

Livestock farming systems and local development: A review of the multiple dimensions of “Territory” in livestock science

Claire Manoli^a, Alexandre Ickowicz^b and Benoît Dedieu^c

^aUR 18 SEPA (CIRAD Montpellier) & INRA UMR 1273 Metafort; France; manoli@supagro.inra.fr

^bUMR ERRC (INRA-CIRAD-SupAgro) Montpellier, France; ickowicz@cirad.fr

^cUMR 1273 Metafort (INRA) ClermontFerrand, France; benoit.dedieu@clermont.inra.fr

Abstract: A review of the international literature was carried out, in order to describe how researchers study links between livestock farming and local development (i.e. ‘territory’). We highlight three different sets of approaches: the first focused on relations between livestock farming systems and natural resources through landscape / spatial analyses. Secondly, livestock farming systems are analysed through the diversity of the farming systems existing within a territory. The third set of approaches considers livestock farming systems as technical systems structured around human groups. Finally, some publications combine two or three sets of approaches. The combination of these three approaches is useful in a landscape and territorial perspective.

Keywords: Livestock farming systems, local development, territory, global change, land-use, production systems, social dynamics, multifunctional agriculture

Introduction

Livestock activities are facing a critical period at the global level: on the one hand they are particularly criticized for their environmental impacts, e.g., water pollution (concerning especially the monogastric farming systems), green house gas emission, land degradation, competition for land with human food production (concerning especially the cattle farming systems) (Steinfeld et al., 2006). On the other hand, livestock farming systems contribute to the production of meat, milk and eggs for human diet: animal proteins represent 33% of the human diet (Steinfeld et al., 2006) and they are known to be particularly adapted to children’s needs. Moreover, the proportion of proteins in human diets usually increases with the GDP of developing countries. Therefore, in developing countries, demand for animal products is expected to increase significantly: the word ‘livestock revolution’ (Delgado et al., 1999; Delgado, 2008) has been used to describe this expected growth. Other functions are attributed to livestock; the production of fibre and organic fertilizers, a source of employment and income for farmers and the overall market chain, a “living bank” and a direct source of food for the most vulnerable populations, a landscape and biodiversity builder, a user of industrial or agricultural wastes, and in the end symbolic uses.

The global level is therefore one main scale of discussions on the future of livestock farming notably through the environmental and the ‘protein provider’ issues. But livestock farming makes sense at other levels, notably at the local one (Hubert, 1994) where livestock is an activity for communities of farmers and can be considered a landscape “shaper” (Caron and Hubert, 2000). Here local authorities may specify what they are expecting from livestock and livestock activities with other words than “Green House Gas Emission” and “protein”. In this paper, we propose to discuss the trends for the future of livestock with this local perspective, through a literature review. What are the main issues that relate livestock to local development?

Materials and methods

The aim of the review was first to browse through an international diversity of publications: diversity of the fields of study around the world, diversity of the research teams involved in these studies.

Indeed, we wished to distinguish different streams in scientific communities, regarding different regions of the world. Bibliographic search was built on key words, chosen in the AgroVoc thesaurus, a tool proposed by the FAO.

The French language provides a concept that enlarges the notion of local: “Territoire = territory”. Territory is defined as ‘a stretch of area used and managed by human societies’ (Brunet et al., 1992). This definition thus embeds “territory” in a disciplinary field that associates, behind “local”, nature and society and factors in their relationships. It confers upon “territory” a double dimension: a physical-spatial dimension and another one, socially constructed (Bassett et al., 2007; Blanc-Pamard and Boutrais; Brunet et al., 1992; Deffontaines, 1998). The concept of territory emphasizes the importance of spatial issues in agricultural development.

Key words were chosen to represent the links between livestock activities and “territory” in its double dimension. Two different queries were built:

- Query A, built to illustrate the physical dimension of territory, combines key-words related to: livestock farming systems x spatial x temporal dimensions x scale issues.

Publications selected were mostly publications from natural and technical disciplines.

