherent with the ecological and social conditions of production, and secondly of adapting the technical systems to these markets. It is not a mere question of maximizing the valuation of the resources, by substituting those which are insufficient by outside inputs. It is a question of finding an appropriate balance in the use of resources of the own socio-ecosystem, which guarantees both the economic viability of farms and the reproduction of these resources in the long term. It is no more a resource sufficiency approach, but reasoning within functional integrity paradigm, for a sustainable development in a context of high uncertainties.

Global changes and decentralized policies as drivers of pastoralism dynamics in the Sahel, Western and Central Africa

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In the arid and sub-humid areas of Western and Central Africa, the natural resources (pastures, forests and savannahs, arable lands and water) are threatened by degradation over the past few decades. This situation is due to the severe draughts of the seventies and the eighties as well as the result of the continued exploitation of the environment which has surpassed the natural regeneration capacity (Steinfeld *et al*. 2006). Pastoral livestock rearing (camels, goats, sheep and cattle), the main rural activity in arid regions, had the capacity to withstand the crises and continued to develop and adapt itself, which is manifested through the increase of livestock number, pastoralists still present but with evolved social and economic objectives, enlargement to the sub-humid regions, etc.

The respective dynamics of the natural resources and the pastoral livestock seem to be contradictory. How can we explain their persistence? Affected by the new large-scale changes in political, climatic, economical and social fields, which affect all agricultural systems, how could the pastoral systems succeed in adapting themselves to the present context and the new challenges? What is the capacity of public policies to indirectly preserve the ecosystems' functional integrity?

Deep persistent changes affecting pastoral systems in dry and sub-humid areas

In the beginning of this 21st century, changes are rapid: unprecedented population increase, increase in the number of herders and livestock, while at the same time, a continuous advancement of agricultural frontier on former rangelands, even beyond raisonable climatic limits. Draught periods during the last 4 decades have resulted in social, economical and environmental difficulties; now some people apprehend the consequences of climate change, potentially leading to food insecurity and poverty for much of the population. These difficulties are worsened by political troubles and insecurity (rebellion, hostage capture, armed robery), reducing the capacity of pastoralists to adapt themselves to changes.

Recent decentralisation policies linked with the disengagement of the governments, especially concerning natural resources management and land use organisation, modified traditional management, which used to link local authorities and central power. The present weak regulations and available funds, as well as the insufficient capacity of stakeholders, threatens equity in access to land and other natural resouces at the local level. In this context, pastoral livestock producers, often still marginalised, can hardly maintain their intrinsic qualities of flexibility and adaptability, production and profit from livestock, and its role of capitalisation of wealth and prestige. They encounter difficulties like decrease of natural feed resources, fragmentation of pasture lands, increasing uncertainty of communal land tenure, obstacles to transhumance, complicated access to wet lands encroached by irrigated crops, reinforced protection of reserves for wildlife and sometimes for hunting, slow change of livestock owners with a growing number of people investing in livestock for business, often paying little heed to the environment.

Impact of changes on organisation and strategy of pastoralists

During the last two decades, pastoralists created and organised associations of producers in the aim to defend their interests in the debates on livestock policies. This can have a significant impact on natural resource management. Being conceived first at local and then at national level, these pastoral organisations are now building regional structures, fitting better to challenges of territorial development, livestock mobility and market of animal products. Concerned by the new rules of land allocation, these professional organisations try to sit in local assemblies to secure pastoral areas.

The national rural codes or their application hardly take into account pastoral use as a legitimate common right for land; consequently pastoralists often use temporary or fictitious cropping activities to secure lands. Moreover, confronted with a reduction in pastoral areas and the increasing uncertainty of natural resources, and due to competing markets unfavourable to remote arid areas, the low productivity of breeds, and the low level of economic and social investments in pastoral regions, pastoralists are obliged to diversify the family income by working in agriculture, trade, and various salaried activities (Ancey *et al*. 2007). Herders also try to explore new pastoral lands by extension of the transhumance movements to zones under wetter climate, searching for water and pastures in spite of sanitary issues (for example tsetse fly). However, the advantage of

these movements far from the *terroir d'attache* (family base encampment) offers opportunities to shepherds to sell a part of their production in markets close to the consumers or to suburban feed-lot units (Vall *et al.* 2002).

