Food and Agriculture Organization of the United Nations

Shaping the future of livestock

sustainably, responsibly, efficiently

The 10th Global Forum for Food and Agriculture (GFFA)
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GLOBAL FORUM FOR FOOD AND AGRICULTURE

The 10th Global Forum for Food and Agriculture (GFFA) aims to address concerns about the sustainability of the global livestock sector. 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."*

Introduction

Livestock are terrestrial, domesticated animals raised in an agricultural setting to provide traction or produce commodities such as meat, milk, eggs and hides. They contribute to diverse agri-food systems globally, playing many roles for different groups of people. From the perspective of the sustainability of the global livestock sector, there are four important and interrelated aspects:

- food and nutrition security;
- livelihoods and growth;
- health and animal welfare; and
- climate and natural resource use.

Sustainable livestock are at the interface of these four topics, which provide the structure of the breakout sessions in the 10th GFFA.

This brochure has been prepared by FAO to help guide discussions during the Forum in general and specifically during the four breakout sessions. First an overview of global livestock sector dynamics is presented, followed by four sections covering breakout session topics and discussing challenges, opportunities and possible areas for policy action. Sustainable livestock is then discussed in relation to the 2030 Sustainable Development Agenda. Finally, the diversity of global livestock systems is presented as a global map showing the distribution of the main systems.

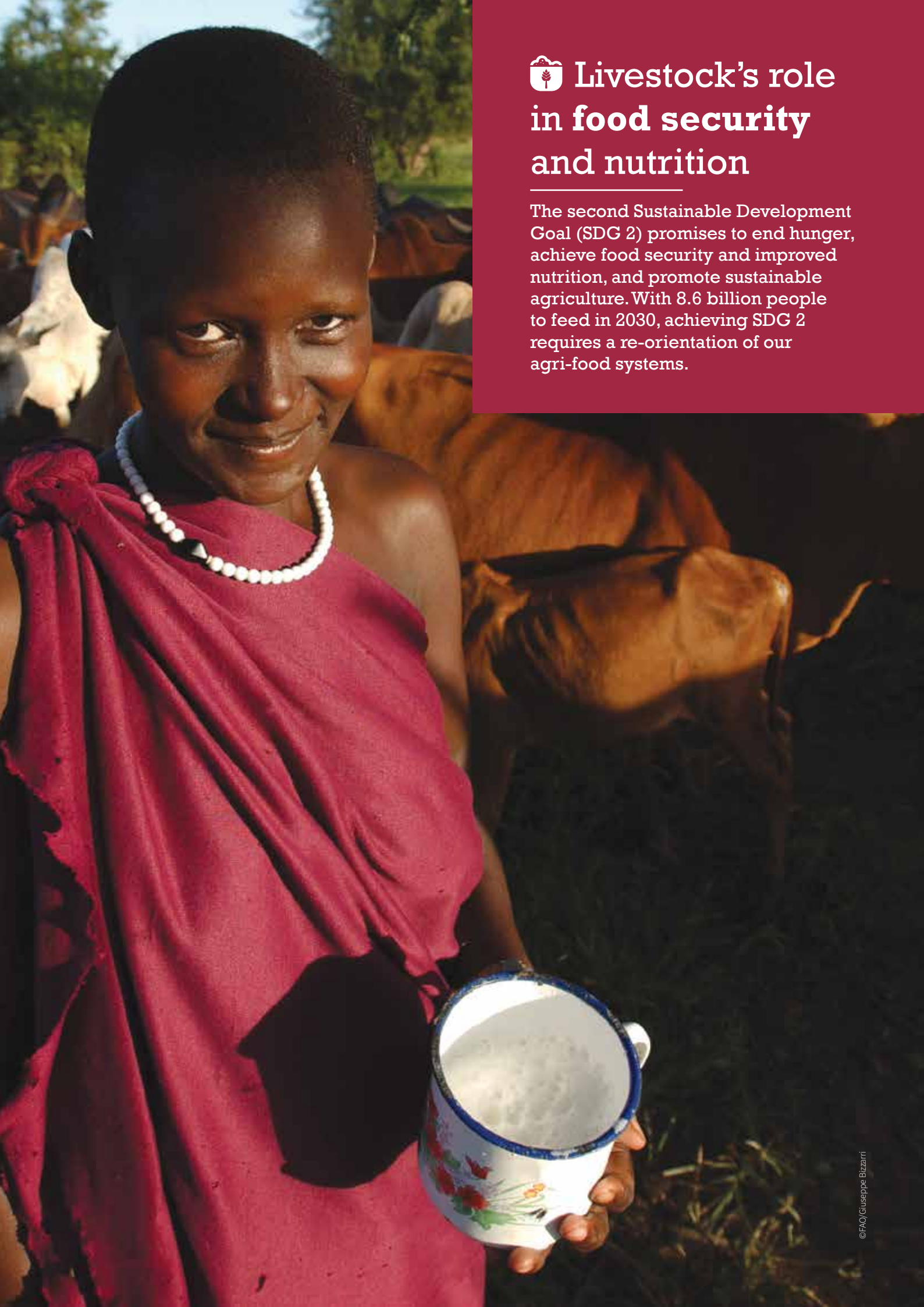
The global livestock sector: drivers and outcomes

