Shaping the future of livestock
sustainably, responsibly, efficiently
The Brundtland Commission introduced the concept of sustainable development in 1987, defining it as that “which meets the needs of current generations without compromising the ability of future generations to meet their own needs”. While humankind harvests a great many benefits from livestock, animal production draws increasingly heavily on an already overstretched natural resource base. If we are to sustain these benefits for our own and future generations, we must carefully shape the future of livestock systems.
Introduction

Livestock are terrestrial, domesticated animals raised in agricultural settings to produce goods and services. Livestock systems refer not only to production, but also to the upstream inputs and downstream activities resulting in the eventual consumption or disposal of animal-source foods (ASFs). Livestock systems are diverse and play many roles for different groups of people.

The sustainability of livestock systems is the focus of growing public debate, extensively discussed in the media and increasingly on the agenda of high-level political meetings such as the United Nations General Assembly in 2016, which tackled antimicrobial use in livestock; the 23rd Conference of the Parties (COP23) to the UN Convention on Climate Change in 2017, which addressed climate-related issues relating to livestock; and the 2018 Global Forum for Food and Agriculture, which tackled the sustainability of livestock more broadly. There are many aspects of livestock systems where technical, institutional and policy interventions could help enhance sustainability and optimize the contribution of the sector to achieving the United Nations 2030 Agenda for Sustainable Development launched in January 2016. The Shaping the future of livestock policy brief presented here highlights some key issues around sustainability and propose policy options towards a more sustainable livestock sector.

The global livestock sector: drivers and outcomes

Over the last 30 years, consumption of meat, milk and eggs in lower-middle-income countries (LMICs) has more than tripled. Population growth, urbanization, income gains and globalization continue to fuel the “livestock revolution”, offering attractive opportunities to many livestock producers. According to FAO projections, under a business-as-usual scenario, demand for meat in LMICs will increase by a further 80 percent by 2030, compared to 2006 levels, and by over 200 percent by 2050. Livestock systems are cranking up production to meet this demand while adapting themselves to satisfy the changing food preferences of an increasingly affluent and urbanized population in a globalized economy. Such rapid growth in production and trade entails risks as well as opportunities. Growth is uneven, mostly involving large-scale systems, with relatively to offer smallholder producers. There are also concerns over food security and nutrition, livelihoods and equity, human and animal health, animal welfare and the environment.

Drivers

- Population growth
- GDP growth
- Urbanization
- Globalization

Leading to...

- More demand for ASFs – especially in low- and middle-income countries

Outcomes

- Increased production and productivity to meet demand
- Structural changes in the livestock sector
- More movement and trade in livestock and products

Priorities for sustainability

- Food and nutrition security
- Livelihoods and economic growth
- Health and animal welfare
- Climate and natural resource use
Food and nutrition security

The second of the 17 Sustainable Development Goals (SDG 2) calls for ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture. With 8.6 billion people to feed in 2030, achieving SDG 2 requires a reorientation of our agri-food systems.
Opportunities and challenges

As defined by FAO, food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences to ensure an active and healthy life. However, approximately 815 million people in the world currently go hungry, and their number has recently increased. Most of them live in LMICs, where approximately 14 percent of the population is undernourished.

Micronutrient deficiencies affect more than 2 billion people globally. Deficiencies in zinc, vitamin A and iron lead to stunting, anaemia, compromised immune functions and impaired cognitive development. Animal-source foods are dense in essential micronutrients such as vitamin B12, riboflavin, calcium, iron, zinc and various essential fatty acids, which are difficult to obtain in adequate amounts from plant-based foods alone. Healthy nutrition is particularly important during the first 1 000 days of life – during pregnancy, lactation and early childhood. Including even modest amounts of ASFs in diets adds much-needed nutritional value. Less than one-third of infants in LMICs meet the minimum dietary diversity standards needed for proper growth.

