Sustainable growth of the Kenyan dairy sector

A quick scan of robustness, reliability and resilience

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Report 3R Kenya 979

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Abstract
This report provides an overview of how the Kenyan dairy sector performs in three analytical domains: the robustness of the supply chains, the reliability of institutional governance and the resilience of the innovation system. Analysis is by literature review, stakeholder interviews and a validation workshop guided by a SWOT framework to identify strengths, weaknesses, opportunities and threats. The findings inform the existing opportunities and challenges that potentially impede growth in the sector. The report is a first step towards documenting and sharing insights that support the move towards a more Robust, Reliable and Resilient (3R) dairy sector. The findings and recommendations presented will guide policy engagement and action in the transition of Dutch government bilateral engagement in Kenya from development aid–support to a trade approach in the agricultural sector, with a focus on partnering opportunities to drive competitive market-oriented dairy sector development that attracts investments.

Work in progress
This working paper aims to identify how the dairy sector in Kenya performs in terms of the robustness of supply chain, reliability of institutional governance and resilience of innovation systems, by analysing the opportunities and constraints with respect to the 3Rs. The working paper entails the first output of the 3R project and provides a first stepping stone in project implementation. Therefore this is work in progress and the authors welcome any feedback from stakeholders on this working paper.

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Finally, we acknowledge Dr Fedes van Rijn for the development of the methodology guidelines that were used in compiling this working paper; Dr Philliph Musyoka for providing technical support to the team in applying the methodology; and ir Joep van Mierlo for overall guidance. We also thank them for reviewing and providing critical comments on earlier versions of this document.

It is our hope that this working paper will contribute to the further development of a robust, resilient and reliable Kenyan dairy sector and drive sustainable and inclusive trade, providing opportunities for different investors– to the benefit of all.

The authors

Summary

This summary highlights findings of a scan of the Kenyan dairy sector conducted in the inception phase of the 3R project that aimed to understand: "**How does the Kenyan dairy sector perform in terms of the robustness of the supply chains, the reliability of institutional governance and the resilience of the innovation system?".** A SWOT analysis combining a literature review, stakeholder interviews, and a validation workshop, identified existing opportunities as well as challenges that could potentially impede sustainable growth in the sector. This analysis is considered to be useful for actors in the Kenyan dairy sector as well as international private and public actors interested in investments in the industry.

Overview of the dairy sector in Kenya

Kenya has a vibrant dairy industry with an estimated value of 4% of gross domestic product (GDP). This vibrancy is anchored on the increasing domestic milk production (averaging 5.3% per year), processing capacity (averaging 7% per year), annual per capita milk consumption (averaging 5.8% per year, currently at 110 litres) and export potential (MoALF 2010ab; KDB 2015). The country is experiencing a growing demand for milk and dairy products driven by expanding urbanization and a rising middle class. This attracts both domestic and international investors who seek to seize opportunities in the domestic and export market (Business Daily 2016a).

The expanding sector is characterized by an increasingly sophisticated supply chain. Chain actors include producers consisting of small-, medium- and large dairy farmers, with the majority consisting of about 1.8 million households who own one to three cows (KDB 2015, ILRI 2008). They are served by diverse public and private agro-input suppliers and service providers. Aggregators include milk bulking and chilling facility operators. Four out of 27 active processors control 85% of the milk intake, with 616 million litres processed in 2015 (KDB n.d., ACET 2015). The scale of retail operations varies from small shops to large supermarkets.

The dairy value chain is broadly divided into informal and formal market channels, based on compliance with regulatory frameworks for quality and safety standards and payment of statutory revenues. The bulk of marketed milk is raw fresh milk (ca. 70%), which is sold to consumers through informal market channels (KDB 2015). Growth of the formal channel is possible via the chilled, processed chain by targeting capacity building and enabling policies. The *Kenya National Dairy Master Plan* defines strategic actions to enable a shift from informal to formal chain channels (MoALF 2010a).

Issues in the dairy sector assessed through the 3R framework

Robustness of the dairy value chain

Robust supply chain integration refers to efficient and trusted interactions between supply chain partners. Efficient interactions reduce transaction costs and the risks involved in enhancing product quality and safety and reinforcing sustainability and adaptability. A robust supply chain is essential to the success of the dairy industry in Kenya. The dairy value chain is complex, with a diversity of actors and a proliferation of inputs, services and dairy products. The robustness of the dairy sector is approached from the perspective of sustainability, with a particular focus on economic, social and environmental sustainability. Challenges in the chain include low productivity and a fragmented market and concerns with quality and safety of dairy products. Addressing these challenges translates to seizing opportunities.

Addressing low production and productivity – With smallholder milk producers dominating the industry, the vision of it becoming globally competitive will be difficult to attain. Most of these producers lack economies of scale and have low productivity coupled with seasonal fluctuations. They also lack the necessary resources to modernize and expand their enterprises. The increasing demand for milk is currently being met with more smallholder farmers taking up dairy across agro-ecosystems, rather than by sustainable intensification through smart investments in production, marketing and human resources. This production strategy results in high production costs and presents ecological threats to land, soil, water, and biodiversity. Enhancing milk production and productivity requires

support for entrepreneurial farmers through enhancing dairy farming practices and farm enterprise management, supported by innovative business models to ensure reliable access to inputs, services and finance. The opportunities are in leveraging economies of scale and producing safe milk

Growing reliable and quality markets – The market challenges include unstable milk supply with cycles of abundance and scarcity, high cost of milk processing, poor milk quality and safety, and the risk of unfair competition from oligopolies in milk processing. Despite the challenges, the growth in demand for high quality milk and diverse dairy products in both the domestic and regional markets, are opening investment opportunities. Medium and large-scale farms and entrepreneurial smallholders can benefit from delivering milk to expanding diverse, well-structured and trusted formal markets. Other market opportunities are offered by a growing demand for equipment for milk handling, bulking, chilling, processing and dispensing by various enterprises. The Government of Kenya and many county governments are investing in local milk-chilling and -processing equipment to drive growth of the dairy market.

Reliability of institutional governance of the dairy sector

Reliable institutional governance refers to a policy framework that supports investment and cooperation to enhance trade opportunities in the dairy sector. A reliable institutional governance framework can guide the evolution of a common vision and coordinate sector players towards shared objectives.

Harmonizing regulatory instruments – Since 2010, the development of appropriate policy frameworks has been the responsibility of the Government of Kenya, while the development of the sector has been devolved to the county governments (Makoni et al. 2014). Dairy-specific policies are numerous and scattered, which raises questions about their coherence and enforceability. Generally, the enforcement of standards and regulations is limited, which does little to induce adoption and further innovation. Policies that directly target dairy research, training and extension are not yielding the innovations needed by the sector due to low engagement between relevant knowledge institutions and supply chain actors; consequently the ongoing research, training and extension is of limited end-user relevance.

Economic instruments and (dis)incentives for investment in dairy –The dairy value chain is ranked high as priority sector in two-thirds of the counties according to the agricultural sector development programme of the government. Economic instruments that are used to promote the sector include:

Subsidies – Counties are implementing growth models including the 'one cow initiative' and subsidy programmes for delivering AI and installing milk cooling tanks to promote inclusive dairy development, targeting resource-poor households, youth, women and the disabled. These initiatives reflect a wider orientation of policies in promoting 'hardware', but this is not matched with the development of 'software' solutions, targeted training and advisory services, and data collection and analysis, is by and large neglected. A market distortion effect is the likely result of these approaches.

