Food and Agriculture Organization of the United Nations

IN BRIEF

Five practical actions

towards resilient, low-carbon livestock systems

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Acronyms and abbreviations

AFOLU	Agriculture, Forestry, and Other Land Use
COP	Conference of the Parties
FAO	Food and Agriculture Organization of the United Nations
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
KJWA	Koronivia Joint Work on Agriculture
NDCs	nationally determined contributions
UNFCCC	United Nations Framework Convention on Climate Change

Chemical formulae

CH_4	methane
CO_2	carbon dioxide
N_2O	nitrous oxide

What are resilient, low-carbon livestock systems and why do we need them?

Livestock provide valuable nutritional benefits as well as supporting the livelihoods and resilience of families and communities.[1] Demand for animal products is expected to scale up with a growing global population. Worldwide livestock production is also ramping up in response to demands from an increasingly affluent and urbanized population in a globalized economy that is seeing a spike in overconsumption. Demand for animal-source foods in low- and middle-income countries more than quadrupled from 1970 to 2012 and is still predicted to increase by 35 percent from 2012 levels by 2030 and by 50 percent by 2050.

In spite of gains in production efficiency, greenhouse gas (GHG) emissions from livestock are still on the rise, and the 2019 Intergovernmental Panel on Climate Change (IPCC) special report on land flags considerable emissions originating from the Agriculture, Forestry, and Other Land Use (AFOLU) sectors, and from livestock in particular, which generate nearly 15 percent of global anthropogenic GHG emissions, with cattle responsible for about two thirds of this. The three main GHGs emitted from livestock systems are methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). Methane accounts for half the emissions and is an especially important target because it is an extremely potent GHG, but short-lived in the atmosphere. In the race to manage global warming, reducing methane emissions can therefore provide fast returns.

Successful action on climate change is an urgent priority, but it must not come at the expense of other sustainability objectives, particularly those relating to ending poverty and achieving zero hunger by 2030. Hence, there is a need to balance the benefits of animal–source foods and livestock keeping for

[1] This brief focuses on livestock action towards the Koronivia Joint Work on Agriculture (KJWA) and summarizes a policy document that was produced by FAO in support of the 25th Conference of the Parties (COP25) to the United Nations Framework Convention on Climate Change (UNFCCC): "Five practical actions towards low-carbon livestock" (www.fao.org/3/ca7089en/ca7089en.pdf).

nutrition, health and well-being, with the urgent need to reduce GHG emissions to tackle the climate crisis, which also threatens food security. Resilient, low-carbon livestock systems – what we can refer to as "healthy livestock systems" – can help countries achieve a balance whereby animal-source foods are produced in a way that minimizes their environmental impacts.

Countries party to the Paris Agreement are already raising their ambitions for reducing national GHG emissions, adapting to the effects of climate change, and reporting these intentions in their Nationally Determined Contributions (NDCs). National commitments to reduce GHG emissions should reflect sustainable livestock agrifood systems in climate change mitigation and adaptation plans.

The Koronivia Joint Work on Agriculture (KJWA) represents an important step forward in the negotiations on agriculture within the United Nations Framework Convention on Climate Change (UNFCCC) and emphasizes the importance of agriculture and food security in the climate change agenda. Five of the six priority areas directly relate to livestock: (b) Methods and approaches for assessing adaptation, adaptation co-benefits and resilience; (c) Improved soil carbon, soil health and soil fertility under grassland and cropland as well as irrigated systems, including water management; (d) Improved nutrient use and manure management towards sustainable and resilient agricultural systems; (e) Improved livestock management systems, including agropastoral production systems and others; and (f) Socioeconomic systems and food security dimensions of climate change in the agricultural sector.

Working towards resilient, low-carbon livestock will address each of these priority areas and the following five practical actions can be widely implemented for measurable and rapid progress towards healthy livestock systems:

- **Action 1:** Boosting efficiency of livestock production and resource use
- **Action 2:** Intensifying recycling efforts and minimizing losses for a circular bioeconomy
- **Action 3:** Capitalizing on nature-based solutions to ramp up carbon offsets
- **Action 4:** Striving for healthy, sustainable diets and accounting for alternatives
- **Action 5:** Developing policy measures to drive change.

Shaping a sustainable future will depend on understanding the diversity and complexity of livestock agrifood systems and the particular motivations and challenges stakeholders face in periods of transformative change. What works for a producer in a capital–intensive system can be very different from what works for a pastoralist or a mixed crop-livestock smallholder. Sustainable action means respecting these differences and working closely with these diverse stakeholder groups to develop context-specific, practical actions.