Animal-source foods currently comprise 39 percent of protein and 18 percent of calorie intake worldwide, but this is not equitably distributed. Poor people in LMICs often do not consume enough ASFs, while others – particularly in high-income countries (HICs), but increasingly in middle-income countries (MICs) – exceed their dietary needs.

Livestock contribute to food security on several levels. For households, keeping livestock ensures healthy and nutritious diets and contributes to incomes. In communities, the sector creates employment opportunities. Nationally and globally, livestock generate value and help provide populations with sufficient and reliable supplies of nutritious, affordable food.

Areas for policy action

- **Promote healthy, nutritious diets for all**, especially during the first 1 000 days of life – during pregnancy, lactation and early childhood.
- **Promote actions that simultaneously address the triple burden of malnutrition**: food insecurity, undernutrition, and overweight and obesity.
- **Make best use of feed resources**, that are inedible by humans, reduce the competition between food and feed and encourage the safe recycling of crop residues, agri-food industry by-products and food waste.

Livestock’s contribution to protein in diet by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Protein supply (g/capita/day)</th>
</tr>
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<tbody>
<tr>
<td>Africa</td>
<td>69.1</td>
</tr>
<tr>
<td>Asia</td>
<td>76.9</td>
</tr>
<tr>
<td>Latin America and Caribbean</td>
<td>83.3</td>
</tr>
<tr>
<td>Europe</td>
<td>102.1</td>
</tr>
<tr>
<td>Oceania</td>
<td>101.4</td>
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<tr>
<td>Northern America</td>
<td>108.8</td>
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</table>

Source: [FAOSTAT, 2013](http://www.fao.org/gleam/results/en/).

Highlight Feed for livestock versus food for people

In recent years the “food vs feed” issue – how animal feed production competes for land and other resources with growing food for direct human use – has been gaining mounting attention. Livestock consume a third of all cereals produced and use about 40 percent of global arable land. They occupy 2 billion ha of grasslands, of which about 700 million ha could be used to grow crops.

Yet the cereals fed to livestock make up only 13 percent of their overall diets, with another 1 percent coming from other human-edible crops. Grass and leaves make up the greatest part – 46 percent – of what livestock eat. Of the remainder, 19 percent comes from crop residues; 8 percent from fodder crops; 5 percent from oilseed cakes; 5 percent from other by-products; and 3 percent from other plant sources that are non-comestible for humans. Of the plant material fed to livestock, 86 percent is converted by the animals from matter that people cannot eat into valuable food for human consumption, thus contributing significantly to food and nutrition security.

About 3 kg of human-edible materials, mostly grains, are needed on average to produce 1 kg of meat. However, global figures such as these mask vast differences across species and production systems. While ruminants use more dry matter per kilo of protein produced than pigs or poultry, they require less human-edible protein since they rely more on grass and forages. Pigs and poultry consume less feed to produce the same amount of protein, but a far higher proportion of what they consume could be eaten directly by humans. For example, India is the world’s largest producer of milk, with dairy cattle and buffaloes in the country fed almost exclusively on crop residues and by-products.
Livelihoods and economic growth

Large-scale livestock production is booming around the world, but most small producers in LMICs fail to participate fully in that growth. Of the 782 million people surviving on less than USD 1.90 per day, as many as half depend directly on livestock for their livelihoods.
Opportunities and challenges

Livestock reward their owners with a wide range of products, from milk, meat and eggs to fibres, leathers, hides and skins. Livestock are flexible assets that can be sold in times of crisis. They increase total farm productivity in mixed systems by providing traction and fertilization and by turning crop residues into valuable protein. Sustainable intensification of livestock production – i.e. increasing productivity without negative consequences – enhances livestock’s contribution to livelihoods.

Poverty, livelihoods and economic growth are intricately linked and, in LMICs, livestock are key in all three. The livestock sector currently accounts for about one-third of value addition in agriculture in LMICs, a proportion that increases as countries develop economically. Livestock contribute to poverty alleviation by building resilience and supporting the livelihoods of large numbers of rural people. They also create employment in livestock systems, stimulate demand for goods and services, and promote economic transformation by contributing to human and financial capital, allowing other sectors of the economy to develop.

