

# Towards sustainability in the extensive and intensive livestock sectors

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## Summary

An increase in both human population and economic growth has been accompanied by rising per capita demand for animal products. The livestock industry is under pressure to meet this demand, but its current patterns of production are not environmentally sustainable, causing negative health impacts on humans and raising welfare concerns for animals. With little regulation of the intensive livestock sector in most countries, animal products are available at cheaper prices on consumer markets, undercutting more sustainable production systems, such as those used by pastoralists and organic farmers. Other beneficial aspects of sustainable intensification and sustainable pastoralism should also be taken into account. However, it is unclear whether moving towards sustainable animal husbandry (both intensive and extensive) will meet the projected demand from nine billion people in 2030, unless attention is also paid to fairer and more responsible consumption.

This paper proposes a conceptual framework to transform the livestock sector, using principles of sustainable consumption and production, environmental stewardship, inclusive prosperity, and healthy lifestyles. It also highlights several areas where additional research and modelling are required.

## Keywords

Animal welfare – Biodiversity – Climate change – Common property tenure – Consumption – Fair trade – Green economy – Grey water – Health – Intensive livestock sector – Investment – Land degradation – Livestock – Mobility – Nutrition – Pastoralism – Pollution – Sustainability – Transhumance – Zoonosis.

## Introduction

This article looks at the livestock industry from an holistic point of view, linking consumption with production, and intensive production systems with extensive ones. It suggests a three-pronged approach to sustainable animal husbandry, through

- sustainable consumption of animal products
- sustainable intensive production systems
- sustainable extensive pastoralism on healthy rangelands.

Its central hypothesis is that sustainability is needed in both intensive and extensive systems and requires a life-cycle approach that links the social, economic and environmental dimensions of sustainable development. The endorsement

by 193 countries of the United Nations 2030 Agenda for Sustainable Development provides an historic opportunity to implement projects and strategies that test this hypothesis.

The article provides a scientific overview of trends and patterns in the consumption and production of livestock in both intensive and extensive systems. It suggests a conceptual framework for linking all dimensions of sustainable development, through the three-pronged concept outlined above, and concludes with concrete recommendations for an integrated approach.

The focus is on ruminant livestock and particularly meat production. While the article draws parallels with data from other livestock systems, the author does not intend to address those comprehensively. Definitions of livestock systems vary considerably, depending on the author and

institution involved, which is also one reason behind the disparity in estimated total numbers of pastoralists worldwide. In this paper, 'extensive systems' are defined as those relying primarily on natural grassland or rangeland with basic improvements in availability of water and shelter. In 'intensive systems', animals are raised in confined spaces, relying entirely on externally sourced feed – some have labelled them 'factory livestock'. The paper deliberately juxtaposes the two extremes of the livestock industry (large commercial intensive systems versus very extensive and mobile pastoral systems) for the purpose of simplicity, but the author recognises that there are many types and forms of livestock systems in between, and that the integrated solutions discussed here would need to be adapted to each system.

## Consumption

The consumption of meat and eggs has risen exponentially in the past three decades, according to statistics from the Food and Agriculture Organization of the United Nations (FAO). The world's livestock sector is growing at an unprecedented rate and, according to the World Health Organization (WHO), the driving force behind this enormous surge is a combination of population growth, rising incomes and urbanisation. The rising personal wealth of the middle classes in emerging economies, especially those of China and Brazil (1), is the primary driver of increasing meat consumption. World per capita consumption of meat was 30 kg per year in 1980, growing to 41.2 kg in 2005. If current trends continue, it is expected to increase to 45.3 kg by 2030 (2). The share of meat and offals, as a percentage of dietary energy supply, more than doubled between 1992 and 2014 (3).

In global terms, the supply of animal protein per capita increased by about 29% between 1992 and 2014 (4), and annual meat production is projected to increase from 218 million tons in 1997–1999 to 376 million tons by 2030 (4). However, meat production in some countries, especially those with traditionally strong livestock sectors, has decreased – for example, in Chad, Mongolia and Switzerland, each for very different reasons. Prices are expected to continue to fall because of overall increasing trends in production, and consumption is expected to continue to increase. However, if rising meat consumption is associated with the rise of the middle class in urban areas and growing obesity among the rich (5), then it is unclear how the poor have benefited or will benefit from falling prices. Urbanisation may be associated with increased meat consumption, but there is anecdotal evidence to suggest that in some developing countries there may be a gender gap. For example, in the city of Moshi (Tanzania), the rate of kwashiorkor (protein deficiency) among

women is very high, because traditionally men take the choicest and most nutritious parts of the animal's meat (Dr E. Mrema, Director, United Nations Environment Programme [UNEP], personal communication, 2015). More research into the relationship between rising meat consumption, malnutrition and poverty are necessary before firm conclusions can be drawn. An increase in the consumption of meat and milk is associated with better nutrition for the undernourished, but is not necessarily a benefit for those who over-consume. The FAO suggests that the safe level of protein consumption is about 58 g per adult per day (or 21 kg per year). It is possible to live healthily without eating animal products, but they do provide nutritional benefits, particularly through micronutrients. The FAO states that, although essential minerals such as iron and zinc are also present in cereal staples, they have lower bioavailability in plant-based foods, due to their form and the presence of absorption inhibitors, such as phytates (2). WHO similarly states that the high-value protein provided by the livestock sector improves the nutrition of the vast majority of the world.

The WHO also cautions that the excessive consumption of animal products in some countries and social classes can lead to excessive intakes of fat and resultant health problems. Such concerns are leading to calls for a complete conversion to plant-based diets. One in eight British adults has now given up eating meat and fish, according to new research by analysts Mintel. Some 12% now follow vegetarian or vegan diets, or 20% of those aged between 16 and 24. Millions more are 'flexitarians', cutting back substantially on the amount of meat they eat. This has led to a booming market (£625 million per year in 2013) for meat-free products in Britain (6).