Action 1

Boosting efficiency of livestock production and resource use

Within-system comparisons reveal large variations in GHG emissions intensities, so there remains much to be done to improve efficiency through broader adoption of best practices. Notably, the variability of emission intensities is greatest for ruminant species, which have higher average emission intensities. Whilst much of this variability is due to prevailing agroecological conditions, a considerable proportion is due to differences in management practices that could be improved through various forms of intensification.

In many parts of the world, improved organizational strategies and technological innovations – such as improved feeding, genetics, animal health, general husbandry and information technology – are driving up productivity, making resource use more efficient with potential to reduce GHG emissions. There is considerable scope for higher efficiency in fertilizer production and use in growing feed; for example, by using renewable energy and precision application.

The opportunity to increase production efficiency is particularly striking where livestock serve social and economic purposes other than production, such as asset building in the form of stock accumulation, particularly in Africa and parts of Asia, and land speculation, as occurs in Latin America.

Intensification also needs to be sustainable – avoiding negative impacts on other sustainable development objectives. Intensification comes with an inherent risk of disrupting natural cycles, such as separating animal production from feed and fodder production, resulting in nutrient imbalances; for example when animal units are established close to markets rather than close to feed supplies. There are also animal health and welfare considerations that must be considered in plans to optimize productivity; for instance, the extent to which animals can be contained in spaces without serious restrictions on natural behaviour. Potential animal and public health risks linked to the emergence of virulence and drug-resistance in pathogens in high-density, genetically homogenous animal populations are also factors requiring the right balance between optimizing productivity and managing animal and public health risks. There are also ìlivelihood concerns that need to be managed.

The pandemic the world is facing has highlighted that human, animal and planetary health are linked, and that the good health of our planet plays an important role in halting the emergence and spread of zoonotic diseases. Healthy livestock systems contribute to nutrition and food security and household incomes, which are the necessary foundation for the financial and economic systems that make farmers more resilient in the face of crises such as COVID-19.

Action 2

Intensifying recycling efforts and minimizing losses for a circular bioeconomy


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Agrifood systems rely on natural resources as primary inputs. However, the future of food is under threat as resources such as phosphorus or potash are used at a speed and level of inefficiency that compromises natural cycles of replenishment. To support increases in food, fibre and feed production to meet global demand in a sustainable way, there are key recycling and loss reduction mechanisms available that can be more widely implemented, and there is ample opportunity for innovations in resource re-use.

Promoting a "circular bioeconomy" – as opposed to a linear process of extraction, production, use and disposal – involves recycling resources at every possible step in the agrifood systems, as well as "closing systems" to minimize the loss of resources and nutrients. Increased circularity in food systems – where waste from one process becomes a resource input for another – offers ways to increase the efficiency of food production.

Globally, around 14 percent of food produced is lost between harvest and retail and further significant quantities are wasted in retail and at the consumption level. A first priority to tackle both hunger and GHG emissions, and to enhance nutrient use efficiency, is to cut food waste and losses as far as possible in livestock systems. In spite of their perishability, the high value of livestock products tends to minimize waste but there is still room for improvement. Food waste can be reduced by the use of suitable packaging, for example, but a trade-off with single-use plastics must be managed.

Food that would otherwise be lost or wasted can be put to better use. Food waste from restaurants and supermarkets or second–grade grains can be valuable sources of livestock feed, as long as they are tested and treated for pathogens to ensure feed safety. With the right incentives, legislation, and systems in place for feed safety, some countries manage to recycle food waste into high value "ecofeed", thus reducing their reliance on imported grains and soy to feed animals.

While there are considerable differences in recycling practices within and between countries, large amounts of potential feed, such as crop residues, food waste and loss, and agro-industrial by-products, are often unused when instead these could be fed to animals. Crop residues can be used as livestock feed, after being made more digestible through the addition of various supplements, instead of burning them, which results in unnecessary GHG emissions and contributes to air pollution.

The livestock sector can further benefit from restorative and regenerative practices, for more resource-efficient production to maintain and enhance natural capital. Ties between production systems become increasingly severed in the processes of intensification, with livestock operations concentrating in areas with limited cropland on which to apply manure. However, net emissions can be reduced by re-integrating livestock and crop production for better recycling of nutrients and production of renewable energy. At present, only 62 percent of nitrogen in manure is returned to cropland and grassland in a useful way, globally.

Action 3

Capitalizing on nature-based solutions to ramp up carbon offsets

The AFOLU sector differs from others, such as energy or transport, in that it removes carbon from the atmosphere and sequesters it, as well as emitting it. This uniquely positions the sector to offset its own emissions directly and requires accounting for emissions net of sequestration. Livestock is one component of AFOLU but is difficult to consider in isolation from the wider sector because of the many interactions and interdependencies across AFOLU components. For instance, 30 percent of all crops are grown to feed livestock, and most livestock are raised in mixed crop-livestock systems, including agroforestry and silvo-pastoral systems.

