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MEAT, MILK AND MORE:

Policy innovations to shepherd inclusive and sustainable livestock systems in Africa

A Malabo Montpellier Panel Report 2020

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Policy innovations to shepherd inclusive and sustainable livestock systems in Africa

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Foreword

This report was written as the COVID-19 pandemic unfolded across the globe (January–June 2020) and the longer-term impacts on African economic growth, agricultural productivity, food supply chains, and food consumption patterns remain yet unknown. Transport restrictions and quarantine measures are likely to restrict farmers' access to input and output markets, curbing productive capacities and reducing access to markets and services. The impact on Africa's livestock sector will be significant, with reduced access to animal feed, veterinary services and diminished capacity of slaughterhouses due to logistical constraints and labor shortages. Moreover, food demand responds strongly to changing incomes in poorer countries, meaning loss of income-earning opportunities will cause consumption to contract. At the same time, livestock affords important coping strategies, such as the sale of live animals to maintain cashflow or continued provision of milk and eggs, even if the coming crop season were to fail. Regardless, as governments respond to the immediate and longer-term consequences of the pandemic, aspects of animal and human health, particularly in the context of increasing urbanization, will gain prominence along with the opportunity to transform the African livestock sector for the better and for good. Over the past decade, Africa's food system has begun to transform, sparked by prolonged economic growth, a growing population, urbanization, and shifting dietary preferences and habits. An increased demand for more animal-sourced foods, such as dairy, eggs, and (processed) meat, has been driven by a growing middle class across the continent. Although most African countries are still heavily import-dependent, domestic livestock sectors have been growing steadily to meet demand. Moreover, Africa's livestock sector forms the basis of the livelihoods of millions of people in pastoralist, mixed crop-livestock farming, and commercial systems, with the potential to generate much-needed employment opportunities—especially for women and young people—along the value chain, ranging from research and development to production, product processing, and product transformation as well as marketing and trade. However, livestock policies must be designed against the backdrop of climatic changes and growing resource scarcities and animal health and human safety concerns, as well as a better understanding of how livestock-based products can both help address malnutrition and in fact contribute to a range of noncommunicable diseases.

This report— **Meat, milk and more: policy innovations to shepherd inclusive and sustainable livestock systems in Africa**—provides options for sustainably promoting growth in the livestock sector, drawing from what four African countries—Ethiopia, Mali, South Africa, and Uganda—have done successfully in terms of institutional and policy innovation as well as programmatic interventions. The report highlights several key recommendations, including the need for livestock sector policies and strategies to be developed jointly across ministries and supported through innovative financial mechanisms designed to specifically meet the needs of the different livestock systems, the seasonality of production, as well as the environment. It is also critical to have in place systems for technical and institutional innovations in the sector and regulations to spur inter-regional and international trade, while guaranteeing the health and safety of both animals, producers and consumers. To fully harness the opportunities of the sector, support must be given to women, young entrepreneurs, and small and medium-sized enterprises.

The Malabo Montpellier Panel convenes 16 leading experts in agriculture, ecology, nutrition, and food security to facilitate policy choices by African governments to accelerate progress toward food security and improved nutrition. The Panel identifies areas of progress and positive change across the continent and assesses what successful countries have done differently. It identifies the most important institutional and policy innovations and program interventions that can be replicated and scaled by other countries. The related Malabo Montpellier Forum provides a platform to promote policy innovation by using the evidence produced by the Panel to facilitate dialogue among high-level decision-makers on African agriculture, nutrition, and food security.

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THE MALABO MONTPELLIER PANEL

The core mission of the Malabo Montpellier Panel, a group of leading African and international experts from the fields of agriculture, ecology, food security, nutrition, public policy and global development, is to support evidence-based dialogue among policy makers at the highest level. The Panel's reports seek to inform and guide policy choices to accelerate progress toward the ambitious goals of the African Union Commission's Agenda 2063, the Malabo Declaration and the global development agenda. The Panel works with African governments and civil society organizations to provide support and evidence-based research that facilitate the identification and implementation of policies that enhance agriculture, food security and nutrition.

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1. Introduction

Robust and steady economic growth across Africa over the past two decades—coupled with population growth, rising incomes, a growing middle class, and urbanization—provides significant opportunities for African countries to transform their food systems. Meat and dairy are considered high-value food products and their consumption is well correlated with income levels. In this context, shifting dietary habits mean a growing demand for animal-sourced foods. As of 2013, the average African consumed 19 kg of meat and 44 kg of milk—this is projected to increase to 26 kg of meat and 64 kg of milk in 2050.[1,2,3] These projections are significant, given that Africa's population is expected to reach 2.2 billion by 2050.[4] It thus appears to be reason for optimism that the livestock sector in some African countries is the fastest growing agricultural subsector, contributing not only to food and nutrition security but also to economic growth and providing important foreign exchange reserves through increased trade within and between African countries, as well as with other regions, such as the Middle East.

However, these developments are occurring against a backdrop of demographic pressures and growing scarcity of land and water.[5] Moreover, much of Africa's livestock production is highly dependent on rainfed fodder (pasture). As a result, producers experience seasonal fluctuations. In the absence of alternatives or incentives, grazing land is turned into arable land, even where marginal, and the remaining pastures are often of poor quality and severely degraded. Yet the quality and availability of feed determines the well-being, yield, maintenance, growth, and reproduction of livestock. In addition, adhering to basic biosecurity standards for human and animal health continues to present a challenge for many small livestock keepers and pastoralists, and is an obstacle to market participation and trade. While much progress is being made across the African continent in improving feed for livestock, the availability of reasonably priced, high-quality feed is a major challenge to raising livestock productivity. Given these constraints and under current projections, African producers will be unable to satisfy the growing demand for livestock products. In 2030 and 2050, between one-tenth and one-fifth of the beef, pork, poultry, and milk consumed in Africa will come from outside Africa.[6]

Livestock production occurs across a wide range of heterogeneous production systems: pastoral systems and mixed crop-livestock systems, as well as larger, commercial systems, each with their distinct characteristics, challenges, and opportunities. Small producers and pastoralists rear livestock largely for subsistence and are rarely in a position to sell any products for commercial gain. As such, they face limited options to boost productivity and improve their livelihoods. At the same time, livestock supports diverse functions in the well-being of livestock keepers, including health and nutrition, employment, income, asset store and generation, draught power, transport, soil nutrient production, social security, and insurance. As a result, livestock value chains are complex, comprising compound networks, relationships, and transactions. Importantly, livestock ownership and management and new employment opportunities in livestock value chains could contribute to greater economic empowerment of young people and women.

If designed in a way that factors in important environmental, health, and socioeconomic impacts, risks, and challenges, government strategies and policies to sustainably strengthen Africa's livestock sector can provide a major opportunity to boost economic growth, improve livelihoods and advance progress toward broader national, continental, and global development targets. As more and more African countries move toward growing their livestock sectors, important lessons can be learned from successful government actions taken across the continent that can be replicated and scaled up.

The first part of the report begins with an overview of the state of Africa's livestock sector, looking at trends in the consumption and production of key livestock products—meat, milk, and eggs—in each region. This is followed by a presentation of existing policy agendas at the continental and at the global that can function as frameworks within which African countries can develop or strengthen their livestock sectoral policies. Next, the report discusses the opportunities of a growing livestock sector as well as the risks, including those related to animal and human health, environmental degradation, and conflict between farmers and pastoralists. The next chapter reviews the livestock value chain and highlights employment as well as growth opportunities from the production to the consumption stage. Finally, the report describes what is needed to create an enabling environment for the livestock sector that benefits Africa's rural communities and smallholder farmers, such as regulation, access to finance, technology adoption and better data.

The second part of the report highlights the experiences of four African countries that have been at the forefront of sustainably expanding and growing their livestock sectors to benefit local communities through institutional innovation and innovative policymaking—Ethiopia, Mali, South Africa, and Uganda. The report closes by drawing some key lessons and offering recommendations for action by African governments, in cooperation with the private sector, research institutions, and development partners.

2. Action Agenda

Important lessons can be learned from the livestock sector policies and strategies in several African countries. By adapting these lessons to countries' specific contexts and by bringing them to scale, African governments will accelerate their progress toward the targets set under the African Union Agenda 2063 and the Sustainable Development Goals. Drawing on the findings of the four case studies presented in this report, the Malabo Montpellier Panel makes seven recommendations for action by governments and the private sector.

Creating an enabling environment

1 Overarching policy frameworks: Given the duality of livestock production in many countries, with large market-oriented producers operating alongside small and subsistence producers, and formal markets operating alongside informal markets, an overarching policy framework is needed to create an inclusive, holistic, innovative, productive, and profitable livestock sector, that is also environmentally sustainable and promotes further involvement of women and youth. Dedicated departments for livestock can ensure that the sector is funded better, and that there is clear oversight of livestock activities, while cross-departmental committees composed of representatives from livestock, agriculture, environment, health and finance ministries would ensure that cross-cutting themes receive the attention and coordination they require.

2 Regulation: A nimble but clear and health conscious regulatory environment will be critical to ensure that a flourishing livestock sector maintains high safety, quality, and welfare standards, produces nutritious food, preserves environmental sustainability, and protects producers' and consumers' health. Domestic regulations for input and output markets need to be harmonized and simplified, while strengthened services are needed to support such regulations. Property rights of herders need to be recognized.

3 Private sector-led development: A viable private sector, including farmer and herder organizations, will facilitate increased investments, and drive growth, job creation, and entrepreneurship in the livestock sector. Dedicated investments in infrastructure—such as provision of electricity, cooling facilities, and transport—could significantly reduce market transaction costs and improve the efficiency of value chains through innovations as well as the safety and production of animal-sourced products, and make the commercialization of livestock production more feasible. The feed sector needs to expand based on sound investment for stable supplies and innovation in pasture grassland quality.

4 Finance and livestock assets: Despite its significant contribution to agricultural and national gross domestic product (GDP), the livestock sector in most African countries remains heavily underfunded. Financing common goods such as animal health, animal improvement, and research creates a strong foundation upon which both market-oriented and subsistence livestock sectors can prosper. Financial services must be (re-)designed to cater for the unique circumstances of livestock producers, such as the need for different loan sizes and duration of borrowing, alternative forms of collateral, seasonality of production, and other inherent risks. Livestock insurance also provides a vital source of financial support, particularly during and following emergencies. Livestock distribution programs to smallholders can be considered at greater scale when combined with services.

5 Trade: There is great potential to increase the intra-African trade of livestock products and live animals through strong partnerships that improve trade flows across the continent. Given the size of its livestock population, Africa could also own a significant market share of the global livestock trade by ensuring that livestock products meet international quality and food safety and animal health standards. One way is for governments and the private sector to develop programs aimed at complying with stringent food safety standards and integrate them into international marketing channels such as through contract farming, as well as applying a price bonus for meeting quality and safety standards.

6 **Data and research:** Availability and access to comprehensive and good quality information and data on all aspects of the livestock sector, including breeding, is critical for facts-based policy design. Digitalization can go a long way toward focussed breeding programs, combining digital monitoring with insemination services. There is an urgent need for greater financial and technical support to national and commercial livestock research programs, investments in data collection, data collection systems, and analytical capacities across the continent to ensure that policies and regulations are designed on the soundest evidence.

7 **Conflict:** Conflicts between pastoralists and crop farmers can be reduced by focusing on a holistic approach to supporting all stakeholders' livelihoods, including a robust network of support services adapted to the mobile livelihoods of pastoralists. The design and enforcement of inclusive legislation that ensures access to land and natural resources to both pastoralists and farmers is critical and can be informed through enhanced community-level dialogue.

Sectoral interventions

8 **Ruminants:** As countries strive to meet the increasing demand for meat, milk and dairy products, productivity needs to be sustainably increased factoring in animal and human health aspects while using new technologies and breeding instead of growing herd sizes. Moreover, as ruminants are often kept for non-productive functions – for economic assets, nutrient value and risk management – supporting the transition of livestock keepers to producers requires context-specific strategies and significant investments in infrastructure such as feedlots and abattoirs.

9 **Poultry:** Employment and entrepreneurship opportunities in the poultry sub-sector are particularly attractive for young people and women due to the relatively small capital investment and land ownership needs and should be supported through targeted government programs. Given the duality of poultry production, government strategies also ought to support and regulate both small-scale breeders as well as larger commercial producers. Moreover, the excessive use of antimicrobials in feeding and treating and preventing diseases needs to be better regulated.

10 **Dairy:** Africa's dairy sector offers a multitude of opportunities for employment generation and entrepreneurship along its entire value chain. Given that the dairy sector is capital intensive, significant upfront and continuing investments are necessary by both public and private sector actors. There is the opportunity for some countries, particularly in East Africa, to specialize in dairy production and to become key trade partners within Africa, particularly under the African Continental Free Trade Area.

11 **Pork:** As demand for pork steadily increases across the continent and the focus is on increasing productivity and promoting value addition, interventions targeting the adoption of improved technologies and better management of feed are needed. Moreover, given that the subsector is particularly vulnerable to outbreaks of new infections and diseases close attention needs to be paid to the compliance with animal health and human safety standards.

What works at the country level?

The experiences of four African countries that have been at the forefront of strengthening their livestock sectors through dedicated and effective government action offer a wealth of lessons. Their successful policies and interventions, if replicated at scale, could enable African countries to make faster progress in the fight against poverty and hunger. The policy and institutional innovations as well as programmatic interventions by Ethiopia, Mali, South Africa, and Uganda are discussed in depth in section 8. The table below offers a summary of some of the key actions:

Ethiopia	The government of Ethiopia has carefully and systematically adapted institutions and policies for pastoralist and non-pastoralist producers to ensure that the livestock sector can contribute toward achieving its commitments on poverty alleviation, food security, and improved nutrition. A multipronged approach to simultaneously building capacity in animal health, research, and marketing has attracted significant investment both from the private sector and development partners, further ensuring that the sector thrives.
Mali	Mali stands out for a focus on improving animal health and feed, and promoting an increase in the productivity of local cows through breeding. The government has also invested in infrastructure development and equipment to commercialize the livestock sector and facilitate the export of live animals in the region.
South Africa	Success in South Africa's livestock sector is underpinned by a vibrant private sector and national efforts to include and commercialize production from small and emerging farmers. A relatively well-established animal health system, in conjunction with better marketing and access to finance, enable farmers to prosper from livestock production.
Uganda	Uganda stands out for its commitment to strengthening its dairy sector through dedicated policies, including the Dairy Master Plan to liberalize the dairy industry and to restructure and privatize the state-owned dairy processing company Dairy Corporation, which have contributed to the transformation of the dairy industry. Uganda's programmatic interventions are directed toward enhancing the livestock sector with a primary focus on the dairy value chain and maintaining self-sufficiency in milk production.

3. An overview of livestock in Africa

Livestock numbers and distribution

Africa is a livestock-rich continent representing about one-third of the world's livestock population, with significant regional variations in the share of the different species of animals kept.[7] Across the continent, livestock is considered as one of the most valuable agricultural assets for the rural and urban poor, especially for women and pastoralists, providing an important source of income and insurance against socioeconomic and climatic shocks, offering employment opportunities, and contributing significantly to food security and improved nutrition outcomes.[8,9] The African livestock sector contributes between 30 and 80 percent to countries' agricultural GDP,[10] ranging from almost 85 percent in Somalia to 82 percent in Djibouti to 47 percent in Ethiopia,[11] while East Africa's livestock sector generates more than US$1 billion annually through the export of live animals and meat to the Middle East and North Africa.[12]

Livestock keepers in Africa primarily depend on cattle, sheep, goats, donkeys, camels, and poultry, for livestock production. In addition, there is a growing trend of pig farming across Africa south of the Sahara (SSA),[13] with particularly high production in Burkina Faso, Ghana, Nigeria, Togo, and Uganda. Poultry farming and consumption, particularly chicken, play a key role in many African countries. For example, South Africa has the largest chicken population and is the leading producer of poultry in Africa, with about 2 million mt in 2018, while both Senegal and Tunisia are self-sufficient in terms of poultry production.[14,15,16]

As indicated in figure 1, Africa's total livestock population in 2018 was estimated at 2 billion poultry birds (1.9 billion chickens, 26 million guinea fowl, 27 million turkeys, 22 million ducks, and 11.5 million pigeons), 438 million goats, 384 million sheep, just under 356 million cattle, 40.5 million pigs, almost 31 million camels, and 38 million equines (including 30 million donkeys, 6.5 million horses, and 885,000 mules).[17]

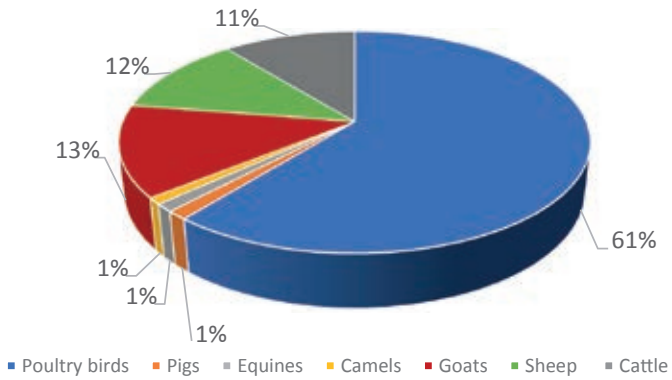

Figure 1. 2018 Livestock population in Africa.

Source: FAOSTAT 2019.

Eastern and western Africa have the largest goat populations, while cattle dominate East Africa's livestock sector.*[18] A recent study found that across the continent, cattle densities are highest in the East African highlands, particularly in Ethiopia, as well as in Nigeria.[19,20,†] As figure 2 indicates, eastern Africa had the highest concentration of livestock per agricultural land area in 2017, with 0.37 livestock units‡ per hectare (LSU/ha). In comparison, northern Africa had 0.31 LSU/ha, western Africa 0.28 LSU/ha, and central Africa 0.25 LSU/ha, while in southern Africa, the density was only slightly above 0.10 LSU/ha.[21] Figure 2 also shows that, with the exception of southern Africa, livestock densities steadily increased in all regions between 1990 and 2017.[22]

* FAO classifications: eastern Africa (equivalent to East Africa and Horn of Africa), western Africa, northern Africa, southern Africa and central Africa.

† Ethiopia: 56 million cattle, 29 million sheep, 29 million goats, and 57 million poultry. Nigeria: 34.5 million goats, 22 million sheep, and 14 million cattle.

‡ Livestock units per agricultural land area is an indicator of total livestock density, calculated using livestock units (LSU) that facilitate aggregating information for different livestock types such as cattle, buffalo, sheep, goats, and equines. One livestock unit (LSU) is the grazing equivalent of one adult dairy cow producing 3,000 kg of milk annually (Eurostat 2013).

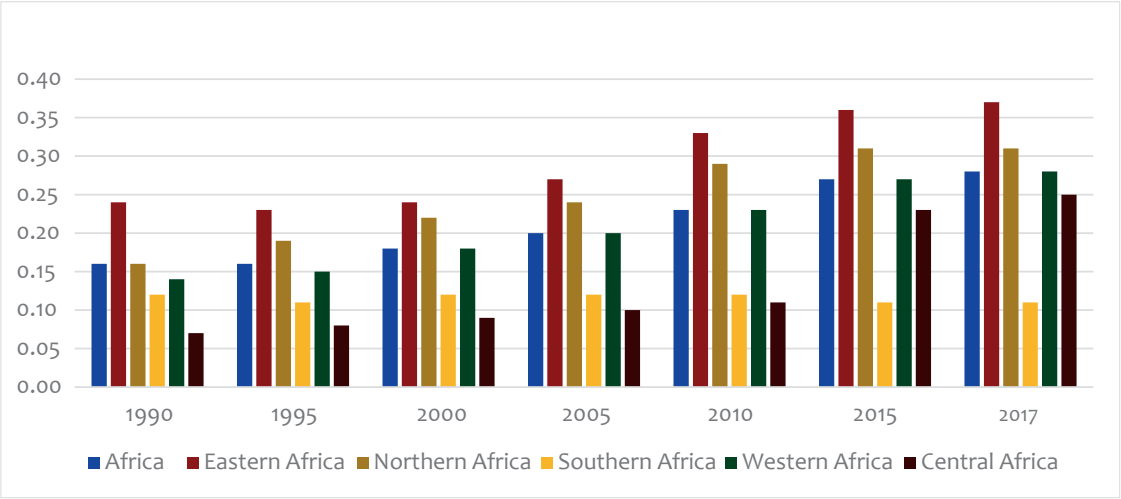

Figure 2: Livestock per agricultural land area (LSU/ha) for major livestock types in Africa's sub-regions.
Note: Major livestock include cattle, buffalo, sheep, goats, and equines. Between 1990 and 2017, livestock densities have substantially increased in all subregions: central Africa (+257 percent), western Africa (+100 percent), northern Africa (+94 percent), and eastern Africa (+54 percent) with the exception of southern Africa (-8 percent).
Source: FAOSTAT (2019).

Women and livestock

There are approximately 249 million women livestock keepers in Africa for whom livestock represents a major source of income and an opportunity for wealth accumulation.[23] It is the only non-land asset that women in most countries can own relatively easily, compared to purchasing land or managing other physical or financial assets. Women can acquire livestock through inheritance, before or during marriage, farmer associations, and livestock markets, and can sell them to meet emergency and family health needs.[24] As such, ownership of livestock is widely recognized as an important aspect of women's economic empowerment. It contributes to a reduction in gender disparities in ownership of assets and resources and has positive effects on household food security, child nutrition, and education.[25]

Several studies have shown that women who own livestock have greater bargaining power and improved decision-making authority, and benefit from overall empowerment within their households.[26,27,28] Ownership of livestock also means that women are more likely to be taking important decisions on how livestock-derived income from the sale of milk, eggs, cattle, and sheep and goats is spent, thereby increasing the probability that households, especially children, consume animal-sourced foods (milk, meat, and eggs) that are rich in proteins and other micronutrients.[29,30,31] Evidence shows that where women own livestock, the number of months that households have sufficient and nutritious food increases and the frequency of meat consumption is significantly higher than in households where women do not own livestock.[32] For instance, in Tanzania, women control about half of the income from the sale of chickens and milk even when they do not own the livestock,[33] whereas a study of pastoral markets in north-eastern Somalia shows that women play a key role in the commoditization of pastoral camel milk.[34] In eastern Ethiopia, women's participation in the sale of milk products contributes more than 80 percent of the income needed to satisfy energy requirements among pastoral households. By managing livestock products, women can participate in specific livestock value chains—local dairy production and marketing, or other segments of value chains—informal trading and processing, or as service providers.

Organizations such as Heifer International, FARM-Africa, and Land O'Lakes have supplied livestock to women free of charge for several years in several African countries. For instance, in 1998, Heifer International developed a "Women in Livestock Development" initiative, providing livestock such as cows, goats, water buffalo, and poultry to women to support themselves and their households.[35] Although few evaluations have assessed the impacts of such initiatives, anecdotal evidence shows positive effects on women. Livestock research, development programs, and policies can play an important role in reducing gender disparities, particularly in asset ownership, market participation, and income management. Applying gender-transformative approaches and gender integration in a systematic way in livestock research and development programs can thus result in more equitable development outcomes.[36] Overall, closing the livestock gender gap will require programs targeting an increase in women's ownership of livestock to enhance their income-generating and decision-making abilities, improving their access to finance, and facilitating greater participation in livestock value chains, which could ultimately help them move out of poverty.

Livestock production systems

Livestock production occurs across a wide range of heterogeneous production systems: pastoral systems, mixed crop-livestock systems, and commercial livestock systems, each with their distinct characteristics, challenges, and opportunities.

Pastoral systems

Pastoralism is one of the most viable livelihood options in Africa's drylands,[37] and is the primary livelihood of an estimated 268 million people in 36 African countries.[38] Pastoralism is an extensive livestock production system, characterized by mobility and shared use of natural resources, both of which are key strategies to manage environmental variability and shocks.[39] Approximately 43 percent of Africa's land mass is conducive for pastoralism across different regions, extending from the Sahelian West to the rangelands of eastern Africa and the Horn and to southern Africa.[40] The highest concentration of pastoralists within SSA can be found in Sudan and Somalia with 7 million pastoralists each, while Ethiopia hosts 4 million pastoralists.[41] Pastoralist systems mainly comprise camels, cattle, sheep, and goats that can easily digest forage. This livelihood option is critical for food security and is a key source of national GDP. It is estimated that pastoralism contributes between 10 and 44 percent of GDP in African countries.[42] For instance, pastoralism produces 90 percent of the meat consumed in East Africa: in Kenya, 60 to 65 percent of total meat supply originates from pastoralist systems, including imports from Ethiopia, Somalia, Tanzania, and Uganda.[43] Pastoralism also provides 80 percent of the total annual milk supply in Ethiopia.[44] In West Africa, it contributes about 60 percent of the meat and milk products consumed.[45] Some studies suggest that the contribution of pastoral livestock production is underrepresented in national and agricultural GDP estimates, rarely accounting for the other economic benefits derived from livestock, such as supplying power for farming and transport, and serving as a form of insurance for owners.[46] A study by the Intergovernmental Authority on Development's (IGAD) Center for Pastoral Areas and Livestock Development (ICPALD) suggests that the value added to national GDP by pastoral livestock in 2009 was 19 to 150 percent greater (varying by country) than the official estimates when the other economic benefits are factored in.[47]

There has been a transition toward intensified agro-pastoralist production systems, for instance in East Africa's drylands.[48] The transformation from pastoralism to a livestock-based agro-pastoral system, with enclosures for land rehabilitation, fodder production, and land and livestock management, may serve as a sustainable and productive development and transformation. In western Uganda, for example, the Nyabushozi area gradually transformed from pastoralism to a livestock-based agro-pastoral system between the 1960s and 1990s.[49] The consequence of this has been more investment in the processing and value addition of dairy products. The area has the biggest concentration of dairy processing plants per capita in Uganda today.[50] This highlights the fact that organizing farmers into associations or groups encourages investment in the sector.

Mixed crop-livestock systems

Mixed crop-livestock systems, in which crops and livestock are produced on the same land, are central to smallholder production in most of SSA.[51] This largely reflects food security and cultural considerations. Mixed systems are primarily rainfed, and predominantly subsistence-oriented and crop-dominated.[52,53,54] In the IGAD region,[§] mixed systems account for nearly 40 percent of all livestock farming, producing 35 percent of total beef, 30 percent of goat meat, 29 percent of mutton, and 16 percent of cattle milk outputs.[55] Similarly, in the Sahel and West Africa, mixed crop-livestock systems contribute 40 percent of total pork production, 35 percent of beef, 35 percent of poultry, 20 percent of goat and sheep meat, 15 percent of milk, and 10 percent of egg production.[56] Cattle account for almost three-quarters of the entire stock of mixed farming systems in eastern Africa.[57]

Livestock in mixed crop-livestock systems also contribute to cropping. For instance, 23 percent of nitrogen for crop production in crop-livestock systems comes from manure, and about 15 percent of farms in Southern Africa and 81 percent in Northern Africa rely on traction for plowing.[58] In addition, about 7 million oxen are the primary source of power for tilling in the Ethiopian highlands.[59] These systems also improve land productivity as well as efficiency of water use.[60] However, a key challenge to increased crop-livestock integration is the complexity of efficiently managing and operating mixed systems.[61] Nevertheless, integrating crop and livestock activities is a good way for smallholders to increase livestock and agricultural productivity while improving resource use efficiency, enhancing household incomes, and reducing vulnerability to food insecurity and other shocks and stresses.[62]

Commercial livestock production systems

Unlike pastoralist or mixed livestock-crop systems, in which livestock hold sociocultural values too, commercial systems produce livestock purely for income-generating purposes.[63] Commercial livestock production is less labor-intensive and focuses on streamlining the value chain for maximum returns. This is usually done by concentrating the availability of inputs such as land, feed and water. Although the majority of commercial systems produce ruminants on ranches across most of SSA—beef and dairy cattle, sheep, and goats—commercial poultry farms are increasing in number on the continent. Overall, the number of commercial livestock enterprises is still small, but it is growing. Much of the increasing demand for livestock products has been met with an expansion of commercial poultry production. This is true especially for southern Africa, where most of the poultry originates in one of three vertically integrated companies, with activities ranging from breeding and feed production to managing large-scale abattoirs.[64] In Zimbabwe, large-scale producers provided 2,600–3,000 mt of chicken per month to the formal market,[65] in contrast to small-scale producers who sold around 6,000 mt of chicken per month, often through the informal market or traders.[66] Nigeria's poultry sector is also highly commercialized, producing 21 percent of the total chicken output in the country.[67]

§ IGAD comprises Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan, and Uganda.

