

Innovation for sustainable livestock: Livelihoods and economic growth

Shirley Tarawali, Vincent Amanor Boadu, Isabelle Baltenweck, Nicoline de Haan, Ilse Kohler-Rollefson

Key messages

- Recognize and support sustainable livestock's contribution to multiple development ambitions (and avoid unintended consequences)
- Harness diversity and growth for a sustainable livestock sector
- Support sustainable livestock enterprises through financing, business and trade innovations
- Invest and use the latest technologies at a faster pace 'innovation expedited'
- Undertake awareness and engagement actions to ensure livestock roles in livelihoods and economic growth are included in livestock-specific and wider development policies/agendas

Introduction

This paper explores the opportunities for innovations in the livestock sector to contribute to sustainable livelihoods and economic growth. 'Livelihoods and economic growth' are broad areas covering the sector's multiple roles in poverty alleviation and contributions to national economic growth, notably for women and the younger generation. The paper considers the transformation of the sector as it adapts to meet the rapidly growing demand for milk, meat and eggs (especially in LMICs) and how there can be a sustainable transition for the billion or so people across the world whose livelihoods depend on livestock in one way or another.

The livestock sector is highly heterogeneous within and across regions around the world. High degrees of heterogeneity are observed in the types of livestock, the production systems used, as well as in the structure of the various input-output value chains. For their part, production systems vary greatly because they need to be adapted to available resources, the cost of natural resources and resource constraints including markets.

In capital-intensive systems (where natural resource costs are high), livestock are raised and kept at high stocking densities and fed high levels of concentrates to maximize production outputs. Poultry and swine are often produced under vertically integrated systems where a single large company controls all aspects all production stages, from breeding to production occasionally with the involvement of external growers for processing and retailing. Cattle and other ruminants are raised in a variety of extensive and labour-intensive systems across the world, often with lower resource costs. In labour-intensive systems there are, literally, hundreds of millions of small- and medium-scale production enterprises with varying degrees of management, inputs and market engagement. Much of the heterogeneity in these systems stems from variations in agro-climatic conditions, access to markets and services as well as socio-cultural norms, ranging from backyard chicken systems using minimal inputs to dairy systems that are well integrated into value chains.

Fostering sustainable livelihood and economic growth opportunities for such a diverse sector requires a careful appreciation of the strategic objectives of all its varied actors at the production level, upstream (genetics, feed, health services suppliers, etc.), and downstream (aggregators, transporters, processors, distributors, retailers, etc.). It is also important to understand the public policy and institutional environments that confront the different actors across systems, regions and countries. Consumers, competitors and market conditions defined and framed by cultural and economic conditions all influence the sustainability of livestock sector contributions to the livelihood and economic growth of its stakeholders across the world. Understanding the production, distribution and marketing environment in which the sector operates in the different regions must precede the development of innovative solutions that can secure sustainable livelihoods for the

various stakeholders in the different segments of the sector while continuing to contribute to their national or regional economies.

Issues, opportunities and risks

Livelihoods; poverty and income growth

Historically, increasing incomes have correlated with increasing demand for meat, eggs, dairy and other livestock products. Recent reports suggest that demand is projected to increase by 70% by 2050 (FAO, 2019a).

Globally, it is estimated that over a billion people are involved in livestock – from input supply production, processing to sales, and marketing; and at least half of these totally depend on the sector, including some of the world's poorest peoples (Robinson et al., 2011). More specifically, the numbers of people engaged directly in livestock production tend to be smaller in capital-intensive than in labour-intensive or extensive systems. Capital-labour substitution is evident in the livestock sector globally. In many HICs, where labour wages tend to be higher than capital costs given their relative productivity in the livestock sector, production tends to be capital intensive, resulting in a lower proportion of people depending on the sector for their livelihoods. Contrarily, in most LMICs, a larger proportion of people tend to be dependent on the livestock sector for their livelihoods because the relative cost of capital makes labour-intensive systems competitive. For example, the UK, where just 0.5% of the population (19% of whom are women) are employed in the livestock production industry (Warwick University, 2010), contrasts sharply with Kenya where, at farm level, more than 800,000 people are directly employed in dairy production, representing about a third of the total agricultural labour force. Fifty thousand more people are involved in milk trading and processing, stressing the important role dairy production has in creating employment across many segments of society (Staal et al., 2008). It is noteworthy that these figures are now more than 10 years old and are likely to underestimate the weight of the sector in the Kenyan economy; the Kenya Dairy Board currently estimates about 3 million jobs in dairy alone (smallholder farmers plus other employment: <http://www.kdb.go.ke/>). Across the EU, around 4 million people are employed on livestock farms, with 30 million employed (about 12% of the adult workforce) across the entire livestock sector, largely in processing (The Animal Task Force, 2017a). In the US livestock sector production is estimated to support 0.4% of the US population (US Bureau of Labour Statistics, 2018).

Typically, in HICs, the sector employs people and pays them wages, and they make their living from these wages. In many LMICs beyond those who have salaried jobs, livestock plays multiple roles in the socio-economic realities of households: store of wealth; source of income; insurance and safety net; symbol of social status; and numerous others depending on culture and situation. Especially in LMICs and labour-intensive systems, sales of milk, meat and eggs are an essential source of regular cash income (FAO, 2009) and livestock are an asset that allows households to manage risks and prevent total financial disaster when crops fail or other shocks hit (Moll, 2005; Wade, 2013). For several hundred million pastoralists in marginal areas (World Bank, 2014; FAO, 2019b), livestock are their only asset and the only means of using the more than two-thirds of the world's agricultural land that is classified as permanent pastures to produce food. These systems have evolved over centuries to cope with spatial and temporal climate variability. Herds are intentionally managed to withstand drought (McPeak 2005; McPeak et al 2012) and animals sold to provide cash for school fees or to buy grains. From the drylands of Africa, to the extensive drylands of Asia, the north of Scandinavia, dry and mountainous areas of Europe and the Americas, animals in extensive systems are essential for livelihoods and for ecosystem stewardship.

Regardless of where they are produced, livestock have strong cultural roles: as gifts and dowries in social networks and marriage; as dishes on special occasions, such as festivals and holidays; and in

religious rituals and celebrations. In some communities, livestock are important for sporting events and entertainment, from rodeos in north America, to the *Naadam* in Mongolia.