- Query B, built to illustrate the ‘territory’ as a social environment, combines key-words related to: livestock farming systems x social x temporal dimensions x scale issues.

Publications selected were mostly publications from social sciences.

These two queries were performed on Web of Knowledge (a bibliographic database specialized in natural and technical sciences), Econlit, Francis (bibliographic databases in socio-economic sciences). Publications resulting from these queries were relevant to our definition of ‘territory’. This bibliographic work was enriched by discussions with a panel of French experts on the topic of « livestock farming systems and local development».

Finally, the review was limited to ruminant production systems, and mainly grassland and rangeland based systems. Indeed, these systems use spatial natural resources. Monogastric systems and landless systems in general, even if they are considered very interesting for this topic, are so different from grassland based systems that they should require a specific review.

Results and discussion

Three different ways of thinking the links between livestock farming and territories appear: the first focus on relations between livestock farming systems and natural resources through landscape / spatial analyses. Secondly, livestock farming systems are analysed through the diversity of the farming systems existing within a territory. The third set of approaches considers livestock farming systems as technical systems structured around human groups.

1. Livestock farming and spatial natural resources: connecting livestock activities to land use issues.

These studies focus on land use and land users. Territory is here ‘**land**’ or ‘**landscape**’. It is a natural area, also used for human activities. Natural resources are defined firstly by their spatial dimensions. Livestock farmers are therefore one of the potential multiple land users of a specific space, and are considered through land use practices. Two types of approaches can be distinguished: on the one hand, these relations between livestock farming and natural resources can be analysed with a static analysis of factors of location; on the other hand, the analysis is dynamic and focused on the land use change process.

The first group of papers aims at describing the location of production systems or animal densities in large geographic areas, in order to identify spatial location factors. The classification of livestock production systems made by Sere & Steinfeld (1996) was one of the first. In this worldwide classification, the different types of production systems are mapped at a ‘regional’ (i.e. several

countries from the same area of the world) scale. The production system locations are placed in relation with agro-ecological factors. Other factors of location were presented in the zoning of European livestock systems, by Pflimlin et al. (2005): the different zones delimited mostly through pedoclimatic factors, are then analyzed regarding the socio-economic dynamics and local histories. 'Livestock long shadow' report (Steinfeld et al., 2006) was another important work showing the links between livestock production systems and geographical attributes. It relates the impact of urban and rural areas, of existing infrastructures to the type of livestock found (species, systems of production, etc.), in addition to natural constraints (mountains for example). Bourn and Wint (1994a, b) working especially on livestock densities, based on the same hypothesis, propose other indicators than agro-ecological ones to predict livestock densities: density of human population, agriculture and animal diseases. Most of these studies refer to 'livestock geography' (e.g. Kruska et al., 2003; Reid et al., 2000; Sere and Steinfeld, 1996; Thornton et al., 2006; Wint, 2007). Maps of livestock densities, livestock systems at large regional scales are common products of all these studies. Maps result from the use of GIS tools and they give a static image of the different factors of location of livestock activities: agro-ecological factors are emphasized (climate, mountains, animal diseases); anthropogenic factors (market, urban areas, infrastructures, agriculture) are taken into account. These maps aim to contribute to the elaboration of international and national livestock development policies: therefore the focus is at a global level (national to regional level).

The second group of studies describes the dynamics of land use, in order to understand the processes and mechanisms underlying these land-use changes. Pocard Chapuis (2005a, b) analyzes the process of Amazonian deforestation and the place of livestock farming system dynamics in this process. The social networks linked to livestock and the local, regional, national and international meat market influences are described. Boserup (1965) elaborated hypotheses about the process of intensification in Africa. She links increases of human density with the apparition of technological innovation, and intensification of production. Lambin et al. (2000); Lambin et al. (2001); Stephenne and Lambin (2001); Veldkamp and Lambin (2001) illustrate a specific stream of researches on 'land use and land cover changes'. Notably, Lambin et al. 2000 specify the mechanisms underlying land-use changes, with a deconstruction of the numerous simplifications ('the myths', for example: 'carrying capacity) often used to explain land use changes: degradation of rangeland pastures, urbanization, deforestation or intensification. They suggest the need for rigorous understandings of the local context (by case studies for example) to understand the reformulation of global trends in a particular place. Global hypothesis (such as the Boserup hypothesis about intensification), may need to be re-examined, or at least, used in pertinent space and time scales.

