Chapter 3

LIVESTOCK SECTOR TRANSFORMATION IN KENYA: CURRENT STATE AND PROJECTIONS FOR THE FUTURE

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The livestock sector plays a major role in the Kenyan food system, contributing about 12 percent of the country's overall GDP and 40 percent of agricultural GDP, and employing about half of the agricultural labor force (Kenya Markets Trust 2019a). The livestock sector also contributes 22 percent of food system GDP. Projections from the Kenya National Bureau of Statistics (KNBS) indicate that the country's population will continue to grow, and may reach around 96 million by 2050, with nearly 50 percent residing in urban areas by then compared with 27 percent in 2019 (FAO 2019; MacMillan 2019). Demand for animal-source foods is expected to grow substantially with this population growth and as higher numbers of affluent and more urban consumers seek nutrient-rich foods and more diversified diets (FAO 2019). This change in demand could potentially drive exponential growth in the livestock sector, generating new business opportunities along various livestock value chains. Realizing such growth will require concerted investments to support increased productivity and enhanced natural resource management, including enhanced water availability and management, to ensure sustainable growth of the sector (ILRI 2019; Bosire et al. 2022).

Consistent with these expected increases in demand and supply, Kenya's Vision 2030 agenda calls for accelerated development of the livestock sector (FAO 2019). Appropriate livestock-mediated interventions in markets, institutions, and the policy space could also support the emergence of a food system with increased capacity to meet the population's growing needs for nutrition, food security, employment, and income, among other benefits. However, the choice of interventions today that can steer development toward the desired livestock sector and food system of tomorrow must consider the existing constraints, opportunities, and uncertainties. The dynamics of socioeconomic

change, climate change, geopolitics, and other drivers shaping the Kenyan food system are uncertain, as are the outcomes of the interactions of these drivers.

Foresight and scenario analyses can play a key role in assessing potential alternative futures, considering uncertainties. Such analysis can also support the development of policies, processes, and programs to support sustainable, resilient food system transformation in Kenya (Wiebe et al. 2018). By incorporating foresight analysis into livestock sector planning, analysts are also better able to provide evidence on how transformative growth in the livestock sector will bring major development opportunities and challenges for the overall food system, considering strategic policy decisions investments made today that could ensure the long-term sustainability of the sector and the overall food system (FAO 2019).

This chapter provides a meta-analysis of multiple previously published scenario analyses of future demand and production of commonly consumed and/or produced livestock-derived foods in Kenya. To this end, we use the results from quantitative future scenarios to assess the demand and supply of foods of livestock origin in Kenya, adopting this as an appropriate approach for identifying policy options to guide the sustainable transformation of the livestock sector. In addition, we have synthesized the major constraints and opportunities in the livestock sector identified in a recent stakeholder workshop on value chain-specific constraints, opportunities, and improvement strategies as part of the development of a livestock master plan for Kenya.[1]

Demand for livestock products

Livestock-derived foods (meat, milk, and eggs), or LDF, comprise an essential part of people's diets in Kenya (FAO 2019). Estimates of the level of consumption are, however, subject to some uncertainty. Our review of the demand or consumption of LDF commodities in Kenya relies on data from numerous sources, including the Food and Agriculture Organization of the United Nations (FAO) and studies by various organizations and researchers, to address the challenge of inaccuracies and inconsistencies that have been reported to exist in the available information (ICPALD 2013; Kenya Market Trust 2019a). We first evaluate recent trends in the consumption levels of various livestock products over 10 years (2010–2019). We then review findings from recent demand studies for insights into how the demand for livestock food commodities is evolving. Finally, using food balance sheet data from FAO (FAOSTAT

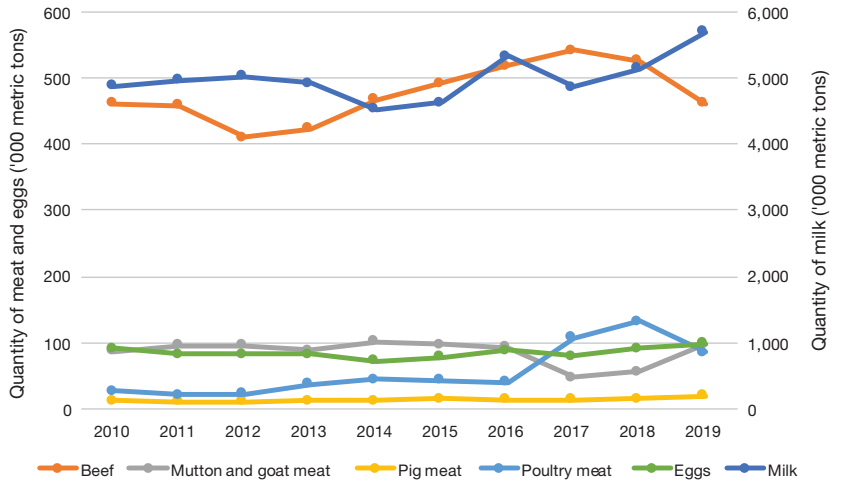
1 www.ilri.org/livestock-master-plans

2022) and parameter estimates obtained from the demand studies, we derive projections of consumption levels over the next 15 years.