However, alongside such benefits lie issues of inequality. Large numbers of low-income livestock keepers are women, who often have less access to productive resources and markets than men and are therefore unable to derive significant benefits from rearing animals. Child labour is common in the sector, with young boys and girls tending herds and flocks instead of going to school. As livestock systems expand to meet demand, millions of smallholder livestock producers – efficient but not competitive – are driven out of the business.

Areas for policy action

- **Promote sustainable intensification** of livestock farming in diverse environments, ensuring that productivity gains are equitable and do not take place at the expense of animal health and welfare, human health or the environment.
- **Support value chains** that are inclusive, safe and protective of the environment.
- **Take an integrated approach** to improving livestock agri-food systems. Lifting one constraint while leaving others in place is likely to produce limited returns.
- **Create employment and alternative livelihood opportunities** for farmers who choose or are forced to leave the livestock business.
- **Curb the uncontrolled and poorly regulated growth** of intensive livestock production units.

Livestock’s contribution to agricultural GDP by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Livestock</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>295</td>
<td>46%</td>
</tr>
<tr>
<td>Europe</td>
<td>430</td>
<td>25%</td>
</tr>
<tr>
<td>Asia</td>
<td>1,798</td>
<td>51%</td>
</tr>
<tr>
<td>Latin America and Caribbean</td>
<td>309</td>
<td>51%</td>
</tr>
<tr>
<td>Africa</td>
<td>245</td>
<td>46%</td>
</tr>
<tr>
<td>Oceania</td>
<td>47</td>
<td>50%</td>
</tr>
</tbody>
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Source: FAOSTAT, 2015.

Highlight  Livestock can contribute to poverty reduction

There is robust evidence that investing in livestock reduces poverty. Under pilot projects organized by an international consortium in Ethiopia, Ghana, Honduras, India, Pakistan, and Peru, 11 000 poor households were offered selected productive assets plus services such as training and health care. The assumption was that a “big push”, would help the families involved escape poverty once and for all, establish sustainable self-employment activities and generate lasting improvements in livelihoods. The assets most frequently chosen by the households were livestock, such as cattle, sheep, goat, chickens and guinea pigs, because of the wide range of benefits animals provide, from cash through food to savings and draught power.

A rigorous evaluation was performed to assess the impact of the programme. This involved assessing changes in consumption levels, food security, productive assets, financial inclusion, time use, income and revenues, physical health, mental health, political involvement, and women’s empowerment, among other indicators. After two years, beneficiary households had increased their per-capita consumption by PPP USD 4.55 per month, with associated improvements in food security, asset value, physical and mental health and all other variables. After three years, all these positive effects were still significant, and often larger than after two years.

The conclusion is that a multifaceted programme distributing live animals to improve the livelihoods of the extreme poor is sustainable and cost-effective.

Health and animal welfare

Human health is closely linked to the health and welfare of animals and to that of the environment. This is the principle underpinning the “One Health” approach, which recognizes that livestock systems stand at the intersection of human, animal and environmental health.
Opportunities and challenges

Animal diseases constrain production and reduce livestock’s contribution to resilient livelihoods, economic growth and food and nutrition security. For example, the 2001 Foot-and-Mouth Disease (FMD) outbreak in the United Kingdom cost the economy about USD 14 billion, while the cost of the 2016 and 2017 avian influenza outbreaks may have been even bigger. In 2010, the global burden of food-borne diseases, many of which are spread by livestock products, was 33 million disability-adjusted life years (DALYs) (one DALY equals one lost year of “healthy” life). Of those lost years, 40 percent concerned children under five.

Zoonotic diseases with pandemic potential – emerging from increased proximity between people and animals in the environment – pose an even greater threat. For example, poultry systems in areas along wild bird habitats provide ideal conditions for the emergence of avian influenza viruses. Another worrying virus is Middle East Respiratory Syndrome (MERS), which appeared where people are in close contact with camels. As people and farmers encroach deeper into natural habitats, they increasingly run into wild-host reservoirs of pathogens such as SARS, Nipah (carried by bats) or Ebola.