Land use change studies are complementary to location approaches, because they give a dynamic analysis of land uses (= the process), whereas the zoning approaches are static "snapshots" (= the result). In both approaches, livestock densities, repartition and location are mostly linked to agro-ecological factors. Authors show that livestock farming systems have good reasons to be located where they are. Livestock activities have to be reconnected to all the land they use (Naylor et al., 2005) because they are users of spatial natural resources. Mapping livestock (or "gridding it" - Wint, 2007) everywhere in the planet is a necessary step in this perspective.

However, one cannot stay at this global level (regional or national level) to understand clearly the process and driving forces related to land use changes. Lambin et al. (2000) in a perspective of elaboration of land policies (development), conclude with the necessity to describe these global driving forces, but also to take into account "the specific human-environment conditions under which the drivers of change operate". On one hand the socio-economic level is in fact not often analysed. In particular, the farming unit level does not exist in these studies. Wint (2007) presents this as a limit of these approaches. On the other hand, the understanding of local conditions, from case studies analysis appears as a necessity when scientists elaborate proposals for development. And, finally, the particular features of livestock activities are not emphasized in this kind of approach: as the topic is centred on natural resources, there is no questioning of the spatial specificities of livestock activity in comparison with agriculture for example.

2. Livestock farming systems in a diversity of production systems: understanding the complementarities and different ways for local development.

The objectives of this group of papers are local development, in a context of environmental concerns. We can sum up the questionings about livestock farming systems in: ‘How does the production of livestock farming systems evolve and change, and what do they offer to local population?’ Territory is here a spatial basis. It is a delimited area where local diversity of production systems will be studied. Territory is defined not only as an area of resources but of production of goods and of ecosystem services too (Costanza et al., 1997). Livestock farming systems are studied through their products and modes of production.

One focus of this group of studies is the diversity of farming systems or practices. Authors underline the role of this diversity for local dynamics. Mishra et al. (2003) and Namgail et al. (2007) studied the dynamics and diversity of practices of land users in a zone of Himalaya mountains. The pastoral system is presented as a system of mediation of the environmental risk, and production maximisation. These studies are similar to a consideration of the ecosystems services fulfilled by a particular system of production.

Van der Ploeg (Ploeg, 1994 ; Vanclay et al., 2006) is another reference who analysed the diversity of systems of production: he analysed farmers’ farming styles. Diversity is a social diversity: a farming style is “shaped by a cultural repertoire”. The focus is more on the diversity of technical systems and farmer practices, analysed with this concept, than on the outputs of the activity.

Thornton et al. (2007) analyses the diversity and dynamics of the “systems of production’ in four countries of Africa. In a local development perspective, he shows that adaptive capacity of households depends largely on the possibility of diversification. All the family economic activities and their complementarities are analysed and considered as the basis for local development. The insertion of livestock in a more complex system of activity (Anseeuw and Laurent, 2007; Berzborn, 2007; Laurent et al., 1998; Thornton et al., 2007) at the family farm scale level appears as a critical point: livestock is a source of income among others. Complementarities and interactions between these different sources of incomes are used to explain the technical choices and practices at the farm level. So the diversity and heterogeneity can be inside the farm (Dedieu, 2001; Laurent et al., 1998) or outside the farm (existence of different sources of incomes, resources, markets...). In the same perspective, crop/livestock systems have been largely studied (see the literature review of Iiyama et al., 2007): the use of complementarities between agriculture and livestock (recycling of crop/animal residuals) are thought to be sustainable (“economically feasible and environmentally sound solution”), particularly for poor populations in developing countries.

