



Livestock Production and Poverty Alleviation—Challenges and Opportunities in Arid and Semi-Arid Tropical Rangeland Based Systems

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Presenter Information

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Livestock production and poverty alleviation—challenges and opportunities in arid and semi-arid tropical rangeland based systems

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Key points :

Rangelands are the largest land use system on Earth . They predominate in arid and semi-arid areas of the World . Large numbers of poor and vulnerable people live in them . Arid and semi-arid rangeland systems are constrained by low primary productivity , low population densities , lack of market access and infrastructure and high transaction costs .

Population density and climate change are creating important changes in land use , access to resources and livelihood strategies of pastoralists in these areas . Arid and semi-arid rangeland systems are no longer seen as livestock enterprises but as multiple use systems with important consequences for the global environment and for more diversified livelihood strategies . They are crucial for the protection of ecosystems goods and services , for tourism and for mitigating climate change . Research agendas need to take into account the trade-offs and synergies arising from these multiple uses so that the poor are able to reap the multiple benefits provided by these ecosystems .

Introduction

Rangelands are the largest land use system on Earth . They constitute some 35 million km² of the earth's surface , with the majority in developing countries and some 65% (almost 22 million km²) of this in tropical Africa . Over 180 million people in the developing world depend for their livelihoods on these systems , with just over half of them living on less than \$ 2 per day and a quarter on less than \$ 1 per day (Thornton et al . , 2002) . Rangelands predominate in dryland areas where they may be defined as regions where there are less than 20 persons/km² and where the length of the growing period (LGP) is less than 60 days/annum and does not permit significant crop growth . Figure 1 shows the location of the arid and semi-arid rangeland systems in tropical and subtropical regions of the World .

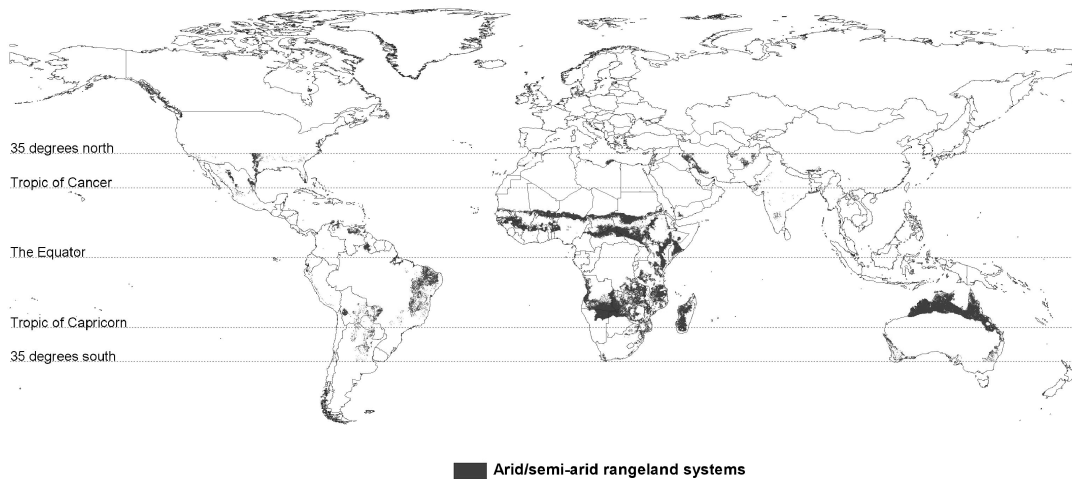


Figure 1 Distribution of tropical and subtropical arid and semi-arid rangeland systems (ILRI Targeting and Innovation databases 2008) .

These pastoral systems are heterogeneous , as there are marked differences between pastoral groups , between communities , and access to livelihood assets . There are those in which people depend entirely on livestock for their livelihoods , to mixed agro-pastoral systems where there is close integration of pastoral resources with cropping (FAO , 2001) . In some cases , the role of diverse sources of off-farm income also plays a significant role in the subsistence of pastoral households . For example in parts of Maasailand (Kenya) , income diversification and remittances can account for more than 50% of the family's income (Kristjanson et al . , 2002 ; Nkedianye et al . , 2008) .

These systems make use of natural vegetation and other natural resources and play a key role in the protection and maintenance of ecosystems goods and services . However , they have a limited primary biomass production with considerable , and increasingly unpredictable , temporal and spatial variation . In this respect , a key feature of these systems is the movement of

animals to take advantage of spatial and temporal variation in feed and water resource availability (often linked to weather patterns). Whilst pastoral movement is traditionally considered in relation to these two key elements, there are other reasons too, some of which become increasingly prevalent in today's changing world—such as access to markets, or social issues like conflicts, provision of services like schooling, health services and others.