Cess, levies and taxes – Attempts to improve access to financial services for farmers until recently were hampered by steep loan conditions. The Kenya Dairy Board (KDB) raises significant funds, with which it is expected to regulate and promote the dairy value chain. The environment for investors is rather unpredictable as the county governments are proposing to impose new taxes on many items. Unrealized tax opportunities for the sector include removal of VAT on dairy equipment, processed milk and feed ingredients, and the 60% import tariff on dairy products from outside the East African Community.

Soft instruments for promotion of collaboration and innovation, such as innovation platforms, public-private partnerships, and codes of conducts, are used sporadically, e.g. a pilot school milk program in Mombasa and Migori counties. Some starting points for increased collaboration exists, but increased stakeholder involvement, co-investment, and a more convincing role of KDB are needed for success.

Resilience of innovation support systems

The ability to address the challenges and exploit the growing opportunities in the Kenyan dairy sector hinges on actors continually exchanging and applying knowledge, mobilizing resources and coordinating co-innovation networks.

Stakeholder collaboration – Due to the lack of a shared vision for the dairy industry, the linkages between various actors are generally weak. Besides some pockets of coordinated action, there is no

coherent innovation system for problem solving and to sustainably exploit opportunities to drive innovation in the sector (Odame et al. 2009). This is characterized by supply-driven research, unresponsive to the sector needs, extension and advisory support systems that are equally ineffective, and education actors unable to meet the sector's demand for skilled personnel (Makoni et al. 2014, Muriuki 2011, Odame et al 2009). Furthermore, weak organizational capacity of various industry associations prevents effective interaction, investment facilitation and lobbying. Most donor-supported development interventions are not well-coordinated with other initiatives, resulting in duplication of efforts and limited cross-learning and co-creation. These gaps reflect underlying institutional challenges including lack of trust and dependability among value chain actors (Kilelu et al. 2013, Kurwijila and Bennett 2011). There is need to strengthen networks through platforms to foster dialogue and co-learning to drive innovation in the sector. Such platforms need to be championed and driven by the sector stakeholders. KDB is seen as key facilitator for such platforms, but needs significant strengthening to effectively convene and collaborate with stakeholders.

New models for innovation support – Some new approaches to supporting knowledge transfer and innovation support are occurring in the changing dairy sector. The focus is on demand-driven, market-led approaches to dairy innovation support systems. Examples include practical dairy training centres, dairy business hubs, and private dairy business advisory services (Kilelu et al. 2016, Katothya and van der Lee 2016). These innovation support systems, coupled with emerging inclusive business models and public-private partnerships are targeting to build capacity in relevant practical skills and entrepreneurial attitudes of smallholder dairy farmers, sometimes linked to medium and large scale producers or international experts., Investments by county governments also) present opportunities for new partnership investments that can drive innovation. Nonetheless, there is need to understand how well these models are working.

ICT and knowledge management – Development of ICT infrastructure has provided new opportunities for strengthening of innovation support systems, e.g. through development of dairy-specific applications that enable information and knowledge sharing. While many of these ICT initiatives are promising, uptake and effectiveness need critical assessment.

Conclusions and recommendations

The strong growth in demand for milk offers many opportunities to Kenyan and international actors that can translate into new investments and 3R sector development from production to marketing. The increasing commercialization offers concrete business opportunities in private training and advisory services, input supply and service provision to entrepreneurial smallholders, commercial fodder production, heifer supply, dairy product diversification, contracting and machinery for fodder production, equipment for milk handling, bulking, chilling, processing and dispensing by various enterprises; increased use of equipment requires capacity building in mechanical support services and spare parts supply.

However, for the dairy sector to be robust, reliable, and resilient, it will need to do more than react to market opportunities. It will require better supply chain integration, improved linkages and trustworthy interactions between chain actors to reduce transaction costs and improve milk quality and safety. Better supply chain integration dovetails with dependable regulatory and policy and innovation systems that ensure dynamic innovation of the sector and attracts trade and investment that support sustainable people-profit-planet sustainability.

While the policy ambition of the Government of Kenya's for the sector, embodied in the Kenya National Dairy Master Plan (MoALF 2010a), is to increase the share of the formal processed milk market, little headway has been made. Reasons for the strong position of the raw milk chains (chilled and unchilled) include consumer preferences, consumer purchasing power, and insufficient price/quality advantage of processed milk. The latter is a prime cause for inhibited growth of exports as well. The sector does show diverse market pathways to development that could roughly be distinguished in conventional, niche, and local bulk. What seems to be missing in the sector is debate on the relative advantages of and opportunities for these pathways.

This study identified gaps in entrepreneurial skills and chain fragmentation as the key limiting factors that inhibit growth to a robust, reliable and resilient sector. 3R's involvement in the sector should focus on approaches that counter these key limiting factors. It can do so when focusing on the priority areas that provide the entry points for implementation: "*Quality of feed and fodder and of milk*"; "*Capacity building for producers skill development";* and "*Reliable and competitive markets*". The cross-cutting issues of "*Policy lobbying and regulatory issues*" and "*Inclusion of women and youth*" require attention in all efforts.

Shortened forms and definitions

3R	Robust, reliable and resilient
AECF	Africa Enterprise Challenge Fund
AFC	Agriculture Finance Corporation
AI	artificial insemination
AKEFEMA	Association of Kenyan Feed Manufacturers
CBE	collection and bulking enterprise, governed by a DFCS or a private entity
CET	common external tariff
CFP	commercial fodder producer
COMESA	Common Market for Eastern and Southern Africa
DCED	Donor Committee for Enterprise Development
DFCS	dairy farmers cooperative society
DVC	dairy value chain
DTI	Dairy Training Institute (Naivasha, Kenya)
EAC	East African Community
EADD	East Africa Dairy Development program, 2008–16, Heifer International and partners
EADRAC	East African Dairy Regulatory Authorities Council
ECF	East Coast fever
EKN	Embassy of the Kingdom of the Netherlands
FNS	food and nutrition security
GDP	gross domestic product
GMP	Good Management Practices
GoK	Government of Kenya
ICIPE	International Centre of Insect Physiology and Ecology
ICRAF	World Agroforestry Centre
ICT	information and communication technology
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
KALRO	Kenya Agriculture and Livestock Research Organization
KAGRC	Kenya Animal Genetics Resource Centre
KAVES	Kenya Agricultural Value Chains Enterprises project, FINTRAC, 2013-18
KDB	Kenya Dairy Board
KeBS	Kenya Bureau of Standards
KES	Kenyan Shilling
KMDP	Kenya Market-led Dairy Program, SNV, 2012–19
KVB	Kenya Veterinary Board
MCDFCU	Meru Central Dairy Farmers Cooperative Union
MFI	microfinance institute
MoALF	Ministry of Agriculture, Livestock and Fisheries
New KCC	New Kenya Cooperative Creameries
NGO	non-government organization
NMCS	Nyala Multi-Purpose Cooperative Society
NFDK	National Fund for the Disabled of Kenya
PDAS	private dairy advisory service
PDTC	practical dairy training centre
PPP	public–private partnership
PUM	senior export program from the Netherlands
QA	quality assurance
QBMPS	quality-based milk payment system