Trends in consumption of major livestock commodities

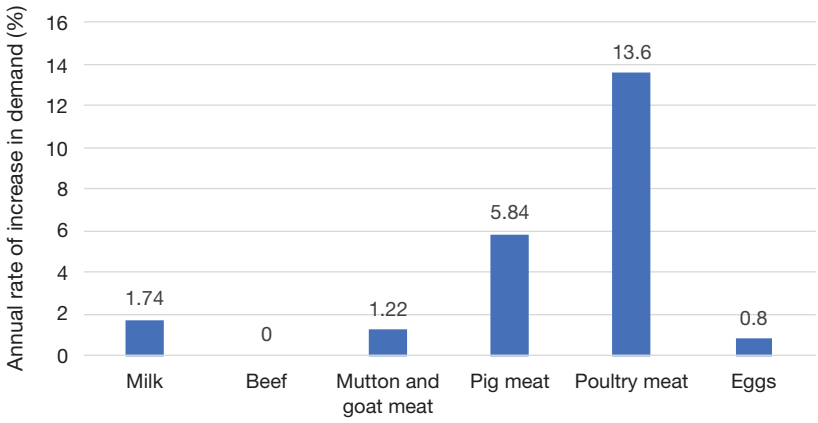
According to food balance sheet data (FAOSTAT 2022), the main LDF commodities consumed in Kenya are milk, beef, sheep, goat, pig, poultry, and eggs. For many commodities, there was a slight upward trend in total annual quantities consumed nationally between 2010 and 2019 (Figure 3.1). Milk consumption was highest in volume terms among all LDF consumption recorded, highlighting the importance of this livestock product for diets in Kenya (see also Chapter 4 in this book). The total annual volume of milk consumption rose from 4.43 billion liters in 2010 to 5.17 billion liters in 2019. Figure 3.2 presents the average annual rates of increase in national consumption levels of various commodities calculated based on consumption levels in 2010 and 2019. Growth in total quantities consumed varied substantially across different livestock products. For the 10 years analyzed, consumption growth was highest for poultry (13.6 percent per year), followed by pig meat (5.8 percent per year) and milk (1.7 year). The average rate of increase for beef was zero over the period

FIGURE 3.1 Annual national levels of consumption of different livestock food products in Kenya, 2010–2019



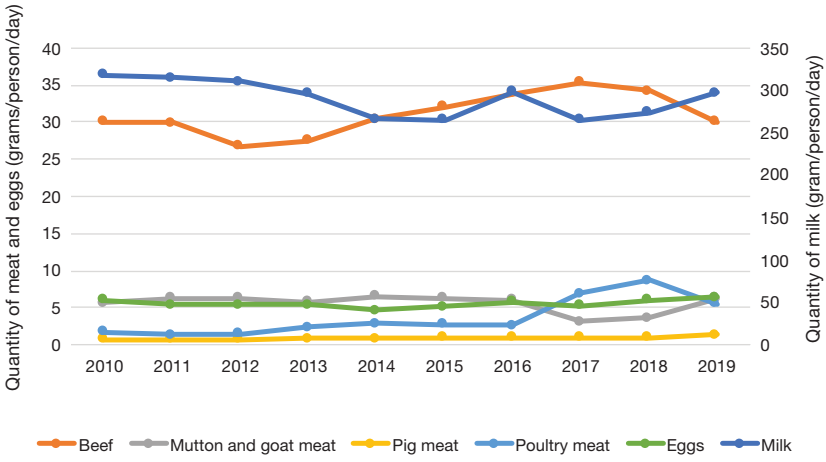
Source: FAOSTAT (2022).

FIGURE 3.2 Average annual percentage rate of change in aggregate demand for livestock food commodities, 2010–2019



Source: FAOSTAT (2022).

FIGURE 3.3 Per capita levels of consumption of different livestock food products, 2010–2019



Source: FAOSTAT (2022).

(Figure 3.2), which is explained mainly by a decline in the total consumption volumes observed in 2018 and 2019 that canceled out the steady increase previously observed between 2012 and 2017 (Figure 3.1). Estimates of per capita levels of consumption based on FAO data for 2012 show that, except for poultry meat consumption, which increased by 200 percent (from 1.8 to 4.4 g/person/day), consumption per person of LDF remained more or less static in the country over the 10 years (Figure 3.3). The FAO-based estimates perhaps understate the level of consumption: a survey by Kenya Market Trust (2019a) estimated that consumption of red meat (beef, goat meat, and mutton) was 15.08 kg per person per year.

A survey by FAO (2019) presents additional details on the patterns of LDF consumption in Kenya. Results show that milk and beef constitute the main supply of LDF in diets, with approximately 86 percent and 46 percent, respectively, of households across various income groups consuming fresh milk and beef. In addition, calculations based on data from FAOSTAT (2022) show that milk contributes 6.03 grams of protein per capita per day, or 48 percent of the average daily per capita protein supply of LDF (12.62 grams), whereas meat contributes 6.17 grams, of which 4.00 grams, or 65 percent, comes from beef

Numerous studies have been conducted in recent years on the dynamics of demand for livestock products in Kenya, including Bett and colleagues

TABLE 3.1 Consumption of livestock-derived foods, 2018

LDF type	Protein consumption (grams/capita/day)	Share of average daily per capita protein supply of LDF (%)
Meat (total)	6.17	49
Beef	4	32
Chicken meat	1	8
Buffalo meat	0.09	1
Sheep and goat meat	0.43	3
Pig meat	<0.01	<0.01
Other	0.65	5
Eggs	0.42	3
Milk (total)	6.03	48
Milk, whole fresh cow	5	40
Milk, whole fresh camel	1	8
Milk, whole fresh goat and sheep	0.03	<0.01

Source: FAOSTAT (2022).

(2012), Ngula (2014), Shibia, Rahman, and Chidmi (2017), and Korir, Rizov, and Ruto (2018). The studies focus mainly on the effects of prices and income on demand. Table 3.2 presents estimates of own-price elasticities and income elasticities of demand for various livestock commodities from recent demand studies. As expected, all the studies show that price increases are likely to reduce demand for various livestock food commodities, and vice versa for price drops, authenticated by the negative own-price elasticities. Consistent with the seminal literature on the livestock revolution (Delgado et al. 2001), various studies also show that income increases positively affect demand.