Furthermore, livestock provide numerous benefits, ranging from manure for fertilizer, and fuel for cooking and heating, and energy for ploughing and transportation of humans and goods, many of which support crop farming, thereby improving overall farm productivity. In the EU, manure accounted for 38% of the nitrogen input in 2014 (European Commission, 2018) and is likely to be more in countries where inorganic fertilizers are less available. In Kenya, non-monetary benefits (including store of wealth and prestige) amount to almost 20% of the animals' total value across different livestock systems (Ouma et al., 2003). In some cases, livestock play important roles in wealth creation and management, asset building or access to cash where classical banking is not yet fully functioning.

Opportunities: Rising demand for animal-source foods means there will be new and growing income generating opportunities to be grasped especially in labour-intensive systems. Capital-intensive systems may also be part of addressing such demand, notably through trade arrangements. In extensive systems, new income streams such as payment for good stewardship of animals and the natural resources on which they depend (for example Pappagallo, 2018) along with risk mitigation strategies such as insurance ([Index Based Livestock Insurance](#) (IBLI); Jensen et al., 2017) can improve resilience if appropriate combinations of public and private partnerships and well-designed products can be achieved. Considerable interest in index-based livestock insurance products has led to a new regional initiative being explored by governments and investors in the Horn of Africa (See: <http://livestockinsurance-igad-conference.org/index.php>). Especially in LMICs there are, therefore, real opportunities to utilize livestock as a means to escape poverty (Dorward et al., 2009; Kristjansson et al. 2004), and thus important roles for international and national financing institutions.

Across the world, richer consumers are showing a preference for branded livestock products that are produced in more sustainable ways (with a lower environmental footprint) using less anti-microbials and enhanced animal welfare standards (Grandin, 2014). These issues are creating opportunities for small and large producers alike.

Risks: With around one billion people across the world depending on livestock for their livelihoods, rapid changes in the sector to respond to rising demand is a potential threat, if deliberate actions and policies that support and enable effective participation by all actors are not considered. This applies especially to millions of small-scale producers and other livestock-related players who could fail to benefit from the emerging opportunities and may even lose their existing livelihoods as other larger-scale players come to dominate the sector. Progress in some parts of the world is likely to be further hampered by lack of investment in the sector, inadequate credit, finance and land tenure modalities. Investment in the sector could also be impacted by increasing anti-livestock sentiments which could also impact negatively on many individuals whose livelihoods relate to livestock.

Currently, especially in the U.S. and Europe, there is considerable discourse about the desirability of reducing per capita consumption of livestock products. One manifestation of this is the emergence and rapidly increasing demand for plant proteins processed in ways to closely mimic meat and animal products. The recent very successful initial public offering of Beyond Meat, a company shifting from animal to plant-based protein, is just one example of this trend that is bound to accelerate investments in research supporting this line of products. Addressing sustainable livelihoods demands a consideration of innovations in products and processes that could adversely affect livestock producers and their supply chains; the most vulnerable are likely to be those in low income countries with smaller degrees of maneuverability. It is prudent, therefore, to explore the motivators of change in consumer protein preferences that are defining demand in high income

countries and develop solutions to ameliorate the impact of any such shifts in low income countries, alongside the essential focus on sustainability domains.

Economic growth

Growth rate estimates reported by the World Bank (World Bank, 2019) show that high-income countries' livestock production grew at 0.8% per annum between 1990 and 2014, compared to 2.9% for low income countries, 3.3% for lower middle-income countries and 3.6% for upper middle-income countries. However, average annual per capita meat consumption in high-income countries is over 60kg higher than low-income countries (OECD, 2019). Predictions indicate that demand for meat, milk and eggs will continue to rise in LMICs in the coming decades driven partly by population (especially in Africa) and partly by incomes rising (Asia, Latin America) (World Economic Forum, 2019). This makes it crucial to explore innovations that could enhance the sustainability of livelihoods of people making their living from livestock production and processing especially in LMICs where the growth in demand is greatest.

Globally, the livestock sector contributes an average of 40% of agricultural GDP (Salmon, 2018). In LMICs there is a wide variation, from 15-80% and growing as rising demand for meat, milk and eggs is addressed. Extensive systems are especially important contributors to GDP in some of the poorer countries (Kratli et al., 2013) and across the EU the livestock sector contributes Euro 168 billion annually, 45% of the total agricultural activity (The Animal Task Force, 2017a). For many nations, data on livestock is not disaggregated from a wider 'agriculture' metric, making it difficult to assess the sector's contributions (Pica-Ciamarra et al., 2014a). This lack of data is further compounded when livestock's multiple roles beyond direct production are overlooked (eg Behnke, 2010; Pica-Ciamarra et al., 2014b). In the US, agriculture contributes about 5.7% to the country's GDP. Livestock accounts for about 50% of US agriculture and it is, thus, estimated that the livestock sector's contribution to the nation's GDP is about 2.8%. As economies transition and livestock systems evolve from labour- to capital-intensive, the share of agriculture as a proportion of total GDP tends to fall, but the proportion of livestock in agricultural GDP rises (Salmon, 2018).

Opportunities: Taking advantage of the potential for the livestock sector to contribute to GDP requires deliberate, prioritized and targeted actions. Not all livestock enterprises or systems have the potential to grow and make significant national contributions in every situation. So, while investing in and supporting sustainable growth in the capital-intensive cattle industry in the US, the labour-intensive dairy sector in Kenya and India and extensive cashmere in Mongolia makes economic sense; others will be less economically profitable and environmentally sustainable. For example, in labour-intensive systems, cost-benefit ratios look very different once labour costs increase, for example, when family labour is replaced with paid employees – even though some of them are currently profitable (Lapar et al., 2012).

Risks: Investing and supporting livestock sector growth to respond to demand without an appropriate policy environment could result in negative externalities, particularly those related to environment and health. Responding to growth also requires a commensurate increase in production efficiency (not just more animals) and that the disease constraints to production and sustainability are mitigated.