The force of these approaches is to consider the unit of decision in agriculture, i.e, the farm level, ignored by the other studies presented above. Diversity appears as a crucial point: diversity of “farming styles”, of technical and organizational systems, of combination of activities within farms, of land use practices are also taken into account; further importance of this diversity is given at a territory scale. Why so? Because the link between diversity and adaptive capacity is admitted, notably in reference to the resilience of socio-ecological systems (e.g. Carpenter et al., 2001; Holling, 2001; Walker et al., 2002).

The limits of these approaches are a lack of reference to spatial dimensions: the diverse production systems are often not linked to their spatial distribution or impact on spatial issues. Similarly, the dynamics and temporal aspects are not so developed. The spatial dimension here is just an envelope.

3. Livestock farming systems and social dynamics: understanding the long term dynamics and the human dimensions of technical systems and changes.

The general objectives of this group of papers are the understanding of farmer practices and their position regarding change and innovation. In these approaches, ‘territory’ is a social construction: its spatial dimensions are always related to the social group. A territory is a place of local identity. People acknowledge their personal history and identity is linked to a geographic area. So livestock farming systems are technical systems embedded in social groups and they can be pillars of local

identity, especially in areas where livestock farming has been historically an important activity. Their relations with other groups of society, and the way all these elements evolve and influence actions are developed.

In pastoral systems of sub-Saharan countries, the link between spatial organisation and social dimensions have been largely studied (i.e: Bonfiglioli, 1988; Boutrais, 2007; Dupire, 1962). The mobility (nomadism or transhumance) of the entire human group associated with the herd is a traditional characteristic of these systems. As a consequence, the transhumance routes of this group (i.e their spatial organisation of natural resource use and production) has to be understood through historical, ethnological analysis. Clanet (1999, 2004) for example studied the different paths of transhumance followed by nomads in central Sahel, for decades. He showed that these paths are organised by social relations (alliance, conflicts) between clans. Pastoral territory appears as unstable when it is delimited by natural resource indicators (because of the variability of rains, pastures have very various locations). But it is quite stable when it is defined by the herder's ethnic affiliations and by the social relations between ethnic clans.

The understanding of the link between farm work, family identity and a geographical site is crucial to understand changes or non acceptance of innovation in rural areas. Burton 2004 (a, b) and Wilson (2001, 2008) define the territory with social indicators. But here, they define a territory through the local construction of identity, among English family farms. Burton for example explores the complexity of links between farm-families and their spatial roots. This root can be the farm as a spatial unit (field, buildings...). It can also be the local area, in which the family-farm holds an historical social status. These links are historically built. Lémery et al. (2005) worked on the elaboration of collective norms in professional areas. Working specifically in livestock production (beef cattle production in Burgundy), they showed how farmers refer to social norms when they explain how they change, innovate or perpetuate their modes of production. These norms are mostly elaborated in the family and at a local level, by the professional network in which farmers are involved.

The focus on social dynamics is crucial to understand long term dynamics. As Holling (2001) explains it, the scales at which changes occur depend on the underlying process: cultural process elaborates on a long time scale (from centuries to millenaries); traditions develop and disappear at a scale of ten to a hundred years; values are between the year and the decennia; fashions are on a monthly scale.

The study of the dynamic process of change occupies its own place in social sciences. Social sciences are useful to understand the historical construction and definition of a territory, as well as to understand how humans perceive spaces. To better determine local dimensions of farming system dynamics, all these concepts of identity, conception and elaboration of norms are useful. One limit of these approaches is that the links to spatial aspects are not well developed: "space" stays an abstraction, and except for the case of pastoral mobility, the particularity of studying an activity related to space is not highlighted.

4. Crossed approaches: toward scientific proposals for livestock and a 'territorial' development?

Combining spatial sciences, techno-economic and social sciences is not easy, because of gaps between time and space scales; and because of management considerations between these different approaches. Some attempts to combine them have been made in the literature.