The International Food Policy Research Institute (IFPRI) International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) predicts that, by 2030, if high-income people were to reduce meat consumption in favour of healthier diets, and low-income people were to increase meat consumption for improved nutrition, then the global consumption of meat would fall by 19.2% (compared to the baseline of 2000), and the demand for coarse feed grains would fall by 14% (7). It is not clear whether market forces alone (such as price variability of livestock products) can cause changes in global patterns of consumption, and more research is needed to establish the correlative factors.

## Intensive production systems

Most animal products today are being supplied through intensification of the livestock industry. A recent report estimates that 66% of all land-based animals (i.e. not

counting fisheries) are produced in intensive farming systems (S. Lindholt, unpublished data, 2015). The World Bank states that the majority of meat is expected to be produced in the intensive, large-scale commercial sector because of at least three factors:

- i) continuing benefits from economic concentration
- ii) preferential treatment for tariffs and subsidies, and
- iii) poor environmental regulation, so that such enterprises spend less on mitigating these effects (8).

However, less is known about trends in the production of ruminants than about trends in the production of poultry and pigs, and it is likely that global statistics are skewed by very large transformations in the latter.

Historically, industrialised countries have been able to double their meat production while reducing land requirements for livestock by 20% through intensification (2). Between 1981 and 2000, the total factor productivity of livestock increased at an annual rate of 1.1–2.7% (ruminant and non-ruminant), outstripping that for crops (0.5%) (9), and signalling the potential for intensification to increase the efficient use of natural resources. The FAO has also concluded that intensive systems today have lower carbon footprints than extensive ones (10). For example, a study in North America showed that there was a 74% increase in carbon footprint per unit for pasture-raised beef, compared to corn-fed feedlot beef. Another study showed 1.3 kg of carbon dioxide equivalent (CO<sub>2</sub>e) per kg of milk in North America, compared to 7.6 kg of CO<sub>2</sub>e per kg of milk in Africa. Other studies in the United States (USA) also support this conclusion (11). The key differences are due to lower growth rates/finished weights, reduced feed conversion efficiency, and more roughage in the diets (and therefore higher methane production) in extensive systems. However, controversy continues as to the methodologies used in these different studies and the comparability of their results. Furthermore, very few studies have compared the full range of greenhouse gases across systems – for example, there is evidence that nitrous oxide emissions are higher in intensive systems than in extensive ones, due to the use of fertiliser in feed production (see [www.ghgonline.org](http://www.ghgonline.org)). Similarly, methane emissions from liquid system manure management in North American intensive dairy operations are relatively higher than those from pasture-raised dairy operations (10).

It is also crucial to consider all environmental factors, not just greenhouse gases. A study in Uruguay compared carbon, erosion, nutrients and energy use in rangelands, seeded pastures and confined feedlots, and concluded that intensive systems create more environmental damage than extensive systems (12).

Forty percent of all arable land is being used to produce animal feed (1), with a grain-to-food conversion ratio that does not compare well with directly converting grain to human food. UNEP estimates that the cereals used to produce feed for animals could instead feed 3.5 billion people (13). Fifty percent of fertiliser applied to agricultural land and 70% of herbicide use in agriculture are attributed to animal feed production (14). However, there is evidence of large differences between countries in the use of synthetic fertiliser. For example, Chinese farmers apply, on average, 525 lbs of fertiliser to each acre of cropland (of which 200 lbs is estimated to be in excess and released to the environment), while Kenyan farmers apply, on average, 6 lbs per acre (15). Globally, it is estimated that, in the period between 1950 and 2000, the amount of fertiliser used resulted in a net soil surplus of more than 80% for nitrogen, and the phosphorus surplus increased by a factor of seven (16). As a result of this excessive application, nutrient accumulation in watersheds is on the rise, causing 'dead zones' and eutrophication, the leading cause of wetland and marine hypoxia (17). Methane and nitrous oxide emissions from such releases also add to global warming.

Feed production uses 37% of all the water estimated to be used in crop production (18). The grey-water footprint (pollution of surface or groundwater) for industrial livestock is more than double that of pasture-raised livestock: an average of 712 m<sup>3</sup> of grey water per ton of beef in industrial beef production, compared to 243 m<sup>3</sup> per ton in extensive beef production in seven industrialised countries (19).

Waste management from intensive systems is also an increasing challenge, especially in urban and peri-urban areas. For example, increasing demand for pig meat in the Philippines has fuelled a rapid rise in intensive urban and peri-urban pig farming, but these enterprises are unable to manage the accumulation of waste and nutrients. On the other hand, pig farming in rural areas does not leave the same footprint because of the availability of cropland to absorb the manure/nutrients as factors of production (20). Another form of waste, i.e. food loss and wastage, is of growing concern to many. About one-third of the food produced for human consumption – around 1.3 billion tons (21) – is lost or wasted every year. A quarter of this would be enough to feed the hungry in the world (22). But such estimates do not include the losses associated with producing feed for animals (roughly one-third of all cereals, one-quarter of all fish, etc.).

Although they have been banned internationally for the past decade, some types of persistent organic pollutants (especially dioxins) continue to appear in meat products, due to contaminated feed. For example, incidences of increased dioxin levels in milk or animal feed have been traced back to clay, fat or citrus pulp pellets used in the production of animal feed. In late 2008, Ireland recalled

many tons of pork and pork products when up to 200 times the safe limit of dioxins was detected and traced back to the use of herbicides and pesticides in feed (23).

Antibiotics used in animal feed for non-therapeutic reasons increased from 91,000 kg in 1950 to 9.3 million kg in 1999. Almost half of the world's antibiotics are fed to livestock as growth enhancers. Between 30% and 90% of antibiotics are excreted in faeces and urine, with residual impacts on the environment, and are a direct cause of growing antibiotic resistance (24). Livestock intensification has led to an increased risk of zoonosis (25). Some forms of zoonoses have been known for a long time and affect all livestock systems (26) (e.g. rabies, anthrax, brucellosis and influenza), but more than three-quarters of new, emerging, or re-emerging human diseases (e.g. avian influenza, West Nile virus, and severe acute respiratory syndrome) are caused by pathogens originating either from animals or from products of animal origin (25). An important contributing factor is the close proximity of intensive livestock production systems to people in urban and peri-urban areas (8). There is also evidence to show that intensively produced animal foods are less nutritious than those produced in extensive systems. For example, a study on reindeer meat showed a higher concentration of Omega-3 fats in range-fed meat than in intensively produced meat (27). Concerns have also been raised about the welfare of animals in so-called 'factory farms', particularly because of confinement, high density, and other ill treatment (28, 29).