R&D	research &development
SACCO	savings and credit cooperative
SADC	Southern African Development Community
SDCP	Smallholder Dairy Commercialization Program, MoALF and IFAD, 2006–2015
SNV	SNV Netherlands Development Organization
SWOT	strengths, weaknesses, opportunities and threats: analysis tool
TB	tuberculosis
TBD	tick-borne disease
T&E	training and extension
TVET	technical vocational educational training
UHT (milk)	Ultra-High Temperature (milk)
USAID	United States Agency for International Development
VAT	value added tax
WEF	Women Enterprise Fund
YEDF	Youth Enterprise Development Fund

Glossary

Benchmarking	Comparing your farm or company to the (average of) peers to see how you are doing
Innovation platform	"A multi-actor configuration deliberately set up to facilitate and undertake various activities around identified agricultural innovation challenges and opportunities, at different levels in agricultural systems" (Kilelu et al. 2013)
Robust	Systematic interactions between agents that enable them to adjust to uncertainties within the boundaries of their initial configuration
Reliable	The ability of a system or component to perform its required functions under changing conditions for a specified period of time
Resilient	Dynamic adaptive capacities that enable agents and systems to adequately respond to changing circumstances
Supply chain	The links that connect inputs to farm and then on to storage, processing, transport and distribution to consumers for a given product through a single chain (Wiggins and Keats 2013)
Value-chain	The value chain may consist of several supply chains for a particular product. It includes the supporting services that allow the supply chains to operate. It may even be taken to include the factors in the economic environment as well (Wiggins and Keats 2013).

1 USD ≈ 100 KES

1 Background

1.1 Introduction

This report provides insights into the Kenyan dairy sector with a focus on three main analytical domains: the value chain, institutional governance and innovation support systems. Jointly, these are viewed as essential in understanding and guiding the transition towards a robust, reliable and resilient (3R) sector (see Boxes 1 and 2). Since 2012, the Food and Nutrition Security (FNS) programme of the Embassy of the Kingdom of the Netherlands (EKN) has been supporting market-led agricultural development interventions of various agrifood sectors in Kenya, including dairy, horticulture and aquaculture. The programme has invested in market-led approaches that provide opportunities for Dutch and Kenyan experts and investors to develop business solutions and innovate in knowledge development and application relevant to growing competitive agrifood sectors in Kenya.

This report presents findings of a scan of the dairy sector that was conducted as an initial analysis of the FNS programme and similar market-led interventions. It assesses and validates scalability of these lessons for a trade- and investment-focused approach to the sector's development. The study applied the 3R framework to three domains of the sector: the value chain, institutional governance and innovation support systems. The study is a first step for the 3R Kenya project towards assessing and documenting lessons from the FNS programme and sharing insights that will guide policy engagement and action in the transition from a development aid–supported sector to a competitive market-oriented dairy sector that attracts trade and investment opportunities.

The sector scan sought to find out **the performance of the Kenyan dairy sector in terms of the robustness of the supply chains, the reliability of the institutional governance and the resilience of the innovation system.** Qualitative data collection and analysis were employed to draw conclusions with regard to the objectives of the scan. Secondary information was collected through literature review, and primary information was collected through interviews with sector stakeholders and group discussions organized through a workshop held for the stakeholders.

The report is organized as follows: the remainder of Chapter 1 provides an overview of the dairy sector in Kenya. Chapters 2–4 describe the myriad of issues that the sector faces, in terms of challenges and opportunities, which characterize the robustness of the dairy value chain (DVC), reliability of institutional governance and resilience of the innovation support systems along the DVC. These three domains are the main subject of this report. Examined together, they provide an understanding of the robustness, reliability and resilience of the dairy sector. Chapter 5 contains conclusions, recommendations and recommended areas of action for the 3R project.

Box 1. Triple R: robust, reliable and resilient

Robust refers to systematic interactions between agents that enable them to adjust to uncertainties within the boundaries of their initial configuration.

Reliable refers to the ability of a system or component to perform its required functions under changing conditions for a specified period of time.

Resilient refers to dynamic adaptive capacities that enable agents and systems to adequately respond to changing circumstances.

Box 2. 3R Kenya project

As part of the Dutch transition strategy from aid to trade in Kenya, Wageningen UR in partnership with Kenyan research institutions will implement a project that assesses and validates lessons learned from the Netherlands Embassy's FNS programme and other related programmes that support competitive market-led agricultural development. The 3R (robust, reliable and resilient agrifood sectors) Kenya from Aid to Sustainable Trade project investigates whether the lessons from the aid era can be transferred and scaled up in the coming trade era. 3R Kenya focuses on the aquaculture, dairy and horticulture sectors.

1.2 Overview of the dairy sector in Kenya

Kenya has a vibrant dairy industry that contributes 14% of the agricultural gross domestic product (GDP), 40% of the livestock sector GDP and 4% of the national GDP. The industry is currently growing at an average rate of 5–7% per year. It provides employment to over 1.2 million citizens (KDB 2015). There are over 1.8 million smallholder milk-producing households who own one to three cows, which in aggregate own over 80% of the national dairy herd (estimated at 4.2–6.7 million cattle) (KDB 2015, ILRI 2008). Milk yields of small-scale producers in Kenya are about 5–8 litres per cow per day, while large-scale farmers typically reach yields of 17–19 litres per cow per day (ACET 2015).

The economic vibrancy of the sector is shown in the growth of domestic milk production, processing capacity, per capita milk consumption and exports as reported in various reports (KDB 2015, ILRI 2008). Between 2003 and 2012, total milk production for all species together grew at an average of 5.3% per year, from 3.2 to 5.2 billion litres (**Figure 1-1**).

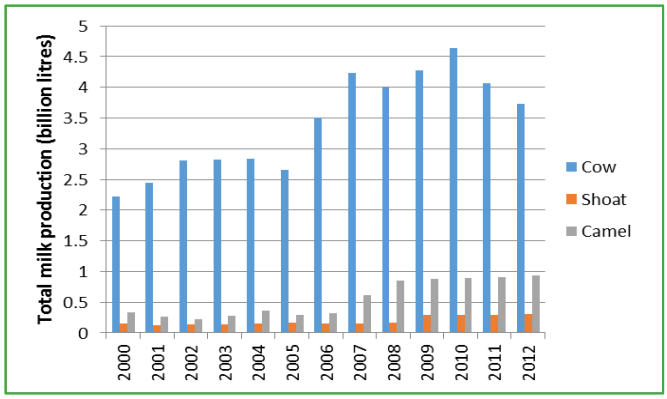

Figure 1-1 *Total milk production trends all species*

Source: KDB n.d.

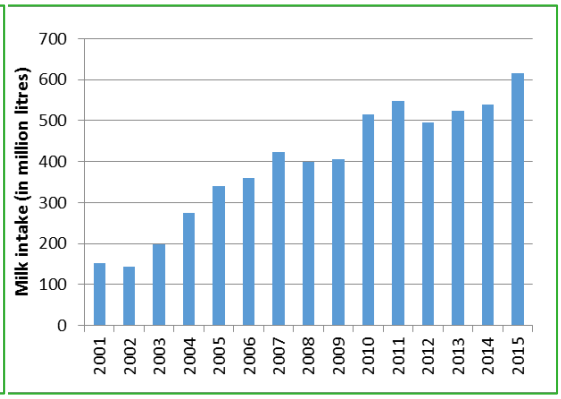

Figure 1-2 *Trend of annual milk intake formal sector*
Source: KDB n.d.

