Sustainable Intensification of Livestock Production Systems

An Environmental Perspective with Particular Attention to
Animal Genetic Resources

by

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Introduction :

Decision makers concerned with the livestock sector of the developing world face a formidable challenge. Fueled by population growth, rapid urbanization and rising incomes, demand for meat in the developing world is expected to increase from 65 million tons in 1990 [1] to 170-200 million tons[2] in the year 2020 (Rosengrant et al. 1996) This growth is especially strong in Asia, where demand is expected to more than triple, as shown in table 1. It is also strong, compared with cereals and tubers, for which the demand is expected to increase with only 70-88 percent over that period.

Table 1. Growth in demand and production (million tons per year) for meat in the different developing regions of the world.

Regions	Demand 1990	Demand 2020		% growth	Production 1990	Production 2020		% growth
		Low GDP growth	High GDP growth			Low GDP growth	High GDP growth	
Asia	37.8	110.4	135.0	292-357	37.6	99.8	116.4	265-309
Latin America	17.4	32.1	35.0	184-201	18.2	32.8	36.9	180-202
Sub-saharan Africa	4.4	11.9	12.9	270-293	4.3	8.7	9.9	202-230
West Asia & N. Africa	6.2	14.5	16.0	233-258	5.0	10.8	11.8	216-236

Source: Adapted from Rosengrant et al (1996).

[1] Already increased to 75 million tons now (FAO, 1996)

[2] Range refers to assumptions on income and population growth

This paper will first provide an overview of the effect of the increasing demand on the growth of different livestock production systems[3], then describe the environmental implications of these trends for each production system, and the main tools to improve the sustainability of future production. The paper will conclude with a set of recommendations concerning the role of the public and private sector in this domain. While focusing on overall sustainability of global livestock production, the emphasis, especially in the examples, is on the conservation of domestic animal diversity, as one of the key components of the global natural resource base.

Future growth characteristics of livestock production

Most of the future demand for livestock products will have to be met through intensification, increasing the productivity of land and livestock:

- The potential for expanding the grazing areas is limited, as the best range and grasslands are lost to expansion of cultivated land and urbanization. For example, over the last five years, the area for permanent grassland in Asia has stagnated at 800.000 km^2 (WRI, 1996). Expansion of the grazing system seems only possible in the sub-humid zones of Latin America and Sub-saharan Africa, where human and animal diseases and poor infrastructure still prevent intensive livestock production.

- The potential for increasing arable areas for *mixed farm expansion* is also limited. While theoretically, the area for arable crops can be doubled (Buringh and Dudal, 1987) Crosson and Anderson (1993), estimate that over the next three decades, an expansion of only 25 percent is economically feasible.

[3] In this paper, the definitions of the different production systems are as follows: (i) grazing systems, where animals get 90 percent of more of their feed from pasture; (ii) mixed farming systems, where animals get at least 10 percent of their feed from crops and crop residues produced on the own farm; and (iii) industrial systems, where animals get less than 10 percent of their feed from the own farm.

Over the last decade, the growth in meat production has stagnated in grazing systems, been moderate in mixed farming, and been quite strong in the industrial systems (Table 2). This trend would most likely continue. First, arid and semi-arid rangelands are already used at the maximum of their potential (Breman and de Wit,), whereas for the tropical savannas, the main remaining underutilized grassland area in the world, there has been no significant breakthrough (nor is there one in sight) in improving the nutritive value of their fibrous forages. Second, many mixed farming systems of the developing world, show a fast deterioration of the grazing to arable land ratio, with livestock being pushed out, for example in the East African Highlands, Central Java, and the densely populated areas of the Indian Sub-continent. On the other hand, rising demand for higher quality products in the more developed world and economies of scale lead to specialization and industrial production modes.

While rising feed grain prices, concern for animal welfare and stricter environmental regulations might reverse these trends somewhat, the most likely development path will consist of fast expansion of the industrial system, in parallel with increasing animal pressure in the grazing and mixed farming systems.