TABLE 3.2 Income elasticities of demand for various livestock food commodities

Livestock product	Year data were collected	Own-price elasticity		Income elasticity	Study
		Compensated	Uncompensated		
Beef	2012	–0.1844	–0.5282	1.0010	Ngula (2014)
Shoat meat	2012	–0.2612	–0.5368	1.0652	
Chicken meat	2012	–0.26078	–0.4778	0.8519	
Pork	2012	–0.7129	–0.8764	1.1435	
Bone beef	2013	–0.5790	–0.9480	1.0257	Shibia, Rahman, and Chidmi (2017)
Boneless beef	2013	–0.7270	–0.8050	0.9894	
Goat meat/mutton	2013	–0.7490	–0.8100	0.8937	
Chicken meat	2013	–0.4950	–0.6430	1.0993	
Pork	2013	–0.4200	–0.7650	0.9594	
Indigenous chicken meat	2012	–0.1876	–0.7705	0.8537	Bett et al. (2012)
Exotic chicken meat	2012	–0.0738	–0.1089	1.5020	
Beef	2012	–0.5485	–0.6630	0.8455	
Mutton	2012	–0.5945	–0.6030	0.2547	
Goat meat	2012	–0.5150	–0.6605	1.7619	
Other meats	2012	–	–	2.6917	
Dairy products					
Rural	2015	–0.4280	–0.5096	0.8804	Korir, Rizov, and Ruto (2018)
Urban	2015	0.4202	–0.4990	0.8708	
Overall	2015	–0.4250	–0.5057	0.8770	

Source: Authors.

Note: Own-price elasticity of demand is the ratio of the percentage change in quantity demanded of a product to the percentage change in price. Income elasticity of demand is the ratio of the percentage change in quantity demanded of a product to the percentage change in income. Compensated price elasticities (also called Hicksian elasticities) ignore the income effect of a price change and comprise only the substitution effect. Uncompensated price elasticities (also called Marshallian elasticities) consider both the substitution and the income effects of a price change.

Projections of the future level of demand for livestock food commodities

Using the information on consumption levels of the various livestock commodities and additional data from the literature, projections of future levels of demand for the commodities were generated for this study following Shapiro and colleagues (2017). The projected total consumption (TLC_t) of a given livestock product in year t was calculated by multiplying the projected per capita consumption (LC_t) by the projected population (POP_t) for a given period t (Equation 1).

$$TLC_t = LC_t * POP_t \quad (1)$$

In turn, LC_t was calculated as follows:

$$LC_t = LC_0 * (1 + \eta * \gamma)^t \quad (2)$$

where LC_0 is the baseline per capita consumption of a given livestock product, η is the income elasticity of demand for the livestock product, and γ is the annual growth rate of real per capita GDP.

The results from recent demand studies in Kenya informed the values of income elasticities of demand (Table 3.2). Note that, in the results presented in Table 3.2, income elasticity estimates by Ngula (2014) and Shibia, Rahman, and Chidmi (2017) are quite close to each other but differ remarkably from those by Bett and colleagues (2012). The values of income elasticities we adopt for our projections are informed by the estimates from the studies by Shibia, Rahman, and Chidmi (2017) and Korir, Rizov, and Ruto (2018). Besides corroborating each other, the two sets of elasticities are consistent with the rates of growth in consumption available in the FAO data.

Baseline per capita consumption was estimated by dividing the national consumption values from FAOSTAT by the total human population estimate for 2019. The annual growth rate of real GDP per capita (γ) was estimated using economic survey data for the years 2016 and 2019 from KNBS (2021). To project the population (POP_t), a growth rate of 2.3 percent per year was used based on the 2009 and 2019 national census results.

Table 3.3 presents projections of annual total quantities consumed for various livestock products between 2019 and 2037. The projected quantities of various types of meat in 2037 are 108–123 percent higher than the level in the base year (2019).

The projected rates of increase in demand in this study were compared with interpolations derived from projections in 2050 by Enahoro and colleagues

TABLE 3.3 Projected levels of consumption of various livestock products between 2019 and 2037

	'000 metric tons				
Year	Milk	Beef	Mutton and goat meat	Pig meat	Poultry meat
2019	5,156.0	418.6	85.6	19.0	28.5
2020	5,370.8	437.2	89.3	19.9	29.8
2021	5,594.6	456.7	93.2	20.8	31.1
2022	5,827.7	477.0	97.3	21.8	32.5
2023	6,070.5	498.2	101.5	22.7	33.9
2024	6,323.4	520.4	106.0	23.8	35.4
2025	6,586.9	543.5	110.6	24.9	36.9
2026	6,861.3	567.7	115.4	26.0	38.6
2027	7,147.2	593.0	120.4	27.2	40.3
2028	7,445.0	619.4	125.6	28.4	42.0
2029	7,755.2	647.0	131.1	29.7	43.9
2030	8,078.3	675.8	136.8	31.1	45.8
2031	8,414.9	705.8	142.8	32.5	47.8
2032	8,765.5	737.2	149.0	34.0	49.9
2033	9,130.7	770.1	155.5	35.6	52.1
2034	9,511.1	804.3	162.3	37.2	54.4
2035	9,907.4	840.1	169.3	38.9	56.8
2036	10,320.2	877.5	176.7	40.7	59.3
2037	10,750.2	916.6	184.4	42.5	61.9

Source: KNBS (2021); FAOSTAT (2022).

TABLE 3.4 Comparison of projected increases in consumption of various livestock commodities from different studies

Livestock food commodity	Current study (%)	Increases seen in Enahoro et al. (2018) (%)				Increases seen in FAO (2019) (%)
		Moderate rates of economic growth	High rates of economic growth	Low rates of economic growth	Significant challenges to global climate change adaptation and mitigation	
Milk	108	32	26	46	32	56
Beef	119	65	67	71	64	86
Mutton and goat meat	115	65	66	71	65	–
Pig meat	123	99	117	90	97	–
Poultry meat	117	137	171	118	16	89
Eggs	–	79	90	79	80	67

Source: Enahoro et al. (2018); FAO (2019).