The offspring of pastoralists are still poorly educated, but a part of this new generation hopes to leave livestock, migrating to find other activities in town or cities, and then sending a part of the salary to the family; such money transfers contributing to improved food security and development in the villages. Besides of this, traditional farmers start owning and rearing livestock, in addition to crops, with several benefits: increase and diversification of income, introduction of animal draft power (extension of ploughed areas, alleviation of laborious works and transports). The number of salaried workers employed by local or remote livestock owners is also on the increase among the pastoral groups (Wane *et al*. 2008). Banking system being weak in rural area, livestock constitutes a savings system; it also provides cash for day to day or casual needs (Njoya *et al.* 1997). Hides and skins contribute to development or artefact activities (*ibid.*).

Requalification of resources, practices and areas

Confronted with diversification, the collective rules for access to and management of natural resources evolve and often become weak. Joint efforts of pastoralists through organisations, members of the Governments and international institutions, scientists and private livestock professionals advocate for a better perception of the pastoral system and its interactions with resources and market. Now the relevance of pastoral system and the important role it plays in dry regions is better understood in terms of its influence on food and meat production, land and land use maintenance, persistence of social networks, several positive consequences on biodiversity, biomass and nutrient transfers, indirect contribution to bush fire protection and carbon sequestration (Diouf *et al*. 2005), in addition to the valuation of crop residues in sub-humid zones.

Sustainability of pastoralism depends not only on the persistence of the natural resource cycles and flows (water, carbon, and biomass) but to ensure their viability, pastoral systems must also rely more than before on technical and transport infrastructure, networks and flow of marketed products, information, manpower and finance.

Conclusion

Simultaneous sustainability of rangelands and the population living off them is dependent on collectively decided and applied measures. Some of which are : the application of the principle of transhumance and respect of corresponding infrastructures, development of early warning and information systems for pastoralists and professionals of livestock (including follow up of long term evolutions), amelioration of market networks and elaboration of laws specific to pastoral resources, especially securing communal rangelands and access to water.

Pastoral livestock rearing has thus shifted from a relatively autonomous resource use and management system to a situation in which the pressures on resources have became diverse, numerous, and contradictory. Such an evolution needs political arbitration, and also pastoral professional organisations lobbying with the policy makers. Maintaining functional integrity of pastoralism also depends on the migration of young pastoralists to other poles of employment and on organisations adapted to negotiations with the other concerned operators. According to a certain point of view, the changes in the social and economic context oblige pastoral societies to extend their field of influence and actions.

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Threatened community shared pastureland
Case study in the Gobi area, Mongolia

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The context

Traditional Mongolian nomadic herding practices are believed to be based on the assumption that some pasture resource is underused somewhere, and when existing pastures are exhausted, herders can move elsewhere. This widely held assumption is no longer plausible. Mongolia's natural resource or rangeland is seriously overused and misused. Effective ways to deal with a widespread scarcity of grazing land must be developed in order to avoid severe environmental degradation. Natural resources are shrinking in Mongolia.

In Mongolia, animal husbandry activities were centrally planned during more than thirty years of collectivisation, until 1991. Production targets were defined annually for each area. At that time, herding systems did not only rely on local resources but the production and utilisation of water and rangeland were planed at national level as well as the production and distribution of fodders.