Good animal welfare requires not only disease prevention and veterinary treatment, but should also include appropriate shelter, management, nutrition and humane slaughter procedures.

Higher livestock production often leads to increased use of antimicrobials, not only to treat infections but also to prevent disease and sometimes to promote growth. Livestock consume almost three times more antimicrobial drugs than humans. Inappropriate use of the drugs in livestock encourages the development of antimicrobial resistance (AMR) in livestock pathogens, which compromises treatment and readily spreads to the human population, making many antibiotics virtually useless.

In many countries, poultry-sector growth is not well-regulated. Sanitary standards are lacking and welfare levels low, with birds kept at high densities and transported and marketed under poor conditions. Food-borne diseases such as salmonella are a constant concern, as are frequent outbreaks of highly virulent strains of influenza. About one-third of all antibiotics used in livestock is for poultry production, which is roughly the same amount as is used in human medicine globally.

These are some of the constraints on the sustainability of intensive poultry production. However, through legislation and consumer pressure, some countries have taken major steps to improve the situation, including better and less crowded housing conditions and improved sanitary standards. Dependence on antibiotics has been greatly reduced by improved husbandry and preventive health care. Environmental outcomes have been improved by feeding birds on locally-grown protein crops and agri-industrial by-products, and by better management and use of manure.

Areas for policy action

- Support the One Health approaches to tackle health threats of animal origin.
- Minimise the use of antimicrobials in livestock production by improving husbandry practices and protecting animals from disease in order to limit the sector’s role in building AMR.
- Promote multi-stakeholder dialogue, linking the public and private sectors, to address animal health and welfare issues and improve risk management.
- Strengthen regulatory bodies, surveillance and early warning systems against health threats.
- Promote improvements in production practices by investing in the sector, creating incentives for good husbandry practices and legislating against harmful ones.
- Treat the welfare of animals as a priority in livestock systems everywhere as a path to improved animal husbandry and health.

Drivers of emergence events for zoonotic infectious diseases in humans from 1940 to 2005

- Land use changes
- Intensification of agriculture
- Changes in human susceptibility
- Changes in the food industry
- Bushmeat (or wild meat)
- War and famine
- Other


Highlight Poultry production

Poultry is the fastest-growing livestock subsector due to its high turnover, good feed conversion and popular products such as meat and eggs. In LMICs poultry meat and egg production has grown by 250 percent since the early 1990s, and similar growth is projected through to 2030. Most of this growth is in large-scale, intensive production systems, which are vertically integrated and closely linked to the feed industry and to industrial processing and marketing. Poultry feed is largely derived from cereals and legumes that could be used directly for human consumption. Feed is produced far from poultry farms, breaking natural cycles and typically depending heavily on chemical pesticides and fertilizers.

In many countries, poultry-sector growth is not well-
Livestock are highly versatile, helping hundreds of millions of people to survive in marginal areas, withstand climate shocks and adapt to changing climatic conditions. But livestock, in aggregate, are also the biggest users of agricultural land for feed, pasture and forages, drawing heavily on natural resources and contributing significantly to climate change.
Opportunities and challenges

Livestock draw heavily on natural resources but they can also contribute to the conservation of biodiversity and genetic resources for food and agriculture. If managed sustainably, livestock can play a valuable role in maintaining important ecosystem functions such as nutrient cycling and soil organic carbon sequestration, and in preserving agricultural landscapes.

Grazing land covers about one quarter of the Earth’s land area and accounts for some 70 percent of agricultural land. Approximately one-third of the crops produced globally are used to feed livestock. Many of these croplands and pastures were converted from forest and are degraded, with the result that a great quantity of carbon is released into the atmosphere. Livestock systems use significant amounts of water and contribute to biodiversity losses.