Table 2. Growth of meat production (% per year, 1981-83 to 1992-93) in different production systems and different regions.

	Grazing system	Mixed system	Industrial system
Asia			
Latin America			
Sub-saharan Africa	**0.1**	**2.3**	**7.3**
West Asia and North Africa			
Global (incl. OECD countries)	**0.7**	**2.2**	**4.3**

Source: Adapted from Sere and Steinfeld (1996).

Implications for the environmental sustainability of livestock production

If environmentally sustainable agricultural production is defined as the capacity to produce enough food and fiber over time, keep the use of non-renewable resources in equilibrium with the creation of new resources, and maintain the production of waste within the assimilative

capacity of the local environment, then the above sketched development paths would affect for the sustainability of the world's livestock production negatively:

- In *grazing systems*, and in particular in those using communally owned land, the pressure would cause continuing erosion of traditional grazing rights, with crop-encroachment in the "key resources" and a shift to open access "free-for-all" grazing in the remaining areas. This is currently a major trend in the arid and semi-arid areas of Sub-saharan Africa, India and Central Asia, and is there the main cause of soil degradation. The poor sustainability of these systems, is shown by the declining livestock productivity, in particular on a per human capita basis in the semi-arid areas;

- In *mixed crop-livestock systems*, the equilibrium situation, where most of the waste products (manure, crop by-products) can be used in the same system, is disturbed, either because livestock is expelled from the system, causing soil nutrient and energy deficits, or increasing reliance is placed on outside inputs, such as feed and chemical fertilizer, causing levels of nutrient surpluses, which exceed the adsorptive capacity of the land. For example, the OECD countries have still on average a nutrient surplus of N per ha, of which for comes from feed imports. Similar, or even higher nutrient surpluses are being reported from China (Ke, 1997); and

- In *industrial systems*, waste products are often not be used in the system, and the growth will cause increased amounts of waste to be discharged outside the system. For example, the industrial pig and poultry systems of Asia already produce an estimated 250 million tons of waste per year, projected to increase to almost one billion tons in the year 2020. This discharge pollutes soil and ground and surface water, affects air quality and alters natural habitats and thus causes bio-diversity loss. Most importantly for the specific topic of this symposium, the intensive mixed farming and the industrial systems require uniform genotypes, for production purposes because of the need for uniform growth rhythms to achieve economies of scale in housing and efficiency in feeding, and for processing and

consumers purposes to have a uniform product to process, pack, promote and sell. The heavy pressure on local livestock breeds, caused by this demand for uniform genotypes, is well documented (Hammond and Leitch, 1994).

The tools to promote environmental sustainability of livestock development

Introduction

A wide variety of technologies exists improve the sustainability of livestock production (de Haan et al, 1997). However, the quest for sustainability should not be limited to technological interventions, such as controlling the stocking rate to prevent land degradation, or improving feed quality to reduce methane emission and global warming. Because it is not livestock production per se, but human actions and activities, which shape livestock's effect on the environment. The key challenge is to introduce those policies, which lead to environmentally sustainable development, correcting the pressures which cause negative and obstruct positive environmental effects. Some of these pressures go beyond the realm of livestock policy, such as population growth and consumption habits. Other are easier to amend, such as subsidies on feed, fertilizer and AI, or inappropriate land tenure rules. They are the main focus of this paper.

In identifying the appropriate policies, it is clear that blanket solutions do not exist. First, certain societies, especially in the developing world, give a higher value to income generation and food security, and a lower value to immediate environmental concerns. These valuation differences must be acknowledged. Second, the sustainability of livestock production is mainly a result of local resource endowment and prevailing policies and institutions. Any intervention needs therefore to be designed according to prevailing local and national priorities and resource endowment, balancing human needs and environmental concerns.