The environmental impact of the intensive livestock industry is rarely regulated, and so producers do not factor in the costs of remediation. The domination of the market by the large commercial sector undermines local rural economies. This is more evident in regional and national markets than global ones, although it may have an adverse effect on developing countries that import most of their livestock products, such as Mexico. Because of their perishable nature, livestock products tend to be traded regionally rather than globally, with a few exceptions, e.g. ultra-high treated (UHT) long-life milk or milk powder (dry milk).

Large-scale livestock production frequently produces unsaleable surpluses, often as a consequence of an intricate nexus of subsidies. Frozen meat and milk powder periodically glut world markets and eventually end up being sold in developing countries at unrealistic prices or distributed as food aid. Dairy products imported into sub-Saharan Africa rose by more than 300% between 1972 and 1982, while dairy consumption as a percentage of total consumption increased from 1% to 27% (30).

One consequence of such large-scale imports can be to depress production in some pastoral systems. For example, hill farmers in Wales are going out of business because of

a catastrophic decline in prices caused by international competition (31). Wool producers in India and Syria struggle to compete with imports from Australia and Canada (32). On the other hand, Somalia has seen record exports of five million head of cattle from pastoral systems in 2014, mostly as the result of the lifting of a trade ban by Saudi Arabia (33). What remains to be seen is whether this strong demand will result in an intensification of the system, as has been seen in Asia and Latin America.

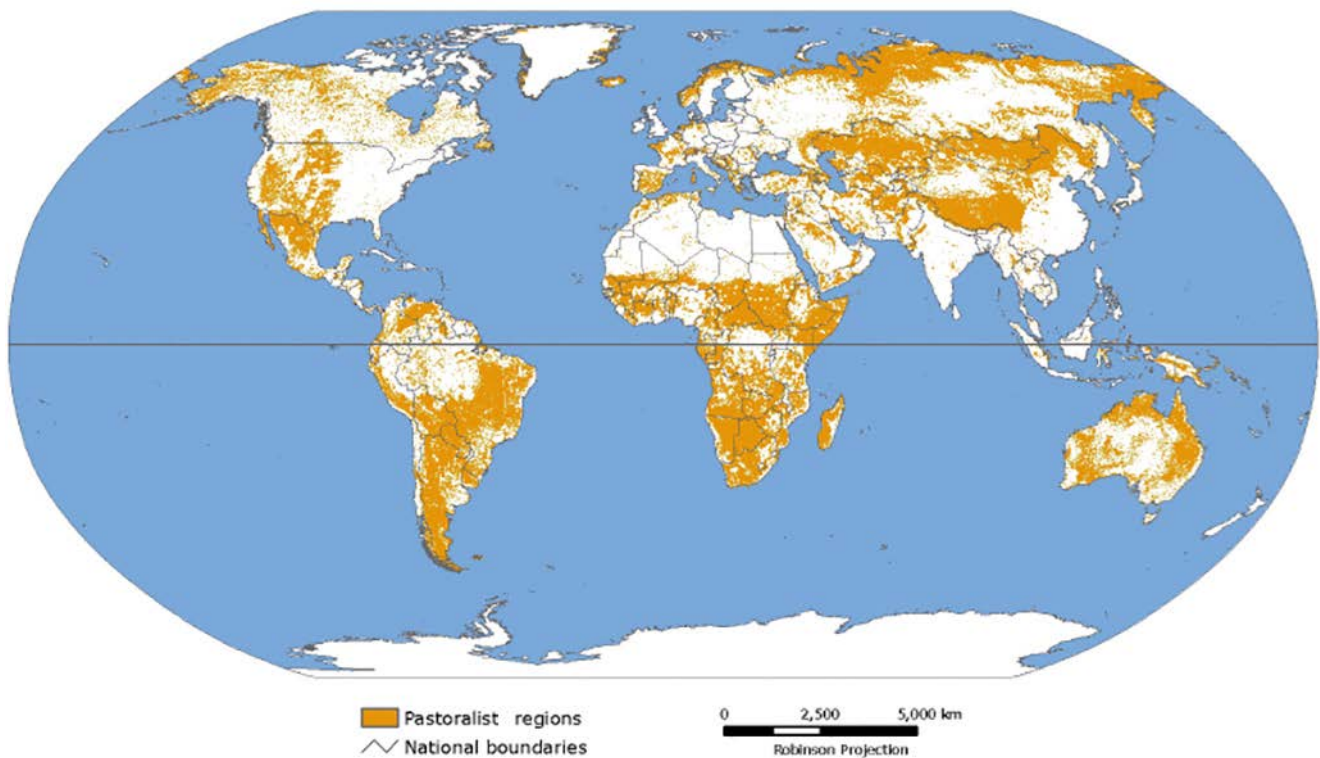
Most of the data and statistics available on trade in livestock products cannot be sufficiently disaggregated to enable us to accurately compare intensive with extensive systems. We cannot, therefore, draw very strong conclusions and more research would be helpful to correlate the growing intensification of livestock systems, especially in developing countries, with impacts on rural economies. Nevertheless, various institutions, such as the World Bank, have called for legislation that: 'supports supply chains that adequately protect the interests of all stakeholders, including smallholders, and prevent the monopolies or collusion of the large intensive operations', as well as for the development of environmental and health regulations, zoning plans and laws that help to mitigate and distribute the total footprint of intensive livestock operations (8).

European countries have the most extensive regulations today to counter the many negative externalities of the intensive livestock sector. The Netherlands is currently contemplating additional standards for certifying meat. There are also calls to apply such standards to developing countries sooner rather than later, in anticipation of the growing intensification of livestock production in urban and peri-urban areas. For example, this would include:

- requiring large livestock enterprises to pay the full environmental costs of their activities
- enforcing animal and human health rules for urban and peri-urban livestock enterprises, to reduce the risk of zoonoses and the rapid spread of diseases among confined livestock (26).