Over the last 30 years, consumption of meat, milk and eggs in low- and middle-income countries (LMICs) has more than tripled. Population growth, urbanization, income gains and globalization continue to fuel the "livestock revolution", offering business opportunities for many livestock producers. According to the latest FAO projections, under a business as usual scenario meat demand in LMICs will increase by a further 80 percent by 2030 and by over 200 percent by 2050. Livestock agri-food systems are cranking up production to meet this demand and adapting to satisfy the changing food preferences of an increasingly affluent and urbanized population in a globalized economy.

But such rapid growth in production and trade comes not only with opportunities – it also entails risks. Growth is not even, with the majority occurring in intensive systems and with relatively little contribution from smallholder producers. The risks include concerns over food and nutrition security, livelihoods and equity, health and animal welfare and the environment.

Livestock's role in **food security** and nutrition

The second Sustainable Development Goal (SDG 2) promises to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. With 8.6 billion people to feed in 2030, achieving SDG 2 requires a re-orientation of our agri-food systems.



Opportunities and challenges

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 one in nine people suffer from hunger or are undernourished, and the number is starting to grow again. Most of these people live in LMICs, where approximately 13 percent of the population is undernourished.

Micronutrient deficiencies affect some 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 animal-source foods in diets adds much-needed nutritional value.

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 animal-source foods, while others – particularly in high-income countries (HICs) but increasingly in middle-income countries (MICs) – consume in excess of their dietary needs.

Livestock contribute to food security on all scales. At the household level, livestock keeping ensures healthy and nutritious diets and contributes to incomes. At community level, the sector creates employment opportunities. At national and global levels, it helps provide the world's population with sufficient and reliable supplies of nutritious, affordable and safe livestock-derived 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 human-inedible feed resources,** minimize the use of human-edible food in livestock production and encourage the safe recycling of crop residues, agri-food industry by-products and food-waste.

What FAO is doing

- FAO's primary mission is to work towards achieving SDG 2: *End hunger, achieve food security and improved nutrition, and promote sustainable agriculture*. All of FAO's livestock activities converge on this objective, through supporting the integration of livestock policy and practices with sustainable development strategies around the world.
- Strengthening the capacities of governments and stakeholders to optimize the contribution of the livestock sector to the SDGs, mapping linkages, synergies and trade-offs.
- Providing and supporting the use of data, methods and tools to monitor the contribution of livestock to the SDGs.
- Facilitating high-level policy discussions on the role of livestock in sustainable development, and on issues emerging from the livestock sector.

Highlight Livestock feed versus food for people

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Livestock have received considerable attention in recent years over how animal feed production competes for land and other resources with production of human food. 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 used to feed 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 46 percent of livestock diets; 19 percent comes from crop residues; 8 percent from fodder crops; 5 percent from oil seed cakes; 5 percent from other by-products; and 3 percent from other human-inedible plant sources. Of the plant material fed to livestock, 86 percent would be inedible by humans directly but is converted into valuable food for human consumption and contributes greatly to food and nutrition security.

About 3 kg of human-edible material, 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 kg 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 do consume could be eaten directly by humans.

For example, India is the second largest producer of milk in the world, with dairy cattle and buffaloes in the country fed almost exclusively on crop residues and by-products. They produce enough milk to cover the caloric needs of some 115 million people and the protein requirements of about 230 million people.