Worldwide pastoral and agro-pastoral systems are undergoing unprecedented changes, and combined with the uniqueness of such systems, these present some particular development challenges which in turn imply research cannot be conducted as business as usual, but must be tailored so as to ensure the changing multiple service roles of these ecosystems are taken into consideration in order to have positive impacts on livelihoods and the environment. Increasingly, livestock are being recognised as part of integrated solutions for sustainable natural resource management in the broader development context (World Bank 2007).

This paper focuses on dryland pastoral and agro-pastoral systems in the tropics and sub-tropics. It describes the major drivers and trends changing these ecosystems at global, regional and local levels and the challenges these present for development. It also presents elements of a new research agenda that will be required to deal with the increasingly varied uses of these ecosystems. This is, at a fundamental level, related to choices that can help to alleviate poverty and vulnerability of pastoral communities living in these ecosystems, while ensuring that the poor living in these regions are able to take advantage of new opportunities provided by a rapidly changing world.

Drivers of change in pastoral regions

Human population density: Table 1 presents the human and livestock populations of arid and semi-arid regions in different parts of the World. On a global scale, the increase in human population density is a major driver of change for a wide range of livestock production systems, including pastoral and agro-pastoral systems. Increases in population density have serious consequences on different dimensions of pastoral regions. First, land use changes can be significant as there is increased competition between rangelands and marginal cropping in these areas. At the same time, increases in cropping and sedentarisation have led to land fragmentation, which in turn decrease the grazing ranges and mobility of pastoralists and reduce the buffer dry season grazing reserves. This has led to a reduction in livestock numbers and increased vulnerability in these areas (Reid et al., 2004). For example, in Maasai regions the numbers of animals (tropical livestock units) per capita have decreased from 15-20 to 3 animals per person in a span of 50 years (Herrero et al., 2003). In some areas, notably in parts of Africa, this has also led to increased conflicts in pastoral regions.

Overall, livestock numbers in these regions are slowly increasing, partly due to the increases in demand for livestock products caused by the increases in human population densities and economic growth (Delgado et al. 1999). For example, Herrero et al (2008) estimated rates of increase below 1%/year to 2030 for the livestock populations of diverse rangeland ecosystems in Africa. Since this rate of growth is lower than the human population growth rate, animal numbers per capita are generally decreasing in these regions. This increases the vulnerability of pastoralists in general and creates a need for finding more diversified livelihood strategies to survive.

Climate change is also a driver, though its effects will be most severely felt in the coming decades—its key effects will be increased dryness and higher temperatures, reductions in primary productivity, land use changes, animal disease distributions, land degradation in some cases, changes in species composition (and thereby animal diets and feeding strategies), livestock productivity, incomes and food security. Climate change impacts that lead to some regions becoming drier may also mean that areas previously suited for crop production become too risky for such enterprises, and that pastoral systems become the only way of managing such environments well. Climate change is also a key driver that will determine a new research agenda for the rangelands of the world. Since this is the largest ecosystem on earth, there is an increased need to understand the role that rangelands might have in determining global climatic patterns and how their management might affect climate change.

A number of local and global trends are placing increased pressure on productivity and livestock production of the rangelands in pastoral and agro-pastoral areas. Some of the key consequences, are described below.

Table 1 Area, human population and ruminant livestock numbers in tropical and subtropical rangeland systems of the World (ILRI Targeting and Innovation 2008).

Region	Area (Km ²)	Tot. people (yr 2000)	Cattle TLU total	Sheep TLU total	Goat TLU total	Buffalo TLU total
East Asia	39,286	517,388	142,511	136,593	78,475	9,161
North Africa	51,364	1,931,660	137,064	218,806	92,353	0
South Asia	44,078	5,821,210	642,833	187,932	150,070	283,456

(continue)

Region	Area (Km ²)	Tot . people (yr 2000)	Cattle TLU total	Sheep TLU total	Goat TLU total	Buffalo TLU total
Lac	1 006 230	8 886 420	9 796 930	447 039	413 432	0
Se Asia	38 750	386 390	221 684	729	4 768	138 949
West Africa	841 451	15 579 500	4 309 350	1 077 310	1 283 290	0
Central Africa	572 019	3 228 620	1 636 200	123 222	284 505	0
East Africa	1 535 010	14 826 800	12 858 600	2 111 240	2 123 430	0
Southern Africa	2 051 810	12 739 900	5 735 070	280 616	488 221	0
Australia/Oceania	1 672 811	311 839	7 054 910	2 252 895	5 529	0
Total	6 179 998	63 917 888	35 480 242	4 583 487	4 918 544	431 566