Gender and youth

In much of the world, livestock, especially small-stock, are almost the only assets women can own and benefit from (Kristjanson et al., 2014). In labour-intensive systems, some estimates indicate that two-thirds of the livestock are raised by women (Thornton et al., 2002) who are also often responsible for processing commodities, especially dairy (Njuki and Sanginga, 2013). In extensive systems, women also tend to have specific roles which often relate to their proximity to the

homestead, such as looking after young or sick animals and processing and selling milk or manure (Kristjanson et al., 2014). Despite such key roles, targeted gender-specific information, technologies and support to improve all aspects of the livestock enterprise is generally lacking. In capital-intensive systems, female entrepreneurs are becoming increasingly prominent (see for example, Jamali, 2009; Vossenbergh, 2013; Chozick, 2019). Across all systems and regions of the world, to varying degrees, women have particular roles in relation to household nutrition, particularly for young children both through choices related to the provision of nutritious animal-source foods and (mainly in extensive and labour-intensive systems) using proceeds from livestock sales to buy nutritious foods. This is a key intersection with the domain on food and nutrition security discussed below.

For land- and labour-intensive systems women and youth face challenges in terms of access to resources, especially land and finance. Youth and women are both strongly affected by issues around migration (CGIAR Research Program on Livestock, 2019). Over 60% of Africa's more than 1.2 billion people are below the age of 35 and will need more than 315 million new jobs by 2035 (FAO, 2013). At the same time, there are growing concerns that across the world agriculture, including livestock, is becoming increasingly reliant on an aging population as the younger generation exit a sector often perceived to lack opportunities for an exciting and prosperous future. In many HICs young people are already disconnected from agriculture and there are specific initiatives such as [FFA](#) and [4-H](#) which through education and practical training programs aim to reinvigorate engagement of young people in the sector.

Opportunities: Animal agriculture has a unique role in women's empowerment. Livestock are assets many women in LMICs are already familiar with and providing opportunities to improve livestock productivity enables women to move up the 'livestock and livelihood ladder' (gradually adopting higher-value and more productive species or breeds) thereby increasing the productivity of the entire system (Galiè et al., 2015) and enhancing household nutrition (Price et al., 2017). There are opportunities for young people as the newest IT and other transformative technologies will play important roles in livestock sector transformation: increasing addressing productivity and efficiency, addressing environmental challenges or applications that provide innovative solutions for food safety and traceability. Business opportunities in input and service provision could be very lucrative for the livestock sector, already valued globally at over USD 1 trillion (FAOSTAT, 2019). In HICs, niche markets may present limited new opportunities for young people include engaging in landscape restoration grazing and urban shepherding, or 'ethical' dairying (Sustainable Food Trust, n.d.).

Risks: Women's access to land, finance, information and markets is very uneven, particularly in extensive and labour-intensive systems. There are also instances where, as labour-intensive systems transition to be more capital-intensive systems, and livestock activities become more lucrative or formalized, women's roles and access to income benefits can become marginalized (Galiè et al., 2019). In some extensive and labour-intensive systems, child labour can be an issue that needs to be tackled (Isenberg et al., n.d.).

Smallholder competitiveness and sector exit

Particularly in LMICs in Africa and Asia, labour-intensive, mixed small and medium scale crop-livestock farms of less than 20 ha currently provide around 70% of both livestock and cereal commodities (Herrero et al., 2017). Livestock are integral to such production enterprises, which support the livelihoods of at least half a billion people (Robinson et al., 2011). For some enterprises, for example dairy in Kenya and India, such farms have proved to be competitive with capital-intensive production largely because of access to family labour (especially women) and strong synergies between crop and livestock production. Such labour dynamics are likely to change as economies develop and there are opportunities in other sectors. For other commodities, particularly

monogastrics, economies of scale mean that larger production units sometimes evolve rapidly alongside or replacing smaller enterprises. In HICs, small and medium crop-livestock farms provide a smaller percentage of total livestock derived food, accounting for 30% in Europe and 10% or less in the Americas (World Economic Forum, 2019). Small scale, integrated farms are also increasingly promoted in HICs as environmentally friendly, addressing 'niche' markets (see below) and providing environmental services like landscape management and conservation of specialty breeds. The central questions to be addressed are what role and at what scale do such farms have in supplying livestock-derived foods in the future, and doing so in ways that are environmentally sound, economically sustainable, healthy for people and the planet. For those in LMICs, this demands transformation, especially in terms of production efficiencies and food safety issues, as well as efficient connections to input and output markets, while not losing some of their benefits, such as the balanced integration of crop and livestock production enterprises.

Opportunities: Given the multiple roles of livestock in livelihoods and food provision, especially in LMICs, the transition from many millions of small and medium scale livestock production systems to future livestock agri-food systems presents multiple opportunities – both meeting demand and addressing development – to be grasped. In many instances, with the right policy and institutional context, many of today's smallholders could transition to out of the sector, using their present livestock enterprises as a stepping stone to make a positive sector exit (Dorward et al., 2009). For those that remain, transformation of production efficiencies, food safety, environmental footprint and market engagement will be among the ingredients for them to become medium and larger scale, more capital-intensive livestock agri-food systems in future. Incorporation of the newest science solutions and IT approaches will be important elements of such transformation.

Risks: For LMICs, where rapidly rising livestock demand presents opportunities to be part of sector transformation, there are risks that today's smallholder farmers in extensive and labour-intensive systems could be excluded as larger scale enterprises step in to respond to the market. For many, their exit from livestock could end up as a tumble into disaster, and the multiple development benefits of small-scale integrated farming could get lost as fast growth and economic opportunities are grasped. In HICs, anti-livestock sentiments or trade barriers with areas of greatest demand could threaten future livelihoods.

Innovations to enhance sustainability

Note: Our examples of innovations are drawn from across the World, with some notable exceptions: Latin America, China, middle-east and parts of Asia are not represented, and while many issues will be common, examples from these regions could further enrich the scope of the cases presented.

Extensive systems

We provide here examples of innovations in extensive systems that respond to opportunities and mitigate risks by providing incentives for land and ecosystem management, new income streams from niche products or payment for ecosystem services and addressing the risk of asset losses.