It is notably the case in a scientific project published in a special issue of the Journal of Arid Environment (issue: 70, 2007) concerning the Namaqualand of South Africa. Namaqualand is a historically pastoral area with current important issues of biodiversity conservation. The scientific project was constructed to be multidisciplinary. Historical changes that occurred in this area are analysed with ecological, economic and social perspectives and the future issues and perspectives of the region are analysed. The three approaches we have described were developed during the project: land use (Hoffman et al., 2007; Samuels et al., 2007), diversity of production systems (Anseeuw and Laurent, 2007; Richardson et al., 2007); social dynamics and conceptions of actors (Allsopp et al., 2007; Kleinbooi and Lahiff, 2007; May and Lahiff, 2007). Combining these approaches is useful to make a synthesis on the development issues of this territory. As a synthesis, Cousins et al.

(2007) describe the most important issues with which this region will have to deal: biodiversity conservation, climatic change and limitation of livestock production; land distribution. The traditional mobility of livestock and the diversification of activities are presented as major levers for local development.

Another example of a combination between two approaches (i.e.: land use changes X diversity of the production systems), is given in Mottet et al, 2005. The authors present an analysis of both spatial landscape changes and the local dynamics of the systems of production, with the help of simulation tools (Multi-agent Systems) and modelling. Another project carried out with the same approach, in several countries of the world (Brazil, Senegal, France, Uruguay) is to be published (Gibon and Ickowicz, Eds). This multidisciplinary project (involving scientists from agronomy, sociology, ecology, modelling) highlights the common factors of livestock dynamics in several contexts: search for complementarities between activities, specific social and cultural dynamics of farmer groups but also global land use change trends due to demographic pressure.

Conclusion

Livestock farming has a part of its future closely related to local and territorial characteristics for three reasons: i) livestock renews and uses natural resources, land and produces landscapes, ii) there is a diversity of production systems and practices in a local area and this diversity enhances local dynamics, iii) territory is the place for elaboration of local identity, norms, and conceptions of players. These are key elements in the acceptance and development of innovations: territorial innovations are endogenous innovations that can be strength for agriculture and livestock farming in particular, and should be well studied to be enhanced. The geographical denomination of agricultural products ("AOC" labelling In France, Protected Geographical Indication in Europe) clearly constitutes examples where the 'territory' has become a resource. This aspect was not developed in this review but it certainly constitutes an illustration of territorial dynamics.

Territorial livestock studies do not consider green house gas emissions, or do not consider some kinds of generic innovations, to be applied in every context.

But territorial livestock studies give keys to understanding many dimensions of livestock farming systems: animal numbers and densities; natural and land resources; livestock as an income activity; livestock as a social construction. They also give keys to understanding that the future of livestock farming also depends on its entire environment: the ecological and the social. All these aspects must be taken into account to plan livestock farming development. Each item requires further research and generic methodologies. Approaches are mostly pluridisciplinary, and combining natural sciences and social sciences appears to be a necessity for territorial studies.

But integrated approaches are rare, because they combine explicit related land approaches with more distant social approaches where spatial dimensions are not really the focus. To fulfil this role, a scientific community should be organized, gathered, strengthened, brought forward to other communities.

Actually, this review has been used in two scientific projects of this kind. The first one is the elaboration of an international network on livestock and local development (work in progress): this review was a base to elaborate the main guidelines of the future debates.

The second one is a scientific project proposed to the French research funding agency (ANR), in the SYSTERRA program (ecosystems, living resources, landscapes and agriculture). In this project, the dynamics of livestock and territory relationships are analyzed with the concept of ecological intensification.