Livestock products by type

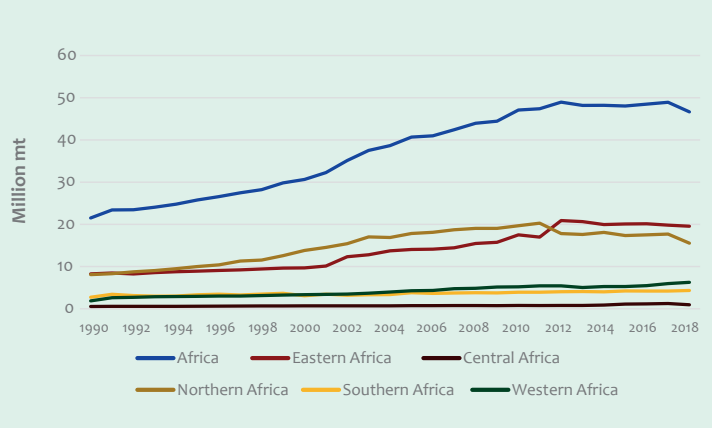

Figure 3: Milk production (million mt) in Africa and subregions.[68]

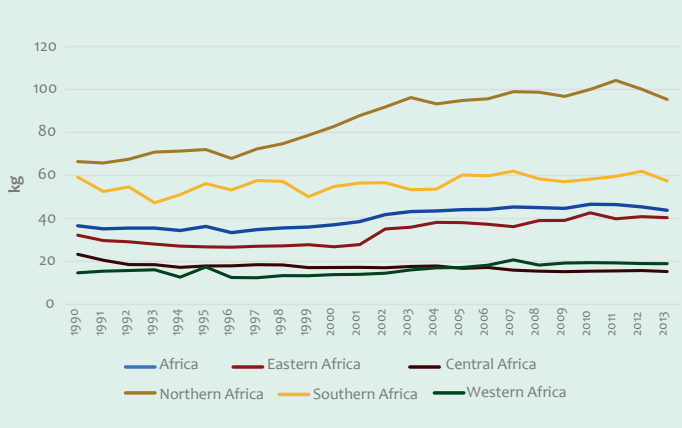

Figure 4: Per capita milk consumption (kg) in Africa and subregions.[69]

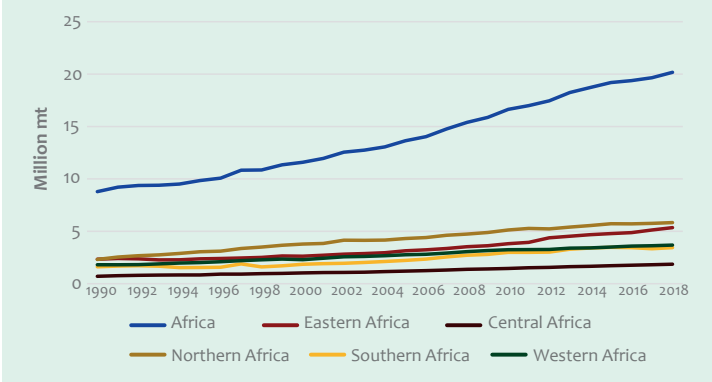

Figure 5: Meat production (million mt) in Africa and sub-regions.[70]

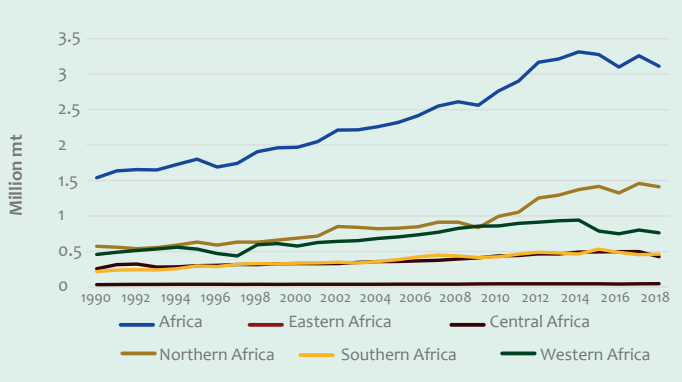

Figure 6: Egg production (million mt) in Africa and subregions.[71]

As figure 3 shows, between 1990 and 2018 total milk production in Africa more than doubled from around 22 million to 47 million mt.[72] Almost three-quarters is cow milk, followed by goat (9 percent), buffalo (6 percent), camel (6 percent), and sheep (5 percent) milk.[73] Approximately half of the total milk is produced in just six countries: Egypt (5.6 million mt), Kenya (5 million mt), Sudan, Algeria, and Ethiopia (4 million mt each), and South Africa (3 million mt).[74] More than 70 percent of total milk produced is either consumed on the farm or is distributed via informal markets, while only around 15 percent is processed into fresh products such as cheese, pasteurized milk, yogurt, or butter.[75]

Over the period 1990 to 2013, average per capita milk consumption in Africa increased from around 37 kg to 44 kg, led by growth in northern Africa as indicated in figure 4.[76] Consumption varies greatly between and within countries:[77] in 2013, Sudan and Algeria had a per capita milk consumption of 115 kg and 142 kg respectively[78], while Kenya showed one of the highest per capita consumption levels in SSA at 95 kg.[79]

In most of central and western Africa it is less than 30 kg.[80] In comparison, in 2013, the average Western European consumed 261 kg, and Asians consumed 60 kg.[81] However, it is important to note that consumption patterns vary greatly between urban and rural areas. For example, in Kenya, the estimated annual per capita milk consumption varies between 19 kg in rural and 125 kg in urban areas.[82] The per capita recommendation by World Health Organization (WHO) lies at 200 kg of milk per year.[83]

As shown in figure 5, over the period 1990 to 2018 total meat production in Africa—including cattle, poultry, sheep/mutton, goat, pork, and wild game—more than doubled from almost 9 million to 20 million mt.[84] Meat production was estimated at 5.4 million mt in northern Africa in 2018, the highest among Africa's subregions.[85] Across Africa, poultry meat production increased from 2 million to 6 million mt between 2000 and 2018. The top five producing countries are South Africa, Nigeria, Cameroon, Zimbabwe, and Cameroon.[86] South Africa is the largest poultry producer. Between 2000 and 2018, poultry meat production in South Africa more than doubled, increasing from 816,000 to almost 2 million mt. [87] However, in 2018, about 90 percent of this meat was from the commercial broiler industry and the remainder from subsistence stock. South Africa also has the largest market for animal feed, which is a key component of poultry production.[88] Estimates show that in 2010, total annual per capita livestock meat consumption was particularly low in western Africa and eastern Africa at less than 10 kg.[89] In contrast, southern Africa had the highest per capita consumption of ruminant (large and small) and chicken meat, which amounted to 19 kg and 30 kg respectively.[90] South Africa is currently the largest poultry consumer in this region, with consumption having increased from 23 kg per capita in 2003 to nearly 40 kg per capita in 2015.[91] Currently, per capita consumption of pork in Uganda ranks highest in eastern Africa, at about 3 kg/year.[92]

Total egg production in Africa more than doubled from 1.4 million to 3 million mt between 1990 and 2018, as shown in figure 6. During this time, northern Africa experienced the highest rate of increase (146 percent), followed by southern Africa (113 percent), eastern Africa (67 percent), western Africa (66 percent), and central Africa (42 percent).[93] Nigeria is the largest single producer of eggs across the continent, with almost 500,000 mt of eggs in 2018.[94,95] However, when compared to other developing regions, Africa's total egg production is still meager: with around 140 million eggs in 2018, Asia produced almost 45 times more eggs.[96] Consumption of eggs too is low compared to other regions. In 2013, average annual per capita egg consumption in Africa was 38 eggs, in contrast to 86 and 134 eggs (equivalent to approximately 6 kg and 9 kg) in Western Europe and Asia. Egg consumption also varies substantially between and within countries. For instance, Kenyans consume about 45 eggs per year[97] while in Burundi, Chad, Niger and Rwanda, annual per capita consumption is as low as 6 eggs per year.[98] One reason is that flock sizes in Africa tend to be small—usually ranging between 5 to 20 birds while productivity is low—30 to 80 eggs per hen per year in unimproved systems.[99]

By some projections, it is estimated that milk consumption will triple across SSA between 2000 and 2050 while that of pork, poultry meat and eggs will grow as much as sevenfold by 2050.[100] While this increasing demand for livestock derived products across the continent offers a number of benefits and opportunities to African economies, the possible negative impacts—including on health, climate, and conflict need to be carefully addressed when devising continental, regional and national livestock sector growth strategies.

4. Continental, regional, and global policy frameworks

Continental and regional policy frameworks

At the continental level, the African Union (AU) Agenda 2063 indicates the common African position on transforming the livestock sector to become more productive and resilient. As part of Aspiration #1—to achieve a prosperous Africa based on inclusive growth and sustainable development—Goals 1, 3, and 5 reflect African governments' commitment to enhance livestock production in order to improve livelihoods, provide nutrient-rich animal-sourced foods, and promote policies that contribute to value addition in livestock to meet several targets, including the doubling of agricultural productivity.[101]

Under the Malabo Declaration, Goal #3, African governments are committed to facilitate a sustainable and reliable livestock production and access to quality and affordable inputs in order to accelerate agricultural growth and end hunger in Africa by 2025.[102] According to the 2019 AU Biennial Review (BR) Report, which captures the progress made by African countries in implementing the Malabo Declaration, no country is currently on track to meet Goal #3. However, 16 countries[¶] were on track to double the current levels of quality agricultural inputs for livestock by 2025.[103] Furthermore, Goal #6—commitment to enhancing resilience of livelihoods and production systems to climate variability and other related risks—seeks to ensure that at least 30 percent of smallholder farmers and pastoralists are resilient to climate and weather-related risks by 2025.[104] Between 2017 and 2019, Burundi, Cabo Verde, Ethiopia, Ghana, Mali, Mauritania, Morocco, Rwanda, Seychelles, Tunisia, and Uganda were on track to meet this goal.[105]

In 2014, under the mandate of the African Union Commission (AUC), the Livestock Development Strategy for Africa (LiDeSA) (2015–2035) was launched to transform the African livestock sector to significantly contribute to socioeconomic development and equitable growth.[106] In line with the AU Agenda 2063, the aim of LiDeSA is to position the livestock sector as the main driver for providing the desired 6 percent annual growth in agriculture. The strategy acts as a framework and advocacy tool to increase reforms and development in the livestock sector. It aims to increase public and private investments in livestock sector value chains, improve animal health, and strengthen the resilience and productivity of livestock production systems. In addition to improving market access, the strategy aims to develop new technologies and capacities and enhance the entrepreneurial skills of livestock value chain actors, such as producers, traders, processors, and livestock service providers. Within the framework of LiDeSA, AU- Inter African Bureau for Animal Resources (IBAR) has created a continental program known as Livestock for Livelihoods and Sustainable Development in Africa, which aims to strengthen countries' policy and institutional environments and improve livestock management systems and practices.

The AU Policy Framework for Pastoralism in Africa (PFPA) is the first continentwide policy initiative that aims to enhance the livelihoods of pastoralist communities.[107] It seeks to harmonize political commitment to pastoral development in Africa and highlight the role of pastoral livestock at national, regional, and continental levels. Although the Comprehensive Africa Agriculture Development Programme (CAADP) initially intended to cover all aspects of agriculture, issues pertaining to livestock were not emphasised. It was only in 2006 that the livestock sector was specifically included in CAADP through the Companion Document.[108] The AU-IBAR was mandated to support the implementation of the Livestock Component of the CAADP Companion Document at regional and country levels. As a result, in 2010, AU-IBAR released a framework to mainstream livestock in the CAADP pillar framework.[109] AU-IBAR also created a guide for CAADP country teams to incorporate livestock in their CAADP Compacts and recognize livestock priorities for all CAADP pillars. Livestock priority in CAADP pillar 1 focuses on access to water and pasture management and maintaining pastoral mobility; pillar 3 highlights the provision of animal health services.[110]

In addition, in 2015, the Common Market for Eastern and Southern Africa (COMESA) validated a regional livestock policy framework, which provides guidance to COMESA member states to improve intra- and interregional livestock and livestock product trade and to strengthen livestock production. In the policy landscape of COMESA member states, national-level livestock policies and legislation are usually included within broad agriculture sector development policies. Zambia is among the few COMESA member states to develop a Draft Livestock Development Policy.[111]

The East African Community (EAC) aims to enhance livestock production for domestic consumption as well as exports within and outside the community. The goal of the EAC's livestock development policy is

¶ Angola, Botswana, Eritrea, Gambia, Ghana, Guinea, Madagascar, Malawi, Mali, Mauritania, Nigeria, Rwanda, Senegal, Tunisia, Uganda, and Zambia

to encourage a productive use of livestock assets and to increase resilience to climate-related risks such as droughts and extreme temperatures in order to secure livestock assets as well as improve and sustain growth in livestock productivity. In the Economic Community of West African States (ECOWAS) region, the main goal of its Strategic Action Plan for Development and Transformation of the Livestock Sector (2011–2020) is to accelerate the transformation of the livestock sector in order to achieve food security and increase livelihood benefits. Furthermore, the Regional Action Plan for the development of livestock farming in West Africa is expected to promote the livestock, meat, and dairy sectors and their products. However, more than half of member states have not developed specific livestock policies nor dedicated animal health/veterinary strategies. In the IGAD region, the IGAD Centre for Pastoral Areas and Livestock Development (ICPALD) was established in 2013 as an IGAD specialized institution mandated to facilitate sustainable livestock development. It serves as a platform for regional cooperation and coordination in livestock development and addressing livestock issues in the region. Some IGAD member states, including Djibouti, Ethiopia, and Eritrea have adopted national-level livestock development and animal health/veterinary policies and strategies. Finally, under its Regional Agricultural Policy (2013) the Southern African Development Community (SADC) has proposed interventions that will involve harmonizing national veterinary service systems to meet international standards as well as coordinating national and regional early warning and response systems for transboundary animal diseases, zoonoses, and crop pests. Although all SADC member states have detailed animal health/veterinary legislation, many of these laws require updating.[112]

Global policy frameworks

At the global level, livestock contributes to all 17 of the Sustainable Development Goals (SDGs) and is directly linked to 8 SDGs, in particular SDG #1—End poverty in all its forms , SDG #2—End hunger, achieve food security and improved nutrition and promote sustainable agriculture, and SDG #3—Ensure healthy lives and promote well-being for all at all ages.[113] Within the SDGs, the need for enhancing the livestock sector is highlighted as a key element to contribute to food and nutrition security and overall sustainable economic development. Furthermore, promoting women's participation and decision-making powers in the livestock sector contributes significantly to meeting SDG #5—Achieve gender equality and empower all women and girls.[114]

Several international organizations play an important a role in the area of animal disease policy, such the World Organisation for Animal Health (OIE), Food and Agriculture Organization of the United Nations (FAO), and WHO.[115] The role of the OIE is recognized by the World Trade Organization as an international reference organization for standards concerning animal health and zoonoses. OIE's 182 member countries are required to provide information on the presence of notifiable animal diseases within their borders. It has recently expanded to focus on animal welfare, animal production, and food safety in line with its expanded mandate "to improve animal health worldwide."[116] FAO addresses animal health mainly through its Animal Health Service, within the Animal Production and Health Division.[117] The Animal Health Service includes three groups: the Veterinary Public Health group (committed to prevention and control of zoonotic diseases), the Production Diseases group (dedicated to addressing diseases from parasites and poor nutrition), and the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (which deals with transboundary animal diseases). WHO is mandated to improve animal health with the objective of eliminating public health risks arising from animals.[118] Through the implementation of the International Health Regulations framework, WHO monitors the main capacities of member states to detect, control, and prevent zoonotic diseases. All three organizations work in close partnership, through for instance, the Global Framework for the Progressive Control of Transboundary Animal Diseases (GF-TADS), a global early warning system for transboundary animal diseases and the main zoonoses[119] and the Global Early Warning System for Major Animal Diseases.[120]

In 2018, FAO launched the USAID-funded project Africa Sustainable Livestock 2050 (ASL 2050), an initiative to investigate the possible futures of the African livestock sector.[121] It operates in Burkina Faso, Egypt, Ethiopia, Kenya, Nigeria, and Uganda. The aim of ASL 2050 is to ensure that national, regional, and continental institutions have access to sufficient information to promote policies that ensure a sustainable livestock sector in the long term. ASL 2050 activities include three main milestones: characterizing current livestock systems and assessing their impact on society, developing long-term (2050) livestock scenarios to anticipate emerging livestock-associated opportunities and challenges, and identifying policy actions to take today that will result in a sustainable livestock sector by 2050.

5. Livestock - the benefits and risks

The livestock sector has high potential to reduce poverty in Africa's rural and peri-urban areas, forming the basis of the livelihoods of almost one out of three people on the continent. A growing demand for animal-sourced foods also points toward new employment opportunities, and—because these foods are rich sources of bioavailable energy, protein, and micronutrients—the possibility of addressing persistent malnutrition. Moreover, livestock contributes to agricultural production by supplying inputs, including organic fertilizer and farm power, and livestock exports can generate important foreign exchange revenues. However, alongside the benefits and opportunities, there is a set of challenges that require careful government and private sector consideration when devising livestock sector sustainability, value addition, and growth strategies. These are linked particularly to both animal and human health and nutrition, environmental sustainability, and conflict between pastoralists and crop farmers.

Benefits

Livestock as source of employment and income

Livestock ownership is an important source of employment and income. Evidence from seven countries in SSA—Ghana, Madagascar, Malawi, Niger, Nigeria, Tanzania, and Uganda—shows that almost two-thirds of rural households are involved in livestock keeping, ranging from 44 percent in Nigeria to 79 percent in Niger.[122] Of these households, over 90 percent earn an income from the sale of live animals, meat, milk, and eggs. This revenue, representing between 9 and 22 percent of total income, allows households to buy food as well as agricultural inputs, such as seed, fertilizers, and pesticides.[123] As discussed in section 6, the growing demand for high-value livestock products creates new investment and employment opportunities in livestock value chains, including in livestock breeding, artisanal and modern processing of livestock products and transport. Research programs involving breed selection, animal feed sustainability and nutrition, disease control, environmental sustainability, and renewable energy-based cold chain support, as well as veterinary services are also important sources of employment.[124] Studies in Kenya have shown that for every on-farm dairy job, an additional 1.3 jobs were created in the processing and service sectors.[125] In 2012, over 2 million jobs were generated by the Kenyan dairy industry, representing around 13.5 percent of the country's total labor force.[126] For women and youth in particular, the relatively small capital investment and land ownership needs in the production, processing, and marketing of short-cycle species—including small ruminants and poultry—offer new employment opportunities.[127] In Zambia, the broiler chicken value chain alone provides approximately 31,000 jobs, of which over 25,000 are in the traditional production system and 6,000 in the modern production system using new technologies and practices resulting in feed efficiency. In addition, estimates indicate that, under the assumption of constant market shares between traditional and modern production systems, the broiler chicken value chain could create an additional 16,000 jobs in Zambia by 2022 due to the growing demand for poultry.[128] Furthermore, studies from Zambia suggest that households trading eggs make net earnings of nearly US$10,000 per year.[129] It is predicted that, by 2030, the value of agriculture and agribusiness industries in SSA will reach US$1 trillion, up from US$313 billion in 2010.[130] Given the current consumption trends for animal-sourced protein in Africa, the livestock sector is expected to be the largest contributor to agricultural value in the coming decades.[131] Strengthening the development of livestock value chains can thus facilitate the integration of smallholder farmers in reaping the benefits of this rapidly growing sector.

Livestock as a source of food and nutrition

Livestock products provide an important source of nutritious foods in the form of milk, meat, and eggs and other livestock-derived products. Increased livestock productivity and consumption could thus play a significant role in improving food security and nutrition in Africa. While livestock products are rich in protein, they also contain essential micronutrients such vitamins A, D, and E and zinc, as well as highly bio-available iron and amino acids. These are difficult to obtain in adequate amounts from a plant-based diet alone.[132] Studies, for example in Rwanda, have shown a positive link between livestock ownership and the nutritional status of young children and pregnant and lactating women,[133,134] while a study in Kenya found that the positive nutritional impact of livestock ownership is greater when livestock is owned by women.[135] A 2003 evaluation of a dairy goat project in Ethiopia showed a positive effect on milk consumption among the 100 beneficiaries, especially among children aged between 6 and 72 months. The project was managed by five women's groups and sought to increase the productivity of local goats through a combination of better management techniques, genetic improvements, and information exchange.[136]

In addition, livestock can be a reliable source of food through the regular supply of eggs and milk during

the year, being less subject to seasonality than crop production and more resilient to environmental shocks than crops.[137] Whether livestock products are consumed in a household depends largely on affordability[138] (when a household does not keep its own livestock), or on the type of animals that livestock producers or pastoralists keep. Larger ruminants, such as cows and sheep, are expensive and are often kept as assets or for religious celebrations, while poultry is more affordable. In Uganda, the number of large ruminants owned or managed by a household was positively linked to dairy consumption, but insignificantly increased levels of meat consumption. However, ownership of poultry increased consumption of both meat and eggs.[139] Crucially, estimates show that consumption of animal-sourced foods is predicted to grow faster than the demand for cereals in Africa: until 2030, meat and milk consumption are projected to grow by 2.8 and 2.3 percent per year respectively, while the demand for cereals, fruits, and vegetables is expected to grow by about 2.1 percent per year.[140] Yet, as discussed in section 3, domestic production in many African countries does not meet the current demand for livestock products, resulting in a growth of net imports of animal products and animal feed. Unless significant investments are made in countries' livestock sectors, Africa will continue to be a net importer of livestock products, with imports projected to account for 12 to 15 percent of livestock products consumed in Africa between 2030 and 2050.[141]

Livestock as a form of input

A significant amount of fertilizer used on African farms is derived from livestock manure, which is more widely available and affordable than synthetic fertilizer and its use is growing steadily. Estimates show that the share of total livestock manure nitrogen (N) inputs has nearly doubled from 14 percent in 1961 to 25 percent of total fertilizer use in 2017. In comparison, manure use increased only slightly from 14 percent to 16 percent in South America; and from 26 percent to 35 percent in Asia over the same period. In Europe on the other hand, manure use dropped from 25 percent to 10 percent and in North America and Oceania from 9 percent to 4 percent.[142] Livestock manure is rich in nutrients, including nitrogen, phosphorus, and potassium, while its organic matter enhances the water and nutrient retention capacity of soil with a positive impact on crop production.[143] Evaluations across Africa have shown the positive effects of efficient use of livestock manure on crop yields. A study conducted in 2018 in Zambia found that the application of 4 mt/ha of poultry manure increased cassava crop yields from just under 20 mt/ha to over 28 mt/ha, while in Malawi the application of 5 mt/ha of cattle manure increased the yield of cassava from 22 mt/ha to almost 28 mt/ha in 2015.[144] However, the composition of animal manure is heterogenous.

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For example, chicken manure contains more N than that from ruminants. Thus, technical considerations on application timing, location, and amount of manure applied must be factored in to minimize environmental impacts–contamination of water and soil resources and contribution to greenhouse

gas (GHG) emissions—as well as production risks to livestock keepers. Although livestock manure is theoretically abundant in Africa, more affordable and available than synthetic fertilizers, and its use has increased, in many places there is still room to expand its use. Under use of manure fertilizer is primarily due to the fact that most livestock in Africa are free-ranging or spatially separated from crop farms. Moving dispersed, small volumes of manure to farms is labor-intensive and costly. For instance, in South Africa, only a quarter of the estimated 3 million mt of livestock manure is used as fertilizer. The remaining manure is lost, with just a small portion used for energy generation.[145] In addition, in Uganda, biogas from cattle manure is being used to power refrigeration units to store milk.[146]

Livestock can also be an important source of draught power for agricultural production and transport, varying by type and size of animal, nutritional status, and general condition.[147] In many parts of Africa, bovines, equines, and camelids are used for traction in pulling agricultural equipment, pumping water for irrigation, and transporting harvest. Unlike the rest of the world, which has seen a decrease in the use of animal power in agriculture-related activities, there has been a significant increase in Africa. For instance, the number of oxen, the main agricultural work animals in West Africa, increased six-fold—from 350,000 to 2 million—between 1960 and 2010.[148] Currently, 25 percent of power for land preparation in Africa—such as plowing, seeding, and mowing—is provided by animal-powered tools.[149] Compared to manual farm work, animal-power-based mechanization increases the capacity of production by 5 to 20 times. Famers using animal power can reduce the drudgery of farm work, expand the land under cultivation more easily, and better plan the time to plant. Overall, the use of animal power improves productivity in agriculture compared to relying on human power only. In 2007, a study in Kenya found that farmers using draught animal power on average obtained over 1,200 kg of maize per ha, while farmers who manually tilled their land harvested around 880 kg per ha.[150]

Livestock as a source of foreign exchange revenue

Although Africa is a net importer of livestock products and feed, the export of livestock products or live animals can be an important source of foreign exchange revenue for some African countries. The eight East African countries of the IGAD region are the leading exporters of livestock, accounting for 42 percent of the continent's livestock exports.[151] For Somalia, exports of bovines, sheep, and goats have represented over two-thirds of total exports in recent years,[152] while for Ethiopia, the export of live animals, meat, and other animal products as a share of total exports increased from 11 percent in 2005 to 13 percent in 2015.[153]

Between 1995 and 2012, intraregional trade of livestock accounted for only 29 percent of total exports and 15 percent of total imports Africa-wide.[154] However, this varies across regions. In West Africa, livestock products (including live animals) constitutes the largest share of intraregional trade. It is estimated that the total intraregional trade flows of ruminants—three quarters of which are cattle and one quarter small ruminants—was worth nearly US$400 million annually between 2013 to 2015. This amounts to six times more than the value of cereals traded.[155] In Mali, bovine exports in 2017 generated US$109 million of foreign exchange revenue, representing almost 5 percent of the country's total export value.[156]

The predicted increase in demand for animal-sourced foods from US$51 billion in 2007 to more than US$151 billion annually by 2050 hence creates important opportunities for African countries to improve their trade balances.[157] In addition, the uneven distribution of livestock resources across the continent—with over half of Africa's livestock located in the East Africa region[158]—shows the potential for increasing the intra-African trade of livestock products and live animals. Furthermore, with the second largest livestock population in the world after Asia, Africa could own a significant share of the global livestock trade by ensuring that livestock products meet international quality and food safety standards. In particular, the export of processed livestock products, such as dairy and meat, could significantly increase African countries' income. However, as discussed in more detail in section 7, for countries to be eligible to export outside the continent, for example to the European Union, products need to comply with specific technical requirements as well as regulations on animal health and food safety standards.[159] For small livestock producers and pastoralists in particular, this is a major obstacle.

Risks

Health risks for consumers and producers

Although livestock products are rich in macro- and micronutrients, their unsafe production, storage, and consumption can have adverse impacts on people's health. Livestock can be a reservoir of pathogens responsible of zoonoses, such gastrointestinal diseases, avian influenzas, rabies, brucellosis, and tuberculosis. Risk factors for human zoonotic infections include exposure to livestock, livestock feces, and animal slaughters, and the handling and consumption of unsafe livestock products.[160] Furthermore, low levels of biosecurity, due to limited access to clean water and soap, increases not only risks to human health but also severely limits market opportunities. Evidence shows that pathogens that can be harbored in livestock, including *Campylobacter spp., Cryptosporidium spp., Salmonella enterica, Giardia intestinalis,* and certain serogroups/-types of *Escherichia coli (E.coli)* are responsible for more than 60 percent of gastrointestinal diseases in SSA.[161] In addition, inadequate storage for livestock products may increase the incidence of food poisoning. The risk is particularly high in Africa where many households lack access to reliable energy for refrigeration of perishable products.[162]

Through the excessive use of antimicrobials in feeding farm animals and treating and preventing diseases, livestock may also be a source of antimicrobial resistance (AMR). Pathogens that are exposed to antimicrobial drugs can develop AMR, which in turn threatens the effective prevention and treatment of an increasing number of infections caused by bacteria, parasites, viruses, and fungi in humans and animals.[163] The highest use of antimicrobials is found in Asia's pig and poultry production, estimated at US$1.8 billion since 2011. Although figures in Africa are currently lower, an increased use of antimicrobials is evident largely due to intensified livestock production, particularly in the poultry sector. The share of farms using antimicrobials in commercial poultry farming ranges from 77.6 percent in Nigeria to 100 percent in Tanzania, Cameroon, and Egypt. Studies also found that pathogen *E.coli* is increasingly becoming multidrug-resistant in Kenya, Nigeria, South Africa, Zimbabwe, and Tunisia.[164]

Furthermore, excessive consumption of *processed* livestock products, particularly processed red meat, is considered a major dietary risk factor that contributes to overweight and the incidence of noncommunicable diseases (NCDs) including cardiovascular disease, cancer, and diabetes, as well as mortality. There has been a significant increase in the prevalence of NCDs over the past two decades in Africa, and the number of deaths linked to NCDs rose by 68 percent between 1990 and 2013.[165] It is estimated that this figure will increase by a further 20 percent between 2010 and 2020.[166] In addition, the WHO estimates that deaths from NCDs will increase globally by 17 percent by 2030, of which over a quarter—28 million deaths—will arise in Africa alone.[167] The estimated prevalence of childhood (ages 7–11) overweight also increased from 4 percent in 1990 to 7 percent in 2011, and is expected to reach 11 percent in 2025.[168]

Climate change and environmental impacts

Livestock systems are a significant contributor to global human-induced GHG emissions and hence climate change. Cattle, buffalo, sheep, goat, and chicken production in SSA emitted about 403.5 million tons CO_2eq. in 2010. Ruminant production systems are responsible for 96 percent of these emissions, which are mostly in the form of enteric methane (266 million tons CO_2eq.) and methane and nitrous oxide from manure management (23 million tons CO_2eq). On the other hand, poultry farming contributes 4 percent to total GHG emissions.[169] Livestock also contributes to global human-induced GHG through the production of feed and other inputs, as well as downstream operations for transport, cooling, storage, and processing of livestock products. Although Africa's contribution to global GHG emissions is comparatively small, emissions from the "agriculture, forestry and other land use" (AFOLU) sector—which includes crop and livestock production–are relatively high and continue to increase by 1.6 percent per year. Africa's AFOLU emissions accounted for 15 percent of global

GHG emissions from agriculture, with East Africa contributing 5.9 percent, West Africa 3.5 percent, North Africa 3.1 percent, Central Africa 2 percent, and Southern Africa just 1 percent (averages for the period 2005–2014). Moreover, livestock-related emissions from enteric fermentation and manure together contributed nearly two-thirds of total emissions, with 39 and 28 percent, respectively.[170] GHG emissions from the livestock sector can be mitigated by promoting animal productivity improvements that reduce emission intensities from livestock through technological innovations as well as through more efficient value chain operations.[171]

Overgrazing—often as a result of growing livestock populations and the extension of cropping areas into grazing land—as well as reduced seasonal mobility and insecure land tenure are among the main causes of grassland degradation in Africa. Estimates show that 18.5 percent of the total grazing area land is degraded in SSA, while in the Near East and North African (NENA) region only 2.9 percent of the total grazing area is affected.[172] By restoring the quality of pastures and increasing the sequestration of soil organic carbon, the negative impact of livestock on grassland can be reduced.[173] In addition, livestock overgrazing can lead to biodiversity loss through a reduction in plant cover, which negatively affects the population sizes of wild herbivores and predators. Poor manure management practices, especially from large-scale livestock farms, can further amplify nutrient pollution (soil, water, and air). The excess use of manure can reduce soil fertility and lead to excess minerals and nitrates in surface and underground water resources. Furthermore, livestock systems can contribute to the depletion of important water resources, being a major user of water for animal watering, feed production, cleaning, and processing in slaughterhouses. Although most feed production is currently rainfed, as countries move to expand their land under irrigation this will require careful planning. Depending on the production system, species, and feed, the amount of drinking water required varies between 5 and 50 liters per one tropical livestock unit (TLU) ** per day, while daily feed production for livestock requires about 100 times the daily water requirements.[174]†† Efficient use and recycling of water in the livestock sector can hence limit water depletion.