Innovations for land and ecosystem management

In many traditional pastoralist areas, over recent years disputes over land use rights have escalated as smallholder crop farmers and large-scale commercial farming investors have increasingly encroached into rangeland areas that have for hundreds of years served as important seasonal grazing land for pastoralists. The rising tensions this causes often flares up into violence: in just one district of Tanzania 34 lives were lost in a two-year period and the insecurity also has serious negative impacts on productivity and food security. To address these problems government and non-governmental partners have come together to implement joint village land use planning, a participatory process that aims to secure shared resources such as grazing and water; crucially this is

done across village boundaries. Clusters of villages in the district have been facilitated to develop village land use plans, a joint village land use plan, a joint village land use agreement and a joint livestock keepers' association. This has led to almost 150,000 hectares of land being covered by agreements that cover secure grazing rights and the fair use of other shared resources. It is anticipated that this will help ensure sustainable use of rangelands and reduce conflicts between pastoralists and farmers. The lessons from this Sustainable Rangeland Management Project ¹, have been shared with other African governments and the joint village land use plan approach has now been integrated into the Tanzania government's National Land Use Framework 2013-2033 (Kasyoka 2018, 2019a).

Among the innovations for ecosystem management are the conservancies particularly in the east African rangelands that provide opportunities for diversification by combining livestock raising, conservation and tourism (Bedelian and Ogutu, 2017). Making conservancies work is a delicate balance between the livestock enterprise and new income streams from tourism that may help reduce risk from single livestock enterprises, because conservancy payments provide reliable, year-round income. On the other hand, conservancies sometimes lead to reduced livestock access to extensive grazing resources while the conserved 'grass banks' retain good quality forage for the dry season. Income from conservancy payments may also at times be inequitable, for women or for land owners.

Innovations for new income streams from niche products or payment for ecosystem services

Over the past few decades, because of changing regulations and less reliance on draught power, traditional pastoral and nomadic camel keepers in Rajasthan, India have found it increasingly difficult to support themselves through camel herding. The state camel herd decreased from around one million in the mid-1990s to fewer than 200,000 today. Responding to the loss of camels and the important ecological and cultural roles they fulfilled, a local welfare organization for livestock keepers' organization, Lokhit Pashu-Palak Sansthan (LPPS) was established. In early 2019 a micro-dairy enterprise, focused exclusively on camel milk was opened. The milk is processed into a wide range of products, from frozen pasteurized milk to cream cheese, now being promoted to supermarkets and restaurants as healthy and nutritious foods. The camel keepers have quickly adapted to selling their milk to the extent that the potential supply of milk now exceeds the capacity of the micro-dairy, so plans are in place for expansion (Atlas Obscura, 2019).

A growing proportion of more affluent consumers across the globe are becoming increasingly concerned about where their food comes from, how it is produced and the impact this has on communities, livestock and the environment: many are willing to pay a premium for food, especially animal-source foods, that are produced in ways that are demonstrably more economically, socially and environmentally sustainable and with higher animal welfare standards. This has created an opportunity for livestock producers to market their produce in a way that emphasizes its provenance, often with third-party certification. Marketing innovations based on geographical area of origin, breed or production system have emerged, such as Criollo goat meat produced under a protected designation of origin seal by 1,500 traditional transhumant goat herding 'crianceros' families in the Argentinean Andes (Raggi et al., 2010; Krishna et al., 2010).

A similar innovation is taking off in South Africa, [*Meat Naturally*](#) combines ecological and economic empowerment, market engagement and benefits for environmental actions and the training to support these together with facilitating connections of all actors in the meat sector.

¹ SRMP has now entered its third phase (2016–2020) with the financial support of International Fund for Agricultural Development of the United Nations, Irish Aid, the International Land Coalition (ILC), International Livestock Research Institute (ILRI) and the government of Tanzania.

Biocultural Community Protocols (BCPs) are a tool that is formally recognized by the Nagoya Protocol on Access and Benefit-Sharing under the Convention on Biological Diversity (CBD) <http://www.community-protocols.org/>. BCPs, which are legally binding on all countries that are signatories to the CBD, put on record the roles of pastoral and other communities in managing biological diversity and its related contributions to the entire ecosystem. This can include for example community animal breeds, traditional knowledge of the animals and a lifestyle that maintains the environment. BCPs therefore represent a new approach to supporting pastoralists' rights and at times challenge counter-productive perceptions and policies. BCPs have been developed by at least ten pastoralist communities across India, Pakistan and Kenya; others are under development in Iran, Latin America, and for the Fulani pastoralists in West Africa (Köhler-Rollefson, 2016; Köhler-Rollefson et al., 2012).

Innovation to reduce the risk of asset loss

One of the impacts of climate change already affecting the lives of pastoralists in arid and semi-arid areas is the increasing frequency with which drought occurs. Droughts are a major threat to pastoralists' flocks and herds and can lead to large-scale losses as animals die due to lack of grazing and water. Losing animals which are the only asset for many such communities almost guarantees a descent into poverty and may precipitate drought-related emergencies such as witnessed in the Horn of Africa (IFRC, 2011). Index-based livestock insurance (IBLI) offers an innovative solution to this problem. In return for a small annual premium, pastoralists can insure their animals against the risk of drought. IBLI uses satellite imagery to measure the impact of drought on rangeland vegetation: once a threshold is reached, pastoralists are automatically compensated with cash that they can use to buy food or feed, water and medicine to help keep their animals alive. Such insurance payments are triggered earlier than traditional aid-based responses. Initial short-term and causal studies have demonstrated that IBLI adoption increases productive livestock investments and household income, reduces distress animal sales, improves resilience and food security (Chantararat et al., 2017; Cissé and Barrett, 2018; Janzen and Carter, 2013; Jensen et al., 2017; Matsuda et al., 2019). So far around 18,000 pastoralists in Kenya have taken out IBLI policies, which are sold by local insurance companies and partially subsidized by the government but that is only a small fraction of the millions of Kenyans who depend on livestock for their livelihoods. Efforts, such as the use of trusted local radio stations, are therefore underway to increase awareness of the IBLI product and overcome hinderances to uptake (Thompson Reuters Foundation, 2019). With increasing climate change and variability, more exploration of insurance solutions is required, evidenced for example by recent engagement of ministers, public and private sector national and regional agencies to address this challenge in the Horn of Africa (see: <http://livestockinsurance-igad-conference.org/index.php>).

Labour-intensive systems

Our examples of innovations impacting on sustainable livelihoods and economic growth for labour-intensive systems describe new IT applications attractive to youth, a tool that enables better assessment and targeting of solutions to empower women, an approach that enables prioritized investments to support sector transition and contribution to national economies and ways of engaging actors to promote sustainable transformation of livestock value chains.