Agriculture is the largest direct driver of deforestation globally. In Latin America, for example, cattle and livestock feed production are the dominant drivers of deforestation. Halting expansion into forests for feed production and pasture is an urgent priority and remains one of the most effective ways for livestock systems to contribute to climate change mitigation. The global livestock sector can ill afford to be assigned the carbon losses associated with deforestation so commitments to reshape forest management are essential.

Vast quantities of carbon are sequestered in the cropland used to produce feed, and the grazing lands on which ruminant livestock are raised. However, much carbon is unnecessarily lost from cropland and a large proportion of the world's rangelands are degraded and could capture far more carbon in soil organic matter, if restored. Regenerative forms of grazing can provide much needed carbon offsets. Well-adapted grazing systems – with improved pasture and optimized grazing regimes – have the potential to stimulate plant growth and capture carbon in the soil, particularly in areas where degradation is not yet severe. The introduction of trees in tropical pastures on previously forested land (silvo-pastoralism) can help stabilize productivity and generate many social, economic and environmental benefits. Regenerative grazing can contribute to improved biodiversity and water efficiency, as well as making the land more resilient to a changing and more variable climate.

Another area with great potential for creating offsets is in the generation of renewable energy on livestock farms. This includes using manure and other waste to generate biogas, prior to recycling as a source of nutrient replenishment, that can offset the use of energy-intensive synthetic fertilizers. There is also scope for more widespread use of the land and buildings linked to livestock farms to install solar and wind power facilities. Solar panels can even be used to shade livestock from the sun. The economics of such offsets would need to be made favourable to livestock keepers, and appropriate carbon-accounting mechanisms put in place, for the resulting emission savings to be offset against those produced by livestock. This is a promising area that warrants attention.

Action 4

Striving for healthy, sustainable diets and accounting for alternatives

Malnutrition is unacceptably high across all regions of the world, with about a third of women below the age of 50 anaemic, at least one in five children under five years old suffering from stunted growth, and nearly a third of these children wasting. Healthy nutrition is particularly critical during the first 1 000 days of life – during pregnancy, lactation and early childhood – as deficiencies in zinc, vitamin A and iron severely restrict growth, cognitive development, and proper immune function. Animal-source foods are dense in these and other essential micronutrients, such as vitamin B12, riboflavin, calcium and various essential fatty acids. These nutrients are difficult to obtain in adequate amounts from plant-based foods alone. Including even modest amounts of animal-source foods in diets adds much-needed nutritional value for better health outcomes.

Overconsumption is also a problem, with 40 million children under five years old reportedly overweight, and if current trends continue, more children and adolescents will be obese than those moderately or severely underweight by 2022. Explicit links between overconsumption of livestock products and overweight and obesity are still being investigated, and some studies have examined a possible link between consumption of red meat and processed meat and certain cancers. Overall protein consumption, and the contribution from livestock products, are closely linked to wealth; with people in richer countries generally consuming far more animal-source foods than in poorer ones. While some segments of society are under-nourished and others over-consume, there must be a convergence on healthy, nutritious diets for all in order to meet the 2030 Agenda for Sustainable Development.

With heightened awareness, there is growing consumer interest in lower-emitting animal-source foods, such as poultry meat and eggs, and plant-based alternative protein sources. Consumer demand tends to drive rapid innovation, and these growing trends represent unique opportunities for expansion of the agrifood system. Cellular agriculture, where animal proteins and whole cells are generated in bioreactors, is being further developed. While it may be some time before replica meat cuts can be made in this way, protein supplements, and alternatives to powdered milk, powdered eggs and ground beef for the agrifood industry would seem already to be in reach.

The search for alternative protein sources is perhaps having even greater impacts in the domain of livestock feed. Biotechnological innovations are revolutionizing the way that protein can be produced and used for feeding livestock. This includes established practices like the application of synthetic amino acids, as well as newer approaches involving algal, fungal and microbial protein replacing conventional feed protein such as soy, as well as the use of insects. Some feed additives, such as seaweed, have shown considerable potential to reduce enteric methane emissions, but need to be made more widely available to farmers.

As new products cross regulatory hurdles and enter the market, there will be a clear need for proper environmental accounting to help chart the way forward for the continually evolving agrifood system vis-à-vis health and climate goals.

Action 5

Developing policy measures to drive change

Public policy interventions are needed to implement the above action areas by engaging the appropriate stakeholders with appropriate incentives to drive change. Successful policies using an evidence-based and people-centred approach will reflect the concerns of multiple stakeholder groups, involving them early in the process of policy development. Policy options include market-based instruments (e.g. pricing, taxes, incentives), investments in infrastructure and support for research and development, and direct regulatory interventions ("command-and-control"). Together, such approaches can discourage inefficiencies and high-emission practices while enabling and incentivizing innovations for the adoption of more sustainable practices, thus creating an enabling environment to encourage transformative practices and help reduce stakeholder risk.