Conversely, the livestock sector is also highly vulnerable to the adverse impacts of climate change. Climate change is projected to increase water stress as well as the frequency of droughts and floods, causing lower crop yields and higher livestock mortality. In addition, a fall in productivity and quality of forage due to more extreme weather events is detrimental to the sector, while a change in temperature and rainfall levels can affect the severity and distribution of diseases and parasites impacting animal health.[175] It is also expected that climate change will increase animal movement, especially in the pastoral and

** Herd structures have been defined in terms of number of heads of animal as well as in terms of reference Tropical Livestock Unit (TLU) defined as a mature animal weighing 250 kg. (Houerou and Hoste 1977; Stotz 1983)

†† Livestock typically require daily feed intake of dry matter amounting to about 3 percent of their weight and about 500 liters of water is required to produce 1 kg dry matter. (Peden et al., 2002)

agro-pastoral systems, thus increasing the occurrence of transboundary animal diseases and potential of conflict with crop farmers.

Farmer-pastoralist conflict

In the Sahel, parts of North Africa and the Horn of Africa, conflict between crop farmers and pastoralists is frequent largely due to a combination of land-use dynamics, pressure on natural resources (grassland, water), and land tenure. In the absence of clear laws and regulations and lack of capacity to enforce them, these conflicts are set to increase. During the first half of 2018, more than 1,300 people died in Nigeria in violence involving herders and farmers.[176] Women and children are the main victims of these conflicts, often losing access to land or their herds after the death of the household head (usually the husband or father). Conflicts also severely limit private sector investment by increasing the risk and uncertainty associated with the stability of a region or country. Several African governments have sought to reduce the risk of conflicts through inclusive legislation that ensures access to land and natural resources to both pastoralists and farmers. For instance, in Mali and Mauritania, governments have passed laws, developed in dialogue with all stakeholders, to protect pastoral lands and to enhance livestock mobility through the creation of grazing corridors. In the Central African Republic, the government has allocated land and provided proper veterinary services to pastoralist communities.[177]

The farmer-pastoralist conflict in Nigeria

In recent years, conflicts between nomadic herders and sedentary agrarian communities have increased in the Sahel region, threatening countries' national security. In Nigeria, drought and desertification have destroyed pastures in the country's far-northern Sahelian belt, while growing animal populations compels herders to move from the predominantly Muslim north to the predominantly Christian south in order to find grassland and water for their herds. Insecurity in the north (an impact of the Boko Haram insurgency in the northeast and rural banditry and cattle rustling in the northwest and north-central zones) also triggers many herdsmen to migrate south. The conflicts between pastoralists and crop farmers have taken a substantial humanitarian and economic toll: in 2016, 2,500 deaths in Nigeria were linked to the conflicts,178 while 62,000 people were displaced between 2015 and 2017. Conflicts between herders and farmers have been further fueled by religious tensions. To find a permanent solution to the conflicts, the government of Nigeria passed a Grazing Bill that aims to expand and legalize pastoralists' access to grazing land.[179]

However, more needs to be done to develop early-warning or rapid response mechanisms and to enhance livestock management practices to reduce tension with agrarian communities. This could be achieved through enhanced community-level dialogue. Other possible solutions to pastoralist-farmer conflicts could include: improving security for both herders and farming communities, including campaigns against cattle rustlers and livestock tracking; strengthening conflict mediation, resolution, reconciliation, and peace-building mechanisms, in particular local and community-based dispute resolution mechanisms; establishing shared – at times cross-border - grazing reserves and improving livestock production and management in order to reduce contact and disputes between herders and farmers; addressing climatic and environmental factors contributing to herders' migration; and coordinating with neighboring countries to stem cross-border movement of armed herders.[180]

More recently, restrictions that have been put in place in many African countries to mitigate the impacts of the coronavirus pandemic of 2020 will likely further impact livestock keepers' ability to move in search for pasture or water—a key coping strategy in the Sahel and the Horn of Africa. This will affect herd concentrations in some areas, and may spark new tension or conflicts between pastoralists and crop farmers. Crucially, targeted interventions along each segment of the value chain can help countries to capitalize on the opportunities that the livestock sector offers and to minimize the risks and adverse impacts.

6. Interventions to strengthen livestock value chains and food systems

To meet the increasing demand for animal-sourced foods and to capitalize on the potential of inclusive growth in the livestock sector, livestock production and the entire value chain need to be sustainably intensified. Livestock value chains represent all stages of value addition in animal-sourced foods—such as milk, meat, and eggs—from production through processing, distribution, and wholesaling/retailing to consumption. At each stage or transaction, the animal or its product gains "value" either as its quality improves or as its delivery to the final consumer is made more efficient. Livestock value chains are complex, comprising compound networks, relationships, and transactions.

Livestock value chains support a multitude of subsidiary value chains for services, inputs, and outputs. For instance, livestock value chains interact with other agricultural value chains as they create demand for fodder crops and crop residues from farmers.[181] Live animals can be exchanged through multiple stages during their lifetimes: from herders and farmgate producers through aggregators; fatteners; markets, traders, and middlemen; transporters or trekkers; and finally, to slaughterhouses. They gain or lose monetary value at each stage, depending on their health and appearance and other market information. Meat products gain value as they are traded from slaughterhouses to butchers and retailers, while dairy products gain value as they are transformed to processed products such as yoghurt.[182] At each stage where value is added, actors along the value chain retain a share of the additional value. Small-scale livestock producers and other value chain actors can engage by upgrading production processes and producing new upstream or downstream goods and services.[183] Adopting a market-oriented value chain approach will ensure that interventions are demand-driven and meet market requirements. This approach will encourage greater productivity, improve supply linkages, strengthen relationships among suppliers and attract investment across the whole the value chain, ultimately leading to increased incomes for all actors, when proper regulations are in place.[184,185]

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Often value chains are integrated within an enterprise to streamline the production and supply of inputs for the subsequent activities. For example, Brade Gate Poultry Industries in Kenya is a major poultry business investing in all segments of the value chain from feed milling, breeding, hatchery, broilers and layers to processing and marketing. Established in 2011, the company also has stores dedicated to the sale of inputs and equipment for poultry farming and subsidiaries in hotels that consume poultry from Brade Gate, and it provides financing for poultry farmers. In addition, the company provides education for farmers through a technical school, the Bradegate International College of Poultry Science.[186]

Supporting a vibrant livestock value chain also requires investments in critical value chain points, to "pull" demand from subsidiary value chains like the production of feed, animal health and extension services and genetics. This section provides an overview of the challenges and potential interventions for strengthening livestock value chains across Africa.

Production

Livestock productivity in Africa, measured in terms of yield per animal, is below other developing regions, and much lower than developed countries. In Africa, increases in livestock production to date are founded on growth in herd and flock size rather than yield increases. Several factors affect the productivity of livestock, including nutrition, feed availability, feed quality, diseases and parasites, access to inputs, genetic composition, animal health services, and access to markets, as well as extreme weather events and a changing climate. Accordingly, sustainable solutions combine scientific, technological, institutional, and social approaches, requiring the participation of a wide range of value chain actors such as research organizations, policymakers, feed and forage farmers, veterinarian services, local agro-dealers, and equipment providers to strengthen local veterinary drug production and research on indigenous knowledge on disease control among other things.

Animal feed and nutrition

Much progress is being made across the African continent in improving feed for livestock. However, the availability of reasonably priced, high-quality feed remains a major challenge to raising livestock productivity.

> Despite progress in improving feed for livestock, the availability of reasonably priced, high quality feed continues to remain a major challenge to raising livestock productivity.

There are several types and sources of feed and fodder, such as tree fodder (leaves, flowers, seeds, fruits, and pods), shrubs, grasses, and crop residues, as well as commercial supplies such as agro-industrial by-products, cultivated fodders, oilseed cakes, and permanent crops. The International Center for Tropical Agriculture (CIAT) has developed new varieties of *Brachiara* and *Panicum*, two local grass species, to provide higher land and animal productivity. The grasses are high-yielding, adaptable to poor soils, drought and flood resistant, and more palatable and nutritious.[187] Preliminary data from *Brachiara* test plots in Kenya showed an increase in milk yields by 15 to 40 percent and an average of 36 percent in Rwanda. In addition, cattle fed on *Brachiara* instead of elephant grass in Rwanda benefited from a daily increase in average body weight of 205 grams over a 12-week period.[188,189]

The last few decades have also seen vigorous promotion of fodder trees and shrubs—both indigenous and exotic—such as *Calliandra calothyrsus*, *Sesbania sesban*, *Gliricidia sepium*, and *Leucaena leucocephala*.[190] Not only do these provide highly nutritious leaves for livestock consumption, they are also fast growing and fix nitrogen in the soil, thus improving fertility of the land on which they are grown. Within two years of planting *Calliandra calothyrsus* in East Africa, its use as a substitute for concentrates (animal feeds rich in energy and protein but low in fiber) to feed dairy cows led to an increase in milk production and corresponding income of US$62 to US$122 per year in 2003.[191] Leaves from *Calliandra calothyrsus* can also replace soybean in the diets of goats raised for meat.[192]

The choice of feed is contextual, contingent on biophysical, socioeconomic, and policy environments. Much of Africa's livestock production is highly reliant on rainfed fodder (pasture). As a result, producers experience seasonal fluctuations that make them vulnerable to a changing climate and impacts the health of the animals as well as the environment (through overgrazing, for example, as covered in section 5). In areas where the seasons are distinctly wet or dry, the quality of pasture declines significantly during dry seasons, as does the productivity of livestock. In these regions, transhumance (seasonal migration) or supplementary feeding with concentrates of phosphate, calcium, and trace minerals can help to overcome this seasonal weight loss. Introduction of *Faidherbia albida*—a leguminous tree—into crop-livestock systems can provide nutrition during extended dry periods. The tree is unique in that its leaves grow during the dry season and shed during wet seasons, providing critical fodder during periods of drought.[193]

However, where supplementary feeding is insufficient, animals can lose between 20 and 40 percent of body weight during the dry seasons.[194] Moreover, a lack of adequate feed over the longer term also undermines productivity as animals suffer from low birth rates, body weight, and output.[195] While some breeds have developed physiological responses to periodic shortages of nutrition, such as storing fat in tails and humps, a prosperous livestock sector year-round must be supported by an effective feed and forage value chain for continuous supply. Fostering a viable commercial feed and forage subsidiary value chain—involving forage seed producers, marketers and distributors, millers, and transporters—is critical to supply both wet and dry season feed, increase productivity, and thus reduce overall production costs.

Fodder seed business in Zimbabwe

In eastern Zimbabwe, the ZimCLIFS project aimed to demonstrate the potential viability of a pasture seed business and increase access to improved forage cultivars. The project trained farmers on the production of forage seed using a lead farmer approach, farmer-to-farmer technology dissemination, innovation platforms, and field demonstrations. At the end of the four-year trial in 2016, the total land under forage plantation increased by 147 percent from 14.6 ha. Total yield increased by 163 percent, much of which was subsequently distributed outside the project area. Farmers earned up to US$800 for producing lablab (Lablab purpureus) and US$750 for mucuna.[196,197] The quality of meat also improved, leading to higher prices for goats, up from US$8 in 2006 to US$60 in 2015.[198] Moreover, the project led to the entry of a private seed company, which contracted farmers to produce forage seed, resulting in improved distribution of seed and an increase in incomes.[199]

On the one hand, dedicating land to the production of fodder requires secure land tenure, time, financial and labor investment and a reliable supply of water—all of which come at a great opportunity cost to small producers. On the other hand, smallholder farmers producing forage can also benefit from an additional source of income. Providing a market for feed and forage producers to sell directly to livestock producers creates a sustainable value chain partnership. Zambeef in Zambia works with over 10,000 smallholder farmers to source feed inputs and cattle for its operations.[200] Zambeef's feed mills also give farmers forward offtake signals on volumes and quality and indications on price floors. These are supplemented with technical assistance for farmers to maximize yield. Farmers benefit from access to a reliable market for their produce, thus reducing waste, and Zambeef's miller can operate at optimum capacity.[201,202]

Livestock keepers can benefit from interventions that ensure that animals are able to extract maximum nutrition from their feed. This can be done by improving the physical constitution of feed such as on-site drying, mechanized chopping and grinding, and good storage.[203] For instance, mobile, manual chaff-cutters reduce the time required to process a cartload of crop waste from a full day to just 30 minutes, making the fodder easier to store, transport, and trade. The chopped fodder is also easier for livestock to consume, reducing the amount of waste.[204] Crop residue blocs can further be modified by adding water, salt, and urea to improve their digestibility and nutrient value.[205] It is essential that fodder be appropriately stored in sacks or indoors to reduce the loss of dry matter and protein, and thus nutrition.[206]

Commercialization of the feed sector is also a means to engage young entrepreneurs in the livestock sector and to capture a larger market share from global trade in livestock feeds, valued at over US$400 billion per year.[207] Moreover, the cost of imported feed prices African livestock products out of international markets. Imported commercial concentrate feeds are also not tailored to local needs and contribute to the high cost of production.[208] Although the production of compound feed produced in Africa grew by 156 percent between 2013 and 2017 to 39.14 million mt[209], this represents just 1 percent of global animal feed output.[210] Commercializing the production of the feed industry—raw ingredients and finished compound feed—is essential to support a growing livestock sector and to reduce the cost burden to livestock producers, especially as feed can represent up to 65 percent of production costs for livestock keepers. To keep up with the growth in livestock stock and meet the growing demand for animal-sourced foods, Africa's feed industry requires an overhaul. At the same time, any investments in this industry will also require equal attention to the management of animal health.

Animal health and veterinary services

Disease and poor health are among the main reasons for low productivity in Africa's livestock sector. Lack

of access to good quality veterinary care, including limited diagnostic infrastructure, and poor extension services, particularly in rural areas, underlie the high prevalence of disease.[211] Although the disease burden has been falling in SSA, it still remains higher than in Asia and the burden of zoonoses is twice as high.[212] It is also likely that progress made to date may be undermined by a changing global climate, which will impact vegetation and rainfall patterns and affect the dynamics of disease type, incidence, spread, and interactions in African livestock.[213] Livestock trade –which increasingly also takes place in peri-urban and urban areas - and mobility further speed up the spread of animal and zoonotic diseases.[214]

Diseases such as animal trypanosomiasis, bovine pneumonia, and East Coast fever kill thousands of livestock in Africa each year and reduce overall productivity among the surviving herds.[215] Costs of diseases are further aggravated by the cost of treatments, loss of fertility, newborn diseases, and mortality and loss of weight among the survivors. Furthermore, as discussed in the previous section, zoonotic diseases, which are transmitted from animals to humans reduce human health and capacity, together inflicting a serious burden on economic growth. For instance, the cost of bovine tuberculosis (TB) in animals and humans to Nigeria in 2016 totaled US$9.6 billion, equal to approximately 0.9 percent of national GDP.[216] Bovine TB is also the most burdensome disease in Burkina Faso, where an outbreak in 2016 caused nearly US$50 million in losses to livestock and human lives.[217] Yet data measuring the cost of outbreaks is not available universally, comprehensively, or regularly. A new program, the Global Burden of Animal Diseases (GBADs), led by the University of Liverpool seeks to close this gap through a systematic process to determine the burden of animal disease on the health and well-being of humans. The aim is to identify the deficiencies of the animal health system and offer solutions to support the needs of smallholder farmers and commercial operations. [218]

Addressing the challenges of animal health in Africa requires comprehensive packages of interventions, including data collection and transmission, reform of the veterinarian value chain from diagnostics to supply of veterinary products, veterinary drugs use and control, use of traditional herbs and medicines, and training of professional and community-based animal health workers (CAHWs)—as part of a wider program of upgrading extension services. Strengthening surveillance, early warning systems, and epidemiology work particularly for new and emerging diseases is of critical importance. This in turn will require a review of policies, veterinarian infrastructure and service provision, investments in higher-level education in veterinary and animal sciences, legal recognition of CAHWs, and regional partnerships to address transboundary movements of livestock and diseases. Equally important is the use of digital tools to enhance timeliness and increase geographical coverage. This process demands coordination with agricultural extension programs and wider policies too.

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Vaccination programs

Several African laboratories, including in Ethiopia (see case study) Kenya, Morocco, Senegal and South Africa (see case study), are working to produce vaccines for zoonoses and other livestock diseases. However, they are often working with outdated technology and under inadequate standards. Poor vaccination storage and delivery systems lead to further limitations in access and availability for livestock keepers.[219] Where multiple doses are required, livestock keepers often cannot afford or do not have the appropriate storage facilities for additional doses. Moreover, where vaccinations may be available, they are not always administered correctly or consistently, risking the overall success of vaccination programs. Ensuring that vaccination programs are successful requires training and awareness-raising through outreach services and technical extension programs. In addition, technology such as diagnostic tools and vaccinations must be appropriate for the specific contexts and easy to use.[220] For instance, it is essential to develop and provide access to single-dose vaccines that remain stable at higher temperatures (thermostability) for longer to ensure that they can be transported to, and stored safely in, remote communities where access to refrigeration may be limited.[221] The Global Alliance for Livestock Veterinary Medicines (GALVmed) is a not-for-profit organization, which deploys the latest scientific knowledge to produce and market vaccines, medicines and diagnostics for livestock producers. Once products have been mainstreamed, private vaccine manufacturers are introduced to scale production and accessibility. Since 2008, GALVmed has raised over US$100 million from the Bill & Melinda Gates Foundation and the UK Government's Department for International Development (DfID) to seek solutions for 17 neglected livestock diseases.[222]

Providing vaccination programs for nomadic pastoralists adds another complication to successfully protect national herds, particularly for communities with transboundary mobility.[223] For these communities, water access points and markets act as key sites for delivering livestock disease control interventions.[224] Traders also provide a vital link between farmers and consumers, so they are well placed for targeted inclusion in disease control and prevention strategies.[225] In Chad, a successful joint human and livestock vaccination campaign optimized visits by professionals from both disciplines to nomadic communities and sharing costs and infrastructure between them. The campaign was implemented by the Chadian Ministries of Health and of Livestock Production, in partnership with local private health and veterinary providers. It successfully vaccinated 149,255 livestock against anthrax, pasteurellosis, blackleg, and contagious bovine pleuropneumonia, 4,653 children against diphtheria, whooping cough (pertussis), tetanus, and polio; and 7,703 women against tetanus.[226]

Various public-private partnerships (PPPs) have also been formed across the continent, including in Ethiopia, Kenya, Mali, Namibia and Tunisia, drawing upon the expertise and strengths of each sector to deliver effective vaccination campaigns.[227] PPPs can streamline supply chains by driving innovation, and supporting the registration, commercialization, and distribution of vaccinations—eventually leading to reduced costs and greater availability.[228,229] It is essential to foster local SMEs to produce vaccines and to participate in the delivery system needs to be strengthened.

Another successful approach has been the deployment of CAHWs, for example in Ethiopia. As the first point of contact for livestock keepers, CAHWs provide more effective disease surveillance and data collection—an indispensable service for timely detection of any outbreak and supervision of implementation of control measures.[230] In addition, even with low levels of formal education, CAHWs can be trained to administer vaccinations. Partnering networks of CAHWs with private suppliers of veterinarian products ensures that vaccinations reach remote areas in a cost-effective manner. Furthermore, by institutionalizing their services, CAHWs can partake in formal training and be provided with adequate levels of supervision and monitoring.[231] Similarly, supporting veterinary stakeholders with professional development and business training courses safeguards their long-term viability, while ensuring that this is done alongside training for agricultural extension that extends their outreach potential.

Finally, new digital solutions that combine geographic information systems (GIS), spatial analysis, and performance monitoring systems can further transform the management of livestock health. Mobile phones can facilitate the collection of health data in a timely manner and broadcast advice and information at low cost across countries.[232]

CowTribe's digital animal health services

CowTribe in Ghana was founded in 2016 to deliver animal vaccine and other livestock last-mile services and information delivery to farmers via phone. The aggregated demand for livestock farming inputs and services creates market incentives for veterinarians and suppliers to service rural communities, particularly the remote ones. CowTribe also sends SMS alerts to farmers with information on disease outbreaks and offers practical advice. In 2016–2017, CowTribe was piloted with 10,000 farmers in 119 communities in northern Ghana and has since scaled up to reach 29,000 farmers. In less than two years, vaccine coverage among CowTribe users increased from 18 to 65 percent, and early data show livestock mortalities decreasing rapidly—in some communities to less than 5 percent. In addition, farmers using the CowTribe service—many of whom were living on less than US$1 per day—have been able to add an estimated US$300 to their annual household income.[233]

Preventing the occurrence and spread of diseases is essential to reduce the costs to human health and losses incurred by livestock keepers and to raise animal productivity. However, some losses may be unavoidable. In these cases, compensation and insurance schemes (see section 7) can be considered, as have been applied in Australia, Canada, Germany, the Netherlands, and Viet Nam. For animals that survive, ensuring that the markets are accessible and provide a fair price for the produce is key to supporting livestock-based livelihoods to recover their productive capacity post-disaster.

Livestock extension services

The traditional distinction between crop farmers and livestock keepers is gradually fading and information on production methods, animal health, and fodder is increasingly requested by livestock producers.[234] In addition to enhancing skills and knowledge among livestock producers themselves, more qualified extension agents are urgently needed to deliver this much-needed advice and training. Currently, there are animal health and agricultural extension agents, but few countries run separate services for livestock only. Integration of livestock and agricultural extension services is therefore key, while information needs to be delivered at local levels and respond to local needs. Livestock services, and the ministries or departments that are responsible for them, often have a strong focus on animal health. Yet, livestock production extension could be managed in different ways. In addition to national or regional governments, extension services could be managed by NGOs, cooperatives, universities, or national agriculture research institutes as well as by the private sector. For example, in India, some extension services are provided through a system of dairy cooperatives, which reaches from village-level primary societies to a national federation.[235]

Genetics

Africa has a very diverse stock of livestock that are well adapted to the harsh conditions under which they live,[236] including the diseases to which they are exposed.[237] Yet with careful breeding, it is possible to improve productivity; increase fertility and reduce the need for a large breeding stock; accelerate the rate at which new and stable breeds are developed; and reduce susceptibility to diseases and a changing climate, all while maintaining livestock's adaptability to local conditions and prevailing husbandry practices. Breeding can also be beneficial for environmental outcomes. For instance, greater productivity reduces the number of animals kept, with implications for land use. In addition, altering ruminal microflora through selective breeding can potentially reduce methane production.[238] Breeding can be done within indigenous types; within introduced breeds; or by creating exotic varieties resulting from crossing indigenous genotypes with introduced varieties, originating from either within Africa or outside. By using technologies such as juvenile in-vitro fertilization and egg transfers, artificial insemination (AI), and semen sexing, livestock keepers can have access to better genetic material and improve the genetic composition of the herd.[239] Furthermore, better understanding the adaptive ability of livestock is a key factor in the context of climate change for conservation and sustainable farming management practices.

Therefore, animal science, breeding, and genetics research capacities across the continent need to be strengthened to equip African institutions and researchers with the practical skills needed to understand livestock population genomics and improve breeding techniques for a greater productivity of African livestock. For example, since 2000 the International Livestock Research Institute (ILRI) has been running several training courses. In 2019, ILRI and the Swedish University of Agricultural Sciences (SLU) hosted a one-week workshop for African researchers working in animal science, breeding, and genetics. The goal was for the researchers to apply the knowledge from the training to improve the productivity of African livestock, including dairy cattle. Twenty-six researchers from 14 African countries took part in training on current genomic data tools, methods, and trends and their application in Africa.[240]

> Better understanding the adaptive ability of livestock is a key factor in the context of climate change for conservation and sustainable farming management practices.

Artificial insemination

The relative potential of AI has remained generally un- or underexploited across Africa and is mainly used for exploratory purposes by research institutions or with the support of government subsidies. A few African countries including Botswana, Ethiopia, Ghana, Malawi, Mali, Nigeria, Uganda, Senegal, and Sudan have taken the technology to the field, but mostly to upgrade indigenous stock and to enable a limited number of commercial farmers to keep exotic dairy cattle breeds.[241] To maximize calving, procedures such as estrus synchronization, detection of reproductive disorders, pregnancy testing, and nonpregnancy diagnosis require skilled technicians and sophisticated technology coupled with extensive

training and experience. For bulls, the procurement, storage of semen for prolonged periods and transport over long distances requires its appropriate storage in liquid nitrogen tanks. The International Atomic Energy Agency (IAEA) and the Nuclear Techniques Division at FAO have implemented several technical cooperation projects across the African continent to improve livestock production and reproduction through capacity enhancing, strengthening operational and regulatory frameworks, and providing physical infrastructure.[242] Through this initiative, the Bambui Cattle Centre in Cameroon was able to develop a chilled semen processing methodology using egg-yolk and coconut water in which sperm can survive for up to seven days.[243] By providing AI services alongside dairy cooperatives, farmers can benefit from negotiated rates and shared costs, rather than shouldering individual costs of private agents.[244]

Record-keeping and sharing

Livestock producers—including pastoralists—have long practiced selective breeding strategies, not only to increase productivity but also for characteristics such as size, color, shape of horns, the taste and quality of meat, or the number and quality of eggs.[245] However, without accurate and continuous data combined with information related to the environments in which livestock are kept, it is difficult to identify which breed compositions work best and are better adapted in what conditions (agro-ecological zones, production systems, feeding systems). These constraints are particularly acute where the herds are small, with low access to inputs, and lack appropriate management of mating.[246] Consequently, farmers may not achieve the desired outcomes and might prefer to work with improved breeds.[247] In these cases, digital technology plays an important role to reduce cost and simplify the recording, storage, and management of data.[248]

At the same time, several projects have been initiated across the continent to *retrospectively* identify the genetic composition of local cattle stocks. By reverse engineering the genotypes, experts were able to generate an estimate of ancestral breed composition of each animal. Combining this information with the environments in which the animals operate at optimum, development workers can tailor future livestock programs to suit both the animals and their environment. For example, in Kenya, the Dairy Genetics East Africa project implemented by ILRI, the University of New England, and PICOTEAM, showed that animals with less than 50 percent of exotic breed perform best in smallholder farms while those with a higher mix of exotic breeds require high input environments to succeed. In comparison, the Senegal Dairy Genetics project—implemented by ILRI, in partnership with the Interstate School of Veterinary Science and Medicine of Dakar, the University of Helsinki, and Natural Resources Institute Finland—concluded that the productivity of exotic breeds under better management was markedly higher than for indigenous zebu cattle in poor management systems. Crossbreeding indigenous zebu with *Bos taurus* generated up to 7.5-fold higher milk yields and 8-fold higher household profit per cow per year.[249] Results from each of these studies is being applied to improve decision-making at both the farm-level and the national policy level.

To scale up interventions in genetic upgrading of Africa's livestock, significant investment in local

research capacity and technology with a specific focus on African indigenous breeds is urgently required. In addition, a corresponding training program for extension workers and CAHWs to communicate the opportunities more widely is essential. Not only will this ensure that policymakers and livestock keepers better understand and protect the continent's unique animal resources, it will also ensure that they are better able to exploit specific traits and support the requirements of livestock keepers.

Commercialization, processing, and marketing

Despite increases in livestock production, Africa has not been able to translate its vast livestock potential into value-added products that can generate higher income and well-paid employment opportunities. The continent largely exports unprocessed animal products internationally and reimports them in processed form.[250] However, rapid growth in demand for animal-sourced foods presents a great opportunity to develop the livestock sector. Livestock value chains offer a multitude of opportunities for processing animal-sourced products from primary commodities, such as live animals, fresh meat, milk, eggs, hides and skins, and wool and other animal hair; to secondary goods that require little technological inputs such as leather and leather products; to those that require bigger investments, such as prepared meat, dried or frozen egg contents, butter, cheese, and animal oil and fat.[251] In fact, there is an extraordinary range of African local dairy products, ranging from fermented milk to fresh and ripened cheese to butter and dairy by-products. Commercializing and standardizing their production are an immense opportunity for promoting locally sourced and produced dairy products, as well as cottage industries.[252] The rapid transformation of staples crop value chains such as cassava and millet, fueled by a rising processing sector driven by a large and growing number of small and medium enterprises, could be replicated here.

Commercialization

In response to growing demand and better prices for their produce, supported with better access to technology and extension services, Africa's small-scale and subsistence livestock producers have a great opportunity to transition into a market-oriented production system. By promoting inclusive producer organizations livestock farmers may reduce market transaction costs and increase the return on their investments by capturing a fair amount of the value added.[253] The commercialization of livestock products, such as milk, requires the appropriate cooling and storage infrastructure. Access to storage and processing facilities may allow farmers to supply more and safer products to markets and increase their bargaining power, ultimately making more profit on what they produce. To support commercialization and processing of dairy in East Africa, the East African Dairy Development (EADD) project has introduced a network of milk hubs to collect milk.