Livestock in **livelihoods** and economic growth

Intensive production of livestock is booming globally, but small producers in LMICs are failing to participate fully in sector growth. Of the 770 million people surviving on less than USD 1.90 per day, about half depend directly on livestock for their livelihoods.

Opportunities and challenges

Livestock reward their owners with a wide diversity of products, ranging from milk, meat and eggs to fibres, feathers, 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, by increasing livestock productivity whilst avoiding negative externalities, enhances livestock's contribution to people's livelihoods.

Poverty, livelihoods and economic growth are intricately linked and, in LMICs, livestock are key to 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 agri-food systems, stimulate demand for goods and services, and promote economic transformation by contributing to human and financial capital for other sectors of the economy to develop.

However, alongside the benefits of livestock keeping lie issues of equality. Large numbers of low-income livestock keepers are women, yet they often have less access to productive resources and markets than men, preventing them from deriving significant benefits from their livestock. Child labour is common in the livestock sector, with young boys and girls tending herds and flocks instead of going to school. As livestock agri-food systems expand to meet demand, millions of smallholder livestock producers – efficient but not competitive – are forced to abandon the business altogether.

Areas for policy action

- **Promote sustainable intensification** of livestock farming in diverse environments, ensuring that productivity gains are equitable and do not come 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 generate 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.

What FAO is doing

- Educating and building capacity at local level, using mechanisms such as Farmer Field Schools to promote best practices.
- Facilitating access to markets and value chains, making credit available and promoting producer associations.
- Working to lift constraints on livestock production, for example in October 2016 FAO and the OIE launched a 15-year effort to eradicate *Peste des Petits Ruminants* (PPR) by 2030.
- Supporting countries in the implementation of the Global Plan of Action for Animal Genetic Resources, the intergovernmental framework on management of genetic diversity in livestock.

Highlight Small ruminants and PPR

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Sheep and goats are particularly important livestock assets for poor households. FAO estimates some 300 million smallholders depend on small ruminants for food and income. They provide nutritious milk and meat, as well as wool and hides. They are hardy animals and their small size and value compared to cattle makes them a less risky and more versatile investment. However, PPR is causing devastating losses to the livelihoods of millions of sheep and goat farmers on four continents.

Since it was first identified in Côte d'Ivoire in 1942, PPR has been reported in more than 70 countries in Africa, Eastern Europe, the Middle East and Asia – home to over 80 percent of the world's sheep and goats. The annual global cost of PPR is estimated to be between USD 1.4 billion and USD 2.1 billion. The disease kills up to 90 percent of infected animals, but is easily prevented with an effective and inexpensive vaccine that can be administered at low cost to provide life-long protection.

Many characteristics of PPR make it an ideal candidate for a concerted eradication effort. The virus is antigenically stable, has a relatively short infectious phase, does not survive for long outside a host and has no known wildlife reservoir. But there are also barriers to uptake of vaccination that must be overcome. These include low capacity of veterinary services in much of the PPR zone, high turnover of small ruminants, the remoteness and mobility of many small ruminant producers, the relatively low value of individual animals and low levels of investment in improved husbandry.

Economic analysis indicates a cost-benefit ratio greater than 30:1 for eradicating PPR over the 15-year period. If these barriers were overcome, removing one of the major constraints to small ruminant production could greatly benefit some of the most vulnerable livestock-keeping communities.

Animal health and animal welfare linked to human health

Human health is closely linked to the health and welfare of animals and to that of the environment. This is the principle underpinning "One Health", whereby livestock agri-food systems are at the crossroads 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 surpassed that figure. The global burden of foodborne diseases, many of which are carried by livestock products, was 33 million disability-adjusted live years (DALYs) in 2010. Of that burden, 40 percent was borne by children under five years of age.

Zoonotic diseases with pandemic potential – emerging from the growing interface between people, animals and 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 MERS, which appeared at the interface between people and camels. As people and their agriculture encroach deeper into natural habitats, they are increasingly brought into contact with wild-host reservoirs of pathogens such as SARS, Nipah or Ebola.

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

With the growth in livestock production comes an increased use of antimicrobials, not only to treat infections but also to prevent disease and promote growth. Antimicrobial consumption by livestock is almost three times that in human medicine. Inappropriate use in livestock exacerbates the development of antimicrobial resistance (AMR) in livestock pathogens, which compromises treatment and readily spreads to the human population.