Innovation to strengthen IT applications

All around the world it is proving to be increasingly difficult to attract young people to follow farming and related activities as attractive career options. Farmers in both LMICs and HICs have an average age of about 60, even though the population of the former is predominantly under 24 years old (FAO, 2014). The sector is widely regarded by young people to be poorly paid and associated with physically hard, dirty and monotonous work. To make the sector more financially attractive and somehow compensate this negative impression, efforts are being made to promote farming as a

rewarding, interesting and important career choice. One way of doing this is to tap into young people's passion for technology as an approach to making farming more efficient and profitable. An example of this in the livestock sector is the use of digital platforms to facilitate herd performance recording and farmer education in Kenya under the auspices of the African Dairy Genetic Gains (ADGG) project. This entails establishing National Dairy Performance Recording Centers (DPRCs) for herd and cow data collection, synthesis and genetic evaluation linked to timely farmer-feedback to enable dairy farmers to make the necessary adjustments to increase productivity and profitability. So far, more than 50,000 farmers in Ethiopia and Kenya are benefitting from over 6 million digital education messages via mobile phones and based on performance recording of their individual cows and herds. This is enabling them to make better informed decisions. Ultimately, the goal is to close the milk yield gap between what is currently being achieved by the majority of small-scale dairy farmers, what a small minority of farmers achieve and the yield potential of the animals (Okeyo et al., 2017). This work partners with a broader innovation in Kenya, [iCow](#) which provides information on production and connects farmers to key players in their agricultural ecosystem.

Innovation that enables better assessment and targeting of solutions to empower women

Empowerment of women in the livestock sector is fundamental to achieving gender equality as well as essential for increased productivity and enhanced household health and nutrition. Livestock can also contribute to empowering women. Many different strategies are being implemented to empower women with regard to livestock, but it is difficult to assess their relative impact or select the best options to scale up, without a suitable means to measure women's empowerment. The Womens Empowerment in Livestock (WELI; Galiè et al., 2019) is a newly developed tool to address this issue. WELI facilitates meaningful assessments of the effectiveness of project interventions to enhance empowerment of women as related to livestock. The WELI includes six dimensions of empowerment: decisions about agricultural production; decisions related to nutrition; access to and control over resources; control and use of income; access to and control of opportunities; and workload and control over own time. It also moves beyond the default approach of using the head of household as the gender proxy.

Innovation to enable policy makers and private sector to prioritise investments and balance trade-offs to increase sustainable livestock's contribution to national economies

As stated above, the first difficulty faced by the livestock sector both globally and nationally is the recognition that the sector offers good opportunities to simultaneously contribute to economic growth and improve livelihoods. Once this hurdle is passed, national stakeholders face another challenge: how to prioritise investments in the livestock sector. One innovation applied in the last five years is the Livestock Master Plans (LMPs), that offers a roadmap on the type and level of investments needed to reach an agreed level of livestock impact indicators. Working with various stakeholders and actors, from both public and private sector spheres, the process starts by identifying the long-term objectives of the livestock sector, such as income growth, food and nutrition security, gender and social equity as was recently the case of the state of Bihar India (Shapiro et al., 2018). The 15-year plan sets out the investments that would be required to achieve these objectives, as well as a 5-year, more precise, investment plan. Using this approach, LMPs are now available for Ethiopia (Shapiro et al., 2015), Tanzania, Rwanda and the State of Bihar in India and processes are under way for several other countries in Africa and Asia. While it is too early to assess the outcomes of these plans, qualitative evidence from Ethiopia where the process was followed first indicate that it has positively influenced private sector (in the poultry industry) and public investment (World Bank). The LMP processes together with the Livestock Sector Investment Policy Toolkit (LSIPT) which is the primary analysis model together with associated models are being further developed and implemented by a consortium of partners including CIRAD, ILRI, FAO and the World Bank.

Innovation to strengthen engagement of all value chain actors

In many LMICs and for various products, the coordination among livestock actors has been weak, due to the long distances between producers and end users, along with the geographic dispersion of producers. Due to lack of, or poor, market pull, there are limited incentives for producers to invest more in livestock production, meaning they stay at a low input-low output level, even though livestock products are highly valued and in increasing demand. Due to the low level of productivity, providers of inputs and services (e.g. feed, animal health and breeding services) do not have markets for their products, exacerbating the low level of production and productivity. This inter-dependency among actors also means that solutions must be found through multi-stakeholder engagement and discussions (also called innovation platforms). Such engagement mechanisms have been operational for dairy in Tanzania and Kenya and the pig sector in Uganda. Research has shown that multi stakeholder platforms work best in a 'nested' system, whereby results of discussions at lower levels, e.g. at district level, are fed into national level discussions where policy changes and wider actions can be influenced (Cadilhon et al., 2016; Kilelu et al., 2017). While such platforms for dairy have shown improvements in household income because of better linkages to processors, there are still opportunities to improve the farm level productivity (Rao et al., 2016). In Kenya, Uganda, Tanzania and Rwanda a program led by Heifer International based on dairy hubs ([East Africa Dairy Development](#)), provided training and strengthening of business acumen. The initiative trained 179,000 farming families, established 37 milk collection hubs and formed 68 farmer business associations over its first five-year period. Although the model may not have been as successful as initially anticipated, the hubs are well established and farmers are using them to access inputs and sell their milk (Mutindi et al., 2015; Omondi et al., 2017).

Capital-intensive systems

Innovations in capital-intensive systems include examples that respond to consumer concerns, identify new niche product opportunities and mitigate environmental hazards. We also highlight a recent EU initiative on sustainable livestock.