Since de-collectivisation, more than fifteen years ago, pastoralists re-learn to manage their herds individually relying on local resources in a market economy. Facing a situation of great uncertainty worsened by unclear land tenure status, the threat of climatic disasters, and a high unemployment rate, the herders' strategy is to keep as many animals as possible.
In the Gobi region, harsh winters and scarce water resources impose the setting up of winter settlements close to a water-well and in a relatively higher location. The access to appropriate winter settlement locations is crucial and has been regulated since generations by customary rights. The present increase in animal numbers is causing severe deterioration of the winter pastureland. This situation is worsened by the arrival of neo-herders, persons who worked in the secondary or tertiary sectors before de-collectivisation and lost their jobs within the new system. Not only the winter pastures are overloaded but most of the pastures are grazed all year long as well. Herders are looking for available pasture, especially in wintertime, and move long distances towards the North, far away from their customary grazing grounds and the county where they are registered and pay taxes. In the Gobi region, during recent years severe droughts enhanced the scarcity of pastureland resources.

This case study focuses on ways to look at resource sufficiency and the on-going dynamics. Three main factors are considered hereafter:

Market
During the last 20 years of market oriented economy period, total numbers of animals and herders increased by 38 percent, the number of cashmere goats, economically the most valuable animals but environmentally the most destructive increased by approximately 32 percent.
Herders tend to move closer to the markets in order to reduce expenses linked to transportation of their products. As a consequence, the animal density is increasing in the surroundings of urban areas, equipped with better infrastructures including railways facilitating sales and exports of animal products to China and Russia.
Relying on animal products for their subsistence, herders tend to keep as many animals as possible in order to keep up their income and to minimize risks e.g. climatic disasters, markets changes, which results in the overuse of local natural resources. Moreover, to diversify their sources of income, some livestock producers are trying to develop crop cultivation as well, which is an important cause of water shortage and soil degradation.

Environment
Reduced precipitation and moisture affect the availability of surface water, as well as ground water, which worsen the pressure on water resource availability. The growing season is delayed resulting in accelerated soil erosion and sand movement.

Policies
Many political interest groups tend to influence government policies and regulations. This is the case in the mining sector which attracts high economic interests. Legal environment is influenced in favour of the business interest groups right. This of course affects the natural resources widely. Mining exploration and exploitation often enter in conflict with herding for access to land.

Legislations and regulations do exist, but the level of institutional responsibility is not clear. Many different government bodies are dealing with allocation of land. This unclear situation affects the access to and management of natural resources.

Perspectives

Because of the lack of economic alternatives to herding and the absence of taxation on animals, there is no reason for this dynamic to slow down. The privatisation of winter and spring settlements foreseen in the Government pipeline will likely reinforce the existing situation of overgrazing. In addition, it is likely to limit the access to water-wells and key winter-land to few families, enhancing the socio-economic differences and process of exclusion. A potential way of improving the situation would be to limit the number of animals, especially when the animals represent a substitute to a banking system rather than a production mean: set-up a dissuasive taxation system on big herds and set up a reliable and easily accessible banking system.

Commercial and technical innovation networks for the functional integrity of outdoor farming with hardy breeds in Haut-Languedoc (France)

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Today, agriculture is confronted with new issues : dealing with increasing pressure from consumers, politicians and economical operators requiring production to be secure, authentic and local, in addition to coping with impoverished and increasingly scarce natural resources (Joly, Paradeise, 2003 ; Amilien, Holt, 2007). Finding new solutions is often considered a constraint; but some farmers use this context as an opportunity for adding value and recognition to innovative systems formerly considered as "marginal". The aim of this communication is to examine the construction of systems based on commercial and technical aspects of production, illustrating the principles of "functional integrity" through the example of an outdoor breeding system using direct marketing strategies. This paper illustrates the new trends and the debate on the social aspects of the construction of markets orientated towards "economy of quality" (Karpik, 1989), considered here as the development of innovation networks (Callon, 2001), embedded in social systems (Granovetter, 2000), and co-built around intermediary technical and cognitive items (Vinck, 1998). The breeder's principles and pioneer practices are shown and then explained through two aspects : his position in relation to markets, his farming practices and cognitive networks in interaction with his professional group and the agricultural institutions. This example illustrates the importance of going beyond linear and sectorial approaches to innovation in order to make a model out of a "swirling" process.