Areas for policy action

- **Support One Health approaches** to tackle health threats of animal origin.
- **Minimize the use of antimicrobials** in livestock production by improving husbandry practices and protecting animals from disease, in order to limit the sector's contribution to 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 husbandry practices.
- **Treat the welfare of animals as a priority** in all livestock systems globally, as a means to improved animal husbandry and health.

What FAO is doing

- Helping countries develop and implement animal disease control strategies and progressive disease risk management pathways for high-impact diseases such as influenza, FMD, PPR, and swine fevers.
- Helping countries develop and implement national action plans against AMR.
- Transferring technologies, diagnostic tools, information systems and surveillance methodologies to countries.
- Contributing to standard-setting, for example by the World Organisation for Animal Health (OIE), Codex and the Advisory Group on Integrated Surveillance of Antimicrobial Resistance.

Highlight Poultry production

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Poultry is the fastest growing livestock sub-sector due to its high turnover, good feed conversion ratios and popular products in meat and eggs. In LMICs the production of poultry meat and eggs has grown by 250 percent since the early 1990s, and similar growth is projected to 2030. Most of the growth is in 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 for direct human consumption. It is produced far from the location of poultry farms, breaking nutrient cycles. Feed production typically depends on inputs of pesticides and chemical fertilizers.

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 viruses. About one-third of all antibiotics used in livestock are in poultry production, which is approximately the same amount 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-food system by-products and by better management and use of manure.

Livestock, natural **resource** use, **climate change and environment**

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 are also the biggest user of agricultural land for feed and forages, drawing heavily on natural resources and contributing significantly to climate change.

Opportunities and challenges

Livestock draw heavily on natural resources but they also have the potential to contribute to the conservation of biodiversity and genetic resources for food and agriculture. If managed sustainably, livestock can contribute to important ecosystem functions, nutrient cycling, soil organic carbon sequestration and maintaining 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. Much of this crop and pastureland has been converted from forest and much is degraded, both of which release carbon stocks into the atmosphere. Livestock agri-food systems use significant amounts of water resources and contribute to biodiversity losses.

Beyond land-use change, livestock systems contribute to greenhouse gas (GHG) emissions directly, mostly through enteric fermentation and manure. They also contribute upstream, through the production of feed and other inputs, and downstream in transportation, cooling, storage and processing of livestock products.

Livestock systems have 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 phosphorous in crop and grass harvests fed to livestock ends up in our food. Many of the lost nutrients make their way to ground- and surface-water and are transported through freshwater 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 from the 23rd Session of the Conference of the Parties (COP 23)** to include agriculture in the United Nations Framework Convention on Climate Change negotiations.

What FAO is doing

- Facilitating multi-stakeholder partnerships to integrate broad sustainability objectives, such as the Global Agenda for Sustainable Livestock (GASL).
- Helping countries build inventories of GHG emissions from the livestock sector by developing guidelines and standards, for example through the Livestock Environmental Assessment and Performance (LEAP) partnership.
- Identifying and promoting low-carbon options for livestock sector development, for example through the Global Livestock Environmental Assessment Model (GLEAM).
- Supporting countries to implement best practices, such as through the Climate and Clean Air Coalition (CCAC) which focuses on reducing enteric methane emissions in 13 countries.

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 feed used for beef production is inedible by humans, so cattle make a net-positive contribution to protein balances. This contribution is especially important in marginal areas, where agro-ecological conditions offer few alternatives. Cattle also improve soil fertility through their impact on nutrient flows and organic cycles.

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 300 kg CO_2 eq. per kg of protein produced, but this too varies depending on the production system.

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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 in these systems. Poor resource-use efficiency constrains both productivity and environmental performance so 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 in their own right.

Livestock and the **2030 Agenda for Sustainable Development**

In January 2016 the United Nations launched the 2030 Agenda for Sustainable Development. The 17 SDGs seek to address, in a sustainable manner, the root causes of poverty and hunger and the universal need for development. With sustainability at its core, the topics covered by the 10th GFFA are highly relevant to achieving the SDGs.