At 110 litres, Kenya has the highest annual per capita milk consumption in sub-Saharan Africa (the equivalent of 5.2 billion litres a year). The demand for milk and value added dairy products is growing, owing to strong tradition of including milk in diets, expanding urbanization, a rising middle class and export opportunities in the region. In response to growing consumption estimated at 5.8% annually, the *Kenya National Dairy Master Plan* aims to stimulate annual per capita milk consumption to 220 litres by 2030 (MoALF 2010a).

Marketed milk amounts to 55% of the total production (45% is home-consumed or fed to calves). The bulk of the marketed milk (~88%) is sold as unchilled or chilled raw fresh milk directly to consumers through informal market channels. These channels are characterized by non-compliance with the regulated safety and quality standards and collection of statutory revenues (taxes, cess, levies, VAT) (KDB 2015). The formal cow milk market has witnessed steady growth over the years, with milk intake growing at an average of 7% per year, from 153 million litres in 2001 to about 616 million litres in 2015, being 12% of the estimated production (KDB n.d.) (**Figure 1-2)**, but with a marked seasonality of between 11 million and 16.5 million litres in monthly variations in the 2010-2015 period (**Figure 1.3**). This growth is attracting both domestic and international private investors seeking to seize business opportunities in the domestic and export markets (Business Daily 2016a). Export opportunities are mainly in the Eastern and Southern African region (Reardon et al. 2015). In 2014, exported milk and dairy products were worth KES 1 billion (KDB 2015).

The dairy industry is regulated by the Kenya Dairy Board (KDB), mandated to regulate, develop and promote the dairy industry in Kenya. The regulatory roles are in licensing, inspections and surveillance and certification of locally marketed, exported and imported milk to assure consumer safety from physical, biological, chemical or adulteration hazards. KDB's promotional role is to enhance consumption of milk and dairy products among Kenyans. The Ministry of Agriculture, Livestock and Fisheries (MoALF) also plays a role in regulation and policy direction of the sector, while the Kenya Bureau of Standards (KeBS) has the mandate of assuring quality standards for milk and dairy products traded in the domestic market.

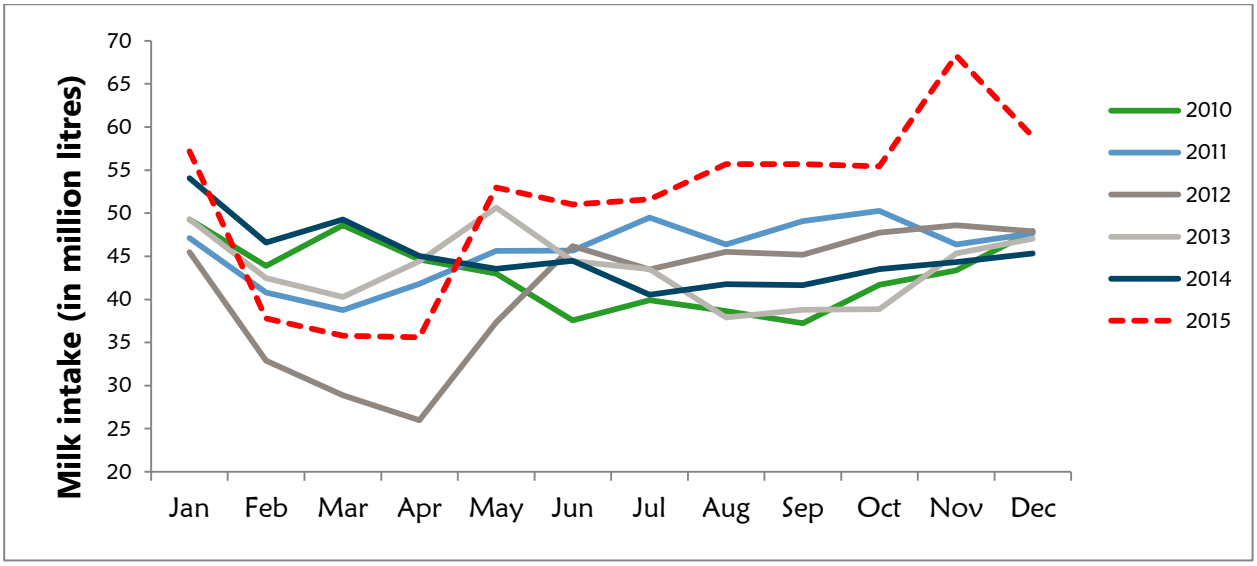

Figure 1-3 *Seasonality of milk intake over the year* *Source: KDB n.d.*

The authorities have defined strategic actions in the *Kenya National Dairy Master Plan*, anchored on a vision of becoming a globally competitive milk production sector, envisaged to push a shift from informal to formal supply chains (MoALF 2010a). There are multiple objectives in this push, including reducing market share of low quality liquid milk, encouraging progressive investments in the development of the dairy industry and assuring public health for consumers, while in the process creating skilled jobs and earning revenues for public expenditures (MoALF 2010a). Improving milk quality by increasing the percentage of processed milk is the most emphasized objective in the dairy master plan (MoALF 2010a), even though results from International Livestock Research Institute (ILRI) studies have demonstrated that scores for quality indicators are as poor for formal traded pasteurized milk as they are for the informal traded raw milk (Omore et al. 2005).

The growth of the dairy industry is private sector–led; however, numerous challenges are affecting the different nodes along the DVC and limit the potential of the Kenyan dairy sector to become globally competitive as envisaged in the *Kenya National Dairy Master Plan* (MoALF 2010a). At the input level, the demand is for innovative business models that offer quality inputs and services in a more competitive manner to lower the milk production costs, which at present are among the highest in the region and consequently restrict export market opportunities. Recent estimates of milk production costs per litre in Kenya show them to average KES 16–18 compared to KES 10 in Uganda (Tegemeo 2016). Consequently, the retail price per litre of milk is KES 103 in Nairobi compared to KES 80–84 in South African cities (Business Daily 2016a, Otuki 2016).

The growing demand for milk is being met by more smallholders taking up dairy farming for welfare and livelihood objectives, which widens the geographical spread of milk production in more smallholder farm in the country across agroecosystems (Muriuki 2011, Bebe et al. 2002). Most smallholders also meet the growth in milk demand and supply by increasing their herd size, without matching with the feed demand; this presents ecological threats, as the required feed resources have to be produced by changing land use (i.e. increasing the area of land used for dairy farming rather than sustainably intensifying) with consequences of degrading land, soil and water and farm animal biodiversity when exotic dairy breeds replace the indigenous cattle population.

At the production level, what is needed are good dairy farming practices with a shift to economies of scale and with entrepreneurial farmers; access to quality fodder and concentrates to support increased productivity (yields are presently far below the genetic potential); consistent record keeping for planning and strategic decisions; production of safe, quality milk; and access to financial services (credit and insurance schemes) (Bebe et al. 2002, ILRI 2008, Udo et al. 2011).

With smallholder milk producers and traders dominating the industry, the vision of it becoming globally competitive will be difficult to attain without fostering the cooperative movement, good pasture management to overcome challenges in economies of scale in production (1–3 cows) and low productivity (5–10 litres of milk per cow per day), and mobilizing sufficient resources to invest in modernizing and expanding the dairy enterprises.