## Extensive production systems

Pastoralism – extensive livestock production in the rangelands – is practised by between 200 and 500 million people worldwide, encompassing nomadic communities, transhumant herders, agro-pastoralists, ranchers and conservancies. Many of these are facing similar challenges in both developed and developing countries (Fig. 1). Pastoralists are stewards of more than a quarter of the world's land. In less-developed countries, development progress in pastoral areas generally falls behind that of other



**Fig. 1**  
**Global map of pastoralism**

*Source:* Reproduced with permission from the World Initiative for Sustainable Pastoralism, United Nations Environment Programme and International Union for Conservation of Nature, 2014

societies, creating poverty and vulnerability that undermine the sustainability of the system. For example, in Kenya, pastoral areas have a poverty index of 0.7, more than twice the national average of 0.3 (27). About 1.3 billion people do not have access to clean energy – the so-called ‘energy poor’. These are mostly rural populations living in remote and marginalised areas of sub-Saharan Africa and Asia, although the proportion of pastoralists is hard to measure (34).

Many countries do not adequately protect pastoral land tenure, and chronically under-invest in these areas (35). In infrastructure-poor drylands, opening roads can have a profound impact on livestock marketing (36). Poverty is driving pastoralists off their land and out of the livestock sector, leaving many destitute and dependent on food aid (37). Poverty is also a driver for insecurity in some pastoral regions, providing the impetus for illegal poaching and other criminal activities, or fuelling political grievances and separatist movements, for example in the Saharo-Saharan region (38).

Demographic changes affect pastoralists around the world in different ways. In many African countries, growing pastoral

populations are surviving on a declining resource base as herd sizes have remained the same but the total available land area has declined. In a number of industrialised countries, the challenge is depopulation of rural areas, which leads to insufficient labour for effective herding and a breakdown in the transmission of local knowledge.

In 1992, it was estimated that 70% of drylands were subject to some form of degradation (39), and that about 1–6% of the dryland human population lived in degraded areas. It has been estimated that soil degradation affects 20% of drylands (40). The Millennium Ecosystem Assessment concluded with ‘medium certainty’ that the true figure was approximately 10–20% of drylands. In 2000, FAO and UNEP estimated that 20% of the world’s pastures and rangelands were degraded (41). The degradation of the rangeland ecosystem increases variability and unpredictability, not only in its current state but also in its ability to recover.

Opinions are divided: some believe that extensive livestock production is the principal cause of land degradation, while others see it as a solution. Land conversion of drylands for conservation, biofuel production, urbanisation, small-

and large-scale agriculture, mineral extraction, and other activities (legal and illegal) is occurring at a fast rate. Over the past 50 years, rangelands have been reduced in size (42). As a result, what rangelands remain are considerably more arid and less productive than those traditionally exploited by pastoralists (43). They are also more fragmented, either because of land conversion or because of private pastures, often illegally fenced off from common properties (44), resulting in less ecological connectivity (thus more constraints on natural processes) and less livelihood viability.

By contrast, the area under improved pasture has been expanding in the same time period, mostly due to deforestation in Latin America. The expansion of pastureland at the expense of natural habitats in the developing world has occurred in the order of 330 million hectares over the past 40 years (2). This expansion has occurred mainly in Latin America and is projected to increase by a further 100–120 million hectares by 2050 under current practices (45).

In the natural grasslands and rangelands that remain, there are many causes of degradation. Some result from pressures that come with abandoning the transhumant way of life (sedentarisation); others from population growth and boreholes (46, 47). Land grabbing, whether by influential community leaders (48) or urban businesspeople and international consortiums, is on the rise – with some predicting a ‘land rush’ in the coming years, especially on communal lands that are not legally protected. It is estimated that, since 2001, over 227 mega hectares (Mha) of land in developing countries have been sold or leased by international investors alone (see data from the Land Matrix, a program of the International Land Coalition, at [www.landmatrix.org/en/](http://www.landmatrix.org/en/)).

Recent cases of the government-sanctioned acquisition of pastoral land in Karamoja, Uganda, by international hunting and tourism businesses, have become a *cause célèbre* for the European Parliament and civil society (49). This resulted in a Parliamentary Resolution condemning such actions and calling for the application of the FAO Voluntary Guidelines on Governance and Tenure.

Acquisition under eminent domain – the ability of a national government to take private property for public use, such as dam construction or establishing protected areas – can deeply affect community rights and livelihoods (50), and not all pastoral communities are adequately compensated for such actions. For example, there are no plans to compensate Turkana pastoralists who may be affected by wind farm development around Lake Turkana because they are not deemed to have legal rights to the land (51). This may change soon, however, if the Community Land Bill of Kenya is passed. This specifically allows for documentation

of existing forms of communal tenure and requires the involvement of communities in decisions such as resource allocation, management and revenue sharing (52). The Turkana will then have to deal with the plans for damming the Omo River in Ethiopia, which is expected to reduce the flow of water into already-shrinking Lake Turkana, as well as result in the resettlement of Ethiopian pastoralists to make way for irrigated cotton and sugar plantations.

There are other causes for degradation of rangelands. Trucking feed and water to livestock in North Africa has resulted in over-exploitation of pastures and water sources, as animals are being continuously kept on what used to be seasonal rangelands (53, 54). The closure of borders to the movement of livestock has also played a role in pasture degradation. Many borders straddle traditional transhumance routes, especially in Africa, so border closures have seriously undermined pastoral productivity, reduced pastoralists’ ability to manage drought, and contributed to conflict (55); this has resulted in degradation when pastoralists have failed to find alternatives (other transhumance routes, or exiting the system entirely). In Romania, since the revolution in 1989, transhumance has been diminished by the opening of markets to imports, the encouragement of large-scale cropping in fertile valleys, and the development of forest enterprises (56). Decades of fire suppression (because of forest protection agendas) and heavy grazing cause the spread of dense, woody vegetation (bush encroachment) (57). The spread of invasive and persistent stands of species can mean a long-lasting decline in species diversity and the productivity of grazing domestic ruminants, as well as a decline in wild herbivores, although these declines are not necessarily irreversible (58).