Innovations responding to consumer concerns over welfare and AMR

Many livestock enterprises are responding to changing consumer preferences such as welfare sensibilities. However, the rapid adoption of these responses suggests that any premiums associated with them will dissipate rapidly and in their stead penalties for non-compliance will emerge. Reducing the administration of sub-therapeutic antibiotics, hormones and/or steroids leads to lower growth rates which are being addressed through innovation in feed and the administration of natural feed additives. In the USA, for example, companies, such as Purina and ADM, are responding with products that support gut integrity and improve feed intake in swine and beef animals (Burgoon, n.d.; ADM Animal Nutrition, 2018). Similarly, Tyson Foods, Perdue Farms, Foster Farms and some of the major poultry producers have eliminated the use of sub-therapeutic antibiotics from their production at a time when poultry farmers in developing countries are discovering the benefits of these technologies. The major feed companies are exploring custom blends that focus on decreased dependency on medicated feed, improved digestibility and gut health. At the same time there is a shift from treatment of diseases when they occur, for example with antibiotics, to preventing disease through enhanced biosecurity and reliance on new generation vaccines. In high income countries (HICs), emerging opportunities include products produced without the use of sub-therapeutic antibiotics, hormones and steroids: major integrators are voluntarily adopting these policies and using them as a differentiator in the marketplace (Tyson Foods, 2017) and a means of securing premium prices. Early adopters of such innovations are more likely to benefit from these premiums because once these approaches become mainstreamed, the premiums will disappear (Carlson, 2016). In LMICs, many enterprises are already close to meeting such standards, largely because they cannot afford or access the inputs, but production levels, market organization, sanitary regulation (e.g. poultry in Ghana (Amanor-Boadu et al., 2016)) and other trade barriers

hamper their participation in potentially lucrative opportunities, including export to high value markets.

Innovations in niche products and markets

Producers are also exploring niche production and marketing. For example, with increasing consumers preference for meat products with identity preservation and traceability, cattle and swine producers have adopted (by choice in some countries, legislation in others) ear tags and chip technology to provide consumers with the traceability they demand. However, as it is with every profitable niche activity, it goes mainstream. In the US organizations such as Walmart and IBM have partnered to bring the rapidly developing area of blockchain technologies to manage food safety (as an add-on to the Food Safety Modernization Act requirements) for Walmart's upstream suppliers provide these consumers with what they desire (Sander et al., 2018; Yiannas, 2018). Other companies are bound to join, and the increasing participation will bring down cost and make these technologies more mainstream. The early adopters of these technologies perceive them as providing them with first-movers' advantages.

Uruguay is considered among the leaders in traceability for its meat sector, and as a result earns higher premiums than other major exporters and reaches over 100 markets. Sales in 2012 reached USD1.4 billion (IICA, 2019).

Innovations to mitigate environmental hazards

Innovations to transform manure management into an opportunity are becoming a reality. In the US a recent study of a feeder-to-finish almost 9,000 head swine operation with installed anaerobic digesters that generate biogas for generation of electricity through a microturbine showed economic promise (Adair et al., 2016). As the search for renewable energy becomes intense and the cost of installing microturbine power generators fall, concentrated animal feeding operations will not only have an opportunity to solve their manure problem but to simultaneously transform it into value that contributes to a reduction in greenhouse gases.

A roadmap for a sustainable EU livestock sector

An example of a comprehensive initiative for sustainable livestock in the EU resulted from the EU40, a network of young Members of the European Parliament bringing together livestock industry stakeholders to develop a roadmap for a sustainable EU livestock sector (The Animal Task Force, 2017b). The aim was to help the industry to become more environmentally sound, socially responsible and economically viable. The roadmap focuses on innovation, technology and science-based solutions. The overall goal is to enable the conditions towards a strong sustainable EU livestock sector, and to maximize its contribution to the achievement of the Sustainable Development Goals.

Synergies and trade-offs

Sustainable improvements that benefit livelihoods and economic growth can have many co-benefits with other domains, as well as presenting trade-offs that the sector must be cognizant of and address. Here we highlight some of the key intersections in this regard, many of which relate to challenges that may arise if the sector growth is not accompanied by suitable enabling environments to manage emerging hazards and support the growing opportunities.

With food and nutrition security

Livelihood and economic dimensions of sustainability are closely intertwined with food and nutritional security, not least because of the relationship between income and decisions on food and nutrition that every household makes. The essential roles of women in livestock raising, commodity processing and trading along with their roles in household food choices mean that innovations to

improve engagement and empowerment of women are can be supported to have co-benefits with overall health and nutrition outcomes. Similarly, income from jobs in the livestock sector or from selling livestock products can be used to buy nutritious foods. Alongside, it is essential to mitigate any reduction in the attention women can give to household nutrition because of increased production pressure (Njuki et al., 2015).

Approaches that provide nutritional guidance for livestock-derived foods (Kimani, 2019), helping promote balanced diets that include milk, meat and eggs are important – but look very different, worldwide (WHO, 2018; Willett et al., 2019). Perhaps this is one of the areas where the contrasts and trade-offs across a global livestock sector are most often overlooked – from those for whom a reduction in consumption of animal-source foods would benefit their health and the planet, to those for whom an increase in consumption of animal-source foods would provide significant nutritional benefit as well as immense livelihood pay-offs. Importantly, in extensive and labour-intensive systems in LMICs, there are a range of issues to tackle to ensure that these nutrient-rich foods are accessible, available and affordable for all the population.

Food-borne diseases, including those transmitted by animal-source foods, are a major worldwide human health issue (Jaffee et al., 2019). When the livestock sector grows in labour-intensive systems there is a potential for new risks to emerge, or existing ones to be exacerbated if appropriate risk management approaches are not in place. Women in farm households, who are often closely associated with processing animal products, may be more exposed to food borne diseases and at the same time have a key role in preventing such.

With animal health and welfare

In LMICs, responding to growth opportunities, if not well managed with good health, hygiene and husbandry guidelines, could result in increased risks from zoonoses. This may especially be the case for women who are often closely associated with raising and caring for animals, ensuring their welfare in all dimensions – which at the same time places increased labour demands on women. This of course, equally presents opportunities to support a transition that mitigates these challenges, including for example opportunities for women as service provider of animal health.

There are new opportunities in the animal health sector for applications of the latest technologies, providing exciting opportunities for young people – use of blockchain for traceability or mobile apps to monitor, gather and advise on diseases for example. Such innovations may also come along with new challenges, including for example the legal frameworks that identify who along the ‘chain’ bears the liability.

Animal welfare is paramount in all production systems as transition occurs to more sustainable enterprises that also meet demand. Excellent welfare is part of a triple or quadruple win because it reinforces investments in productivity and thus incomes. Deliberate actions are required to ensure that all systems transition animal welfare issues are not overlooked and are integral to every livestock production enterprise.