The East African Dairy Development (EADD) project

The EADD project seeks to boost milk yields and incomes of small-scale farmers through the formation of producer organizations. Each hub can include several collection points within a 30-km catchment area, where milk is collected from farmers, measured, tested for quality control, and stored in chillers prior to sale and transportation to major processors in the area. Farmers negotiate better prices for their produce because each hub—managed by a cooperative—provides a guaranteed supply of quality milk. The cooperative can also leverage its relationships with local banks and credit agencies to support farmers, allowing them to borrow against milk delivered, rather than having to wait up to 90 days for payment. During the first phase from 2008–2013, 82 farmer-owned dairy enterprises were established and supported, representing 200,000 farmers in Kenya, Uganda, and Rwanda. Of these, 51 went on to become self-sufficient enterprises, 29 continued to require support, and only 2 were unsuccessful.[254] There was a nearly six-fold increase in the amount of milk supplied to the hubs, up from 529,000 to 3 million liters per month. Dairy income per household increased by 164 percent in Uganda, 124 percent in Kenya, and 64 percent in Rwanda.[255] The milk hubs also provided an opportunity to buy and sell inputs and supplies such as feed, vaccines, and other farm hardware, and for farmers to access additional services such as veterinarians and transporters. During the first phase, farmers earned US$113 million for milk deliveries while supported businesses earned an additional US$18 million. In Tanzania, the project was also combined with a campaign to promote the health benefits of milk in an area of high malnutrition.[256]

In chicken and egg production, commercialization can take several different forms such as micro-franchising, microfinancing, cooperative farming, enterprise development, and the outgrower model.[257] In Ethiopia, EthioChicken adopted a micro-franchising approach to sell improved chickens to rural populations, in partnership with the government. The company sells day-old chicks to independent agents who rear them for 45–56 days before selling them onward to farmers via agricultural extension agents; the government receives 20 percent of the profits.[258] The introduction of improved breeds, which gain weight and produce eggs faster than traditional breeds, provides a strong incentive for farmers to engage in this value chain. From its establishment in 2010, the company has grown exponentially, managing eight poultry breeder farms and two feed mill production plants.[259] Crucially, participating farmers produced 151 percent more eggs per week, sold 80 percent more eggs, and earned nearly 200 percent more income than those with indigenous breeds only.[260]

Processing

Across Africa, several simple techniques are used traditionally to process animal-sourced foods to increase their shelf-life and ease transportation requirements. Meats are dried, salted, or smoked, broiler chickens are plucked or eviscerated, and milk can be cooled, pasteurized, or soured. More complex processes include hanging and chilling meats as well as the production of milk powder, butter, cheese, and yogurt.[261]

Camel milk business in Mauritania

In Mauritania, female engineer and entrepreneur Nancy Abeid Arahamane established Africa's first camel milk dairy in 1989. Based in Nouakchott, Tiviski now produces over 20 different products out of camel, cow, and goat milk. The milk is collected at three collection centers from nomadic pastoralists, some dispersed as far as 800 km from Nouakchott. Tiviski's products are sold at supermarkets and numerous small shops in the capital city. The company is also looking to export camel cheese to European markets, but regulatory hurdles have limited access. By 2016, the company had already acquired half of the Mauritanian pasteurized milk market. It received a US$9.5 million investment from the International Finance Corporation (IFC) and the Global Agriculture and Food Security Program (GAFSP) in 2016 to expedite its modernization and diversification and expand its milk production. This investment has unlocked the company's capacity to process milk from over 2,000 livestock herders from across the Mauritania Sahara, 15 percent of whom are women. The company has created over 200 direct jobs at the dairies, all of which are allocated to Mauritanians, and further indirect jobs for milk collectors in Mauritania's Trarza and Brakna regions.[262,263]

Poultry business in Senegal

Established in 1976, Senegal's Sedima Group is a vertically integrated poultry business, consisting of a feed mill, hatcheries, and breeding farms. In January 2017, the company invested in a highly automated processing plant, where all the activities from live-bird handling to electrical stunning, scalding, defeathering, evisceration, water chilling, and grading are carried out. Some 780 people are employed directly at the plant, which has the capacity to process up to 6,000 birds per hour.[264] The output from the processing plant also feeds directly into two KFC restaurants in Dakar, with which Sedima has a national franchise agreement.[265]

Despite some interventions to process animal-sourced foods in Africa, more opportunities in this segment can still be harnessed to allow both youth and women to enter the value chain and create profitable enterprises.

Marketing

Access to information

Livestock producers are dependent on reliable and up-to-date information related to markets, specific value chains such as dairy, competitors, and consumer preferences to help them plan their enterprises. Yet, most livestock producers in Africa still have limited access to real-time marketing information that would enable them to make calculated decisions on when and where to buy livestock inputs or sell live animals or livestock products, how much to sell and what at what prices.[266, 267]

Marketing of live animals and livestock products in Africa occurs both in formal and informal settings. Animals are sold at varying ages and weights, involving a wide range of traders and middlemen along the value chain, until the final product reaches consumers. At the same time, animal products are sold at farm-gates, village markets, cooperatives, via traders or butchers or directly to supermarkets. In informal markets, products are often less standardized, regulation and monitoring of quality is weak, and measurement infrastructure (weights and scales) is poor or nonexistent. Moreover, marketing information and intelligence is less accessible, especially to rural livestock producers. Instead, traders have better access to information about market conditions from their informal or formal networks further downstream.[268] In addition, prices fluctuate drastically across seasons or public or religious holidays and products are often bought and sold "by eye."[269]

The provision of relevant marketing information to smallholder livestock producers would afford them the opportunity to generate an environment of inclusiveness, which enhances transparency and increases market participation.[270] With access to livestock prices at different regional markets, livestock producers' negotiating power increases and the risk of selling their livestock products below their value is reduced. There is evidence to suggest that access to adequate and relevant information prevents exploitation of livestock producers by speculators or middlemen.[271] Market information systems that gather and deliver current livestock market information and services to livestock producers[272] can help to "level the playing field" for all actors, particularly those who cannot meet the costs of accessing information.[273]

The widespread use of mobile communications technology combined with increasing satellite and satellite television capacities can help to bridge this information gap, improve decision-making among livestock producers, and provide an opportunity to formalize markets.[274] In Kenya, for instance, the Livestock Information Network and Knowledge System (LINKS) aims to fill this gap by collecting and disseminating information by text message regarding prices and any other information relevant to livestock producers.[275]

Better market information also provides producers and other value chain actors with the incentives and ability to adjust production and grasp the opportunity to meet the needs of new urban and export markets. Innovation platforms help small livestock producers to connect with various actors along the livestock value chain, access markets and information on prices and quality standards, and connect with potential buyers. One successful innovation platform is the LiLi-Market project in Mozambique. The project—introduced by the governments of Mozambique, Namibia, and Zimbabwe, ILRI, and ICRISAT beginning in 2007—aims to connect goat keepers and cattle growers to markets.[276] The project seeks to establish a system of continuous communication to identify local bottlenecks in livestock production and marketing, and to choose the most feasible solutions to be trialled and subsequently implemented.

Other options, such as commodity associations, can also play an important role in the provision of market information by offering reliable and accurate market information to livestock producers.[277] Livestock producers use those platforms to share knowledge regarding relevant and affordable technologies, while commodity associations establish linkages between producers and service delivery institutions as well as agribusinesses and lending institutions. Ultimately, increased access to information as well as greater transparency around product demand allows livestock farmers and herders to make more better informed decisions on when and where to market their products.

For a thriving livestock sector that reduces poverty and enhances food security and nutrition, all actors along the livestock value chain need to have good access to local, regional, and international markets. Responding to demand from markets requires, at the very least, access to relevant and timely information as mentioned above, and adequate transport infrastructure and services to deliver animals and livestock products to their designated markets.

Transport, trade and regional cooperation

The transport of livestock in Africa is a complex affair as it varies by animal, produce, region, season, and even religious festivals. Producers incur significant transaction costs when trying to market their animals or livestock products, due to challenges associated with transporting live animals and perishable products to markets.[278] At the production stage, transportation is required for bringing in inputs, such as feed and water. Transportation is also required for milk, meat, and eggs, from primary production to processors and then to markets. One particular challenge in dairy value chains is the dispersed nature of small and pastoralist producers. Collecting milk involves complex logistical arrangements and incurs significant transaction costs, especially to ensure that the milk is chilled before it spoils.

Milk collection in northern Senegal

In Senegal, La Laiterie du Berger—a dairy company that produces bottled milk and yogurts—has solved this challenge by introducing motorbike-trailers to collect milk from herders near the country's northern border with Mauritania. Without refrigeration on the motorbike-trailer, however, they have to return to the factory as quickly as possible. Once the milk is delivered to a factory in the town of Richard Toll, it is pasteurized, processed into yogurt and fermented milk, and packed into glass bottles to meet hygiene, quality, and flavor requirements. It is then transported to Dakar in refrigerated trucks.[279] On average, the herders earn US$844 per annum from selling milk to La Laiterie du Berger, and the number of herders supplying milk has quadrupled in the company's first four years. Seventy-one percent of respondents acknowledge that participating in this initiative has given them a better standard of living.[280] Despite the success of La Laiterie du Berger, there are few other successful interventions in improving transport conditions for live animals and animal-sourced foods.

In eastern Africa, camels and cattle are often 'trekked', across vast distances and several borders, and shipped to markets as far away as the Middle East. In the Sahel, three types of livestock mobility patterns are evident throughout the year: movement to optimize access to water and forage resources; to the market; and during religious festivities.[281] Transporting live animals on foot or by truck can cause stress to the animals, causing weight loss and severe bruises or cuts that can lead to diseases or even mortalities and lower market value when they are still alive. It is critical that animals be cared for appropriately during their handling, loading, unloading, and transit.[282,283] As a result, the transport requirements for the livestock sector vary greatly, from trekkers on foot to trucks (open, caged, or refrigerated) and for international trade in live animals, shipping and airlines. In many cases, due to a lack of oversight and compliance with hygiene and sanitary regulations, meat is also transported using rudimentary methods such as carts, wheelbarrows, and bicycles.[284] Building or upgrading road infrastructure that connects livestock production areas to markets and increasing proximity to market platforms to aggregate sales is critical to reducing transportation costs and travel time to avoid loss of value to live animals and animal-sourced products.

Although agreements on the free movement of goods and services do exist in Africa—for example, under the ECOWAS and the Common Market for Eastern and Southern Africa (COMESA)—regional livestock trade is constrained by high transport costs, corruption, and nontariff barriers.[285] For example, in 2015, it is reported that there were 50 checkpoints along the 1,000-km long trade corridor between Ouagadougou and Accra, with average illegal payments at each checkpoint amounting to around US$141 in Burkina Faso and US$30 in Ghana per every 100 km, significantly raising the costs of transportation and ultimately access to markets.[286] Delays during the transport of live animals can trigger weight loss and increase mortality rates.

Overcoming barriers to movement of livestock and livestock products through enforcement of agreements under regional economic communities could increase the livestock trade flow within Africa and create more income and employment opportunities. However, legislation must be in place and enforced to ensure animal welfare during transport, avoiding injury or unnecessary suffering.[287]

Livestock commodity trade partners

Across the continent, intraregional trade of livestock products is very limited, contributing 29 percent of total exports and 15 percent of total imports between 1995 and 2012.[288] At the regional level, there are large variations. Southern and West Africa are the leading regions with respect to intraregional livestock trade. In West Africa, the share of intraregional livestock trade is 45 percent of total exports, with total imports at less than 8 percent.[289] In Southern Africa, a little more than a third of exports and about a quarter of imports take place within the region.[290] In other regions, livestock trade is minimal. For example, in Central Africa, intraregional exports and imports of livestock products account for just 9 percent and 3 percent, respectively, while intraregional trade in East Africa stands at 13 percent of total exports and imports of livestock products.[291] Similar trends are also observed for the North Africa region. Overall, these findings indicate that more effort is needed to strengthen trade partnerships in order to improve trade flows across the continent. There are opportunities for some countries in East Africa to specialize, for example in dairy production, and become a key trading partner for other parts of Africa.

Livestock products originating in Africa could also be integrated into global value chains. Access to international markets can increase the return on investment in technologies for the diversification and sophistication of livestock products. Evidence shows that near half of African countries could expand their export basket of livestock products, including more sophisticated products. However, countries need to comply with regulations on animal and human health and food safety standards to be allowed to export outside Africa.[292] For example, in the United States, the European Union, and Japan, legislation requires the traceability of products.[293] Currently, the majority of small livestock farmers cannot comply with international sanitary and phytosanitary (SPS) measures due to a lack of biosecurity, technology, financial means, and technical know-how. In addition, the comparatively low overall competitiveness of the value chain, further compounded by exchange rate fluctuations, makes tapping into global livestock value chains and remunerative international markets more difficult. Moreover, trade-relevant diseases remain a major obstacle. Overcoming these challenges requires financial support, government action, and collaboration with the private sector. One approach is for governments to develop programs aimed at enabling actors along the livestock value chains to comply with stringent food safety standards and integrate them into international marketing channels such as through contract farming, as well as applying a price bonus for meeting quality and safety standards.[294]

Livestock trade between Africa and the Middle East

Cross-border livestock trade is one of the most significant growth areas of regional trade in East Africa and an important source of foreign exchange. Since the 1990s, this trade has grown from a relatively small activity to a dynamic business that contributes to local and regional food security, nutrition, and improved livelihoods, particularly among the most vulnerable rural populations including pastoralists.[295] Livestock export trade not only enables poor pastoralists to access essential goods through barter, but it also provides a basis for improving and strenghtening social and political relations between Ethiopia, Sudan, Djibouti, and Somalia. Cross-border livestock trading from the Horn of Africa to the Middle East and Gulf countries is one of the oldest cross-border livestock trading systems in the world and critical for food security and economic growth in the region.[296] In particular, the Horn of Africa has a long history of exporting large numbers of live animals—sheep, goats, cattle, and camels—by sea to the Middle East. However, the trade in live animals is vulnerable. For example, Saudi Arabia and other Gulf States have imposed several bans on the import of livestock from the Horn due to risks associated with transboundary animal diseases including rinderpest, foot-and-mouth disease, and Rift Valley fever. Such bans impact the lives and livelihoods of millions of the region's pastoralists, who rely heavily on the sale of surplus livestock to support their families.[297] In addition, due to severe and recurrent droughts rangelands are severely degraded, resulting in lack of pasture and freshwater and causing poor animal health, with consequent low prices for producers and high livestock mortality along the export trade routes. Hence, the significant market potential that exists between the Horn of Africa and countries in the Middle East has not yet been fully exploited.

More needs to be done in African countries to enhance animal disease surveillance, vaccination, and disease control, improve compliance of sanitary requirements, and thereby increase their market share in the Middle East and other regions. Nevertheless, without significant policy support to improve their food safety to meet quality standards, formal markets remain largely out of reach for small producers.

> Cross-border livestock trading from the Horn of Africa to the Middle East and Gulf countries is one of the oldest cross-border livestock trading systems in the world and critical for food security and economic growth in the region.

Consumption

Food safety and quality

There is an upward trend in the consumption of animal-sourced foods across low- and middle-income countries. This is the case in Africa, as rising incomes and urbanization facilitate a transition toward consumption of higher-value foodstuffs like dairy, meat, and eggs. At the same time, there are various challenges to be overcome at this stage, including the safety and quality of products, delivering additional nutrition through the consumption of animal-sourced food, and boosting demand beyond urban areas.[298]

The safety and quality of animal-sourced food products are important selling points for consumers. Yet, in 2015, WHO concluded that Africa had the highest per capita incidence of foodborne illnesses, leading to 137,000 deaths and 91 million acute illnesses annually.[299] Poor food safety standards disproportionately affect children and cost up to US$16.7 billion annually in human capital or productivity losses arising from foodborne illnesses.[300] Animal-sourced foods are particularly hazardous in this context.[301] The Global Food Safety Partnership has called for a three-pronged approach to addressing this challenge—one that would prioritize health-based targets to initiate data generation, take ownership and accountability of the challenge, and harness the power of informed and empowered consumers. Importantly, given the economic cost of foodborne illnesses, it is essential that interventions are delivered jointly by government and the private sector.[302] In the dairy sector, in the short-term, interventions can include training farmers, hawkers, traders, and dairy cooperatives on applying higher hygienic standards. Training must be affordable, regular, and easily accessible. Moreover, as women often participate in the informal dairy sector, it is essential that training be gender sensitive.[303] All participants would require support to purchase equipment to test, transport, and store milk products safely.[304] By working closely with dairy cooperatives and investing in improved handling methods and equipment for analyzing the quality of milk in Uganda, The Inclusive Dairy Enterprise (TIDE) was able to achieve a significant improvement in the quality of milk delivered. Milk collection centers observed less watering-down of milk supplied. Staff at milk collection centers also received training on milk quality, testing, record-keeping, milk handling, and farm management, which was then conveyed to farmers. As a result, suppliers benefited from bonus payments and increased competitiveness in the market. The training support also resulted in greater volumes being produced—all culminating in higher prices and profits for the suppliers.[305]

Although there is a clear benefit in providing safe milk to communities, it is essential that the drive to conform with international food safety standards does not restrict informal commercialization of milk. Cost and price increases are likely to lead to a fall in milk consumption, especially within poor households and for children within those households, whose current consumption levels are already very low.[306]

Fortified and enriched products

At the same time, there is greater understanding and expectation from consumers—particularly among the younger, urban middle-class consumers—who are demanding foods based on their nutrient functions rather than simply feeding.[307] The production of milk, meat, and eggs can be manipulated to provide additional nutritional benefits. For instance, if salmon oil is added to the feed for laying hens, their eggs contain higher levels of Omega 3 fats, which are important for brain functioning, immune and nervous systems, and healthy hearts. This is already practiced in egg production in South Africa.[308] Although milk and meat already contain protein, calcium, iron, zinc, and vitamin B12, it is also possible to enrich these products with selenium, iodine, calcium, iron, and beneficial lipids using specialty diets or long-acting supplements, and by modifying ruminal microflora and selecting traits or phenotypes.[309]

Boosting demand beyond urban areas

Some programs are actively encouraging consumption of animal-sourced food, especially at schools. Several school feeding programs across the continent include milk and meat as part of the daily menu.[310] Nigeria's Osun State implemented an Osun Elementary School Feeding and Health (O-MEALS) Programme in 2012, providing one mid-morning school meal a day for over 252,000 primary school children in all 1,382 public primary schools. In addition to the provision of fruit and vegetables in their meals, nutrition experts developed a menu that also included animal-sourced food: eggs, fish, and meat portions once a week and chicken portions twice a week to boost the protein and zinc intake of pupils to support their cognitive development. To supply the program, 15,000 whole chickens, 254,000 eggs, 35 head of cattle, and 10 mt of catfish were purchased weekly directly from farmers, poultry farmers, fish farmers, and meat-sellers associations, including Osun Fisheries Out-growers Production Scheme and the Osun Broilers Out-growers Programme.[311] The food was prepared by 3,007 cooks drawn from within the local community. Not only did the program have positive impact on enrolment, retention, attendance, and performance in curricular and extra-curricular activities,[312] there was also significant growth in Osun State's economy through the purchase of foodstuffs from local producers.[313] The program has now been scaled-up across the country, providing 98.6 mt of fish, 7.5 million eggs, 41,000 chickens and 813 cattle per week – all sourced from smallholder producers – for 9.5 million students.[314]

It is clear that livestock value chains involve a complex web of suppliers and service providers from producers and processors to traders, retailers, and equipment providers, extension service agents, and veterinarians. Interventions in any one value segment would affect actors across the value chain too. Conversely, integrated solutions that upgrade whole value chains can have transformative impacts in local communities. Stimulating the production of value-added animal-sourced food requires investments in infrastructure such as abattoirs, storage facilities, roads, electricity, and water; improving hygiene awareness; better coordination among livestock producers; easing access to finance; enhancing business, entrepreneurial, and marketing skills; and improving access to markets and market information for both inputs and products. These investments in turn support growing meat and dairy markets, create employment opportunities, enable producers to gain access to new, modern national and international markets by achieving required sanitary and hygiene standards, and generate additional income for value chain actors, particularly when dealing with highly perishable products.

7. Creating an enabling environment for Africa's livestock sector

To leverage its potential to significantly contribute to agricultural transformation and improved nutrition outcomes, Africa's livestock sector requires a robust enabling environment and governance system, particularly in the context of a reliance on imports and large-scale industrial livestock systems supplanting small-scale producers. As agrifood systems become increasingly knowledge-intensive and the livestock sector expands beyond its traditional systems with new opportunities along the value chain, the necessary government institutions and support infrastructure need to be in place to support pastoralists and small livestock farmers as well as those living and working in Africa's rural areas. As discussed in this section, various factors create an enabling environment. In addition to commitment at the highest level, a solid regulatory framework that governs animal and human health and food safety standards, access to financial services, technology adoption, as well as access to and availability of reliable data are key ingredients that contribute to a thriving livestock sector.

Regulation

Demand for livestock products has grown rapidly over the past few decades resulting in increasing levels of livestock production and making it one of the fastest growing agricultural subsectors. However, in many countries this is the result of private investment, frequently in high-density, large-scale commercial systems. With little regulation in place, these developments force smaller livestock producers out of the market. In addition, the increase of animal population densities has direct impacts on the environment: land degradation, soil, water, and air pollution, GHG emissions, and an overall reduction in biodiversity. This is coupled with increased risk to human health from animal-borne diseases.

Hence, there is an urgent need for increased public sector investment, institution building, and regulation of the livestock sector. National or regional policies as well as regulations require careful planning and design and must factor in the adverse impacts of climatic, disease, or conflict-related emergencies on national livestock sectors. At the same time, it is critical that policies and regulations be designed or administered so as not to act as barriers to efficient market operation as trade between countries and regions is set to increase.[315] The African Continental Free Trade Area (AfCFTA) will further facilitate trade among African nations and require proper regulation of production systems to facilitate safe inter-African trade and sustainable development.

The expansion of Africa's livestock sector will create new opportunities for Africa's rural populations, but if not managed and regulated well, it could also have negative effects on human health and the environment, as experience elsewhere, for instance in Asia, has shown. In the last 30 years, meat consumption in South Asia, Southeast Asia, and East Asia together increased from about 36 million mt to over 125 million mt, while milk consumption increased from 60 million mt to almost 220 million mt.[316] Coupled with increases on the production side, this has had a number of negative effects on society: smallholder farmers forced out from small-scale poultry and pig production, and human health affected by outbreaks of zoonotic diseases such as avian influenzas and animal-food-borne diseases, by livestock-associated pollution of soil and water, and by metabolic and diet-related illnesses in humans, as a result of high consumption of animal products.[317]

As Africa's livestock sector grows and trade in live animals and livestock products across the continent and with other regions is set to increase, regulation will be critical to ensure that the safety of human and animal health is ensured and the environment preserved.

Regulation governing human and animal health

As livestock production is largely led by the private sector, the main role for African governments will be to ensure that policies—implemented through public investments, and importantly laws and regulations—support a sustainable transformation of the sector. Grassland degradation, soil and water pollution, excess GHG emissions, and animal epidemics and zoonotic diseases are all consequences of inappropriate livestock farming practices that can lead to substantial costs to national economies. Zoonotic diseases, as discussed in section 5, can affect the entire livestock industry. For example, it is estimated that the 2004 - 2005 avian influenza in China reduced poultry production by over one-third

Grassland degradation, soil and water pollution, excess GHG emissions, and animal epidemics and zoonotic diseases are all consequences of inappropriate livestock farming practices that can lead to substantial costs to national economies.

at its peak, and that the 2009 swine flu pandemic infected over 100 million people with a death toll of approximately 20,000.[318] While it is not yet possible to predict the precise impact of the ongoing COVID-19 pandemic on the global, and more specifically the African livestock sector, it is expected to have a significant impact, with important lessons for devising regulations governing the sector in the future.

At the same time, data shows that the demand for livestock products including beef, dairy and poultry, will double to triple in Africa by 2050, and the major share of the demand will be in urban and peri-urban areas. In order to meet this growing demand, the number of medium-sized farms emerging in Africa's peri-urban areas is likely to increase, as well as the number of mixed crop-livestock farms. As livestock farms and keepers now also appear in more densely populated peri-urban areas, the risk of health threats from livestock diseases—some of those transferable to humans, like the avian influenza—is increasing. Without proper regulation in place, the health of farmers and urban populations as well as that of the animals is at risk.

A greater number of unregulated farms in highly populated areas could lead to poor waste management contaminating the soil and local water resources, and to the overuse and inappropriate use of antimicrobials, which contributes to antimicrobial resistance in animals and humans. Governments and regional and local institutions need to design, implement, and ensure compliance with regulations, for example on proper handling of livestock products along the peri-urban value chain, and on biosecurity measures in urban livestock markets. Supporting Africa's growing livestock sector through sound regulation will help to provide affordable and safe food to the population while protecting against serious public health threats.

A set of five principles, known as the Five Freedoms, form the basis of guidelines and, in some countries, of regulation and legislation that contribute to animal welfare.[319] According to the Five Freedoms, good animal welfare should provide "freedom from hunger and thirst, discomfort, pain, injury and disease, and fear and distress, together with freedom to express normal behavior". Particularly problematic in the context of animal welfare can be: *transport*, for example the use of public transport, unsuitable vehicles, or long-distance trekking; *slaughter*, including pre-slaughter management, for example where animals are dispatched with no prior stunning; *limited or no access to food and water*; *handling/herding methods*, culling or inappropriate disposal of sick or low-value animals and keeping of animals. One prominent example is poultry kept in battery cages, or at very high stocking densities.[320] It has therefore been recommended that assessments of local stakeholder attitudes, of animal welfare standards achieved, and of relevant institutions and policies should be included in any national livestock sector review.[321] At the same time, livestock breeders need to ensure that their breeding objectives are directed at sustainably producing healthy animals.

Regulating livestock-environment interactions

Currently, the impact of livestock on the environment is less pervasive in Africa than in Asia.[322] However, the anticipated further expansion of Africa's livestock sector and associated value chains, if uncontrolled, can have adverse impacts on the environment and the natural resources upon which rural communities, and pastoralists depend. Understanding the interactions between livestock and the environment is therefore essential to developing a thriving, sustainable livestock sector. In particular, the extent of grassland degradation, land and water pollution, water scarcity, biodiversity loss, and GHG emissions must be better understood.

Rangelands currently cover an estimated 66 percent of Africa's land surface, although this share varies from country to country. Rangeland degradation, as a result of overgrazing, is an important threat to Africa's livestock sector that requires urgent attention.[323] Lessons can be drawn from past livestock growth in other developing regions to design and implement policies that effectively manage the trade-offs associated with livestock sector transformation and the environment.

Financial services

The livestock sector in most African countries remains seriously underfunded, despite its significance for economic growth and poverty reduction. At the national level, few African countries allocate enough to the development of their livestock sectors, preferring instead to invest in crop farming. For instance, Burkina Faso allocated a mere 0.7 percent of the national budget to the livestock sector in 2004 and 0.9 percent in 2005, compared to 14.3 percent allocated to agriculture in 2005.[324] In Nigeria too, funds allocated to the livestock sector for 2005 amounted to less than 2 percent of the agricultural budget.[325] Nonetheless, 10 African governments have created independent ministries for livestock, ensuring that the sector is better funded and there is dedicated oversight on livestock activities.[326]

Yet, the key challenges lie in enabling finance to reach livestock producers and value chain actors. Growth in the livestock sector is currently severely

constrained by limited access to finance and credit from formal institutions for both livestock producers and other value chain actors. For formal financial institutions, small livestock producers appear to be risky investments with little collateral, are expensive to service and provide infrastructure for, carry high transaction costs, and produce only marginal returns.[327] Hence, livestock producers are forced to finance their activities using their own funds, or by paying exorbitant interest rates on credit from input suppliers or other informal sources such as money lenders or community-based organizations. In fact, in Tanzania as many as 95.6 percent of livestock value chain actors finance their operations from their own sources,[328] while in Ethiopia, informal sources provide up to 69 percent of credit to poor households.[329] This use of informal credit sources can increase the cost of an animal by 20 to 25 percent.[330]

Although livestock producers can be "asset rich" in terms of the size of their animal stock, they lack working capital.[331] As a result, they must sell their prime asset—their livestock—to pay for emergencies, inputs, education, health needs, and disasters such as crop or market failures. Therefore, while livestock can simultaneously serve as assets and insurance, the sale of livestock can have significant impact on producers' ability to continue earning income. Moreover, with the increasing threat of climate change, holding livestock as a capital asset will be even risker. Livestock cannot be "part sold", and their sale is often necessary at a time when other livestock keepers also have to sell their animals—for example, during droughts or crop failure—so prices are depressed. For other actors in livestock value chains, access to finance and credit is equally challenging. As livestock value chains grow, they respond to increased regulatory oversight such as veterinary certification, grading, registration, and standards as well as slaughtering fees. The implementation of new formal business procedures and compliance requires financial support, as new institutions and infrastructure are put in place.[332]

Financial products must be (re-)designed and made available in a coordinated way to cater for the unique circumstances of all livestock value chain actors in order to overcome the physical distance, seasonality of production, and inherent risks in livestock production.