At the processing level, what is needed are reduced costs of milk processing; stabilized milk intake that is less affected by seasonal fluctuations in production; a reward payment system based on milk quality; and reduced risk of expanding unhealthy competition from oligopolistic control in milk processing. Milk glut and scarcity is a periodic feature with which processors grapple (**Figure 1.3**). Processors who have invested in expanding processing infrastructure for long-life dairy products face cash flow challenges sometimes to the tune of KES 4 billion when left with stock – butter, ghee, cheese, milk powder and UHT – related to glut production and low consumption of these dairy products (Business Daily 2016b).

Despite the challenges, the growth trends in the sector are opening investment opportunities for entrepreneurs in dairy farming, service and input provisions, feed production and processing and milk retailing. Opportunities in dairy farming are more attractive in pasture systems, where milk production costs are lower (Bebe et al. 2002, Tegemeo 2016). Studies point to growing demand for fodder, which is opening business opportunities for fodder production (pastures, hay, silage) and feed processing able to supply quality feeds in large volumes that benefit from economies of scale. Opportunities exist in providing delivery services so that dairy enterprises can supply their milk to the expanding processing plants in response to a growing demand for milk in both domestic and regional markets. The growing middle class and urbanization open business opportunities in milk processing to produce diverse dairy products. There is an expanding market demand for equipment and facilities for milk handling, bulking, chilling, processing and dispensing from commercially oriented farmers; the GoK and county governments are investing in local milk-chilling and -processing capacities. The growth occurring in the dairy sector creates demands for supportive inputs and services in knowledge application, herd health and breeding, financing and insurance facilities.

1.3 Methodology used

The analysis in this report is based on an extensive review of grey literature, supplemented with scientific literature, interviews with sector stakeholders and a stakeholder validation workshop.

Literature review

During an expert meeting in Nairobi in February 2016, a selection of key documents was made that were considered a good starting point for a scan of the sector (ACET 2015, SNV 2015, Makoni et al. 2014, PPD Consultants 2013, Kruse 2012, Kurwijila and Bennett 2011, Muriuki 2011, MoALF 2010a). These key documents were coded in Atlas.ti, a software program that facilitates analysis of qualitative data. To supplement the information from the key documents, additional grey information was obtained from team members and by searching the internet with Google. To elucidate issues that came up during analysis, scientific literature was sought on a case-by-case basis using Google Scholar.

Interviews

Key actors – be it individuals or organizations – in the Kenyan dairy sector were selected using team knowledge of the sector, in such a way as to ensure inclusion of actors involved with activities along the DVC and from commercial-, government- and research and extension-related work. Key actors were identified based on information from various sources, while additional actors were identified during the fieldwork ('snowball sampling'). **Table A1-1** in Annex 1 lists the actors that were interviewed in May–June 2016. Interviews were semi-structured, using open questions and a checklist. The interviews were recorded after permission to do so was granted. The interviews were transcribed using Transcription Buddy and FTR Player software, and summaries were made.

Validation and prioritization workshop

An executive summary and a PowerPoint presentation summarizing a draft of the present report were used as input for a stakeholder workshop held on 19–20 July 2016 in Nairobi. The stakeholders who were invited included those who were interviewed, supplemented with other key stakeholders, again based on team knowledge of sector actors. The objectives of the workshop was to share and reflect on the findings from the sector scans by the stakeholders sharing their experiences. Feedback from this workshop was used to complement the draft report (which combined results from the literature review and interviews), with the present report as result.

2 Robust value chains

This chapter explores the **dairy value chain (DVC)** in Kenya, focusing on interactions and exchanges between different DVC actors. It aims to understand the robustness of the value chain with its different supply chains. In line with the 3R proposal, robust here refers to "systematic interactions between agents that enable them to adjust to uncertainties within the boundaries of their initial configuration (3R Kenya n.d.)". A robust value chain integration is described as "efficient and trustful interactions between DVC partners that reduce transaction costs and risks for enhancing product quality and safety and reinforcing sustainability (3R Kenya n.d.)". An initial assessment of robustness is derived from SWOT analysis of the DVC (**Table 2-1**).

2.1 Overview of the dairy value chain

The expanding sector is characterized by an increasingly sophisticated value chain that has a diverse range of actors and different nodes (**Figure 2-1**).

The actors include agro-input suppliers who are small agro-vet stockists or large national and international firms and numerous feed manufacturers; and various service providers (including private consultants) offering a range of services including veterinary, animal health and breeding, training and extension. There is also a range of transport services provided by dairy farmer cooperative societies (DFCSs), processors or by contracted transporters.

At the production node, there are milk producers who may be small-, medium- or large-scale dairy farmers. At the marketing node of the DVC there are milk bulking and chilling facility operators who may be DFCSs, processors or government-installed facilities. There are milk traders procuring milk from farmers to sell directly to consumers or acting as collecting agents of processors. Next are the processors, of which there are currently 27 active in Kenya, four of which control 85% of the milk intake (ACET 2015). Retailers vary in scale of operation from small neighbourhood shops to large supermarkets, and consumers are segmented into buyers of raw unchilled, chilled or processed milk and dairy products.

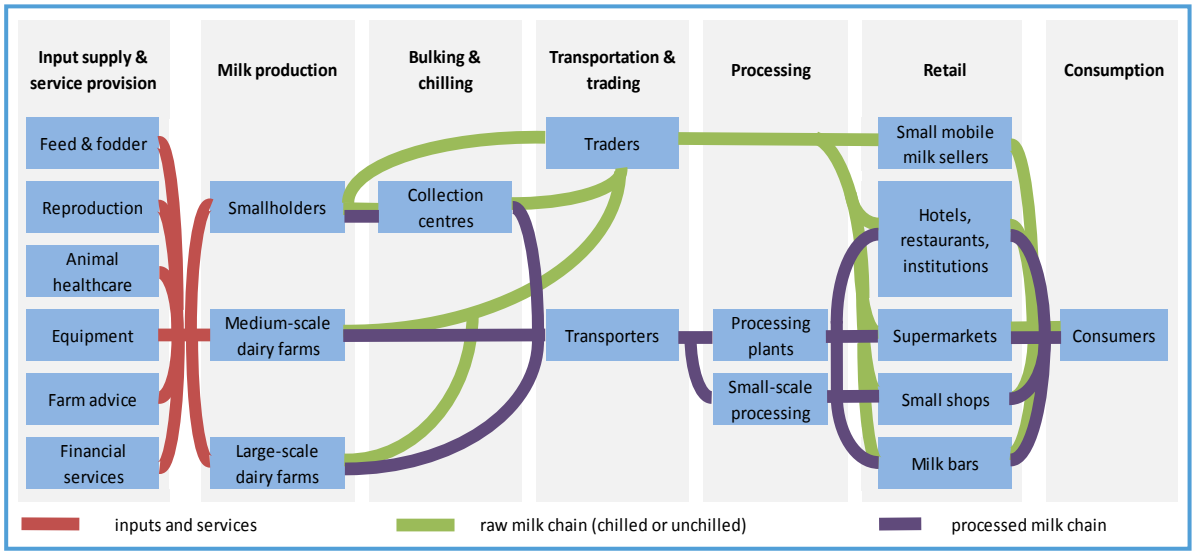

Figure 2-1 *Overview of the dairy value chain in Kenya (N.B. Some actors combine several steps)*

Additionally, various public research organizations, universities, training institutes and NGOs support the development of the sector, including the KDB, the ministry (MoALF), the Dairy Training Institute in Naivasha (DTI) and the Kenya Agriculture and Livestock Research Organization (KALRO).

