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The U.S. Government's Global Hunger & Food Security Initiative

FEED THE FUTURE ENABLING ENVIRONMENT FOR FOOD SECURITY PROJECT



THE ENABLING ENVIRONMENT FOR ANIMAL SOURCE FOOD MARKET SYSTEM SUCCESS:

ASSESSING FACTORS THAT SUPPORT COMPETITIVE, INCLUSIVE, RESILIENT, NUTRITION-SENSITIVE SYSTEMS

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ACRONYM LIST

AU-PANVAC	Pan African Veterinary Vaccine Center of the African Union
AI	Artificial Insemination
AH	Animal Health
ASFs	Animal Source Foods
CBT	Commodity-Based Trade
CAHW	Community-Based Animal Health Worker
DOCs	Day-Old Chicks
EU	European Union
FAnGR	Farm Animal Genetic Resources
FAO	Food and Agriculture Organization of the United Nations
FAO STAT	FAO Statistical Databases
FMD	Foot-and-Mouth Disease
ICT	Information and Communications Technology
IBLI	Index-Based Livestock Insurance
LMIS	Livestock Market Information System
NCD	Newcastle Disease
NGOs	Non-Governmental Organizations
NBTs	Non-Tariff Barriers
OIE	World Organization for Animal Health
PPR	Peste des Petits Ruminants
PVS	Performance of Veterinary Services Tool
SPS	Sanitary and Phytosanitary Standards
UN	United Nations
USAID	United States Agency for International Development
VPPs	Veterinary Paraprofessionals

EXECUTIVE SUMMARY

Animal source foods (ASF) market systems present significant potential to facilitate **inclusive economic growth, resilient livelihoods, and improved household nutrition**. Attaining this potential however will rely on improving the enabling environment — the formal rules, informal norms, and implementing institutions — which influence incentives for ASF production, marketing, and service provision.

ASF market systems are complex with various interconnected considerations – uniquely distinct from crop subsector considerations – that must be well understood by policymakers, development agencies, and private sector actors. Further, ASF market systems are diverse, with enabling environment considerations that are **specific to livestock type, environment, and product channel**.

The Feed the Future Enabling Environment for Food Security (EEFS) project has developed this guidance document, based upon a comprehensive literature review, to identify a set of factors in the enabling environment that support competitiveness, inclusiveness, resilience, and nutrition-sensitive impacts from ASF systems. U.S. Agency for International Development (USAID) Missions, Operating Units, and Implementing Partners; other development agencies; impact investors; private sector enterprises; and national policymakers can leverage this guide to identify whether and to what degree these enabling environment factors are in place to inform and target investments in ASF for maximum impact.

The guidance document is structured in three parts: **1) supply-side factors** – those that enable or impede the production of ASF, **2) marketing factors** – those that affect consumer demand and the ability of producers to reach their end market destination safely and efficiently, and **3) financial services factors** – those that enable system-wide uptake of improved technologies and practices by reducing risks and increasing liquidity.

Specifically, the supply-side factors identified will influence the quality and availability of critical ASF inputs, including animal feed (commercially processed and forages); improved, context-appropriate genetics by animal type; and animal health products (therapeutics and vaccinations) for common concerns by animal type as well as service delivery by veterinarians and para-veterinarians. The supply-side factors identified also include primary factors of production, such as land, water, and labor, and the informal business orientation of producers, including their responsiveness to market incentives.

The marketing factors identified in the guidance document include the nature of consumer demand as well as various requirements that enable market access, including infrastructure related to live animal movement; the hygienic collection, slaughter, and transport of ASF products; cross-border regulatory considerations such as sanitary and phytosanitary standards (SPS); and food safety control mechanisms that prioritize consumer well-being while fostering a competitive market system.

The financial service factors include those that provide necessary liquidity and risk mitigation for supply-side actors to adopt improved practices/technologies. Factors are identified that affect the provision of formal credit from commercial lenders, informal credit through community-based schemes, value chain financing between ASF producers and buyers, and livestock insurance to reduce risks from environmental shocks.

Throughout the guidance document, practical **successes and failures** from developing countries are cited as evidence of the importance of the factors identified. Additionally, the guidance document provides a set of **qualitative and quantitative indicators** and sources for primary/secondary data collection to assess each factor.

1. INTRODUCTION

The demand for animal source foods (ASF) continues to grow, particularly in developing countries, along with opportunities for a range of actors to participate gainfully in their production, processing, marketing, and in providing backend services and inputs. ASF market systems are typically complex, requiring increasingly sophisticated and interactive technologies on the production side and increasingly stringent requirements for hygiene, food safety, and quality on the market side. To capitalize on emerging opportunities, and for nations to sustain development gains as a result, there are several important and often interconnected considerations that must be well understood and appropriately integrated into adaptive programming.

Successful ASF systems are subject to a range of factors driven by public sector and/or market forces which constitute the enabling environment and are conditioned by traditional norms, institutional capacity, geography, natural environment, and the resource base.[1] The objective of this guidance document is to identify, in as comprehensive a manner as is feasible, a set of factors in the enabling environment that support competitive, inclusive, resilient, and nutrition-sensitive outcomes. The initial methodology to identify those factors is a wide-ranging literature review, which is the basis for this document.

1.1 WHAT IS "SUCCESS" IN ASF MARKET SYSTEMS?

First and foremost, success in any market system development initiative is not a binary outcome that is either achieved or not. It is more important to examine success as a spectrum where the objective is to achieve continual improvements over time. This analytical tool does not suggest that *all* of the factors presented in aggregate are a prerequisite for a successful outcome, and that without any one factor in place, ASF project investment will result in failure. Instead, this tool seeks to build an understanding among USAID, other donors, social impact investors, policymakers, and private sector enterprises of the various factors in the enabling environment that will contribute to varying degrees of success as related to improved competitiveness, inclusiveness, resilience, and nutritional outcomes.

Additionally, success should be considered both in terms of outcomes and impacts, where outcomes are an intermediary step towards achieving impact. For instance, changes in government policy and regulations, the uptake of improved production technologies, or the facilitation of a new commercial investment are regarded as outcomes. Such outcomes may, however, contribute to broader impacts, such as increased income, poverty reduction, improved human nutrition, and self-sustaining economic growth.

This tool is intended to enable development planners, policymakers, and investors to match their impact objectives against the range of factors in the enabling environment in order to prioritize a clear understanding of the variables which may affect the ability to achieve desired outcomes and impacts unless/until certain constraining factors are addressed. Where particularly important enabling factors are found to be absent or insufficient, thereby influencing the performance of a system, USAID, its implementing partners, private sector partners, and policymakers should consider targeting resources accordingly to address these constraints.

1.1.2 Understanding Potential Impacts on Gender, Youth, and Nutrition

It is important to acknowledge the unique and substantial contributions that successful ASF market systems can make towards USAID and other development agency priority objectives, including women's empowerment, youth engagement, and household nutrition. Where USAID and other development actors are prioritizing investment in ASF market systems, this tool will enable their ability to assess and identify the opportunities and barriers to advancing objectives related to gender, youth, and nutrition. These important welfare impact opportunities may be affected in different ways by the various factors highlighted

[1] This guidance document considers investment to be any or all of these: private sector investment at the enterprise level by local or international actors (e.g., SMEs); public sector and/or development actor investments (e.g., project-based investments); livestock producer investments in new technologies and practices.

in this document, which are indicated in several cases. Since they are not addressed separately, they are highlighted here because of their cross-cutting nature and importance.

It is widely recognized that women often play a central role in developing livestock systems. It is estimated that two-thirds of the world's 600 million livestock keepers are women.[2], [3] Livestock may be the main assets that women have some degree of control over, although typically less than men. Livestock keeping by women can improve gender equity, and interventions that increase women's control over livestock have been found to be associated with more equal ownership of household assets.[4] Women provide the bulk of labor for animal husbandry and feeding on smallholder farms, and one study in northern Kenya found that building capacity of women farmers can increase livestock system productivity and mitigate risks.[5] A useful reference bibliography on gender in livestock value chains has been developed by the Feed the Future Innovation Lab for Livestock Systems.[6]

Providing sustainable livelihoods for youth is also critical, particularly in Africa, where populations are expected to grow significantly for decades. As consumer demand for ASFs grows, and livestock systems increase in economic importance, there are likely to be many opportunities for youth employment and entrepreneurship.[7] These opportunities may not only be in production but also in provision of services and inputs. Young people may also be more inclined to take up novel enterprises, as illustrated by a program in East Africa training youth to raise insect larvae for poultry feed.[8]

ASFs are also a vital source of high-quality protein and micronutrients among resource-poor people in developing countries. This is particularly important for children and for women of a maternal age. Studies have shown that a small amount of ASF consumed regularly by children, even one egg a day, can have significant positive impact not just on growth and to reduce stunting, but also on cognitive development and lifelong performance.[9] Recently, studies have shown that livestock keeping on its own can have a positive impact on nutrition of household members, and even their communities.[10]

While implementing this tool, the range of factors for success can be evaluated as to how they interact with gender, youth, and human nutrition objectives. For example, access to land or credit may be particularly limited for women and youth. Veterinary, genetic, and extension services may be largely provided by men, with more limited access for women. By identifying these limitations, USAID and its implementing partners can focus efforts and resources on addressing those enabling environment constraints to maximize the impact ASF market systems can have on gender and youth empowerment and human nutrition.

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[2] Thornton, P.K. et al. *Mapping Poverty and Livestock in the Developing World.* (Nairobi: International Livestock Research Institute, 2002).

[3] "Why Livestock Matter," Global Sustainable Livestock Advocacy for Development, https://whylivestockmatter.org/2018/06/08/womens-role-in-livestock-enterprises/.

[4] Bravo-Baumann, H. "Livestock and Gender: A Winning Pair - Capitalisation of Experiences on the Contribution of Livestock Projects to Gender Issues." *BRIDGE*, (September 2000), https://www.eldis.org/document/A51926.

[5] Grillos, T. "Women's Participation in Environmental Decision-Making: Quasi-Experimental Evidence from Northern Kenya." *World Development* 108, (August 2018): 115-130, https://doi.org/10.1016/j.worlddev.2018.03.017.

[6] Serra, R. et al. "Gender and Livestock Value Chains Annotated Bibliography." *Feed the Future Innovation Lab for Livestock Systems* (Gainesville: 2018), https://livestocklab.ifas.ufl.edu/media/livestocklabifasufledu/pdf-/Gender_Annotated_Bibliography_12.14.2018.pdf.

[7] Anosike F.U. et al. "Youth in Livestock Production: Key to the Actualization of the Agricultural Transformation Agenda (Ata) - A Review." *J. Amin. Prod. Res.* 27, (2015): 213-218, https://pdfs.semanticscholar.org/2341/ff85202ee976cf16706b7499d4443aae62ea.pdf.

[8] Byrne, J. "Internationally Funded Project Behind Insect Feed Approval Push in Kenya and Uganda," *Feed Navigator*, November 17, 2017, https://www.feednavigator.com/Article/2017/11/17/Internationally-funded-project-behind-insect-feed-approval-in-Kenya-and-Uganda.

[9] Iannotti, L.L. et al. "Eggs in Early Complementary Feeding and Child Growth: A Randomized Controlled Trial." *Pediatrics* 140, no. 1 (July 2017), https://doi.org/10.1542/peds.2016-3459.

[10] Jodlowski, M. et al. "Milk in the Data: Food Security Impacts from a Livestock Field Experiment in Zambia." *World Development* 77, (January 2016), https://doi.org/10.1016/j.worlddev.2015.08.009.

1.2 HOW TO USE THIS GUIDANCE DOCUMENT

This tool provides analytical guidance for a comprehensive, context-specific assessment of an ASF market system in a particular national or subnational setting. It should not be viewed as a required checklist of factors which must be in place for a donor project or private sector investment or policy reform initiatives to achieve success. Instead, this tool should be viewed as a set of guidelines to identify positive factors and/or risks in the environment that may hinder a project investment.

This guidance document does not attempt to prioritize, rank, or score the enabling environment factors identified. The relative importance of any given factor will depend largely on two issues: 1) the type of livestock system and species being targeted, and 2) the type of project investment and its specific set of priorities/objectives. For instance:

- In the case of intensive smallholder dairy, greater attention may be given to the cost of labor; the nature of local demand for dairy products; reliability and availability of key inputs and services, such as veterinary and improved genetics; and access to livestock credit.
- In the case of small- to medium-scale poultry, priority conditions may include the availability of key vaccines, access to foreign currency to import the required genetics, and the local demand dynamics for eggs and chicken meat.
- In the case of rangeland cattle and small ruminant systems, weighted importance may be given to sanitary and phytosanitary standards (SPS) compliance capacity, access to animal health services, and insurance products to mitigate risks of regular shocks.

Using this guidance document to carry out a context-specific assessment requires the expertise of a trained analyst or team of analysts with extensive experience in ASF market systems and an in-depth understanding of local dynamics. Areas of identified weaknesses will inform recommendations for enabling environment reform initiatives within a new project investment or to complement an ongoing ASF project investment.

It is recommended that the context-specific assessment can be carried out in two parts.

1. A priority setting exercise among a small team of national and international experts with knowledge of the technical, economic, and policy environments in the target system(s). Such an exercise may begin with, and be informed by, a joint ASF market system scenario development. The outcome would be a weighted list of factors from among those presented in this document, along with a draft plan as to how to collect the information. Care must be taken to avoid prioritization using preconceived assertions which are not evidence-based as well as to avoid equally weighting all factors.
2. A team-led structured assessment using both secondary data available through reliable existing sources as well as primary data collection through customized surveys of various market system actors (e.g., policymakers, regulatory agencies, producers, processors, input providers, importers/exporters, traders, retailers, etc.).

1.2.1 Structure of the Guidance Document

The enabling environment conditions for ASF market system success identified in this document are grouped into three sections:

1. ***Supply-side factors***: those which affect livestock production.
2. ***Marketing factors***: those which affect markets and access to markets for ASF products.
3. ***Financial services factors***: those which affect financial products, including insurance and credit, for market system actors.

1.2.2 Other Factors to Consider: The Political Economy

The list of factors presented in this guidance document is not intended to be exhaustive, and in specific contexts other conditions not addressed here are likely to be important. For instance, this guidance document largely does not address underlying social norms, structures, and/or institutional biases that may be pervasive in a particular social system and which may influence incentives and behavior throughout the system. The lack of a full discussion of these issues should not suggest that they are unimportant. To the contrary, these issues are critical and will certainly affect many of the conditions discussed here. These norms, structures, and biases will influence the political economy of how formal rules (laws, policies, regulations, and standards) are established in a system, and how they are enforced (or not).

The political economy will also influence how powerful actors may attempt to coopt the rulemaking and enforcement process within a system. In the case of ASF systems this may include a national veterinary association's efforts to block the certification of lower cost competitors, such as veterinary paraprofessionals; collusion between large market actors to restrict entry by new actors; or a veterinary drug manufacturer that blocks provision of animal disease prophylactics, such as vaccines, in order to maintain demand for their therapeutic products. These are just a few examples of how the political economy may manifest itself in practice within a local system.

While the informal political economy is not an explicit factor discussed in this document, the key informant exercises to collect information will help to uncover evidence of these factors where they exist and the extent to which they are likely to impact ASF project investment success. For a more detailed analytical framework to consider how underlying social norms, structures, and institutional biases influence actor behaviors/incentives and overall market system performance there is an alternative relevant analytical tool developed by the Feed the Future Enabling Environment for Food Security Project: the forthcoming *Practical Analytical Framework for Inclusive, Entrepreneurial Market Systems: Assessing the Underlying Factors Enabling Inclusive Economic Growth.*

2. SUPPLY-SIDE FACTORS

This section discusses factors in the enabling environment that affect the capacity and incentives for the production of ASF. These include the factors that influence the quality and availability of animal feed, improved genetics, and animal health products/services as well as the conditions which affect the sustained delivery of these services and inputs. Also important on the supply side are the primary factors of production, such as land, labor, and capital, and the business orientation of producers, including responsiveness to market incentives.

2.1 FEEDS AND FORAGES: QUALITY AND AVAILABILITY

The cost, quality, and seasonal availability of animal feeds are key determinants of success in any ASF market system development effort. Across many systems, depending on species, feeds may comprise up to 70 percent of production costs. This section will not address factors related to feed demand, except to point out that in nearly all developing country settings, livestock are typically chronically underfed in relation to their productive potential. Thus, feed supply and producer access to feed become the key issues underlying the system conditions related to improved feeds uptake.

Smallholders keeping ruminants will often rely on a wide range of feed materials seasonally and opportunistically, from natural pasture to crop residues, such as maize stover and rice straw, to crop/food by-products, like oilseed cake and rice husks, or gathered fodder from trees and shrubs or planted forages intended specifically for feeding livestock. The latter are typically high biomass-yielding grasses, such as Napier grass, or herbaceous legumes, in addition to fodder trees and shrubs, also typically leguminous, thus contributing to soil nutrients through nitrogen fixation. The continued competitiveness of smallholder

ruminant producers is partly driven by their ability to source feed materials from their own farms or the land resources to which they have access.[11]

In the case of monogastric species such as pigs and poultry, which cannot subsist on forage-based diets, producers depend on higher quality feed materials that they generally cannot easily produce themselves, such as commercial crop by-products and feeds comprised of oilseed cake, grain legumes, and whole grains, along with important nutritional additives, such as minerals. These are typically supplied by commercial feed processors using imported or domestically sourced materials and are distributed through networks of wholesalers and retailers, including producer cooperatives and small rural shops, which may sell feed in the small quantities targeted towards smallholders.

2.1.1 Commercial Feed Quality

The quality of commercially available feed materials can vary significantly,[12] particularly over the course of seasons when availability and prices of source materials change, and processors alter feed mixes accordingly while still aiming for minimum composition of protein, energy, etc. This variability leads to poor livestock performance and lack of trust among producers, who may choose to create their own feed mixes using purchased crop by-products — a practice which reduces costs but may not improve performance.

In the Philippines, a study[13] found that large pig producers were more competitive than smaller units, because they were able to invest in their own feed mills and therefore control feed quality — a strategy often seen in larger scale operations across countries. Smallholders who rely on variable quality marketed feed are therefore at a disadvantage. The formal feed industry selling compounded feeds may thus comprise a relatively small share of the overall feed supply, given these producer incentives to mix their own feed from purchased feed materials. In addition, as observed in East Africa, commercial feed producers may face competition from small-scale backyard feed producers who make "tailored feeds for farmers to match what they can afford," a situation that results in often poor-quality feeds and feed safety risks.[14] An absence of market information regarding feed price and quality further disadvantages small producers, as does limited availability of affordable feed quality lab services. Limited capacity for feed material storage and preservation will also impact feed quality and potentially safety.

Table 1. Commercial Feed Quality Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Commercial Feed Quality	Regulations covering a) animal feed quality and safety and labelling, b) feed quality surveillance procedures and responsibilities, and c) enforcement mechanisms	Sourcing official government documents from public offices or online
	Industry data on feed quality variability	Data from industry associations, or other relevant private sector bodies Relevant academic studies by national/international researchers

[11] McDermott, J. et al. "Sustaining Intensification of Smallholder Livestock Systems in the Tropics," *Livestock Science* 130, (May 2010), https://doi.org/10.1016/j.livsci.2010.02.014.

[12] *Successes and Failures with Animal Nutrition Practices and Technologies in Developing Countries.* Food and Agriculture Organization of the United Nations, 2011. Proceedings of the FAO Electronic Conference, September 1-30, 2010, Rome, Italy. http://www.fao.org/3/i2270e/i2270e00.pdf.

[13] Lapar, L. et al. "Policy Options Promoting Market Participation Among Smallholder Livestock Producers: A Case Study from the Philippines," *Food Policy* 28, (February 2003): 187-211, https://doi.org/10.1016/S0306-9192(03)00017-4.

[14] Lukuyu, B. et al. "The Concentrate Feeds Supply Chain in Uganda: Emerging Trends and Implications on Access to Quality Feeds by Smallholder Farmers," (2013), https://cgspace.cgiar.org/bitstream/handle/10568/34469/Concentrate%20Feeds%20Supply%20chain%20in%20Uganda.pdf?sequence=1.

Table 1. Commercial Feed Quality Indicators and Measurement Methodology

	Indicator	Information Gathering Method
	Perceptions of feed quality and safety and regulatory enforcement mechanism effectiveness	Key informant interviews: regulators, feed processors, distributors Relevant academic studies by national/international researchers
	Barriers to improved quality, including feed quality labs, storage facilities	Key informant interviews: feed processors, distributors, buyers

2.1.2 Feedstuff Imports

Countries without adequate supplies of relatively low-cost feed materials may rely heavily on imported feedstuffs, including vitamins, minerals, and other additives. Reasons for undersupply are typically shortage of arable land, high demand for grains for human food consumption, rising prices, or lack of feed or oilseed crops being grown domestically due to market/comparative advantage reasons. In addition, specialized feed additives such as vitamins and minerals may not be locally produced in less developed countries.