References

- Allsopp, N., Laurent, C., Debeaudoin, L. M. C. and M. Igshaan Samuels (2007) Environmental perceptions and practices of livestock keepers on the Namaqualand Commons challenge conventional rangeland management. *Journal of Arid Environments* 70, 740-754.
- Anseeuw, W. and C. Laurent (2007) Occupational paths towards commercial agriculture: The key roles of farm pluriactivity and the commons. *Journal of Arid Environments* 70, 659-671.
- Bassett, T., BlancPamard, C. and J. Boutrais (2007) Constructing locality: the terroir approach in West Africa. *Africa* 77.
- Berzborn, S. (2007) The household economy of pastoralists and wage-labourers in the Richtersveld, South Africa. *Journal of Arid Environments* 70, 672-685.
- Blanc-Pamard and Boutrais. A la croisée des parcours: pasteurs, éleveurs, cultivateurs.
- Bonfiglioli, A. M. (1988) "Dudal. Histoire de famille et histoire de troupeau chez un groupe Woodabe du Niger," Ed. de la Maison des Sciences de l'Homme / Cambridge University Press, Paris.
- Boserup, E. (1965) "The conditions of Agricultural Growth: the economics of agrarian change under population pressure," Aldine, Chicago.
- Bourn, D. and W. Wint (1994a) Comments on livestock, land use and agricultural intensification in sub-Saharan Africa (paper 37a). In "Paper - Pastoral Development Network".
- Bourn, D. and W. Wint (1994b) Livestock, land use and agricultural intensification in sub-Saharan Africa. In "Paper - Pastoral Development Network".
- Boutrais, J. (2007) Crises écologiques et mobilités pastorales au Sahel : les Peuls du Dallol Bosso (Niger). *Sécheresse* 18, 5-12.
- Brunet, R., Ferras, R. and H. Théry (1992) "Les mots de la géographie, dictionnaire critique," RECLUS-La Documentation française,/Ed., Montpellier-Paris.
- Burton, R.J.F. (2004a) Reconceptualising the 'behavioural approach' in agricultural studies: a socio-psychological perspective. *Journal of Rural Studies* 20, 359-371.
- Burton, R.J.F. (2004b) Seeing through the 'good farmer's' eyes: Towards developing an understanding of the social symbolic value of 'productivist' behaviour. *Sociologia Ruralis* 44, 195-+.
- Carpenter, S., Walker, B., Anderies, J., and Abel, N. (2001). From Metaphor to Measurement: resilience of what to what? *Ecosystems* 4, 765-781.
- Caron, P. and B. Hubert (2000) De l'analyse des pratiques à la construction d'un modèle d'évolution des systèmes d'élevage: application à la région Nordeste du Brésil. *Rev.Elev.Méd.Vét.Pays Trop.*, 53(1), 37-53.
- Clanet, J. (2004) Conflits éleveurs-agriculteurs: une partition spatiale consensuelle. *Sécheresse* 1E.
- Clanet, J.C. (1999) Stabilité du peuplement nomade au Sahel Central. *Sécheresse* 10, 93-103.
- Costanza, R., dArge, R., deGroot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., Oneill, R. V., Paruelo, J., Raskin, R. G., Sutton, P. and M. vandenBelt (1997) The value of the world's ecosystem services and natural capital. *Nature* 387, 253-260.
- Cousins, B., Hoffman, M. T., Allsopp, N. and R.F. Rohde (2007) A synthesis of sociological and biological perspectives on sustainable land use in Namaqualand. *Journal of Arid Environments* 70, 834-846.
- Dedieu, B. (2001) Stratégies de répartition du pâturage sur le territoire de l'exploitation. In "Colloque INRA-CIRAD La Blaquièrre", La Blaquièrre.
- Deffontaines, J.P. (1998) The paths of a geoagronomist. In "Les sentiers d'un geoagronome." pp. 360 p. Editions Arguments, Paris; France.
- Delgado, Christopher, L., Rosegrant, M. W., Steinfeld, Henning, Ehui, Simeon, K. and C. Courbois (1999) "Livestock to 2020 : the next food revolution." International Food Policy Research Institute (IFPRI); Food