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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, and trade-offs that 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 has multiple social benefits, such as tackling poverty, hunger and improving health. Better efficiency also reduces the environmental burden of livestock relative to production. But there are trade-offs that need to be managed. 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 risk of emergence and spread of zoonotic diseases. Promoting a more competitive sector with greater market concentration constrains the capacity of small producers to compete and participate in markets. These are just a few examples from a long list.

Maximizing livestock's contribution to the 2030 Agenda not only involves steering sector 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 thereby be more competitive. 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 sustainable livestock sector development. These must combine: i) 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 practices. Interventions must, however, be tailored so as not to compromise livestock's contribution to sustainable development objectives.

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

These issues are reviewed in detail in the forthcoming FAO World of Livestock (WoLi) publication: *Advancing the livestock sector towards the 2030 Agenda for Sustainable Development*.


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"... 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 agri-food system diversity

Livestock's contribution to the 2030 Agenda – and the risks they could present to achieving specific SDGs – varies greatly in different contexts. The global livestock sector 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 very distinct from those of farmers linked to highly competitive, international markets. If we are to shape a sustainable future for livestock, we need to understand the diversity of livestock agri-food systems and the motivations of the livestock keepers and other players involved.

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 diverse livestock agri-food systems.

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Livestock are broadly divided into ruminants – which through enteric fermentation have the capacity to digest rough plant material – and monogastric species, whose dietary needs are more similar to our own. The main ruminant species are cattle and buffaloes, which may be multi-purpose or specialized for beef, dairy or draft power; camelids, such as camels, llamas and alpacas, which play important roles for traction and fibre but which also provide meat and milk to many societies; and small ruminants, sheep and goats, which are important sources 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 in terms of the relative availability and cost 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 the next page.

Using this approach we define three broad livestock systems. Extensive systems are characterized low labour and capital inputs and generally occur in marginal habitats. Labour-intensive systems are typically smallholder farms with low returns and a surplus of labour, often constrained by scarcity of both land and capital. Capital-intensive systems 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. With few inputs beyond basic animal health care, these systems are efficient but of low productivity. They tend to occur in lightly managed areas that are unsuitable for crop growth and therefore do not compete with direct food production, making use of environments that would otherwise not contribute to feeding the world's population. Livestock are integral to the social fabric of pastoralist societies, so benefits extend well beyond food and livelihoods to fulfil many social and financial roles. Already living at climatic extremes, pastoralist people are vulnerable to climate change, with harsh winters or extended droughts causing high levels of mortality among their livestock. 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.

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Labour-intensive systems

Labour-intensive systems are typically smallholder-based and mostly occur 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 family farms with a focus on producing staple foods for subsistence, with surpluses sold or exchanged 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 400 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, payment of bridal dowries and communal feasts. Livestock also provide an important source of food for people outside farming households, particularly dairy production in developing countries where smallholders produce by far the largest share of the milk. They also ensure employment through associated agro-industries. If measured simply by yield gaps, the production of livestock in these systems is generally inefficient compared to extensive or capital-intensive systems. However there are other efficiencies that must be accounted for, particularly in relation to nutrient cycling, giving value to crop residues, and providing draft power.