As a result of the ecological dependency of rangelands on grazing, under-grazing is often as much of a problem as over-grazing. In many developed countries, particularly in Eastern Europe, evidence shows that the abandonment of former livestock farms has resulted in a deterioration of ecological and biological diversity and health (59). This has led to the development of environmental payments to encourage mobile herding in countries such as Spain, Switzerland and Australia.

Drylands host 35% of the global biodiversity hotspots in the world, and 28% of the endangered species. Drylands are also estimated to store 35% of terrestrial carbon (60). Pastoral mobility has been shown to promote healthier ecosystems and greater wildlife compatibility (59, 61). Pastoral systems are also the reservoir of genetic diversity for livestock. One example is the sheep of North Ronaldsay in Scotland, which eat only seaweed (62), while another can be seen in the efforts of the League for Pastoral People to save indigenous breeds of camels, sheep and goats in Rajasthan (31).

The International Panel on Climate Change (IPCC)'s Assessment Report (AR5) predicts that a 2°C rise by 2080 would result in a high risk of deteriorating livelihoods in drylands, due to the environment reaching tipping points for crops and livestock production (63). Pastoralism is a natural adaptation to climatically uncertain and variable environments, because it is generally more resilient and adaptive than sedentary farming in drylands (27). A study in the Limpopo Basin of South Africa concluded that pastoralists have already adapted to droughts and climate variability and are therefore more resilient than households that do not raise livestock (64). A modelling study for southern Morocco concluded that, with the projected reduction in precipitation of 20% by 2050, mobile pastoralists' incomes will be barely affected, while the income from sedentary pastoralists will drop by 8–19% (65). On the other hand, climate change is expected to increase the incidence of drought in already drought-prone areas. For example, African drylands are expected to expand by 20%, continent-wide (66). Some researchers conclude that a combination of actions involving health services, increased offtake, increased livestock mobility, and the provision of supplemental feed will be necessary to assist African pastoralists to adapt to climate change (67).

There is some evidence that pastoralists are using traditional responses to drought (more small ruminants; more frequent mobility) as a permanent response to climate change. Sheep have also become predominant in recent times, due to their greater marketability (31). Furthermore, the results of a 2009 study in Uganda suggest that children in households with high numbers of small ruminants are less likely to be underweight than children in households with large ruminants (the meat of large ruminants is less likely to be consumed because they are kept for other purposes, e.g. farm labour) (68).

So, there is evidence to show that sustainable pastoral systems are more efficient, productive and resilient than sedentary agricultural systems in rangelands, once all factors and environmental benefits have been taken into account, and that they provide healthier products for human consumption (27). Some estimates show that improved grazing management of the world's five billion hectares of grassland could sequester 9.8% of anthropogenic emissions (27). In Canada, studies show that carbon storage can be increased if cropland is returned to perennial pasture, with sequestration initially occurring rapidly and gradually plateauing over a 20-to-25-year period. If beef cattle are switched from grain to a perennial forage-based production system, and the forage associated with this transition is derived from newly seeded cropland, the entire beef production cycle becomes a net sink of carbon (69). However, there is continued controversy, at least in

North America, on the merits of switching from intensive to extensive systems, with each side able to bring scientific evidence to prove its case.

Pastoralists are faced with relatively high transaction costs to compete fairly in local, national or global markets. Many face long distances to processing plants, lack access to formal markets, have poor access to information and fair contracts, suffer from a lack of financial services such as credit facilities, and are burdened by excessive government bureaucracy and fees. In many countries, the intensive system is privileged with supportive subsidies. Although pastoralism already contributes significantly to both food production and environmental protection, long-term under-investment and policy constraints mean that it still falls a long way short of its potential. This also means that the price of extensively produced meat and milk will remain high and unable to compete with intensively produced products.

Already some countries are taking steps. Australia now has the world's largest area of certified organic land (about 12 million hectares), of which the majority is rangeland (70). The constraints faced by organic producers include: distance to markets; length of time that animals are confined in stock crates; and lack of organically certified pastures along routes to abattoirs. As another example, Diné sheep-herders in the south-western USA have joined the Presidia Slow Food project to market products from endangered Navajo-Churro sheep. Kalahari grass-fed beef is the first beef of its kind to be certified in Africa, and 'bird-friendly' beef certification is now practised on the South American pampas. European Council Regulation 1698/2005 aims at preserving farming that places a high value on nature, including mountain pastoralism (71). In the 1990s, Switzerland passed a law in which pastoralists were compensated for feeding animals on 'coarse fodder' from mountain pastures, in recognition of the benefits to biodiversity (particularly birds) and the prevention of bush encroachment and fires (72). Some believe that organic crop and livestock production will probably be able to adequately feed the projected world population of 9.6 billion by 2050 (73).

Land tenure regimes rarely recognise or legally protect common property resources, except when they are state-owned. The continued mobility of pastoralists can be ensured either through common property regimes (state or community managed) or through bilateral agreements among private landowners. Increasing the size of ranches in the USA and Australia, and the ability to rely on publicly held rangelands, has helped ranchers to manage inherent dryland uncertainty better than in the last century, since they now have more land area for moving and managing their animals. In some cases, neighbouring ranches are known to collaborate on reciprocal arrangements for sharing resources.

Similarly, in Spain, Parliament enacted a law in 1995 to re-establish 120,000 km of traditional transhumance routes (74), some of which stretch for 100 km, and included subsidies for establishing watering and veterinary services along the routes. The increased extensification in these countries contrasts with the trend in many parts of Africa and Latin America, which are undergoing the size reduction and fragmentation that Europe saw in the early 1900s.