- and Agriculture Organization of the United Nations (FAO); International Livestock Research Institute (ILRI), Washington, D.C. Rome Nairobi, Kenya.
- Delgado, C. L. N., Clare, A.; Tiongco, Marites M.; Barros, Geraldo Sant'Ana de Camargo; Catelo, Maria Angeles; Costales, Achilles; Mehta, Rajesh; Naranong, Viroj; Poapongsakorn, Nipon; Sharma, Vijay Paul; de Zen, Sergio (IFPRI) (2008). "Determinants and implications of the growing scale of livestock farms in four fast-growing developing countries," Rep. No. 157. International Food Policy Research Institute (IFPRI), Washington, D.C.
- Dupire, M. (1962) Peuls nomades: étude descriptive des WoDaaBe du Sahel Nigérien, Université de Paris.
- Gibon A., Ickowicz A. Eds. Transformation des systèmes d'élevages extensifs et dynamiques des territoires : Approche comparative et modélisation pour un développement durable. Cahiers Agricultures 2, 2010 (In press).
- Hoffman, M.T., Allsopp, N. and R.F. Rohde (2007) Sustainable land use in Namaqualand, South Africa: Key issues in an interdisciplinary debate. *Journal of Arid Environments* 70, 561-569.
- Holling, C.S. (2001) Understanding the complexity of economic, ecological, and social systems. *Ecosystems* 4, 390-405.
- Hubert, B. (1994) Pastoralisme et territoire: modélisation des pratiques d'utilisation. *Cahiers Agricultures* 3, 9-22.
- Kleinbooi, K. and E. Lahiff (2007) "Die man is die hoof en vat voor": Women's attitudes to land and farming in the communal areas of Namaqualand. *Journal of Arid Environments* 70, 799-817.
- Kruska, R.L., Reid, R.S., Thornton, P.K., Henninger, N. and P.M. Kristjanson (2003) Mapping livestock-oriented agricultural production systems for the developing world. *Agricultural Systems* 77, 39-63.
- Lambin, E.F., Rounsevell, M.D.A. and H.J. Geist (2000) Are agricultural land-use models able to predict changes in land-use intensity? *Agriculture, Ecosystems & Environment* 82, 321-331.
- Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., Coomes, O. T., Dirzo, R., Fischer, G., Folke, C., George, P. S., Homewood, K., Imbernon, J., Leemans, R., Li, X. B., Moran, E. F., Mortimore, M., Ramakrishnan, P. S., Richards, J. F., Skanes, H., Steffen, W., Stone, G. D., Svedin, U., Veldkamp, T. A., Vogel, C. and J.C. Xu (2001) The causes of land-use and land-cover change: moving beyond the myths. *Global Environmental Change-Human and Policy Dimensions* 11, 261-269.
- Laurent, C., Ponchelet, D., Mundler, P., Rémy, J., Cartier, S. and C. Fabre (1998) L'activité agricole des ménages ruraux et la cohésion économique et sociale. *Économie rurale* Volume 244, 12 - 21.
- Lémery, B., Ingrand, S., Dégrange, B. and B. Dedieu (2005) Agir en situation d'incertitude : le cas des éleveurs de bovins allaitants. *Economie Rurale* 288, 57-69.
- May, H. and E. Lahiff (2007) Land reform in Namaqualand, 1994-2005: A review. *Journal of Arid Environments* 70, 782-798.
- Mishra, C., Prins, H.T.H. and S.E.V. Wieren (2003) Diversity, Risk Mediation and Change in a Trans-Himalayan Agropastoral system. *Human Ecology* 31.
- Mottet, A., Ladet, S., Coqué, N. and A. Gibon (2006) Agricultural land-use change and its drivers in mountain landscapes: a case study in the Pyrenees. *Agriculture, Ecosystems and Environment* 114, 296-310.
- Namgail, T., Bhatnagar, Y. V., Mishra, C. and S. Bagchi (2007) Pastoral nomads of the Indian Changthang: Production System, Landuse and Socioeconomic Changes. *Human Ecology* 35, 497-504.
- Naylor, R., Steinfeld, H., Falcon, W., Galloways, J., Smil, V., Bradford, E., Alder, J. and H. Mooney (2005) Losing the links between livestock and land. *Science* 310, 1621-1622.
- Pfimlin, A., Buczinski, B. and C. Perrot (2005) Proposition de zonage pour préserver la diversité des systèmes d'élevage et des territoires européens. *Fourrages* 182, 311-330.
- Ploeg, J.D.v.d. (1994) Styles of farming: an introductory note on concepts and methodology. In "Born from within: practice and perspectives of endogenous rural development (Assen: van Gorcum)" (J.D. van der Ploeg and A. Long, eds.), pp. 7-30.
- Poccard-Chapuis, R. (2005a) La filière viande: un levier pour contrôler les dynamiques pionnières en Amazonie Brésilienne.