Additionally, any tariffs and non-tariff barriers (NBTs) on imported feedstuffs will increase costs and reduce reliable availability for domestic feed processors. Heavy dependence on imports of feedstuffs may create risks due to the resulting demand for foreign currency, which may lead to policymaker intervention. Dependence on feed imports also creates risks linked to macroeconomic shocks. In Southeast Asia, the financial crises of late 1990s and 2008 caused severe losses in the commercial poultry industry due to its dependence on feed imports.[15] This import dependence should be assessed in the context of those potential risks.

Table 2. Feedstuff Imports Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Feedstuff Imports	Volume of imports of feedstuffs compared to nationally produced supply	Trade databases (e.g., UN Comtrade) and production databases (e.g., FAOSTAT and/or official government sources such as Bureau of Statistics, Ministries of Agriculture or Trade/Commerce)
	Tariffs on imports of feedstuffs and related minerals, vitamins	Sourcing official government documents from public offices or online
	NBTs to feedstuff imports, including restrictions on GMO products, mycotoxins, onerous certification or inspection requirements	Sourcing official government documents from public offices or online Key informant interviews: importers, feed processors
	Ad hoc export bans of feed grains from neighboring trade partners	Relevant academic studies by national/international researchers

2.1.3 Crop Residues

It should be recognized that in many countries, forages, hay, and crop residues such as straw are marketed, sometimes at large scale, providing in certain cases a large proportion of the feed supply to the ruminant production systems. For example, in India, the world's largest milk producer, a significant proportion of

[15] Udo, H.M.J. et al. "Impact of Intensification of Different Types of Livestock Production in Smallholder Crop-Livestock Systems." *Livestock Science* 139, no. 1 (July 2011): 22-29, https://doi.org/10.1016/j.livesci.2011.03.020.

feed to the dairy systems consists of marketed crop residues, such as chopped sorghum stover.[16] Further, there is ample evidence that such markets are able to price residues according to feed quality to some extent. A study in Hyderabad, India, found close correlation between the observed market price of sorghum stover and its levels of *in vitro* digestibility, a key attribute for feed quality for ruminants.[17]

While such forage and fodder markets may be largely informal and unregulated, they may depend to some extent on public infrastructure, such as designated market points to store material and conduct transactions. Any public support to such fodder market systems, where they play an important role, may lead to positive outcomes for feed supply reliability.

It is important to note that in some cases, these crop residues come from crop varieties which have been bred as dual-purpose, food-feed crops. They have been bred to increase the digestibility of the stover or straw by ruminants without sacrificing grain yield for food, leading to significant gains in animal productivity.[18] Sorghum, pearl millet, and maize have been the targets for the development of food-feed crops. While currently somewhat limited in uptake, proponents highlight increasing importance as land resources become more scarce and feed and food production increasingly compete.[19] Where such varieties are locally available through national crop breeding systems, opportunities for improved feeding among producers will be greater. To be made publicly available, any new varieties may be subjected to a certification process, which requires time and resources and may impede availability.

Table 3. Crop Residues Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Crop Residues	Formal regulations or licensing regarding marketing of crop residues	Sourcing government documents from public offices or online
	Seed certification requirements covering food-feed crops	Sourcing government documents from public offices or online
	Market actor perceptions of functioning of fodder markets, main impediments, regulatory burdens, and infrastructure constraints	Focused stakeholder discussion groups with representative participants from across the sector, or separated into groups by roles (producers, officials, market actors)
	Breeder and producer perceptions of availability and suitability of available food-feed crops	Key informant interviews: breeders and producers

2.1.4 Forage Crops

As demand for ASFs continues to grow, the availability and quality of natural forage and crop residues may not be adequate. In many mixed-crop livestock systems experiencing intensification, producers are increasingly turning to specialized planted forages, such as those indicated above. However, reliable producer access to planting material for these forages may be constrained by several factors. Some forage species require seed production and delivery systems.[20] Private sector seed systems have shown limited

[16] Rao, P.R. and Hall, A.J. "Importance of Crop Residues in Crop–Livestock Systems in India and Farmers' Perceptions of Fodder Quality in Coarse Cereals." *Field Crops Research* 84, nos. 1-2 (October 2003): 189-198, https://doi.org/10.1016/S0378-4290(03)00150-3.

[17] Jabbar, M.A. "Feed and Fodder Markets in South Asia and East Africa: A Synthesis of Four PRA Case Studies." *International Livestock Research Institute,* (January 2008), https://doi.org/10.22004/ag.econ.181847.

[18] Hall, A.J. et al. "Sorghum and Pearl Millet as Food-Feed-Crops in India," *Animal Nutrition and Feed Technology* 4, (2004): 1-15, https://hdl.handle.net/10568/3603.

[19] Pattanaik A.K. et al. "Food-Feed Crops Research: A Synthesis" *Animal Nutrition and Feed Technology* (2010): 1-15, http://exploreit.icrisat.org/sites/default/files/uploads/1378282959_anft-10s-spl-001.pdf.

[20] Among others, these include *Desmodium, Calliandra*, berseem clover, etc.

interest in investing in production and distribution of forage seed, and while national systems may support forage seed production and delivery, their effectiveness and efficiency at scale is often constrained. Public, cooperative or nongovernmental organization (NGO) support to entrepreneurs or farmer groups may be needed to catalyze seed production and distribution for forage species. In Kenya it has been demonstrated that there are also business opportunities for women's groups or youth groups to collectively raise forages for sale to dairy producers.

Other planted forages, such as Napier grass, are propagated vegetatively using cuttings that producers can obtain from their neighbors. Although this greatly facilitates uptake and has in part led to widespread use of Napier grass in East Africa, this limits the ability to introduce improved varieties. In particular, such grasses have been increasingly affected by debilitating diseases, which reduce yield, such as Napier head smut and stunt diseases. Some varieties have shown disease resistance, but again, in order to allow their utilization, both public and private investments in breeding and distribution may be required, with farmer-group fodder banks playing a key vehicle for local distribution.

It should be noted that some dryland forage species have been found to be suitable for agro-pastoral areas where some seasonal rainfall or soil moisture is available.[21] When stored, these can provide dry season forage and generate income through the sale of forage seeds to other producers, also raising overall system productivity. USAID Feed the Future projects in northern Kenya have promoted this technology.[22] Initial support to producer groups is very likely to be required to establish uptake.

Table 4. Forage Crops Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Forage Crops	Government regulations covering planted forages	Sourcing official government documents from public offices or online
	Volume and source of distribution of forage germplasm (seeds, cuttings)	Source from government or industry databases
	Inventory of planted forage species and varieties available, suited for local conditions including rangelands	Source from National forage germplasm institution
	Public sector and development agency support to forage germplasm supply by public, collective or private actors	Source from government, development project, NGO and private sector documents
	Producer demand and preferences for different forage species	Focused stakeholder discussion groups: producer groups
	Level of participation of private sector in forage germplasm supply	Key informant interviews: commercial enterprises and industry groups

2.2 ANIMAL GENETICS: QUALITY, RELIABILITY, AND EFFECTIVE SUPPLY

The productivity of livestock even in low input smallholder settings is of course significantly determined by the genetic makeup of the animals being kept — or Farm Animal Genetic Resources (FAnGR).[23] FAnGR impact an animal's ability to convert feed resources into outputs such as meat, milk, and eggs as well as

[21] Kidake, B.K. et al. "Promotion of Range Pasture and Fodder Production Among the Pastoral and Agro-Pastoral Communities in Kenyan Rangelands: Experiences and Lessons," *Livestock Research for Rural Development* 28, no. 151 (2016), http://www.lrrd.org/lrrd28/8/kida28151.html.
[22] See REGAL project summary at https://www.acdivoca.org/2017/08/regal-ag-elevates-investments-in-kenyas-neglected-zones/.
[23] Rege, J.E.O. and Gibson, J.P. "Animal Genetic Resources and Economic Development: Issues in Relation to Economic Valuation," *Ecological Economics* 45, no. 3 (July 2003): 319-330, https://doi.org/10.1016/S0921-8009(03)00087-9.

their rate of reproduction and fitness for traction functions. FAnGR also play a significant role in the animal's ability to survive and produce in the agroclimatic setting in which they are kept. That environmental setting includes ambient temperature and its seasonal and daily variations, the level of animal disease challenge related to husbandry practices, infectious diseases or through insect vectors, and the reliable availability of quality feedstuffs. Livestock keepers have for generations selected for breeding those animals which exhibit the combinations of productivity, input needs, and resilience traits, resulting in genotypes that best meet their objectives.[24]

Smallholder livestock producers typically raise their own replacement stock, although that varies somewhat by species. Improving the animal genetics they use, even within-breed, thus requires either coordinated breeding effort among producers, or external provision of improved breeds. Efforts to improve performance of smallholder livestock keepers similarly aim for an optimal combination of traits, but typically favor higher productivity, while also retaining some traits for resilience as needed. In some settings, the environment in which livestock are kept can be significantly managed, including housing, cooling, and warming to reduce temperature extremes as well as limiting movement and creating biosecurity barriers to reduce disease risks. Such interventions are more feasible in intensive, confined systems, but much less so in extensive systems where livestock must necessarily largely face the natural environment. In all settings however, some degree of improved genetics, even within existing genotypes, is seen as one pathway to overall increased productivity, and so availability of suitable genotypes and systems for their sustainable production and effective delivery are vital.

2.2.1 General Factors for Improved Genetics

There are some general factors for improved genetics that apply across the key livestock species. This section addresses them, and subsequent sections revisit the topic in some cases, such as addressing species-specific issues, recognizing in all cases that animal performance is also conditioned by feed, disease, and other environmental factors.

Given the need for sustained investment to improve breed performance over multiple generations, the public sector has typically been the core initial resource for this sort of effort, after which partnerships with private breeders typically develop. Some of this initial public sector investment is in the form of government or university run breeding stations and farms, which select and breed animals and produce semen or breeding animals for distribution to target breeders or producers.

Such public-managed institutions in developing countries are sometimes mismanaged and under-resourced, or subject to corruption, which diverts their outputs to influential actors. A key factor for their ability to support genetic improvement is not only their ability to demonstrate year-on-year genetic gains towards agreed breeding objectives, but also their operational capacity and ability to deliver genetics at the necessary scale and at a cost and in a manner which reaches target producers. Genomic tools to assist in selection of breeding animals are beginning to be used in Africa by researchers,[25] and the extent to which these technologies can be taken up by public breeders may determine the pace of future gains.

Closely related to such centers are the centralized performance and pedigree recording schemes on which professional breeders rely to identify breeding animals and monitor generational genetic gain among animals across the production systems. Although important for all species, this is particularly significant for cattle breeding, and is therefore discussed in more detail in the species-specific sections below.

As livestock systems develop and producers become more commercially oriented and more willing to invest in the improved genetics to drive their enterprises, private sector animal genetics producers and distributors will play a larger role, supplying semen or breeding animals (often along with other farm

[24] Rege, J.E.O. et al. "Pro-Poor Animal Improvement and Breeding — What Can Science Do?" *Livestock Science* 136, (March 2011): 15-28, https://doi.org/10.1016/j.livsci.2010/09.003.
[25] Marshall, K. et al. "Livestock Genomics for Developing Countries – African Experiences in Practice," *Frontiers in Genetics* 10, no. 297, (April 2019), https://doi.org/10.3389/fgene.2019.00297.

services). Ideally, these actors work in close cooperation with public breeding programs, sharing strategies, facilities, and germplasm and conducting joint training. Some of these private actors may rely heavily or entirely on imported genetics from large global suppliers.

The presence of such private sector actors is a favorable factor, since they generally provide high-level expertise and options for improved genetics. However, private actors necessarily seek buyers who can afford their products, and at a scale and volume that can justify their investments in production and distribution. Thus, suppliers of high-quality (and cost), imported dairy semen operate in areas where commercial dairy producers are present, and suppliers of high-quality beef cattle genetics target commercial ranches. Smallholder producers not only may be unable to afford these genetics, but also they may not be geographically located to have access to them. The challenge may lie in the balance and roles of between often unreliable and poor-quality public genetic services and private providers of genetics, which target only economically promising markets.

Further, governments impose rules and regulations on some of the actors involved in genetic services, such as the certification, training and supervision of artificial insemination (AI) technicians, among others. The regulatory framework can either facilitate or restrict the availability of such services depending on how they are structured and enforced and on the interest groups which they favor.

There are also tariffs and NBTs to importing improved genetics (e.g., semen, embryos, etc.) that need to be considered. For instance, issues such as access to foreign exchange may constrain importers' financial ability to access improved genetics. Alternatively, SPS standards, such as FMD-free sources of genetic material, can protect local systems from transboundary disease risks but reduce access to important genetic material. The Philippines, which is FMD-free, for example, is unable to import dairy buffalo genetics from India, where FMD is endemic, and yet is the largest source of high-quality buffalo genetics.

Table 5. General Factors for Improved Genetics Indicators and Measurement Methodology

	Indicator	Information Gathering Method
General Factors for Improved Genetics	Regulations on imports of genetic material, and licensing of market participants in support of animal genetics, breeding, and/or delivery	Sourcing government documents from public offices or online
	Perceptions of enforcement, and the regulatory impact on breeders and other service providers to meet producer needs	Key informant interviews: importers, breeders, AI providers, etc.
	Performance indicators of public breeding stations in terms of delivery of breeding animals/semen, year on year genetic gains and prices charged to livestock producers	Source from public breeding stations, or national livestock ministry
	Presence, scale and scope of private sector animal genetics producers and suppliers, and their orientation towards the genetics needs of smallholders; presence of regional organizations supporting animal genetics	Interviews with existing private sector actors and/or industry associations

2.1.2 Species-Specific Factors for Improved Genetics

The systems for the production and delivery of genetics for different livestock species can vary significantly, such as in the degree of producer control of breeding and breed choice versus more centralized breeding, the degree of large private sector participation, and the means by which genetic material is made available to end producers. For those reasons, the key species are addressed separately below.

Cattle Genetics

Unlike small ruminants, cattle cross-breeding has been widely demonstrated as a least cost way to improve genotypes even in smallholder settings, which in essence is a means to utilize the many decades of public and private investment in breed improvement, which has often taken place in other countries. This is typically observed in dairy systems, for which many countries have developed their own breeding programs, supported by imported genetics.

Even among the poorest countries, national semen distribution systems from established AI centers generally exist and are usually government-run. A considerable amount of imported semen is typically distributed, and the choice of breeds usually driven by private and foreign agencies.[26] However, improvement through cross breeding can also be observed in rangeland and even pastoral settings, particularly by commercially oriented cattle keepers.[27] In both dairy and beef systems where commercially oriented producers are adequately represented, private sector suppliers of genetics using imported and/or commercially produced semen are likely to be active.

Delivery of reliable and quality AI services requires a degree of sophistication and continual investment in reproductive technology. The simple existence of AI systems may not be a guarantor of their effectiveness or their level of uptake. Even in the relatively well-developed smallholder dairy systems of Kenya, which has Africa's largest dairy herd, utilization of AI by producers was found to be generally less than 20 percent.[28] This low uptake can be attributed to poor quality/expired semen necessitating repeated insemination, lack of producer participation in the choice of semen which is instead dictated by the inseminator, and/or simply the proximity of the farm from the AI service point. Regarding the latter, spatial analysis found that in Kenya a single additional kilometer of poor quality road between farm and cattle crush reduced use of AI by 10 percent.[29] Additionally, lack of reliable access to liquid nitrogen can impact the performance of AI services. And where uptake is possible, limited producer knowledge of and ability for heat detection in cows may reduce the success of the AI service.

In tropical settings, and even in temperate highlands in the tropics, management by smallholder producers of 100 percent exotic breeds is generally unsuccessful, but the supply of cross-bred heifers is limited and of cross-bred semen generally nonexistent due to difficulties in maintaining reliable cross-breed semen production, including maintaining and improving at least two breed lines. This lack of access to cross-breed genetics forms a major constraint to sustained genetic performance among dairy cattle in particular and requires sometimes ad hoc breed choice at the farm level.[30]

An emerging technology is sexed semen which leads to a much higher proportion of female calves. But this technology is tightly restricted by patents held by the private companies which developed it, and if available, is very expensive. That is simply the unavoidable reality until a publicly available sexed semen technology emerges which can be managed at the developing country level.

Well-established cattle breeding programs, such as in developed countries, rely very heavily on performance records and sophisticated analysis of the resulting data, which then guide selection of breeding animals with the desired traits over multiple generations. In developing countries, the general lack of cattle performance records among producers, even in intensive dairy systems, is a significant constraint to long-term breed improvement programs. Many efforts to introduce performance recording among smallholder dairy farmers have failed, largely because of the labor and time required on the part of

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[26] Zonabend Koenig, E. et al. "Infrastructure for Sustainable Use of Animal Genetic Resources in Southern and Eastern Africa," *Animal Genetic Resources* 53, (2013): 79-93, https://doi.org/10.1017/S2078633613000295.

[27] Zaal, F. "Pastoral Integration in East African Livestock Markets: Linkages to the Livestock Value Chain for Maasai Pastoral Subsistence and Accumulation." in *Economic Spaves of Pastoral Production and Commodity Systems*, eds. Gertel, J., Le Heron, R. (Farnham: Ashgate, 2011), 107-126.

[28] Staal, S. et al. "Dairy Systems Characterisation of the Greater Nairobi Milk Shed." *Smallholder Dairy (R&D) Project Report*, KARI/MoA/ILRI Collaborative Dairy Research Programme, (Nairobi: ILRI, 2001).

[29] Baltenweck et al. "Targeting Pro-Poor Investment in the Kenyan Dairy Sub-Sector." ILRI Research Report. (Nairobi: ILRI), 66.

[30] Rege, J.E.O. et al. *Pro-Poor Animal Improvement and Breeding — What Can Science Do?* (2011).

producers to record and transfer performance information as well as the lack of sustainable business models for the analysis of the pedigree and performance data and provide practical feedback of the results.[31] Currently, few such arrangements in developing country contexts are observed outside of development projects.

Where publicly supported performance recording systems are nonexistent, cattle breed societies and studbook associations play an important, if only partial, role. These are typically comprised of commercially oriented producers who are willing to support the costs and occur in both dairy and beef systems.[32] They provide a body of records, including pedigree and performance, which can be used for some degree of animal selection and genetic improvement. Ideally these groups can facilitate the existence of specific markets for breeding animals, which can also be an important avenue to upgrading herd performance.

An important innovation to support performance recording is the emergence of the use of smartphone or hand-held devices for more efficient data collection and transmission from remote villages, thus facilitating speedy compilation, verification, and dissemination of livestock information. These practices are in experimental stages, and sustainable business models need to be developed, but going forward will present lower-cost and more timely results. There are various additional enabling environment factors that will facilitate or hinder the rural availability and uptake of such digital technologies, which are not explicitly addressed in this study.

Given the expertise in reproductive technology, breed evaluation, and analysis of performance recording, a shortage of skilled trained personnel is seen to be a major constraint to sustained improved cattle genetics. Maintaining semen quality, which affects the rate of conception, has been demonstrated to require consistent, high levels of technical expertise. A study in Africa found that countries with limited university training in animal breeding display the least developed FAnGR activities.[33]

There are thus a number of factors which significantly affect reliable smallholder access to cattle genetics over the long term, given the requirement for sustained support and investment for long-term success of genetic improvement. These range from performance recording and analysis systems, presence of private sector providers to smallholders, and availability of and capacity for the application of reproductive technology.

Table 6. Cattle Genetics Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Cattle Genetics	Availability (number and types of AI suppliers public/private/collective) and extent of use (semen doses) of improved animal genetics (by breed type) through AI for dairy/beef	Sourcing government documents, or industry associations
	Number and percent of repeat inseminations	Sourcing relevant government ministry data, and/or industry association data
	Number and extent of training programs in animal genetics and genomics nationally and locations relative to production areas	Sourcing relevant government ministry data, and/or industry association data
	Formal requirements for AI technician training and certification	Sourcing official government documents

[31] Rege, J.E.O. et al. "Pro-Poor Animal Improvement and Breeding — What Can Science Do?" (2011).
[32] Zonabend Koenig, E. "Infrastructure for Sustainable Use of Animal Genetic Resources in Southern and Eastern Africa," (2013).
[33] Zonabend Koenig, E. "Infrastructure for Sustainable Use of Animal Genetic Resources in Southern and Eastern Africa," (2013).