As an example, "pull incentives" can help to generate market demand in support of shifts towards best practices. And governments, regulatory bodies, professional societies and co-operatives can respond to consumer pressure on markets by developing and implementing "climate smart" certification schemes. This would entail benchmarking, monitoring and evaluation to deter poor practices and incentivize practices that will help countries meet national targets.

Subsidies counterproductive to meeting environmental objectives can be replaced with cross-compliance regulation, under which conditions direct payments can be made to farmers and other agrifood system stakeholders for reducing emissions by adopting good practices. Incentives and market-based approaches, incorporating consumer concerns depend on reliable certification schemes for farms and other agrifood system components, with rigorous traceability and appropriate labelling systems for livestock commodities at the point of sale. To discourage unsustainable practices the prices of livestock commodities could be allowed to reflect the presence of GHG emissions. "Carbon taxes" are an example of a pricing instrument that has already been applied in some countries for select sectors – transport and energy in particular. Applying a carbon tax to livestock commodities would be complex, requiring careful consideration and monitoring and evaluation mechanisms, since baseline emissions and mitigation potential vary from farm to farm.

Regulations are already in place for animal health, animal welfare, environmental pollution, and food safety in many countries and could similarly be introduced for reducing livestock-related emissions. Managing manure correctly is an example of a practice that would lend itself to regulation. Soft law, in the form of normative guidance, can also be effective and quicker to implement. "Top-down" interventions tend to be more successful when applied in combination with "bottom-up" behaviour change initiatives. Stakeholder assessments, including vulnerability and risk assessments, and building awareness are key to bringing about change. Policies can also be put in place to ramp up research and development efforts in support of resilient, low-carbon livestock systems. Whichever combination of technical and policy interventions are proposed, special attention must be paid to impacts on prices for livestock commodities – whether they arise from efficiency gains, low-cost alternatives, subsidized production or taxation – to guard against unintended consequences for livestock and other associated sectors.

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A call to action
for integrated approaches

The most appropriate technical and policy approaches towards resilient, low-carbon livestock systems will vary across livestock systems, agroecological and socioeconomic contexts, and reflect different priorities. For example, some high-income countries may focus on introducing regulatory frameworks, improving recycling and facilitating trade in order to ease resource constraints, while in some emerging economies with strong growth, objectives may focus on the need to avoid increasing total GHG emissions through improvements in efficiency and carbon sequestration. On the other hand, some low- and middle–income countries – with large numbers of smallholder farmers and pastoralists – may focus on resilience, nutrition, food security, livelihoods and payments for environmental services to support adaptation to climate change. Some approaches will be more suited to particular regions and sub-sectors and will need to be nuanced in order to avoid unintended impacts on other objectives, such as livelihoods, public health and animal welfare.

Each of these five actions alone has the potential to reduce net livestock emissions but there is great benefit to an integrative approach as part of an ongoing process of continual improvement towards sustainable livestock agrifood systems. Improving resource use efficiency can go hand in hand with restoring degraded grasslands through regenerative grazing, for example. Enabling policies and institutions can further enhance uptake of the appropriate practices. Such improvements can also harness synergies with other sustainability objectives – increased productivity and farm revenues, boosted nutrition and food security, enhanced soil health, improved human health, and greater resilience, are all positive outcomes that can be achieved together.

Making progress towards resilient, low-carbon livestock systems will depend on strong policies creating the right incentives, regulations, investments, and market responses. The right systems will also need to be put in place for measuring baselines and tracking progress down to the level of the farm. There is currently limited capacity for implementing such policies and for monitoring emissions in many low- and middle-income countries, as indicated by the low number of livestock mitigation targets from NDCs in many cases. These capacities must be built as a matter of urgency.

Climate change is a global problem that demands well-integrated solutions at local, national and regional scales. It is essential that burdens are addressed, rather than shifted. For example, improving ruminant production efficiency through increased use of feed, or shifts from ruminant livestock to monogastric species, can result in "virtual resource transfers", whereby negative impacts can occur far from the point of production or consumption, through land-use change, fertilizer use or feed-food-energy competition elsewhere in the world, for example. Intensification may also threaten broader sustainability objectives, resulting in trade-offs in other aspects of environmental protection, or in food and nutrition security, livelihoods, human health, animal health and welfare. Therefore, safe and sustainable climate action in the livestock sector requires holistic approaches that harness synergies and manage trade-offs to achieve global prosperity in our lifetime and for generations to come.

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