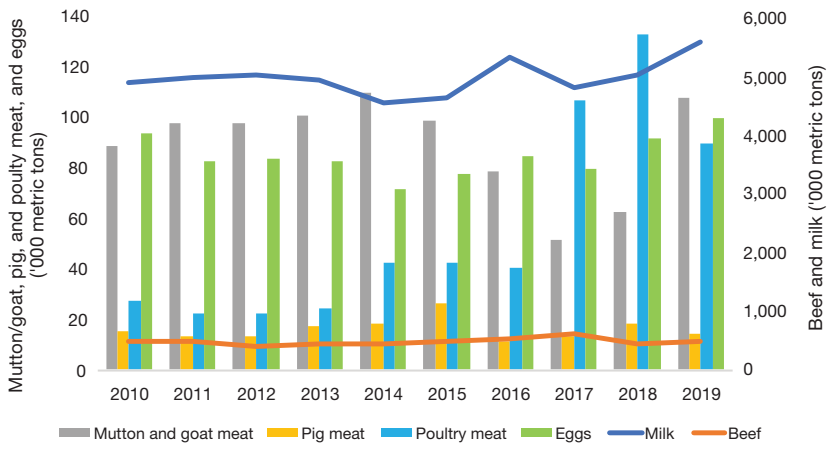
(2018) and FAO (2019) (Table 3.4). While the rates of increase in demand in this study compare well with those from the two other studies in the case of pig and poultry meat, they are markedly different (that is, lower than the estimates by Enahoro et al. and FAO) for milk, beef, and sheep and goat meat. These differences are likely attributable to the effects of the different methods and data used to generate the projections. Nevertheless, the results from all three studies point to some significant increase in demand for the various livestock products over the projection period.

Supply of livestock-derived food products

Historical trends of supply

The total supply of LDF in Kenya—that is, the overall quantities consumed or otherwise used by the population—consists predominantly of domestically produced items (FAOSTAT 2022). However, growth in domestic LDF production has been quite varied, with changes in the total output more pronounced in some livestock subsectors than in others. Over 2010–2019 decade, the national production of poultry meat, for example, increased by nearly 230 percent (from 27,000 metric tons in 2010 to 89,000 metric tons in 2019). Egg and milk production increased by around 6 percent, and small ruminant meat production

FIGURE 3.4 Quantities of livestock-derived foods produced domestically, 2010–2019



Source: Authors using FAOSTAT (2022).

by 22 percent. On the other hand, beef production was the same in 2010 and 2019, although substantial year-on-year fluctuation occurred between these years (Figure 3.4). Pig meat production declined more than 6 percent over the 10 years.

Within Kenya, dairy is produced in intensive, semi-intensive, and extensive production systems, while beef production occurs in pastoral systems, semi-intensive (agropastoralist) ranching systems, and commercial feedlots (FAO 2019). Pig and poultry production are typically not directly associated with land-based systems and may be carried out on smallholder farms or specialized poultry operations (for example, meat or egg) (Herrero et al. 2013).

Data from 2014 showed that beef production occurred mostly in arid and semiarid lands (ASALs), where 36 percent of the human population resides. Most of Kenya's beef production is recorded to have come from Marsabit, Meru, Kwale, Embu, Taita, and Laikipia counties, with two of the counties (Marsabit and Meru) together producing more than 8,400 metric tons, or 55 percent of the county-level totals recorded for that year (Table 3.5).

Cow milk production was highest in Turkana (127,000 metric tons), while Garissa accounted for the highest county-level supply of sheep and goat meat (2,660 metric tons in total). Only a few counties reported poultry and pig production data, and we have not included those in the table.

TABLE 3.5 Meat and milk production in 2014 for selected counties

	Metric tons						
County	Beef	Sheep meat	Goat meat	Chicken meat	Cow milk	Goat milk	Camel milk
Mandera	257	–	103	6	207	166	488
Garissa	137	1,380	1,380	–	28,000	8,000	436,000
Marsabit	4,474	938	663	26	4,131	–	–
Samburu	553	729	519	–	3,300	1,163	193
Turkuma	71	54	89		127,000	221,000	110,000
Embu	950	68	162	–	45,000	0.0	–
Kwale	2,368	191	105	16	–	–	–
Meru	4,000	681	1,425	–	100,320	–	–
Tharaka Nithi	551	91	4177	–	19,000	60	–
Lamu	23	84	122	8	3,700	–	–
Taita	1,077	159	31	–	17,230	–	–
West Pokot	2	15	26	–	8,000	–	–
Laikipia	874	242	134	2	99,000	2,200	2,200

Source: KNBS (2017); Ministry of Devolution and Planning (2017); Ministry of Agriculture, Livestock, Fisheries and Irrigation (2019).

Projections of future supply

While a few studies provide quantitative estimates of plausible supply of LDF in Kenya in the future, most of these studies generate the projections at the national and not subnational (for example, county) level, deriving these using aggregated statistics (for example, elasticities) of LDF demand and supply. Two key approaches to quantifying future LDF (or other agricultural/food commodity) projections will be (1) the derivation of future growth rates using knowledge of the past with probabilistic estimates of the future and (2) exploratory projections that start from the present and investigate the impacts of various drivers, trends, and interactions into the future (Wiebe et al. 2018). A relevant quantitative approach that is based on the latter derives supply growth as the endogenous output of an integrated assessment model, solving for a stated market objective (such as partial equilibrium) while accounting for biophysical realities such as Earth system changes, crop physiology, and water basin management (Robinson et al. 2015).

