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Publication date:
2021

Document version
Other version

Citation for published version (APA):
Garcia Bouyssou, C., Jensbye, L. G., Jensen, J. D., & Yu, W. (2021). *The global animal food market: drivers and challenges*. Department of Food and Resource Economics, University of Copenhagen. IFRO Report No. 298

The global animal food market: drivers and challenges

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June 2021

EXECUTIVE SUMMARY

Production and consumption of livestock and animal food products have received intensive public policy attention and media coverage in recent years, primarily due to the climate and environmental impacts attributed to their production processes and their roles in diets and food and nutrition securities. It is widely recognized that the livestock sector accounts for a significant share of the annual anthropogenic GHG emissions. At the national level, GHG emissions from the livestock sector depends on the size of the livestock sector and emission intensities per unit of outputs, which differ significantly across countries and different livestock species. About 40% of the global agricultural GDP is from the livestock sector, a testament of the importance of the sector in global agriculture. The share of livestock in agricultural GDP, however, varies significantly across countries/regions and the role of livestock production in the economy varies with respect to a country's development stage, the production system, and the environmental characteristics, among other things.

Animal food products such as meat and dairy provide valuable nutrition such as protein, fatty acids, minerals, and vitamins and are widely regarded as an important part of the dietary choices of consumers in many countries and cultures. Increasing meat and dairy consumption has motivated numerous studies of their dietary and nutrition roles, as well as their health implications in connection with both over- and under-consumption of such products and to food safety, zoonoses, and antimicrobial resistance issues connected to their production. Per capita consumption levels of the different animal food products vary widely across and within countries, with the per capita intake of animal proteins in some of the world's poorest countries amounting to only a small percentage of that in North America and Europe. This uneven distribution mirrors disparities of food and nutrition security situations across poor and rich countries.

While not intensively traded as some other agricultural products, significant trade flows of animal food products take place between countries with surplus production and those with insufficient domestic supply, leading to a complex trading network that is also shaped by differential trade barriers, trade agreements, food safety standards, and other regulations. In 2019, 36 million tons of meats (in carcass weight equivalents) and 76.7 million tons of dairy products (in raw milk equivalents) were traded internationally.

In the following decades, population and income growth in developing countries are expected to boost livestock production and consumption. However, the per capita consumption levels of animal food products are likely to evolve along different pathways across different countries. For instance, rising income and population is expected to push up consumption in the emerging and developing economies, whereas countries already with high consumption levels may not follow the same pattern. Likewise, the composition of animal food consumption across individual product categories (i.e. beef, pork, poultry, fluid milk, milk powder, butter and cheese) may also change, particularly due to shifting preferences and changing production patterns in connection with environmental regulations. For instance, while meat and dairy consumption is growing in much of the developing world, stagnated consumption and saturated markets have been observed in the EU. In fact, per capita beef consumption has decreased in many parts of world in the last three decades, whereas poultry consumption rises across the globe. Expected growth in meat and dairy consumptions in the developing and emerging economies in the

coming decades can also stimulate rising import demand from the world's traditional exporters of such products. In parts of the developed world, such as Western Europe, heightened attention to climate change may change their production patterns, which in turn can alter the existing trade patterns. In the case of uneven de-carbonization ambitions in agriculture across countries, particularly when countries with higher emission intensities in the livestock sector committing to lower de-carbonization targets, countries committed to higher de-carbonization ambitions may resort to trade policy remedies such as border carbon adjustment to safeguard their production and trade positions on the global market. This discussion has emerged in the EU and more recently also in the US. However, such actions would further add to costs and barriers in animal food trade and upset the already fragile global trading system that in recent years has suffered from several major setbacks such as BREXIT, US-China tariff war, and the stalled multilateral trade liberalization process under the WTO.