Financial products must be (re-)designed and made available in a coordinated way to cater for the unique circumstances of all livestock value chain actors in order to overcome the physical distance, seasonality of production, and inherent risks in livestock production. Products must also accommodate the varying needs of value chain actors who require different sizes of loans and for different durations. For example, while producers may need short-term loans for livestock acquisition or forage production, processors may need larger loans for the medium to long term for equipment purchase or investments in processing.[333]

Conventional formal sources of finance would have to reinvent their products—in partnership with the public sector—to reach new markets. In addition, value chain actors themselves can act as financiers through forward contracts or by providing inputs on credit.[334] Livestock insurance also plays a vital source of financial support, particularly during and following emergencies or to enhance the creditworthiness in the eyes of banking and nonbanking institutions. Finally, innovative solutions using digital technologies can also provide additional sources of finance and a means to reach remote communities. For instance, a young entrepreneur has pioneered a "crowd-farming" app in South Africa to buy shares in a cow. The Livestock Wealth app connects livestock producers to investors who can invest from US$41 upward in pregnant cows or free-range oxen for a return of between 5 to 14 percent when they are sold or slaughtered. In this way, livestock producers use their stock itself as collateral to raise funds. Indeed, livestock itself can be used as collateral where supported with thorough recordkeeping. The company began with 26 cows in its portfolio in 2015. It now trades with more than 2,000 cows and has raised more than ZAR 50 million (approximately US$2.8 million).[335,336]

Microfinance institutions (MFIs) are another alternative source that can provide short- and medium-term financing for livestock producers. For example, in 2015, there were 33 MFIs in Ethiopia serving 3.3 million clients. They provide facilities for savings, loans, micro-leasing activities, micro-insurance, and money transfer services.[337] Although they often cater for smaller clients and crop farmers, some MFIs also provide loans for large equipment purchases and to livestock farmers. However, MFIs themselves have to borrow from larger formal institutions such as national or private banks, which in turn affects the rates that they are able to offer downstream. To reduce the risk to the MFI and by extension the banks, the government of Mali established the Fonds de Garantie pour le Secteur Privé (FGSP, the Guarantee Fund for Private Sector) to support agricultural finance. By combining financing from the government (40 percent) and the banks themselves (60 percent), the FGSP effectively underwrites the loans made to MFIs, guaranteeing up to CFA 500 million (US$1 million) for up to 10 years.[338]

These types of guarantees have also been provided to regular banks to encourage them to extend credit to livestock value chains in Swaziland. To support the commercial viability of beef production, the government of Swaziland established a US$100,000 Stabilization Support Fund, underwritten by the International Fund for Agricultural Development (IFAD) and implemented by ILRI, to share the risk of loss-related loans and subsidize the interest due from livestock value chain actors. As a result, Nedbank—a South African bank—was able to offer credit to cattle fatteners and feedlot companies at rates comparable to lending rates for agricultural activities. By supporting this downstream value chain activity, the program encouraged more efficient production of cattle, leading to an overall improvement in income from cattle-raising activities. Farmers were able to earn US$600 per animal after the intervention, compared to US$250–350 per animal previously.[339,340]

Finally, social impact investment funds such as Oikocredit and SilverStreet Capital also provide access to finance for small livestock producers or value chain actors, either directly or through MFIs. For instance, by investing in the construction of feed-processing, storage, hatching, and rearing infrastructure in Tanzania, SilverStreet Capital transformed the local poultry value chain. Within four years of its start, Silverlands Tanzania has increased production of soya from almost nothing to 4,000 mt in 2018, and grown by almost 8,000 smallholder farmers. In addition, the sale of day-old chicks has increased from 0 in 2014 to 4.5 million in 2017 and 7.1 million in 2018.[341]

While access to finance and credit can enable livestock producers to forward-plan their production systems, access to insurance prevents them from sliding into poverty and debt following disasters and emergencies such as droughts and disease outbreaks. The availability of insurance, such as the Kenya Livestock Insurance Program, contributes significantly towards the resilience and economic viability of pastoralism as a livelihood.[342]

Kenya Livestock Insurance Program

A significant development in livestock insurance has been the application of satellite-based index data, first pioneered in Kenya by ILRI and SwissRe, in partnership with the Kenyan government, the World Bank, and local insurance companies. The Kenya Livestock Insurance Program uses satellite data to calculate the normalized vegetation difference index (NDVI), which assesses grazing conditions. As conditions worsen, insurance payments can be released as soon as a threshold is met, rather than waiting for individual losses to be reported, verified, and indemnified, as per classic insurance claims, thereby allowing pastoralists to purchase feed and water to survive the worsening conditions. By combining this solution with mobile money (m-Pesa), insurance companies also overcome the logistical challenge of having to verify claims in remote and infrastructure-deficient locations. Premiums for the pastoralists are funded through the Hunger Safety Net Program, which covers five animals per household, with voluntary top-ups added in 2018. Following the success of the pilot, during which 275 nomadic herders in Wajir County received payments, the program was extended across the rest of the country, and then into Ethiopia. By 2017, the program covered 18,000 households and was expected to cover 50,000 households by the end of 2018. The success of the program has relied on having a relatively advanced insurance and re-insurance industry and a supportive government. To further scale the success and enable insurance companies to innovate, legal and regulatory frameworks must be strengthened, as well as the provision of index-based data. Competition among providers will also encourage the development of products that are further tailored to meet the needs of pastoralists and other livestock producers.[343,344,345]

A lack of access to finance for livestock producers and value chain actors severely hinders growth and development of the sector. However, several innovative approaches are being designed by public and private sector players to address the challenges in reaching remote communities that have little collateral and engage in high-risk livelihoods. Substituting or reducing the role of livestock as a capital asset by implementing and scaling up other financial products would also provide co-benefits in terms of climate change, natural resource use, and productivity.

Technology adoption

As described in the Malabo Montpellier Panel's 2019 report on digital agriculture, Africa's digital transformation is already underway, and the continent now has the opportunity to leverage the potential benefits of digitalization and new technologies for its growing livestock sector.[346] Key benefits of digitalization include greater access to information and services - including finance and links to markets - as well as timely animal health and disease information for quick response. Importantly, digital technologies can also help bridge the gender divide in access to information. Digitalization can also lead to a sustainable increase in productivity. It can help to overcome the geographic, social, and economic isolation of rural livestock farming and pastoralist communities and connect them better to other segments of the value chain, while the ability to broadcast information fast and cost-effectively can bring successful technologies to scale more quickly.[347] Furthermore, the Malabo Montpellier Panel's 2019 report on energy provision to Africa's rural areas stresses the importance of off-grid and mini-grid solutions—such as solar electricity supply—to enable cold chains for meat, dairy, and vaccines or the use of mobile electric fences for lower-cost grazing management.[348] Thus far, technology adoption among small livestock farmers and pastoralists is limited, primarily due to limited or no access and connectivity to the internet or other new technologies and services. And where technologies are accessible, they are often expensive or there is lack of technical know-how on how to operate them.

However, in some parts of the continent, new technologies are already being used to benefit livestock farmers. As theft and disease outbreaks are common and costly, farmers turn to new technologies to manage their animals and herds. Although GPS is usually used to track wild animals, GPS tracking devices are now being adapted by some small- and large-scale farmers to manage their livestock, notably in Kenya, Uganda, Botswana, and South Africa, to precisely pinpoint an animal's location and alert farmers when an animal goes missing or is stolen. Such Livestock Identification and Traceability Systems (LITS) can also enhance livestock production and trade through improved surveillance, management of infectious diseases, and control of livestock movement. Animal identification and traceability can further increase animal health and food safety. While traditional methods use hot-iron livestock branding, digital technologies use radio frequency identification (RFID) or microchips to track animals. RFID technology, which is inserted into each animal's ear or rumen, can be scanned by handheld readers. A unique identification number on each tag records a full history of the animal's production, distribution, processing, and sale as meat, as well as health of the animal.[349] While there are recent trials of the new LITS technology in the northern Tanzania–Narok–Nairobi trade route,[350] only a few African countries (Botswana, South Africa, and Namibia) are already using LITS successfully and export chilled and frozen beef to the European Union. The Namibian Livestock Identification and Traceability System (NamLITS) also helped to minimize the impact of an outbreak of foot-and-mouth disease in 2015/16. Using digital technologies, animal technicians were able to accurately track the movement of cattle and detect the exact areas of contamination and possible contamination to prevent further spread.[351, 352]

Other technologies, such as blockchain, can be applied to increase the transparency and traceability of livestock and livestock products, which is becoming increasingly important as livestock trade between countries and with other continents grows. In Morocco, the National Office for Sanitary Safety of Food Products developed a new national system for animal identification and traceability (SNIT), implemented in 2015 as part of the Plan Maroc Vert. Livestock can be identified using electronic tags that communicate with the national SNIT database via mobile phone networks. The system serves as a tool to increase transparency and traceability while promoting Moroccan animal products on international markets such as the European Union. In addition, the identification tags have other benefits for breeders too, including providing evidence of ownership and theft prevention, facilitating access to government subsidies, and ensuring that meat meets quality and safety standards.[353, 354]

Farmers can also use technologies to access information on current prices of agricultural commodities and livestock products or receive mobile livestock extension services. As discussed in the previous chapter, access to this information significantly improves farmers' decision-making about where to sell their produce or purchase inputs,

thereby reducing transport costs to markets and allowing farmers to sell their produce when demand and prices are high.[355, 356] Especially in areas where education levels are limited, mobile technologies can reach livestock producers through videos, pictures, or voice messages to provide relevant advice on best livestock production practices for animal breeding and animal health, livestock-related activities, and nutrition.[357] Examples of such interventions include Kenya's SMS Sokoni project, operated by the private firm Kenya Agricultural Commodities Exchange in collaboration with Safaricom, that allows recipients to receive agricultural information by text message for free. Another example is a project led by Syngenta Foundation and the Uganda National Farmers Federation, that supports dairy farmers to use mobile phones to directly deal with buyers, negotiate prices, and organize delivery.[358]

Finally, digital solutions are being introduced to ensure that pastoralists have access to pasture, such as the Predictive Livestock Early Warning System in Kenya. The use of satellite information can provide important information on forage quality to livestock farmers and pastoralists so they can decide where to move their livestock. Both local weather conditions and pasture management have a direct effect on livestock productivity and pasture quality and hence output. Regular monitoring and prediction of pasture growth rates using satellite information can improve the use and management of pastures by avoiding overgrazing, providing guidance with regards to food supplement decisions, or even alerting farmers to wastage during periods of surplus pasture availability. Project Concern International uses satellite imagery to develop maps that show the current state of forage and grazing land quality in different areas of a country. The information is accessible via the AfriScout app. Using the app, pastoralists can access maps and obtain localized, real-time information about vegetation and surface water, enabling them to make better decisions about where to move their livestock. This results in improved profits for nomadic herders and their families, for whom livestock—the sale of meat, milk, and by-products, such as leather—is often the only source of income.[359]

The Predictive Livestock Early Warning System

The Predictive Livestock Early Warning System (PLEWS) in Kenya provides a forecast for areas with acute and chronic food and forage insecurity. The system combines data on water depth in surface pans or ponds used by livestock, forage biomass growth and grazing, rainfall, temperature, and normalized difference vegetation index—measuring live green vegetation to provide six-monthly estimates of forage security for animals and food security for humans. The resulting actionable information can also be linked to contingency funding at the National Drought Management Authority and integrated into an index-based livestock insurance scheme to support livestock keepers during prolonged droughts.[360] In Ethiopia, the Satellite Assisted Pastoral Resource Management project initiated by Project Concern International (an NGO) also provided digital maps to pastoralists displaying the amount of vegetation in the area. In a successful pilot project in the Afar and Oromo regions, up to 78 percent of pastoralists used the maps, with a consequent reduction in livestock mortality of 47 percent.[361]

Livestock data

Currently, there is very little high-quality, reliable and frequently collected data available on livestock in Africa—including on the number and type of livestock at country or regional level, productivity, and animal health. This lack hampers the design and implementation of public and private sector policies, strategies, and investments for further livestock sector development. The sector's potential contribution to economic growth, poverty reduction, and food system transformation thus remains largely untapped. A 2014 report by FAO, ILRI, the World Bank, and other partners reviewed existing livestock-related data/datasets for African countries.[362] The report found that:

- There are a variety of livestock-related indicators within Africa at country level, including figures on animal numbers and meat and dairy production, consumption, and trade flows of a number of livestock products. The quality of available data, however, is often questioned by livestock stakeholders, even for the most basic indicators such as livestock numbers.
- Nationally representative household, agricultural, and/or farm surveys tend to marginally appreciate livestock. The survey questionnaires contain only a few, if any, livestock-related questions, mainly focusing on the number of animals owned and value of production.
- Specialized livestock surveys are rarely undertaken by national governments. These surveys would typically target technical issues—such as animal breeds, feed, animal diseases, and meat production—with an ultimate objective of better understanding the determinants of livestock production and productivity.
- Although national governments regularly collect data on animals, the quality of the collected data, including their timing and accuracy, is uncertain.
- Finally, all sources of livestock data and statistics—such as agricultural and livestock censuses, periodic and *ad hoc* agricultural sample surveys, and household income or expenditure surveys—rarely, if ever, generate comprehensive information on pastoral production systems, which is of considerable relevance, particularly to countries in the Sahel and the Horn of Africa.

Availability of and access to comprehensive and good quality information and data on all aspects of the livestock sector, particularly for policymakers, and is critical for the design of effective policies, regulations, and investments from national to the farm level. This information is equally important for researchers informing policy design, private businesses and investors making decisions on how to grow their livestock businesses, extension agents advising livestock farmers and pastoralists, and not least farmers and herders themselves. A new livestock data portal launched in May 2020 and managed by Supporting Evidence Based Interventions (SEBI) on behalf of the Livestock Data for Decisions (LD4D) Community of Practice pulls together data and evidence on the livestock sector in low and middle-income countries. The portal aims to create a demand-driven knowledge base of open access data, interactive tools, and visualizations that policy makers and investors can use to make evidence-based decisions. Data is provided by its members, including from FAO, ILRI, and the Food Systems and Global Change group at CSIRO.

8. Evidence from country-level analysis

Methodology

In several countries in Africa, livestock production– breeding, rearing, and owning– is an important component of the agriculture sector. Some governments have demonstrated a high commitment to strengthening the role of the livestock sector in improving food security and nutrition and economic growth. Their experiences in terms of policy and institutional innovation and programmatic interventions provide important lessons for other African countries seeking to develop and strengthen their livestock sector. To select countries for this analysis, two indicators were combined: the stock of animals and the growth rate of the livestock subsector.

As a first step, the average livestock stock TLU per 100 people over the period 2000–2016 (FAO data) was the indicator chosen to assess countries' levels of animal stock. To define high and low levels of animal stock, the threshold was set at the median. Countries that reported a stock of livestock above this threshold, 23.44 TLU per 100 people, were categorized as having a high level of livestock stock. Countries below that threshold were categorized as having a low level of livestock stock.

In the second step, we identified countries showing a high growth rate for the livestock subsector. The average growth rate of the gross production value (GPV) of livestock (in constant 2004–2006 international dollars) over the period 2000–2016 (FAO data) was chosen as the indicator for this second attribute. The GPV has been compiled by multiplying gross production in physical terms by output prices at farmgate. As the prices used to derive the GPV are the average prices over 2004–2006, known as the base period, this indicator shows how the quantity or volume of products has changed. The median was also considered as the threshold for this indicator. Countries showing an average growth rate of the GPV of livestock above 2.2 percent were grouped within the high livestock sector growth category. Those countries ranking below the threshold were grouped within the low livestock sector growth category. The two indicators were combined to generate four clusters as shown in table 1.

The resulting cluster of countries evidencing both a high stock of livestock and a high growth rate of livestock production is representative of countries where livestock resources are abundant and the subsector is dynamic: Cameroon, Central African Republic, Djibouti, Eritrea, Ethiopia, Guinea, Mali, Kenya, South Africa, Uganda, and United Republic of Tanzania.

Table 1: clustering of countries

	Low growth	**High growth**
High stock	Botswana, Burkina Faso, Chad, Eswatini, Guinea-Bissau, La Reunion, Lesotho, Madagascar, Mauritania, Namibia, Niger, Senegal, Somalia, Tunisia, Zimbabwe	Cameroon, Central African Republic, Djibouti Eritrea, **Ethiopia**, Guinea, Kenya, **Mali**, **South Africa**, Tanzania, **Uganda**
Low stock	Cabo Verde, Comoros, Democratic Republic of the Congo, Equatorial Guinea, Gabon, The Gambia, Libya, Mozambique, Nigeria, Sao Tome and Principe, Seychelles	Algeria, Angola, Benin, Burundi, Congo, Côte d'Ivoire, Egypt, Ghana, Liberia, Malawi, Mauritius, Morocco, Rwanda, Sierra Leone, Togo, Zambia

Based on the regional representation and availability of key literature, four countries – Ethiopia, South Africa, Mali, Uganda – were selected from the cluster of high stock and high growth as case studies. Furthermore, South Africa and Uganda, displayed a relatively high milk yield per animal between 2000 and 2016 (FAO data). This can also be reflective of the potential of the livestock sector in these countries to sustainably supply food products, particularly dairy products, with the potential for poverty alleviation and improving food security and nutrition.

CASE STUDY

Ethiopia

Ethiopia has the largest livestock population in Africa, with nearly 63 million cattle, over 31 million sheep and 33 million goats, and 61 million chickens in 2018.[363] The sector contributed up to 40 percent of agricultural GDP, nearly 20 percent of total GDP, and 20 percent of national foreign exchange earnings in 2017.[364] Between 2000 and 2016, the average stock of livestock, measured in tropical livestock units (TLU) per 100 people, stood at 50.970 TLU, more than double the continental median of 23.44 TLU. At the same time, the average growth rate of gross production value during the same period was 4.54 percent—also twice the continental median of 2.2 percent. These successes are an outcome of comprehensive government action at the institutional and policy levels for both, pastoralist and non-pastoralist communities. Interventions across livestock value chains on animal health, inputs, research and marketing as well as incentivizing private sector engagement have ensured that the sector thrives. Combined with a young rural workforce and proximity and strong relationships with the Middle East—one of the world's largest meat markets—Ethiopia has the prerequisites to develop a vibrant and competitive livestock sector that can also help to improve the food security and nutrition status of its population, as well as meet its ambition to become a middle-income country by 2025.

Institutional innovation

The livestock sector has gained prominence in Ethiopian politics and institutional presence over the last 10 years. Until 2013, elements of the livestock sector value chain were allocated to different departments within the Ministry of Agriculture (MoA) and Ministry of Trade (which primarily handled the trade of live animals).[365] The MoA led the development of the Livestock Master Plan to coordinate activities in the sector (see below). In 2013, MoA created the State Ministry of Livestock and Fisheries to guide overall livestock and fisheries development in the country. Three departments—for livestock production and fisheries, veterinary services, and pastoral development—were formed within the State Ministry to administer the sector.[366] The State Ministry was mandated to bring to scale good practices in livestock productivity; reduce the prevalence of animal diseases; facilitate private sector participation across the value chain; oversee pastoral area development; regulate import and export of livestock, livestock products and inputs; and expand research in the livestock sector.[367] In 2015, the State Ministry was formalized as the Ministry of Livestock and Fisheries (MoLF), thereby affirming the importance of the sector to the Ethiopian economy and politics. MoLF comprised three state ministers, for Animal Health and Feed (including veterinary drug regulation), Animal Production and Fisheries, and Marketing of Inputs and Outputs. In addition, the State Ministry for Animal Production had a specific unit for Pastoral Area Development and Cooperation. Creating MoLF as an independent ministry provided more focus and autonomy to scale up government support for the sectors.[368] Its formalization was also financed by a US$170 million loan from the World Bank in 2017 to increase commercialization of producers and processors, improve service delivery, and respond to emergencies in mixed-crop livestock production systems.[369] Currently, the primary institution responsible for livestock is the Ministry of Agriculture (MoA), while the Ministry of Peace oversees pastoralist issues. MoA assumed responsibility for the livestock sector following a merger between MoLF and MoA in 2018 meant to align priorities and deliver joint agriculture and livestock targets simultaneously.[370]

The Ministry of Peace, established in 2018, leads the management and oversight of pastoralist issues, previously located under the Ministry of Federal Affairs and Pastoralist Development. The key role of the Ministry of Peace in this respect is to coordinate, harmonize, and monitor interventions in pastoralist areas by different ministries. Pastoralist matters are also represented in Parliament by the Agriculture Pastoral Affairs and Environmental Protection Standing Committee (formerly the Pastoral Affairs Standing Committee (PASC)) within the House of Peoples' Representatives.[371] PASC was founded in 2002 to ensure equitable pastoral development through legislative, oversight, and representative processes. Committee members were drawn from different ethnic groups and regional states.

Front-runner on animal health

Responsibilities for animal health and marketing have also advanced in parallel. Veterinary services were first boosted by the establishment of the National Veterinary Institute (NVI) in 1964, through MoA, to develop, manufacture, and disseminate vaccines. It achieved internationally recognized certification for the production and distribution of vaccines in 2005.[372] By 2020, NVI was producing 20 different vaccines for domestic use and occasionally for export to up to 26 African countries. From producing nearly 4 million doses of vaccines per year in its early years, NVI now (2020) produces approximately 200 million

doses per year.[373] In October 2018, NVI received a lyophilizer (freeze dryer) from FAO and the European Union to produce thermostable vaccines against sheep and goat plague (PPR). The technology is expected to support the eradication of PPR from Ethiopia by 2027.[374] A new manufacturing plant is also being constructed at the main campus to augment production of veterinary drugs and boluses.[375]

To complement NVI's remit to produce vaccines, the Department of Veterinary Services at the MoA authorized the construction of a second national laboratory focused on disease investigation in 1995. This National Animal Health Diagnostic and Investigation Center (NAHDIC) was mandated to lead national efforts in disease surveillance and monitoring, investigation and research, and support laboratory testing for export and import animals.[376] Both NVI and NAHDIC are supported by regional veterinary laboratories across the country. The formation of the Ethiopian Veterinary Association (EVA) in 1974 provided further momentum in the promotion and strengthening of the veterinary profession and service provision, now representing over 1,500 professionals.[377]

More recently, the Veterinary Drug and Animal Feed Administration and Control Authority (VDAFACA) of Ethiopia was established in 2011 to regulate the delivery of safe and quality feed and effective veterinary drugs . VDAFACA registers manufacturers, importers, and wholesalers of veterinary drugs, equipment, and feed, thereby ensuring a clear role for private entrepreneurs in the livestock sector.[378]

Finally, the National Institute for the Control and Eradication of Tsetse Fly and Trypanosomiasis (NICETT) was established in 2014 with the support of the International Atomic Energy Agency (IAEA). NICETT is an independent organization, accountable to the MoA, mandated to eradicate the pest and disease across the country.[379]

Prioritizing research

At the same time, Ethiopia has invested heavily in the development of its agricultural research capacity. To expand home-grown competence in animal health, a Faculty of Veterinary Medicine was founded in 1984 at Addis Ababa University. Four additional faculties were added by the Ministry of Education at the turn of the millennium,[380] and the number of veterinary schools increased from 1 to 15 between 2005 and 2015.[381] Moreover, a new research system was formalized through the establishment of the Ethiopian Agricultural Research Organization in 1997. Renamed the Ethiopian Institute of Agricultural Research (EIAR) in 2005, the organization is mandated to adapt, produce, and demonstrate new agricultural technologies. Within the livestock sector, EIAR has led the development of several new breeds (particularly crosses of local Boran cattle with Jersey and Holstein Friesian breeds), new varieties of forage and pasture, and husbandry methods, such as generating feeding strategies for dairy, beef, and poultry production, production processes for camels, and housing and health management for poultry.[382] EIAR is also supported by regional research institutes. Complementing the technical and scientific research capacity provided by EIAR, the Ethiopian Agricultural Transformation Agency (ATA) supports both public and private sectors to promote the uptake of specific solutions, including within livestock value chains.[383]

Export-oriented production with private sector support

Much of Ethiopia's livestock production is destined for export markets, primarily in the Middle East. Since the sector is a key source of foreign exchange, forming strong marketing institutions has long been a focus of Ethiopia's livestock sector development.

Ethiopia

Initially located inside federal ministries, the Livestock Marketing Agency (LMA) was established in 1998 within the Ministry of Trade to promote and govern domestic and export trade of livestock and livestock products. This was done by issuing quality control regulations on exportable and importable materials, organizing quarantine stations, facilitating the construction and maintenance of markets and abattoirs, and nurturing research. To improve cooperation between marketing and veterinary services, the LMA was redeployed as the Livestock and Fishery Marketing Department (LFMD) in 2005 within the Ministry of Agriculture and Rural Development.[384] The LFMD led efforts to privatize functions in the livestock value chain, including promoting private tanneries, export abattoirs, leather industries, and poultry farms.[385] Marketing responsibilities have since been transferred to the Ethiopian Meat and Dairy Technology Institute, formalized in 2010 and renamed as the Ethiopian Meat and Dairy Industry Development Institute (EMDIDI) in 2013, which is mandated to raise the sector's global competitiveness. Upholding the objectives of the LFMD, EMDIDI also facilitates private sector involvement in the meat and dairy industries.[386]

In addition, in 2003, the Ethiopian government established the National Export Coordinating Committee, subsequently renamed the National Export Council (NEC). NEC is mandated to boost trade by assisting companies to overcome export-related challenges and coordinating among government institutions. NEC is chaired by the Prime Minister's office, and comprises relevant ministerial and institutional representation, such as the Ethiopian Revenue and Customs Authority, the Ministry of Trade, and the Ministry of Industry, as well as the National Bank of Ethiopia, Commercial Bank of Ethiopia, and Ethiopian Airlines. Six export sector committees—for coffee, oil seeds, minerals, leather, horticulture, and meat and live animals—meet periodically to review export performance.[387] This leadership from the NEC contributed to the growth in exports by about 22 percent per year on average between 2006 and 2012.[388]

Stimulated by a national drive to increase the export of live animals and meat, combined with greater private sector engagement, there were seven operational slaughterhouses and eight more under construction by 2015. In addition, 28 abattoirs were serving the domestic market.[389] The sector also attracted foreign investment from companies like Verde Beef Processing PLC (Norway) and Allana Group (India), catapulting the Ethiopian companies to become the largest cattle processing operation in East Africa.[390] Over 20 years from 1999 to 2019, the volume of meat exports increased from approximately 8,000 mt to over 19,000 mt. The corresponding value of meat exports (chilled shoats, beef carcasses, and offal) rose from US$1.7 million to US$92.65 million. Of this, shoat carcasses alone accounted for just over US$80 million (86.72 percent).[391]

Policy innovation

The Government of Ethiopia (GoE) has introduced several policies and strategies focused on agricultural and livestock development. To meet the long-term economic goals of poverty eradication and transitioning into a middle-income country by 2025, national development plans (NDPs) have emphasized export-led growth to drive rural development and transformation. Ethiopia's NDPs have steered progress in the livestock sector through improved extension and financial support, liberalization of markets, and a more supportive macroeconomic framework.[392] The NDPs have also formed the basis for a Livestock Master Plan (LMP), developed in 2015, in turn inspiring the formulation of similar plans in Rwanda and Tanzania.[393] This continued and

dedicated policy focus has contributed to growth in production and productivity in Ethiopia's livestock sector. Policy and incentive packages have further catalyzed foreign direct investment in the livestock sector, while companies like EthioChicken (see section 6) have transformed the poultry sector.

Special effort for pastoral areas

Although considered a minority population, pastoralists owned approximately 69 percent of Ethiopia's cattle, 53 percent of sheep, 67 percent of goats, 25 percent of camels, and 22 percent of poultry in 2017.[394] They are therefore a central pillar for success in Ethiopia's livestock sector. Since the 1990s, the GoE's view on pastoralism has shifted away from its former top-down approach, toward a more inclusive approach focusing on poor livestock-holders and poverty reduction, rather than only focused on the livestock.[395] Crucially, Ethiopia's constitution—adopted in 1995—guarantees pastoralists the right to grazing land and not to be displaced from their lands. The constitution also endorses farmers' and pastoralists' right to receive fair prices for their products, thereby ensuring that they obtain an equitable share of the national wealth, commensurate with their contribution.[396] Informed by these principles, and recognizing the value of pastoralism in contributing to the development of the livestock sector, subsequent NDPs and dedicated policies address the challenges faced by pastoralists. Policies (and projects) have guided the provision of physical infrastructure and successfully overseen the control of contagious animal diseases. There is also a symbolic shift away from forced sedentarization to voluntary settlement.[397] NDPs in the 2000s—the Plan for Accelerated and Sustained Development to End Poverty 2005–2010 (PASDEP), Growth and Transformation Plan I 2010-2015 (GTP I), and Growth and Transformation Plan II 2015–2020 (GTP II)—all promoted the provision of veterinary services, access to water resources (water points), enhancing extension services, and improving access to markets for live animals and livestock products. In addition, the introduction of early-warning systems has made pastoralist communities more resilient to a changing climate.[398] Importantly, the change in attitude toward pastoralism, not least through the Ministry of Peace and the Agriculture Pastoral Affairs and Environmental Protection Standing Committee mentioned above, has made a noticeable contribution in raising the awareness of pastoralists and building their capacity to manage their own development affairs.[399]

Pastoralist policy in Ethiopia is also aligned with and informed by the Intergovernmental Authority on Development's (IGAD) regional Drought Resilience and Sustainability Initiative (DRSI). Following a severe drought in 2011 that affected 13.4 million people in the region, DRSI was designed to strengthen mid- and long-term resilience and reduce the need for emergency assistance, particularly among pastoralists and agro-pastoralists in the region. DRSI's vision of holistic development programming and increased investments in arid and semi-arid lands was endorsed by each IGAD country through a corresponding Country Program Paper (CPP). Ethiopia's CPP (2012) identified six components to boost production, processing, and marketing of livestock and livestock products—all aligned with other ongoing government interventions.[400] The availability of a clear vision in the CPP mobilized resources from development partners such as the World Bank, IFAD, USAID, and the German Corporation for International Cooperation (GIZ) to implement programs targeted at resilience-building and economic development in pastoral communities. The second phase of the CPP (2019–2024) aims to scale up successful results from these interventions.[401]

A new policy for pastoral development is currently under review at the Ministry of Peace, designed to sustain pastoralist livelihoods, improve food security, and coordinate interventions by public and nongovernmental actors. The policy is expected to focus on commercialization and diversification of livestock production under pastoral livelihoods with support from infrastructure development, natural resource management and tenure security, fostering good governance, and building on best practices.[402]

Advancing holistic livestock development

Livestock has been at the heart of Ethiopia's "agriculture development-led industrialization" strategy, in place since 1991. Methodical adjustments to successive NDPs—PASDEP, GTP I, and GTP II—have guided attention toward the development of a commercially viable and sustainable sector. Each NDP sets out ambitious targets for production (quantity of meat, milk, eggs and other animal products), activities for ancillary value chains (such as feed and health) to achieve those targets, and a commensurate allocation of national funding for the whole agricultural sector. Following the success of PASDEP, under which meat production rose by 39,000 mt and milk production by 1.43 million mt, the focus of livestock development evolved toward enhancing productivity.[403] During GTP I (2010–2015), the number of crossbred cattle and milk cows more than doubled, establishing the basis for intensifying productivity over the following five years. Emphasizing export markets, GTP II (2015–2020) proposes an increase in average daily

milk yield from crossbred cows from 8 to 12 liters per cow per day and an increase in average cattle carcass yield from 107 kg to 138 kg.[404] To fulfill these targets, the Livestock Master Plan—developed by the MoA in partnership with ILRI—presents a series of five-year budgeted roadmaps (covering 2013 to 2028) that identify priority investment interventions, such as better genetics, feed, and health services, to meet projected demand in poultry, red meat, and dairy value chains. Distinctively, the targets set out in the Livestock Master Plan have been aligned with Ethiopia's Climate Resilient Green Economy plan to ensure that higher livestock production remains compliant with climate ambitions.[405] The meat sector is further guided by the Meat Industry Sub-Sector Strategic Plan (2015–2025) of the Ethiopian Agro-Industry Strategy, developed by the Ministry of Industry. This strategy provides a costed plan to revitalize meat processing, eliminate inefficiencies, maximize competitiveness, stimulate upstream linkages driving commercialization in production, and support the country's progress toward becoming a middle-income country by 2025.[406]

Coordinated financing for livestock sector development

In 2010, as part of its commitments to the CAADP process, the GoE issued an Agricultural Sector Policy and Investment Framework (PIF) for 2010 to 2020. PIF aimed to align national-level aspirations in PASDEP, GTP I, and CAADP by raising production and productivity through commercialization of agricultural activities and greater natural resource and disaster risk management. PIF identified a number of priority areas for investment in the agriculture sector and highlighted the need for a focused approach to the livestock subsector, which the authors discerned had received little coordinated policy focus until then. PIF allocated a growing share of GDP to the budget for agriculture and rural development, increased from 6.2 percent of GDP in 2008/09 to 7.5 percent by 2020. Over the duration of PIF, this would amount to a total of US$11.83 billion. In addition, PIF recommended an incremental amount of US$6.23 billion over the 10 years to achieve the high agricultural growth target.[407] Although lacking specific allocations for the livestock sector, it is argued that PIF paved the way for a new investment thrust in the livestock sector by highlighting the subsector's potential and raising its profile sufficiently to warrant leadership at the state minister level. This process also contributed toward the development of the Livestock Master Plan.[408] However, not all investment priorities identified in the PIF could be funded from the national budget. Therefore, PIF highlighted a funding gap that would require investments from the domestic private sector as well as foreign private and development investments.