Statutory recognition of community-held common property tenure is now found in countries as diverse as Scotland and Uganda (75). A new land act in Bolivia in 1996 created the concept of 'community lands of origin', which enabled the restitution of large tracts of land to their original inhabitants (indigenous peoples constitute over half the Bolivian rural population) (76). Similarly, in Senegal, the government placed vast tracts of rangeland in the Ferlo in trust for pastoralists through a scheme in which traditional transhumance routes were documented and recognised (77). China's National Grasslands Act allows for communal control of pastures by village-level groups (78). In Nigeria, as a response to increasing conflicts over land between farmers and pastoralists, the government established a Federal Commission in 2011, in charge of acquiring land with due compensation, establishing and improving grazing routes and reserves, and issuing permits for their use (79). However, if such formalisation of communal land is not carried out correctly, it can also lead to growing conflict between and among pastoralists and farmers (80).

Extensive livestock systems in developing countries often have poor access to Veterinary Services, with lower availability, affordability, relevance and quality of services. Trials with the concept of 'barefoot vets' in the 1980s were largely successful and have been replicated (81). Some countries, such as Uganda, have privatised their Veterinary Services, while ensuring that the government maintains a role in standardisation, monitoring and regulation (82). An important area of work is to develop veterinary interventions that target disease and epidemiological patterns in extensive systems, thus leading to more relevant and manageable standards for sustainability certification.

A key challenge often cited by development practitioners is to identify investments in extensive systems that would be appropriate and sustainable. If traditional systems are so well adapted to dryland conditions, what more could be done to improve the system? One modelling effort concludes that, 'given the right socioeconomic conditions and technology to reduce costs and increase productivity, with modest expansion [in grassland areas] to guarantee feed sources, pastoral systems in arid regions could triple production of cow's milk and increase small ruminant milk and meat production by a factor of five or six relative to the production levels of 2000' (26). This model, however, predicts that the increase in grassland area would be at the

expense of sparsely wooded savannahs, with some impact on primary forest. It would be instructive to see what the model would show if this grassland area were increased by re-converting marginal rainfed cropland – lands that were previously rangeland but that have low cropping productivity today.

One of the key challenges for dryland development has been the deeply entrenched prejudice that sees extensive pastoralism as 'primitive', unviable, environmentally destructive and outmoded. Pastoral livelihoods, especially in developing countries, are portrayed as unproductive and destructive to the environment. Local languages have disparaging names for pastoralists, and school textbooks promote an urban-biased outlook that does not meet the needs of pastoralist communities (83). Decades of neglect by state authorities, combined with remoteness of the population, due to their mobility and transhumance, has, however, allowed Sahelian pastoralists to maintain their cultural identity and social life, as well as their reluctance to deal with the powers of state authority (38).

On the other hand, extensive pastoralists can no longer be stereotyped as 'disorganised', 'ill informed', and 'hostile to change'. Many are experimenting with such innovations as vertical integration (such as the Maasai butchers, who also generate bio-gas to sell to the community), diversification and tenure security (e.g. community-held conservancies in Kenya that mix livestock and wildlife, such as the Northern Rangelands Trust), and increasing their influence on government policies through the election of parliamentarians, as well as investing in education for their community (e.g. Maasai Mara University outside Narok, Kenya). In Mali, efforts are under way to codify and formalise oral rules of natural resource management as a way of protecting and enforcing traditional sustainable approaches (84).

Mobile phones are now ubiquitous among pastoral societies, allowing vastly increased access to information. While the use of mobile phones for herding is widespread, the extent and efficacy of information-sharing is strongly influenced by pre-existing social struggles to gain access to prohibited grazing locations (85). In some countries, sophisticated computer software has been developed and aggressively marketed to help pastoralists (e.g. in Australia); however, there is little evidence to show that these programs actually help (31).

There is a growing pastoralist voice demanding action to uphold pastoralists' rights and take their livelihoods into consideration in sustainable development. Many initiatives are working to empower pastoralists; for example, the work undertaken by Food Sovereignty (86) and efforts to organise pastoralists through the World Initiative for



Sustainable Pastoralism, including the Pastoral Women's Alliance of India (see [www.iucn/wisp](http://www.iucn/wisp)). State-sponsored projects that are designed and implemented with the full participation of pastoralists can help to reduce the perception that governments are repressive, and improve stability, especially in conflict-prone areas (see statements made by the governments of Colombia, Mexico, Brazil, Sweden and Switzerland at the United Nations General Assembly negotiations on the 2030 Agenda for Sustainable Development: 'Transforming Our World') (38, 87).

## An integrated conceptual framework

The three segments of the conceptual framework provided in the previous sections are interwoven and interlinked. Each section drives the other two. Figure 2 provides a schematic diagram of these relationships.

Intensification, if sustainable in all aspects, can reduce natural resource use per unit of production and therefore enhance production efficiency and sustainability. Governments and development practitioners have also recognised that smallholder production matters when it comes to poverty alleviation, addressing inequalities and increasing the diversity of human food, hence the growing attention to smaller-scale enterprises in both extensive and mixed livestock systems. This leads to the conclusion that both intensive and extensive systems must move towards sustainable patterns of production.

Achieving sustainability in the intensive livestock sector will probably increase the costs of production by requiring increasingly stringent environmental and health regulations. This may drive up the price for meat and other products, although, taking the current market surplus into account, its impact may be delayed. A price increase may benefit pastoralists and, depending on the country and context, may make their products more competitive on the open market. It is unclear what the impact will be on food consumption by the poor: if increasing meat consumption is associated with the rise of the middle class in urban areas and increasing obesity among the rich, then increasing the cost of meat may not affect the poor but result in more responsible consumption by the rich while also allowing poor smallholders and pastoralists to gain a competitive edge for their products in local and regional markets. More research and modelling would be useful to explore these interconnected implications further.

It is likely, but again not adequately proven, that increasing concern about healthy diets and environmental impacts among the rising urban population will result in a

movement towards sustainable consumption. But it is not certain to what extent this will also result in more equitable consumption patterns between the rich and the poor. What is more certain is that changes in consumer behaviour and demand will drive the supply of meat in coming decades.

