What do we know about THE FUTURE OF ANIMAL-SOURCE FOODS AND FOOD SYSTEMS?

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Key messages

- Urbanization and income growth lead to more diverse diets and increased consumption of animal-source foods (ASF) in lower-income countries, while in some higher-income countries, consumer preferences may slowly be shifting away from ASF.
- A significant shift in diets is projected for lower-income countries, with the demand for ASF expected to increase by 20 percent in absolute kcal/person/day terms under conditions of baseline socioeconomic trends to 2050.
- Projected shifts in ASF consumption will disrupt local-to-global food production and distribution, but most attention has focused on its implications for nutrition and health, climate, and the environment, with less attention to socioeconomic and livelihood impacts.
- Strategies proposed for addressing the complex and multidimensional future impacts of changes in ASF demand, production, and distribution need further exploration.

RECENT TRENDS AND CHALLENGES

In a reflection of the persisting challenge to achieve the Sustainable Development Goal target of zero hunger, around 733 million people, or 1 in 11 globally, faced hunger in 2023. This is according to the 2024 United Nations report on the state of global food security (FAO et al. 2024). That report also indicated that up to 2.33 billion people experienced moderate to severe food insecurity in 2023, and, if current trends persist, a projected 582 million people will be chronically undernourished in 2030. Despite these recent setbacks in global food security, in many places where the consumption of protein from animal sources has been historically low, including among vulnerable populations within Africa and Asia, higher intakes of animal-source foods (ASF) contribute to reducing chronic challenges of calorific hunger and hidden hunger; that is, too-low intakes of foods of high nutritional value (Adesogan et al. 2019; UN-Nutrition 2021).

Following decades of high consumption in higher-income countries and regions, per capita demand for ASF types such as beef and mutton declined in many regions over the last decade (Table 1). Whereas issues of price and affordability dominate trends of ASF consumption in countries where average incomes are still very low, heightened concerns about potential negative impacts on human health and the environment, among other issues, have been influencing a slow dietary shift toward reduced consumption of meat in higher-income countries (Mathijs 2015). At the global level, however, demand for ASF has increased, driven by strong growth in demand for poultry (Table 1). Beyond the global statistics, changes in ASF demand are occurring in different directions (that is, up and down), and at varied rates for different locations and ASF types (Herrero et al. 2023). For example, while per capita demand for poultry meat increased in all regions over the last decade (although to varying degrees), pork demand per capita increased in the Americas, Asia, and Africa, but declined in Europe.

Rapid urbanization and income growth, among other changes, lead to more diverse diets and consumption of higher quantities of ASF, legumes, fruits, vegetables, and processed foods in developing economies (FAO et al. 2023). These dietary changes have direct effects on food security and nutrition, and — through changes in demand, production, and trade — drive major transformations in local to global food systems. This chapter examines selected key issues in the transformation of livestock-based ASF systems.

LATEST FORESIGHT RESEARCH

Demand, production, and distribution

In a report simulating responses of the global agricultural and food system to changes in population, income, and prices from 2020 to 2050, global calorie demand per person is projected to increase by 8.4 percent between 2020 and 2050 under a baseline scenario; that is, a continuation

TABLE 1 Change in annual meat demand (in kilograms) per capita between 2012 and 2022, selected regions

Region	Beef	Mutton/Lamb	Pork	Poultry	Meat
World	0.26	0.18	0.27	2.63	3.34
United States	0.96	0.28	2.57	3.89	7.70
Europe	(1.83)	(0.22)	(0.28)	2.56	0.23
South America	(4.41)	(0.06)	3.99	5.50	5.02
Africa	(1.07)	(0.19)	0.44	1.21	0.39
Asia	1.78	0.34	0.58	3.07	5.77

Source: Authors' calculations based on published statistics (FAOSTAT 2024).

Note: The numbers presented are the difference between per capita demand for the various meat products in the selected regions between 2022 (the most recent year for which data are available) and a decade prior (that is, 2012). Negative values are presented in parentheses, indicating a decline in per capita demand between 2012 and 2022.

FIGURE 1 Overview of the livestock sector's links to nutrition, health, the environment, and livelihoods

Source: Adapted from ILRI (2019).

of current socioeconomic and climate trends (Rosegrant et al. 2024). Developing countries will mainly drive this result, with per person calorie demand in this bloc increasing by 10 percent to 2050, from 2,560 to 2,816 kcal/person/day. The absolute changes in food demand in lower-income countries are also projected to be accompanied by a significant diversification of diets, wherein the share of cereals in calorie demand will decline by 4 percentage points, to be replaced by increases in the shares of other food commodities, including ASF. According to these projections, demand for ASF will increase by 20 percent in absolute kcal/person/day terms in lower-income countries.