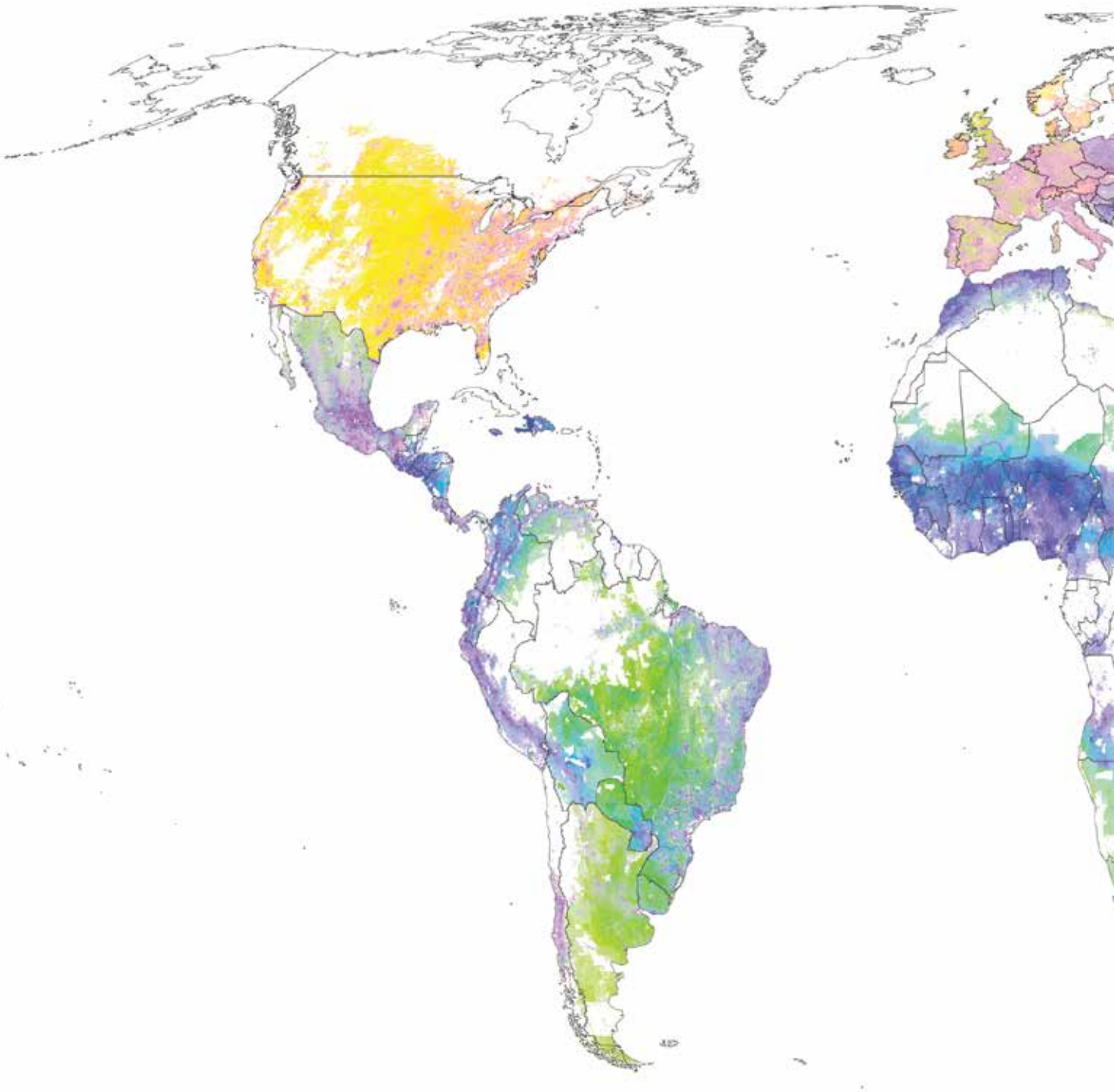
Capital-intensive systems

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 prevalent. Half of America's milk now comes from farms with more than 1 000 cows, and this proportion is increasing each year. Pigs and chickens in particular lend themselves to industrial production. These are the mainstay in HICs but are becoming much more prevalent in LMICs as well, where they contribute to feeding growing urban populations. Few people profit directly as farmers from these systems, but many 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 telecoupled effects in locations distant from the production unit. Such effects include deforestation, disruption of nutrient cycles, and pollution with pesticides and chemical fertilizers. With so many animals in such high densities, dealing with manure is a challenge for these systems and a major source of soil and water pollution. Capital-intensive systems use large amounts of antimicrobials and foster ideal conditions for the emergence of microbes that are hard to treat.