As the initial output of a research project focusing on the future of the animal food sector, the purpose of this report is to provide a nuanced explanation of how these different aspects – supply drivers, demand-side determinants, trade relations, climate impacts, technological advancements and potential future regulations – interlock with each other and how they will jointly affect the future development of the global livestock and animal food market. The report provides a solid foundation from which further research and analysis can be carried out to understand the future development of the livestock and animal food markets in the long-term. This report is built upon an extensive literature review, detailed data compilation and analysis, and direct dialogues/interviews with industry experts in key decision-making roles. The report is structured as follows. Chapters 2 and 3 examine, respectively, the key demand and supply drivers, including an overview of available methodologies to understanding these drivers in the economic literature. Chapter 4 provides an overview on the implications of livestock production and animal food consumption on international trade, climate and environment, and health. Chapters 5 and 6 are devoted to detailed data analysis on the historical and current consumption, production, and trade of individual meat products (e.g. beef, pork, poultry) and dairy products (e.g. fluid milk, milk powder, cheese, and butter), respectively. A synthesis of short- and long-term market projections on these products are also offered in these chapters. Last but not the least, a number of research gaps are identified for further studying the sector's future development, for purposes of mapping out the research priorities to be focused upon in our further research. In what follows, we provide some highlights on the main findings of the report. Readers are invited to read the main text for more details.

Demand drivers. In the economics literature, income and prices have long been considered the fundamental determinants of food demand, e.g. as revealed by the well-known Engel's Law (that food consumption shares decrease with rising income) and Bennett's Law (that shares of livestock products rise with higher per capita income). Recent evidence, however, suggests a divide between consumption patterns between developing and developed countries: while income and population changes continue to drive consumption patterns in developing countries, increasing attentions to the environment, climate and health implications of animal food consumption in many developed countries have seemingly led to shifting consumer preferences.

Studies on projecting consumer demand traditionally rely upon demand system estimations and use demand elasticities to approximate demand behaviors. Despite the fundamental role of these concepts in empirical economic analysis, estimates of income and price elasticities for animal food products in the current literature are quite fragmented or outdated in terms of coverage of product categories, geographical areas and time period, pointing to the need to conduct more systematic studies.

Supply drivers. The supply of animal food products concerns both the primary production (livestock sector) and processing activities. Livestock production systems range from extensive grazing-based production system to intensive "landless" production system, as determined by animal species, land and water resource availability, climatic conditions, access to feed, technologies, and proximities to demand.

Regulations regarding environment, health, and animal welfare also play important role in shaping the supply and composition of animal food products. The livestock sector is directly and indirectly impacted by climate change and is also an important contributor of GHG emissions. Climate impacts on livestock production require adaptation measures. To mitigate the burden of livestock production on climate change, technical solutions aiming at improving feed efficiencies and limiting direct emissions are considered. More direct policy interventions such as carbon tax are also proposed and debated. Both adaptation and mitigation measures are expected to be important future factors driving future national and global supply pattern in the animal food sector.

Quantitative economic models such as computable partial equilibrium (PE) and general equilibrium (GE) models are developed and applied to numerically evaluate how the development of these drivers would shape the sector's future development, including long-term projections conducted by organizations such as the FAO, OECD, EC and USDA. Common to these modeling exercises are the exogenous assumptions on general macro-economic and demographic development and sectoral specific development concerning technological development and resource use efficiencies. A notable omission in the existing model-based projections are the insufficient characterization of climate impacts of livestock production and the role of future climate policy. This omission mandates further research.

International trade. International trade of meats and dairy products are an important part of agricultural trade worldwide but they generally faces higher trade barriers as compared to non-agriculture products. The stalled WTO multilateral trade negotiations imply that actual reductions in tariff barriers limiting the international movements of animal food products have largely been achieved in the last two decades by regional or bilateral trade agreements, thus intensifying trade flows within trade blocs and between partner countries within trade agreements. Due to the more stringent food safety and sanitary requirements and the added costs associated with cold chain transportation, trade costs are also higher for fresh/chilled/frozen animal food products. This limits the participations of countries without the necessary infrastructure. Future trade growth therefore depends not only on the demand potentials and supply capacities, respectively, in importing and exporting countries, but also relies on the elimination of trade barriers, the lowering of trade costs, and harmonization/convergence of regulations.