Fostering private sector involvement

Fiscal incentives

In 2012, the GoE outlined fiscal incentives to facilitate private sector investment in Ethiopia.[409] For the livestock sector, these include tax exemptions for capital expenditure— for example for dairy factories or farm machinery, including spare parts. In addition, entrepreneurs receive income tax exemptions for up to five years, or longer if enterprises grow by at least 50 percent during this time.[410] Taking advantage of these incentives, which were promoted during a business promotion trip by then Prime Minister Meles Zenawi, one of China's largest shoe exporting companies—Huajian International Shoe City Plc—opened operations in Ethiopia in 2012. By 2016, approximately 3,800 Ethiopian employees were producing 6,500 pairs of shoes per day at Huajian, using locally produced skins and hides. Since Huajian demanded higher standards in inputs, local tanneries were compelled to raise the quality of their leather outputs.[411] Indeed, the success of Ethiopia's leather and leather products industries is the result of over 15 years of careful and systematic fiscal and industrial policy interventions to upgrade the outputs and nudge producers further up the value chain.[412] However, without significant adjustments in livestock production (including animal health) and slaughtering processes, farmers are unlikely to benefit from this burgeoning industry.[413]

Clustering industries

GTP II in 2015 marked the formal initiation of Ethiopia's clustering approach, implemented through the creation of industrial parks. To deliver on its premise of export-led growth, GTP II outlined strategic sectors—including leather and leather products—that would be included in industrial parks and benefit from more efficient trade logistics and transport services, energy supply, and trade and customs facilitation. Industrial parks catalyze integration within supply chains, ensuring more efficient production, and attract foreign and domestic investments.[414] To further entice private sector investments in industrial parks, the GoE introduced fiscal and nonfiscal incentives such as: income tax exemption for 8 to 10 years, customs duty exemption for capital goods, construction materials and spare parts, and export credit guarantee (payment for exports in the event

that a customer defaults). Although exports from industrial parks are exempt from export taxes, hides and skins are not exempted so as to boost the export of value-added products.[415] In addition, milk processing facilities receive income tax exemptions for up to 15 years if located within these agro-processing parks.[416] By 2020, three government owned industrial parks were engaged in combined production of apparel and textiles as well as leather and leather products. They employ 23,000 workers and had exported approximately US$43 million worth of products in the previous year. In addition, one privately owned industrial park, George Shoe IP, produces only leather and leather products. Huajian has also developed a privately-owned industrial park, attracting other upstream and downstream companies in the leather industry.[417] Four additional integrated agro-industrial parks are under construction and are expected to be accessible for private investors in 2020. These will attract more private sector engagement in agro-processing, thus enhancing agricultural production and productivity.[418]

Programmatic interventions

Guided by governmental strategies, several value chain interventions have been implemented in Ethiopia's cattle and small ruminant value chains by the public sector and development partners.

Improving the Productivity and Market Success of Ethiopian Farmers

In response to concerns about low productivity among smallholder farmers and pastoralists, the Ministry of Agriculture and Rural Development in partnership with ILRI initiated the Improving the Productivity and Market Success of Ethiopian Farmers (IPMS) project in 2005. The project adopted and adapted best practices from across the world to transform subsistence cattle, small ruminant, and poultry production to more commercial systems. Interventions focused on core segments of the value chains, including inputs (feed and veterinary products and services), production (breeding and fattening), and marketing (clustering, quality improvement, and storage and processing).[419] With improved breeding technologies and techniques such as coordinated mass insemination, as well as greater uptake of commercial feeds, milk yield grew over the first five years by 30 percent from 4.48 liters per cow per day to 5.79 liters per cow per day. As the number of dairy producers participating in the program increased, total annual milk production increased from over 725,000 liters in 2005 to 3.32 million liters in 2010, and total revenue rose by 200 percent in real terms. Among producers of small ruminants, improved fodder production, greater use of crop residues, credit supply, and linkages with input and output markets led to a near doubling of the number of animals undergoing a fattening process and a growth in revenue from ETB 46 million (US$5.3 million) to ETB 120 million (US$8.9 million). With similar interventions in cattle production, the total number of fattened animals nearly quadrupled during the same period and total revenue grew by 867 percent. Finally, the adoption of exotic chickens combined with improved feed and management practices led to a 29 percent increase in egg productivity and a revenue increase from ETB 1 million (US$116,000) to nearly ETB 4 million (US$295,000).[420]

Livestock and Irrigated Value chains for Ethiopian Smallholders projects

IPMS was succeeded by the Livestock and Irrigated Value chains for Ethiopian Smallholders (LIVES) project in 2012, which culminated in 2018. Its key objective was to scale out successful approaches and interventions in high-value livestock value chains for income generation in a gender-balanced and environmentally sustainable manner. Deploying a "research for development" approach, the project centred around public research and extension service provision for technology development, capacity building, and knowledge generation and dissemination. LIVES recognized that unlocking the full benefit of livestock value chains can engage different stakeholders at different stages of the value chain.[421] Interventions in cattle, sheep, and poultry value chains resulted in several outputs highlighting lessons learned and implications for scaling out.[422,423]

Feed Enhancement for Ethiopia Development project

The Feed Enhancement for Ethiopian Development (FEED) project was implemented by ACDI/VOCA in 2009 through USDA's Feed for Progress program. The aim of the project was to boost access to, and use of, high-quality feed for livestock and poultry. Through training and technical assistance, FEED sought to stimulate additional production of animal feed to increase its availability and affordability. Working in collaboration with local government offices and the private sector, FEED established new nurseries and rehabilitated existing ones to expand the production of quality forage seeds such as alfalfa, Rhodes grass, elephant grass, and pigeon pea. FEED also supported cooperatives to transition into feed production; 13 commercial enterprises were established by 2013. In addition, the project invested nearly US$400,000 in fish and fruit processing operations to provide

alternative sources of animal feed. Feed processors were also trained on strategic procurement and stock management. The use of improved feed raised milk production by 80 percent per household, and reduced the time required for fattening by 28 days, which in turn reduced the amount of feed needed by 10 percent.[424] The project also provided training and technical support to dairy cooperatives to facilitate more processing and better storage of milk. At one dairy cooperative, milk collections increased tenfold.[425] To scale up the success of the first phase of the FEED project (ended 2013), the second phase (FEED II, 2013–2017) established a further 12 commercial feed-manufacturing operations and 15 forage multiplication nurseries by 2016. FEED II also trained 26,000 smallholder farmers—32 percent of whom were women—in sustainable forage production and improved feeding management and recordkeeping.[426] At the end of 2015, some of the cooperatives became indispensable suppliers of feed during the severe drought.[427] FEED III, initiated in 2018, seeks to dramatically scale up production by strengthening capacity and coordination with the private sector. During 2018, 25 farmers' unions produced and sold nearly 20,000 mt of compound feed—108 percent above sales in 2016—valued at nearly US$4.7 million. By 2018, milk production per cow per day had also increased by 200 percent and the number of eggs produced per household increased by 747 percent.[428]

Agricultural Growth Program

In 2010, several development partners including the World Bank, FAO, and GAFSP joined forces to contribute to the realization of GoE's poverty reduction strategy through agricultural development-led industrialization. The key aims of the Agricultural Growth Program (AGP) were scaling up production and commercialization and small-scale rural infrastructure development.[429] In 2012, USAID initiated the Livestock Market Development component of the AGP (AGP-LMD, 2012–2018). This overlapped with the second phase of AGP (AGP II), which was initiated in 2015 to sustainably increase agricultural production and productivity of crop and livestock commodities, establish market linkages and accelerate commercialization, and improve dietary diversification.[430] Over the duration of AGP-LMD, the project leveraged the capacity of existing cooperatives, government agencies, and private enterprises to provide commercial farm inputs and services, elevate and actualize 11 policy discussions and outcomes, disseminate nutrition messaging to 160,000 people through community mobilization, and train more than 400 women entrepreneurs in business and leadership. Moreover, collaboration with the GoE also led to the launch of the Ethiopian Livestock Identification and Traceability System (ETLITS) in 2017.[431]

Ethiopia

Enhancing Dairy Sector Growth in Ethiopia project

Between 2013 and 2017, the Ministry of Livestock and Fisheries (now MoA) collaborated with SNV – the Netherlands Development Organisation to implement the Enhancing Dairy Sector Growth in Ethiopia (EDGET) project. Covering 65,000 smallholder dairy-farming households, the project aimed to expand production, processing, and marketing to double household income and improve the nutritional status of children by promoting dairy consumption. EDGET was implemented in 51 *woredas* (districts) in the three regional states of Oromia, Amhara, and the Southern Nations, Nationalities and Peoples' Region (SNNPR). To enhance production and productivity, the project targeted interventions to:

- extension system: public extension, farmer-to-farmer training, and distribution of extension materials;
- forage production: providing forage seed, improved feeding techniques, and promoting supplementary feeding;
- agro-input dealer network: establishment and development of 50 agro-input dealers through trainings, networking, and access to microfinance institutions;
- dairy processing units: training on administrative management, quality testing, equipment for milk collection, storage, and processing; and
- nutrition awareness raising.

Although the project was unable to reach 65,000 dairy farmers as planned, by 2017, there were more farmers who received forage seed, established forage plots, practiced calf feeding, and used more hygienic containers to collect and store milk. Nearly 54,000 households benefited from forage input supply support. Some 52,000 households had developed forage plots with at least two different types of forage.[432] In addition, 26 dairy processing units were also in operation in 2017. Milk production and net income from milk were also found to be significantly higher in 2017 than in 2013. Over the duration of the project, average household net income—for the households supplying dairy processing units—increased from ETB 792 (US$42) to 6,221 (US$268) per household.[433] The increase in milk production was significantly higher in female-headed households (1,523 liters per year) than for male-headed households (1,100 liters per year). However, with poor baseline data on income, the overall impact remains unclear. Nevertheless, there was a small increase in the daily consumption of milk, particularly during the fasting season.[434]

Livestock and Fishery Sector Development Project

At the end of 2017, the World Bank extended US$170 million in credit to MoLF for the Livestock and Fishery Sector Development Project (LFSDP). Drawing on recommendations in the Livestock Master Plan, LFSDP was initiated to increase the productivity and commercialization of producers and processors in dairy, poultry, red meat, and fisheries value chains, and to foster private investment in the sector. Interventions focus on improving linkages to markets and strengthening national institutions and programs on animal health, breeding, extension, and advisory services. It is being implemented in Amhara, Oromia, SNNP, Tigray, Gambela, and Benishangul-Gumuze regions.[435] Within the first two years, LFSDP had already facilitated the training of nearly 900 trainers who subsequently cascaded the learnings to 4,875 development agents. In addition, a Jersey Breeding Center is being rehabilitated in Holeta, and 263 tons of forage seed and 30 million forage cuttings were distributed and planted on nearly 2,000 hectares of land in Oromia and Amhara.[436]

Ethiopia's livestock sector has benefitted substantially from comprehensive government action at the institutional and policy levels for both, pastoralist and non-pastoralist livestock keepers and producers. This progress forms a strong foundation to achieve greater successes. Ethiopia's livestock sector has enormous potential to achieve several of its national and international commitments on poverty alleviation, food security, and improved nutrition. While there is clear recognition of this opportunity on the institutional, policy, and programmatic fronts, there is a need to simplify and clarify roles to improve the overall efficiency of implementation. Streamlining the overall system that supervises the sector will also ensure that it is nimble enough to provide leadership in responding to future challenges, including climate change, urbanization, and changing demographics.

CASE STUDY

South Africa

The South African livestock sector has undergone several policy and programmatic interventions to improve its productivity, socioeconomic impact, and sustainability. Consumption of meat grew from 42 kg per capita in 2000 to 60 kg in 2017.[437] Between 2000 and 2016, the average stock of livestock per 100 people, measured in tropical livestock units, stood at 29.98 TLU—above the continental median of 23.44 TLU. During the same period, the average growth rate of gross production value (GPV) was 2.53 percent—also higher than the continental median of 2.2 percent. Total agricultural GPV grew from ZAR 1 billion (US$95 million) in 2013/2014 to over ZAR 1.4 billion (US$118 million) in 2017/2018. Animal products contributed more than half of total agricultural GPV in 2017/2018. Within this sector, poultry meat made the largest contribution (14.6 percent), followed by beef and veal production (14.3 percent). Milk, eggs, sheep, pork, wool, and ostrich constituted the remaining income.[438]

Poultry meat production in South Africa has more than doubled, growing from 816,000 mt to 1.8 million mt between 2000 and 2018.[439] However, as of 2018, about 90 percent of this meat came from large commercial operations and the remainder from subsistence stock; four of the continent's six largest broiler producers are based in South Africa.[440] In addition, 520,000 mt of chicken meat was imported in 2018, 60 percent of which was sourced from Brazil. In response, the government introduced a higher customs duty on imports of chicken meat to reduce dumping practices.[441] Although South Africa was a key supplier of chicken meat to neighboring countries, an avian flu outbreak in 2017 led to suspension of trade to Zimbabwe, Namibia, and Botswana.[442] South Africa is usually self-sufficient in eggs, producing as many as 7.6 billion eggs per year (in 2015).[443] The growth in the South African poultry subsector—driven by vibrant growth in the broiler-meat market—has boosted overall growth in the poultry sector in Africa south of the Sahara (SSA). South Africa contributed over 50 percent of total poultry sector growth between 2007 and 2017.[444] At the same time, in 2017, South Africa was identified as the thirteenth largest beef producer in the world and the top beef producer in Africa. Its beef exports have also been growing, especially to the Middle East. Yet South Africa remains a net importer of cattle, with 99 percent of all live cattle arriving from Namibia in 2017.[445] Two key challenges that have been the focus of interventions are (1) the maintenance of good animal health and reducing the incidence of disease outbreaks, and (2) transforming emerging and communal farmers into commercial producers (although the sector still remains quite segregated). At the same time, a vibrant private sector has channeled investments into the sector, making South Africa one of the continent's largest poultry and cattle producers.

Institutional innovation

Institutional integration

The key national institution overseeing South Africa's livestock sector is the Department of Agriculture, Land Reform and Rural Development (DALRRD). This department was formed as a result of a merger of the Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Rural Development and Land Reform (DRDLR) following a redefinition of national priorities by President Ramaphosa in June 2019. The mission of DALRRD is to initiate, facilitate, coordinate, and implement an integrated rural development program. The department's overarching structure is replicated at the provincial, district, and community levels to ensure an inclusive bottom-up process, reflective of local needs. Within DALRRD, responsibility for the various elements of the livestock sector are assigned within three branches/divisions: Agricultural Production Health and Food Safety; Food Security and Agrarian Reform; and Economic Development, Trade and Marketing.

Animal health, research and marketing

Other state entities working alongside DALRRD on livestock matters include the Agricultural Research Council (ARC), the National Agricultural Marketing Council, Onderstepoort Biological Products SOC Ltd, and the South African Veterinary Council. The ARC is the principal agricultural research institution in South Africa. Its primary research areas for livestock include: breeding and improvement, including management of the national database on animal improvement known as the Integrated Registration and Genetic Information System (INTERGIS); rangelands ecology and forage production; food science and technology; and nutrition.[446]

Onderstepoort Biological Products (OBP) is a South African state-owned animal vaccine manufacturing company, established in 2000.[447] It is mandated to prevent and control animal diseases that impact food security, human health, and livelihoods.

OBP produces affordable vaccines and distributes them widely across the country, to regional partners in Botswana, Namibia, and Zimbabwe, and to East African counterparts.[448] While OBP produces vaccinations, veterinary services are regulated by the South African Veterinary Council (SAVC). Formed in 1982, SAVC ensures that animal healthcare services provided by veterinarians and para-veterinarians are competent, efficient, accessible, and needs-driven.[449]

Public-private partnerships

The National Agricultural Marketing Council (NAMC) is a statutory body, accountable to the Minister of Agriculture, Land Reform and Rural Development and responsible for increasing international market access for agricultural products. NAMC leverages the potential of smallholder producers through partnerships, providing market information, technical assistance, and training. It also connects private sector actors to DALRRD through dedicated Agricultural Industry Trusts. There are four Industry Trusts for the livestock sector (meat, mohair, lucerne (alfalfa), and wool trusts), each one mandated to conduct research into all aspects of production, processing, storing or marketing; disseminate information; coordinate relevant stakeholders; extend financial support in the form of grants or loans; and provide training to start and manage agricultural operations. Each trust is managed by a board of trustees that includes ministerial representatives.[450]

Multi-departmental interventions

Recognizing the potential of livestock in driving job creation and meaningful economic transformation and growth, the Department of Trade, Industry and Competition (DTIC) invested ZAR 1.2 billion (US$101 million) in the agro-processing subsector and leveraged ZAR 7 billion (US$590 million) from multinational and domestic stakeholders between 2009 and 2018. This includes a ZAR 1 billion (US$84 million) Agro-Processing Support Scheme initiated in 2017 to foster further development in the subsector. Furthermore, the 2018/2019 Industrial Policy Action Plan outlines time-bound actions to unlock the challenges that inhibit investment in the poultry value chain, including through a pilot processing facility that produces mechanically-deboned-meat.[451] DTIC also led the formulation of a Poultry Sector Masterplan, approved by the minister in November 2019.[452] The plan will guide the development of a strong domestic poultry industry that creates employment and supports the South African economy.[453]

Access to finance

Access to finance for South Africa's commercial and emerging farmers can be gained through the Industry Trusts at NAMC, directly through DALRRD, some private sector associations, and from the Land and Agricultural Development Bank of South Africa (Land Bank). Land Bank is a specialist agricultural bank established in 1912 to enable farmers—especially those who are historically disadvantaged—to finance land and equipment, improve assets, and obtain production credit. In 2017, Land Bank subsidized interest rates to the value of ZAR 74 million (US$5.7 million), further supporting poor farmers with cheaper access to finance.[454] During the year ended March 2019, Land Bank extended loans worth over ZAR 34 billion (US$2.3 billion), 15 percent of which went to the dairy, feedlot, grain, livestock, pork, and poultry lines.[455]

Cooperation with private and professional associations

SA has a vibrant private sector involved in all aspects of livestock production. Industry associations play a key role in coordinating its engagement with the government and with farmers. In the cattle sector, the South African Meat Processors Association (SAMPA), National Emergent Red Meat Producers' Organisation (NERPO), and South African Meat Industry Company (SAMIC) convene value chain actors to create a more inclusive and sustainable industry. Founded in 1945, SAMPA has been instrumental in the formulation of voluntary and statutory regulations in the interest of consumer protection, food safety, and nutrition.456 NERPO was founded to support the commercialization of emerging livestock producers by providing access to information, finance, and technical support. NERPO is a key beneficiary of funding from the Meat Industry Trust at NAMC. In turn, NERPO extends financial services in the form of reduced transaction costs and credit facilities to black smallholder livestock farmers and holds a portfolio of enterprises operating in meat, tourism, and related industries through acquisitions and partnerships with existing businesses. Finally, NERPO advocates for appropriate legislation and policies for the growth and development of the sector. Although it was originally created as a voluntary commodity farmer organization in 1997, NERPO was subsequently registered as a not-for-profit company in 1999.[457,458,459]

SAMIC is a government appointed company, responsible for grading the quality and safety of red meat in South Africa. This is done by auditing the use of quality marks registered at the (former) DAFF to ensure that appropriate meat classification standards are applied in a uniform manner.[460] SAMIC's remit extends to all red meat production, including that from sheep, goats, and pigs. Other institutions relevant for sheep and goat production are the SA Mohair Growers' Association (SAMGA) and the National Wool Growers Association of South Africa (NWGA). In addition, the Mohair Empowerment Trust was formed in 2011 to formalize SAMGA's involvement in the Black Economic Empowerment program.[461] South Africa now produces nearly half of all mohair globally from its large population of Angora goats.[462]

NWGA was established in 1929 to promote profitable and sustainable wool sheep production. The association supports commercial producers to improve productivity by providing cutting-edge technology, enhancing skills in shearing, and encouraging responsible wool production. For producers in communal areas, services include genetic improvement, access to markets, training and mentorship, and data collection for better management. By 2012, half of its 8,000 volunteer members were black producers and 65 percent of its budget was spent on black empowerment.[463] Marketing of wool by communal farmers increased from 222,610 kg in 1997/98 to 3.8 million kg during 2013/14.[464] In addition, the wool income of black farmers increased from ZAR 1.5 million (US$298,000) in 1997/98 to ZAR 73 million (US$9.5 million) in 2012.[465]

Other industry associations supporting diverse aspects of livestock value chains include the Red Meat Producer Organisation, South Africa Feed Lot Association, Animal Feed Manufacturers' Association, South Africa Poultry Association, Milk Producers' Organisation, and South African Milk Processors Organisation (SAMPRO).

Policy innovation

South Africa's livestock industry operates in a dual system comprising a highly developed commercial sector and an emerging/developing sector. While the commercial sector—accounting for approximately 35,000 farmers—tends to be specialized, coordinated, well-equipped, and often vertically integrated, the emerging and communal sectors are often more fragmented and more subsistence oriented. It is this latter group of some 3.2 million farmers that has been targeted by South Africa's post-independence livestock policies.[466] In this respect, South Africa's policy has been able to raise productivity for small farmers through animal breeding and genetic improvement as well as maintaining high-quality animal health by raising the country's capacity to prevent and cope with disease outbreaks. In addition, a dedicated Livestock Development Policy, developed in 2007, provides an ambitious vision of fast-tracking progress.

Strategic plans for South African agriculture

From the turn of the millennium, the Department of Agriculture, Forestry and Fisheries issued annual strategic plans to outline progress made in the previous year and its ambitions for the following year. The first Strategic Plan in 2001 was developed jointly by the government and the private sector to build a united, nonracial, and prosperous agricultural sector. It set the benchmark for subsequent plans, compiled by the government, to provide access to emerging farmers through well-designed empowerment processes and programs and enhance competitiveness of the sector.[467]

South Africa

2006, 2007, and 2008 Strategic Plans for the Department of Agriculture

Following dedicated efforts to control the outbreak of animal diseases, South Africa was declared free from avian influenza in November 2005. The 2006 and 2007 Strategic Plans for the Department of Agriculture aimed to build on this success by expanding the provision of veterinary services, improving surveillance systems for effective monitoring of diseases, updating a disaster management program, and using early warning systems to manage future outbreaks. The plans outlined measures to reduce the incidence of animal diseases and ensure compliance with international standards by setting targets to improve physical controls in high-risk areas: [468,469]

- Enhancing capacity: building a community of scientific experts composed of new recruits, retaining existing experts, and facilitating retired experts to transfer their experience and knowledge to young scientists; strengthening the Interdepartmental Technical Committee on Agriculture veterinary working group.
- Updating national systems: extending service provision to remote communities, coordinating a comprehensive review of standards, policies, and legislation across provincial and national levels, enhancing law enforcement.
- Regional cooperation: increasing participation in standard-setting bodies at regional and continental levels; and urging regional cooperation to manage cross-border transmission of diseases.

By 2008, livestock contributed 40 percent of South Africa's agricultural output. Yet, the supply of livestock products did not meet domestic demand, making South Africa a net importer—especially for red meat. Therefore, the 2008 Strategic Plan adopted key recommendations from the Livestock Development Strategy (see below) and outlined policy interventions to increase livestock production by 10 to 15 percent within the following three to five years. These included:

- allocating land for livestock farming;
- improved extension programs, targeted for emerging livestock producers;
- investments in communal areas;
- creating awareness about an animal breeding support program; and
- better marketing for existing and new secondary industries such as leather and dairy, supported by an amended Marketing of Agricultural Product Standards Act.

2007 Livestock Development Strategy

The 2007 Livestock Development Strategy (LDS) was developed to build a more inclusive, competitive, and sustainable livestock sector in South Africa.[470] The LDS addresses all segments of the value chain, as well as the role of the private sector. To facilitate the entry of resource-poor and emerging farmers into the sector, the LDS called for:

- providing infrastructure and information;
- strengthening institutional links between farmers and responsible government agencies;
- easing access to finance;
- expediting market development through trade negotiations and a review of tariffs, recognition of domestic protocols as equal to international standards, and implementation of a traceability system for export certification;
- providing safety and security against stock theft;
- enabling the production of healthy animals and safe and quality products;
- fostering research, technology transfer, and training in partnership with the private sector by increasing the R&D budget to more than 2 percent of agricultural GDP, encouraging more skills-based training programs, creating paid mentorships, and requiring community service participation by veterinary graduates;
- improving efficiency in production and supply chain management; and
- increasing private sector market research to cater for diverse markets.

Following the presidential election in 2009, policy interventions were expanded to cover a wider range of elements including fencing, animal health, animal improvement, and increased productivity through value chain programs, especially for small stock and poultry value chains. However, budgetary allocations for animal health fell from approximately 60 percent of the budget for biosecurity and disaster management in 2006 to a projected expenditure under 40 percent in 2010/2011.[471]

On the other hand, the National Infrastructure Policy adopted by the government in 2012 allocated ZAR 827 billion (US$108 billion) for investments in building new and upgrading existing infrastructure over three years beginning in 2013/14. The Policy defined 18 strategic integrated projects (SIPs) to create jobs, enhance service delivery, and transform the economy. SIP #11, Agri-logistics and Rural Infrastructure, sought to catalyze investments in agricultural and rural infrastructure, including

investments in abattoirs and dairy facilities. Although three agri-parks had been constructed by 2017, their scope had to be downscaled to ensure that they have sufficient impact. Nevertheless, by 2019, the DRDLR reported that significant progress had been made, especially in red meat development, through the addition of custom feedlots, wool improvement and shearing sheds, and goat improvement auctions and feedlots. Between 2013 and 2019, 2,350 beneficiaries earned ZAR 109 million (US$10.4 million) through these agri-parks.[472]

Programmatic interventions

The South African livestock sector has benefited from both government-led and private-sector-led interventions. The Comprehensive Agricultural Support Programme, National Red Meat Development Programme, Kaonafatso ya Dikgomo, and Sernick Emerging Farmers Programme have all sought to raise productivity and promote commercialization.