The DVC is broadly divided into informal and formal market channels, based on compliance with regulatory frameworks for quality and safety standards and payment of statutory revenues (cess, levies, taxes, VAT). The market channels have three distinct chains: a) unchilled, raw; b) chilled, raw; and c) chilled, processed chains. The transformation towards a larger formal channel is possible via the chilled, processed chain by targeting capacity building and enabling policies. The *Kenya National Dairy Master Plan* defines strategic actions to enable a shift from informal to formal chain channels (MoALF 2010a). The strategies include encouraging progressive investments for developing the dairy industry by reducing the market share of low quality liquid milk and ensuring consumers' health, and in the process creating skilled jobs and increasing public revenue (MoALF 2010a).

2.2 Economic aspects of the value chain

2.2.1 Inputs, services and milk production

Compared to the dairy sectors in the neighbouring countries, the Kenyan dairy sector has well-developed inputs and services delivered through diverse channels (Makoni et al. 2014). The most important input and service relationships are discussed in the next sections.

2.2.1.1 Feed and fodder supply chains

Enhancing feeding systems is central to improving productivity in the sector and critical to growing a sustainable sector, particularly in light of the effects of dairy production on climate change (CCAFS 2015). Three aspects are key: a) impact of feed and fodder on cost price of milk; b) concentrate feed supply chain issues; and c) fodder production, conservation and marketing.

Fodder production, conservation and marketing

Forages form the most important feed resource for dairy cows. Forages grown explicitly for feeding to dairy cows in the East African context include protein-rich and energy-rich varieties. Fodders fed to dairy cows include crop residues (Perfometer Solutions 2013). Many smallholders (and some medium-scale farms) are unable to produce sufficient fodder because of their small holdings and have to supplement with forage harvested from public areas using hired casual labour or purchase of fodder– such as hay, silage, agro-by-products, or crop residues – obtained from traders (Wambugu et al. 2011).

The limited availability of land is a primary challenge for fodder production in smallholder farms, necessitating intensification and commercialization of fodder production, but success requires availability and affordability of inputs such as high quality seed, pesticides and fodder conservation technology. Box 3 describes the experiences in this field of the Kenya Market-led Dairy Program (KMDP). It is noted that forage seed is expensive due to high initial costs and limited availability. Other challenges include yield loss due to plant diseases (Aketch 2014, Mulaa et al. 2008, interview with F. Wandera[1]). KALRO and the International Centre of Insect Physiology and Ecology have developed a resistant Napier variety called Ouma. KALRO is also investigating and developing alternative grasses such as *Setaria* spp. and *Brachiaria* spp.(interview with F. Wandera). Finally, fodder supply is heavily dependent on rainfall, resulting in inconsistent supply. Adoption of grass conservation technologies, such as haymaking and silage production, remains limited, despite extension and training on the need for fodder and feed budgeting (Makoni et al. 2014).

Recent experiences indicate emerging models in commercial fodder production (see Box 3). Medium- and large-scale farmers are functioning as commercial fodder producers (CFPs), or so-called nucleus farms, by selling surplus hay (Makoni et al. 2014). Some DFCSs are offering access to fodder as an embedded service to their members through increasing the availability of fodder seeds in their agro-vet shops, enhancing linkages to credible fodder seed suppliers, promoting on-farm fodder production by members – improving both quality and availability – and creating linkages with CFPs for supply of hay (Rademaker et al. 2016). One example is Nyala Multi-Purpose Cooperative Society (NMCS), which sells hay mainly in the dry season when fresh grass availability is low (interview with S.G. Maina). There is need for more analysis on the effectiveness of the different CFP business models.

[1] *See annex 1 for more detail on interviews cited*

Table 2-1 *SWOT analysis of the Kenyan dairy value chain*

	Strengths	Weaknesses	Opportunities	Threats
Economic robustness	- Relatively well-established sector with diverse input and services markets -- Diverse financial services (banks, MFIs, SACCOs) offering agriculture (dairy farming) financial products - Strong history of keeping cattle; large livestock population with availability of quality dairy genetics - Widespread market distribution network for milk and dairy products - Growth in formal processors with incentives for milk suppliers	- High cost of production; low milk quality; high milk losses; high consumer prices - Low overall value addition due to 3/4 of milk sold raw - Poor access to and quality of inputs and services (feeds, AI, extension equipment, etc.) - DVC fragmentation and low supplier loyalty - Low bargaining power of smallholders -Processor oligopoly - Few appropriate financial products for dairy sector (rigid conditions and high interest) -Limited data availability and poor record keeping in the sector; accusations of unethical practices by feed suppliers and milk traders - Weak governance and management capacity of DFCS to operate effectively	- Growth in commercial and on-farm fodder production and conservation, fodder contracting services and feed rationing at farm level - Increased demand for, and improved, services (AI and animal genetics, animal health, heifers, vaccines, drugs) - Provision of embedded services by DFCSs to reduce side-selling - Combining insurance with credit packages to reduce risks for banks/MFIs and enhance access to finance -Growing domestic and regional markets -Growing demand for diverse dairy products and expanding possibilities in value addition attracting investors - Entry of young farmers willing to commercialize dairy (inheriting or leasing land) - Large tracts of land available in some regions for medium- and large-scale dairy farms (from 50 to 5,000 acres) - Use of ICT options to enhance data collection and record keeping - Exploration for QBMPS and feed quality testing -Many county governments have prioritized dairy sector development with big plans for investment	- Decreasing farm sizes - Public concerns with milk quality (aflatoxin, antibiotics, microbial) - High fodder and animal disease and zoonoses incidence (ECF, FMD, TB, brucellosis) - Road infrastructure, transport facilities not up to par in all areas; high cost of power - Environmental degradation and climate change impacts (e.g. increased risk of disease outbreaks) - Danger of market distortions through donor investments - Cheap milk imports from Uganda threaten market for domestic milk - Poor quality feed resources imported from neighbouring country - Low attractiveness of sector for foreign input suppliers - Protectionist policy (taxes for milk imports from non-EAC countries)
Environmental robustness	-Mixed farming systems with integrated farming practices; availability of compost, manure and nutrient recycling - Favourable agro-climatic conditions for dairy production	- Limited awareness about environmental impact of dairy production and processing -Limited attention to reduction of greenhouse gas emissions	- Promote green energy, e.g. biogas from dairy manure and wastewater - Promote organic fertilizer use - Increase support for mitigation in dairy sector through development of dairy national appropriate mitigation actions	- Environmental degradation and climate change impacts; erosion; increasing manure management issues in landless farms - Loss of indigenous breeds - Invasive weeds threatening fodder production
Social robustness	-Key livelihood activity (direct/ indirect) for many households - DFCS and farmer group development contributes to sense of ownership, trust and broader community development - Tradition of livestock (cattle) keeping	- Low attraction of farming for youth; poor access to production factors for youth and women -Poor negotiation position of smallholder producers - Insufficient entrepreneurial approach, with inadequate dairy farming practices	- Expanding school milk program with public and private actors - New employment opportunities for various groups along the DVC (e.g. transporters, service providers, traders)	- Lack of interest in investing in smallholder farming - Increased subsidization keeps smallholders uncompetitive, reducing their options to transition to commercial farming or changing livelihoods - High zoonosis incidence and poor milk quality threatens public health

Box 3. Turning around the fodder challenge: KMDP's work on improving production and business models

Access to quality fodder and feed remains a systemic issue hampering the growth of a sustainable and competitive dairy sector in Kenya. SNV'S Kenya Market-led Dairy Program (KMDP) has an explicit focus on fodder supply chain development, aiming to increase efficiency and competitiveness of the dairy value chain (DVC). KMDP carries out various interventions in the area of fodder development, conservation and mechanization practices:

1. Promotion of fodder practices through the dairy farmer cooperative societies (DFCSs) Training and Extension (T&E) unit, Service Provider Enterprise Network groups and development of fodder development strategies
2. Training of medium- and large-scale farmers with advice from international (Dutch) experts (in this case ,PUM's senior expert program) and local agronomists (in this case, private dairy advisory service companies or local capacity builders, such as Perfometer Agribusiness Solutions Ltd)
3. Training of commercial fodder producers (CFPs) on improving fodder production and marketing through the same partners
4. Facilitating linkages between CFPs and local and international seed suppliers and between CFPs and dairy farmers.