Environment impacts. Livestock production contributes to GHG emissions through land use, feed consumption, enteric fermentation, manure application and the associated pollutions to soil, water and air. There are different accounting methods for measuring emissions from the sector, including the production-based "territorial" approach adopted by the IPCC and the consumption-based approach that tracks emissions along the whole supply chain. The rather wide range of estimated GHG emissions from the livestock sector not only reflects the differences in emission accounting methods and statistical errors, it is also due to data issues related to livestock population, feed composition, and physiological assumptions. Despite these differences, there are general agreement on the relative emission intensities across animal food products, with cattle meat emitting the most, followed by pork, milk, and poultry. According to the FAO's on-farm emission database, there are also very large variations of emission intensities across countries, most notable for cattle meats and pork. Multiple measures are proposed for reducing the negative environmental implications of livestock production, ranging from technical solutions directly targeting livestock production, supply side policies such as regulations and environmental standards, and demand side measures such as carbon tax, information campaigns, and dietary recommendations.

Human health implications. Animal food products contains important nutrients such as high-value proteins, fatty acids, minerals, and vitamins, positioning it for an important role in attaining health-related SDGs concerning hunger and undernourishment. However, over-consumption of products such as red meats and processed meats is identified as a risk factor of cardiovascular disease and other diseases. Thus, in recent years, dietary guidelines tend to prioritize plant-based food over animal food products. Beyond nutritional aspects, meat and dairy production is also related to other health concerns

such as food safety, the spread of zoonoses, and antimicrobial resistance. Some countries are already implementing policies or guidelines that try to deal with such concerns.

The meat sector. Countries in East Asia and Southeast Asia, notably China, Vietnam, South Korea, and the Philippines, are expected to be growth markets for meat exporters from the EU and the Americas. Over the next decade, changing composition of meat demand is expected, led by growing demand for poultry and followed pork demand. Aggregated beef demand is expected to increase moderately and only Asia is projected to increase its per capita beef demand. In developed countries, while per capita meat demand stagnates, consumers increasingly demand more processed meat products that are convenient and/or available from food services. Increasing environmental and health concerns are also changing the consumption patterns in some countries, for example in the EU where there are increasing demands for organic meat and plant-based alternatives. As the public debate on the environmental implications of meat consumption intensifies, future consumption of meat products may subject to policy interventions, particularly in high-income countries.

On the production side, current differences and potential future divergences in environmental and veterinarian regulations can lead to cost differentials in production and trade. For instance, meat products sourced from the EU are subject to more stringent environmental regulations and health and food safety standards and will have to continue to market their products on these terms, whereas other countries such as the US and Brazil compete more in prices and volume terms. The latter's price advantage can also be attributed to their access to ample domestic feed supplies, as both are major producers and exporters of bulk commodities such as maize and soybean. Potential cross-country differences in regulating GHG emissions from livestock production can further influence production costs and export performance, with countries with more stringent emission regulations possibly bearing higher costs. There is also a risk of carbon leakage: if GHG regulation becomes more stringent in countries with low emission intensities, countries with high emission intensities and low emission reduction ambitions may gain market share and emit more. Responding to policies targeting production, producers may relocate production to regions with lax emission ambitions; similarly, responding to policies targeting consumption, producers can redirect their products from domestic markets to export markets.

