

## **Incorporating livestock in global integrated assessments of land use and agro-ecosystems services**

M. Herrero, P.K. Thornton, M. Rosegrant, P. Havlik, S. Msangi, S. Fritz, H. Lotze-Campen, A. Notenbaert, A. Popp, B. Eickhout, C. Muller, J. Van de Steeg, D. Gerten, T. Sulser, C. Ringler, S. Wood, H.A. Freeman

International Livestock Research Institute, P.O. Box 30709-00100, Nairobi, Kenya

Contact: m.herrero@cgiar.org

### **Introduction**

The World is changing at unprecedented rates due to a range of drivers such as increased human population, rural/urban migrations, income increases, dietary changes, climate change and others. These changes exert significant pressures on the use of resources, and at least in some places, they hamper the functioning of agro-ecosystems and affect several aspects of human well-being (nutrition, mortality, incomes and others). In the process, the poor become more vulnerable and the sustainability of ecosystems for future generations gets compromised. The last decades have seen a crop of forward looking integrated assessments that try to understand better these effects and to find solutions (policies, technologies, investments) to satisfy the global requirements of future food production, ecosystem functioning, poverty reduction and others. Notable examples of these assessments are the Millennium Ecosystem Assessment (MA, 2005), the Comprehensive Assessment of Water in Agriculture (CA, 2007), IPCC's Fourth Assessment Report (IPCC, 2007), GEO4 (UNEP, 2007) and the International Assessment of Agriculture, Science and Technology Development (IAASTD, 2008). Some of these have not considered livestock at all, or as explicitly as it is required in order to fully elucidate the impacts and contribution of livestock on the use of land and other resources, food security and other dimensions of human well being and ecosystems functioning. This is somewhat surprising considering that livestock systems are the largest land use system on Earth (Reid *et al.*, 2008) and that they play a key role in the livelihoods of many people around the World, especially the poor. This paper examines the key elements and feedbacks of livestock systems that could be included to improve integrated assessments of land use, agro-ecosystems services and human well-being.

### **Methods**

We reviewed the main global assessments mentioned above and the tools and models they used. We identified gaps of where the key linkages with livestock were missing in these models and proposed the key aspects and ways of incorporating them for future assessments. This led to the development of a framework for incorporating spatially differentiated livestock systems, livestock numbers and productivities by species, management parameters and use of resources for use in a range of global integrated assessment models.

### **Results and discussion**

Some key features of livestock systems that need to be incorporated in global integrated assessments are presented in Table 1. They all relate to dynamic aspects of livestock production, competition and trade-offs for resources, sometimes between systems and others with other sectors (i.e. water, grains), to the sustainability of ecosystems and to how they support humans (food). Including these important dimensions will allow us to understand the beneficial and negative aspects of global livestock production in the future, and to develop policies to ensure that livestock keeps having an important role in global food security and in the livelihoods of the poor.

Table 1. Some aspects of livestock systems that need to be represented in global integrated assessments.

Land use	Better estimates of global rangeland productivity. Rangeland composition and dynamics for assessing future change. Better estimates of carrying capacity of rangelands. Feed supply, both for monogastrics and ruminants.
Livestock productivity	Consumption of feeds by different species. Changes in the productivity of different species as genetics and feeding changes over time by production system.
Livestock numbers	Better understanding of what drives the spatial distributions of animals (ruminants, pigs and poultry). Feasibility of animal numbers in different systems due to resource constraints.
Water use by livestock	Water embedded in the production of feeds for different species and water intake by animals. Competition for water between livestock and other sectors.
Livestock systems and their changes	Improved definitions of livestock systems (i.e. industrial, mixed, pastoralist, etc). Systems transitions between pastoral and mixed systems due to intensification, service and technology provision and others. Systems transitions between mixed and industrial systems. Disaggregated food supply (milk, meat, others) from different systems. Intensification thresholds of livestock production. Environmental impacts in different livestock systems (excretions, etc).
Livestock and climate change	Animal species changes due to changes in environmental and production conditions. Mitigation measures for greenhouse gases. Feeding animals under different climate change scenarios.

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