Consequences of the drivers of change

(1) *Land use changes* . Land use change has increased pressure on pastoral communities because it affects their access to natural resources and hence their ability to respond to new shocks . For example , the fraction of rangelands in agro-pastoral territories in South-western Niger declined from 78% in 1950 to 13% in 1996 whereas the fraction of land cultivated increased from 10% in 1950 to 55% in 1996 (Turner et al . , 2005) . In addition , the marginal lands that were previously used by pastoralists for their livestock are increasingly coming into focus as protected areas for biodiversity conservation and tourism (FAO , 2001) . There is increasing pressure on governments to declare large regions as protected areas , in response to the conservation lobby and the potential income from tourism , for example in East Africa where large mammals are still abundant and the tourist industry is highly developed (Reid et al . , 2007) . The key is to find mechanisms to ensure that pastoralist communities share the benefits from these alternative sources of income .

(2) *Transformation of land ownership from common to private property in some pastoral areas* . Privatization of former grazing lands is ongoing in Africa , Central Asia and China . It is often the more productive areas that are the first to pass into private hands for agricultural use . This again impacts on resource access and thereby reduces resilience of pastoralists since these "key resource" areas used to act as grazing refuges during times of drought (Reid et al . , 2007) .

(3) *Sedentarization policies* . The Tragedy of the Commons hypothesis (Hardin , 1968) has been influential among policy makers and has led to resettlement and sedentarization policies in various parts of the world (FAO , 2001) . In many cases these policies have led to further degradation of the pastures they were designed to preserve (e . g . Wu and Richard , 1999) . As well as centrally influenced sedentarisation , mobile pastoralists increasingly choose to reduce their mobility as they develop closer linkages with markets and social services and as they purchase land (Fratkin and Roth , 2005) . This reduction in mobility can lead to concentration of grazing pressure on particular areas and reduces the resilience of grazing lands previously subject to rotational grazing as a result of mobility .

(4) *Market development and evolution* . Changes in market access resulting from increased population , urbanisation and the demand for livestock products are also an important consequence for the development of rangeland systems . Market access provides new income opportunities both from direct provision of livestock as well as service functions associated with such improved markets and associated infrastructure . Market development demands new and improved communication of information to pastoral communities and new social organisation mechanisms . These also provide improved opportunities for input and service provisioning .

In some cases policy and institutional responses have supported pastoral development . These include advances in service delivery and access to technologies , as well as increases in prevalence and function of pastoral self-help organizations .

Development challenges

The trends observed in pastoral systems and their consequences have resulted in a number of development challenges . For pastoral and agro pastoral systems , the overarching development challenge is to reduce poverty and vulnerability in these regions and also to provide livelihood strategies that provide sustainable pathways out of poverty . Because of the particular circumstances and both macro and local drivers and trends , these systems present some distinct challenges . In this section we will consider these challenges and future research needs .

(1) *Low population density and low carrying capacity of the ecosystem* . The key constraint of dryland pastoral regions is their low biomass productivity and consequent low human population density . Low biomass productivity and high climatic

variability make these regions to be inhabited by households inherently food insecure and following semi-subsistence livelihood strategies . In general terms , these marginal areas with low population densities have high percentages of poor people and a high depth of poverty (Kelley and Byerlee 2007) . Unfortunately data on the distribution of poverty in pastoral and agropastoral areas are scarce . However , estimates by Thornton et al (2002) show that pastoral and agropastoral systems account for 24% of poor people in South Asia , 34% in Sub-Saharan Africa and 32% in WANA . Recurrent droughts exacerbate the vulnerability and poverty of these pastoral societies mainly due to loss of their livestock assets (Little et al . , 2007) . These levels of poverty combined with low education levels and lack of development of these regions present a formidable challenge for the promotion of new alternatives beyond very modest levels of livestock production .