Table 6. Cattle Genetics Indicators and Measurement Methodology

	Indicator	Information Gathering Method
	Perceptions of quality, availability, and cost/benefit of AI services and other means of supply of genetics	Key informant interviews: producers
	Presence of and perceptions of usefulness of cattle performance recording programs	Key informant interviews: breeders and producers
	Foreign currency availability/constraints to importing improved genetics	Key informant interviews: importers

Poultry Genetics

Many efforts to promote small-scale poultry for livelihood development and poverty reduction have relied on hardy indigenous breeds of chickens, but increasingly dual purpose (meat and eggs) crossbreeds are being used in projects such as EthioChicken[34] which aims to increase domestic supply as well as improve rural livelihoods in Ethiopia. These crossbreeds include Kroiler and Sasso among others, in addition to specialized dual-purpose breeds such as Koekoek. Such breeds can subsist on scavenging kitchen or agricultural scraps and by-products, and they yield more meat and eggs than local breeds. The specific production model may vary by level of confinement, improved feeding, and other context specific factors.

Local breeds of chickens are often favored for their taste and texture by traditional consumers and fetch a higher market price (and therefore supplement household incomes) but typically are not produced commercially, given their low feed conversion performance, and so their breeding may not be systematic.[35] While there are emerging examples of efforts devoted to the genetic improvement of indigenous chickens to increase yield[36] and/or increase resistance to infectious disease,[37] particularly Newcastle disease (NCD), these are largely still in pilot phase, and practical lessons may not be available soon for replication.

In addition to poultry development aimed at livelihoods and poverty reduction, investment in commercial chicken meat and egg production has, of course, also increased across many developing countries. In many cases, such as in India and Sri Lanka, the production model is at least in part through contract farming, whereby commercial poultry integrators supply genetics, feed, and animal health to contracted small to medium producers. Risk sharing between producer and contract buyer is the main incentive for such arrangements.[38]

Delivery of chicken genetics of any type requires a number of different interconnected actors and technologies, connections which almost inevitably cross borders. Commercial poultry breeding is highly sophisticated technologically and, unavoidably, the source genetics are controlled globally by a handful of multinational corporations which tightly guard the intellectual property rights and run a business model based on the sale of parent stock day-old chicks (DOCs) to commercial hatcheries within the producing countries.[39]

[34] See: https://www.ethiochicken.com/.
[35] Padhi, M.K. "Importance of Indigenous Breeds of Chicken for Rural Economy and Their Improvements for Higher Production Performance," *Scientifica,* (April 2016): 1-9, https://doi.org/10.1155/2016/2604685.
[36] Such as the African Chicken Genetic Gains project, see: https://africacgg.net/.
[37] Disease resistance is the aim of the Feed the Future Innovation Genomics to Improve Poultry. See: https://gip.ucdavis.edu/.
[38] Priya, V.P. et al. "Case Study: Institutional and Socio Economic Factors influencing the Participation of Indian Farmers in Poultry Farming," *Advances in Management* 8, (July 2015): 10-15, https://search.proquest.com/openview/34fd4e34d5cd16d542be0a11cd4e5f54/1?pq-origsite=gscholar&cbl=2030322.
[39] Olori, V.E. "Breeding Broilers for Production Systems in Africa," *Nigerian Poultry Science Journal* 5, (2008): 173-180. https://www.researchgate.net/publication/260824934_Breeding_Broilers_for_Production_Systems_in_Africa.

Access to improved poultry genetics therefore requires the ability to pay, access to foreign currency, and easy importation of DOCs, which must occur regularly for a hatchery to maintain egg-laying performance of the parent hens through regular replacement. Any delivery of genetics in a developing country setting will require some form of this input of commercial genetics.

The supply chain of poultry genetics may be anchored by domestic private commercial hatcheries that regularly import parent stock DOCs — typically two different breeds — and raise them to produce eggs, which are then hatched to produce cross-breed DOCs, which are vaccinated and distributed.

Because DOCs are vulnerable to temperature and disease, smallholder producers may not have the ability to raise them successfully. Instead, specialized brooders may play that role raising several hundred birds at a time to an age of 30 to 45 days, at which point they can be sold and distributed to small-scale producers, to be raised in confined or semi-scavenging settings for meat and/or eggs. In developing countries, brooders may be in the form of groups, rather than individual enterprises, and are often supported by NGO or public extension agents, given the key role they play between commercial DOC suppliers and small-scale poultry producers and the degree of expertise needed for raising vulnerable chicks in often harsh settings.

Another specific factor for the successful delivery of poultry genetics regards vaccinations for NCD and other poultry diseases such as Gumboro,[40] etc. NCD is endemic in tropical and other settings and causes rapid and near total flock mortality. The close link to genetics delivery lies in the need to vaccinate DOCs before delivery and additional need by brooders for repeat vaccinations.

Good quality NCD vaccines are widely available and often produced domestically, but significant constraints remain in the need for a cold chain for even thermostable vaccines,[41] and the fact that vaccines are typically delivered in batches of 200 or 400 doses.[42] This creates logistical challenges for smallholders who may only keep a few dozen birds, requiring veterinary agents to assemble birds from multiple producers to economically perform vaccinations or use similar strategies.

Table 7. Poultry Genetics Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Poultry Genetics	Number of commercial hatcheries, capacity, and location with respect to target production areas	Relevant government ministry documentation and/or industry association data
	Number of brooding groups or private enterprises in target areas, and capacity	Relevant government ministry documentation and/or industry association data
	Availability of thermostable vaccines for NCD, Gumboro, etc.	Government ministry and private supplier documentation
	Perceptions of reliability of local/nationally produced vaccines	Key informant interviews: producers, distributors, animal health professionals
	Number and range of veterinary workers conducting NCD and other vaccinations	Key informant interviews: animal health professionals

[40] Infectious bursal disease.

[41] Campbell, Z.A et al. "Preferences for Newcastle Disease Vaccines by Chicken-Owning Households in Tanzania," *PLOSONE* 14, (August 2019), https://doi.org/10.1371/journal.pone.0220963.

[42] Mebrahtu, K. et al. "Evaluation of Spray and Oral Delivery of Newcastle Disease I2 Vaccine in Chicken Reared by Smallholder Farmers in Central Ethiopia," *BMC Vet Res* 14, (2018), https://doi.org/10.1186/s12917-018-1355-x.

Table 7. Poultry Genetics Indicators and Measurement Methodology

	Indicator	Information Gathering Method
	Breed types locally available from hatcheries and their suitability for local production systems and markets demand	Key informant interviews: hatcheries
	Public, NGO, and/or private training in raising/brooding target chicken breeds	Key informant interviews: public, development, and private extension agents
	Foreign currency availability/constraints to import improved genetics	Key informant interviews: importers

Small Ruminant Genetics

In the case of small ruminants, it is generally agreed that past attempts to introduce exotic or cross breeds into tropical systems, or to create synthetic breeds, to substitute for indigenous breeds have largely been a failure.[43] These efforts have largely been project-driven and have not survived beyond project lifetime due to lack of sustained infrastructure or business models for continued multiplication, inadequate extension support, or to lack of market demand for key products, such as goat milk in the case of dairy crossbreeds. This has led to a shift in orientation of breeding programs in tropical countries towards a focus on indigenous breeds and thus towards within-breed improvement programs.[44]

Given the complexity of sustainable production and effective delivery of animal genetics, a number of institutional arrangements have been developed, which are suited for particular small ruminant species and systems.[45] All of these are closely tied to community-based strategies, particularly given the limited options for widespread delivery of small ruminant genetics, such as the general absence of AI delivery. Approaches to these within-breed improvement programs for small ruminants include sire rotation or loan schemes, community-based and managed programs,[46] and nucleus-based programs run by the public sector or linked to community-level multipliers.[47]

However, there are some conditionalities that favor success using these approaches and innovations. Rotation or loan schemes work better if there are already similar community-level practices, managed and regulated by self-created groups.[48] Similarly, community-based programs may work best in situations where livestock keepers already manage their animals together, such as in communal grazing areas.[49] These are important conditionalities, which may limit the settings in which small ruminant genetic improvement programs can be effectively implemented. Effective public investment in within-breed improvement can nevertheless expand these opportunities, particularly if using the genomic tools mentioned above, and which have already been demonstrated for use among small ruminants in Ethiopia.[50]

[43] Rewe, T.O. et al. "Integrated Goat Projects in Kenya: Impact on Genetic Improvement," *7th World Congress on Genetics Applied to Livestock Production*, (August 2002) http://wcgalp.org/system/files/proceedings/2002/integrated-goat-projects-kenya-impact-genetic-improvement.pdf.
[44] Kosgey, I.S. et al. "Successes and Failures of Small Ruminants Breeding Programs in the Tropics: A Review," *Small Ruminant Research* 61, no. 1 (January 2006): 13-28, https://doi.org/10.1016/j.smallrumres.2005.01.003.
[45] Rege, J.E.O. et al. "Pro-Poor Animal Improvement and Breeding — What Can Science Do?" (2011).
[46] Peacock, C. et al. "Practical Crossbreeding for Improved Livelihoods in Developing Countries: The FARM Africa Goat Project," *Livestock Science* 136, no. 1, (March 2011): 38-44, https://doi.org/10.1016/j.livsci.2010.09.005.
[47] Duguma, G. et al. "Design of Community-Based Sheep Breeding Programs for Smallholders in Ethiopia," *EAAP—60th Annual Meeting*, Barcelona, Spain (2009): 122.
[48] Bett, R.C. et al. "Analysis of Production Objectives and Breeding Practices of Dairy Goat Farmers in Kenya," *tropical Animal Health and Production* 41, (March 2009): 307-230, https://doi.org/10.1007/s11250-008-9191-9.
[49] Duguma, G. et al. "Design of Community-Based Sheep Breeding Programs for Smallholders in Ethiopia," (2009).
[50] Marshall, K. et al. "Livestock Genomics for Developing Countries – African Experiences in Practice," (2019).

Table 8. Small Ruminant Genetics Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Small Ruminant Genetics	Number of structured improved breed programs for small ruminants	Sourcing documents from public offices, relevant NGOs, community organization, or online
	Existence of and perceptions of effectiveness of publicly supported open-nucleus and other within-breed improvement programs	Key informant interviews: regulators, breeders, producers, NGOs, market agents

Pig Genetics

With increased disposable income among consumers, pork meat has increased in importance in some African countries, such as Uganda and Kenya,[51] and analysis conducted as part of a Livestock Master Plan for Tanzania found that the pig sector offers growing opportunities for the next 15 years compared to other livestock market opportunities.[52] As pigs become more important, the presence and effectiveness of breeding programs becomes more critical, otherwise producers may be inclined to use their own boars.[53]

In Africa, most pig breeds are derived from imported breeds and locally developed pigs emerging from uncontrolled breeding.[54] In Asia, among smallholders there is an important presence of indigenous breeds and crosses with commercial European breeds. In all developing country settings, like in the case of poultry, the genetics for commercial pig production systems are controlled by a limited number of large corporations. Also like poultry, discontinuous crossbreeding (pure breed parent stock used repeatedly to deliver the animals for production) is a successful delivery approach.[55] The selection decisions are concentrated in the hands of these specialized companies, rather than producers, leading to increased rates of genetic gain and simplified management at the farm level.

Market-oriented pig production may be conducted by independent smallholders, by contracted small-scale producers, or by large commercial enterprises. Systems for genetic delivery need to be able to serve all of these where present. In many countries such as those in sub-Saharan African, there may be little to no formalized pig genetic improvement and delivery systems.[56] In those parts of Asia where pigs are important (particularly in East and Southeast Asia), genetic delivery systems have been developed.

The importance of public breeding centers in general has already been noted, but in the case of pigs, as for poultry, the existence and capacity of private breeding enterprises will also affect factors for genetic improvement. Large commercial producers may manage their own breeding systems using imported genetics. In many countries outside of Asia, there has been very little public or donor interest in pig system development, apparently for cultural reasons, in spite of clear evidence of growing consumer demand and smallholder livelihood opportunities. The presence of and level of effort of initiatives to control what may

[51] Atherstone, C. "Analysis of Pig Trading Networks and Practices in Uganda," *Tropical Animal Health and Production* 51, (January 2019): 137-147, https://doi.org/10.1007/s11250-018-1668-6.
[52] "Tanzania Livestock Master Plan," United Republic of Tanzania Ministry of Livestock and Fisheries, 2017, https://www.mifugouvuvi.go.tz/uploads/projects/1553601793-TANZANIA%20LIVESTOCK%20MASTER%20PLAN.pdf.
[53] Mutambara, J. "Non-Regulatory Constraints Affecting the Pig Industry in Zimbabwe," *Online Journal of Animal and Feed Research* 3, no. 1 (2013): 62-67, www.ojafr.ir/main/attachments/article/92/Online%20J.%20Anim.%20Feed%20Res.,%203(1)%2062-67;%202013.pdf.
[54] Blench, R.M., "A History of Pigs in Africa," in *The Origins and Development of African Livestock: Archaeology, Genetics, Linguistics and Ethnography*, edited Roger Blench and Kevin MacDonald, Routledge, 2000.
[55] Rege, J.E.O. et al. "Pro-Poor Animal Improvement and Breeding — What Can Science Do?" (2011).
[56] Tatwangire, A. "Uganda Smallholder Pigs Value Chain Development: Situation Analysis and Trends," (Nairobi: International Livestock Research Institute, 2014), https://cgspace.cgiar.org/bitstream/handle/10568/34090/PR_UgandaSituationAnalysis.pdf.

otherwise be uncontrolled breeding systems will have positive impacts on efforts towards genetic improvement.

Table 9. Pig Genetics Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Pig Genetics	Number and capacity of private breeders (producing piglets for sale to growers)	Key informant interviews: breeders and/or industry association
	Types of genetics used and location with respect to target production areas	Key informant interviews: breeders
	Perceptions of breed types locally available from breed centers and suitability for local production systems and markets	Key informant interviews: producers and/or industry association, market agents, and buyers
	Level of public, private, and/or development project support to pig breeding training	Key informant interviews: extension agents, development agents
	Foreign currency availability/constraints to import improved genetics	Key informant interviews: importers

2.2.3 Livestock Breed Strategies and Policies

The drive for higher productivity to meet increasing demand for livestock products may lead to loss of genetic diversity and to the transformation of smallholder systems toward new genotypes and their management, which may in turn lead to increasingly complex partnership arrangements to produce and deliver those FAnGR,[57] as discussed above in terms of the role of commercial suppliers of genetics.

Driven largely by animal scientists, national breed strategies and policies often prioritize the conservation of FAnGR given the real or perceived threats as a result of uncontrolled crossbreeding and introduction of higher yielding breeds, largely by the private sector.[58] This concern is in recognition of the long-term value of retaining these genetic resources to mitigate future risks, including those associated with climate change, emerging diseases, and changing market demands. This is closely in line with the Global Plan for Action for Animal Genetic Resources. This emphasis on genetic conservation may not, however, be shared by livestock producers, who, as discussed, are interested in a number of traits including resilience but also productivity. The issue that needs to be considered is whether public breed strategies and policies place additional constraints on access to the type of improved genetics which producers are likely to seek.

A review of livestock breeding policies in Africa found that a number of countries have signed up in principle to the Global Plan for Action for Animal Genetic Resources, and although many countries are making efforts to develop breeding policies, few formal policies have been agreed and related infrastructure and organization have been little developed.[59] In many cases, due to inefficiencies and mismanagement, public breeding and multiplication stations are ineffective in delivering significant numbers of improved animals to target producers. In addition, support to animal genetics improvement may be scattered across different agencies — Ministry of Livestock, AI centers, universities, etc. — reducing coordination and the effectiveness of those programs. These cases, among others, raise questions as to

[57] Rege, J.E.O. and Gibson, J.P. "Animal Genetic Resources and Economic Development: Issues in Relation to Economic Valuation," (2003).
[58] Wollney, C.B.A. "The Need to Conserve Farm Animal Genetic Resources in Africa: Should Policy Makers Be Concerned?" *Ecological Economics* 45, no. 3 (July 2003): 341-351, https://doi.org/10.1016/S0921-8009(03)00089-2.
[59] Zonabend Koenig, E. et al. "Infrastructure for Sustainable Use of Animal Genetic Resources in Southern and Eastern Africa," (2013).

whether a breeding strategy and policy have any material impact on choices of genetics by breeders and producers and in any way constrains or facilitates their enterprise or market opportunities.

An important consideration is whether breed policies impose restrictions on choice of breeds by producers in certain zones. In South Asia, restrictive dairy cattle breed policies for specific settings have at times led to producers to informally seek heifers/semen from other zones, when non-approved breeds were more suited to their needs.[60] This results from breed policies which emphasize suitability of breed with the local environment, and do not adequately recognize producer's ability to manage the animal environment to successfully keep higher productivity breeds.

On the factors for facilitation, a breeding strategy which lays out an organizational framework (both institutions and policies) and programs that will support successful delivery and use of the appropriate livestock genetics will be central to creating an enabling environment for the private sector and various public and research bodies to coordinate efforts.[61]

Table 10. Livestock Breed Strategy and Policy Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Livestock Breed Strategy and Policy	Existence of a formal livestock breed policy and strategy	Official government documentation
	Level and type of public investment in improved genetics and related infrastructure and training in direct support of national breed strategy	Official government documentation
	Livestock breed policy and strategy demonstrated to support the FAnGR needs of target producers and details process for coordination between actors involved in livestock genetics	Evaluation of livestock breed policy/strategy (if any)
	Stakeholder perceptions of usefulness of policies regarding breed choice by smallholder producers and breeders for key livestock species	Key informant interviews: smallholder producers and breeders
	Perceptions of the degree of observed and effective coordination between organizations involved in development and delivery of animal genetics	Key informant interviews: industry association, breeders, government ministry officials, distributors/suppliers

2.3 ANIMAL HEALTH PRODUCTS AND SERVICES

In many of the least developed countries, livestock diseases continue to constrain production and opportunities to respond to growing market demand. In traditional ruminant production systems of sub-Saharan Africa for example, calf mortality may be as high as (22 percent), calving rates are low (60 percent), and milk output per lactation is around 250 kilograms — all partly due to the consequences of disease challenges.[62]

[60] International Livestock Research Institute, "Comprehensive Study of the Assam Dairy Sector: Action Plan for Pro-Poor Dairy Development." Unpublished project report, (2007).
[61] Rege, J.E.O. et al. "Pro-Poor Animal Improvement and Breeding — What Can Science Do?" (2011).
[62] Otte, M.J. and P. Chilonda, "Cattle and Small Ruminant Production Systems in Sub-Saharan Africa: A Systematic Review," *Livestock Information Sector Analysis and Policy Branch, FAO Agriculture Department*, (Rome: Food and Agriculture Organization of the United Nations, 2002), http://www.fao.org/3/a-y4176e.pdf.

Infectious diseases also constrain export opportunities, given strict World Organization for Animal Health (OIE) and Codex requirements for disease control, which limit the conditions under which live animals and livestock products can be traded across international boundaries. Disease control measures themselves can generate negative outcomes in the short term that are larger than the direct impacts of the disease itself through disruptions to market activity[63] or the culling of potentially exposed animals.

A wide range of animal health services and veterinary products[64] are optimally required to be effectively delivered to mitigate the multiple types of risk associated with animal disease, not just to producers but to multiple market actors along the supply chain. The delivery of these services and products is typically based on a complex mix of public, collective, and private actors, working together or independently and sometimes in an unregulated manner.

In recent decades there has been a shift from largely public provision of animal health services to a greater role for private providers, in recognition that public resources are inevitably scarce, and their management may be ineffective.[65] That shift has brought about debate on the most appropriate respective roles for public and private actors, public-private partnerships[66], and what regulatory framework and business models can best support them. Given that women are often responsible for care of livestock, women's effective access to animal health services merits specific attention.

2.3.1 Demand for Veterinary Products/Services

The case may be made that resource-poor livestock keepers are unable to afford to pay full or even partial costs of private clinical services. However, some evidence suggests that the income elasticity of demand for animal health services is low, and that demand is more related to service quality than it is to price or willingness to pay.

A study in India, confirmed by work by the Food and Agriculture Organization of the United Nations (FAO), found that poor producers are willing to pay if they get effective services that make important contributions to maintaining their livestock-related livelihoods.[67], [68] A study in Kenya found that the most important barrier to use of veterinary services was physical access, more so than cost,[69] a finding also borne out by a study in Nepal.[70] In a recent study on willingness to pay for Peste des petits ruminants (PPR) vaccines for small ruminants among livestock producers in Mali, access and quality were key positive drivers of uptake.[71] Thus, fee charging veterinary services and labs can be economically viable even in resource-poor settings, if they are delivering good quality services as perceived by clients and if they are also accessible.