Training is conducted through demonstrations, on-the-job coaching, and field days, focusing on agronomic as well as business practices. Demonstration pilots are established for a range of fodder varieties, especially protein-rich varieties.

Rademaker et al. (2016) found that silage production among member farmers of DFCSs had increased significantly in most collection and bulking enterprises, even if only few smallholders were growing and preserving new fodder crops (Rademaker et al. 2016). De Jong et al. (2015) found that these KMDP interventions support improvement of fodder quality and availability during the dry season, thereby reducing seasonality of milk production at medium- and large-scale farms and in a number of DFCSs, notably in Meru Central Dairy Farmers Cooperative Union (MCDFCU)'s in Meru region.

Specific to interventions with individual CFPs, De Jong et al. (2015) report that 50 CFPs were established as businesses, and that fodder production and conservation had increased. Moreover, Rademaker et al. (2016) found that sales of fodder seed suppliers had increased significantly. But CFPs and medium-scale farmers continue to face difficulties in accessing fodder seeds and equipment, including spare parts (De Jong et al. 2015). In Eldoret, a member of the Eldoret Dairy Farmers Association and Nundoroto Farm Ltd. started collaborating to harvest fodder using an innovative arrangement called the 'maize train', where different machinery owners combine their resources and schedule fodder production activities collectively (interview with Kirwa and Limo). Thus, there are business in contracting services for fodder production and harvesting and in repair, maintenance, financing and leasing of equipment. However, commercial fodder production needs to be complemented by feed rationing to satisfy the nutritional requirements of dairy cows and so increase productivity (interview with Jansen and Muchina).

While more systematic analysis of these approaches is needed, lessons learned so far indicate that fodder establishment and preservation have contributed to increased milk production among smallholders, thereby reducing seasonality of milk supply (interview with K. Gitonga).

Sources: Ettema 2015, Perfometer Solutions 2015, Rademaker et al. 2016, SNV 2015.

Concentrate feed supply chain issues

The provision of concentrates for supplementary feeding of dairy cows is pivotal if milk production is to be increased. Yet, the concentrate feed supply chain in Kenya faces key bottlenecks, including low and variable quality of concentrates; high cost of feed; reliance on imported feed ingredients, of which the quality is not certain as quality assurance is weak; and rampant trade malpractices in the feed industry (ACET 2015, ABS TCM 2013, PPD Consultants 2013, MoALF 2010a), not to mention the on-farm utilization issues due to limited farmer skills in feed rationing and in supplementing quality fodder with concentrates. The supply chain bottlenecks are attributed to:

1. *Variability in access and quality of key inputs for feed manufacturing* – this is due to use of substandard raw materials by feed millers following scarcity of by-products (MoALF 2010a, PPD Consultants 2013).

2. *Mixing of commercially produced feeds with lower quality ingredients* –traders produce cheaper concentrates to meet farmer demand for cheaper feeds (interview with Odede and Kipkoech; ACET 2015).
3. *Absence of a functioning feed quality assurance (QA) system* – enforcement of quality standards is weak and does not address other systemic feed quality issues, such as aflatoxin contamination.
4. *High prices of concentrates*–the Association of Kenyan Feed Manufacturers (AKEFEMA) attributes high cost of concentrates to the low feed-mill capacity utilization (about 45%), shortage of grain and food processing by-products, and a 16% VAT charged on some feed ingredients used in ration formulation (interview with Kinoti). AKEFEMA is lobbying for extending VAT exception to the feed ingredients left out in the 2016 budget (interviews with Kinoti; Matoke and Otiang).

Input suppliers such as Sidai Africa Ltd sell mostly to smallholders, as medium- and large-scale farmers prefer to produce their own feed on-farm (interview with Odede and Kipkoech) to overcome quality and costs constraints. Various feed manufacturing companies, such as Unga, are implementing stringent measures to ensure they use quality ingredients (e.g. screening maize for aflatoxins). The opportunities in the concentrate supply chain lie in enhancing QA of concentrates.

Impact of feed and fodder costs on the cost of producing milk

Farmers generally point to high cost of feeds as a constraint to their enterprises (PPD Consultants 2013). A study by Wambugu et al. (2011) found that concentrates account for 34% and 26% of variable costs of production in zero-grazing and non-zero-grazing systems respectively. The next highest variable costs were for maintenance of real estate (25%) in zero-grazing systems and for labour (24%) in non-zero-grazing systems. Fodder accounted for, respectively, 12% and 14% of variable costs. The share of costs of fodder and concentrates, including farm-grown feed and fodder, has increased over the years. According to Muriuki (2011), in 2008 feed prices increased from KES 100 to KES 200 per bale of hay and from KES 1,000 to KES 1,400 per 70 kg bag of concentrates – perhaps due to the post-election crisis and the world economic downturn. A recent study found that DFCSs were (still) able to sell a bale of hay for KES 120–180 to members (Perfometer Solutions 2013), but that could well have been a subsidized price. Today's concentrate prices are as high as KES 1,650 per 50 or 70 kg bag, depending on the quality (interview with Odede and Kipkoech). Recent analysis shows that overall costs for feeding stands at 67% of total costs of production (Perfometer Solutions 2013), which influences the cost of milk production and subsequently the gross margin.

2.2.1.2 Reproductive and breeding services

Kenya is relatively advantaged compared to neighbouring countries with respect to the dairy herd with high potential for milk production. A study for the East Africa Dairy Development (EADD) program found that 55.6% of households in Kenya keep Holstein-Friesian(s) (crosses), compared to 30.1% in Rwanda and 16.4% in Uganda (Mburu et al. 2011); in addition, Ayrshire(s) (crosses) were kept by 49.6% of Kenyan households. The main challenge is to tap the full genetic potential of the current herd through improvement of dairy cow management.

AI is an established practice in Kenya, although AI service use has declined, attributed to neglect of the dairy sector after the liberalization and collapse of KCC in the 1990s (Baltenweck et al. 2004; Makoni et al. 2014). A number of genetics and breeding service providers are active, including ABSTCM, World Wide Sires, and Indicus. Kenya Animal Genetics Resource Centre (KAGRC) has been the main (public) supplier of semen for AI for a long time and increased production from 40,000 straws in 1996 to 1 million straws annually to date. Nonetheless, KAGRC's market share has fallen from 90% to 60% between the 1980s and 2010s (interview with N.F. Makoni). Total import of semen by private service providers has increased to 400,000 straws in 2015 (Makoni et al. 2014). Apart from this reliance on imported semen, other issues that affect maintenance and improvement of the genetic quality of the dairy herd through reproduction and breeding service include:

- *Expensive and unreliable AI services*– in 2013, PPD Consultants (2013) found that AI services cost between KES 600 and KES 3,000 per insemination, with semi-zero and zero-grazing regions incurring the higher costs. Some of the County governments subsidized AI and sexed semen at a cost of KES 700 for AI and KES 2,500 for sexed semen, which is half the current market rate. One lead farmer visited obtained semen from KAGRC at KES 2,000 for local semen and KES 2,500 for imported semen (interview with S. Langat).