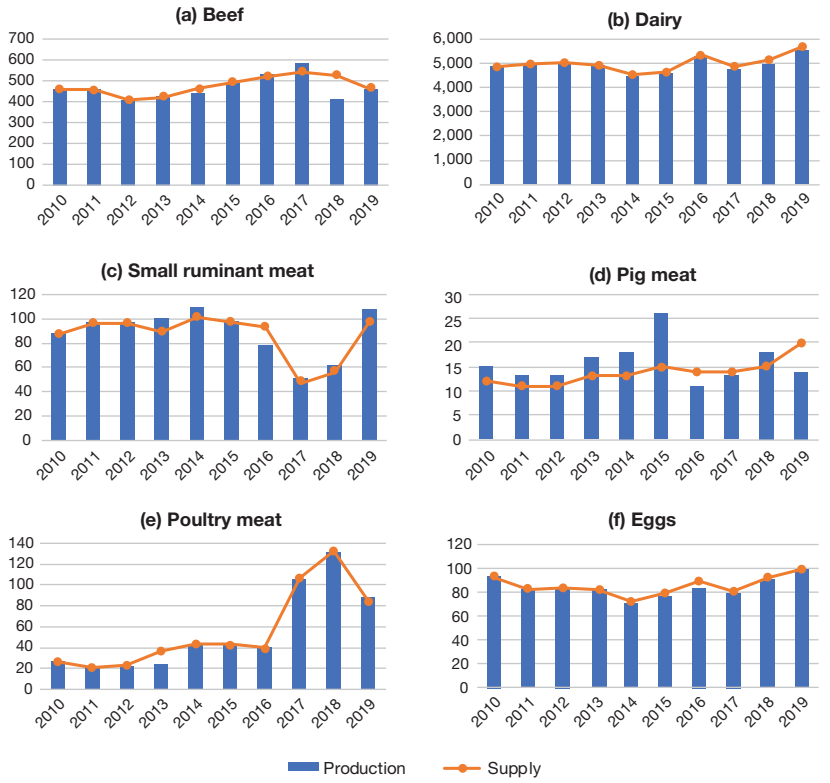
Projections reported by Enahoro and colleagues (2018) suggest that the production of milk, beef, small ruminant meat, pig meat, poultry meat, and eggs could increase by between 8 percent (eggs) and 69 percent (poultry meat) over 15 years. A future scenario of livestock health intervention further generates a 166 percent increase in the domestic supply of beef by 2034 following the widespread adoption of a cattle disease vaccine in areas with high mortality from diseases. However, a major practical obstacle remains that vaccine uptake rates are still very low in affected areas, hindering supply expansion (Toye et al. 2020). A different challenge to modeling the potential expansion of LDF supply has to do with weak accounting for livestock feed availability and use in available economic models (Msangi et al. 2013). Although Bosire and colleagues (2022) partially address this challenge, a key gap persists in how well the current models can represent the potential expansion of livestock production systems in Kenya, as in many developing countries.

Production-demand gaps

Historical trends in production-demand gaps

Recent trends, such as the significant increases in demand discussed earlier and other market changes, coupled perhaps with a less responsive production side, are creating scope for a larger role of other—that is, nondomestic sources of LDF supply in Kenya (FAO 2019).

FIGURE 3.5 Production and total supply in Kenya of livestock-derived foods, 2010–2019 ('000 metric tons)



Source: Authors using FAOSTAT (2022).

Note: Production refers to the quantity of livestock products produced by the country in a calendar year; supply refers to the amount of the commodity available to consumers in a country in a calendar year.

On average, over the past decade, according to published national statistics (FAOSTAT 2022), annual national production of pig meat and small ruminant meat has generally surpassed the aggregate demand for these commodities, but this has not been the case for beef, dairy, poultry meat, or eggs (Figure 3.5).

Model projections of production–demand gaps

The projected levels of consumption of LDF were compared with projected levels of domestic production (Figures 3.6 to 3.8). The production levels were interpolated based on levels reported in the published national statistics for

2015 (FAOSTAT 2022) and projected levels in 2050 obtained from a study on the future of livestock in Kenya by FAO (2019). Our study assumes that the transformation of Kenya's livestock sector depends on several relatively well-understood factors (such as existing policies, megatrends such as population, urbanization) and some less well-understood factors (consumer behavior, government accountability, climate change, technology development). The assumption is that livestock supply chains will satisfy the demand of a growing affluent urban population in Kenya through increased uptake of technology and the nature of food-feed competition.

The FAO (2019) study generated projections of levels of production of milk, beef, and chicken meat under four scenarios intersecting macroeconomic and governance conditions, including (1) a good governance[2] good economy[3] scenario; (2) a good economy bad governance scenario; (3) a good governance bad economy scenario; and (4) a bad governance bad economy scenario. Scenario 1 represents the best context for livestock activities and Scenario 4 the worst. In Figures 3.6 to 3.8, the projected best case scenario maps the highest projected production levels whereas the projected worst case scenario maps the lowest projected levels for milk, beef, and chicken. The projected consumption level comprises two sets of data—that is, calculations using Equation 2 in this study and interpolations based on projected changes in consumption levels between 2015 and 2050 in the study by FAO (2019). Figures 3.6 to 3.8 show the highest and lowest projected consumption levels in different years from the two datasets plotted side by side. Results presented in the three figures indicate that, depending on the prevailing macroeconomic and governance situation, domestic production of milk could be higher than the highest projected level of consumption (thus leaving some surplus for export) or lower than the lowest estimated level of consumption (making the country a net importer of milk) (Figure 3.6).

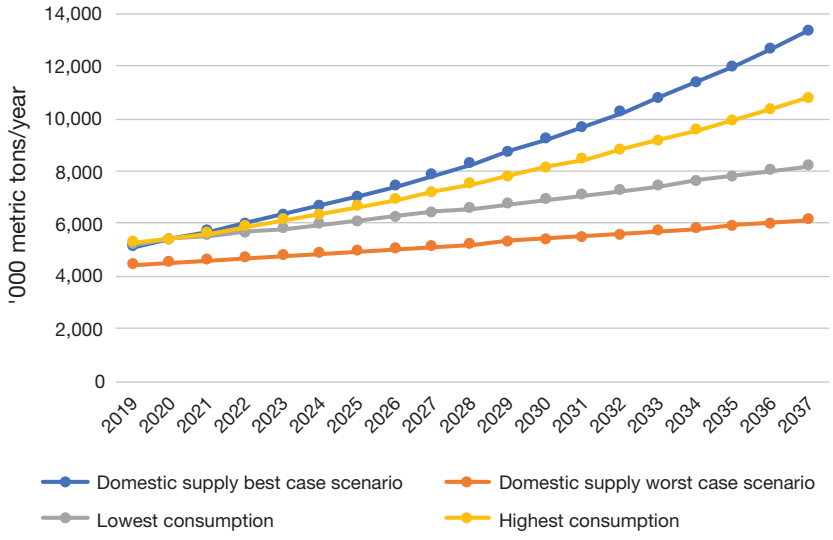
For beef, the highest projected level of domestic production is much greater than the highest projected level of consumption (Figure 3.7), implying that, under the best governance and macroeconomic environment, Kenya can produce beef in excess of domestic needs.