1. Principles and practices of an unconventional farming system

At the beginning of the 1980s, Jean-Marie Welch, student shepherd, discovers the Scottish Highlands and their traditional farming practices. He then applies the same principles in Haut-Languedoc, a region with similar weather and agronomic conditions :

- exclusive use of natural resources, in their diversity, including those considered "unproductive" (heaths, swamps…),
- compensating the low productivity of the herd by reducing costs (open air farming, very few inputs, minimal equipment…)
- use of breeds adapted to ecological and ethological conditions of farming, based on a "work ethic" between the man and his animals : animals need to learn how to manage in complex environments, with poor and fluctuating food resources, and the breeder needs to know how to read his animals' behaviour in order to choose the right moment to do adjustments (change pastures, provide minimal food supplement in the fields,…),
- provide products that are consistent with the chosen farming strategy and available food resources, without succumbing to economical pressure to intensify the system.

Applying these principles in Haut-Languedoc is however difficult and has led to some disillusions.

2. From exclusion to market integration : extensive farming with hardy breeds as a basis for a hypermodern position

By choosing techniques that are different from the usual local practices, the breeder isolates himself from his professional group (breeders), from his social environment (territory) and institutions (Chamber of agriculture…). He therefore cumulates three dimensions of exclusion : disqualification, social exclusion, disaffiliation (Autès, 2004). Selling lambs out of standard to butchers enabled him to create a link to the market over a first period, although it made the farm's identity and income fragile. A second step was made when he explored new commercial and social areas, based on forestry resources, enabling him to begin and valorise "appropriate" farming (Thévenot, 1990) : a herd of hardy breed cows with very low energy cost, sold directly to "AMAP"[1] members or to consumer groups close to the same principles (Dubuisson-Quellier, Lamine, 2004). This direct and multiplex link with hyper-modern operators (Lipovetsky, Charles, 2004), consisting of consumers looking for social link , but also pleasure and quality of life, whilst defending civic values (including respecting Nature), encloses him as a pioneer (Rogers, 1962), in the position of a citizen driven by (and overwhelmed by) a « humanist individualism », being simultaneously « inside and outside the market» (Le

[1] *Association pour le Maintien d'une Agriculture Paysanne:* French version of Consumer-Supported Agriculture systems developed in the USA, where a group of consumer is linked to a producer who complies to ecological, economical social principles.

Velly, 2006). Maintaining the functional integrity of his system and valorising it in alternative commercial channels presume appropriate action-orientated practices and knowledge production networks.

3. From the functional integrity project to the development of an appropriate cognitive style

By importing an alternative farming model in Haut-Languedoc, disparaged by the local farmers group, the breeder has been deprived of technical supervision and of integration in their usual "schemes"- but he also wanted to be distinguished from them. At the head of an outdoor experimental unit, he has adopted a specific cognitive style, based on observation, enabling him to identify mute original entities (Callon, 1986) such as hardy cattle breeds, heather, or behaviour monitoring. This observation work has led to new questions like the effect of frost on heather's appetence. By promoting this system, he builds a referential that he shares with other marginalised breeders (Wenger, 1998) and therefore interests heterodox researchers. By building on his experience (Conein, Jacopin, 1994), he enlarges the cognitive network through a swirling process which defines farming practices as well as a status (Podolny, 1993). Technical difficulties related to his specific marketing strategies (regularity, diversity of products…) are now becoming too great and it is tough for him to combine efficiently the different items of his hypermodern position. Reducing cattle and increasing the number of hardy pigs in an open air farming system enables him today to preserve the quantity and quality of his commercial relations, as well as to improve his quality of life and collective commitment to the recognition of the right to have a different professional identity (helping farmers to convert to extensive farming and young farmers to get installed).