Beyond land-use change, livestock systems contribute to greenhouse gas (GHG) emissions mostly through enteric fermentation and manure. They also have an impact upstream, through the production of feed and other inputs, and downstream, in transportation, cooling, storage and processing of livestock products. Overall, livestock emit 7 750 million tonnes of CO2 eq. per annum, representing 14.5 percent of all anthropogenic emissions.

Livestock systems in general have a relatively low production efficiency. They leak nutrients into water and air and generate large volumes of manure and by-products. Only about 20 percent of the nitrogen and phosphorus applied to feed crops and pastures ends up in our food. Many of the lost nutrients make their way to ground- and surface water and are transported through water courses to coastal marine systems.

Areas for policy action

- Encourage the production and consumption of low-carbon foods.
- Promote productivity improvements that reduce emission intensities from livestock.
- Restore the quality of pastures and increase the sequestration of soil organic carbon.
- Better integrate livestock into the circular bio-economy by reducing waste and recycling carbon, nutrients and water.
- Follow up the decision of the 23rd Session of the Conference of the Parties (COP23) to include agriculture in the United Nations Framework Convention on Climate Change negotiations.

GHG emissions from the livestock sector


Highlight GHG emissions from the beef sector

Rumination allows cattle to digest fibrous plant matter such as grass, leaves and crop residues. More than 90 percent of the feed used for beef production cannot be eaten by humans, so cattle in grazing systems make a net positive contribution to protein balances. This is especially important in marginal areas, where agro-ecological conditions offer few alternatives.

But there are concerns over the environmental sustainability of beef production. These relate chiefly to the low efficiency with which beef cattle convert natural resources into edible products. Water use, land use, biomass appropriation and GHG emissions are typically higher per unit of edible product in beef than in other livestock systems. Beef is the commodity with the highest emission intensity, with an average of over 285 kg of CO2 eq. per kg of protein produced, but this too varies depending on the production system.

In extensive systems, environmental impacts per unit of product are generally high, but absolute impacts are low because of the small production volumes. In these systems, natural resources should be managed sustainably to increase productivity and resilience. Positive environmental outcomes should be considered as co-benefits. Beef production in mixed systems generally has lower environmental impact intensity but a larger overall impact due to the sheer size of the cattle populations involved. Poor resource-use efficiency constrains both productivity and environmental performance, so that improving efficiency through sustainable intensification should be a primary objective. Capital-intensive feedlot systems have been developed to meet demand for beef from growing middle class and urban markets. Given the strong capacity to invest and innovate in these systems, positive environmental outcomes should be pursued as a priority.
Livestock and the 2030 Agenda for Sustainable Development

In January 2016, the United Nations launched the 2030 Agenda for Sustainable Development. Its 17 component SDGs seek to address, in a sustainable manner, the root causes of poverty and hunger and the universal need for development. The four priorities for sustainability each relate to a number of the SDGs.
Synergies and trade-offs

The livestock sector contributes directly or indirectly to each SDG. The figure opposite indicates those to which livestock contribute most strongly and highlights those SDGs to which an unsustainable livestock sector would pose challenges. For many of the Goals, there are both positive and negative contributions. As well as trade-offs within Goals, there are potential synergies across the SDGs that must be optimized, while the trade-offs need to be managed.

Because of the complex interactions among the SDGs, optimizing livestock’s contribution to the 2030 Agenda requires careful planning, implementation and monitoring. There are clear synergies to be harnessed. For example, increasing efficiency in livestock production may have multiple social benefits, such as tackling poverty and hunger, and improving health. Better efficiency also reduces the environmental burden of livestock relative to production. But there are trade-offs that must be addressed. Increasing production in the short term by overexploiting resources reduces long-term productivity. Despite reduced emission intensities resulting from improved efficiency, a rise in production may lead to greater overall GHG emissions. Shifts towards monogastric production may reduce GHG emissions but could increase the use of grains and legumes for animal feed, at the expense of food for direct human consumption. Intensification of production may increase output but could compromise animal welfare and human health, through antimicrobial use and increased risks from zoonotic diseases. Promoting a more competitive sector with greater market concentration constrains the competitiveness of small producers.