Comprehensive Agricultural Support Programme

The Comprehensive Agricultural Support Programme (CASP) was launched by the Department of Agriculture in 2004 to create employment in the agriculture sector, raise incomes, reduce poverty, and improve national and household food security.[473] CASP facilitated agricultural development among subsistence farmers by providing a range of services including: information and knowledge sharing; technical assistance and regulatory services; marketing and business development; training and capacity building; on- and off-farm infrastructure and input supply; and financial support. The livestock sector was an important beneficiary of CASP as production rose significantly. The number of animals kept also increased by 296 percent on CASP-supported projects. The largest gain was among sheep producers, who kept 508 percent more animals than prior to the intervention, and the number of broilers increased by 307 percent. However, livestock marketing, disease control, and marketing were less successful elements of CASP. Some 30 percent of livestock producers sold their animals at formal auctions and markets, meaning that 70 percent were considered noncommercial farmers.[474] More than ZAR 14 million (US$1.2 million) was spent on the CASP between 2004 and 2018, supporting over 11,400 projects and benefiting more than 675,000 participants.[475] An impact evaluation of CASP, prepared by the University of Pretoria in 2015, concluded that there was some progress toward achieving its objectives.[476]

National Red Meat Development Programme

In 2005, the ConMark Trust launched the Livestock Programme in partnership with NAMC to increase the production of beef to meet local demand and reduce the need for imports. The initiative sought to encourage commercialization among small livestock producers in the region. ConMark Trust closed in 2008 and NAMC took over administrative oversight of the project under a new name, the National Red Meat Development Programme (NRMDP). Through NRMDP, NAMC developed a feedlot system, established new and revived existing auction pens and abattoirs, and facilitated access to markets by negotiating pre-slaughter agreements between producers and retailers. NRMDP also organized visits to commercial feedlots, auctions, and abattoirs, and delivered training on animal health, husbandry,

and marketing. Total offtake between 2005 and 2012 grew by an average of 13 percent across five districts. More weaners were sold, and the price for cattle sold also increased by an average of ZAR 1,540 (US$200) per animal. Producers generated ZAR 7 million (US$912,000) in income from sales in 2012, compared to ZAR 228,600 (US$37,000) in 2005. During the year 2018/19, over 4,000 cattle and 764 goats were auctioned through NRMDP, raising over ZAR 34 million (US$2.3 million) for participants. Given the success of NRMDP in Eastern Cape province, the initiative has been rolled out in Kwa-Zulu Natal and North West provinces, where two feeding facilities are operational each.[477,478,479,480,481,482]

Kaonafatso ya Dikgomo project

In 2007, ARC initiated the Kaonafatso ya Dikgomo (KyD) project, designed to foster adoption of breeding and improvement approaches, combined with better recordkeeping among emerging and small livestock producers. Farmers are trained on breeding and animal health as well as recording information such as birth, weaning weight, and weights at 12 and 18 months. This information is then transferred to INTERGIS for analysis to enable farmers to make selection and culling decisions. The project is supplemented by additional services provided through a mobile laboratory, such as bull fertility tests, synchronization of cows, artificial insemination, embryo transfer, and pregnancy tests.[483] By 2014, over 8,000 producers had benefitted from KyD.[484] The project has resulted in higher calving rates and growth in herd sizes. KyD has also been particularly successful in promoting the use of more lucrative marketing channels, such as auctions. As a result, market offtake rates increased by 16 percent.[485] Participants also benefited from thrice as many visits from extension officers as nonparticipants. Sustaining this progress will require continued investments in extension services and further commercialization among the producers, including maximizing their use of formal marketing outlets.[486,487]

Sernick Emerging Farmers Programme

The Sernick Group is a vertically integrated livestock company, connecting feed production with livestock producers, abattoirs, and retail outlets. In 2018, the company, in partnership with the Jobs Fund administered by the Department of Finance, launched the Sernick Emerging Farmers Programme (SEFP). Through the program, 660 farmers will be given accredited training and an opportunity to exchange their old stock for higher quality cattle; and 300 of these farmers will also receive technical training on managing their own herds and financial flows. Furthermore, 50 of the 300 farmers will have an opportunity to purchase shares in a new wholesale company, Sernick Wholesale, and rent 35 cows and a bull from the Jobs Fund Programme. Over the first year, SEFP pays for the supplements and medicines and farmers have access to the company's infrastructure to ensure that they have a firm footing. In turn, farmers will have to create three jobs each and will be financially independent themselves. The first batch of "graduates" from SEFP signed their contracts in April 2019.[488] By November 2019, 22 farmers had received cattle and 50 farmers were undergoing training to become fully commercial producers.[489]

Success in South Africa's livestock sector is underpinned by a vibrant private sector and national efforts to include and commercialize production from small and emerging farmers. A relatively well-established animal health system, in conjunction with better marketing and access to finance, enable farmers to prosper from livestock production. However, the sector is also facing various changes and challenges. Domestically, the sector is undergoing a structural shift as more emerging farmers, commercially oriented farmers, urban farmers, and game farmers all integrate more livestock into their livelihoods.[490,491,492] At the same time, international trade agreements are testing the strength of nascent industries within the sector. Finally, climate change and recurring droughts—like the ones in 2015/16[493] and 2019[494]—threaten the long-term viability of the sector. Nonetheless, with more effective implementation of policies and programs, and closer collaboration with the private sector, South Africa's livestock sector has the potential to be a standard-setter on the continent. This in turn demands a streamlining of roles and responsibilities. The current reorganization at the Department of Agriculture, Land Reform and Rural Development is an opportune moment to streamline responsibilities among and within ministries, parastatals, and other entities. It is also timely to form a dedicated branch to oversee the livestock sector. Such a focused approach would reinvigorate productivity and enable a more coordinated response to the changes and challenges facing the sector today.

Uganda

The government of Uganda has been ambitious in developing policies and regulations to strengthen the livestock, meat, and dairy sectors. Agriculture overall contributes about 24.6 percent to Uganda's GDP, while the livestock sector contributes about 17 percent to agricultural GDP and 4.3 percent to overall GDP.[495] The significant contribution of livestock to agricultural GDP is largely due to policy and institutional innovations and programmatic interventions put in place by the government. Between 2000 and 2016 the average livestock stock, measured in tropical livestock units (TLU) per 100 people, is estimated at 28.33 TLU, which is above the African median of 23.44 TLU. The average growth rate of the gross production value of livestock for this period is 4.39 percent, which is double the African median of 2.2 percent.[496,‡‡] Consumption of livestock products is projected to more than triple between 2012 and 2050.[497]

Institutional innovations

The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) oversees Uganda's policies and plans for the agriculture sector, including livestock. Specifically, it is the Directorate of Animal Resources (DAR) situated within MAAIF that is responsible for spearheading the development of the livestock sector.[498] Headed by a State Minister for Animal Industry, the DAR is mandated to design, review, and implement policies and regulations to improve food security and household income through improved animal health, and market-oriented animal production, food quality and safety. Correspondingly, DAR is composed of three departments: the Departments of Animal Production, Animal Health, and Entomology, overseeing all segments of the dairy and meat value chains.[499]

‡‡ The average livestock stock TLU per 100 people over the period 2000–2016 (FAO data) was chosen to assess countries' levels of animal stock. To define high and low levels of animal stock, the threshold was set at the median. The average growth rate of the gross production value (GPV) of livestock (in constant 2004–2006 international dollars) over the period 2000–2016 (FAO data) was chosen as indicator of value addition growth of the sector.

Focus on dairy and meat sub-sectors

The primary attention of livestock sector development in Uganda are the dairy and meat sub-sectors, as evidenced by the formation of a dedicated Division of Dairy and Meat (DDM) in the Department of Animal Production (DAP), strong linkages with a statutory body, the Dairy Development Authority (DDA), partnerships with animal product associations, and the presence of effective cooperatives. DDM is mandated to create and maintain a sustainable dairy and meat production system through policy, regulatory and legislative oversight.

Emphasis on higher food standards

The DDA is the key institution supervising the dairy industry. It was established as a government agency in 2000 through the Dairy Industry Act of 1998 to liberalize, coordinate and regulate the industry. DDA is responsible for attaining and maintaining self-sufficiency in milk production in Uganda.[500] The Act also empowered the DDA to enforce milk hygiene standards and quality controls.[501] As a result, traders were licensed to meet public health and milk quality standards. The improved quality and safety of milk and dairy products facilitated access to high-value markets, both domestically and internationally. In partnership with the Uganda National Bureau of Standards (UNBS), the DDA also develops new and updates existing standards for milk and dairy products. Moreover, in 2003, the government passed The Dairy (Marketing and Processing of Milk and Milk Products) Regulations, which constitute the framework for the implementation of quality standards and good hygiene and handling practices.[502] Jointly, the DDA and UNBS developed the code of hygienic practice for milk and milk products, which provides guidelines for hygienic production and handling of milk and milk products at various stages of the dairy chain.

Finally, the Uganda Bureau of Statistics, established in 1998, is a semi-autonomous government agency, which, in collaboration with the MAAIF, conducts data collection and analysis for the livestock industry. Results published in 2018 are the most up-to-date official statistics on the Ugandan livestock industry.[503]

Liberalizing the dairy industry

Although economy-wide liberalization began in the 1990s, it did not apply to the livestock sector for another decade. The formation of the DDA in 2000 was a key milestone that signaled the relaxation of government control on dairy sector activities and heightened competitiveness. The private sector scaled up its activities, investing in milk collection, cold chain infrastructure, milk distribution, and marketing, leading to a rapid expansion in processing capacity, eventually propelling Uganda to become a net exporter of dairy products. Amongst the investors was Sameer Agriculture & Livestock Ltd. (SALL), a joint venture company established by the Sameer Group of Kenya in and RJ Corp. of India, which took over the state-owned dairy processing company Uganda Dairy Corporation in August 2006. By 2011, SALL owned the largest of 39 dairy processing plants, with the capacity to process about 550,000 litres of milk per day with an annual turnover of over US$30 million.[504] Exports of milk powder grew almost thirteen-fold to two million kgs over five years from 2011 to 2015, primarily supplied by SALL and a second large-scale dairy, Pearl Dairy Farms.[505] By June 2017, there were at least three privately-owned large-scale plants with the capacity to process over a billion liters per day[506] – compared to three government-owned plants in 1993, with a capacity to process 160,000 liters per day[507] – as well as nearly 40 medium- and small- scale processors[508]. Exports of dairy products to Kenya, the Middle East and Asian markets also grew in value from almost zero in 2007 to US$50 million in 2015.[509]

Effective professional associations and cooperatives

The Uganda Dairy Processors Association (UDPA), established in 2003, brings together 38 large and small dairy processors, including large dairy processing companies and small and medium-sized enterprises involved in milk processing and marketing, as well as dairy farmers' organizations and milk traders.[510] It provides a collaborative platform for processors to build partnerships and drive innovation to improve efficiency and expand the range of products. The UDPA also acts as a unified voice of processors in interacting with the government.[511] In addition, the Uganda National Dairy Traders Association (UNDATA) convenes small processors and other dairy traders – such as transporters, cooling operators, farmers, and vendors – to promote, manage, and upgrade operations, including the collection, transportation, and marketing of quality dairy products in Uganda and to export markets.[512] UNDATA was instrumental in ensuring that the new regulations introduced by the DDA were better adapted to local conditions and not too burdensome on operators in the informal milk-marketing segment. This in turn has encouraged more informal processors to register themselves and formalize their operations. UNDATA also encouraged buyers of raw milk to boil it before consumption therefore contributing towards the overall improvement of quality standards in Uganda's dairy sector. UNDATA now has more than 1,000 members and handles more than 300,000 litres of milk per day.[513] The two associations – UDPA and UNDATA – have also been key conduits through which the DDA has been able to negotiate greater uptake of improved technologies, leading to an overall modernization of the whole dairy sector.[514]

To meet the growing demand from higher processing capacity, more farmers have also come into the market. Uganda Crane Creameries Cooperative Union (UCCCU) has been instrumental in assisting farmers to market their milk collectively, and in facilitating the commercialization of the dairy sector. UCCCU was established in 2005 as the commercial arm of the Uganda National Dairy Farmers Association, itself formed in 2001 as the primary organizing body for dairy farmers. UCCCU's members produce over 700,000 liters of milk daily, collected at 140 collection centers across south western Uganda. UCCCU has also invested in 10 milk tankers and 120 coolers, which have significantly reduced post-harvest losses from 40 percent to 2 percent. UCCCU provides its own extension services to members on improving the quality of milk. As a result, by 2016, productivity per cow increased by 5 percent and net income for its members rose by 48 percent.[515] UCCCU also raised funds from its members in 2012 – by issuing shares paid for in cash or live cows – to build its own processing facility.[516]

Meat industry

In parallel with the dairy industry, the meat industry has also advanced, although more modestly. Liberalization saw a growth in small- and large-scale private-sector abattoirs. An US$11 million investment by Egypt in an export abattoir in 2015 raised Uganda's slaughtering capacity by up to 1,000 cows daily. The Egypt-Uganda Food Security Company sources its cattle within Uganda and can hold a further 5,000 animals on its premises.[517] Although the company has faced some challenges in reaching optimum production, it successfully exported its first consignment of 50 mt of beef to Egypt in 2018.[518]

Beef producers are organized through the Uganda Meat Producers Cooperative Union (UMPCU), which provides training, mentoring and peer-to-peer learning opportunities as well as access to finance. In 2019, UMPCU established two animal diagnostic laboratories, in collaboration with Zoetis – the world's largest animal health company – to provide subsidized and readily available access to tests for its members and for 2,600 farmers from surrounding areas.[519] UMPCU is also engaged in technology transfer (for example of dewormers) and veterinary service provision, with funding received from the EU's Farmer Led Beef Livestock Investment and Sustainability project (FALBIIS).[520]

Poultry producers are organized through the Poultry Association of Uganda, which was established in 2004 and officially inaugurated by the Minister of Agriculture, Animal Industry and Fisheries.[521] PAU brings together actors across the value chain, including poultry farmers, hatchers, feed millers, veterinary service providers, and nutritionists to transform Uganda's poultry production into a broad-based commercial activity through integrated production, marketing, and trade.

Animal nutrition and health

The Division of Animal Nutrition in DAP provides technical and regulatory oversight and support for a sustainable animal nutrition sector, through an effective animal nutrition management information system, appropriate infrastructure for feed production and promoting the use of improved pastures and rangelands. It works alongside national research institutes (see below) to develop and disseminate technologies and information that directly address animal nutritional challenges in the country.[522]

Animal health and its overlap with human health in Uganda involve a multitude of institutions, both internal and external to the MAAIF. The Division of Veterinary Public Health (DVPH) at the DAR operates at the intersection of animal and human health. It is responsible for overseeing the implementation of veterinary public health policies, plans, and legislations. DVPH is tasked to operate an effective veterinary public health management information system and provide technical support and capacity building in local government institutions including guidance for planning, locating and construction of abattoirs and tanneries. DVPH operates alongside the Departments for Animal Health and Entomology, which aim to reduce the occurrence and spread of animal diseases in Uganda. Working in tandem with national, regional and international counterparts, the Departments for Animal Health and Entomology are mandated to monitor, investigate and control disease outbreaks through research, data collection and dissemination, infrastructure development for controlling pests and insects, certification and traceability of entomology products, and managing the availability and use of major animal disease vaccines and drugs.[523]

One of the more serious animal health issues in Uganda is the high prevalence of trypanosomiasis – spread by the tsetse fly, which seriously undermines the profitability of the livestock sector, especially cattle production. To consolidate research and control of tsetse and trypanosomiasis, Uganda's parliament created the Uganda Trypanosomiasis Control Council (UTCC) in 1992 with the overall ambition to demarcate tsetse free zones and eliminate diseases caused by this vector. The UTCC operates as a parastatal and works in partnership with several ministries including health, finance, planning and trade, as well as development partners (such as NEPAD, FAO and IAEA) to formulate and jointly implement strategies and programs to control the persistent threat of the tsetse fly.[524] In intervention areas, combined programs by the government and development partners have succeeded in shrinking the tsetse fly population by 75 to 95 percent.[525] However, sustaining this success without donor support remains financially challenging. UTCC's secretariat, the Coordinating Office for Control of Trypanosomiasis in Uganda (COCTU) pro-

duces and disseminates tsetse and trypanosomiasis maps to enhance awareness and control of the vector and disease. The united efforts to minimize the threat of the tsetse fly has resulted in the identification of a 'cattle corridor' stretching diagonally across the country from the south west to the north east. More than two-thirds of the cattle population is confined to this area, which experiences a lower incidence of tsetse fly infestations.[526,527]

Uganda's biosecurity and veterinary services were boosted immensely in 2019 when a new high-tech laboratory was opened within the National Livestock Resources Research Institute (NaLIRRI, see below). The US$2.5 million facility was constructed by the US Department of Defense to strengthen Uganda's ability to detect, diagnose, conduct surveillance and report on emerging and re-emerging diseases of international concern. It will also support Congolese and South Sudanese diagnostic capabilities.[528]

Genetics and breeding

At ministerial level, the Division of Dairy and Meat at DAR oversees some aspects of breeding with the aim to continuously grow the national herd. Alongside this division, the National Animal Genetic Resources Centre and Data Bank (NAGRC&DB) – created by the Animal Breeding Act of 2001 – is responsible for the breeding aspects of the animal industry, especially the commercialization and expansion of animal breeding activities. NAGRC&DB was previously situated within the Department of Animal Production and Marketing but was elevated to a parastatal of MAAIF with an independent budget.[529] NAGRC&DB is responsible for developing and implementing a National Animal Breeding Programme, which meets the needs and interests of actors along the livestock sub-sector value chains. It does this by selling breeding and reproduction equipment and inputs (liquid nitrogen) as well as stock of semen, ova and embryos; rearing sires to supply semen, and for sale; and operating a national data bank.[530] NAGRC&DB also operates a community breeding program through which it recruits breeders under a contract-mating scheme. The breeders are promoted to farm specific breeds of animals with desired performance traits and are then mobilized outward into communities through breed societies or associations.[531] Through the program, farmers gain access to high-quality animal genetics that achieve a slaughter weight of over 350 kg at 18 months and production capacity of over 30 kg of milk per cow per day.[532] NAGRC&DB hosts the Eastern Africa Regional Gene Bank, which is one of five Regional Multi-Purpose Animal Genetics Banks established through the genetics project at AU-IBAR in 2019. The regional gene banks will protect genetic materials from indigenous breeds and serve as centres of excellence for training researchers on use of modern cryopreservation (prolonged cold storage) technologies.[533]

Research and extension

The National Agricultural Research Organisation (NARO) is a public research institution created in 2005 and mandated to coordinate, oversee, and guide all agricultural research activities in Uganda. With respect to livestock, NARO conducts research into improving local breeds and development of technologies in animal health and livestock nutrition.[534,535] The National Livestock Resources Research Institute (NaLIRRI) is one of Uganda's 16 semi-autonomous public Agricultural Research Institutes, guided by NARO, with the aim of providing livestock research services. NaLIRRI focuses its research activities on apiculture, livestock breeding, the development of livestock vaccines and disease diagnostics, ethno-veterinary research, livestock feed and food safety, forage breeding and agronomy, the development of strategies for the control of diseases, parasites and vectors, ration formulation and evaluation and lastly, on improving the diagnostic capacities and control strategies of the brucellosis disease.[536] Furthermore, the NaLIRRI Strategic Plan (2017-2022) is considered the Institute's transformation strategy for collaborative stakeholder participation in generating and promoting technologies, improving efficient operations and sustainable resource mobilization and utilization to deliver on NaLIRRI's objectives.[537]

The 2005 NARS Act provides for the development of an agricultural research system for Uganda – the National Agricultural Research System (NARS) – with the purpose of improving agricultural research services delivery, financing, and management. The NARS brings together a cross section of public and private stakeholders, for example public and private universities, and private research institutions. In addition, the National Agricultural Advisory Services (NAADS) is a statutory semi-autonomous body under MAAIF, established in 2001. NAADS manages the dissemination and transfer of technologies and information for enhanced production and productivity. Under the National Agricultural Advisory Services Act of 2001, NAADS is also responsible for delivering extension services to farmers.[538]

Uganda's livestock sector, especially the dairy industry has benefitted immensely from clear and dedicated

institutional development. According to FAOSTAT, Uganda's cattle herd size nearly trebled from 2000-2016 to 14.7 million heads and milk production grew to 1.6 million mt from 660,000 mt during the same period.[539] By 2017, nearly 70 percent of rural Ugandan households – particularly smallholders and pastoralists – owned livestock of some sort.[540] Continuous policy innovation further ensures that the sector thrives and contributes towards achieving its national and international development commitments.

Policy innovations

Coordinated, consistent and well-funded policy-making

The government of Uganda has been implementing various policies and strategies to enable the sustainable growth and transformation of the livestock sector.[541] The policies and strategies draw from, and build on, the overall ambition to become an upper middle-income country by 2040, as outlined in Uganda Vision 2040 in 2007. **Vision 2040** seeks to enhance Uganda's competitiveness for sustainable wealth and employment generation, and inclusive growth. It acknowledges the importance of the agricultural sector in achieving this aspiration – especially livestock farming and aqua culture – and proposes a transition of crop and livestock farmers to commercial producers to make the overall sector profitable, competitive and sustainable. Vision 2040 emphasizes the goal to unlock water resources to facilitate commercial livestock farming.[542]

To achieve the ambition of Vision 2040, the government produced a series of five-year plans called the **National Development Plans** (NDPs). The first NDP (NDPI) covered the period 2010/11 to 2014/15, and the second plan (NDPII) covers 2015/16 to 2019/20. Each NDP emphasized the construction of large- and small-scale water schemes to increase cumulative storage and ease access to water for irrigation, livestock and rural industries. Such high-level attention to water provision for livestock facilitated the construction of 11 new dams and 959 small and medium valley tanks (open, excavated reservoirs) in the cattle corridor between 2006 and 2015, adding a total of nearly 18 million m^3 of capacity. However, as this only provided access to water to about half of Uganda's livestock, NDPII extended the ambition to double water capacity for livestock to 55 million m^3 over the duration of the plan.[543]

NDPI also fed into the **2013 National Agricultural Policy** (NAP). Of six overarching objectives, the NAP dedicated one to increasing farming households' incomes from livestock production by raising output, improving quality and more collective organization (for example through cooperatives). To facilitate these activities, the government outlined thirteen strategies, including greater access to technologies (including biotechnology) and inputs (such as vaccines), and training and skills development programs. In addition, NAP outlined strategies to promote dry season feeding through pasture preservation; upgrade financial service provision; foster a private sector-led agricultural input supply system; strengthen the certification and regulatory system; and encourage sustainable use and development of water and land resources. Although it is the prime responsibility of MAAIF to implement NAP, the policy also proposed coordination among relevant ministries including the Ministry for Water, Environment and Natural Resources, Market Infrastructure Development, and Trade and Industry.[544]

Funding for a more detailed delivery program mirroring the policy recommendations in the NAP was outlined in the **Agricultural Sector Strategic Plan** (ASSP) 2015/16 to 2019/20, which prioritizes investments in beef, dairy cattle, poultry, and goats.[545] The ASSP was initiated following a 2015 review of the Agriculture Sector Development Strategy and Investment Plan, which developed the first-generation National Agriculture Investment Plan for Uganda for 2010/11 to 2014/15. The ASSP is designed to deliver on Uganda's commitments under CAADP and the Malabo Declaration.[546] It also builds on aspirations set by the **NDPII** (2015-2020), which identified 12 strategic commodities that would form the basis of agricultural growth and receive priority in investment allocations to increase productivity, ease access to inputs such as machinery and water and markets. Livestock, particularly dairy and beef cattle, was included as one of the 12 strategic commodities. In addition, NDPII highlighted that improvements in maize and cotton value chains, specifically processing and milling would also contribute towards an increase in the availability of animal feed.[547]

ASSP defined various investments for enhancing the livestock sector, to be implemented through a multisectoral approach involving different government institutions, development partners, civil society organizations, and the private sector. Investments include, for instance, provision of one cow (heifer) per household; support to dairy extension services; increased dairy regulation and inspection; establishment of a

national dairy herd information system as well as mobile and regional laboratories; control of vectors and diseases through vaccinations and disease surveillance and construction of infrastructure for disease control; and pasture development.[548] By 2020, the ASSP seeks to increase milk production to 3.35 billion liters annually, supporting annual exports of milk and related products; and to increase beef production to 360,000 mt, pork production to 139,185 mt, mutton and goat meat production to 39,775 mt, and poultry production to 63,647 mt. A budget of UGX 200 billion (US$60 million) was allocated to dairy sector interventions while UGX 794 billion (US$241 million) was allocated to meat and other livestock products. Programs on water and agricultural mechanization were allocated a further UGX 548 billion (US$165 million).[549]

Sub-sector policies

Dairy & meat

The Dairy Master Plan, which was implemented in 1993 is the key document guiding the development of Uganda's dairy industry.[550] Some of the main recommendations of the Dairy Master Plan that have been adopted include the liberalization of the dairy industry, restructuring and privatization of the state-owned dairy processing company (*Dairy Corporation*), and creation of a Dairy Board. The Master Plan was updated to the National Dairy Strategy 2011-2015, to spearhead increases in production, productivity, value addition and marketing of milk and milk products, with an investment budget of US$150 million. Although about half of this investment budget was expected to come from the public sector, the National Dairy Strategy stood for prioritizing private sector investments (29 percent) in the dairy sector, with the balance being invested by development partners. Further demonstrating a maturing sub-sector, investments were also primarily directed to market access and value addition, rather than production.[551]

Value chain policies

Animal health

Clinical veterinary services, support for breeding and spraying for tick control were among the government-provided facilities that were decentralized and privatized during the economic liberalization of the 1980s and 1990s. On the other hand, vaccination against epidemic diseases, quarantine facilities and tsetse fly management continued to be supported by MAAIF. In place of government provided services, many actors of varying capacities and specialties entered the market to provide veterinarian services and inputs.[552] However, this meant that the government lost some oversight of disease development thus reacting to outbreaks rather than proactively managing diseases. Nevertheless, the **2001 National Policy for the Delivery of Veterinary Services** was introduced to ensure that the delivery of veterinary services remained i) inclusive such that remote areas were also served, ii) cost-effective and efficient, iii) clearly delineated, especially for public service provision, and iv) of high quality.[553] In doing so, the country would maintain effective control of notifiable and emerging diseases and minimize potential losses occurring from outbreaks. The policy demanded that the government conducted regular testing to detect diseases, implemented surveillance and monitoring of diseases (including zoonoses), and that outbreaks were promptly reported. The policy set responsibility for setting standards, inspection, licensing, registration and monitoring of all diagnostic laboratories with MAAIF.[554] The **2002 National Veterinary Drug Policy** was implemented in parallel with the 2001 National Policy for the Delivery of Veterinary Services which addressed the supply (manufacture, procurement, storage, distribution) of quality drugs, legislation and inspection of veterinary drugs, and supervise the licensing of veterinary drug outlets.[555] Despite teething issues, MAAIF has successfully implemented quarantines at the national and local levels by communicating, coordinating and cooperating with relevant agencies and, when necessary, enforcing legal and security measures, such as the police.[556]

In 2018, the government introduced the Antimicrobial Resistance National Action Plan (AMRNAP) (2018–2023).[557] This serves as a guideline for Ugandan stakeholders contributing to efforts to control antimicrobial resistance (AMR) in the livestock sector. The AMRNAP is associated with the WHO Global Action Plan's strategic objectives and recommends actions for governments and partners to raise awareness of AMR and containment options, improving the use of antimicrobial medicines, and research and innovation. Furthermore, the government's 2018–2022 One Health Strategic Plan was developed to strengthen the prevention, preparedness, and response to zoonotic diseases, AMR, and biosecurity threats. The One Health Platform involves stakeholders from the Ministry of Health, MAAIF, Ministry of Water and Environment, and the Uganda Wildlife Authority of the Ministry of Tourism, Wildlife and Antiquities with support from the USAID-funded Preparedness and Response (P&R) Project. The Platform requires both public and private sector actors to contribute to ca-

pacity building efforts and to focus on cross-sectoral collaboration, with the aim of decreasing the prevalence of zoonotic diseases and AMR by 50 percent by 2022.[558] With different priorities, timeframes, and perspectives, all these policies, which are still in effect, aim to support sustainable development of the livestock sector.

Animal feed

In 2005, MAAIF implemented the National Animal Feeds Policy that targets a private sector-led increase in the availability of high-quality animal feeds, lower production costs, and capacity development for private and public sector actors by providing better access to research, raw materials and finance.[559] The policy offers a framework to manage and regulate the animal feeds industry. In combination with fiscal incentives such as duty-free importation and VAT exemption on machinery for agricultural processing there has been proliferation of informal and formal actors in the feed industry. In 2017 there were 112 small and large commercial feed producers in Uganda. However, they are unable to satiate domestic demand. In 2015, Uganda's feed deficit was the largest in the region at 4.2 million mt.[560] An Animal Feeds Bill was passed in 2019 to regulate feed producers and importers to ensure that they uphold high quality standards.[561]

Programmatic interventions

Over the past 20 years, the private sector, cooperative societies, and local and international NGOs have played a major role in enhancing Uganda's livestock sector in collaboration with the government. Interventions have focused primarily on the dairy value chain and included support to increase milk production and productivity, farm management, milk processing, market access, disease control, and livestock genetic improvement.[562]

Heifer International (HI) has been operating in Uganda since 1982, providing dairy cows to poor households, particularly women. Between 1986 and 2007, over 15,000 households directly benefited from HI's support through placement of various livestock species. In addition, HI's East Africa Dairy Development (EADD) program was implemented in Uganda in 2008 to support the commercialization and processing of milk products.[563] The EADD is a network of milk collection hubs seeking to increase milk yields and thereby the incomes of small-scale farmers through the creation of producer organizations. During phase one (2008–2013), 82 farmer-owned dairy enterprises were created, comprising of 200,000 farmers in Kenya, Rwanda, and Uganda. The amount of milk supplied to the hubs in Uganda increased from 529,000 liters to 3 million liters per month, while income per household increased by 164 percent. For the second phase of the program HI received a US$25.5 million grant from the Bill & Melinda Gates Foundation to expand the EADD to support more than 136,000 farm families in Uganda.[564]

Pearl Dairy Farms Limited, established in 2012 and part of the Midland Group, is the largest of seven dairy processing companies in Uganda, sourcing raw milk from more than 10,000 smallholder farmers. The company has the capacity to process 800,000 liters of raw milk per day[565], and under the brand name Lato Milk produces powered and liquid milk, flavored milk, yogurt, ghee, butter and butter oil. The products are sold in Uganda and exported to other countries, including Burundi, DRC, Egypt, Kenya and Tanzania.[566,567] In 2017, the International Finance Corporation (IFC) collaborated with Pearl Dairy Farms to introduce the Dairy Development Programme. The program facilitated the training of 50 dairy development executives, who are now providing guidance to 500 farmers on techniques to enhance productivity and implement good agricultural practices.[568] The objective is to generate a stable supply base of 1,000 dairy farmers supplying high-quality raw milk, provide a further 5,000 farmers with advice, and help them transform into competitive commercial dairy farmers.