Specific policy tools

With these caveats, and on the basis of the previous analysis, the key policy framework to make livestock production more sustainable, would seek to control the spill-over effects (or internalize the externalities) and establish the incentives to minimizing environmental costs and maximizing environmental benefits. The would require the following tools (Young 1966):

(a) information tools

There is clearly a need for better information on livestock-environment interactions. Decision making is seriously hampered by poor or incorrect information on the size and direction of livestock-environment interactions. This is one of the main reasons that livestock is so often made the scapegoat of environmental problems. This has serious consequences, and has led to wrong decision making. For example, following the droughts of the seventies, "desertification" , provoking images of advancing deserts caused by overgrazing, has led efforts to control stock numbers in these areas and brought considerable investments in arid areas (greenbelts, etc.). However, pictures of the vegetation in the arid Gourma of Mali (Hiernaux, ILRI), data from NASA-NOAA (Tucker et al, 199 1) and our own work (de Haan et. al, 1997) show the strong resilience the arid vegetation. The real problem is in the semi-arid and sub-humid zones. Similarly, the lack of accurate information on the number of domestic livestock breeds and the rate of extinction seriously hamper priority setting in breed conservation. Information is also lacking on the methodological aspects of estimating the value of the environmental benefits of livestock production, and thus on their actual value. For example, unless we arrive at reasonable estimates on the environmental benefits of breed conservation, it would be difficult to establish the correct breeding and breed conservation policies. In all cases, better quality information and analysis would have enable better decision making.

(b) Education and public awareness tools.

On the basis of good data, the next step would be to increase the emphasis on education and public awareness. This could include:

- the linkages between the consumption of livestock products, health and environmental effects. This is strongly advocated by environmental groups, although experience indicates that, up to a consumption level of about 60 kg meat and 100 kg milk per year, meat and milk products have a very high incomes elasticity of demand. Restricting consumption in the developing world seems therefore highly unlikely.

- better education under other stakeholders seems more appropriate. Farmers and especially young farmers education on the possibilities of more sustainable production forms has large pay-offs. For example, the introduction of farm level mineral accounting in the Netherlands, made farmers aware of nutrient loading and led to more targeted and lower fertilizer applications. The characterization of some of the trypano-tolerant breeds in Sub-saharan Africa and the widespread dissemination of the results in the early eighties (ILCA,) has greatly increased the interest for these breeds.

(c) Property tools

The establishment of clear and enforceable rules for access and ownership of land, water and bio-diversity is a further critical component of any effort to improve the environmental sustainability of livestock production and processing. For example:

- Pastoral development in Africa would be environmentally better sustainable, if adequate flexibility and mobility for the pastoralists would be maintained and access rights to critical dry-season grazing areas be clearly established and enforced, to allow them to utilize the highly variable (in time and space) vegetation efficiently. Clear ownership rights on bio-diversity (such as wild life) by local communities and game ranches (rather than by government) would help to promote better livestock-wild life associations; and

- Animal genetic would also benefit from clear ownership rights. Several cattle and small ruminant breeds, based on genetics of developing world breeds, are now being used in the developed world. Clearly established ownership rights on these genetics would improve the incentives for conservation.

(d) Pricing tools .

The introduction of market prices for inputs and products would be a key instrument to induce more intensive and at the same time environmentally friendlier livestock production and processing. Ideally, the prices of meat and milk should reflect all direct and indirect environmental costs and benefits. Environmentally the most appropriate balances between the different production systems and between natural resource conservation and human needs are established, if all environmental costs are internalized and environmental benefits are adequately shared. Internalization of environmental costs promotes efficient input use, hence reduces the production of waste and saves non-renewable resources, and therefore improves the sustainability of production. For example:

- the introduction of cost recovery for water and grazing would reduce incentives for pastoralists to keep marginally productive stock, and therefore reduce grazing pressure;

- the introduction of market pricing for inputs, such as feed, Artificial Insemination, and veterinary treatments, would promote the conservation and use of local breeds as it would reduce the unfair advantages that many using introduced breeds still enjoy in developing countries; and

- the introduction of levies and taxation on waste disposal, " the polluter pays principle" would reduce waste discharge, at a limited direct costs (5-10 percent, to internalize the direct environmental effects of waste from industrial production systems, Steinfeld, et al 1997). Environmental cost valuations of meat and milk produced in grazing or mixed

systems are scarcer, but can be expected not to exceed the costs levels of waste treatment of industrial production.