Projected future trends of ASF demand are expected to disrupt patterns of ASF production and distribution, with important environmental and social impacts in both high- and low-income countries (Fukase and Martin 2020). Livestock production systems will need to respond to changing ASF demand and are known to be intricately linked to indicators of human nutrition and health, livelihoods, and the environment (Figure 1). Agricultural value chains are also expected to undergo significant changes that mirror global shifts in food demand. In low- and middle-income countries (LMICs), agricultural and livestock value chains could become more structured and important to countries' economies (Barrett et al. 2022). Production and processing of ASF in LMICs may also see more rapid intensification in poultry, pork, and dairy than in beef systems (ILRI 2019). These changes have implications for climate and other indicators within countries facing rapid changes in their livestock value chains. Other studies suggest that under business-as-usual trends for ASF demand that are not accompanied by interventions to stimulate increased domestic production, demand for ASF (mainly poultry) could increase substantially in many LMICs, including across Africa, to outstrip domestic production (Enahoro et al. 2021). In this scenario, local demand for many ASF types could increasingly be met through imports.

Climate and environmental impacts

The ongoing patterns of ASF demand and supply have been linked to climate and environmental impacts. For example, livestock (including feeds) production is estimated to contribute 14–20 percent of total greenhouse gas (GHG) emissions and up to 60 percent of emissions related to agriculture and food systems, including from the processing, retail, and consumption of ASF products (Xu et al. 2021). Since livestock production can account for up to one-half of the agriculture sector's technical potential to mitigate climate change (Herrero et al. 2016), various demand- and supply-side strategies have been proposed to manage the growth in ASF demand and to facilitate the sector's transition toward sustainable food systems (Herrero et al. 2023). These include improving the management of rangelands and switching to the use of livestock feed options with reduced environmental impacts (for example, feed additives containing nitrogen to reduce ruminant methane) (Havlik et al. 2014; Herrero et al. 2016). Pikaar et al. (2018) projected that alternative animal-feed supply routes based on industrial production of microbial proteins can, by 2050, replace 10–19 percent of conventional crop-based animal-feed protein demand, resulting in agricultural GHG emissions decreases of around 6–9 percent. A different report showed that increased environmental optimization of feed compositions, a shift from beef production to more productive systems, and land restoration could enable GHG emissions reductions of 34–85 percent annually without increasing costs (Castonguay et al. 2023).

While changes in ASF demand and production will potentially influence climate change, the converse is also anticipated. Anthropogenic climate change is projected to have major impacts on ASF production, including through increased heat stress in animals in both intensive and extensive livestock systems, potentially affecting weight gain, animal yields (for example, milk), and fertility (Thornton et al. 2021). Thornton et al. (2022) estimated that losses from climate-induced heat stress in cattle could reach almost US$40 billion per year by the end of the century, or nearly 10 percent of the value of production of cattle meat and milk in 2050. That work showed that losses due to climate impacts are projected to be far greater in tropical regions, where they are also more challenging to address, again highlighting the need to focus on LMICs. The effects of climate change will not be negative everywhere, however, and will be experienced at varying levels in different livestock systems and geographies (Thornton et al. 2009).

Demand-side strategies for climate mitigation

Although ASF intake could be increased for nutritionally disadvantaged communities and among vulnerable groups such as children, pregnant women, and the elderly (ILRI 2019; UNEP 2023), in other populations, where current intake is considered too high, demand-side strategies should focus on lowering ASF consumption. Proposed strategies for reducing ASF intake, where that is the appropriate option, include the costing of ASF products to reflect their negative environmental impacts and the substitution of animal protein in human diets with alternatives such as plant-based meats and cultured meat (Herrero et al. 2023; UNEP 2023). Studies have shown the potential to: (1) reduce (by up to 13.5 percent) the carbon footprint of US food production through dietary changes that reduce the number of beef animals (Mason-D'Croz et al. 2022); and (2) address animal welfare and environmental concerns of global ASF consumption through the adoption of novel plant-based meat, cultivated meat, and fermentation-derived foods (UNEP 2023). Using a forward-looking quantitative analysis, Kozicka et al. (2023) show that a combination of strategic dietary changes and agricultural land restoration could lead to substantial reductions in global environmental impacts (for example, a 31 percent reduction in GHG emissions) by 2050.