There are many examples of sustainable production in extensive pastoral and intensive livestock systems, but without conducive government policies and an even playing field their future is in doubt. This integrated framework presupposes that government bodies are willing to cooperate across sectors to develop subsidies, regulations, standards and policies that incentivise sustainable consumption and production. The 2030 Agenda for Sustainable Development, which is predicated on an integrated and cross-sectoral approach, can be criticised for being idealist and ambitious, but at least it has started the momentum towards intersectoral dialogue in many countries (87).

It is again likely but not proven that sustainable pastoralism will not be able to provide adequate livelihoods for all people living in the pastoral system today because of the shrinking land area given over to rangeland. There is insufficient evidence to show that productivity increases in this system can fully compensate for the loss of land. Assuming that this is not possible, then some form of exit strategy will be needed for hundreds of thousands of pastoral families, preferably through individual choice, aided by incentives and social protection schemes from governments.

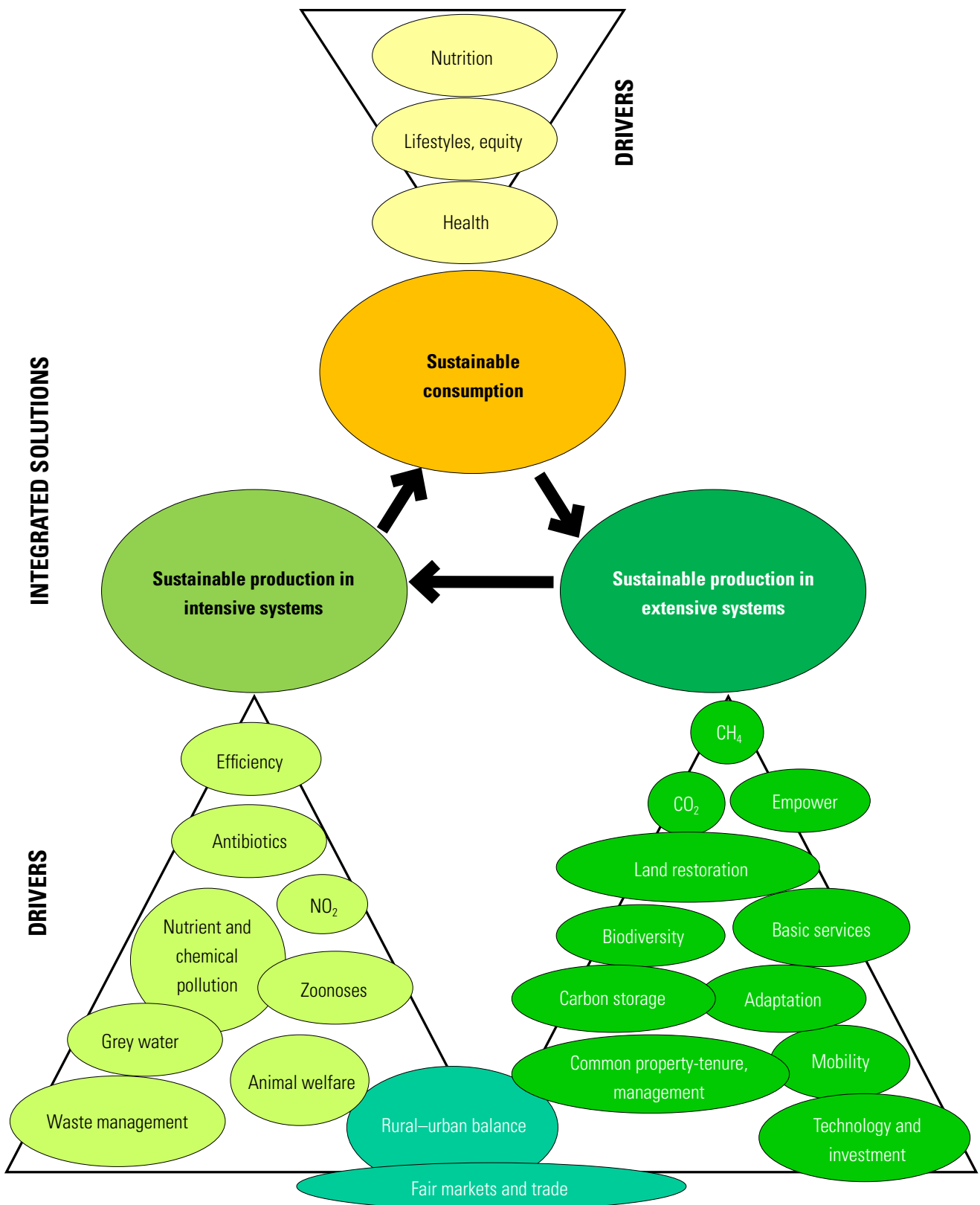
### An integrated solution

The green economy is the vision of a more sustainable future in which production and consumption are sustained within the planet's ecological boundaries (88). Sustainable development aims to leave no one behind and to build social, environmental and economic capital (87). With this vision, and through a conceptual framework that links intensive and extensive production systems with consumption patterns, an holistic approach can be adopted to achieve sustainable animal husbandry with a three-pronged approach:

- i) sustainable consumption of animal products
- ii) sustainable intensive production systems
- iii) sustainable extensive pastoralism on healthy rangelands.

### Sustainable consumption of animal products

A move towards a globally equitable and healthy diet of livestock products by reducing overconsumption is possible by addressing inequality and malnutrition, and increasing the sustainability and diversity of healthy animal products. This will also send the right signals – from responsible demand to sustainable supply.



CH<sub>4</sub>: methane  
 CO<sub>2</sub>: carbon dioxide  
 NO<sub>2</sub>: nitrogen dioxide

**Fig. 2**  
**Conceptual framework for sustainability in the livestock sector**

## Sustainable intensive production systems

The environmental and social impacts of commercial livestock systems can be mitigated through appropriate investment, regulation, and incentives for sustainability. Appropriate fiscal policies and fair trade can create a more level playing field where subsidies are fair, tariffs are levied for environmental and human health costs rather than as trade barriers, and banking, credit and insurance are available to both intensive and extensive systems. Certification schemes can be expanded and unified through a global standard applicable to all types of production systems.