- Poccard-Chapuis, R. (2005b) Les réseaux de la conquête. Filière bovine et structuration de l'espace sur les fronts pionniers d'Amazonie Orientale Brésilienne., Paris X Nanterre.
- Reid, R. S., Kruska, R. L., Muthui, N., Taye, A., Wotton, S., Wilson, C. J. and W. Mulatu (2000) Land-use and land-cover dynamics in response to changes in climatic, biological and socio-political forces: the case of southwestern Ethiopia. *Landscape Ecology* 15, 339-355.
- Richardson, F.D., Hahn, B.D. and M.T. Hoffman (2007) Modelling the sustainability and productivity of pastoral systems in the communal areas of Namaqualand. *Journal of Arid Environments* 70, 701-717.
- Samuels, M. I., Allsopp, N. and R.S. Knight (2007) Patterns of resource use by livestock during and after drought on the commons of Namaqualand, South Africa. *Journal of Arid Environments* 70, 728-739.
- Sere, C. and H. Steinfeld (1996) "World livestock production systems: current status, issues and trends. ." FAO, Rome.
- Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and C.d. Haan (2006) Livestock's long shadow: environmental issues and options. In "Livestock's long shadow: environmental issues and options".
- Stephene, N. and E.F. Lambin (2001) A dynamic simulation model of land-use changes in Sudano-sahelian countries of Africa (SALU). *Agriculture Ecosystems & Environment* 85, 145-161.
- Thornton, P., Jones, P., Owiyo, T., Kruska, R., Herrero, M., Kristjanson, P., Notenbaert, A., Bekele, N. and A. A. O. (2006) "Mapping Climate Vulnerability and Poverty in Africa. Report to the Department for International Development.." ILRI, PO Box 30709, Nairobi 00100, Kenya.
- Thornton, P. K., Booone, R. B., Galvin, K. A., Burnsilver, S. B., Waithaka, M. M., Kuyiah, J., Karanja, S., Gonzalez-Estrada, E. and M. Hererro (2007) Coping strategies in livestock dependent households in East and southern Africa: A Synthesis of Four Case Studies. *Human Ecology* 35, 461-476.
- Vanclay, F., Howden, P., Mesiti, L. and S. Glyde (2006) The social and intellectual construction of farming styles: Testing dutch ideas in Australian agriculture. *Sociologia Ruralis* 46, 61-82.
- Veldkamp, A. and E.F. Lambin (2001) Predicting land-use change. *Agriculture, Ecosystems & Environment* 85, 1-6.
- Walker, B., Carpenter, S., Anderies, J., Abel, N., G., C., Janssen, M., Lebel, L., Norberg, J., D.Peterson, G. and R. Pritchard (2002) Resilience Management in Social-Ecological Systems: a Working Hypothesis for a Participatory Approach. *Conservation Ecology* 6.
- Wilson, G. A. (2001) From productivism to post-productivism ... and back again? Exploring the (un)changed natural and mental landscapes of European agriculture. *Transactions of the Institute of British Geographers* 26, 77-102.
- Wilson, G. A. (2008) From 'weak' to 'strong' multifunctionality: Conceptualising farm-level multifunctional transitional pathways. *Journal of Rural Studies* 24, 367-383.
- Wint, W. R., T. (2007) "Gridded livestock of the world." FAO.