(2) *How to link poor pastoralists to the national economies ?* The lack of investment and infrastructure in dryland pastoral regions makes them intrinsically areas with poor market access . This in turn makes it increasingly difficult to integrate these regions with the rest of the national economy due to very high transaction costs . Traditionally , pastoralists sell only a limited number of livestock products , and only sell live animals in period of emergency (mainly droughts) . The marketing of livestock as the primary household livelihood strategy (rather than keeping animals and selling their products) is a fairly recent phenomenon in Africa and Asia (Reid et al . , 2007) . Hence , pastoral livestock markets are not well developed and are not fully integrated into the national economy . There is a general isolation of pastoralists from the economic development process in many countries in sub-Saharan countries , for example , the Fulani pastoralists in West Africa and the Borana pastoralists in southern Ethiopia (Desta and Coppock , 2003) . Mobility presents challenges for transfer of quality information on market prices , However with recent advances in communications technologies (i.e. mobile phones) this constraint is rapidly disappearing . Besides , the lack of infrastructural development makes it difficult for pastoralists to meet the hygiene and food safety demands required to have access to regional and global livestock markets . Projected increases in global demand for livestock products (Delgado et al . , 1999) do , however , present opportunities for increased marketing of livestock by pastoralists .

(3) *Systems of low priority for public investment .* Marginal arid and semi-arid areas are of low priority for national governments and the private sector . This has led to pastoralists having a weak voice in national politics (Chang and Koster , 1994) . Many factors combine to weaken the influence of pastoral people in national fora . For example , policy makers tend to view pastoralists as a minority vote and view their way of life and farming system as backward and inefficient , especially when only considering the animal productivity of these regions . The general weak representation of pastoral organisations in many regions has not helped advocacy of the pastoral cause before the national governments . Pastoralists are not often keen to develop social institutions to defend their interests as a group , in part because their mobility and flexibility make it hard for such institutions to function over long periods . Beside the weak pastoral organisations , pastoralists generally have an inbred distrust of national government . The marginalization of pastoralists is however beginning to change with increasing interest in the pastoral sector by international organizations .

(4) *Natural resource degradation .* Global rangeland resources are widely perceived to have become heavily degraded in recent decades (e.g. Pittroff et al . 2002 , Steinfeld et al . , 2006) although objective measurement of vegetation degradation is relatively rare and the overstocking paradigm is controversial (Mace , 1991) . Some degradation has undoubtedly occurred , and a variety of factors has contributed to the process of degradation of pastoral lands . Pastoralists have often been accused of overgrazing and desertification because livestock is the major user of primary production in the semi-arid and arid regions . Results from ILCA's long-term monitoring studies in East and West Africa (Ellis , 1992 ; Hiernaux , 1993) have challenged the assumption that livestock are responsible for rangeland degradation and have provided evidence that climate , and not livestock , is the main determinant of changes in the arid/semiarid environments and that the rangelands are resilient and capable of recovery . ILCA studies concluded that the strong seasonality of rangeland production in the Sahel limits the risk of overgrazing damaging the environment to short periods and consequently to confined areas ."

(5) *Conflict in managing common resources .* The use of common property resources by pastoralists inevitably leads to two types of conflict . On one hand , there are substantial conflicts related to access rights and the management of common grazing lands . The poorer sectors of society are largely excluded from the benefits of these common lands . Secondly , conflicts also arise with other forms of land use such as agriculture , forestry and wildlife . Development activities within particular sectors can be politically sensitive and there are multiple examples of development initiatives that have failed because of lack of awareness of the natural resource implications of particular interventions for other sectors . Conflicts over natural resources have occurred for millennia but rising population pressure , demarcation of national boundaries , increased incidence of drought and increasing urbanisation have all increased the potential for conflict in recent decades (Fratkin and Roth , 2005) . These conflicts have changed in nature , as more sophisticated weapons are now used by rival fractions .

Consequences and opportunities for research

Due to the heterogeneity of pastoral systems , clearly there is no one-size-fits-all solution , but a complex of inter connected dimensions that need to be taken into account . Overall , the issue is supporting the inevitable transitions in livelihoods that are going to take place in coming decades and this relates overall to two aspects—the mitigation of risk and the potential to

implement new livelihood strategies that include new market opportunities and engaging in other sectors of the economy . There are several potential transition routes for pastoralists : 1) continuing as usual 2) continuing as pastoralists but implementing new management strategies for their animals and for the environment (to address markets for livestock or ecosystem services) 3) settling and combining livestock raising with new diversified livelihood options 4) exiting pastoralism .