Mainly in HICs, issues of animal welfare are raised to make the case for reducing livestock consumption and production. Welfare issues increasingly influence consumer choices and thus potentially aggregate demand for livestock-derived foods and the related livelihood opportunities. This issue is a good example of messages about very real issues that predominate in capital-intensive systems potentially impacting negatively on extensive and labour-intensive systems development and benefits, where the issue is very different. In HICs, there are livestock keepers and farmers who are specifically addressing this issue and developing more animal-friendly models, such as free-range farming enterprises. It is important to note that these developments are generally in response to

market opportunities and will continue only to the point where the marginal benefit from their implementation is not lower than the marginal cost.

Whether zoonoses or food-borne diseases, mitigating hazards will always need to be considered in relation to potential economic trade-offs which may look quite different at individual household level than they do at national levels and beyond. Information and incentives along with regulations will all need to be harmonized to ensure positive outcomes in all dimensions. Similarly, the topical issue of AMR presents potential synergies and trade-offs with income and livelihood aspects. These include for example, balanced rational use of anti-microbials lowering the cost of production and thus having a positive income result.

With climate and natural resource use

As described above, for extensive and labour-intensive systems, especially in LMICs, sustainable improvements to livelihoods and economic growth means grasping opportunities to respond to growing market demand for meat, milk and eggs. In doing so, there are potential trade-offs with the natural resource base that need to be managed. One of the key dimensions of participation in growing markets is improved production efficiency – meaning reduced GHG emission per unit of output – a reduction in emission intensity, which is often considered a ‘double or triple win’ – addressing market opportunities, reducing GHG emissions and supporting better livelihoods. Whether this has an impact on total emissions will be influenced by other factors, including incentives for keeping fewer but more efficient and productive animals. Reducing animal numbers is often counter-intuitive from the perspective of millions who currently rely on livestock for multiple livelihood functions. This means that beyond incentives, appropriate social structures that address those functions must be in place. Here the livestock sector intersects with multiple others, from banking, to insurance, to health and education and so on.

Capital-intensive systems are among the most efficient in terms of emission intensity, but because of the numbers and volume of production, as well as its concentration and separation from the land base, often record the highest total emissions and other environmental harms. The anti-livestock lobby is often fueled by such statistics; if it succeeds and leads to reduced investment in the livestock sector this will impact livelihoods worldwide. Its noteworthy too that within the livestock sector, we must be careful not to ‘point the finger’ between LMICs and HICs as to who is causing the most environmental harm. Across all systems there are real opportunities for improved resource use efficiency and better grassland and manure management that make not only for environmental sustainability, but ensure the sector continues to support millions of livelihoods.

Across the world, all livestock systems are impacted by climate change, none more so than the extensive systems despite their incredible ability to cope with shocks. Approaches such as livestock insurance (described above) is one of several approaches that can help to mitigate the livelihood devastation that often results from climatic or other shocks. Extensive systems are also important for their roles in supporting ecosystem services such as biodiversity and carbon sequestration, and such aims need to be balanced with their livelihood and gender implications in particular. Schemes that support payments for ecosystem services (and at times related co-benefits) may be explored with regard to supporting both income streams and natural resource management.

Access to and management of natural resources, particularly land is very varied and in many LMICs women and young people in particular are disadvantaged. In some cases, women cannot own land, in others they are the prime land managers – often through their livestock enterprises. Supporting women in good natural resource stewardship and decision-making for livestock management could have good environmental and livelihood pay-offs.

Implications for policy

Our discourse above has highlighted multiple opportunities across several dimensions of livelihoods and economic growth, illustrating the essential roles of livestock in relation to incomes, resilience, economic growth and equity. We have highlighted the diverse and unique roles that the sector can play that are integral to addressing multiple development ambitions. Such unparalleled, but often overlooked potential requires deliberate and targeted policy actions to ensure that livestock's present and future contributions to SDGs are not missed and there are no unintended consequences. Here, we frame policy issues in the context of key messages. With the exception of policies that impact directly on financial, business and trade operations, the majority of policy actions that can impact livelihoods and economic growth are not direct, 'command and control' topics such as legal instruments, sanctions or mandatory standards. Such 'hard laws' however, enacted in relation to other domains (such as food taxes, environmental regulations or public health sanctions) could have significant implications for livelihoods and economic growth, thus stressing need to be integrated into a bigger whole that takes account of all four domains of sustainable livestock (food and nutrition security, livelihoods and economic growth, animal health and welfare and climate and natural resource use) and their interdependencies. A policy environment that supports sustainable livelihoods and economic growth includes supporting the sorts of innovations described above (and many more) and their adaptation at scale to diverse livestock systems, commodities and locations. In many cases this also includes strengthening the capabilities of many actors to access and use innovations. It is one where policies take account of multiple trade-offs and synergies.

Recognize and support sustainable livestock's contribution to multiple development ambitions (and avoid unintended consequences)

Opportunities for livestock to contribute to livelihood and economic growth dimensions can be easily overlooked. Aspects such as food production, environmental impacts, health implications and so on may be easier to both measure and monitor. Here we highlight implications related to growth, resilience and equity that to a large extent frame the context for other policy dimensions.

Growth: Grow livelihoods and economies

New opportunities for stable income streams in the livestock sector as producers and other value chain actors can be supported through actions that engender inclusive, safe, sustainable value chains. They span technologies, business and infrastructure issues, many of which are highlighted below.

New income streams such as payments for ecosystem services (PES), niche products and product differentiation all need to be recognized and supported for livestock farmers across the world.

Among the best known examples is the silvopastoralism initiative in Colombia:

<https://www.worldbank.org/en/news/feature/2019/07/08/trees-and-cows-offer-path-to-recovery-in-colombia>

Support and guide new trade opportunities for both commodities and services and be cognizant of trade-offs that may have significant livelihood implications.

Resilience: Protect assets

Protecting livestock assets includes supporting livestock vaccination campaigns (exemplified by the [OIE PPR vaccine bank](#) for Africa targeting six countries in west and central Africa through the Regional Sahel Pastoralism Support Project (PRAPS)) and insuring against risks across the sector.

Insurance against risk in the livestock sector varies across production systems and reflects the different risk profiles encountered. Insurance based on risk such as drought or forage index (such as the Kenya Livestock Insurance Programme (Kasyoka, 2019b)), on insuring animals themselves (as in

India (<https://general.futuregenerali.in/rural-insurance/cattle-and-livestock-insurance>), government supported programs as in Brazil (<https://thebrazilbusiness.com/article/rural-insurance-in-brazil>) and the USDA recommendations the cover mainly market and financial risks (<https://legacy.rma.usda.gov/livestock/>). Both public and private sector have essential roles in providing insurance to strengthen the resilience profiles of the many whose livelihoods depend on livestock. Such roles are as varied as the insurance products themselves and may range from public sector support for mobile phone infrastructure that allows sales and payouts to function in remote areas, through to national regulations that ensure a fair market price. Private sector insurers may need to tailor their products for the clientele, such as the *Takaful* insurance product in east Africa which is Sharia-compliant.