2.3.2 Public Versus Private Sector Roles in Animal Health Services

[63] Rich K.M. and Wanyoike, F. "An Assessment of the Regional and National Socio-Economic Impacts of the 2007 Rift Valley Fever Outbreak in Kenya," *The American Journal of Tropical Medicine and Hygiene*, 82, no. 2 (August 2010): 52-57, https://doi.org/10.4269/ajtmh.2010.09-0291.
[64] Products include drugs, vaccines, acaricides, insecticides, other chemical treatments.
[65] Leonard, D.K. et al. "The New Institutional Economics of Privatising Veterinary Services in Africa," *Rev. Sci. Tech.* 18, no. 2, (August1999): 544-561, https://doi.org/10.20506/rst.18.2.1178.
[66] World Organisation for Animal Health. *The OIE PPP Handbook: Guidelines for Public-Private Partnerships in the Veterinary Domain* (May 2019), https://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/PPP/oie_ppp_handbook-20190419_ENint_BD.pdf.
[67] Ahuja, V., and Redmond, E. "Economic and Policy Issues in Livestock Service Delivery to the Poor," Background Paper for FAO Project Memo, (May 2001), http://www.fao.org/ag/againfo/resources/en/publications/agapubs/ServiceDelivery_Ahuja.pdf.
[68] Ward, D. et al. "International Experiences with Commercialization / Privatization of Veterinary, Artificial Insemination, and Other Livestock Services," *AgriDoc FAO*, (2000), www.hubrural.org/IMG/pdf/agridoc_fao_anglais.pdf.
[69] Heffernan, C. "Consumer Preferences and the Uptake of Animal Healthcare By the Poor: A Case Study from Kenya," *Journal of International Development* 17, no. 7, (September 2001), https://doi.org/10.1002/jid.827.
[70] Marshall, E.S. and Sischo, W.M. "Paraveterinary Service Use in Nepal's Himalaya," *Preventative Veterinary Medicine* 96, nos. 1-2 (June 2010): 10-15, https://doi.org/10.1016/j.prevetmed.2010.03.003.
[71] Wane, A. et al. "Willingness to Vaccinate (WTV) and Willingness to Pay (WTP) for Vaccination Against Peste des Petits Ruminants (PPR) in Mali," *Frontiers in Veterinary Science*, (January 2020), https://doi.org/10.3389/fvets.2019.00488.

The debate on appropriate roles of private versus public animal health (AH) services can impact the prospects for new livestock investment, if conflict or confusion in those roles reduces reliable access to needed services and drugs. It seems generally agreed that the state should ultimately withdraw from directly financing a number of goods and services, including clinical diagnosis and treatment as well as drug production and distribution, and where appropriate, the control of some endemic diseases through dipping services, for example.[72] In some cases communities or groups may take up the financing of these functions.

Government focus should be on the control of epidemic diseases, including zoonotic diseases, which have large public externality implications and so are generally regarded as a public good. Epidemic disease control would include sanitary measures, quarantine services (although market-driven quarantine requirements could be privately funded), movement controls, surveillance, and vaccination.[73]

The distinction should be made between how services are financed and who actually delivers them. Although epidemic disease control should be publicly funded, private actors can provide the delivery, facilitating opportunities for healthy partnerships. However, public sector vets who provide private services on the side can create monopoly situations, which private veterinary enterprises cannot easily compete with, and therefore necessitate policies which can effectively limit the activities of public veterinarians outside of their official duties, to allow private sector veterinarians to sell their services.[74] The public sector should ensure that institutional and regulatory structures specifically aim to avoid monopolistic behavior as a result of privatizing veterinarian services.

Contracting out public good-type services such as vaccination campaigns or disease surveillance using public funds is appropriate and helps to strengthen the private sector animal health system by supporting incomes and developing experience among private vets. In some cases, such subcontracting is seen to be key to the economic viability of private veterinarians.[75] In addition, the use of specific credit schemes to allow private veterinarians to become established can help promote entry into the market, as was seen in a case in Kenya.[76]

National veterinary associations often have a strong voice in public debate and can influence policies and regulations, including certification of drugs and actors and the roles of other actors such as veterinary paraprofessionals, and control of who can distribute drugs.[77] Ideally, such associations should aim to monitor and improve the performance of public and private veterinary services, and support platform and facilities which further professional development in the service.[78] A recent study of veterinary schools in five countries across Africa and Asia found that no country had an officially sanctioned process for licensing or accreditation of veterinary professionals, and little oversight of continuing professional competence.[79] The quality of veterinary training may thus be a constraint in many cases.

What is often observed however, is that veterinary associations work towards protecting the interests of professional veterinarians, in part by promoting rules and regulations that limit competition from others, such as paraprofessionals. A balance of stakeholder perspectives and an active and sustained stakeholder engagement process are necessary, as prescribed in the OIE guidelines for the performance of veterinary services. The ultimate aim should be an enabling environment that supports an effective relationship

[72] Ahuja, V., and Redmond, E. "Economic and Policy Issues in Livestock Service Delivery to the Poor," (2001).
[73] Holden, S. "The Economics of the Delivery of Veterinary Services," Revue Scientifique et Technique (International Office of Epizootics 18, no. 2 (July 1999): 425-439, https://doi.org/10.20506/rst.18.2.1166.
[74] Holden, S. "The Economics of the Delivery of Veterinary Services," (1999).
[75] Leyland, T. and Catley, "A Community-Based Animal Health Delivery Systems: Improving the Quality of Veterinary Service Delivery," (January 2002), https://www.researchgate.net/publication/228559717_Community-based_animal_health_delivery_systems_Improving_the_quality_of_veterinary_service_delivery.
[76] Holden, S. "The Economics of the Delivery of Veterinary Services," (1999).
[77] Holden, S. "The Economics of the Delivery of Veterinary Services," (1999).
[78] Schneider, H. "Good Governance of National Veterinary Services," *Rev. Sci. Tech.* 30, no. 1 (2011): 325-338, https://pdfs.semanticscholar.org/1f9c/6785ff5d1d12feba11b874790ce85f9158a4.pdf.
[79] Brown, C. et al. "Animal Health in a Development Context," *Global Food Security* 25, (June 2020), https://doi.org/10.1016/j.gfs.2020.100369.

between veterinarians and paraprofessionals for effective reporting, treatment, and control of animal diseases.[80]

Collectives can also play an important role in animal health services, such as dairy cooperatives, which either employ their own vets or collectively contract private vets to serve their members, helping ensure a market for their services. Membership organization/collectives, such as pastoral organizations or livestock user organizations, can help support vet services in extensive dryland systems where both public and private may be weak and support community-led animal health strategies, such as group vaccination programs and vector control through dipping and rotational grazing.[81],[82] A study in Uganda and Kenya found that normal market forces have failed to attract professional veterinarians and trained paraprofessionals in these regions, suggesting that strong public support may be needed in these cases.[83] In addition, NGOs — both local and international — often play important roles in training of animal health workers and supporting service delivery, such as vaccination campaigns.

Provision of all types of livestock services are constrained in extensive systems which are characterized not just by remoteness but also low density of economic activity. Innovations which are trying to fill this need include the franchise-based model of branches of agro-vet shops providing drugs and services, under the brand name of Sidai.[84] Under that model, the privately owned shops are provided with branded animal health products, training, and marketing services. Another approach is establishing One Health centers, which integrate human and veterinary public health services.[85] Again, NGOs may play an important role in enabling service provision to remote areas.

For the overall performance of the national veterinary system, the OIE has developed a tool for the evaluation of the performance of veterinary services: the OIE Performance of Veterinary Services (PVS) tool.[86] The OIE PVS Tool comprises four Fundamental Components, each of which has detailed subcomponents: a) human, physical, and financial resources to effectively plan and implement all elements of veterinary services; b) the technical authority and capability to address current and emerging disease issues, based on science; c) sustained interaction with non-government stakeholders to assist in carrying out relevant joint programs; and d) access to markets through compliance with existing standards and transparency to ensure stakeholder trust. There are five possible levels of advancement within each Component, based on Critical Competencies. Demonstrated use of the PVS tool by the national veterinary system can be one important indicator of both willingness and ability to improve animal health systems. In addition, veterinary diagnostic laboratories are important for disease surveillance and control. FAO has established a support program to African countries to build veterinary diagnostic laboratory capacity, called VETLAB.[87]

[80] Ilukor, J. "Improving the Delivery of Veterinary Services in Africa: Insights from the Empirical Application of Transaction Costs Theory in Uganda and Kenya," *Rev. Sci. Tech.* 36, no. 1 (April 2017): https://doi.org/10.20506/rst.36.1.2628.
[81] Ward, D. et al. "International Experiences with Commercialization / Privatization of Veterinary, Artificial Insemination and Other Livestock Services," (2000).
[82] Rege, J.E.O. et al. "Pro-Poor Animal Improvement and Breeding — What Can Science Do?" (2011).
[83] Ilukor, J. "Improving the Delivery of Veterinary Services in Africa: Insights from the Empirical Application of Transaction Costs Theory in Uganda and Kenya," (2017).
[84] Sidai Africa Limited, http://www.sidai.com/.
[85] Griffith, E.F. et al. "A One Health Framework for Integrated Service Delivery in Turkana County, Kenya," *Pastoralism: Research, Policy, and Practice* 10, no. 7 (2020): https://doi.org/10.1187/s13570-020-00161-6.
[86] World Organisation for Animal Health, *OIE Tool for the Evaluation of Performance of Veterinary Services* (2019), https://www.oie.int/fileadmin/Home/eng/Support_to_OIE_Members/docs/pdf/2019_PVS_Tool_FINAL.pdf.
[87] Food and Agriculture Organization of the United Nations, "Building Veterinary Laboratory Diagnostic Capacity in Africa: The Vetlab Network," *FCC-EMPRES Information Sheets*, http://www.fao.org/3/a-i4728e.pdf.

Table 11. Animal Health Services Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Animal Health Services	Documented numbers and locations of licensed veterinarians and other animal health workers involved in livestock/large animal practice	Official government documentation/data
	Annual numbers of vets and paraprofessionals trained; presence of official accreditation process for vet schools and training curricula	Official government documentation/data and/or veterinary association
	Demonstrated use of the OIE PVS tool to evaluate vet services and demonstrated implementation of resulting recommendations	Official government documentation
	Policy and clear licensing systems on appropriate and differentiated roles for public and private animal health services	Official government documentation
	Regulations and/or procedures governing the private delivery of AH services	Official government documentation
	Number and capacity of public and private veterinary diagnostic laboratories	Relevant government ministry and/or veterinary association documentation
	Perceptions of value and willingness of producers to pay to for AH services	Key informant interviews: producers, including women
	Perceived/real cost-benefit for producers to invest in animal health services/technologies given their production costs and expected market returns	Calculation of production costs and returns Key informant interviews: producers, AH and drug suppliers
	Recent/regular participation by authorities in assessment for managing risks associated with veterinary vaccines (in Africa through cooperation with AU-PANVAC)	Key informant interviews: government ministry staff
	Observed innovation in animal health service and drug supply business models which expand rural reach and quality of delivery	Key informant interviews: veterinary drug suppliers and animal health service providers
	Perceptions of orientation of veterinary service providers towards needs of smallholder producers and toward chronic diseases vs. diseases of trade	Key informant interviews: smallholder producers, including women
	Role of national veterinary association in promoting effective services and appropriate roles of various actors	Key informant interviews: national veterinary association

2.3.3 Paraprofessional Vets and Community Animal Health Workers

Paraprofessional animal health workers can and should play a central role in animal health delivery.[88] These comprise a range of actors with more limited training than professional vets, including formally trained veterinary paraprofessionals (VPPs), animal health assistants, and junior technicians and others, such as community animal health workers (CAHW), who are often trained by NGOs or private veterinarians, as well as owners of agro-vet shops.

[88] Leonard, D.K. et al. "The New Institutional Economics of Privatising Veterinary Services in Africa," (1999).

Paraprofessionals can operate at a lower cost and in more remote areas than those where full veterinarians can or will agree to operate and can therefore fulfill a critical function for resource-poor livestock keepers and livestock market actors. The OIE as the veterinary governing body has recognized the important role veterinary paraprofessionals play for effective veterinary services and have also developed competency guidelines.[89] OIE describes a veterinary paraprofessional of any type as authorized by the national Veterinary Statutory Body to carry out designated tasks delegated to them under the direction of a veterinarian. The OIE does not, however, specifically define roles or qualifications for CAHWs within the overall category of VPP.

The specific tasks assigned and agree to the various types of paraprofessionals will differ by country and the animal health needs, but may range from treating animals for parasites, performing vaccinations or castrations, providing extension services, and disease reporting.[90] CAHWs played an important role in the vaccination campaign which eliminated rinderpest by carrying out vaccinations and disease detection and reporting through a supervising vet. One source describes a vaccination campaign that used teams comprised of a professional veterinarian, several VPPs and a rural network of CAWHs.[91] Local and international NGOs often play a significant role in training and supervising CAHWs.[92]

Animal health development experts agree that CAHW delivery systems can play an important contribution to improved animal health in a regulated manner,[93] although some do not come to that conclusion and question their effectiveness.[94] Studies across a number of countries have found that CAHW can have significant positive impact on reduced animal mortality, increase vaccination rates, and lead to increased incomes and asset accumulation among producers[95] An evaluation conducted in three East African countries found that disease cases handled by CAHWs caused significantly less harm than those not handled by CAHWs.[96] However, some studies have found that in Africa, most paraprofessionals are not operating officially under the public mandate and are not under the supervision of veterinarians.[97] A study across 18 African countries and Vietnam found that only seven countries provided a legal status for CAHWs,[98] and national approaches to managing these animal health workers varies significantly.

In order to be effective, CAHW systems need to be developed in an interactive manner with local communities, including women and vulnerable members who keep livestock, to employ sound business practice and be linked to private sector, and to be in line with the strategies and policies of the veterinary authorities, including disease surveillance and reporting systems, and to participate in control of veterinary

[89] World Organisation for Animal Health, "Veterinary Para-Professionals," OIE, https://www.oie.int/solidarity/veterinary-paraprofessionals/.
[90] Catley, A. et al. "Para-Veterinary Professionals and the Development of Quality, Self-Sustaining Community-Based Services," *Rev. Sci. Tech.* 23, no.1 (April 2004): 391-401, https://doi.org/10.20506/rst.23.1.1476.
[91] Catley, A. et al. "Para-Veterinary Professionals and the Development of Quality, Self-Sustaining Community-Based Services," (2004).
[92] VSF International. "Community-Based Animal Health Workers (CAHWs). Guardians for Quality, Localised Animal Health Services in the Global South," *VSF International*, VSF International Policy Brief n. 5, (September 2018), http://vsf-international.org/wp-content/uploads/2018/08/Policy-Brief-n.5-web.pdf.
[93] Leyland, T. and Catley, "A. Community-Based Animal Health Delivery Systems: Improving the Quality of Veterinary Service Delivery," (2002).
[94] Sastry, N.S.R. and Raju, S.R. "Para-Veterinary Training Programmes in Andhra Pradesh," *A Living From Livestock*, Research Report no. 03-03, (December 2004), http://www.fao.org/3/a-bp335e.pdf.
[95] Schreuder, B.E.C. et al. "A Benefit-Cost Analysis of Veterinary Interventions in Afghanistan Based on a Livestock Mortality Study," *Preventive Veterinary Medicine* 26, no. 3-4 (April 1996): 303-314, https://doi.org/10.1016/0167-5877(95)00542-0.
[96] Leyland, T. et al. Community-Based Animal Health Workers in the Horn of Africa: An Evaluation for the US Office for Foreign Disaster Assistance, (2014).
[97] Ilukor, J. "Improving the Delivery of Veterinary Services in Africa: Insights from the Empirical Application of Transaction Costs Theory in Uganda and Kenya," (2017).
[98] Galière, M. "Réalisation d'une Enquête Sur les Dispositifs de Santé Animale de Proximité Dans les Pays d'Intervention des ONG du Réseau VSF-International," (2017), https://oatao.univ-toulouse.fr/25328/.

drugs. CAHW systems need not be seen as permanent solutions but can evolve as producer demand and ability to pay increases.

Just as in developed countries, the economic viability of veterinary services often depends on the sale of drugs. A viable model which is described is that of a private vet employing several animal health assistants and a network of CAHW.[99] For effectiveness, the key for CAHWs to be recognized officially and to become a permanent part of animal health solutions and not perceived as a competition for vets. NGOs may support training of CAHWs, but any sustainable provision of their services must be based on a viable business model over the long term.

A review of CAHW approaches a myriad of different strategies, all described as community-based even when community members were consulted only in the final stages. In addition, some focused heavily on training as the final target instead of a system for supply, supervision, and monitoring of CAHWs.[100] Key suggested characteristics for a sustainable and effective CAHW system are community participation in the design as regards specific animal health needs, diseases, and business model; agreement by professional vet associations and statutory authorities; and national guidelines for the CAHW system design and implementation be formally issued.

To achieve all of this, authorities need to define the roles of the various cadres of CAHW in revised legislation[101] possibly in the form of subsidiary rather than primary legislation, which can be issued by a Ministry, which stipulates roles, supervision, and regulation of CAHW. Another review study also asserted that the key to success of any CAHW lies in bringing such workers formally into the institutional animal health framework, with all roles and training specified.[102]

Table 12. Paraprofessional Vets and CAHW Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Paraprofessional Vets and CAHW	Guidelines/legislation which specify roles, supervision, training, and licensing requirements for various levels of animal health workers, including CAHW, to determine comprehensiveness and relevance; a functioning licensing system	Official government documentation
	Perceptions of effectiveness of coordination and supervision of various animal health service providers including CAHW	Key informant interviews: animal health service providers
	Existence and effectiveness of paraprofessional and CAHW programs which are community based, linked to private vets	Key informant interviews: veterinarians and paraprofessionals, local and international NGOs, producers (including women)

[99] Catley, A. et al. "Para-Veterinary Professionals and the Development of Quality, Self-Sustaining Community-Based Services," (2004).
[100] Catley, A. et al. "Para-Veterinary Professionals and the Development of Quality, Self-Sustaining Community-Based Services," (2004).
[101] Leyland, T. and Catley, A. "Community-Based Animal Health Delivery Systems: Improving the Quality of Veterinary Service Delivery," (2002).
[102] Riviere-Cinnamond, A. "Animal Health Policy and Practice: Scaling-Up Community-Based Animal Health Systems, Lessons from Human Health," PPLPI Working Paper 22, (2005): https://doi.org/10.22004/ag.econ.23775.

2.3.4 Veterinary Therapeutics and Vaccines

Because commercial livestock services tend to target economically viable livestock producers, availability of veterinary drugs for commercial producers is generally better than for smallholders. In addition, public priority may be toward trade-related diseases and the products required to mitigate those, with less attention given to the availability of products for and control of endemic production disease which smallholders struggle to overcome. However, smallholders may also be more exposed to the counterfeit, substandard, expired, or noncompliant drugs which may be offered in the market at lower costs. Key issues are quality, safety, and efficacy.[103]

Contraband veterinary drugs can pose a significant problem in many developing countries and lead to ineffective disease control and treatment.[104] Adverse reactions can occur with noncompliant drugs, such as in the case of anti-parasitic drugs. A study of drug supply in Kenya found that nine out of 21 anthelmintics, obtained from local pharmacies and merchants, did not contain any active ingredient.[105] Attempts to address the continued marketing of counterfeits can include enforcement of veterinary drug laws and standards and public naming and shaming events to raise awareness, such as reported in Nigeria.[106]

Livestock keepers may be well aware of the risks to their animals from potentially substandard drugs and, along with other stakeholders, develop strategies to mitigate these risks. These may include experimenting carefully with suspect drugs before applying them more widely across their herd and also seeking trustworthy suppliers and establishing long-term relationships. Producers are thus expending time and resources to mitigate risks, adding to the direct cost of the impacts on their animals. Formal institutions can also mitigate these risks by enacting and enforcing intellectual property rights and national labelling regulations in the veterinary drug market, so producers/customers can be confident of the legitimacy of the brand they are purchasing and utilizing.

Individual countries may not have the infrastructure, specialized personnel, and financial resources to assess the risks associated with the importation or domestic production of substandard veterinary drugs. Where this is the case, countries should coordinate with regional organizations to develop and employ standardized and harmonized quality control methods, such as those developed by the Pan African Veterinary Vaccine Center of the African Union (AU-PANVAC) in the case of Africa.[107], [108]

The level of resource commitment by national authorities to enforce drug quality regulation may be beyond their reasonable means, and some suggest a more effective approach is through training and awareness-raising among livestock producers but also veterinarians, drug retailers, stockists, and agro-vet dealers.[109]

These efforts could be supported by private sector importers and producers of quality veterinary drugs, whose intellectual property rights are of course threatened by the market presence of counterfeit drugs. The emergence of more formalized drug suppliers, such as the Sidai agro-vet franchise model already mentioned, will also improve the provision and market share of quality drugs.