Maximising livestock’s contribution to the 2030 Agenda not only involves steering the sector’s development along a sustainable pathway, it also requires policies and investments beyond livestock. Strategies are needed to enhance low-income livestock keepers’ access to productive assets and rural services. Trade reforms are needed to make markets more transparent and efficient. Investment in infrastructure must be made and better access to financial resources and technological innovation provided. Institutions such as livestock or breed associations, indigenous and women’s groups, or specialized commodity groups such as those for dairy or wool, need to be strengthened, enabling small-scale producers to act collectively and thus more competitively. We must strengthen systems for the routine prevention and control of animal diseases and promote the widespread adoption of One Health approaches. Finally, incentives need to be put in place that encourage and reward realistic costing of externalities such as water consumption, GHG emissions or the use of antimicrobials; ii) legislation against unsustainable practices; and iii) rewards for good livestock husbandry. Interventions must, however, be tailored so as not to compromise livestock’s contribution to sustainable development objectives.

National livestock policy frameworks must be designed to help governments and stakeholders to enhance the sector’s contribution to the 2030 Agenda. This implies a shift in the focus of the policy debate from the sustainable development of the livestock sector to how the sector can contribute to sustainable development. This calls for a change from a static approach that addresses dimensions of sustainability independently, towards a systems approach that integrates these dimensions.

These issues are reviewed in detail in the forthcoming FAO World Livestock (WoLi) publication: Transforming the livestock sector through the Sustainable Development Goals.

Livestock system diversity

Livestock’s contribution to the 2030 Agenda – and the risks the sector could present to achieving specific SDGs – varies greatly in different contexts. Global livestock production is complex, involving numerous species raised in different combinations and alongside various other agricultural enterprises. Livestock play different roles depending on the availability of resources, environmental conditions, social and economic context and the political and institutional setting. The concerns of farmers producing livestock primarily to feed their families are different from those of farmers running businesses and linked to highly competitive, international markets. If we are to shape a sustainable future for livestock, we need to understand the diversity of livestock systems and the motivations of the livestock keepers and other players involved.

“...In Bonn, at the 23rd Session of the Conference of the Parties (COP 23) to the United Nations Framework Convention on Climate Change, countries agreed to include agriculture in the negotiation process to address climate change, recognizing its impacts in achieving food security for all. This recognition is a huge step forward for the international community’s endeavour to adequately address climate change, but what we must ensure now is that this also becomes a huge moment for FAO. It is time for the Organization to step up and deliver, and make sure that the potential in agriculture to address climate change is fully realized.”

José Graziano da Silva, Director-General, FAO
Livestock systems of the world

Livestock can serve a variety of functions depending on context. Enhancing their contribution to the 2030 Agenda for Sustainable Development requires interventions tailored to the specific needs of the various livestock systems.

Livestock are broadly divided into ruminants – which, through enteric fermentation, are able to digest rough plant material – and monogastric species, whose dietary needs are more like our own. The main ruminant species are: cattle and buffaloes, which may be multipurpose or specialized for beef, dairy or draught power; camelids, such as camels, llamas and alpacas, which are an important source of traction and fibre, but which also provide meat and milk; and small ruminants – sheep and goats – which are important in terms of meat, milk, wool and hides. Monogastric species include pigs, which are mainly raised for meat; and a range of poultry species such as chickens, ducks and turkeys, raised for meat, eggs and feathers.

Agricultural systems can be broadly defined according to the relative availability and costs of the classical production factors of land, labour and capital. For livestock systems, the land factor is replaced by livestock biomass. Labour refers to the agricultural population and capital refers to the amount of gross domestic product (GDP) available per person. By combining proxy variables for land, labour and capital, these systems can be represented on a map, as shown on p. 14.