Other examples include providing incentives for resilience-building environmental stewardship (such as payments for ecosystem services, and their co-benefits) accompanied by support for wider infrastructure such as financial and mobile services which may be a prerequisite for such incentives to function effectively.

Equity: Broaden the benefits

Be deliberate about approaches that are cognizant of the need to invest in women and youth to enable their effective participation in and contributions to the livestock sector. These may span policies that ensure land (tenure and titles), financing (credit, insurance) and information access are equitable for men, women, young and old, large and small enterprises.

To accomplish these multiple development dimensions, four areas for action are highlighted below.

Harness diversity and growth for a sustainable livestock sector

Prioritize, targeted, smart investment: For many systems where change, and thus opportunity are arising rapidly, being able to target both public and private investments in the sector to contribute to substantial economic returns, whilst minimizing any negative trade-offs will be important. Systematic prioritization of investments using tools such as Livestock Master Plans can facilitate such and ensure that the livestock sector fulfils its potential to contribute (or continue to) to national economies.

Recognize the diversity of the livestock sector so that there are no 'blanket policies'; and be cognizant of long- and short- term synergies and trade-offs among the various dimensions, as considered above.

Support a transition from livestock dependent livelihoods. Whether these are jobs in production, processing, trading (globally or in a traditional market); whether income comes directly from raising or selling animals or being paid to do so; whether animals are a source of cash or of multiple benefits, livelihoods will change. Smart policies need to support change in the livestock sector, without causing a loss of livelihood. All over the World, that includes helping people transition to other enterprises or sectors, it includes providing a range of services, market support and information that help small-scale subsistence farming to become economically viable, often medium and larger scale enterprises. Examples include supporting farmers' collective action, establishing agrovet shops, supporting private sector sales of inputs such as vaccines, providing necessary but straightforward registration for new fodder varieties, and standards to ensure safe feed supplies. Consider trade-offs and synergies. Policy makers will need to consider livelihood dimensions prior to investing in, or instituting legislation that supports or favours particular production systems or trade regulations. For example, in many LMICs, favouring industrial scale livestock production, or importation of livestock products could impact livelihoods of many millions. Instigating certain

export requirements or taxes on feed or animal health products will impact small and large enterprises worldwide.

Support sustainable livestock enterprises through financing, business and trade innovations

In 2017, the World Bank's *Enabling the Business of Agriculture* <https://eba.worldbank.org/> included for first time livestock related parameters, particularly those related to regulations around animal health products. Such studies, especially as they expand to address a wider range of issues can help inform national level finance and business approaches to support a sustainable livestock sector. De-risk new investment. In many LMICs, investing in livestock or related services is perceived as risky from a business perspective. The issue of insurance is mentioned above, other input examples may be new fodder seed enterprises, sales of animal health products or IT based market information solutions. Small and medium scale enterprise start-ups are often fragile ventures especially at the beginning. Innovative financing that helps to de-risk the initial investment may help such enterprises to get off the ground and be part of transforming the livestock sector. Multilateral loans to governments may be successfully deployed in this context (eg <https://www.worldbank.org/en/topic/agriculture/brief/moving-towards-sustainability-the-livestock-sector-and-the-world-bank>).

Tailor financing options. National policies that don't disadvantage women on land inheritance or requirements for accessing credit, goods and services may include finance products that do not necessitate collateral in the form of title deeds, or allowing repayments based on production cycles. Address wider infrastructure issues – power, water, roads, mobile networks that impact on the livestock sector and its roles in livelihoods. In addition to public investment, governments could attract private sector investment, through for example providing support that incentivizes mobile operators to reach areas that are scarcely populated.

Invest and use the latest technologies at a faster pace 'innovation expedited'

Investment in science and technology and ensuring such research is connected to the needs of actors across the sector needs to continue, and to develop new linkages that bring the most advanced technologies to bear on all systems across the world. At present, there is a huge disparity between where demand is growing fastest and where the most advanced livestock sector technologies are availed and deployed. Support for innovative research and technological solutions that can be applied not only in capital-intensive systems in LMICs but globally – covering new innovations in 'traditional' livestock science – feeds, health, genetics through to new applications of IT, traceability, etc. In some cases, smart application of the latest IT and other disruptive technologies could even lead to some of these labour-intensive systems 'leap-frogging' to become the new, sustainable livestock systems of the future.

Policies that support sustainable intensification – moving towards more efficient, less environmentally harmful production with good health outcomes while supporting many livelihoods must be encouraged. In many instances, such policies will support large and small-scale private sector investment through incentives and risk-based solutions, financing and credit mechanisms as mentioned above. Connecting and adapting the latest science and technology solutions globally will underpin such solutions.

Undertake awareness and engagement actions to ensure livestock roles in livelihoods and economic growth are included in livestock-specific and wider development policies/agendas

For the essential roles of livestock in livelihoods and economic growth not to be jeopardized, dialogue, education and engagement within and outside of the sector needs to be strengthened.

Local, national, regional and global policy environments that facilitate the engagement of all actors, including stakeholder platforms as described above and the Global Agenda for Sustainable Livestock, can serve to enhance global engagement and messaging about the actions the sector is undertaking to support sustainable development.

Re-connecting the livestock sector with consumers is important. Encouraging consumers to recognize and support niche products can be also be enhanced by labelling and education. The agenda may also consider the fast-developing world of alternative protein sources and how such initiatives may complement animal-based proteins across the world; this will require a lot of new analyses and engagement.

Supporting fora for consumers, producers and input suppliers to engage helps find joint solutions to sector challenges. Such initiatives could include for example, better linking of nutritious food and balanced diets to 'well-produced' animal products and the role of milk, meat and eggs in balanced nutrition, especially using a food systems approach.

Livestock in surprising places: at a global level, incorporating evidence about a sustainable livestock sector in discourses that focus on wider development will strengthen the recognition and thus investment in solutions including livestock.

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