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[103] Fingleton, J. "Legislation for Veterinary Drugs Control," *FAO Legal Papers Online*, (2004).
[104] Kitaw, G. et al. "Liquid Milk and Feed Value Chain Analysis in Wolmera District, Ethiopia," *CIGAR*, (October 2012), https://cgspace.cgiar.org/bitstream/handle/10568/24736/elf_dairyvca_2012.pdf.
[105] Monteiro, A.M. et. al. "Pharmaceutical Quality of Anthelmintics Sold in Kenya," *Veterinary Record* 142, (April 1998): 396-398, https://veterinaryrecord.bmj.com/content/142/15/396.short.
[106] Kingsley, P. "How Fake Animal Medicines Threaten African Livestock," *World Economic Forum*, February 6, 2015, https://www.weforum.org/agenda/2015/02/how-fake-animal-medicines-threaten-african-livestock/.
[107] See: https://aupanvac.org/.
[108] Sylla, D. et al. "Regulatory Framework and Requirements for Managing Risks Associated with Veterinary Biological Products in Africa: Present Systems and Future Needs," *Revue Scientifique et Technique* 14, no. 4, (1995), 1171-1184: https://doi.org/10.20506/rst.14.4.903.
[109] Kingsley, P. "How Fake Animal Medicines Threaten African Livestock," (2015).

Within-country vaccine production may also be a limiting factor in some countries with some diseases, depending on constraints to importing suitable vaccines. Although data are not easily available, in Africa for example, national capacity to reliably produce quality vaccines is mixed. Several international efforts are underway to build that capacity, including GALVMED[110] and the Livestock Vaccine Innovation Fund[111] among others, as well as the efforts coordinated by AU-PANVAC.

Table 13. Veterinary Therapeutics and Vaccines Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Veterinary Therapeutics and Vaccines	Legislation regarding quality control of veterinary drugs and vaccines, imported or produced domestically – evaluation to determine comprehensiveness and relevance	Official government documentation
	Perceptions of enforcement of legislation regarding quality control of veterinary drugs and vaccines, imported or produced domestically	Key informant interviews: veterinarians, paraprofessionals, veterinary drug providers/distributors
	Capacity of national vaccine production – diseases, volumes, reliability of supply; volumes and types of vaccine imports	Government and private sector sources
	Alignment/harmonization of veterinary drug quality regulations/legislation with regional neighbors	Official government documentation
	Perceived/actual market share among stakeholders of sub-standard and/or counterfeit drugs and effectiveness of existing control measures	Key informant interviews: drug distributors, animal health professionals
	Existence and effectiveness of awareness raising aimed toward wider knowledge of vet drug controls	Key informant interviews: producers and agro-input dealers
	Level of effort and commitment of private sector drug manufacturers, dealers, and retailers to support quality and counterfeit control of vet drugs	Key informant interviews: drug manufacturers, dealers, and retailers

2.4 ACCESS TO LAND, WATER, AND LABOR

This section discusses the importance of understanding how the availability of and access to other critical factors of production will influence the productive capacity of the system. This section specifically discusses the factors for ASF market success related to land tenure, the cost and availability of labor, and producer access to water.

2.4.1 Access to Land

There is evidence that secure land tenure is important in livestock systems in the following ways: to incentivize long-term investments such as fencing; to enable generational transfer of enterprises; to scale up enterprises through land consolidation, to provide clarity in community-managed areas; and to preserve access to rangelands and water.

[110] See: https://www.galvmed.org/.
[111] See: https://www.idrc.ca/en/initiative/livestock-vaccine-innovation-fund.

Livestock production systems are often assumed to be closely tied to land resources, particularly ruminants on rangelands. A significant proportion of land globally is currently allocated to some form of ruminant production. For livestock overall, nevertheless, the connection to land is not always so clear or determinant. Monogastrics such as pigs and poultry can be raised in small, confined settings, and even smallholder-intensive dairy production can be shown to be largely unconstrained by access to land[112] but will still rely on secure tenure to the smallholding they hold or have access to. For example, some 30 percent of milk production in India occurs in landless households.[113] The evidence of effects of land tenure on livestock is thus mixed and depends on livestock species and systems.

Critical issues include risks to sustained tenure on the land and its implications for the livestock enterprise, but also and importantly the effect tenure has on incentives for investment in the livestock enterprise. A study of the impacts of tenure on livestock enterprises in Zambia found no impacts on productivity, but did find that holding the land title increased the odds of fixed investment related to cattle, such as fences and wells.[114] In Ethiopia, one study found no link between land tenure status and the productivity of mixed crop-livestock farms,[115] although another study in Ethiopia found that tenure security was clearly associated with higher productivity.[116] A study in West Africa determined there was a link between tenure status and land fallow and tree planting, but provided little evidence of the link to other input use.[117] A Kenyan study found that security of tenure significantly increased the likelihood of adoption of improved forage technologies.[118]

Even in intensive mixed systems, land tenure may be accorded and assured in different ways, which may be some form of formal freehold, or based on a form of customary or community land rights, some of which may be relatively secure and strongly backed by traditions and norms.[119] In addition to security of land rights, key attributes of this tenure may be the ability to sell/transact the land, and to pass land use on to family members. The ability to efficiently rent land may increase overall productivity and opportunities for new or expanded enterprises, more so than borrowing.[120] Consolidation of land into larger holdings can be associated with higher livestock productivity, as was found among dairy producers in India.[121] Thus the evidence is mixed, but in some settings land tenure and land use rights can impact productivity and investment in the livestock enterprise.

For purposes of inclusive market systems, where women play important roles in livestock production, the security of land rights for women in the case of death of a spouse may impact their livestock enterprise

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[112] Staal, S. et al. "Location and Uptake: Integrated Household and GIS Analysis of Technology Adoption and Land Use, with Application to Smallholder Dairy Farms in Kenya," *Agricultural Economics* 27, no. 3 (August 2005), https://doi.org/10.1111/j.1574-0862.2002.tb00122.x.

[113] Singh, R.S & Datta, K.K. "Future of Smallholders in the Indian Dairy Sector – Some Anecdotal Evidence," *Indian Journal of Agricultural Economics* 68, no. 2 (2013): 182-194, https://doi.org/10.22004/ag.econ.206330.

[114] Smith, R.E. "Land Tenure, Fixed Investment, and Farm Productivity: Evidence from Zambia's Southern Province," *World Development* 32, no. 10 (October 2004), 1641-1661: https://doi.org/10.1016/j.worlddev.2004.05.006.

[115] Gavian, S and Ehui, S. "Measuring the Production Efficiency of Alternative Land Tenure Contracts in a Mixed Crop-Livestock System in Ethiopia," *Agricultural Economics* 20, no. 1 (January 1999): 37-49, https://doi.org/10.1016/S0169-5150(98)00067-X.

[116] Deininger, K and Jin, S. "Tenure Security and Land-Related Investment: Evidence from Ethiopia," *European Economic Review* 50, no. 5 (July 2006): 1245-1277, https://doi.org/10.1016/j.euroecorev.2005.02.001.

[117] Fenske, J. "Land Tenure and Investment Incentives: Evidence from West Africa," *Journal of Development Economics* 95, no. 2 (July 2011): 137-156, https://doi.org/10.1016/j.jdeveco.2010.05.001.

[118] Njarui, D. et al. "Determinants of Forage Adoption and Production Niches Among Smallholder Farmers in Kenya," *African Journal of Range & Forage Science* 34, no. 3 (November 2017): 157-166, https://www.tandfonline.com/doi/abs/10.2989/10220119.2017.1387814.

[119] Simbize, R.M. et al. "Land Tenure Security: Revisiting and Refining the Concept for Sub-Saharan Africa's Rural Poor," *Land Use Policy* 36, (January 2014): 231-238, https://doi.org/10.1016/j.landusepol.2013.08.006.

[120] Benin, S. et al. "Development of Land Rental Markets and Agricultural Productivity Growth: The Case of Northern Ethiopia," *Journal of African Economies* 14, no. 1 (March 2005): 21-54, https://doi.org/10.1093/jae/ejh032.

[121] Singh, R.S & Datta, K.K. "Future of Smallholders in the Indian Dairy Sector – Some Anecdotal Evidence," (2013).

and thus their livelihood.[122] A program to regularize land rights in Rwanda led to improved security of tenure for women and better recording of inheritance rights.[123]

In pastoral settings, sometimes complex traditional community rights to and limitations for land use rights exist along with increasing regularization of rights in legal terms. Traditional rights are also accompanied by community institutional structures to govern them and the management of conflicts around rights which may occur.[124] A study in northern Kenya found that local rangeland management regimes were more effective if the institutions were locally governed, with government playing the role of helping enforce boundaries among groups.[125]

There have been some efforts including by international donors to support the privatization and individual allocation of formerly communal land rights, under the economic principle that private control of resources will incentivize their better management. A study of that process in China, of assigning grassland rights to individual households beginning in the 1970s, did indeed find an associated increase in livestock productivity while constraining increases in livestock population. However, it was administratively a complicated process and may not be easily replicated.[126] A study in Kenya found that subdivision into individual parcels of community land in Maasai areas can lead to reduced ability of the land to maintain livestock populations.[127] Another Kenya study documented the relative benefits to stakeholders if landowners and policymakers act to maintain open or flexible access to individually held parcels rather than narrowly asserting private rights.[128]

There are now active efforts in some places to resist privatization of communal lands, because some households can lose previously held rights, and corruption among community councils can lead to expropriation outside the community. In Tanzania, there are laws to protect against this, and Kenya's new constitution allows some recourse to recover historical land rights by communities; in other countries, however, there is less protection.[129] Some communities have formed NGOs to resist the privatization process.[130] The continued management of rangelands in ways which allow access to vulnerable households and communities may depend on laws which are in place and consistently enforced to protect communal rights.

In the context of increasing populations, farmer-herder competition for land can threaten livestock keepers' access to grazing land and water as well as violence and loss of life. There is evidence that such conflicts may be on the increase, such as in West Africa.[131] Community-based and locally specific solutions, mediated by government, are seen as the best option to address these.

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[122] Davison, J. *Agriculture, Women, and Land: The African Experience*, (New York: Routledge, 2018).
[123] Ali, D.A. et al. "Environmental and Gender Impacts of Land Tenure Regularization in Africa: Pilot Evidence from Rwanda," *Journal of Development Economics* 110 (September 2014): 262-275, https://doi.org/10.1016/j.jdeveco.2013.12.009.
[124] McCarthy et al. "Property Rights, Risk, and Livestock Development in Africa," *ILRI* (1999), https://hdl.handle.net/10568/50993.
[125] McCarthy et al. "Property Rights, Risk, and Livestock Development in Africa," (1999).
[126] Liu, M. "How Does Land Tenure Reform Impact Upon Pastoral Livestock Production? An Empirical Study for Inner Mongolia, China," *China Economic Review* 60, (April 2020), https://doi.org/10.1016/j.chieco.2017.09.009.
[127] Boone, R.B. "Quantifying Declines in Livestock Due to Land Subdivision," *Rangeland Ecology & Management* 58, no. 2 (September 2005): 523-532, https://doi.org/10.2111/1551-5028(2005)58[523:QDILDT]2.0.CO;2.
[128] Hughes, L. "Land Alienation and Contestation in Kenyan Maasailand" (2013), https://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/8915/HUGHES_0880.pdf?sequence=1.
[129] Hughes, L. "Land Alienation and Contestation in Kenyan Maasailand," (2013).
[130] Fratkin, E. and Sher-Mei-Wu, T. "Maasai and Barabaig Herders Struggle for Land Rights in Kenya and Tanzania," *Cultural Survival Quarterly Magazine*, (September 1997), https://www.culturalsurvival.org/publications/cultural-survival-quarterly/maasai-and-barabaig-herders-struggle-land-rights-kenya-and.
[131] Nnoko-Mewanu, J. "Farmer-Herder Conflicts on the Rise in Africa," *Human Rights Watch*, August, 6, 2018, https://www.hrw.org/news/2018/08/06/farmer-herder-conflicts-rise-africa.

Table 14. Land Tenure Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Land Tenure	Formal laws and/or traditional rights assuring individuals and families of secure land tenure in some form and associated exchange/transfer, inheritance, and rental rights (including specific references to rights of women; comprehensive assessment of laws which protect communities from private expropriation of community land rights)	Official government documentation and/or documentation of traditional rights
	Effective, reliable, consistent, and impartial enforcement of land tenure laws (formal and traditional) and for managing conflict	Focused stakeholder discussion group: producers and community leaders, women and youth
	Perceptions of the extent to which existing land rights and their administration impact livestock enterprises (small to large) and investment incentives	Key informant interviews: small and large producers, women and youth

2.4.2 Access to Water

Water is a critical input for all livestock systems, although the needs per animal vary significantly by species and their conditions of husbandry, activity, and environment. Even in relatively high-rainfall East African highland dairy systems, the constraints posed by water access can affect productivity, given that milk is comprised 87 percent of water.[132] It should be noted that a dairy cow typically requires 50 liters of water a day just for drinking. Pig production also requires large amounts of water to maintain hygiene standards.

In relatively intensive crop-livestock systems, water is likely to be available from a variety of sources either as surface water, wells, boreholes, rainwater harvesting systems, public water points, small-scale mobile venders, piped public water supply, or commercial delivery by truck. Water from some of these can be privately controlled by a producer, available publicly for only the cost of labor and transport, or purchased. The type and variety of such sources will affect both reliability of availability and the price. For most livestock systems, it may be important to assess both availability and cost as well as their seasonal variation, since those may impact the viability of the enterprise, even in relatively high-rainfall settings.

In dryland pastoral systems, the sources may be more limited and may vary a great deal seasonally. Pastoralists have traditional practices to access water, including seasonal movement of herds. In many such systems, these are supplemented with boreholes or rainwater harvesting bunds, either operated privately, communally, or by the government.[133] A basic assessment of the extent and effective management of these sources should be conducted to understand the viability and resilience of the target production system.

Table 15. Access to Water Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Access to Water	Price of water (or price of installing water access technology, such as a well or borehole) in target areas from the available sources	National or sub-national utility provider, and/or private supplier

[132] Ward, D. and Mckague, K. "Water Requirements of Livestock," *Ontario Ministry of Agriculture, Food, and Rural Affairs Fact Sheet,* (May 2007), http://omafra.gov.on.ca/english/engineer/facts/07-023.pdf.
[133] Bruins, H.J. et al. *Drought Planning and Rainwater Harvesting for Arid-Zone Pastoralists: The Turkana, the Maasai, and the Negev Bedouin* (Amsterdam: KIT, 2005).

Table 15. Access to Water Indicators and Measurement Methodology

	Indicator	Information Gathering Method
	In pastoral areas, numbers/density of boreholes and water harvesting bunds available to communal livestock producers	Documentation from national, subnational, or community
	Stakeholders perceptions of the reliability and variety of water sources in target areas, and of the degree of effective management	Focused stakeholder discussion groups: producer groups by local area, women

2.4.3 Access to Labor

A sometimes overlooked factor in rural livestock development, particularly in smallholder settings where family labor is assumed to be largely underutilized, is the effective availability of labor compared to other factors of production, such as land. Many improved technologies require increased input of labor, including planted forages, silage making, confined zero-grazing of cattle, and utilization/treatment of crop residues, among others. Simple budget analysis may suggest that returns to labor under these technologies are positive, and that availability of family labor is not a significant constraint. However, the evidence from observed behavior of smallholder households suggests that labor scarcity can be a main obstacle to the uptake of improved technology related to intensification.

In addition, based on societal norms some types of work may be regarded as gender-specific. If the additional work of an improved technology is expected to be carried out by women, their existing labor commitments may limit the uptake of that technology.

A study that looked across diverse livestock systems in 15 countries found that the most important determinant of the use of intensive livestock practices was the ratio of labor wage rates to land rental rates — indicators of the relative scarcity of both resources.[134] Scarce land holdings were associated with more labor-intensive and higher productivity practices.[135] However, even in land-scarce settings, the proximity to urban centers will raise relative wage rates. Some understanding of those ratios may be critical in target areas and can be measured through casual daily wage rates and land rental rates.

Table 16. Labor Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Labor	Ratio of daily causal rural wage rate to land rental rate in the target areas and any observed gradients across the areas	Government, industry, or private sector data on rural wages and land rental prices If not readily available, conduct rapid survey in local area of labor and land prices
	Perceptions of producers regarding the gender-differentiated availability/scarcity, and cost of labor and its impact on their livestock production	Key informant interviews: producers and/or producer groups, women and youth

[134] Baltenweck, I. et al. "Crop-Livestock Intensification and Interaction Across Three Continents," (October 2003), https://cgspace.cgiar.org/bitstream/handle/10568/876/Baltenweck_2003_crop-livestock.pdf?sequence=1.

[135] Similar findings are seen in Gebremedhin, B. and Swinton, SM. "Investment in Soil Conservation in Northern Ethiopia: The Role of Land Tenure Security and Public Programs" (2003) and in Valbuena et al. "Identifying Determinants, Pressures and Trade-offs of Crop Residue Use in Mixed Smallholder Farms in Sub-Saharan Africa and South Asia" (2015).

2.5 GENERAL BUSINESS ORIENTATION OF PRODUCERS

Another factor, often viewed as separate from the enabling environment, is the general business orientation of producers in the system. However, the business orientation of livestock producers across the system is a key determinant of the likelihood of the adoption of improved technology and commitment to participation in more formal market channels. Therefore, the degree of business orientation among producers must be well understood if efforts to increase the commercialization of production systems are to succeed.

In nearly all mixed crop-livestock smallholder systems, the livestock enterprise comprises only one part of a diversified farm household. The FAO suggests that livestock producers earning at least 25 percent of household income from livestock can be categorized as business-oriented and can be expected to display an increasing likelihood of new technology uptake,[136] a finding confirmed by other studies.[137]

While this percentage may be viewed as relatively low, available data show that the percent of total household income from livestock typically ranges from 5 to 40 percent in smallholder households, even in intensive dairy systems, reflecting the diversification strategies most households adopt to mitigate risks. Some find that no more than 20 percent of all rural households are business-oriented livestock keepers in sub-Saharan Africa. In contrast, thresholds of 50 or 75 percent of household income are often used to define specialized crop production households.[138]

In pastoral systems where there is higher dependence on livestock for income and livelihoods, household business orientation is more complex. Marketing of live animals (and milk) occurs regularly for private returns and is reflected in the level of annual offtake, but income-generation strategies are imbedded among other objectives related to accumulation of livestock assets for income smoothing, risk mitigation, and social status — among others.[139] Nevertheless studies of differentiation among producers in pastoral areas show that some producers are more clearly commercially oriented, which is reflected in their buying of improved animals for breeding to upgrade herds towards higher productivity and marketability as well as in the hiring of labor to manage and graze herds.[140]

Table 17. General Business Orientation of Producers Indicators and Measurement Methodology

	Indicator	Information Gathering Method
General Business Orientation of Producers	Proportion of livestock households in target areas which generate 25 percent of their household income from the livestock enterprise	Government documentation (if available) and/or key informant interviews with a representative sample of livestock producing households
	Annual offtake rate of livestock in extensive systems (percent of herd)	Key informant interviews: pastoralists
	Perception of degree of market orientation among target livestock keepers as reflected in their use of improved genetics and feeds and other technology and services, and their use of hired labor to manage herds	Focused stakeholder discussion groups: producer groups in target area, women and youth

[136] FAO. *Developing Sustainable Value Chains for Small-Scale Livestock Producers* (2019).
[137] Zuwarimwe, J. et al. "Factors Influencing Smallholder Farmers' Decisions to Participate in Livestock Markets in Namibia," *Journal of Development and Agricultural Economics* 7, no. 7 (July 2015): 253-260, https://doi.org/10.5897/JDAE2014.0562.
[138] Pica-Ciamarra, U. et al. "Business and Livelihoods in African Livestock: Investments to Overcome Information Gaps," The World Bank and the Food and Agriculture Organization of the United Nations, (2014), https://hdl.handle.net/1959.11/14417.
[139] McPeak, J. "Individual and Collective Rationality in Pastoral Production: Evidence from Northern Kenya," *Human Ecology* 33 (2005): 171-197, https://doi.org/10.1007/s10745-005-2431-Y.
[140] Zaal, F. "Pastoral Integration in East African Livestock Markets: Linkages to the Livestock Value Chain for Maasai Pastoral Subsistence and Accumulation," (2011).