Results from several pastoral livestock projects suggests that technical intervention will have only a very limited impact on overall development of pastoral and agro-pastoral areas (FAO , 2001) . A major lesson from the failures of production-oriented technical interventions in different countries is that an increase in livestock production and productivity is not tantamount to the social development of pastoralists and agro-pastoralists (FAO , 2001) . In other words , pastoral development is more than livestock productivity . Some of the issues to address in development initiatives for pastoral and agro-pastoral areas include the following :

- Increasing need to provide more people with food .
- Livestock mobility to access key resources , pasture and water , especially in period of droughts .
- Improving access to inputs and services for livestock production systems that are already intensifying .
- Improving the resilience of pastoral and agro-pastoral systems in response to climate change and variability .
- Promoting a more efficient use of existing natural resources .
- Livestock asset security and diversification to mitigate risks . Diversification options need to include non-livestock based livelihoods .
- Building marketing infrastructure to link pastoralists and agro-pastoralists to regional and global livestock markets .
- Co-generation and co-sharing of knowledge and information . Sharing of information has changed substantially in parts of Africa . A range of innovative approaches has been tested in the developing world , based primarily around ICT . Access to mobile phones has changed significantly the way pastoralists trade their livestock products . By having access to information about prices , they are able to make better informed decisions on buying and selling animals (KACE , 2005) .
- Building local capacity and institutions , and facilitating community-based initiatives , especially indigenous management of natural resources . For community initiatives to succeed under conditions of poverty and marginalization , enabling policy and legislation are vital . Providing a platform for pastoral communities to advocate their own concerns should be an integral part of any development initiative . Building local capacity and institutions is more than creating organizational structures but also entails the institutional support to organisations in terms of funding , mandate , responsibilities , and technical knowledge and skills available .
- Strengthening pastoral safety nets as these are the primary means of dealing with drought in sub-Saharan Africa . For example , Maasai pastoralists in East Africa maintain kin-based networks for mutual assistance to ensure survival of households during crisis , which includes access to pasture and water (Reid et al . , 2007) .
- Promotion of alternative sources of employment without losing cultural identities . Rural/urban migration to seek alternative sources of income by some members of the pastoral household has had a profound effect on the cash economy of pastoral societies (Nkedianye et al 2008) . Remittances from members of the family from within or outside the region (rural/urban migrations) have significantly reduced vulnerability of pastoral families .

The prioritisation of development issues raised above will depend on policy environment , natural resource base , land use patterns , property rights , credit facilities , market potential and capacity of pastoral organisations . It should be emphasised that many of these development issues cannot be implemented in isolation at local community level but will require the active involvement of regional and national governments .

Perry et al . (2002) identified three pathways out of poverty through livestock : 1) increasing animal productivity 2) protecting and securing livestock assets 3) increased market integration . It is under this framework that we examine the potential for research in pastoral and agropastoral systems . Table 2 presents some of the research needs for pastoral systems .

Table 2 *Some researchable areas in arid and semi-arid pastoral and agro-pastoral systems .*

Research area	Opportunities for research
Spatial analysis , impact assessment	<ul style="list-style-type: none"> • Spatial analysis : Where are the most vulnerable groups of pastoralists now and in the future • Household level analysis : What determines the vulnerability of pastoralists • Trade-off analysis of multiple uses of rangeland ecosystems • Impact assessment and priority setting of integrated rangeland ecosystem uses
Adaptation options to climate variability and change	<p>Management practices</p> <ul style="list-style-type: none"> • Rangeland management for multiple uses (animal production , payments of ecosystems goods and services) • Rangeland management to mitigate climate change effects • Strategies for selling and buying animals • Health management practices • Water harvesting techniques • Insurance-based schemes to reduce vulnerability • Early warning systems

(continue)

Research area	Opportunities for research
Diversification of income sources	<ul style="list-style-type: none"> • Development of practical approaches to quantify delivery of environmental services by pastoralists and markets for such services • Exploitation of niche markets for livestock products with certain characteristics • Development of biofuel crops for ASALS • Mechanisms for promoting increased revenues for communities from wildlife conservation and tourism • Off farm income , remittances and/or exiting from pastoralism
Increased market access	<ul style="list-style-type: none"> • Collective action mechanisms for selling animal and other products • Novel methods of networking and sharing benefits of ecosystems • Increased information and communication on marketing options • Identification of new market options (specialization and diversification)