Using this approach we define three broad livestock systems: a) extensive systems, which are characterized by low labour and capital inputs and generally occur in marginal habitats; b) labour-intensive systems, which are typically smallholder farms with low returns and a surplus of labour, often constrained by scarcity of both land and capital; and c) capital-intensive systems, which are usually associated with highly modified environments where land and labour inputs have been substituted by capital investment through intensification and mechanization.

Extensive systems

Extensive livestock systems are typically pastoralist, with ruminant livestock grazing large expanses of marginal rangelands. About 180 million pastoralists benefit directly from these systems, and many more where they are linked to export markets, such as the small ruminants trade from the Horn of Africa to the Middle East. With few inputs beyond basic animal health care, these systems are efficient in terms of protein production but low in productivity. They tend to occur in lightly managed areas that are unsuitable for crop growth and therefore do not compete with direct food production. Many such systems also make important contributions to conserving biodiversity. Livestock are integral to the social fabric of pastoralist societies, so benefits extend well beyond food and livelihoods and play a number of social and financial roles. Already living at climatic extremes, pastoralist people are vulnerable to climate change, with harsh winters and extended droughts causing high levels of herd mortality. While generally inefficient in terms of GHG emissions, they account for only a small proportion of overall agricultural emissions. Conversely, if degraded rangelands are restored to health they hold great potential to sequester soil organic carbon.
Capital-intensive systems mainly produce beef, dairy, pork and poultry products. Intensive beef production is typified by the feedlots of the southwest of the United States. Mega-dairy farms – which are highly mechanized and extremely productive – are also becoming more common. Half of the milk in the United States now comes from farms with more than 1,000 cows, and this proportion is increasing each year. Pigs and chickens in particular lend themselves well to industrial production.

These factory farming operations account for much of the production in HICs but are becoming widespread in LMICs as well, where they contribute to feeding growing urban populations. But smaller-scale, capital-intensive systems are the mainstay in other areas, such as the grass-fed beef and dairy production in most of Europe. Few farmers profit directly from these systems, but many people benefit from a regular supply of clean, affordable, nutritious food. Capital-intensive livestock systems are highly efficient, despite relying on large amounts of inputs, particularly in terms of grown feed, which often has repercussions in places far away from the production units – including deforestation, disruption of nutrient cycles, and chemical contamination. With so many animals packed in such high densities, dealing with manure is a challenge for industrial systems and a major source of soil and water pollution. Capital-intensive systems use large amounts of antimicrobials, creating ideal conditions for the emergence of microbes that are hard to treat.

Labour-intensive systems

Labour-intensive systems are typically operated by smallholders, mostly as part of mixed crop-livestock farms. As well as arable crops, they may include aquaculture and tree crops and are typified by the smallholder systems of Central America, Africa and Asia. The majority of labour-intensive systems are subsistence family farms, which sell or exchange any surpluses locally. However, in some cases – such as smallholder dairy production in East Africa and South Asia – they are well organized and linked to national and international markets. Of about 600 million poor people who depend on livestock globally, most are in these systems. For these farming families, livestock are an important source of nutritious food and fulfil social and other functions, such as conferring status or paying for bridowries and communal feasts. Livestock are also an important source of food for people outside farming households, particularly with dairy production in LMICS, where smallholders produce by far the largest share of the milk. Livestock also ensure employment through associated agro-industries. If measured simply by yield gaps, the production of livestock on subsistence farms is generally inefficient compared to extensive or capital-intensive systems. However, there are other efficiencies that must be considered, particularly in relation to nutrient cycling, giving value to crop residues, and providing draught power.