Conclusion

This example shows how a breeder has been able to use "marginal" natural resources by building composite networks enabling him to integrate, in a dynamic way, the different functions of a system, whilst respecting its fundamental principles. However, the difficulties of this breeder, now and in the past, show that the functional integrity of an individual system undoubtedly needs a collective functional integration, which conditions its longevity. Therefore, the challenge faced is to think of the inducted networks not only as vectors of the joint construction of a hyper-modern society and an "economy of singularities" (Karpik, 2007), but also as practical entities for the management and recognition of systems that still have to be tested.

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Grazing management on dynamic, heterogeneous vegetation of rangelands: evolution of technical referential and public policies. The case of the northern Alps, the Regional Park of Massif des Bauges

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The organisation of technical systems and the use of rangeland vegetation underwent deep changes in the 20th century as result of massive agricultural mechanisation that led to region-specific agricultural specialisation. In many regions, especially in the greater south-eastern region of France, rangelands continued to play an important role in the herd feeding system but their value is deemed to be diminishing and difficult to exploit (Deverre *et al.* 1996). Even now, the technical references and the herd feeding systems continue to bear the mark of the last 40-50 years of agricultural development.

Changes in public policy requiring rapprochement between agriculture and environment

In an attempt to limit the marginalisation and degradation of this heterogeneous vegetation in the livestock systems, The French Government started offering public incentives that have become part of a two-pronged evolution of agricultural and environmental public policies in Europe since the beginning of the 1990s. On the one hand, since the first reform of the Common Agricultural Policy (CAP) in 1992, Europe has decoupled farm subsidies and production, mainly to conform to the WTO rules. On the other hand, since the Rio Summit in 1992, Europe has been striving to curtail biodiversity erosion and has introduced laws to this effect. In 2004, the French Government decided that the cost of implementing this policy should not be covered by a special budget but rather that it should be factored into agricultural, forestry and land development policies.

Positioned, as it is, at the crossroads of these two tendencies, the CAP is constantly being changed. As concerns the rangelands, the European states have adopted agri-environmental policies, (Buller 2001) operationalised through contractual arrangements that govern agricultural practices to ensure their contribution to territorial upkeep. Since most of the contracts are input based, they impose obligations such as stocking rates, dates, fertiliser use, etc. As of the middle of the 1990s, commitments to ecological performances were beginning to appear in contract specifications (Léger *et al.* 1997). This administrative innovation has been fully developed in a national plan for meadows with abundant species and for heterogeneous rangelands (PDRH, 2007). It stresses the need to link ecological performances with current practices and to define criteria for these performance evaluations (Agreil *et al.* 2008).

Practices ill adapted to heterogeneous, dynamic vegetation

Considering this context and as part of cooperation between technical advisors in livestock production, environmental managers and researchers , we have observed strong demand for developing and upgrading scientific and technical referentials to adapt them for the management of heterogeneous and dynamic vegetation (Mestelan *et al.* 2007). The referentials currently in use bear the mark of the last 40 years of livestock production mechanisation and intensification and is proving to be ill adapted or even contradictory to the use of heterogeneous vegetation (Guérin and Agreil 2007). They are mainly based on optimising productive, fast-growing herbaceous species, thus undermining the value of the species-rich meadows, the bushlands, and leafage from trees, which are actually targeted by mechanical interventions dubbed "pastoral improvements". Moreover, the effects of grazing on plant dynamics, especially on encroaching shrub, are not sufficiently recognised. Ultimately, the use of these referentials does not facilitate the relocation of livestock on dynamic heterogeneous surfaces. The livestock farmers and their advisers, and the nature managers are not equipped to recognise resources and the value of the resources, nor the know-how required to feed their herds and protect their ecological qualities.