Research outputs need to lead to development outcomes at local and regional levels . Targeting and spatial analysis can help to identify where these different aspects should be the focus for research and development initiatives . For example , studies by Thornton et al (2006) have combined climate change predictions and proxy indicators of vulnerability to assess the areas most vulnerable to climate change in Africa . Given the heterogeneity of systems on the ground , such broad brush approaches also need to be scaled down to local and regional levels . Risk mitigation at local level needs to take account of poverty , availability of food , safety nets and insurance . ILRI has conducted research to help target appropriate risk response aspects , focusing on livestock interventions . In a study on livestock , livelihoods and vulnerability in Lesotho , Malawi and Zambia commissioned by the Food and Agriculture and Organization of the United Nations (FAO) , economic shocks , drought , livestock losses due to animal diseases and declining efficacy of delivering livestock services to poor people are identified as major sources of vulnerability (Freeman et al . , 2007) . The study reported that households use a wide range of informal and formal strategies to manage and cope with risks . The study also reported marked differences in ownership of productive assets , livelihood strategies and vulnerability between men and women , and showed that women and female-headed households were more likely to be more vulnerable than the general population (Freeman et al . , 2007) . A major lesson from this study for pastoral and agro-pastoral systems is that vulnerability is an issue that must be addressed in any pastoral development initiatives . It should take into account of the increasing emigration of young men from pastoral areas to urban centres and the associated increase in number of households headed by females .

One of the keys to responsiveness to change , be it market or climate variations , is enhancing the capacity of local institutions and communities . This has been addressed in an ILRI project in East Africa on better policy and management options for pastoral lands called "Reto-o-Reto" (in Maa language , "Reto-o-Reto" means "I help you , you help me") . This project was designed to create the knowledge and relationships to enable poor agro-pastoral communities to influence district and national land use policies affecting their livelihoods and the sustainability of biodiversity in the areas where they live (ILRI , 2005) . To facilitate communication with and active participation of the communities in the project , community facilitators were engaged who served as representatives of their communities . Besides , the facilitators worked with the researchers and represented the communities interests' to the policy makers . Under the project , the community facilitators were trained in GIS mapping and they in turn trained members of their communities to map their land areas . Information products including radio programs and posters in local vernacular languages were disseminated providing information on various practices for effective resource management .

A critical pathway out of poverty is the promotion of new and growing markets . Studies in West Africa (Okike et al . , 2004 ; Williams and Okike , 2007) have shown that in many instances , livestock traders dictate prices because of lack of information by the producers—often the pastoralists , meaning there is little incentive for increased production , whilst in reality there are opportunities for a wide range of cross-regional linkages to increase market opportunities Such research has identified key entry points for improving the income and opportunities for pastoral livestock producers especially in relation to growing regional livestock markets . These include opportunities for credit arrangements to allow value added processing , lowering transportation and handling costs , development of livestock market information systems and harmonising regional policies on livestock trade . New opportunities arise from the increased demands of livestock products by affluent sectors of society domestically and internationally . For example , niche markets for animals with certain characteristics or certain breeds are starting to be exploited as added value alternatives in pastoral regions (i . e . Sudan desert sheep exported to the Middle East , El Chaco beef and others) .

An increasingly important opportunity for pastoral livelihoods relates to the role in managing them for protecting or increasing environmental services . Opportunities will arise for receiving payments for the provision of these services once adequate mechanisms are put in place by the global environmental community . This presents an opportunity of global and local significance . As said before , rangelands are the largest ecosystem of the world and have significant potential to reduce

greenhouse gas emissions through management of the carbon cycle. They have the potential to mitigate carbon dioxide emissions by protecting existing carbon resources (conversion of grazing land to cropland leads to huge carbon losses), by sequestering carbon (e.g. through grasses replacing cropland, reducing grazing intensity and erosion and improving species mixes (e.g. more browse means more carbon sequestered) (Reid et al., 2004). At the same time rangelands provide other services such as a protection of ground and surface water sources in most basins in Africa (Peden et al., 2007). Traditionally, they have been managed from an animal productivity perspective but these new global and regional roles of rangelands will need increased understanding of their multiple values and the trade-offs arising from them. New quantitative and qualitative data will be essential to establish under which circumstances and management practices these multiple uses can satisfy several simultaneous functions. This opportunity will also require new research on the local and global institutional arrangements needed for different sectors to benefit from these multiple uses of the rangelands.

Conclusions

The perceptions about arid and semi-arid pastoral regions are rapidly changing. It is increasingly recognised that these are ecosystems with many functions and some alternative development options. Some of these options, while important for households and communities are also of global and regional interest and might turn into economically viable livelihood strategies if the right systems of incentives and policies are put in place. For poor households this will mean alternatives beyond traditional livestock production such as the payments for ecosystem services like water, carbon sequestration and others, tourism, biofuel production and the development of niche markets. An increased number of options might make these regions more attractive for public and private investment. This could in turn lead to better services and infrastructure in these regions.