The Covid-19 pandemic and the African Swine Fever (ASF) crisis currently affect the global meat market. The initial reaction to the Covid-19 pandemic was a decrease in meat production due to logistic bottlenecks and labor shortages. At the same time, the ASF outbreak represents a major threat to the pork industry in a number of countries in Asia, Europe, and Africa, contributing to reduced domestic supply and increased import demand in countries such as China. In the medium term, demographic patterns in developing countries are expected to be the main determinant of the meat market. Growing population and income are expected to drive the demand growth, especially in South-East Asia. A detailed analysis of the available data on the consumption, production, and trade patterns in the meat sector – disaggregated by beef, pork, poultry – corroborates the views expressed by industry members: the largest changes within the meat market will likely take place in developing and emerging economies. A detailed review of long-term market projections from several major organizations (i.e. FAO-OECD, EC, and USDA) are found to be largely consistent with the patterns already observed from the historical trends. However, major uncertainties on climate change mitigation measures in connection with the Paris Agreement, technological development, and trade agreements and trade conflicts in the coming decades are not adequately reflected in the current market projections but they may change the sector's development trajectories. Therefore, there is a need to incorporate these uncertainties in future studies; furthermore, there is need for projections with a longer time horizon than the 10 years typically covered by the aforementioned market projections.

The dairy sector. Similar to the meat sector projection, the global consumption of dairy products is expected to increase over the coming decades, driven by population growth, changing diets, and higher

purchasing power for a growing middle-class population in developing economies. Large differences in per capita dairy consumption exist across countries, with annual per capita dairy consumption (measured in milk equivalent) reaching 467 kg in Finland, 24kg in China, and only 2kg in Nigeria. In developed countries where per capita dairy consumptions are generally higher, processed dairy products have an increasingly larger share of total dairy consumption, whereas consumers in developing nations continue to consume mainly fresh milk and milk powder. This pattern is expected to persist with developing countries (particularly Southeast Asian, West African and the MENA region) increasing per capita and total dairy consumption. On the other side, having already reached market saturation for traditional dairy products, developed countries' consumption measured in raw milk equivalents is expected to stagnate but a shift towards "sustainable" products and "to go" options is expected, driven in part by increased awareness of climate change and sustainability.

On the production side, South Asia (particularly India), North America, Europe, and Oceania are the main milk producers. For more processed dairy products, the US, the EU, New Zealand are the more important producers. The global distribution of milk and dairy production is determined by a variety of factors that influence herd size and yields, which often differ across countries and in particular between developed and developing countries. Smallholder and subsistence farming still prevail in developing nations, while large-scale intensive production dominates in developed regions. Annual raw milk yields per cow reaches the level of around 10 tons in North America and part of Europe but only a fraction of that in many other countries. Similarly, large differences in total emissions and emission intensities from milk production are also observed. While total emissions are the highest in India, the Americas, China, milk production in Africa and part of South Asia emits more on per unit basis. Such differences can be partially explained by differences in production methods and technologies, which in turn are rooted in the differences of resource endowments, national regulations, and degrees of economic and social development. Therefore, the development of these factors needs to be considered in understanding the sector's future development, not the least in connection with the need to reduce the sector's GHG emissions.

Perishability, the need for cold supply chain, and the high water content of fresh milk limit the tradability of fresh milk. Divergences of Sanitary and Phyto-sanitary (SPS) measures also add to trade costs. Therefore, it is not surprising that only 8% of the total world milk production is traded internationally, most of which is more processed products such as butter, cheeses and milk powder. Technology innovations and economic development have opened up trade of liquid milk and other fresh dairy products in certain new trade routes, such as the exports of liquid milk from New Zealand and the EU to China. In contrast, there is very limited access to the Indian market, the world's largest milk producer. For milk and cream, North America, Australia, New Zealand, the EU are the major exporters, while Asia and Africa are the main importers. In the case of cheese, North America is also a net importer.

Much like the meat sector, the short-term development of the dairy sector hinges on the recovery of the world and national economies from the Covid-19 pandemic, and on the extent to which the pandemic may continue to create supply chain disruptions. In the long-term, the evolution of the dairy sector will be influenced by demand factors such as income growth, demographic shifts and potential changes in dietary patterns, as well as structural changes in production and technological innovations. Using detailed market projections conducted by FAO-OECD, EC and USDA, this report synthesizes the likely market development in the next ten years regarding production, consumption and trade patterns of milk, milk powder, butter and cheese. Furthermore, these projections are compared and contrasted with opinions expressed by industry experts whom we interviewed for this report.