Conversely, under the bad governance and bad economic situation, both the lowest and the highest levels of beef consumption, which are respectively

2 A good governance system is one with high levels of accountability and responsibility and strong stable institutions providing better services.

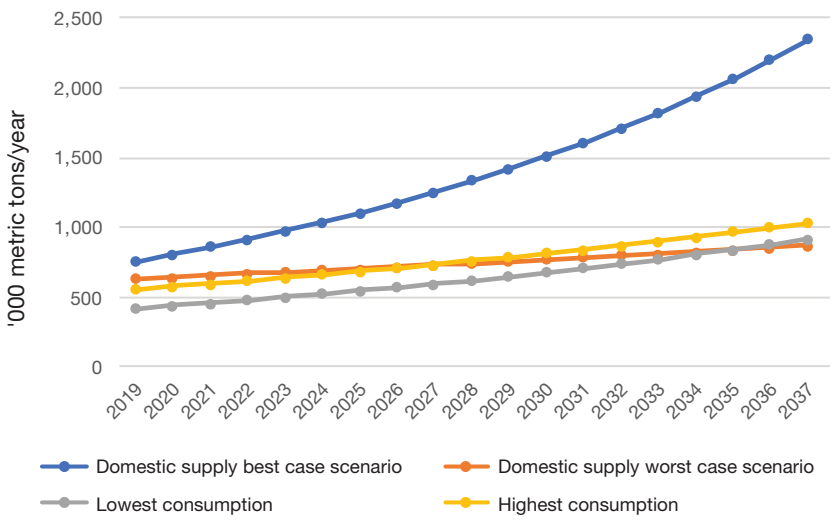
3 A good economy is described as a vibrant, thriving, and diversified economy with effective allocation of resources.

FIGURE 3.6 Projected levels of domestic consumption and production of milk, 2019–2037



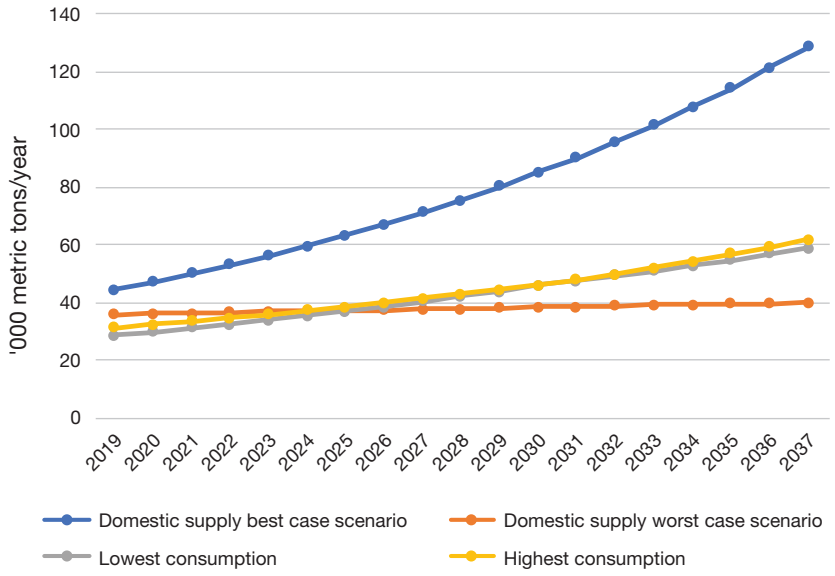
Source: Authors using data from multiple sources.

FIGURE 3.7 Projected levels of domestic consumption and production of beef, 2019–2037



Source: Authors using data from multiple sources.

FIGURE 3.8 Projected levels of domestic consumption and production of chicken meat, 2019–2037



Source: Authors.

less and nearly equal to the lowest projected level of domestic production, are projected to grow progressively and rise above this level between 2029 and 2035, transitioning the country into a net importing position for beef.

In the case of chicken meat, the highest projected level of domestic production is substantially greater than the highest projected level of consumption, indicating some scope for the country to trade surplus chicken meat production (Figure 3.8).

Nevertheless, the projected levels of consumption, which are initially lower than the lowest projected level of domestic production, progressively increase and surpass production in 2025. The gap between demand and production gradually widens, and the country will be required to import chicken meat to close the gap between production and consumption.

Opportunities and constraints

Given plausible outcomes of LDF demand and production dynamics in Kenya, the future holds opportunities and constraints for transforming the livestock sector, including dairy, beef, small ruminants, pigs, and poultry, which we briefly

explore in this section. Our summary is based on a Kenya livestock master plan stakeholder meeting conducted to identify value chain-specific constraints and opportunities related to feeding, animal health, breeding, and markets.[4]

Constraints

FEED AND FODDER AND OTHER NATURAL RESOURCES

Under most future scenarios for Kenya's livestock sector, additional supplies of LDF will be needed to meet the anticipated growth in demand. However, the current sourcing of feed and forage biomass from only a limited set of exploited roughage materials poses a significant challenge to expanding livestock production. Historical overreliance on Napier grass, which is threatened by diseases such as Napier smut and Napier stunting, exacerbates a feed resource problem. In addition, there is diminishing availability of palatable and quality forage species in the ASALs (where much of Kenya's beef production occurs) as a result of overgrazing, invasive plant species, declining soil health, changing climate patterns, competing land use for settlement and crop development, inadequate supply of forage planting materials, and low commercialization of fodder production.

Other challenges arise in the provision of concentrate feeds and in competition with humans using biomass as energy sources. While feed standards have been developed for most livestock species, these do not exist for some livestock categories important to Kenya (Ministry of Agriculture, Livestock, Fisheries, and Cooperatives 2020a).