2.5.1 Responsiveness to Market Incentives

One critical aspect of business orientation, is the responsiveness of producers to market incentives. Supply response by livestock producers to improved market access and other incentives can often be overestimated by development actors/projects and/or private investors seeking to establish processing and marketing/export facilities. This can be particularly true in pastoral settings where offtake is low due to marginal productivity and high mortality, but may also be due to limited producer responsiveness to market incentives for multiple reasons.[141],[142]

In some rangeland settings, livestock ownership can be shared among members of a household, or in cases where owners live in urban areas and do not participate directly in livestock management — both of which contribute to low offtake rates.[143] In addition, pastoralists may hold stock for risk mitigation or for seasonally planned food expenditure cash needs.[144]

Supply response can also be limited in more intensive mixed systems due to additional factors besides the multiple objected of livestock keepers. Dairy projects in East Africa have been seen to rarely achieve their milk volume expectations and so suffer the consequences of underutilized milk collection/cooling capacity, in part due to producer risk mitigation behavior and avoidance of investment in improving productivity.[145] In an issue related to the topic of informal market share above, the local presence of livestock in number or market-oriented producers may not be sufficient to ensure supply, if their orientation is towards informal or traditional market outlets which are typically not the target for capital-intensive or formal market investments.

Competition for the available and potential supply is thus also part of the equation. A realistic assessment of potential supply response will be critical to the business plan of any public, private, or development agent investment in ASF market systems, particularly any which is oriented towards formal market channels.

Table 18. Responsiveness to Market Incentives Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Responsive-ness to Market Incentives	Perceptions of producer willingness to increase on-farm investments in new technologies, or to upgrade practices to supply formal channels (considering market price differential, increased production costs, potential deferred payments, etc.)	Focused stakeholder discussion groups: Producers, women

[141] Rich, K.M. and Perry B.D. "Whither Commodity-Based Trade?" *Development Policy Review* 29, no. 3 (May 2011): 331-357, https://doi.org/10.1111/j.1467-7679.2011.00536.x.
[142] Hamza, K.M. "Commercializing Smallholder Value Chains for Goats in Mozambique: A System Dynamics Approach," in *System Dynamics and Innovation in Food Networks 2014*, edited by U. Rickert and G. Schiefer, 117-134, https://ageconsearch.umn.edu/record/199342.
[143] Turner, M. "The New Pastoral Development Paradigm: Engaging the Realities of Property Institutions and Livestcok Mobility in Dryland Africa," *Society and Natural Resources* 24, no. 5 (February 2011): 469-484, https://doi.org/10.1080/08941920903236291.
[144] Little, P.D. et al. "How Pastoralists Perceive and Respond to Market Opportunities: The Case of the Horn of Africa," *Food Policy* 49 (December 2014): 389-397, https://doi.org/10.1016/j.foodpol.2014.10.004.
[145] Njehu, A. et al. "Assessment of the Cause of Milk Decline in Selected EADD Supported Hubs in Kenya," *East Africa Dairy Development*, (2013), https://cgspace.cgiar.org/bitstream/handle/10568/34448/Milk%20decline%20report.pdf?sequence=1.

3. MARKETING FACTORS

The following section addresses enabling environment factors related to the market for ASF products. All ASF project investments should begin with a comprehensive understanding of end-market demand, and how those dynamics will influence the product specifications that producers will be required to meet in each market channel. However, marketing factors in the enabling environment not only include a consideration of the nature of consumer demand; they also include the factors that influence the ability of producers to reach their end market destination safely and efficiently in order to meet demand. These factors therefore also include various requirements that are specific to ASF market systems, including infrastructure related to live animal movement; the hygienic collection or slaughter and transport of ASF products; cross-border regulatory considerations, such as SPS; and food safety control mechanisms to ensure consumer well-being.

3.1 END-MARKET DEMAND

The first step in assessing the viability of any project investment (public, private, and/or donor) should be a detailed consideration of the end-market demand dynamics. The target market channels (local versus export, fresh versus frozen, etc.) must be identified, and the product specifications/expectations of buyers and consumers in that channel must be well understood. These specifications should drive responsive producers and processors and other actors along the chain to meet those demands by adapting their practices accordingly. This section is not a discussion of how to conduct an end-market demand analysis. Instead, it is a discussion of the growing demand for ASF products globally and the generally overlooked demand from local markets for ASF products. The enabling environment factors that influence local market demand for ASF products will have an outsized effect on local nutritional outcomes and impact.

The demand for livestock products globally is expected to double by 2050, with nearly all of that increase occurring in developing countries.[146] The Livestock Revolution, first described in 1999, continues to grow in scale and geography.[147] Between 2015 and 2050 in Africa, meat demand is expected to triple, while milk demand is expected to double.[148] For potential investors in ASF market systems, a key aspect of the enabling environment is the nature of those demand trends. An understanding of which products in what form (to which specifications/standards) are likely to attract buyers, and who and where those buyers will be, are all critical aspects to assessing the potential for ASF market system success.

Data on livestock product consumption are scarce and often unreliable, and additionally may not differentiate products in the same ways in which buyers do.[149] For example, in many markets, raw milk is preferred by some buyers to processed milk and is priced differently, but official market statistics rarely capture that differentiation. In general, there are no comprehensive secondary datasets in developing countries through which the local market demand for the different retail forms of livestock products can be derived accurately.

Studies have found that in Tanzania, for example, the retail forms of ASF products most often sold are those preferred by lower income buyers.[150] In Senegal, the largest share of the beef market by volume is for offal (organ meat), which sell at the lowest price by weight and is therefore the most affordable meat available to poor consumers.[151] The informal raw milk markets, which still dominate in East Africa and South Asia — variously estimated at up to 80 percent market share in some cases — are driven not just

[146] Thornton, P.K. "Livestock Production: Recent Trends, Future Prospects," (2010), https://doi.org/10.1098/rstb.2010.0134.
[147] Delgado, C. et al. "Livestock to 2020: The Next Food Revolution," *International Food Policy Research Institute*, (1999).
[148] Latino, L.R. et al. "Africa: The Livestock Revolution Urbanizes," *Global Food Security*. Forthcoming.
[149] Pico-Ciammara, U. et al. "Business and Livelihoods in African Livestock: Investments to Overcome Information Gaps," The World Bank and the Food and Agriculture Organization of the United Nations (2014), https://hdl.handle.net/1959.11/14417.
[150] Pico-Ciammara, U. et al. "Business and Livelihoods in African Livestock: Investments to Overcome Information Gaps," (2014).
[151] Rich, K.M. et al. "Perspectives on the Competitiveness of Live Animal Versus Meat Exports in Mali," Nairobi: ILRI (2019), https://hdl.handle.net/10568/106332.

by taste preference, but also by consumer willingness to pay the added costs of processing (pasteurization) and packaging.

There are several implications of this reality. A viable market-driven strategy in certain contexts may more appropriately target poorer consumers, which make up the majority of buyers in many countries. This has been referred to as a "bottom of the pyramid" approach, which in aggregate may lead to larger volumes and revenues.[152] Examples may include the use of cheaper packaging and smaller sizes, which are more amenable to poor consumers. Higher quality product attributes, which may be attractive to buyers with greater disposable income, are likely less attractive to lower income consumers due to their higher cost. Value addition in certain consumer contexts may translate primarily into cost addition and lead to product market failure.[153]

Similarly, due to consumer resistance to the higher costs of formally processed products, informal markets for raw or traditionally processed products are likely to continue to play a large role for the foreseeable future. Top-down government attempts to mandate product and process standards may be expected to fail if they do not reflect buyer demand, and may instead lead to increased informality of market transactions and supply chains.

Low effective consumer demand for quality or safety often leads to lack of product differentiation — for example mixed cuts of meat sold retail at one average price, or set milk prices paid to producers regardless of fat content or quality — as product differentiation increases costs in the form of resources needed for separating cuts or testing milk.

The evidence is clear that demand for product differentiation can only be driven by the nature of consumer buyer behavior. In India, where a significant share of milk goes into products such as ghee and sweets, which need fat, milk is priced based on fat and solids content. In East Africa, where nearly all milk is consumed as liquid, there is little price differentiation to dairy farmers. In Senegal, lack of product differentiation in demand was found to be a major constraint to the development of modern cattle abattoirs.[154] The same study found that prices of imported products, including low-cost offal, significantly affected market opportunities for local products.

Change in consumer preferences related to traditional foods, product attributes including packaging and refrigeration, and to food safety are likely to change only in the long run. The evidence of success of consumer awareness campaigns is mixed. In the context of a near to medium-term investment planning horizon, existing consumer preferences may need to be carefully considered.

Table 19. End-Market Demand Indicators and Measurement Methodology

	Indicator	Information Gathering Method
End-Market Demand	ASF product consumption by income group and time-series trends	Government data and/or private industry association data
	Import volumes and prices for ASF products (to demonstrate local demand currently unmet by domestic production systems)	Government data and/or international trade databases (e.g., UN Comtrade)
	Existing public and/or private ASF product grades and standards administration systems (written standards, certification bodies, accreditation bodies, testing facilities), the	Official public or private standards and data on certified producers Assessment of administrative capacity of standards systems

[152] Prahalad, C.K. *The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits*, Upper Saddle River: Pearson, 2009.
[153] Staal, S. et al. "Livestock Value Chains that Foster Inclusivity and Scale," in Inclusive Growth: Making Value Chains Work for Smallholder Farmers (Jeddah, Kingdom of Saudi Arabia: Islamic Development Bank Group, 2020), 50-67.
[154] Rich, K.M. et al. "Perspectives on the Competitiveness of Live Animal Versus Meat Exports in Mali," (2019).

Table 19. End-Market Demand Indicators and Measurement Methodology

	Indicator	Information Gathering Method
	breadth of uptake, and their administrative capacity	
	Willingness of consumers/buyers to pay for higher quality and grade differentiated ASFs, estimates of informal market share for target products	Structured survey: households/consumers and sellers at retail market locations, particularly women food buyers

3.2 TRADE FACILITATION

Trade in livestock products tends to receive wide publicity, due to the perceived dumping of low-price products on developing country markets, or due to poor animal welfare conditions during live animal transport and handling. It may thus be surprising to some to learn that most livestock products are consumed in the same countries where they are produced, and that, in aggregate, formal international trade in livestock products has long been a relatively small share of production.

It is estimated that only roughly 10 percent of ASF products produced globally are formally traded across borders in any given year. Based on publicly available 2016 data, in value terms, only 2.5 percent of dairy and 12 percent of poultry meat globally was formally traded across borders.[155] These figures likely do not reflect informal and unrecorded trade which may be important in some cases. One recent study, for instance, found that official data on livestock exports to neighboring countries in West Africa significantly underestimate actual numbers.[156]

Nevertheless, in some regions such as the Horn of Africa, the Sahel, and South Asia,[157] live animal and livestock product exports have significant economic importance. Where formal ASF trade is limited, this is in part due to strict OIE/Codes standards for ASF product and live animal health and safety, but is also due to the fact that livestock products have to be in some way preserved to be traded — chilled, frozen, dried, canned — which increases their cost. This section discusses the factors which enable or hinder formal trade in ASF, including infrastructure specific to live animals and ASF, trade policies, livestock market information systems, and SPS standards capacity.

3.2.1 Trade-Related Infrastructure and Policy

Where ASF exports are economically sustainable, specific types of infrastructure will be needed. In the case of live animal trade, certain infrastructure is related to animal movement across distance, including holding pens, water, feed, and health points along transport routes. In some cases, these may be publicly supported, but where there are large private market actors, private providers of these services will play a role, such as quarantine pens in coastal Horn of Africa operated by large buyers from the Arabian Peninsula. Further factors which impede movement may include official animal movement control points and any associated informal taxes at such points or at border crossings.

Exports of milk powder, which Uganda, for example, has successfully developed, mainly require processing plants which can produce the high-quality powder that international markets demand. That level of quality in turn requires relatively high-quality raw milk, and so collection systems with the capacity to deliver that quality are a prerequisite in the supply chain, in addition to the fact that Uganda has some of the lowest milk production costs in the world.

[155] Based on author estimates using FAOSTAT and Comtrade data and also reported in Staal, S. et al. *Livestock Value Chains That Foster Innovation and Scaling* (2020).

[156] Valerio, V.C. et al. "Network Analysis of Regional Livestock Trade in West Africa," *PLoS ONE* 15, no. 5 (May 2020), https://doi.org/10.1371/journal.pone.0232681.

[157] In the form of exports of buffalo beef.

As is discussed in the following section on SPS Standards Capacity, export abattoirs in most countries face significant challenges when they are competing with local markets and the animal and meat quality is low. Even in Mali, where live animal exports are an ancient tradition, export abattoirs face challenges maintaining economic viability as local consumers may not be willing to pay for higher standards and exported products may not compete with competitor products on the market, typically South American or European.[158] The presence of such abattoirs should not usually be regarded as a general factor except in specific export-oriented meat markets.

Some facilitation can occur through rather simple but potentially effective interventions. Mostly informal markets for live animals can be controlled by relatively small numbers of buyers and brokers, and other actors may have limited access to information or to potential buyers/sellers, so interventions to improve networking can improve market performance. A USAID-supported effort in Kenya organized business-to-business forums which brought together livestock market actors for specific counties for half-day gatherings. Follow up monitoring shows that the new business connections formed led to more than 13,000 sheep, goats, and cattle being traded, worth some US $2 million.[159] Regularized and systematic approaches to improve market linkages through public-private partnerships can improve market performance towards exports.

A wide-ranging study of regional livestock trade in West Africa identified a number of constraints to trade, such as tariffs (which were being reduced but differed in structure across countries), NBTs and illicit taxation, and lack of harmonization of standards across countries. Partly as a result of these factors, price transmission was found to be inefficient, which hinders the competitive potential of the market system.

In 2000, West African countries adopted regional trade regulations and pastoral codes which covered zoosanitary agreements, conventions on cattle marketing, and trans-border transhumance movement. However, impact has been limited due to a lack of effective implementation.[160] In addition to reductions in tariffs and NTBs and policy harmonization, livestock keeper associations and livestock trader associations can play an important role in improving trade performance.[161]

Table 20. Trade-Related Infrastructure and Policy Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Trade-Related Infrastructure and Policy	Existence, quality, and breadth of access to holding pens, water, feed, and health points along live animal transport routes	Official government documentation (Ministry of Livestock, Animal Health, and/or Trade) Key informant interviews: points along transport routes
	Existence and quality of quarantine facilities (for live animal trade); rural collection systems (for dairy); abattoirs (for meat export)	Official government documentation Key informant interviews: quarantine facilities, collection points, abattoirs, etc.
	Tariffs and NTBs for ASFs among regional and bordering countries	Official government documentation (Ministry of Livestock, Industry, and/or Trade)

[158] Rich, K.M. et al. "Perspectives on the Competitiveness of Live Animal Versus Meat Exports in Mali," (2019).
[159] ILRI/EATIH. *USAID Hub Livestock Trade Facilitation*, Nairobi, Kenya (2019), https://hdl.handle.net/10568/100151.
[160] CIRAD. "Système d'Information Sur le Pastoralisme au Sahel: Atlas des Évolutions des Systèmes Pastoraux au Sahel 1970-2012" (2013), https://www.cirad.fr/actualites/toutes-les-actualites/articles/2013/ca-vient-de-sortir/systeme-d-information-sur-le-pastoralisme-au-sahel.
[161] Williams, T.O. et al. *Improving Livestock Marketing and Intra-Regional Trade in West Africa,* Nairobi: ILRI, 2006.

Table 20. Trade-Related Infrastructure and Policy Indicators and Measurement Methodology

	Indicator	Information Gathering Method
	Level of activity and effectiveness of livestock industry associations in trade and market facilitation	Key informant interviews: producers, traders, associations
	Degree of harmonization of trade policies and standards among existing and potential trade partners	Official government documentation (see Regional bodies where relevant)

3.2.2 SPS Standards Capacity

One of the key bodies establishing the SPS rules of trade in food products is the Codex Alimentarius, which sets food standards, guidelines, and codes of practice recognized by the World Trade Organization as the benchmark standards for national food safety regulations. These are created by consensus and because they impact all nations, it is important that developing countries participate in the Codex negotiations to ensure their interests are represented. Toward that end, a number of training programs are available from the FAO and WHO to strengthen knowledge of Codex rules and procedures and to improve national planning for Codex participation and preparedness of Codex delegations.[162] The ability of a particular government to actively participate may impact their export capacity.

A key capacity feature of an export-oriented livestock industry is the ability to comply with SPS requirements, which require, among numerous regulations, foot-and-mouth disease (FMD) free animals (and unvaccinated for FMD in certain markets). A number of mechanisms have been developed and to some extent implemented to meet these requirements. These include establishment of disease-free zones and export corridors which keep livestock from being exposed, so that they can be exported even without vaccination. A prominent example of a disease-free zone is that bounded on the north by the veterinary cordon fence which runs through Namibia and Botswana and effectively excludes animals which can transmit FMD from the commercial livestock ranches in the south zone, and which is certified by the OIE.

A still emerging approach is commodity-based trade (CBT), which is a concept based on exporting fresh or frozen de-boned beef that has been proven to be free of the FMD pathogen through the traceability and HAACP processes taken throughout the supply chain. This has been particularly debated in southern Africa, which has acquired access to EU markets, as well as in other African markets, as a possible platform for future trade. One report lays out a range of these approaches for mitigating disease constraints to export, including CBT, however, they don't discuss the economic viability,[163] and there is evidence that these are not cost-effective. An analysis which looked at the potential for CBT as a means to improve market access for beef from communal areas of Namibia found only modest economic gains given the costs of SPS and quality standards compliance.[164] Moreover, while the concept of CBT has largely been accepted in principle, including by the OIE, specific protocols for its use to facilitate trade have not as yet been developed.

The SPS barriers themselves may not be the main hurdle, and instead factors may exist in adequate animal and feed supply to achieve sustainable exports. One study found that the costs of such exports were prohibitive; in the case of Ethiopia, in particular, the costs of fattening and finishing the animals to achieve the degree of product quality that the market demanded. This is partly why export abattoirs in Ethiopia

[162] FAO, "Effective Participation in Codex," http://www.fao.org/food/food-safety-quality/capacity-development/participation-codex/en/.
[163] Scoones, I. et al. "Foot-and-Mouth Disease and Market Access: Challenges for the Beef Industry in Southern Africa," *Pastoralism* 1, no.2 (July 2010), http://hdl.handle.net/2263/16879.
[164] Naziri, D. et al. "Would a Commodity-Based Trade Approach Improve Market Access for Africa? A Case Study of the Potential of Beef Exports from Communal Areas of Namibia," *Development Policy Review* 33, no. 2 (March 2015): 195-219, https://doi.org/10.1111/dpr.12098.

operate significantly below capacity.[165] For all of these reasons, a CBT approach which focuses on products and processes to overcome SPS barriers could be uneconomic and unsustainable when subjected to close scrutiny, given the investment and recurrent costs necessary to develop higher standard supply chains.[166]

In another context where bilateral trading partners have agreed not to comply with the full international SPS requirements, but some degree of disease control is required, systems of vaccination, quarantine, and inspection can facilitate trade. For example, live animals are exported from the Horn of Africa to the Arabian Peninsula, whereby countries can bilaterally agree to apply their own animal health requirements. Since FMD is endemic in both regions, the SPS rules are not strictly followed and instead animals are vaccinated and quarantined. However, outbreaks of diseases such as Rift Valley Fever, which is zoonotic and so can affect human health, can cause livestock import bans, or specific consignments of animals can be rejected. The OIE sponsored a recent analysis which documented the means by which livestock trade between the Horn of Africa and the Arabian Peninsula can be sustained through regional partnerships and joint efforts for disease control.[167]

A study of exports from Somalia found that, if effectively managed, animal inspection and certification at regional markets combined with quarantine inspection and certification at export port would reduce the risk of exporting infected animals and enhance disease control at the regional level, even for priority diseases including FMD.[168] Much of this is financed by private sector buyers and sellers.