Highlight The global dairy sector

Milk is the single most valuable agricultural commodity, with an annual production (in 2013) of around 770 billion litres, valued at USD 328 billion. It is also extremely nutritious, particularly during the first 1,000 days of life. The species contributing to the global supply of milk are cattle (82.6 percent); buffaloes (13.9 percent); goats (1.9 percent); sheep (1.3 percent); and camels (0.3 percent). Milk and dairy products are heavily traded, accounting for about 6 percent of agricultural trade. Dairy production is carried out in diverse agri-food systems, reflecting different combinations of production factors. Extensive dairy production occurs in pastoralist systems, in which milk is the main source of protein. Dairying is popular in labour-intensive systems, usually as part of mixed farming operations typified by the smallholder dairy producers of the East African highlands and South Asia. Dairy farming is also carried on in capital-intensive systems such as the grass-based dairy farms of Europe, but increasingly too in mega-dairies in Europe, North America and China. Such dairies typically host upwards of 2,000 animals and the largest farms can accommodate tens of thousands of cattle.
Global distribution of livestock systems
One way to represent the livestock systems of the world is to create a colour-composite map by projecting proxies of the production factors in different primary colours. In such a map, each combination of production factors corresponds to a unique colour. For livestock systems, which include landless production, livestock biomass is more relevant than land area, so the land production factor is better represented by the average biomass of livestock per agricultural person than by agricultural land area. The density of the population engaged in agriculture represents labour, and per-capita GDP represents capital. These are scaled from low to high and projected in the primary colours of green, blue and red respectively. The key to the map shows how the different production systems occupy different zones in the colour-space. Extensive systems appear as green to pale blue; labour-intensive systems go from dark blue to magenta; and capital-intensive systems range from red to yellow. Such a mapping approach can help target interventions that are more relevant to different livestock systems, and also to explore the systems changes that would result from changes in the production factors, such as increasing wealth or reduced availability of agricultural labour.
A vision of sustainable livestock

A vision of sustainable livestock should be based on the following:

- Recognition of the UN 2030 Agenda for Sustainable Development as the overarching framework guiding the development of the global livestock sector.
- Recognition and accounting by policymakers for the sector’s diversity and multiple functions.
- Understanding that the livestock sector acts as a vehicle for poverty reduction and contributes to food security through sustainable intensification and market access for smallholder producers, as well as contributing strongly to economic growth in LMICs. Livestock’s role as a buffer against economic and climate shocks for vulnerable populations should be optimized.
- Making best use of feed resources that are not comestible by humans and making minimal use in livestock production of feed that people could eat.
- Ensuring healthy diets are available to all and are actively promoted, seizing the specific benefits of ASFs for growth and cognitive development but discouraging excessive consumption.
- Encouraging diets based on foods with low social, health, animal welfare and environmental impacts associated with their production.
- Greatly reducing the climate impact of livestock, with more efficient value chains lowering emission intensities, and sequestration of soil organic carbon in pastures and rangelands optimized through restoration. Water should be used efficiently in livestock production and the sector better integrated into the circular bio-economy through recycling of nutrients, energy generation from livestock waste, and use of recycled food waste.
- Animal welfare must be a priority in all livestock systems globally. Animals should be treated with respect to satisfy ethical concerns and consumer expectations and as a means to improved animal husbandry and health.
- Animal disease constraints must be lifted because they represent a drain on productivity, income and animal welfare. A One Health approach should be widely adopted to address the nexus between human, animal and environmental health. Public health threats stemming from livestock production and sector dynamics – food safety, emerging diseases and antimicrobial resistance – should be minimized through the adoption of best practices and improved monitoring and response to threats at all levels.
- In areas where sector growth is rapid, measures should be put in place to address negative side-effects, particularly in terms of equity, animal and public health, animal welfare and environmental outcomes.

How do we achieve a sustainable livestock sector?

- Adopt an integrated approach to promote the sustainability of livestock systems, jointly taking into consideration social, economic, health and environmental dimensions.
- Work by consensus and joint action, through multi-stakeholder dialogue in which the voice of every stakeholder gets the same hearing.
- Build, implement and disseminate tools and guidelines to facilitate the identification and adoption of sustainable practices. These must be based on evidence and their implementation monitored, reviewed and continuously improved.
- Strengthen capacity in support of sustainable practices and provide enabling conditions.
- Develop and strengthen institutions and policies fostering sustainable livestock. This will require investment in the sector, creating incentives for good husbandry practices and legislation against harmful ones.