Even more difficult and controversial is the equitable distribution of environmental benefits, because of the lack of appropriate valuation techniques and the problems of distributing those benefits in an equitable fashion. One of the most obvious examples concerns benefit sharing from tourism and other forms of wildlife utilization by the users of the common grazing areas in Africa, where still major issues of valuation and equity exist.

(e) Institutional tools

The identification of the main institutions to regulate and control the negative environmental effects and promote the positive ones is the final key component of the policy framework for sustainable livestock production. The two main issues concern the role of the public and private sector and decision making level.

For the discussion on public vs. private, the main criteria should be whether the benefits of an investment accrue exclusively to the investor (a "private good"), or spill-over on the community as a whole (market failure of "public good"). Thus, AI and clinical veterinary treatments, which benefit exclusively the individual farmer, requester of that service, are private goods (Umali-Deiniger et al, 1993). In animal genetic resource conservation, there is also a clear market failure. First, the future value of a conserved breed is not known and second, the results of some of the activities (data base management and DNA characterization), benefit the entire community. There is thus a strong public good nature, and therefore justification for public sector involvement. However, with continuously shrinking public funding availability, the policy should be to ensure that the maximum of benefits of animal genetic resource conservation can be captured by the private sector. Conservation through breed improvement, often advocated (Hammond) is a most appropriate policy in this context.

Regarding the most appropriate decision making level, experience increasingly shows that decentralized decision making and local empowerment are critical in arriving at sustainable resource use. Decisions about local range or water use should not be made in a capital, but by the local community. Fortunately, pastoral and village groups, show increasingly the internal discipline to improve the management of their rangelands. Similarly, village groups have shown to be more efficient in genetic resource conservation than (para) statal ranches. Table 3 provides a proposed breakdown of responsibilities.

Table 3 Potential Distribution of Responsibilities for some Key Tasks involved in Animal Genetic Resource Conservation.

	Breeders	**Breed ass. /NGO**	**Nat. Gov't**	**Int. Agencies**
In-situ	+++	+++	++	+
Ex-Situ	+	++	+++	+
DNA Charact.	-	+	+++	++
Data base mgmt	+	++	++	+++

Source: de Haan et al (1997).

(f) Regulatory tools

Regulations are particular important in countries with strong institutions and clearly identifiable polluters. They would be the tools to improve the geographical spread of intensive units, to bring livestock more in line with the absorptive capacity of the land, as proposed for the industrial system ("a regional mixed farm", Steinfeld et al, 1997) . Aiming for a more even geographical distribution of production would be particular urgent in Asia, where the

concentration of intensive poultry production units and peri-urban dairies is becoming an important issue around metropolitan areas. Finally, a word of caution on the use of regulations to prescribe "breeding policies", interfering with the import of genetics. Quite clearly, breeders should have the decision on which breed to use.

Conclusion.

Over the next decades, decision makers at all levels concerned with livestock development and the environment face a tremendous tasks. The demand for livestock products is most likely to increase dramatically, causing a strong increase in the pressure on the environment. On the other hand, national and international public funding for livestock development has declined (Blackburn and de Haan, 1993). There is thus a need to develop a coherent strategy of the critical public sector functions, which need to be supported, to create the enabling environment for the private sector to conserve land, water and wild and domestic bio-diversity. International funding for livestock development has shifted over the last decade from production and commercial activities, to strengthening of public good services, such as research and extension. It can be expected, that natural resource concerns of a public good nature will gain importance, as the magnitude of the challenge ahead becomes clearer. As livestock development specialists, we should be ready to take up that additional responsibility, use all the tools described above and mainstream environmental concerns of livestock development fully in rural development polices and investments.

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