ANIMAL HEALTH

Another key challenge to livestock production is poor control and management of animal diseases, fueled by, among other things, inadequate capacity among and coordination of bodies and programs responsible for sustained disease surveillance and poor enforcement of existing laws governing disease control and animal movement.

Ticks, tsetse flies, and worms are the major disease transmission agents in animals in Kenya. Cross-border movement of livestock to traditional seasonal grazing grounds and for trade is common, but coordination and collaboration with Kenya's neighbors on disease control across borders is poor. As a result, control of disease transmission poses a significant transboundary challenge, adversely affecting production and productivity in the greater region.

4 The stakeholder meeting was held on July 26–30, 2021, in Naivasha, Kenya.

BREEDING

Animal genetic resources (AnGR), embodied in live populations of animals or conserved genetic materials, are critical genetic resources, forming the biological capital for livestock development and vital to food security and sustainable rural development. In Kenya, efforts to improve livestock productivity have focused on replacing traditional/local breeds with more exotic and mixed breeds. The existing regulatory framework for the importation of germplasm has led to the erosion of indigenous AnGR. As Ruto, Garrod, and Scarpa (2007) note, while such efforts may result in short-term economic gains, the associated loss in genetic resources of the local breed is detrimental in the long run, as these local breeds possess important genetic traits that are well adapted to local conditions. Failures to design appropriate breeding programs for locally adapted breeds and to establish systems needed to facilitate sustainable use remain outstanding challenges.

MARKETS

The key issues facing the aggregation and transportation of livestock and livestock products are insecurity, poor infrastructure, seasonality of production, and inefficient distribution systems. In addition, external trade in livestock and livestock products is affected by limited capacity to meet the sanitary requirements of importing countries, inadequate volumes, and untimely deliveries.

Kenya's livestock products are currently marketed locally and internationally (primarily to neighboring countries) with limited value addition. Value addition is largely constrained by high investment costs, limited demand for value-added products by consumers, an inadequately skilled workforce, limited access to financial and business development services, poor infrastructure, and inadequate value addition technology. In addition, there is insufficient capacity for entrepreneurship among primary producers in the livestock industry, resulting in low margins for their enterprises.

Issues that affect the safety and quality of livestock and livestock products include inadequate capacity to undertake better animal husbandry practices, hygienic practices, or manufacturing practices. In addition, there is inadequate capacity to verify food quality and safety and enforce food safety regulations.

Marketing infrastructure is in a poor state or underdeveloped, and hence not favorable for efficient livestock marketing. Further, marketing information systems are poorly developed, which limits access and use.

Opportunities

The livestock sector offers opportunities in many areas, including animal-source food availability and nutrient supply, incomes and employment, and foreign exchange earnings.

ANIMAL-SOURCE FOOD AVAILABILITY AND NUTRIENT SUPPLY

There is increasing evidence that the demand for LDF will increase substantially in Africa and Asia in the coming decades. For example, Enahoro and colleagues (2018) show that demand for LDF will grow substantially by the year 2050 in eight countries—including Kenya—that are currently facing food security and nutrient supply challenges. An assessment of food demand and supply projections for the global agricultural system shows that the growth in demand for LDF will persist in Burkina Faso, Ethiopia, India, Kenya, Nicaragua, Tanzania, Uganda, and Viet Nam under a range of plausible scenarios for global economic growth and climate change. For all eight countries, the analysis shows higher total consumption of LDF in 2050 relative to 2010, reflecting expected growth in population but also some growth in income and thus in per person LDF consumption. These projections suggest strong potential for improving the livelihoods and nutrition of the rural poor through livestock sector-based transformation strategies. The challenge, therefore, remains in effectively transitioning the domestic livestock sector to enable it to meet this growing demand for livestock products.

INCOME AND EMPLOYMENT

Livestock production could be a significant source of quality employment if the sector is effectively modernized. Generally, there are not enough employment opportunities in Kenya, especially in rural areas, resulting in both underemployment and unemployment. One of the possible solutions is to grow value chains around livestock. A simulation of the employment potential of the livestock sector in two countries (Burkina Faso and Tanzania) in Africa by Frija and Enahoro (2018) found that well-targeted investments could yield annual growth in employment of 10 percent a year, with especially positive returns for women. The rural-based nature of livestock activities makes livestock-keeping a suitable enterprise to improve household incomes and contribute to employment creation.

The use of digital tools to build out value chains and improve employment via extension agents, artificial insemination agents, and veterinarians is also gaining traction in Kenya. One of the known digital tools for livestock development is iCow, an e-extension tool offered by GreenDreams Tech for farmers

in Kenya. iCow serves to provide technical information and link actors across the value chain. iCow also offers a virtual marketplace (iCow Soko), where subscribers buy inputs and sell livestock and livestock products. Moreover, there is a function that enables livestock-keepers to locate veterinary and artificial insemination officers in their area. Users can also contact a resident veterinarian (Dr. iCow) through an SMS, to which Dr. iCow responds with a direct telephone call (Daum et al. 2022).

FOREIGN EXCHANGE EARNINGS

Livestock could become a major foreign exchange earner for Kenya. The livestock resource base is estimated at 17.5 million cattle, 27.7 million goats, and 17.1 million sheep and camels, making Kenya the country with the third-largest endowment of livestock in Africa, behind only Ethiopia and Botswana (Kenya Market Trust 2019b). According to a study by Kenya Markets Trust (2019a), the livestock sector could add 10 percent to the country's GDP if it reaches its latent potential. There is huge potential for meat exports from the country. For example, Namibia, a smaller country, has recently accessed US markets after making a substantial investment in the livestock sector over the past 20 years. Kenya's meat export market once thrived in the euro zone, which has been the largest importer of Kenyan meat. According to Kenya Market Trust (2019a), approximately 400,000 metric tons of processed beef were exported annually to the euro zone. However, in order to regain its former prominence in the meat export market, Kenya must make strategic investments in livestock traceability, overhaul its livestock finishing and fattening enterprises, and foster a conducive market environment. This approach, as suggested by Horizon East Africa (2021), has potential to restore Kenya's previous position in the meat export industry.