Table 21. SPS Standards Capacity Indicators and Measurement Methodology

	Indicator	Information Gathering Method
SPS Standards Capacity	Existence and effective implementation of systems and facilities to ensure compliance with processes and standards for animal health and quality, including rules on domestic product processing	Official government documentation (Ministry of Livestock, Animal Health, and/or Trade) Evaluation of existing systems to determine effectiveness of implementation
	Key government officials have undergone Codex training and have actively participated in Codex negotiations	Official government documentation Key informant interviews: relevant government officials
	Perceptions among stakeholders that government investment capacity to support SPS compliance and other export requirement has been effective	Key informant interviews: exporters, importers

3.2.3 Livestock Market Information Systems

Prices for livestock and ASF products can vary widely by location and season. In northern Kenya, large variability was observed in prices in pastoral meat markets; sometimes prices were only known on market day.[169] The implication was that traders were unable to pass on improved prices to producers/sellers and instead based their pricing on a lower range of averages. While many developing countries have not

[165] Rich, K.M. et al. "Concepts, Applications, and Extensions of Value Chain Analysis to Livestock Systems in Developing Countries," Contributed Paper prepared for presentation at the International Association of Agricultural Economists Conference, Beijing, China, August 16-22, 2009, https://doi.org/10.22004/ag.econ.51922.
[166] Rich, K.M. and Perry B.D. "Whither Commodity-Based Trade?" (2011).
[167] Mtimet, N., et al. "Better Enforcement of Standards for Safer Trade in Livestock and Livestock Products Across the Red Sea: Feasibility Study for a Joint Horn of Africa-Arabian Peninsula Initiative," Paris, France: World Organisation for Animal Health (2020), https://hdl.handle.net/10568/107951.
[168] Knight-Jones, T.J.D. et al. "Risk Assessment and Cost-Effectiveness of Animal Health Certification Methods for Livestock Export in Somalia," *Preventative Veterinary Medicine* 113, no. 4 (March 2014): 469-483, https://doi.org/10.1016/j.prevetmed.2014.01.003.
[169] Roba, G.M. et al. "Making Decisions Without Reliable Information: The Struggle of Local Traders in the Pastoral Meat Supply Chain," *Food Policy* 76, (April 2018): 33-43, https://doi.org/10.1016/j.foodpol.2018.01.013.

consistently demonstrated success in introducing Livestock Market Information Systems (LMISs), this example from Kenya illustrates the potential benefit that a successful LMIS can provide for otherwise marginalized actors in ASF market systems.

Information and communications technology (ICT)-based attempts to improve LMISs have met with mixed success due to the difficulty of establishing a durable business model, but this is an area of active innovation attracting significant donor support.[170] The difficulty of establishing a sustainable business model without continued donor support is documented in a USAID review of market information systems generally in East Africa.[171] To date, LMIS attempts have generally been led by the public sector or NGOs, but private sector participation is observed as well, such as multinational ICT companies partnering with a Dutch NGO in Mali to develop and pilot a LMIS business model. The presence of such innovation efforts may significantly improve responsiveness to markets and improve the enabling environment for LMISs. Given some greater inclination to use of emerging smartphone/ICT technologies among youth, there may be specific opportunities for youth employment in implementation of LMISs.

Table 22. LMIS Indicators and Measurement Methodology

	Indicator	Information Gathering Method
LMIS	Inventory of active/planned LMISs for various ASF products, species of livestock, scope of the LMISs in terms of types of information, and business model for operation	Official documentation from government ministries, development agencies, and/or private sector actors, including ICT companies
	Utilization rate of existing LMISs by producers and traders	Key informant interviews: producers and traders
	Perceptions of the utility and sustainability of LMIS according to users	Key informant interviews: producers and traders
	Levels of participation and roles of private sector in LMIS initiatives	Key informant interviews: private livestock enterprises

3.3 FOOD SAFETY CONTROL

ASFs are ranked among the top sources of foodborne disease risks in developing countries along with other fresh foods, although the full burden is not easily estimated.[172] Most risks are from microbial pathogens such as Salmonella, and of course zoonotic infectious diseases. Some threats are from contaminants. For instance, one study found that over 90 percent of milk in the Addis Ababa milk shed Ethiopia was found to exceed EU levels of acceptable aflatoxin contamination.[173] Although based on a small sample size, the study was widely reported in local media, causing a severe (albeit temporary) drop in demand for milk and a shock to the market. Besides the actual public health threat, such market shocks are an additional incentive for public control of food safety. Risks are exacerbated in some settings where there are traditions of raw food consumption, such as raw beef in Ethiopia and raw milk in West Africa.[174]

Consumer demand for improved food safety control is partly a function of increasing consumer awareness and higher disposable incomes to pay the higher associated costs. In many cases consumers even in

[170] Wane, A. *Situation Analysis of the National Livestock Market Information System (LMIS) for Mali* (November 2016), https://agritrop.cirad.fr/584480/1/Situation%20analysis%20of%20the%20national%20Livestock%20Market%20Information%20System.pdf.
[171] USAID, "An Assessment of Market Information Systems in East Africa," Briefing Paper, (May 2013), https://www.ictworks.org/wp-content/uploads/2013/05/An_Assessment_of_Market_Information_Systems_in_East_Africa.pdf.
[172] Grace, D. "Food Safety in Low and Middle Income Countries," *Int. J. Environ. Res. Public Health* 12, no. 9 (August 2015), https://doi.org/10.3390/ijerph120910490.
[173] Gizachew, D. et al. "Aflatoxin Contamination of Milk. and Dairy Feeds in the Greater Addis Ababa Milk Shed, Ethiopia," *Food Control* 59 (January 2016): 773-779, https://doi.org/10.1016/j.foodcont.2015.06.060.
[174] Grace, D. "Food Safety in Developing Countries: Research Gaps and Opportunities," White Paper. Nairobi, Kenya: ILRI (2017), https://hdl.handle.net/10568/81515.

developing countries may be aware of risks, and studies have indicated their stated willingness to pay for greater food safety, but there is very little evidence of that willingness to pay in observed behavior and transactions.[175]

Public decision-makers have also become more aware of the economic and public health costs of unsafe food, as well as occasional highly public food scares which also have political implications. The threats of unsafe food go beyond those of public health, as they can have significant economic consequences as well. An outbreak of Rift Valley Fever, a zoonotic disease which people can contract through contact with raw meat/blood of ruminants, was estimated to have severely affected the livelihoods of some 50-200 million pastoralists through disruptions to the value chain in several East African countries.[176]

3.3.1 Public Sector-Led Food Safety Control

Public decision-maker interest in mitigating food safety risks in ASF can be driven by a desire to improve public health and to reduce economic costs such as reduced trade, lost livelihoods, and reduced local consumption of nutritious foods. As an example of the latter, a study conducted in Ethiopia which found elevated aflatoxin levels in milk as a result of contaminated feed grain led to a sharp drop in purchases and consumption of local milk.[177]

There are several pathways for the public sector to improve food safety in domestics markets in developing country settings where public resources for regulatory enforcement are limited, and consumers may be less willing or able to pay for increased safety.[178] Among these pathways is the promotion of co-regulation, in contrast to enforcement of regulation. Experience in developed countries has shown that top-down enforcement of regulations through inspection and punishment generally does not work as well as enabling actors to self-regulate, accompanied by appropriate incentives.[179] That requires close interaction and coordination among private sector actors and with public regulators,[180] including those involved in ASF trade.

Co-regulation can apply to large informal markets which many policymakers still grapple with, as well as large private market actors. An example of this was the interactive process which led to a training and certification approach of informal milk traders in Kenya which improved milk safety and officially regularized traders who were otherwise being harassed and punished.[181] Not incidentally, this change in approach and policy also led to some $26M USD in annual gains to the economy by allowing these small-scale actors to operate more freely and efficiently, thus reducing transaction costs.[182]

Another approach is through more reliance on evidence-based risk analysis to reveal risk threat points and types in the value chain.[183] This is generally accepted now as the most effective approach, rather than

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[175] Jabbar, M. et al. "Demand for Livestock Products in Developing Countries with a Focus on Quality and Safety Attributes: Evidence from Asia and Africa," ILRI Research Report 24, ILRI: Nairobi, (2010), https://hdl.handle.net/10568/3010.
[176] ILRI. "Learning the Lessons of Rift Valley Fever: Improved Detection and Mitigation of Outbreaks. Participatory Assessment of Rift Valley Fever Surveillance and Rapid Response Activities," (2008).
[177] Gizachew, D. et al. "Aflatoxin Contamination of Milk. and Dairy Feeds in the Greater Addis Ababa Milk Shed, Ethiopia," (2016).
[178] Grace, D. "Food Safety in Developing Countries: Research Gaps and Opportunities," (2017).
[179] Garcia-Martinez, M. et al. "Co-Regulation as a Possible Model for Food Safety Governance: Opportunities for Public–Private Partnerships," *Food Policy* 32, no. 3 (June 2007): 299-314, https://doi.org/10.1016/j.foodpol.2006.07.005.
[180] Eijlander, P. "Possibilities and Constraints in the Use of Self-Regulation and Co-Regulation in Legislative Policy: Experience in the Netherlands – Lessons to Be Learned for the EU?" *European Journal of Comparative Law* 9, no. 1 (January 2005), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=959148.
[181] Leksmono, C. "Informal Traders Lock Horns with the Formal Milk Industry: The Role of Research in Pro-Poor Dairy Policy Shift in Kenya," Working Paper 266, ODI and ILRI, (May 2006), https://cgspace.cgiar.org/bitstream/handle/10568/1692/InformalTradersLockHorns.pdf?sequence.
[182] Pre-published version of Kaitibi, S. et al. "Kenya Dairy Policy Change and Economic Importance," *World Development* 38, no. 10 (2010): 1494-1505, available at: https://cgspace.cgiar.org/bitstream/handle/10568/881/KenyaDairy.pdf.
[183] Risk assessment begins with assessing the level of hazard – extent of presence of pathogen or contaminant – followed by level of risk – to what extent the risk factor translates to actual harm to animal or person. See: http://www.fao.org/3/x7354e/x7354e12.htm.

relying on expert knowledge. The capacity for this sort of analysis, however, is rare and limited in developing countries and not often implemented.

Enabling environment factors for this type of approach to be effective would be shared risk assessment capacity in the public sector (including research institutes) and private actors, as part of co-regulation, including the use of participatory risk assessment, now recognized as better able to capture multiple sources of information regarding risks.[184] The existence of a single authority to oversee food safety would improve effectiveness, but in practice this is difficult to achieve. Even in developed countries, this authority is generally split between the agricultural and health authorities. Some degree of effective coordination among those authorities would increase the effectiveness of food safety efforts.

Table 23. Public Sector-Led Food Safety Control Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Public Sector-Led Food Safety Control	Organizational structures and policies to coordinate agricultural and health officials around food safety	Official government documentation
	Capacity (skills and facilities) among public and private actors to conduct evidence-based food risk assessment	Key informant interviews: food safety officials, private market actors
	Number and types of ASF safety tests conducted at points along the target supply chains (e.g., processing plants, retail locations, etc.)	Official government documentation
	Perceptions regarding policymaker willingness to co-evolve and implement co-regulation with private actors, and willingness to rely increasingly on food risk assessment	Key informant interviews: relevant officials, and private sector food companies

3.3.2 Private Sector-Led Food Safety Control

Private actors handling ASFs have clear market incentives for reducing food safety risks associated with the products they produce and/or distribute, as health scares related to their products could have a deleterious effect on their revenue stream. In general, however, increased consumer demand for safe food based on their willingness and ability to pay is largely the driving force.

Increased product safety can differentiate ASF products from those on the informal market. This also applies to international buyers who may impose strict safety standards among their various quality and attribute standards. These private food safety standards have emerged increasingly in both domestic and international markets and are all linked to heightened consumer interest in food safety and willingness to pay for increased assurance.[185] Sometimes referred to as voluntary standards, when one considers the fact that they are market-driven and that noncompliance may imply business failure, they are effectively mandatory within particular market channels.

Private standards often exceed public standards in several ways, including stricter specifications for product attributes, and more attention to practices and processes among a number of actors along the supply chain (e.g., Good Animal Husbandry Practices) rather than just end results in terms of food safety attributes. A key focus is on the processes by which animals are raised and the food is produced/processed,

[184] Grace, D., et al. "Participatory Risk Assessment: A New Approach for Safer Food in Vulnerable African Communities," *Development in Practice* 18, no. 4-5 (2008): 611-618, https://doi.org/10.1080/09614520802181731.
[185] Henson, S. and Humphrey, J. "The Impacts of Private Food Safety Standards on the Food Chain and on Public Standard-Setting Processes," Paper Prepared for FAO/WHO (May 2009), https://www.fsis.usda.gov/shared/PDF/Codex_al32_09Dbe.pdf.

which of course affects food safety, and the means for monitoring those processes by the private or public actors (or independent third-party actors, such as certifying agencies).[186]

These have been described as meta-management systems, which jointly address quality and safety at multiple points along the supply chains by enforcing and certifying the implementation of process standards along with incentives for compliance.[187] An example of a process standard which was not stipulated in public regulation can be found in Brazil, where the private dairy industry required dairy farms to install milk cooling tanks on farm so milk can be immediately chilled and the quality preserved. Farms that did not comply were dropped from the milk purchase and collection system. The requirement thus addressed the process directly, not the resulting change in milk quality, although that was the desired outcome. Incidentally, this drove many thousands of smallholder dairy farms either out of business or into the informal market.[188]

For such systems to work effectively, private sector industry associations or networks should develop standards in close partnership with suppliers, buyers/retailers, and of course with the public sector regulators as part of the co-development and enforcement of regulation.

Table 24. Private Sector-Led Food Safety Control Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Private Sector-Led Food Safety Control	Level of capacity (skills and facilities) and numbers among private actors (first or third-party auditors) to conduct evidence-based food safety risk assessment	Key informant interviews: food companies, and auditors
	Documented food safety standards, and process protocols at private ASF companies	Company records
	Number and types risk assessments conducted by private food companies	Company records
	Perception of level of commitment among private industry to cooperate among industry peers (horizontal cooperation), with other actors in the supply chain (vertical cooperation), with public sector regulators (public/private coordination) to jointly develop multiple aspects for a rigorous food safety system	Key informant interviews: ASF processors, suppliers, buyers, retailers, relevant government officials

4. FINANCIAL SERVICES FACTORS

Uptake of improved practices at the producer level to meet end-market specifications is often a function of access to financial services to increase liquidity and reduce investment risks associated with animal mortality. As such, both access to production credit and access to livestock insurance are important financial services that are often factors that enable more robust uptake of improved technologies and practices — and ultimately increased ASF market system success.

[186] Henson, S. and Humphrey, J. "The Impacts of Private Food Safety Standards on the Food Chain and on Public Standard-Setting Processes," (2009).
[187] Reardon, T. and Farina, E. "The Rise of Private Food Quality and Safety Standards: Illustrations from Brazil," *The International Food and Agribusiness Management Review* 4, no. 4 (2001): 413-421, https://doi.org/10.1016/S1096-7508(02)00067-8.
[188] Reardon, T. and Farina, E. "The Rise of Private Food Quality and Safety Standards: Illustrations from Brazil," (2001).

4.1 ACCESS TO CREDIT

Access to formal credit for any type of agricultural activity in many countries is typically very low. One study reported that only 1 percent of commercial lending in Africa went to agriculture.[189] Constraints include high transaction costs for commercial lenders, including for obtaining accurate information, and costs associated with low population densities in rural areas. On the demand side, farmers cannot easily meet loan requirements such as collateral, or provide the required formal documentation,[190] or the loan limits may be too low to enable the purchase of replacement animals. Women farmers in particular may face higher barriers to access to credit.

Livestock can be the most valuable fungible asset in a rural household. Even in resource poor settings, large stock, such local cattle, can be worth hundreds of U.S. Dollars, and higher-grade breeds can sell for much more. Access to the financial resources needed to acquire initial stock can limit new entry to livestock production, and access to working capital can also be a constraint to the enterprise — for example, for feed in fattening operations where no revenue is generated until animals are sold.

Access to credit for working capital can increase productivity. A study in the Philippines demonstrated that access to credit had a positive impact on farmer productivity through greater use of improved technologies, such as improved feeds.[191] A study in Ethiopia and Kenya found that farms that were credit-constrained increased output more when given access to credit, indicating that the credit constraint did limit productivity.[192]

4.1.1 Formal Credit

This section first considers the types of formal credit which are available to agriculture in general and the factors required for formal credit's success and effectiveness in serving the needs of value chain actors and smallholder producers. A key point emerging from this review is that the increasing use of online and mobile platforms is rapidly transforming formal credit systems for agriculture.

The legal framework needed for formal credit includes a real property law, addressing registration and transactions in real property — generally fixed assets such as land and buildings — as well as a secured transaction law,[193] which allows lenders to secure other assets. Together, these provide the framework for registered agribusinesses or individuals to access formal credit and for lenders to seek recourse in the case of a default.

A properly designed secured transaction law allows a range of collateral types to be used from real property to movable assets including livestock or accounts receivable, such as future milk deliveries. An official asset registry is required to facilitate the functioning of credit based on movable assets used as collateral. Requirements include a notarized description of the asset and its value, which is then used to register the security interest of the lender in that asset with the asset registry. Once the borrower meets all the loan requirements, the lender will submit a property waiver, and the assets will be removed from

[189] Doran, A. et al. "The Missing Middle in Agricultural Finance: Relieving the Capital Constraint on Smallholder Groups and Other Agricultural SMEs," Oxfam Research Report (December 17, 2009), https://oxfamilibrary.openrepository.com/bitstream/handle/10546/112348/rr-missing-middle-agricultural-finance-171209-en.pdf.
[190] Rich, K.M. "Perspectives on Improving Financial Access for Livestock Value Chain Development: Addressing the Missing Middle," in Mtimet, N. and Dube, S., (eds.) (2018). International Conference on Livestock Value Chain Finance and Access to Credit: Proceedings book from the livestock finance conference, Ezulwini, Swaziland, 21–23 February 2017. Nairobi, Kenya: ILRI: 5-11, https://hdl.handle.net/10568/93417.
[191] Lapar, M.L.A. and Ehui, S.K. "Factors Affecting Adoption of Dual-Purpose Forages in the Philippine Uplands," *Agricultural Systems* 81, no. 2 (August 2004): 95-114, https://doi.org/10.1016/j.agsy.2003.09.003.
[192] Freeman, H.A. et al. "Credit Constraints and Smallholder Dairy Production in the East African Highlands: Application of a Switching Regression Model," *Agricultural Economics* 19, no. 1-2 (September 1998): 33-44, https://doi.org/10.1016/S0169-5150(98)00044-9.
[193] Enabling Agricultural Trade, "AgCLIR Lessons from the Field: Getting Credit," *USAID*, https://www.agrilinks.org/sites/default/files/resource/files/USAID-EAT%20AgBEE%20Lesson%20Getting%20Credit.pdf.

the official registry.[194] In case of default, the property will typically be auctioned for sale through a receiver appointed by the Registrar.[195]

The establishment of online Asset Registry, as well as an online Business Registry, can significantly reduce the transaction costs associated with extending and securing these forms of credit. A study by the World Bank across 73 countries found that the introduction of movable asset registries (which are particularly relevant for livestock) brought about a significant increase among firms of access to bank finance, including loans, credit lines, and overdrafts as well as a reduction in the rates of interest they paid.[196]

In the case of smallholder producers who hold minimal assets or are unable to easily participate in asset registries, an alternative arrangement is where credit certifying organizations verify the credit worthiness of individual farmers through smartphone collection of regular records of expenses and returns, and are then assessed using algorithms linked to additional data sources. They then link to financial organizations to provide loans directly to those farmers based on the credit certification. This alternative credit risk assessment model has the advantage of avoiding the need for collateral, since the loan is based on income and expense records.[197]

Nonbank lending schemes, such as microfinance, have largely been aimed at consumption rather than agricultural production, with the exception of loans to poor rural households by the Grameen Bank in Bangladesh, which have been used to acquire and raise livestock, including poultry by women.[198] Microfinance loan limits may be too low to buy large animal replacements. To work well, microfinance institutions and credit unions need regulations which establish minimum credit requirements, consumer interest protections, and deposit insurance requirements.[199] Specific laws and regulations for microfinance may facilitate credit to agriculture, although due to the risks, such firms typically diversify into multiple sectors and few specialize in agriculture.[200]

In order to favor agriculture, the legal framework needs to be robust and enforceable to enable lenders to recover assets in the case of default, without which lenders would limit lending to only the lowest risk, highest return, and easily collateralized borrowers. Since agriculture is generally seen as high-risk the lack of that sort of framework is likely to exclude agribusiness.[201]

The loan product characteristics for the livestock sector varies greatly within and across animal and product type. For example, formal loans for dairy farms in Kenya were seen to range from $500 to $20,000 USD with flexible duration up to 60 months, including additional collateral requirements. For large, established livestock enterprises including market actors, larger loans are seen available with a range of

[194] The World Bank. "Secured Transactions, Collateral Registries and Movable Asset-Based Financing," 2019, https://documents.worldbank.org/curated/pt/193261570112901451/pdf/Secured-Transactions-Collateral-Registries-and-Movable-Asset-Based-Financing.pdf.
[195] For an example of WB-sponsored asset registry in Malawi see: https://www.worldbank.org/en/news/feature/2016/02/04/new-online-collateral-registry-system-facilitates-increased-access-to-business-loans-in-malawi
[196] Peria, M.S.M. "Does the Introduction of Movable Collateral Registries Increase Firms' Access to Finance?" *World Bank Blogs*, July 1, 2013, https://blogs.worldbank.org/allaboutfinance/does-introduction-movable-collateral-registries-increase-firms-access-finance.
[197] For an example of alternative credit risk assessment model, see: https://farmdrive.co.ke/.
[198] Jabbar, M.A. et al. "Supply and Demand for Livestock Credit in Sub-Saharan Africa: Lessons for Designing New Credit Schemes," *World Development* 30, no. 6 (June 2002):1029-1042, https://doi.org/10.1016/S0305-750X(02)00021-9.
[199] The World Bank. "Enabling the Business of Agriculture 2016: Comparing Regulatory Good Practices," *The World Bank* (2016), http://documents.worldbank.org/curated/en/315521467995413371/pdf/104281-PUB-Box394875B-PUBLIC-pubdate-3-18-16.pdf.
[200] Miller, C. "Models of Inclusive Value Chain Financing and Investment for Livestock," in Mtimet, N. and Dube, S., (eds.) (2018). International Conference on Livestock Value Chain Finance and Access to Credit: Proceedings book from the livestock finance conference, Ezulwini, Swaziland, 21–23 February 2017. Nairobi, Kenya: ILRI, https://hdl.handle.net/10568/93417.
[201] Miller, C. "Models of Inclusive Value Chain Financing and Investment for Livestock," (2018).

documented requirements and proven commercial records.[202] Studies in Indonesia[203] and Nigeria[204] show that livestock producers are more likely to have access to formal credit if they have large land size or herd size, highlight the continued importance of collateral and the continuing need for alternatives.