Requirements for technical pastoral referentials adapted to current stakes

The use of this vegetation by the livestock farmers and their herds leads first and foremost to the question of assessing the feeding value. We feel that the diagnostic and advisory methods based exclusively on the quantification of dry matter and nutrient content should be replaced by methods that recognise and sustain the *modus operandi* of the livestock producer-herder-cover system. This would demand recognition of the fact that the system is steered by biotechnical management of biological processes that are dynamically organised in time. On the one hand, livestock farmers organise their practices to ensure a satisfactory match during the seasons between their animals' feeding needs and the resources for animal consumption. On the other hand, the behaviour of the herd, and its animals taken individually, falls into patterns for using spatial heterogeneity and feed diversity.

Yet, the challenge is not only to recognise the functionality of the resources in order to assess their feeding value, it also entails obtaining the means to build up resources sustainably on farmlands, taking maximum advantage of their plant dynamics. Heterogeneous vegetation is not stable. It specific composition is prone to rapid, extensive change. The question of feed resources renewal, thus, is linked to the management of species dynamics, especially the dynamics of the dominant species. Grazing management on rangelands cannot be focused exclusively on maximum capitalisation of feeding value in a given year. It also has to allow for another objective, namely, the long-term impact of dominant species . To understand the real capacity of the herds to hold back dominant species such as the ligneous species, it is important to create explicit links, on the one hand, between grazing management methods and level of consumption of each of the organs of the target-species and, on the other hand, between organs consumed and the demographic impact on the target-species population. With this information we can identify grazing management systems that ensure priority consumption of targeted organs, defined as major organs in the demographic dynamics of ligneous species. It is still difficult to accurately predict the consumption level of these organs. But in any case, indicators can be defined to adjust grazing management systems to intermediary performances, which are still incomplete and need to be improved.

On interlinking the functional integrity of the producer-herd-cover system and the ecological quality of the habitats

When the referential is constructed on the basis of a functional description of interactions between livestock management practices, herds and vegetation, it is also useful in working out the links between the goals of agricultural production and biological conservation. By defining the value of vegetation in terms of the functions it should fulfil in the integrated functioning of the producer-herd-cover system, new criteria were identified to describe the expected vegetation state and to guide the grazing management rules (presence of species, structures of vegetation, ability to maintain their value throughout the seasons, feed diversity, etc.) (Guérin *et al.* 2001). Furthermore, vegetation states are identified to fulfil ecological functions (regulations, habitats for species, etc.). At this stage the stakes of the negotiations lie in vegetation states that can, by definition, fulfil a twofold, agricultural and ecological function. This definition is often difficult to devise because of the complexity and instability of the covers and the lack of knowledge of the effects of grazing management on ecological dynamics. It is easier when the objectives of such management involve a single objective such as, for instant, controlling the dominant ligneous species. In that scenarios, an agreement can be reached on an acceptable range of shrub densities. The need to adapt the grazing conditions to partial performance, mentioned above in relation to pastoral resources management, becomes more significant here where environmental objectives are targeted. The greatest challenge is to develop adaptive approaches in pastoral management, specifying the rules for adapting the practices to be used in response to the first zootechnical and environmental performances obtained. In this context, pastoral resources management is to be considered as part of an expanded herder-herd-cover-habitat functional system. Maintaining the functional integrity of this system helps guarantee the long-term sustainability of the resources and the ecological quality of the environments.

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New Initiative in Prairie Conservation: A Large-scale, adaptive management grazing experiment in Grasslands National Park of Canada

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SCIENTIST'S PERSPECTIVE: NICOLA KOPER