Contribution of livestock systems to income, employment, gender equality, and child nutrition

Livestock is an important contributor to the Kenyan economy and the livelihoods of people. At the farm level in Kenya, livestock production generates income through the sale of LDF, as well as the sale of products such as wool, hides, and skins. Besides income generation, livestock is used to accumulate and store wealth and, in pastoral communities, is often the only major asset (Abay and Jensen 2020). Small and large animals constitute a "walking savings account" used to purchase agricultural inputs, to invest in other income-generating activities, or to pay for expenses—planned (education and weddings) and unplanned (medical bills or funeral costs) (Baltenweck et al. 2020).

Livestock production contributes to economic development at the household and community level through this income and saving function. In ASALs, livestock contributes approximately 90 percent of the livelihood of households and accounts for nearly 95 percent of family income (Ministry of Agriculture, Livestock and Rural Development, 2008).

In terms of employment, while there are no recent detailed estimates of this in the livestock sector in Kenya, the economic benefits of the livestock sector are witnessed beyond the farm. This includes jobs for individuals engaged in the many associated industries throughout the livestock value chain. These associated industries relate to agricultural inputs and services such as feed, animal health and breeding services, equipment and machinery, and banks and insurance companies that service farmers. Focusing on the dairy sector, Staal, Nin-Pratt, and Jabbar (2008) record the employment of 77 persons per 1,000 liters of milk produced (farmers, casuals, and long-term laborers) as well as 13 and 18 persons per 1,000 liters of milk handled by the formal and informal sector, respectively, considering both the direct and the indirect effects. Other figures show that the Kenyan dairy sector provides jobs for about 3 million people, corresponding to 15 percent of the labor force (Baltenweck et al. 2020).

Livestock ownership is an essential means of enhancing gender equity in livestock systems and contributing to gender equality (Galie et al. 2019). Gender inequality is estimated to be responsible for a loss of 11 percent of Africa's total wealth, and livestock plays a pivotal role in rural women's lives (Woden and de la Brière 2018). Given the gender norms prevailing in many low- and middle-income countries, livestock is one of the few assets women can own and is a key tool for women's empowerment. Livestock provides a mechanism for women to improve their income, access information, leverage social networks, and provide nutritious food to their families. Livestock is also a key asset that women can own and transfer, unlike land and other physical assets, which might need a title deed (Baltenweck et al. 2020).

Livestock and livestock products are the key entry point to enhance the nutrition of the poor, particularly during the first 1,000 days of life, given that livestock provides nutrient-rich foods, such as milk or meat, shown to improve growth and cognitive functioning, respectively (Grace et al. 2018). LDF are energy-dense and excellent sources of protein and minerals. One of the largest randomized controlled trials conducted to date showed that toddlers in rural areas of Kenya whose diets had been supplemented with cow's milk grew taller than children consuming the usual diet or a diet supplemented with beef (Neumann 2013). Adequate quantity and quality of nutrients is important for the period from conception through pregnancy and up to two years of age

for individuals to not only survive but thrive throughout life (McDonald and Thorne-Lyman 2017).

Policy considerations

Transforming the livestock system in Kenya to meet growing demand for animal-source foods will require investments in priority areas, policies to support investments, and institutions to support implementation. Two main policy documents have recently been completed. The National Assembly has adopted a national livestock policy as Sessional Paper 3 of 2020 on the Livestock Policy (Ministry of Agriculture, Livestock, Fisheries, and Cooperatives 2020a). Similarly, the National Assembly adopted a veterinary policy as Sessional Paper 2 of 2020 (Ministry of Agriculture, Livestock, Fisheries, and Cooperatives 2020b). These broad policy documents are comprehensive and consistent with the Constitution of Kenya and government strategies, including Vision 2030 and its medium-term plans, the Big Four Agenda, and sectorwide development strategies.

As acknowledged in the Livestock Policy, several policy issues are worth considering. Here we highlight a few that stand out and need immediate attention based on the constraints and opportunities identified in this chapter.

- While **feed standards** exist for most livestock species, the standardization of feeds for some categories of livestock is not complete (Ministry of Agriculture, Livestock, Fisheries, and Cooperatives 2020a). In addition, feed ingredients are not fully standardized, especially new feed innovations that arise from new research. It is important to prepare the necessary regulations on feed quality and market regulations for some livestock categories.
- To improve **animal health**, the government needs to strengthen the veterinary laboratory system to provide technical support for disease surveillance, diagnosis, and quality control. The State Department of Livestock and the Zoonotic Disease Unit under the Ministry of Health need to engage jointly in controlling zoonotic diseases within the "One Health" concept.[5] It is also important to establish mechanisms for public and private partnership for the control of cross-county and transboundary infectious diseases, and to coordinate with the Kenya Wildlife Service for the control of diseases at the livestock–wildlife interface.

5 One Health is an approach that recognizes that the health of people is closely connected to the health of animals and our shared environment (www.cdc.gov/onehealth/basics/index.html).

- To facilitate effective **breed improvement**, a uniform national system for animal identification, performance recording, and corresponding genetic evaluation is needed, but is currently missing in Kenya. Additionally, the country has very limited initiatives for in situ and ex situ conservation of AnGR.
- Unstructured **marketing** systems have a negative impact on the industry, leading to its underperformance. Producers and marketing groups need to strengthen their capacities in producing, processing, and storing livestock products. As the Livestock Policy states, it is important to facilitate the dissemination of livestock marketing information to all value chain actors and to establish mechanisms for strengthening and harmonizing market information systems and developing linkages with local and international markets.

The Livestock Policy covers a wide range of policy issues and outlines many interventions, practices, processes, guidelines, and proposals to address the challenges in the sector. However, no clear implementation plan exists, including to prioritize interventions and the resources needed to realize them. An implementation plan and a prioritization exercise should narrow down to the four main challenges highlighted in this chapter (feed and forage, animal health, breeding, and marketing) and be tailored to specific livestock species. The design of such an implementation plan and the priority-setting exercise would usually precede resource allocation and planning decisions.

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