The economic costs and benefits of many identified mitigation strategies are largely unknown, as are some social, environmental, and nutrition and health implications (Herrero et al. 2016; UNEP 2023). While studies would suggest that lower quantities of (for example) bioavailable iron and other essential nutrients make plant-based alternatives less suitable as substitutes for animal proteins in the diets of nutritionally vulnerable populations (such as children, women, and the elderly), very few studies have attempted to quantitatively measure the long-term effects on human nutrition and health (Alonso, Dominguez-Salas, and Grace 2019; UNEP 2023). It is generally accepted, though, that prospects for strategies such as reduction in the consumption of ASF are better suited to some regions (for example, higher-income countries) than to others (Herrero et al. 2023; UNEP 2023).

Wider socioeconomic impacts

Demand-induced changes in ASF production and value chains also interact with social and economic indicators

such as prices, national income, employment, and livelihoods. In an analysis exploring potential future demand for ASF, Komarek et al. (2021) highlighted that consumer preferences are reducing ASF consumption in higher-income countries, leading to lower prices. The lower prices induce increases in demand for ASF in (importing) lower-income countries, but also in higher-income countries, although this price response is more muted in the latter as higher-income consumers are less price-sensitive. Results such as this suggest that price effects are still important in regulating global ASF consumption and can be important in strategies for managing environmental impacts. Pricing and demand-based policies will need to be employed with some caution (ILRI 2019; Springmann et al. 2017). Mason-D'Croz et al.'s (2022) analysis of the long-term potential impacts on the US cattle industry of wide-scale replacement of beef with plant-based alternatives found small positive impacts on the national gross domestic product due to a more resource-efficient food system. Nevertheless, disruptions in agricultural supply chains from the adoption of plant-based alternatives could challenge the livelihoods of the more than 1.5 million people employed in beef value chains in the United States. Similar concerns arise in other countries that a shift in consumption from ASF toward alternative proteins could pose serious threats to the livelihoods and incomes of ASF producers, but not many studies have applied quantitative analyses to explore these dynamics.

KEY GAPS AND OPPORTUNITIES FOR FORESIGHT RESEARCH

Key foresight studies agree on the need to consider nutrition, livelihoods, and other impacts on the poor and in lower-income countries associated with proposed strategies to mitigate the negative impacts of high levels of ASF demand and production. However, it will be important to distinguish between impacts that would be relevant to specific actors in ASF supply chains and specific geographies and communities that rely on these activities, and major impacts for societies overall. While Mason-D'Croz et al.'s (2022) study on the United States indicated the potential for a serious challenge for those in the beef sector, particularly if the simulated changes occur quickly, it did not highlight major concerns for the overall economy. This narrative is not unique to the ASF sector, as it holds true in general for disruptions brought about by events such as the introduction of major new technologies or major shifts in the patterns and volumes of international trade.

More work is needed in quantitative assessments of the future of ASF demand, production, and (local to global) trade, particularly with respect to economic (and non-economic) costs and benefits, trade-offs, and the varied roles and effects of, for example, smallholder producers and other actors at different nodes (for example, production, processing, retail) in animal-source food value chains. Major advancements in quantitative foresight modeling (such as the integration of different modeling platforms), increased availability (and effective use) of big data, and innovations in the use of artificial intelligence are just a few technologies that may make it easier to quantify the multidimensional factors and trade-offs around ASF consumption, production, and their impacts in the future. These prospects hold promises for better decision-making in and for the livestock sector from a local to global scale.

This chapter was supported by the CGIAR Research Initiative on Foresight and the CGIAR Science Program on Policy Innovations. We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund.

The authors are grateful for the research funding received (by DE and CM) for this work and for the constructive feedback and support from Keith Wiebe, Nicola Cenacchi, and other contributors to the CGIAR Foresight Initiative.

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Related chapters on the future of food system drivers and impacts, regional and national perspectives, food commodities, and foresight tools are available in our Table of Contents.

Citation: Enahoro, D., D. Mason-D'Croz, M. Herrero, C. Mensah, and I. Baltenweck. 2025. "What Do We Know About the Future of Animal-Source Foods and Food Systems?" In *What Do We Know About the Future of Food Systems?*, eds. K. Wiebe and E. Gotor, Chapter 28. Washington, DC: IFPRI. https://hdl.handle.net/10568/175019

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