## Sustainable extensive pastoralism on healthy rangelands

Diversified pastoral economies can provide a significant share of livestock products in local and international markets. Such a strategy would:

- provide sustainably derived technologies for the provision of basic services that are appropriate to the production systems of mobile and extensive pastoralists; these would include renewable energy, mobile Health and Veterinary Services, long-distance schools/education and communication, and safe water for humans and animals
- recognise land and natural resource rights by legally protecting collective and private rights to manage grazing areas, water sources and livestock movement corridors; by implementing wildlife management, by encouraging resilience and by enabling pastoralists to plan land use and manage their ecosystems
- build equitable value chains and ensure market access to provide economic opportunities to pastoralists through information, diversification, certification, niche markets, payments for ecosystem services, sustainable tourism, and local and sub-regional marketing infrastructure
- empower pastoralist institutions and systems through respect for indigenous knowledge and breeds, enabling knowledge-sharing and networking, establishing professional certification for herders and shepherds in sustainable management, and ensuring free, prior and informed consent.

## Conclusion

The rising global demand for livestock products (meat, milk, fat, fibre and hides) and, simultaneously, the increasing degradation of rangelands point to the need to urgently find sustainable solutions for the conservation and sustainable use of ecosystems. We need to make urgent and economically viable changes in the production and consumption of livestock products to achieve greater sustainability. Today's patterns of consumption are unsustainable, and expected increases in consumption will fuel greater environmental degradation.

Evidence shows that sustainable alternatives do exist to mitigate such scenarios, but we know that action on only one front (e.g. sustainable intensification or sustainable pastoralism) will not achieve the lasting results needed to address a whole gamut of challenges, including food security, ecosystem health, human well-being, and social protection of the poor and smallholders (89).

These challenges are enormous. Land-use change is occurring at such a rapid rate that some engaged with developing the 2030 Agenda for Sustainable Development have called for a moratorium on global land-use change, and protection of the land rights of indigenous peoples and local communities. Pastoralists themselves are leaving their livelihoods at a fast but largely ignored rate. The industry continues to resist regulation.

It will take a very diverse partnership of stakeholders and champions to turn the tide, including pastoralists and farmers; UN, governmental, intergovernmental, non-governmental, national and local bodies; and forward-looking, private-sector actors wanting to reduce their long-term risks. It will also take considerably more research on sustainable animal husbandry, not only to more fully understand trends, causality, impacts, and future scenarios but also to more effectively develop successful, bankable and sustainable technologies.



## Vers une durabilité des secteurs de l'élevage extensif et intensif

M. Niamir-Fuller

### Résumé

La croissance démographique et économique s'est accompagnée d'une augmentation de la demande de produits d'origine animale par habitant. Le secteur de l'élevage est actuellement sous pression pour satisfaire cette demande mais ses structures de production ne sont pas durables au plan environnemental, en plus d'avoir un impact négatif sur la santé humaine et de poser des problèmes croissants de bien-être animal. La faiblesse de la réglementation appliquée à l'élevage intensif dans nombre de pays permet de proposer au consommateur des produits d'origine animale à un prix bien inférieur à celui des produits issus de systèmes plus durables, par exemple l'élevage pastoral ou « bio ». Le développement de la production et du pastoralisme durables présente d'autres avantages qui doivent aussi être pris en compte. Il n'est pas certain, néanmoins, que la transition vers un élevage plus durable (systèmes intensifs et extensifs) puisse répondre à la demande d'une population estimée à 9 milliards d'habitants en 2030, à moins que des pratiques de consommation plus justes et plus responsables soient également adoptées.

L'auteure propose le cadre conceptuel d'une transformation du secteur de l'élevage reposant sur les principes d'une consommation et d'une production durables, d'une gestion environnementale concertée, d'une prospérité inclusive et de modes de vie sains. Elle souligne également les aspects devant faire l'objet d'études ou d'une modélisation plus poussées.

### Mots-clés

Bétail – Bien-être animal – Biens en propriété collective – Biodiversité – Changement climatique – Commerce équitable – Consommation – Dégradation des sols – Durabilité – Eaux grises – Économie verte – Investissement – Mobilité – Nutrition – Pastoralisme – Pollution – Santé – Secteur de l'élevage intensif – Transhumance – Zoonose.



## Rumbo a la sostenibilidad en los sectores de la ganadería extensiva e intensiva

M. Niamir-Fuller

### Resumen

El aumento de la población humana y el crecimiento económico se han acompañado de un incremento de la demanda per capita de productos animales. La industria ganadera se ve sometida a presión para satisfacer esa demanda, pero sus modos actuales de producción no son ambientalmente sostenibles, además de tener efectos perjudiciales para la salud humana y de plantear problemas de bienestar animal. El hecho de que en la mayoría de los países el sector de la ganadería intensiva esté poco reglamentado hace que en los mercados de consumo estos productos animales se vendan a menor precio que los obtenidos con métodos de producción más sostenibles, como los que rigen en los sistemas pastorales o de agricultura ecológica. También habría que tener en cuenta otros aspectos beneficiosos del uso de procedimientos sostenibles de pastoreo e intensificación productiva. Sin embargo, no está claro si el hecho de avanzar hacia una ganadería (tanto intensiva como extensiva) sostenible bastará

para satisfacer la demanda de los nueve mil millones de habitantes que según las proyecciones contará el mundo en 2030, a menos que también se alienten patrones de consumo más justos y responsables.

La autora propone un marco teórico para transformar el sector ganadero con arreglo a principios de consumo y producción sostenibles, tutela ambiental, prosperidad inclusiva y modos de vida sanos. Asimismo, destaca varios ámbitos en los que se requieren más investigaciones y nuevos modelos.

#### Palabras clave

Aguas residuales – Bienestar animal – Cambio climático – Comercio justo – Consumo – Contaminación – Degradación de la tierra – Diversidad biológica – Economía ecológica – Ganado – Inversión – Movilidad – Nutrición – Pastoreo – Propiedad común – Salud – Sector de ganadería intensiva – Sostenibilidad – Trashumancia – Zoonosis.



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