Additionally, the NGO Send a Cow Uganda (SACU) has contributed substantially to the development of Uganda's dairy industry. Established in 1988, SACU provides support to various farmer groups through training, animal placement, and livestock breeding. SACU projects have emphasized organizing farmers into producer groups and training them on leadership and managerial skills, strengthening their capacity to enhance their living conditions (sanitation, cooking stoves, housing), and assisting them with agricultural inputs, such as high-yielding crop seeds and animal types. In 2012, SACU conducted an evaluation of its operations, which found that just over three-quarters of farming households were now able to have at least two meals a day year-round. Furthermore, by selling surplus farm produce, families' income increased up to six-fold, allowing them to reinvest in their farming businesses and purchase tools, for instance wheelbarrows (289 percent increase) and bicycles (76 percent increase). In addition, more households were able to save money, thereby increasing their resilience to fu-

ture shocks. The evaluation also found that most of the farmers targeted by SACU were women. As a result of the project, about 74 percent of participants reported that women and men were equal partners in making decisions on how to use the family's land and how to share workloads.[569]

In 2016, another program, The Inclusive Dairy Enterprise (TIDE), was created in collaboration with the Dutch government to improve the quality and quantity of milk production. The enterprise aimed to increase dairy farming productivity and reduce poverty for 20,000 dairy farmers in six districts across Uganda. TIDE worked closely with local dairy cooperatives and achieved a significant improvement in the quality of milk delivered. Furthermore, staff at collection centers were trained on quality testing, recordkeeping, postharvest milk handling, and farm management – knowledge, which was then transferred to farmers, leading to overall higher production volumes. To date, 640 farmers have been trained at three Practical Dairy Training Farms, of whom approximately a third were young people and 19 percent women. As a result, suppliers benefited from improved bargaining power as well as increased competitiveness in the market, thereby increasing their overall profits.[570] In addition, TIDE provided a new market and income for dairy farmers, with 1.5 million liters of milk sold through a school milk program. This led to an increase in revenue from milk sales totaling US$395,000, which contributed to the creation of milking parlors, water reservoirs, hay bunkers, pasture development, and purchase of machinery. Lastly, milk production per cow in the dry season increased by 103 percent (and 56 percent in the wet season), resulting in an increase in income.[571]

Uganda has shown strong commitment to improving its livestock sector through institutional and policy innovations, especially the dairy industry. However, it faces several challenges such as increased risks of emergence and spread of zoonotic diseases and AMR. Therefore, more emphasis needs to be put on strengthening the prevention, preparedness, and response to zoonotic diseases and AMR to enable and sustain the growth of the Ugandan livestock sector. There is also significant opportunity to raise the productivity of its beef sector through focused interventions on feed and nutrition. This will allow it to gain a foothold in export markets on the continent and further.

Mali

Livestock is an important component of Mali's agriculture sector, contributing more than 40 percent of agricultural GDP.[572] The livestock sector is diverse, with more than 15 million cattle, 32 million small ruminants, 37 million poultry, and nearly 1 million camels.[573] Mali's stock of cattle represents 30 percent of the region's total. Livestock contributes to 14 percent of the country's total GDP and is the largest export product after gold and cotton, earning CFA 135 billion (US$233 million) in 2016.[574] Between 2000 and 2016, the average livestock stock, measured in tropical livestock units (TLU) per 100 people, is estimated at 70.9 TLU, which is three times the median for African countries of 23.44 TLU, while the average growth rate of the gross production value of livestock is 3.87 percent,[§§] which is also above the median for African countries of 2.2 percent.[575] These achievements are partly due to the government's commitment to strengthening the livestock sector's role in improving food security, nutrition, and economic growth through targeted policy and institutional innovations and programmatic interventions.

Institutional innovations

Mali has a separate, independent ministry overseeing livestock development, outside of agricultural functions. The Ministry for Livestock and Fisheries (MEP), created in 2004, is the main institution governing the livestock sector. The MEP seeks to improve traditional livestock activities through training and extension services for producers; developing pastoral areas; promoting feed and fodder processing industries to boost animal productivity; improving animal health infrastructure and services, and quality control of livestock services, animal inputs, and products; and creating reliable markets for the sale of animal-sourced products.[576]

Under the MEP, the National Directorate of Production and Animal Industries (DNPIA), established in 2005 by merging the Malian Livestock and Meat Agency (OMBEVI), and several divisions of the former National Directorate of Livestock (DNE), is mandated to design national policy and implement programs to support animal production and related industries. The DNPIA is organized into four divisions: pastoral water management, animal product value chains (meat, milk, poultry, skins and hides), animal industries (slaughterhouse management, monitoring of livestock markets); and training and documentation. DNPIA is further represented by Regional Directorates of Animal Production and Animal Industries (DRPIA); Local Services of Animal Production and Industries (SLPIA) at the departmental level; and Support Units for Animal Production and Industries (UAPIA) at the municipality level.[577]

In addition, in its efforts to promote a sustainable increase in livestock production, the government created dedicated institutions for breeding and genetics. In 2013, a center for the genetic improvement of livestock, the Madina Diassa Center for the Conservation, Multiplication and Dissemination of Endemic Ruminant Livestock (CCMD-BRE), was created and is attached to DNPIA. To support DNPIA's mission, CCMD-BRE improves the production and productivity of endemic ruminant livestock, such as the N'Dama cattle breed, through artificial insemination and maintaining an inventory of endemic ruminant livestock breeds. The center also conducts capacity-strengthening activities for livestock associations and cooperatives to increase the adoption of endemic ruminants among livestock keepers.[578]

In 2015, the National Center for Animal Artificial Insemination (CNIA) was created as a public institution.[579] The center has 26 permanent staff, including 10 senior managers 42 inseminators working in 11 production areas. CNIA aims to improve animal production through the use of artificial insemination by making the insemination services accessible to breeders and organizing them around programs of genetic improvement, production of milk and meat and conservation of indigenous breeds. It also seeks to improve the milk productivity of cows by selection and crossing. To this end, CNIA is in charge of the production, export, import, packaging, conservation, storage, quality control and distribution of animal semen and embryos. CNIA also ensures that inseminators are well-trained and monitors and evaluates artificial insemination activities at the national level, including those of approved private artificial insemination centers. Furthermore, it supplies the inputs for artificial insemination to approved private centers.

The National Directorate of Veterinary Services (DNSV), established in 2005, oversees the design of the national policy related to animal protection and veterinary public health, as well as the implementation and enforcement of related legislation and regulation.[580] It also monitors and coordinates the implementation of the policy. In addition, DSNV designs

§§ The average livestock stock TLU per 100 people over the period 2000–2016 (FAO data) was chosen to assess countries' levels of animal stock. To define high and low levels of animal stock, the threshold was set at the median. The average growth rate of the gross production value (GPV) of livestock (in constant 2004–2006 international dollars) over the period 2000–2016 (FAO data) was chosen as indicator of value addition growth of the sector.

national programs for the control of animal diseases, including zoonoses, and develops standards on animal protection and veterinary public health. Moreover, it ensures that veterinary infrastructure, animal health services, and the sanitary control of animals and livestock products meet national veterinary standards. DNSV also collects and disseminates information and data on animal protection and veterinary public health.[581]

Another government agency involved in livestock activities – under the auspices of the MEP – is the Central Veterinary Laboratory (LCV) established in 1979, which performs diagnostic and research activities for animal diseases and the development of animal vaccines.[7] LCV is mandated to :

- contribute to the prevention and eradication of animal diseases, such as contagious bovine pleuropneumonia (CBPP) and sheep and goat plague (PPR) through diagnostic and research activities;
- ensure, as far as public health is concerned, the screening of zoonoses, as well as quality control of food, water and beverages;
- ensure the production of vaccines and sanitary protection of livestock against infectious diseases; and,
- participate in the initial and continuing training of technicians on laboratory techniques.

The LCV's vaccine production for the prevention of major epizootic diseases meets the domestic needs, and the surpluses are exported to other West African countries including Burkina Faso, Togo, Benin, Guinea, Mauritania, Côte d'Ivoire and the Democratic Republic of Congo.

The Institute of Rural Economy (IER)–the government's main agricultural research institute under the Ministry of Agriculture–also conducts research and training on livestock. Founded in 1960, IER is mandated to design, manage, and implement agricultural research programs, including those for the livestock sector, often in collaboration with international development partners.[582] It seeks to improve agricultural, pastoral, and aquaculture production and productivity through the development of new technologies to achieve food security and to preserve human health and biodiversity in Mali. For the livestock sector, through its six regional agricultural research centers, IER carries out research programs on cattle, small ruminants, and poultry. The decentralization allows IER to respond to local needs more effectively in remote areas. Its research findings include the development and promotion of artificial insemination of genetically improved local cattle breeds through crossing, adaptation, and dissemination of improved small ruminant breeds, the development of poultry husbandry practices, and the creation of a synthetic poultry breed.[583]

The Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA), created in 1969 under the

Ministry of Higher Education and Scientific Research, is also involved in livestock training and research.[584] IPR/IFRA conducts graduate and postgraduate trainings in forestry, fisheries, agroforestry, agronomy, soil sciences, agroeconomics, rural engineering, veterinary sciences, animal production, and extension services.[585]

Financing

With respect to financing for Mali's livestock sector, the National Bank for Agricultural Development (BNDA) (51 percent state-owned) makes just over half (55 percent) of its loans to agriculture-related businesses and offers short-term loans to livestock producers, mostly SMEs and larger enterprises. For instance, BNDA charges 10 percent interest over a period of six months to one year on the purchase of animals, and 10 percent over a period of three to six months for loans used for forage production.[586] In addition, BNDA has been providing loans on demand to microfinance institutions at 8 percent for on-lending.[587] Women primarily benefit from those loans through credit unions (*caisses populaires*) for crop production and raising small livestock. However, for some livestock keepers the interest rates remain too high.

Livestock federations

In 1999, the National Interprofessional Federation of the Livestock Meat Value Chain (FEBEVIM) was created to intensify and diversify the production of live animals and their products; better organize the production, marketing, and promotion of livestock products; improve the fattening of cattle; and ensure that the quality of livestock products not only meets domestic but also international safety and quality standards.[588] Furthermore, FEBEVIM is represented in each region in Mali to help livestock keepers and producers gain access to animal feed and medicines.[589] FEBEVIM's headquarters in Bamako facilitate access to credit; conduct capacity-strengthening activities for the production, conservation, processing, marketing, and commercialization of livestock products; identify medium- and long-term investment projects for FEBEVIM; organize the sanitation of slaughterhouses; and mark cattle routes across the country.[590]

The actors of the milk sector are organized in the National Milk Producers Federation of Mali (FENALAIT), created in 2006.[591] FENALAIT supports its member cooperatives by improving their organizational structures and by facilitating networking opportunities in the dairy production sector. It also represents its members in decision-making bodies linked to the local milk sector and builds alliances with other umbrella organizations. In addition, FENALAIT advocates for policies to promote the milk sector at the national and regional levels and plays an important role in validating standards and labeling local milk products.

Finally, the Poultry Sector Stakeholders Federation of Mali (FIFAM), established in 2005, coordinates the interests of all stakeholders in the poultry subsector and represents them at the national and international level. It serves as a common platform for consultation, reflection, and action in support of the poultry value chain. FIFAM plays a crucial role in the organization of the poultry sector with respect to production and distribution channels and coordinates fundraising activities for the Malian poultry sector.[592] FIFAM facilitates the collective purchase of chicks and transport-sharing to markets among its members.[593]

Furthermore, the government focused on developing regulation to improve the provision of veterinarian services. In 1986, a law was passed for the privatization of veterinary services that allowed private veterinarians to supply services to livestock farmers. To improve coverage across the country, the government limited public service provision to reduce competition and increase the uptake of services by private veterinarians, particularly in remote areas where the majority of pastoralists are located. The government also supports the private sector through capacity strengthening activities and the provision of equipment on credit, such as cold rooms to store inputs. As a result, Mali has markedly improved animal health and the private sector now provides more than half of veterinarian services in the country.

Policy innovations

Over the last few decades, Mali's policy emphasis for the livestock sector has been on reducing the impact of animal diseases and improving productivity through access to inputs, services and markets – particularly for pastoralist and agro-pastoralist communities. From 2000-2018, cow milk yield increased over 25 percent and total output increased by 185 percent. At the same time, production of goat milk doubled while that of sheep milk grew by nearly 150 percent.[594] Prior to the 1990s, Mali's livestock sector policy had a strong focus on animal health with vaccination campaigns, in particular against rinderpest, which was eventually eradicated in 1999 in partnership with the Pan-African Rinderpest Campaign implemented by the African Union–Inter-African Bureau for Animal Resources.[595] Following the great droughts of the 1970s and the 1980s, the government's emphasis shifted toward

increasing access to water points and pasture, while support for the marketing and processing of livestock products was also strengthened, for example through increasing the number of slaughterhouses and livestock markets. In 1991, Mali abolished a cattle export tax to reduce market barriers and support growth in the sector.[596] In 1995, the government agreed on an action plan for the development of the red meat sector.[597]

Livestock production in Mali is largely concentrated in pastoralist and agro-pastorlist livelihoods. In 2001, the Pastoral Charter (Charte Pastorale) was passed, acknowledging the right of pastoralists to move their herds in search of water and fodder, including into neighboring countries, while requiring them to respect the property of others and protect the environment, for example, by avoiding overgrazing. Pastoralists were given access to pasture, saline lands, water points, and state-owned resting areas. Transhumance agreements were made with neighboring countries in order to limit cross-border conflicts over shared pastoral resources, and a monitoring mechanism was proposed. Today, the government seeks to promote pastoral farming by developing of rangelands, combatting diseases, and constructing water points, pastoral perimeters, and livestock infrastructure.[598] Despite being considered as only partially enforced by some actors, the Charter has facilitated the implementation of many programmatic interventions, such as the Regional Project to Support Pastoralism in the Sahel (PRAPS, see below). The laws and regulations related to the Charter have significantly strengthened the autonomy of local communities as well as knowledge transfer with respect to the improved management of natural resources. Furthermore, in several municipalities, regulations have been translated into practical planning tools based on the application of the Land Use Planning Scheme (SAT) and the Economic, Social and Cultural Development Plan (PDSEC). However, in some parts of the country, the implementation of the Charter has stalled due to ongoing political instability.

In 2004, Mali adopted the five-year National Livestock Development Policy (*Politique Nationale De Developpement De L'elevage,* PNDE) to improve animal feed and health and the performance of livestock, to build livestock breeding and commercialization infrastructure and equipment, to strengthen the capacity of livestock value chain actors, and to preserve natural resources. Under the PNDE, MEP has implemented strategies to add value to local raw milk; promote the red meat, tanning, and poultry subsectors; improve animal feed; strengthen epidemiological surveillance of diseases; and increase the capacity of milk producers and breeders.[599] PNDE called for an expansion of the budget allocated to the sector such that it matched the livestock sector's contribution to GDP; implementing the PNDE from 2004-2009 was expected to cost CFA 75 billion (US$139 million).[600] However, implementation in the pastoral areas in northern and central Mali was severely hampered by a lack of human resources as well as political instability.

Moreover, in 2006, the government passed the Agriculture Orientation Law (LOA) (*Loi d'Orientation Agricole*), which is the overarching document guiding government actions in the agriculture, livestock, fisheries, and forestry sectors.[601] It aims to develop an intensive and diversified agriculture sector, and defines the functions of government and other entities, stating that government services are to be demand-driven, concentrated on providing technical assistance to farmers and agricultural organizations, and dedicated to setting policies beneficial for agricultural growth and market expansion.[602] In 2008, the government developed a strategy for promoting domestic dairy production with the aim of reaching self-sufficiency in milk and dairy products by 2013.[603] To achieve this objective, the strategy sought to increase private investment in the milk sector; create incentives, such as easier access to land, credit, inputs, equipment, and services, and favorable taxation policies; strengthen the technical, organizational, and institutional capacities of stakeholders in the dairy sector; ensure easier access and collection

of local raw milk for the processing industries; and establish industries for processing local raw milk. However, despite encouraging results, Mali has not yet achieved self-sufficiency.

In 2013, the Agricultural Development Policy (PDA) (2013–2020) was approved by the government as the strategic framework of the LOA, replacing the previous Master Plan for Rural Development 1992–2010.[604] The PDA implemented a sector-focused approach to agricultural development with the objective of reducing poverty, ensuring food security, modernizing agricultural production systems, and improving the competitiveness of the agricultural sector.[605] The PDA provides the framework for all policies and sectoral strategies governing the agriculture sector, including livestock.[606] For the livestock sector, the PDA takes into account the objectives of the PNDE and promotes the development of private farms using intensive production systems for meat, milk, and eggs. It also seeks to preserve and improve local breeds and to implement conservation programs for local breeds threatened by extinction. Furthermore, the PDA encourages the use of biotechnology, such as artificial insemination for genetic improvement. To ensure optimal health coverage of livestock and preserve the competitiveness of livestock products, the government encourages and reinforces the liberalization of the veterinary profession. Incentives have since been put in place to encourage private veterinarians to move to some of the more remote pastoral areas.[607] However, several constraints were encountered including quality of human resources, security issues and late implementation of regulations of the veterinary profession in compliance with international and regional standards such as the free movement of veterinary doctors in the West African Economic and Monetary Union.

Finally, in 2015, Mali finalized its CAADP 10-year investment plan, the National Agricultural Investment Plan (PNISA) covering the period 2015 to 2025.[608] PNISA provides the framework for all investments in the agriculture sector, including strategic investments in livestock value chains, specifically livestock products (both meat and dairy).[609]

Programmatic interventions

Numerous programs have been implemented by the government and its partners as it seeks to develop the livestock sector to boost economic growth and improve food security and nutrition.

Poultry

In the poultry subsector, the government has designed interventions targeting each segment of the value chain. Between 1998 and 2010, the Program for the Development of Poultry in Mali (PDAM) sought to increase the production of eggs and chicken meat through the adoption of modern production technologies and improvement of poultry feed and health. It also sought to increase the incomes of rural populations in the project's intervention areas and organize the actors in the poultry sector. Under the program, poultry markets, slaughterhouses, and cold rooms were constructed. In addition, targeted vaccination campaigns and capacity-strengthening activities for value chain actors – including breeders, merchants, and hatchery operators – were organized. Cars, motorcycles, and bikes to transport goods were also purchased for farmers' organizations.[610] As a result, the stock of poultry increased from 5.6 million to 27 million between 1999 and 2006, while the number of poultry sold and registered in 32 markets increased from 983,000 to 6 million.[611] In 2014, due to the positive impacts of PDAM, the government launched the second phase of the project over a period of five years, with the objective of achieving self-sufficiency in poultry meat.[612]

Milk and meat

To increase the stock of productive local cattle for milk and meat production, the government initiated the Azawak Zebu Selection and Multiplication Support Project in Mali (PASMZAM) in 2000. The project aimed to enhance the living conditions and income of pastoral communities, particularly in the region of Menaka, by increasing the stock of a local breed, the Azawak Zebu, which is known for high milk yield even under harsh conditions. In addition, its carcass yield ranges from 50 to 60 percent, and an Azawak ox can transport loads of 80 to 100 kg over distances of 15 to 20 km at a speed of 3.4 km per hour. The project was implemented in three phases. During the first and second phases (between 2000 and 2006), each beneficiary farmer received four heifers, one bull, and a dromedary, to be repaid at a later stage. The third phase of the project began in 2012 but could not be implemented due to the ongoing conflict in Mali.[613]

In the spirit of achieving self-sufficiency in raw milk production and dairy products, the Projet de Développement et de Valorisation de la Production Laitière au Mali (PRODEVALAIT) was initiated in 2009. The project sought to better organize dairy production areas, provide support to farmers, set up milk collec-

tion centers and processing units, and provide institutional support. To improve the genetic composition of cattle, the project financed the purchase of inputs for the storage and conservation of animal semen, supported the training of inseminators, and artificial insemination service provision across the country, and organized awareness days for pastoralists in the peri-urban areas of Bamako. In 2015, almost 6,000 cows belonging to about 2,000 farmers were inseminated. Also under the project, milk collection centers were renovated to restart widespread milk collection activities. Some milk collection centers were equipped with solar panels for electricity generation.[614,615]

From 2014 to 2019, the Livestock for Growth Project (L4G) was implemented jointly by the governments of Mali and the United States through the Feed the Future program, using the value chain approach to commercialize the livestock sector in Mali.[616] L4G has been mostly implemented by local actors under the supervision of regional authorities. It aimed to strengthen livestock value chain actors' competitiveness, responsiveness to market demands, and access to quality agricultural inputs and services. The main objectives of the program were to enhance livestock productivity, increase trade domestically and in the region, increase the entrepreneurial capacity of livestock value chain actors, and strengthen the enabling environment for the livestock sector.[617] It also sought to increase the capacities of private veterinarians and other livestock professionals to train farmers. The project was affiliated with FEBEVIM and the National Union of Livestock and Livestock Traders, who have benefited from capacity building in market regulations and livestock marketing.[618] The project implemented vaccination campaigns, supported farmers to sell and buy animals, and offered training.[619] L4G also facilitated access to microfinance loans for producer organizations to fund animal fattening activities. In addition, the project supported the rehabilitation of a Livestock Market Information System (LMIS) operated by the Observatoire des Marches Agricoles (OMA).[620] As a result of these interventions, 691 mt of fodder were produced, which led to a significant improvement in meeting animal feed needs, particularly during the dry season, resulting in an increase in both animal productivity and competitiveness when sold at markets.[621] Furthermore, the project developed the Private Proximity Veterinary Service (SVPP) that allowed 287,525 animals to be vaccinated and more than halved the prevalence of diseases in the Koro and Bankass Cercles districts from 45 percent in 2014 to 20 percent in 2018.[622]

In addition, 1,800 full-time jobs were generated (65 percent held by women) in animal fattening, fodder production and sale, and multinutritional salt block production, and working as veterinarian assistants, tree nurserymen, and dual-purpose seed producers.[623]

The government of Mali has also participated in regional interventions to develop its livestock sector. Mali is part of the Regional Sahel Pastoralism Support Project (PRAPS) initiated in 2015 and being implemented in Mauritania, Senegal, Burkina Faso, and Niger. PRAPS aims to improve access to important productive assets, services, and markets for pastoralists and agro-pastoralists in cross-border areas and along the transhumance routes, and strengthen national capacities to respond efficiently to pastoral crises or emergencies. It is expected that the project will directly benefit 440,000 pastoralists and agro-pastoralists, including 132,000 women and young people in Mali by 2021. PRAPS improves animal health through the rehabilitation or building of veterinary infrastructure and support to animal disease surveillance and vaccination campaigns for regional priority diseases such as CBPP and PPR. It also provides support to pastoral and agro-pastoral communities to grant secure access to natural resources such as grazing lands and drinking water. In addition, market access is facilitated through the rehabilitation and building of new livestock markets to increase pastoralists' access to competitive markets, and to boost trade in pastoral products.[624] An evaluation in 2019 found that the herd prevalence of CBPP fell significantly, sustainable land management practices were adopted by pastoral and agro-pastoral communities, and the construction of new water points improved access to reliable water resources. In addition, the building and rehabilitation of seven markets increased the number of animals sold.[625]

Furthermore, to complement the PRAPS Project, over the period 2018 to 2024, MEP coordinates the Mali Livestock Sector Development Support Project (PADEL), which seeks to increase the productivity and commercialization of non-pastoral animal production in selected value chains and to enhance the country's capacity to respond to crises and emergencies.[626] The overall approach is to support sedentary livestock value chains such as cattle and small ruminants (meat and milk) and poultry (chicken and eggs), as well as all livestock development activities along the selected value chains, from production to market. It includes three components: strengthening of livestock services to increase productivity in selected nonpastoral value chains; enhancing the competitiveness of targeted cattle and small ruminants (meat and dairy) and poultry (eggs and chickens) value chains; and creating mechanisms to prevent and better respond to crises and emergencies. Furthermore, it aims to increase project coordination capacities within MEP.[627]

The Malian government has recognized the potential of the livestock sector to deliver economic growth and meet food security and nutrition targets. To support the sector, the government has introduced targeted institutional and policy innovations and programmatic interventions. Mali is a net exporter of live animals. However, it is still strongly dependent on imports to meet demand for dairy products. By pursuing efforts to boost dairy productivity and providing incentives for private investors to invest in milk collection activities and modern processing facilities to produce competitive and quality products, Mali can make significant progress toward achieving self-sufficiency in milk.

9. Conclusion

Over the past two decades, steady economic growth across Africa, accompanied by population growth, demographic changes and urbanization have contributed to a significant shift in dietary preferences and habits. These trends have increased the demand for more animal-sourced foods such as dairy, eggs and (processed) meat. Across the continent, consumption of animal-sourced foods is projected to increase significantly by 2050 and a thriving and sustainable livestock sector will therefore play an instrumental role in meeting targets on food security and nutrition. Furthermore, livestock supports the livelihoods of millions of people in pastoralist, mixed crop-livestock farming and commercial systems. It serves multiple, beneficial roles such as health and nutrition, employment and income generation, economic growth, asset accumulation, draught power, transport, soil nutrient production, social security, and insurance. In addition, livestock provides important coping mechanisms, for instance, the sale of live animals as a source of income or continued provision of milk and eggs during lean seasons or climatic and socioeconomic shocks. Importantly, managing livestock and new employment opportunities in livestock value chains can promote increased economic empowerment amongst women and young people.

While demographic changes and shifting dietary patterns offer an opportunity for the livestock sector to grow and develop, these developments will occur against a backdrop of climate change, growing stresses on land and water resources, conflicts and a global pandemic. Specifically, increasing stress on land and water resources and a reliance on rain-fed fodder (pasture) means that livestock producers are subject to strong seasonal fluctuations. Moreover, with little or no alternatives or incentives, grazing land is turned into arable land, and the remaining pastures are often of poor quality and severely degraded. Projections therefore suggest that, without focused interventions, African producers will not be able to meet the rapidly increasing demand for animal-sourced foods and that between 10 to 20 percent of beef, pork, poultry and milk will need to be imported over the period 2030 and 2050.

To benefit from the potential of inclusive growth in the livestock sector, livestock production and the entire value chain need to be sustainably intensified. Although there has been progress towards improving feed for livestock, access to high-quality feed remains a significant challenge to increasing livestock productivity. In addition, limited technology adoption, low yielding breeds, and stringent biosecurity standards for human and animal health continue to present a challenge for many small livestock keepers and pastoralists and is an obstacle to market participation and trade. Sustainable livestock sector policies in Africa must hence be designed in a way that sustainably intensify value chains, address the multiple and combined challenges of climate change and natural resource scarcities, and capitalize on the potential opportunities arising from demographic changes as well as shifting dietary patterns. These policies need to be accompanied by a solid regulatory framework that governs animal and human health and food safety standards.

As more and more African countries move toward growing their livestock sectors, important lessons can be learned from successful government actions taken across the continent. One strategy is to replicate, contextualize and scale up those policy and institutional innovations and programmatic interventions that have shown to be successful on the ground. Several common features distinguish those African countries that have made significant progress in sustainably expanding and growing their livestock sectors. The examples of the six case studies in this report have shown that success has been most effective where governments have provided supporting infrastructure, increased capacity building in animal health systems and introduced fiscal incentives. In many cases these interventions were combined with a more prominent role for the private sector in the dissemination of modern technologies to increase productivity and enable the commercialization of livestock production.

Ethiopia's thriving livestock sector is the outcome of a clear vision, cascaded into carefully designed policies and aligned with other national ambitions, as well as investments in institutional development. These have attracted significant investment both from the private sector and development partners. The government has prioritized building capacity in animal health, research and marketing, further ensuring that the sector can support both domestic and export demand. **Mali** has had a focus on improving animal health and feed, and promoting an increase in the productivity of local cows through breeding through its National Livestock Development Policy (PNDE). The government has also invested in infrastructure development and equipment to commercialize the livestock sector and facilitate the export of live animals in the region. Success in **South Africa's** livestock sector is underpinned by a vibrant private sector

and national efforts to include and commercialize production from small and emerging farmers - both of which are supported by a well-established animal health system. Finally, strong institutional and dedicated livestock sector policy innovations have successfully transformed and liberalized the dairy industry in **Uganda**. For example, the Dairy Master Plan has contributed to the privatization of the state-owned processing company Dairy Corporation and the creation of a Dairy Board. Furthermore, targeted programmatic interventions in the dairy value chain have allowed Uganda to achieve self-sufficiency in milk production.

The experience of the four African countries analyzed in this report can assist other African governments to develop country-specific strategies to sustainably grow their livestock sectors. The Malabo Montpellier Panel has identified a set of actions summarized below that, if brought to scale, could have a significant impact on livelihoods, food and nutrition security and the overall sustainable growth and transformation of Africa's livestock sector.

Action agenda

Creating an enabling environment

1 Design an overarching policy framework that guides interventions and supports the development of an inclusive, holistic, productive, profitable and sustainable livestock sector.

2 Develop a nimble but clear and health conscious regulatory environment for input and output markets to promote livestock activities.

3 Facilitate private sector-led investments in the livestock sector, including in infrastructure and the commercialization of livestock products and inputs.

4 Design financial services, including insurance, to meet the special requirements of livestock producers.

5 Ensure that livestock products meet international quality and food safety and animal health standards to strengthen intra-African and global livestock trade.

6 Address the urgent need to increase the availability and access to comprehensive and good quality information and data on all aspects of the livestock sector for sound policy design.

7 Apply a holistic approach to tackle the root causes of conflicts between pastoralists and crop farmers.

Sectoral interventions

8 Promote the transition of large ruminant keepers to producers with context-specific, supportive strategies and incentive structures.

9 Leverage employment and entrepreneurship opportunities in the poultry sub-sector particularly for the benefit for women and young people.

10 Mobilize investments in the dairy industry for countries to specialize in dairy production and to strengthen intra-African trade.

11 Promote value addition and increase productivity of the pork sub-sector by adopting improved technologies and better husbandry practices.

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