Highlight The global dairy sector

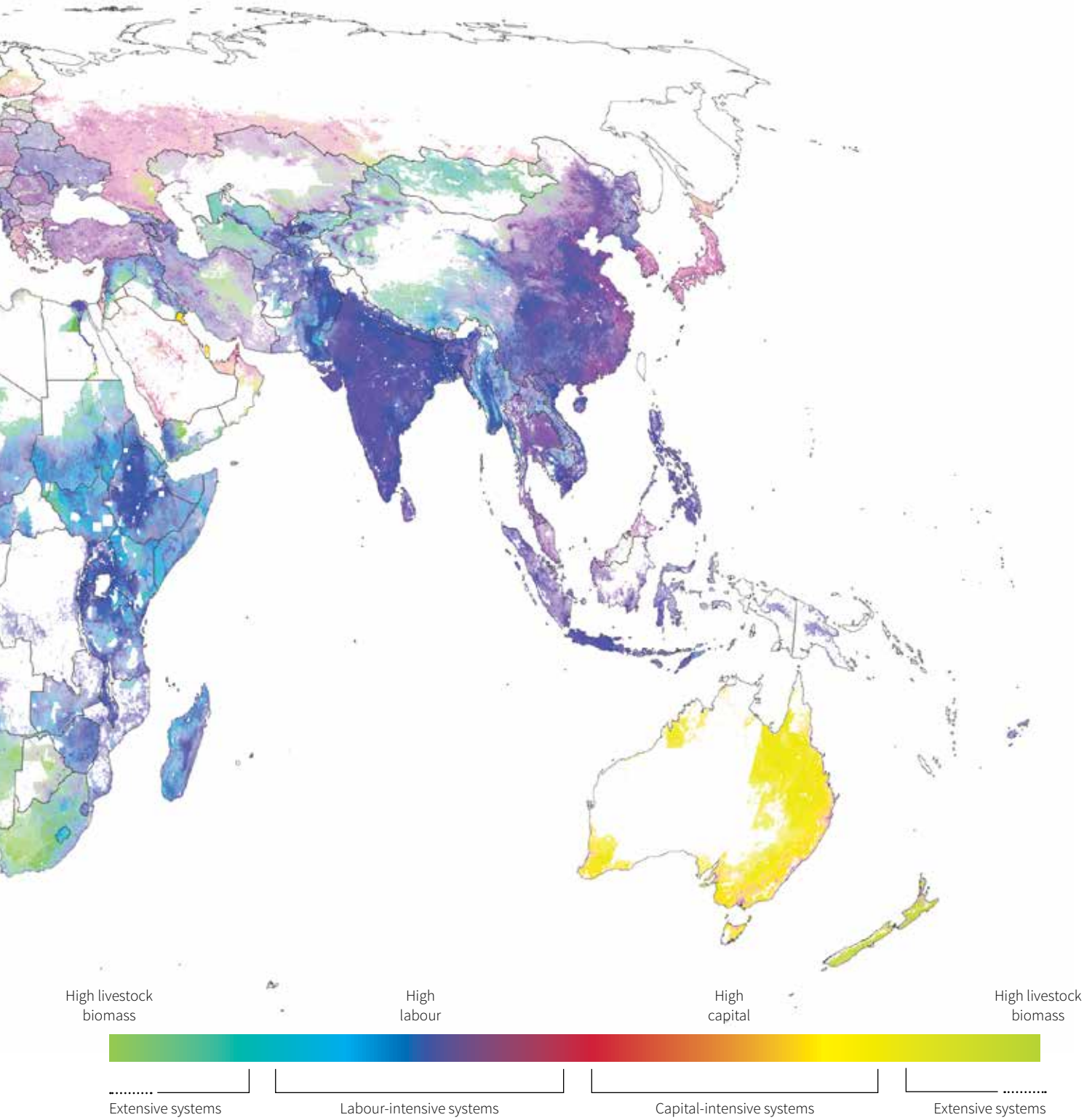
Milk is the single most valuable agricultural commodity, with an annual production (in 2013) of around 770 billion litres, valued at USD 328 billion. The species contributing to the global supply of milk are cattle (87.2 percent); buffaloes (13.3 percent); goats (2.3 percent); sheep (1.3 percent); and camels (0.4 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 a mixed farming system typified by the smallholder dairy producers of the East African highlands and South Asia. Dairy farming is also carried out increasingly in capital-intensive systems, at the extreme of which are the mega-dairies seen in Europe, North America and China. Mega-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.