Traditional research paradigms for the rangelands have been largely about increasing the primary productivity of the land via management approaches and introducing new forage species and drought management interventions. The new role this ecosystem can play requires a different more holistic research paradigm. This new research agenda will have to focus on assessing the synergies and trade-offs, from different perspectives (economic, social, ecological) of the diverse set of options for different members of society. It should seek to find what may work where and also how can the poor benefit from these increased livelihood alternatives. While well engrained in pastoral societies, some of these alternatives will require new collective action mechanisms in order to promote the adequate benefit sharing and proper management of the natural resources.

Rangeland systems will diversify but will also require a degree of specialisation of their livestock systems. This specialisation will be driven by increased integration of the pastoral economy with other regions. Diversification will also lead to more inclusion of different segments of society into the economy and less competition between households, as the potential for different combinations of livelihood strategies expands.

Pastoralism is no longer seen as a tragedy for common grazing areas but rather as having the potential as a viable part of complex livelihood strategies. Redressing the balance of productivity, environment and livelihoods in such fragile regions raises the potential of addressing the needs of the vulnerable. It is a complex and challenging assignment, but increasingly urgent.

References

- Chang C. and Koster, H. A. (eds). 1994. *Pastoralists at the Periphery: Herders in the Capitalist World*. Tucson: The University of Arizona Press.
- Delgado, C., M. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 1999. *Livestock to 2020: The Next Food Revolution*. Discussion Paper 20. Int. Food Policy Res. Inst., Washington, DC.
- Desti, S. and Coppock, L. 2003. *Pastoralism under pressure: Tracking system change in southern Ethiopia*. Research Brief, Pastoral risk management project, Utah State University, US.
- Ellis, 1992. *ILCA's Rangeland Research program in the Arid and Semiarid Zones: Review and Recommendations*. International Livestock center for Africa, Addis Ababa, Ethiopia.
- FAO, 2001. *Pastoralism in the new millennium*. FAO Animal Production and Health Paper 150. Rome, Italy.
- Fratkin, E. and Roth E. A. (eds). 2005. *As pastoralists settle: Social, health, and economic consequences of pastoral sedentarization in Marsabit District, Kenya*. Kluwer Academic Publishers, Dordrecht, Netherlands.
- Freeman, H. A., Kaitibie, S., Moyo, S. and Perry, B. D. 2007. *Livestock, livelihoods and vulnerability in Lesotho, Malawi and Zambia: Designing livestock interventions for emergency situations*. International Livestock Research Institute Report, Nairobi, Kenya.
- Hardin, G. 1968. "The tragedy of the commons". *Science* 162:1243-1248.
- Herrero, M., Kristjanson, P., Radeny, M., Burnsilver, S., Nkedyanye, D., Kamuro, O., Reid, R. S., Thornton, P. K. 2003. *Identifying the information needs of decision-makers in Maasai pastoralist systems in Kenya. A collaborative study between ILRI, Edinburgh University and the communities of Narok and Kajiado*. DFID LPP Report Project ZC0196. 57 pp.
- Herrero, M., Thornton, P. K., Kruska, R. and Reid, R. S. 2008. *Systems dynamics and the spatial distribution of methane emissions from African domestic ruminants*. *Agriculture Ecosystems and Environment*, in press, doi 10.1016/j.agee.2008.01.017.