Another formal channel for credit in the livestock sector includes public sector lending programs, however, there is little evidence of their success, impact, and sustainability. For instance, a study of government backed lending program for livestock producers in Ethiopia, Kenya, Uganda and Nigeria documented a number of problems in implementation and in reaching intended targets.[205] These included very high transaction costs including elaborate screening and community guarantee processes, limited access by smallholder farmers, and poor loan recovery rates, among others. In some cases, loans went to state farms or other parastatals, or through farmer groups, creating additional operational complexity. The study found that public credit institutions were unable to meet the demand for livestock credit and could not manage that credit sustainably. In addition, available credit often did not reach those who need it the most and with whom it could have the greatest impact, due to inappropriate screening criteria or sometimes simply distance and lack of information.[206] For some resource-poor recipients, some offers of credit require group collateral, creating reluctance within the community.[207] The evidence suggests that publicly run livestock credit schemes are costly and may not achieve their intended results among target populations.

Table 25. Formal Credit Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Formal Credit	Existence and enforcement of laws regarding real property, and secured transactions	Official government documentation
	Presence of official moveable asset registries	Official government documentation
	Documented regulations for microfinance institutions and credit unions	Official government documentation
	Formal lender loan portfolio percent to livestock related borrowers	Key informant interviews: commercial lenders, microfinance institutions, and credit unions
	Perceptions of lenders regarding lending to the ASF sector	Key informant interviews: commercial lenders, microfinance institutions, and credit unions
	Perceptions of livestock businesses regarding ease of borrowing	Key informant interviews: producers including women, processors, domestic traders, exporters/importers

4.1.2 Informal Credit

[202] For an example of dairy/livestock loans, see: https://ke.kcbgroup.com/for-your-biashara/get-a-loan/for-agri-business/dairy-loan.
[203] Mahendri, G.P. et al. "Factors Influencing Farmers Uptake of Credit for Cattle Fattening in Two Districts in East Java Indonesia," in Proceedings of the International Conference on Livestock Value Chain and Access to Credit, Ezulwini, Swaziland: 46-52.
[204] Ammani, A. "An Investigation into the Relationship between Agricultural Production and Formal Credit Supply in Nigeria," International Journal of Agriculture and Forestry 2, no. 1 (2012): 46-52, https://doi.org/10.5923/j.ijaf.20120201.08.
[205] Jabbar, M.A. et al. "Supply and Demand for Livestock Credit in Sub-Saharan Africa: Lessons for Designing New Credit Schemes," (2002).
[206] Jabbar, M.A. et al. "Supply and Demand for Livestock Credit in Sub-Saharan Africa: Lessons for Designing New Credit Schemes," (2002).
[207] Kitaw, G. et al. "Liquid Milk and Feed Value Chain Analysis in Wolmera District, Ethiopia," (2012).

Where formal access to livestock production credit is limited, there are several informal credit schemes that have demonstrated success in the livestock sector. For instance, traditional loan practices such as livestock credit in-kind, in the form of a live animal loan, may be carried out between producers. Under traditional live animal loans, a producer loans a female animal to a young farmer, who returns an animal after the herd is established. This arrangement is common in many settings, including Sri Lanka, and is not limited to pastoral setting. This sort of "heifer-in-trust" practice works with farmer groups and provides an initial distribution of some animals, the offspring from which are further distributed to group members.

The significant positive impact of such livestock asset transfer programs has recently been well documented in studies covering several different livestock species, which underlines the potential importance of informal arrangements to establish livestock enterprises, particularly among the most resource poor households where access to formal lending is limited.[208]

Another example of an informal credit arrangement where formal lending is limited includes traditional credit societies such as saving circles to try to overcome liquidity constraints. Partly as a result, smallholder dairy producers in Kenya have been found to be able to largely self-finance their initial purchases of cattle,[209] which is also likely a reflection of limited access to formal credit sources.

Facilitated financing such as through NGOs working with farmer groups may be impactful during the project lifespan, but come with the associated risk of not being sustainable when the project ends.

Despite small-scale successes of informal lending programs, the investment needed to establish and operate modern ASF production, processing, and marketing facilities is more likely to require formal credit through commercial channels as described above.

Table 26. Informal Credit Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Informal Credit	Documented presence of any formal rules or guidelines for animal loan programs (e.g., heifer-in-trust type)	Official government documentation
	Existence and importance of traditional animal loan practices	Key informant interviews: community leaders, livestock producers/pastoralists
	Perceptions among smallholders regarding informal loan arrangements available	Key informant interviews: livestock producers/pastoralists including women

4.1.3 Value Chain Financing

Value chain financing is an implicit shift from credit based on collateral to credit based on transactions of product and cash flows and from client activity financing to chain-focused financing.[210] Thus, value chain actors, suppliers, or buyers themselves arrange credit to producers against a pledge of intangible property in what can be described as buyer-driven financing.[211] Evidence suggests that value chain financing can improve performance and, in many cases, reduce the transaction costs associated with each party having to formally acquire credit.

For formal lenders it is also less costly to finance agribusinesses in a value chain than to independently assess and lend to each actor in a value chain individually. Banks can finance the most creditworthy actor in a value chain, such as the input suppliers or agri-business integrators, and let them provide financing to

[208] Banerjee, A. et al. "A Multifaceted Program Causes Lasting Progress for the Very Poor: Evidence from Six Countries," *Science* 348, no. 6236 (May 2015), https://doi.org/10.1126/science.1260799.
[209] Baltenweck, I. "Conditions d'Accès à l'Elevage Laitier: Le Cas de Petits Expoitants au Kenya," (2000) http://www.theses.fr/2000CLF10217.
[210] Miller, C. "Models of Inclusive Value Chain Financing and Investment for Livestock," (2018).
[211] Rich, K.M. "Perspectives on Improving Financial Access for Livestock Value Chain Development: Addressing the Missing Middle," (2017).

others from whom they buy and to whom sell.[212] In this way, value chain financing uses agribusinesses as aggregation points for smallholder farmers in partnership with financial enterprises.[213]

Therefore, while commercial lenders provide specialized financial services to agribusinesses, it is necessary to recognize the important facilitative role (at least initially) that donors, social impact investors, and governments can play to enable these sorts of value chain models to function well. For example, these stakeholders can provide design and start-up capital and public good data platforms as well as risk guarantees. In these cases, the public/donor investors can be described as a facilitator providing support to private actors to achieve social goals.[214]

An innovative scheme to fund small cattle fattening enterprises in Swaziland combined a government agricultural bank to provide loan guarantee of 90 percent, a bank to finance and administer the loans, a certified business development services provider to train the producers, and links to buyers and input providers.[215]

In the livestock sector, contract farming is perhaps the most common example of agribusiness-driven value chain financing whereby a commercial buyer of live animals will provide in-kind credit to selected producers in the form of young animals (chicks, piglets, etc.), feeds, and veterinary supplies. For the buyer, the return on this investment takes the form of assured product supply and quality. The risks are shared between them. The agribusiness may also receive credit from suppliers of feeds, etc. in the form of advance deliveries. This type of credit does not usually require collateralized assets or even a formal written contract. The security of the arrangement lies in the mutual dependencies between the actors.

Formal laws and regulations of buyer-supplier contracts will help regularize these arrangements but may lie within the normal business domain of enforceable purchase orders, etc. Similarly, many cooperatives provide inputs to members on credit, such as the feed provided by dairy hubs in Kenya, the cost of which is deducted from monthly milk payments. This is yet another form of advance harvest credit whereby the lender, the cooperative, is assured of repayment due to the established relationship with its supplying members. The cooperative, in turn, may establish contracts with feed or animal health suppliers to serve its members. Financing among value chain partners may reduce the need for formal credit. A study in Swaziland suggests that market actors that had informal contracts with buyers/sellers were less likely to access credit, meaning the contracts basically fulfilled some of that need. [216]

Table 27. Value Chain Financing Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Value Chain Financing	Underlying contract laws and/or specific regulations for buyer-seller contracts involving advancing credit-in-kind	Official government documentation
	Perceptions by stakeholders of the effective functioning of value chain financing mechanisms, risks of default, loss	Key informant interviews: producers, processors, financial institutions

[212] Miller, C. "Models of Inclusive Value Chain Financing and Investment for Livestock," (2018).
[213] ISF Advisors, "Value Chain Financing: How Agro-Enterprises Can Serve as Alternate Aggregation Points for Delivering Financial Services to Smallholder Farmers," *Mastercard Foundation Rural & Agricultural Finance Learning Lab*, October 7, 2015. https://www.raflearning.org/post/value-chain-financing-how-agro-enterprises-can-serve-alternate-aggregation-points-for.
[214] A web search reveals several types of these impact investors. For example, see: https://juhudikilimo.com/about/.
[215] Naicker, E. "An Innovative Approach to Cattle Fattening in Swaziland: A Financial Perspective" in Mtimet, N. and Dube, S., (eds.) (2018). International Conference on Livestock Value Chain Finance and Access to Credit: Proceedings book from the livestock finance conference, Ezulwini, Swaziland, 21–23 February 2017. Nairobi, Kenya: ILRI: 115-126, https://hdl.handle.net/10568/93417.
[216] Mamba, T.X., et al. "The Role of Contracts in Improving Access to Credit in the Smallholder Livestock Sector of Swaziland," Mtimet, N. and Dube, S., (eds.) (2018). International Conference on Livestock Value Chain Finance and Access to Credit: Proceedings book from the livestock finance conference, Ezulwini, Swaziland, 21–23 February 2017. Nairobi, Kenya: ILRI: 37-45, https://hdl.handle.net/10568/93417.

4.2 LIVESTOCK INSURANCE

Crop insurance is much more common than livestock insurance in developing countries, accounting for some 90 percent of agricultural insurance premiums.[217] Given the high relative value of livestock assets, livestock insurance would reduce risks associated with loss of animals due to disease, accidents, and other uncontrollable events. However, there are many factors for success of livestock insurance programs/products, and the evidence of success in livestock insurance programs is mixed.

In many cases, cattle insurance programs have failed due to high risk of fraud and complexity of implementation, some of it to mitigate against fraud.[218] In India, a large-scale scheme covering thousands of dairy cattle experienced a number of limitations, including a requirement for animal postmortem report with the cost to the producer, poor access to regular veterinary services to maintain animal health, slow release of claims, and refusal of insurance companies to provide coverage for cattle which were not purchased as part of a government distribution scheme. [219] Government backing was needed for the insurance scheme to be sustained,[220] demonstrating its limited commercial sustainability where enabling environment factors were not met.

The cost of insurance premiums is also a limiting factor. A study in Ethiopia found that a third of livestock keepers were unwilling to pay the 4 percent of animal value premium for insurance.[221] A review of agricultural insurance generally found that government run insurance schemes in the 1970s and 1980s were largely a failure, and the prevalent model currently is some kind of public-private partnership. Public support most often takes the form of premium subsidies, or by providing reinsurance or subsidizing claim payments. The rationale for public support is of course social insurance to protect vulnerable rural communities.

Some forms of privately provided market-based livestock insurance have now emerged, in part due to new technology which helps to mitigate risks of fraud, and in some cases these are available to smallholder producers.[222] Smartphone technology is increasing rural access to agricultural insurance generally, and in the case of livestock has assisted significantly with dedicated apps for animal identification and paper-free claims processing. In India, one scheme uses microchips inserted into livestock to ensure accurate identification. [223] This has reduced both risks and transactions costs but does require direct involvement of a local veterinarian. The USAID-funded Mobile Solutions Technical Assistance and Research (mSTAR) project has documented opportunities for digital access to agricultural insurance, including for livestock.[224] Although these market-driven products are now available in some livestock producing countries, their level of uptake is unclear.

Index-based insurance products are now widely popular, because they reduce information asymmetry and the transaction costs of implementation, and they can insure against events whose probabilities can be accurately estimated and linked to an objective index. Originally applied to insure crops from weather

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[217] Dick, W.A and Wang, A. "Government Interventions in Agricultural Insurance," *Agriculture and Agricultural Science Procedia* 1 (2010): 4-12, https://doi.org/10.1016/j.aaspro.2010.09.002.

[218] Raju, SS and Chand, R. "Progress and Problems in Agricultural Insurance," *Economic and Political Weekly* 42, no. 21 (May 26-June 1, 2007): 1905-1908, https://www.jstor.org/stable/4419629.

[219] Shenoy, G. V. and Raju, K. V., "Management and Effectiveness of Cattle Insurance under IRDP," Journal for Decision-Makers (1990), https://doi.org/10.1177/0256090919900204.

[220] Shenoy, G.V. and Raju, K.V. "Management and Effectiveness of Cattle Insurance Under IRDP" (1990).

[221] Bishu, K. G. "Risk Management and the Potential of Cattle Insurance in Tigray, Northern Ethiopia," PhD Thesis, University College Cork, 2014, https://cora.ucc.ie/handle/10468/1550.

[222] A web search found these examples of private livestock insurance from India and Kenya: https://www.hdfcergo.com/commercial-insurance/cattle-insurance-policy#claim and https://www.hfgroup.co.ke/insurance/product/livestock-insurance/business-insurance-2018-08-25-05-57-23.

[223] "Insuring Livestock to Protect the Poor," *ILO*, October 12, 2012. https://www.ilo.org/global/about-the-ilo/newsroom/features/WCMS_191209/lang--en/index.htm.

[224] mSTAR Project, "Using Digital Tools to Expand Access to Agricultural Insurance," *USAID,* (January 2018), http://www.usaid.gov/sites/default/files/documents/15396/Guide_to_Using_Digital_Tools_to_Expand_Agricultural_Insurance.pdf.

shocks, the product was initially implemented with livestock in Mongolia. Under the program, the level and type of insurance differed by the magnitude. The herders absorbed the cost in the case of small loses (thus self-insurance by herders); larger loses were covered by the private insurer (market-based insurance), and extreme losses were covered by a public safety net program (social insurance).[225]

A variation on the Mongolia index-based insurance model was applied to livestock keepers in Kenya and Ethiopia and was offered through private financial companies (Index-Based Livestock Insurance [IBLI]). The insurance protects livestock keepers from drought-related livestock losses in dryland systems. When satellite data measurements of pastureland show that range conditions predict livestock mortality in excess of a critical threshold, then the insurance issues a payout to contract-holding pastoralists, which may or may not fully cover their losses. No proof of loss by livestock keepers is required, and administering the insurance does not require a separate organizational structure, thereby reducing costs.

An analysis of uptake of the IBLI product in Ethiopia found that a major constraint was lack of understanding by livestock keepers of the concept of insurance, some of whom expected annual payouts regardless of the weather.[226] In Kenya, an IBLI program continues now under government support.[227] The social insurance component of it is now more emphasized, and some donors have now recognized that the IBLI program offers a means to provide a social safety net in drought prone areas without a separate distribution system.

The review of lessons learned from agricultural insurance schemes found that in addition to premium subsidies, public or social investor support can address reinsurance and technical and administrative assistance, helping develop appropriate distribution channels and linkages to government services, such as animal health.[228] As such, livestock insurance should not be viewed in isolation but as part of a support package to producers, with the public sector supporting linkages and coordination.

Table 28. Livestock Insurance Indicators and Measurement Methodology

	Indicator	Information Gathering Method
Livestock Insurance	Documented presence of livestock insurance programs available to smallholder or pastoral livestock keepers	Official documentation from insurance provider
	Scope, scale, and terms of existing insurance programs	Official documentation from insurance provider
	Availability of satellite data measurements of pastureland	Official GIS data
	Presence and level of third party (government, donor, other) subsidization of insurance premiums; presence of ombudsman office	Key informant interviews: insurance provider, development actor/NGO, public sector, etc.

5. CONCLUSIONS

This guidance document has set out to explore in some depth the range of factors across the enabling environment which are likely to influence ASF market system success, in line with objectives of ASF-related investment, interventions, and policy. As has been documented, these range from a set of critically

[225] Mahul, O., and Skees, J. "Managing Agricultural Risk at the Country Level: The Case of Index-Based Livestock Insurance in Mongolia," Policy Research Working Paper 4325, (November 2007), https://doi.org/10.1596/1813-9450-4325.
[226] Takahashi, K. et al. "Experimental Evidence on the Drivers of Index-Based Livestock Insurance Demand in Southern Ethiopia," *World Development* 78 (February 2016): 324-340, https://doi.org/10.1016/j.worlddev.2015.10.039.
[227] Kasyoka, Sarah. "The Kenya Government Declares a Pay Out of Ksh87 Million to Cushion 6,000 Pastoralists from the Effects of Drought," Index-Based Livestock Insurance, March 19, 2019. https://ibli.ilri.org/2019/03/19/the-kenya-government-declares-a-pay-out-of-ksh87-million-to-cushion-6000-pastoralists-from-the-effects-of-drought/.
[228] Dick, W.A and Wang, A. "Government Interventions in Agricultural Insurance," (2010).

important technology and service factors related to feeds, health, and genetics to other market and business environment factors which are likely to drive the enterprise model built around farm-level supply and productivity opportunities.

An extensive review of relevant literature has provided examples and cases from across developing countries that demonstrate the relevance and potential impacts of specific factors, as well as provided examples of how to mitigate risks of weak enabling factors within the context in which those occur. This guidance document also highlights where gender and youth engagement as well as human nutrition may be particularly relevant to certain factors.

The identified enabling or constraining factors are accompanied by suggested indicators to measure their presence or potential effect along with likely sources of information to populate those indicators. Some sources are largely objective, such as public policy and regulatory documents and industry records, while others are subjective, such as those based on key informant and stakeholder consultations. Both are important first to gauge whether the enabling environment is formally legislated or reflected in records and trends, and secondly to understand from the perspective of users and direct actors within the ASF market system the degree and effectiveness of implementation. This guidance document also points out how political economy factors can potentially override formal attempts to provide an enabling environment, leading to the coopting of benefits among influential actors, but does not go into depth on assessing the underlying norms and values that underpin the political economy.

This guidance document does not attempt to prioritize or rank the factors, nor does it provide a quantitative scoring system, as efforts to do so may be practically arbitrary. Instead this guidance document recognizes that factors will differ significantly depending on the type of target livestock system as well as the objectives of the investment. Efforts to develop small and medium-sized livestock enterprises along the ASF supply chain, for instance, may prioritize the business environment, while those aimed at improving pastoral livelihoods may focus on factors relevant to basic rural services and market opportunities.

In order to implement the assessment of the factors, this guidance document has suggested a sequential process beginning with a prioritization process among key experts and the lead investors, followed by a more granular exercise leveraging knowledgeable local experts and organizations to locate and assemble the information to populate and assess the target indicators according to the investment objectives.

The guidance provided here can be of use to a range of types of investors, from national policymakers considering structural changes to ASF systems to meet national objectives, to efforts by international donors and social impact investors aimed at facilitating specific socio-economic impact, and/or to private investors with the need to ensure economic returns and growth opportunities within often underdeveloped ASF market systems.

The **Feed the Future Enabling Environment for Food Security** project is a global support mechanism for Feed the Future-focused and aligned Missions and Washington-based USAID offices to address policies as well as legal, institutional, and regulatory factors that function as market constraints affecting food security. Launched in September 2015, the project enables the rapid procurement of technical analysis, advisory services, and strategic knowledge management. For more information, contact Lourdes Martinez Romero (COR) at lmartinezromero@usaid.gov or Adam Keatts (Chief of Party) at akeatts@fintrac.com.

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