Prairies are the most exploited, yet least protected, biomes worldwide. This has lead to critical declines in numerous prairie species, many of which are now endangered. For example, in the last 4 decades, prairie birds have declined more rapidly than any other group of birds in North America. Commercial cattle ranching provides a strong financial incentive for conserving native prairies, and may play an important ecological role by replacing natural disturbances, such as grazing by bison, with which prairies evolved. It is critical that we develop better management recommendations, such as stocking rate guidelines, that will enable both economically and ecologically viable management plans. Further research is required to accomplish these goals.
Manipulative experiments enable us to link underlying mechanisms with ecological patterns in a way that is unattainable with observational studies, but logistical challenges can be prohibitive. Experiments must be conducted at spatial scales appropriate to management, and must encompass natural levels of variability that are inherent to the system under question, to ensure relevance to both ecological science and management. Cattle grazing is an ecologically important range management tool that is known to be sensitive to both spatial scale and the biophysical structure of the landscape. We present a long-term grazing experiment initiated in 2006 to determine the grazing intensity most appropriate for promoting grassland community heterogeneity. This experiment demonstrates a number of features key to ensuring ecological and management relevance: (1) a Beyond-BACI sampling protocol with before-grazing baseline sampling, (2) large spatial scale (~4000 ha of pastures), (3) similar proportions of 4 key prairie habitat types in each pasture, (4) long-term (15+ years), large, replicated grazed and ungrazed controls, and (5) a hierarchical sampling design, to capture local and pasture-scale effects.
We used a combination of empirical and simulated data from chestnut-collared longspurs, Savannah sparrows, ground squirrels, and several vegetation parameters, to conduct *a-priori* power analyses, to determine the most robust and powerful study design possible within logistical limitations. In particular, we compared between continuous and categorical study designs. Treating grazing as a continuous variable is the most powerful approach to our study, and has a number of other favorable properties. Further, pre-treatment sampling proved critical to distinguishing between spurious patterns and effects of cattle grazing. This project represents a key initiative towards understanding and conserving the Northern Great Plains.

PRACTITIONER'S PERSPECTIVE: PEGGY STRANKMAN, Environment Manager, Canadian Cattlemen's Association.

The North American grassland ecosystem is significant as prairie wildlife habitat and as the base for extensive cattle production and western culture. These prairie grasslands support ranches that bring economic and social stability to the rural communities, as well as providing critical wildlife habitat. However, the viability of these working landscapes is in question due to a variety of factors including decreasing agricultural income and questions regarding the ranch viability for the next generation.
Increasingly sophisticated research on those grasslands will help address these issues, but only if the knowledge can be effectively delivered to the producer community in a way that assist the producer to easily integrate into the existing range management practices.
The Canadian Cattlemen's Association (CCA) is beginning the second year of an Agriculture and Agri-food Canada funded project which helps producers with that kind of integration. The Grazing Mentorship project arranges a mentor/mentee relationship, in which an experienced grazer mentors a producer looking to make changes. This program complements others delivered by the federal agriculture department in Canada.
Improved grazing and water management improves productivity and profits, and can also decrease inputs, which has a positive impact on both economics and the environment. More recently, thoughts have swung from just a strict agronomic return from the landscape to the need to recognize a broad suite of functions that is or could be provided. In acknowledging the balance needed between environmental and economic objectives, we need to realize that the benefits are to the public as a whole, while the costs are usually sustained by the producer. It is therefore critical that we understand how improving or maintaining ecological function may be compensated for financially. Payment for environmental services may be one of the important keys to keeping healthy working landscapes in Canada.

Two other examples of taking new science and technology on to the landscape are the very successful Cows and Fish program and the recent Range Health Assessment Guide. Both provide the producer with additional tools to improve management of the landscape.

Although the first trigger for these types of programs was economic, environmental sustainability concerns have recently become a focus. Producers are looking for information that will help them manage grasslands in an economically and environmentally sustainable manner. The grazing experiment in Grasslands National Park of Canada will provide critical information to develop stocking rates that will result in both economic and ecological sustainability to grassland ecosystems. Further, it will help quantify the potential benefits of commercial cattle grazing to the environment, facilitating calculations of the values of environmental services provided by ranches. Demonstrating the benefits of cattle grazing to grassland ecosystems, and to threatened and endangered species such as Sprague's pipits and burrowing owls, will contribute to both environmental and social stability in the northern Great Plains.