- Hiernaux , P . 1993 . The crisis of Sahelian pastoralism : Ecological or economic ? International Livestock Center for Africa , Addis Ababa , Ethiopia .
- ILRI (International Livestock Research Institute) 2005 . Better policy and management options for pastoral lands : The "Reto-o-Reto" project . Second annual project report . International Livestock Research Institute , Nairobi , Kenya .
- KACE (Kenya Agricultural Commodity Exchange) . 2005 . Kenya Agricultural Commodity Exchange . <http://www.kacekenya.com/home/index.asp> .
- Kelley , T and Byerlee , D . 2007 . Surviving on the margin : agricultural research and development strategies for poverty reduction in marginal areas . Background paper for the World Development Report 2007 . World Bank , Washington D .C . , US . 29 pages .
- Kristjanson , P . Radeny , M . , Nkedyanye , D . , Kruska , R . , Reid , R . , Gichohi , H . , Atieno , F . , Sanford , R . 2002 . Valuing alternative land use options in the Kitengela wildlife dispersal area of Kenya . ILRI Impact Assessment Series 10 . A joint ILRI (International Livestock Research Institute)/ ACC (African Conservation Centre) Report . ILRI , Nairobi , Kenya . 61 pp .
- Little , P . D . , McPeak , J . G . , Barrett , C . B . and Kristjanson , P . 2007 . Challenging Stereotypes : The Multiple Dimensions of Poverty in Pastoral Areas of East Africa . Available at SSRN : <http://ssrn.com/abstract=999623>
- Mace , R . 1991 . Overgrazing overstated . *Nature* 349 : 280-281 .
- Nkedianye , D . , Radeny , M . , Kristjanson , P . and Herrero , M . 2008 . Assessing returns to land and changing livelihood strategies in Kitengela . In : Homewood , K . , Trench , P . , Kristjanson , P and Radeny , M (Editors) . *Changing Land Use and Livelihoods in Maasailand* . Springer , Germany (in press) .
- Okike , I . , Williams , T . O . and Baltenweck , I . 2004 . Promoting livestock marketing and intra-regional trade in West Africa . ILRI/CFC/CILLS West Africa Livestock Marketing Brief 4 .
- Peden , D . , Tadesse , G . and Misra , A . K . , Awad Amed , F . , Astatke , A . , Ayalneh , W . , Herrero , M . , Kiwuwa , G . , Kumsa , T . , Mati , B . , Mpairwe , D . , Wassenaar , T and Yimegnihal , A . 2007 . Chapter 13 . Livestock and Water for Human Development . In : *Comprehensive Assessment of Water Management in Agriculture* (D . Molden et al . Editors) . Oxford University Press , Oxford , UK , 485-514 .
- Perry B D , McDermott J J , Randolph T F , Sones K R , Thornton P K 2002 . Investing in Animal Health Research to Alleviate Poverty . International Livestock Research Institute (ILRI) , Nairobi , Kenya . 138 pp .
- Pittroff , W . , Catwright , T . C . and Kothmann , M . M . 2002 . Perspectives for livestock on grazing lands . *Archivos Latinoamericanos de Producción Animal* 10 (2) , 124-134 .
- Reid R S . , Galvin K . A . and Kruska R . S . 2007 . Global significance of extensive grazing lands and pastoral societies : an introduction . In K . A . Galvin , R . S . Reid , R . H . Behnke , and N . T . Hobbs (eds .) , *Fragmentation in Semi-arid and Arid Landscapes : Consequences for Human and Natural Systems* , 1-24 .
- Reid , S . R . , Thornton , P . K . , McCrabb , G . J . , Kruska , R . S . , Atieno , F . and Jones , P . G . 2004 . Is it possible to mitigate greenhouse gas emissions in pastoral ecosystems of the tropics ? *Environment , Development and Sustainability* 6 : 91-109 .
- Steinfeld , H . , Gerber , P . , Wassenaar , T . , Castel , V . , Rosales , M . , and de Haan C . 2006 . *Livestock's long shadow : Environmental issues and options* . Rome , FAO .
- Thornton , P . K . , Kruska , R . L . , Henninger , N . , Kristjanson , P . M . , Reid , R . S . , Atieno , F . , Odera , A . and Ndegwa , T . 2002 . Mapping poverty and livestock in the developing world . International Livestock Research Institute , Nairobi , Kenya .
- Thornton , P . K . , Jones , P . G . , Owiyo , T . M . , Kruska , R . L . , Herrero , M . , Kristjanson , P . , Notenbaert , A . , Bekele , N . and Omolo , A . 2006 . Mapping climate vulnerability and poverty in Africa . International Livestock Research Institute , Nairobi , Kenya .
- Turner , M . D . , Hiernaux , P . and Schlecht , E . 2005 . The distribution of grazing pressure in relation to vegetation resources in semi-arid West Africa : the role of herding . *Ecosystems* 8 , 668-681 .
- Williams , T . O . and Okike , I . 2007 . Livestock markets in West Africa : potential tools for poverty reduction ? *Faith and Economics* 50 : 12-41 .
- World Bank (2007) *Agriculture for Development* . World Development Report 2008 . The World Bank , Washington D .C . , US . 365 pages .
- Wu , N . and Richard , C . 1999 . The Privatization Process of Rangeland and its Impacts on the Pastoral Dynamics in the Hindu Kush Himalaya : The Case Study of Western Sichuan , China , in *People and Rangelands* . Proceedings of VI International Rangelands Congress , eds D . Eldridge and D . Freudenberger . Townsville , Australia , p . 14-21 .