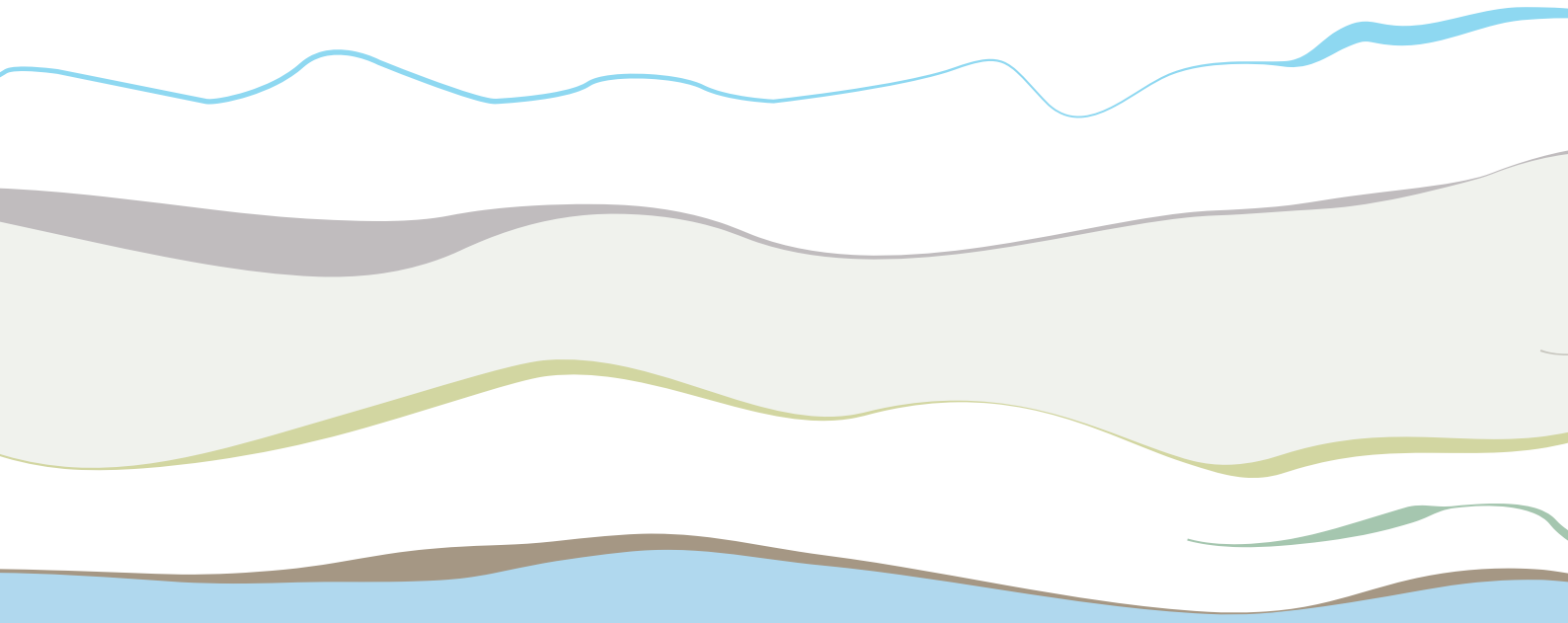


A vision of sustainable livestock

- Recognition of the UN 2030 Agenda for Sustainable Development as the overarching framework that guides the development of the global livestock sector.
- A sector whose diversity and multiple functions are recognized and accounted for in policymaking.
- 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 is optimized.
- Best use is made of human-inedible feed resources and use of human-edible feed in livestock production is kept to a minimum.
- Healthy diets are available to all and are actively promoted, seizing the specific benefits of animal-source foods for growth and cognitive development but discouraging excessive consumption. Diets are based on foods with low social, health, animal welfare and environmental externalities associated with their production.
- The climate impact of livestock is greatly reduced, with more efficient value chains reducing emission intensities and sequestration of soil organic carbon in pastures and rangelands optimized through restoration. Water is used efficiently in livestock production and the sector is better integrated into the circular bio-economy through recycling of nutrients and energy from livestock waste and use of recycled food waste.
- Animal welfare is a priority in all livestock systems globally. Animals are treated with respect to satisfy ethical and consumer demands and as a means to improved animal husbandry and health.
- Animal disease constraints are lifted as a drain on productivity, income and animal welfare. A One Health approach is widely adopted to address the interface between human, animal and environmental health. Public health threats stemming from livestock production and sector dynamics – food safety, emerging diseases and antimicrobial resistance – are minimized through the adoption of best practices and a strong capacity to monitor and respond to threats at all levels.
- In areas where sector growth is rapid, measures are in place to address externalities, particularly in terms of equity, animal and public health, animal welfare and environmental outcomes.

How do we achieve a sustainable livestock sector?

- Take 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 where the voices of each stakeholder are equally heard.
- 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 husbandry practices.



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