- *High AI failure rate* – this increases production losses as well as costs. The high failure rate could be due to low semen quality (PPD Consultants 2013), poor inseminator skills, or poor body condition of cows at the time of insemination. or a combination of all, which exponentially decreases the success rates. Farmers complain that they sometimes get calves of different breeds from what they asked for (PPD Consultants 2013). These factors lead farmers to resume the use of bulls, considered less expensive and more reliable but often at lower genetic potential, often even downgrading the offspring (PPD Consultants 2013)., which seems to be the case especially in the marginal and low production areas of Western Kenya and Nyanza (Muriuki 2011). Lawrence et al. (2015) found that 87% of farmers involved in the EADD program use bull services, while 54% preferred AI services; a possible explanation for the discrepancy between actual and preferred use of AI services by smallholders relates to the challenges described above.

Another cost constraint in herd reproduction is the high cost of upgraded and pure breeds. On average, costs for a good heifer range from KES 80,000 to KES 200,000, which is prohibitive for most smallholders (PPD Consultants 2013). The median price of a cow of improved breed is 24% of the median annual net income of rural households, thus amounting to a major cost for farmers (Burke et al. 2015). The high cost of quality heifers reflects shortage of replacement stock, which a study in Western Kenya estimated is 43% of the total demand for heifers annually for smallholder farms (Bebe et al. 2014). Some medium- and large-scale farmers seize this opportunity and sell heifers to other farmers.

In addition, calving intervals are generally large, up to 450–500 days (PPD Consultants 2013, interview with Matoke and Otiang). This is attributed to inadequate feeding, poor heat detection, high insemination failures, poor herd health and lack of herd recording for decision-making (ACET 2015, PPD Consultants 2013). The high calving intervals are estimated to cause a production deficit of 450–500 million litres of milk per year nationwide, worth over KES 4 billion (MoALF 2010a), which was roughly the annual intake of the formal chain during that period (see **Figure 1-2**).

2.2.1.3 Animal health services

Several animal diseases threaten dairy sector productivity. Diseases such as brucellosis, lameness, mastitis, tick-borne diseases (TBDs) such as heart water and yellow fever, and transboundary animal diseases (TADs) such as foot-and-mouth disease and lumpy skin disease pose a major threat to the sector; other threats include anthrax, helminthiasis, contagious bovine pleuro-pneumonia and Rift Valley fever (Makoni et al. 2014, MoALF 2010a, ACET 2015, FVM 2010). By far the biggest challenge is East Coast Fever (ECF), which has a prevalence of 45–50%, and is reported by 85% of farmers as being the primary cause of cattle mortality (FVM 2010, MoALF 2010a). Climate change is likely to come with more adverse weather conditions, creating extra animal health hazards and an expected increase in outbreaks of TADs, TBDs, helminths and other diseases (MoALF 2010a).

Direct economic losses from disease outbreaks come from cattle mortality and reduced milk productivity (Makoni et al. 2014). Zoonoses also pose a direct threat to public health – for instance, brucellosis – and an indirect threat if milk quality is reduced – for instance, through increased drug residue content. Indirect economic losses at a national level include lost trade opportunities through tighter restrictions to trade for sanitation reasons (MoALF 2010a).

Veterinary products, both preventive and curative, are widely available in agro-vet shops and through DFCSs. The animal health assistants and veterinarians provide easy access to veterinary services (Kruse 2012, MoALF 2010a), but they are relatively expensive. MoALF estimates that acaricide treatment costs range from KES 200 to KES 2,000 per animal per year (MoALF 2010a). Single acaricide spraying of a dairy cow may cost KES 30 (SoG 2015). It is estimated that in most areas, less than 50% of the communal dips are operational due to poor maintenance and management (FVM 2010). Communications with stakeholders would suggest cost is an issue here as well, because repair of communal dips may cost up to KES 300,000, unaffordable for many groups of farmers (SoG 2015); maintaining the proper acaricide concentration in the dipping stations is a continuous challenge (FVM 2010).

The cost of ECF curative treatment has been reported at KES1,000–4,000 per animal per treatment (USD 10–40) (MoALF 2010a). In the interview with Sidai Africa Ltd, it was reported that farmers are charged KES 2,000–3,000 (interview with Odede and Kipkoech). On average, smallholder farmers in Nakuru, Nyamira, Bomet, Kisii Central, Uasin Gishu, Lugari, Nandi North, Trans Nzoia and Bungoma

counties spend on average KES 898 per cow per month on health care, varying from KES 50 for vaccines to KES 4,000 for ECF drugs, compared to a monthly family income from milk of KES 750–45,600 (FVM 2010). This means that the share of income spent on disease treatment can be considerable.

Sidai Africa Ltd is a lead supplier of ECF vaccine to farmers and holds the ECF vaccine stock for the entire country (interview with Odede and Kipkoech). Starting to sell the vaccine was difficult, because initially there was much resistance from ECF curative drug suppliers who were afraid to lose business while at the same time, ECF vaccine was retailed in 40 dose packages, which individual smallholders could not afford for their small herds of one to three cows. This affected the willingness of farmers to buy the vaccine. Over time, however, the delivery of the vaccine has improved and is penetrating the market in 10 dose packages which two or three farmers can jointly team to purchase. Sidai Africa Ltd is partnering with independent service providers in delivering the vaccination on a franchisee basis. Franchising offers advantages in quality control and scalability and provides significant economies of scale which enables franchisees to offer professional services including AI, vaccination and farmer training (MacMillan 2013). The challenge, however, is in vaccine delivery. In addition, a dose needs to be delivered within six hours of the package being opened. Together, this asks for much planning, which adds to transaction costs. The Centre for Ticks and Tick-Borne Diseases in Malawi is working on an innovative, smaller dose package.

2.2.1.4 Farm and dairy equipment and maintenance services

A challenge to farmers is the cost of farm and dairy equipment, be it bailers, feed mixers, dryers, tractors or milk-cooling equipment (interviews with Langat and Angello, Kirwa and Limo; De Jong et al. 2015; MoALF 2010a). The majority of smallholders are unable to invest in equipment at the farm level. Medium- and large-scale farmers invest in equipment such as fodder production machinery, but face utilization capacity problems (Ettema 2015).

An opportunity here is provided by agricultural contracting service provision, which KMDP has piloted with Nundoroto Ltd: In Eldoret, 2015, a member of EDFA (medium and large scale farmers association) managed for the first time to bring down costs of fodder harvesting by letting Nundoroto contracting company pilot a 'maize train', where they brought together two harvesters, tractors with tippers, and a bulldozer from various farmers to speed up harvesting and silaging. The Service Providers Enterprise Network (SPEN) is offering a similar silage contracting service to smallholder farmers, in this case conducted mostly manually (Ettema 2015).

DFCSs, milk processors and a growing number of small private entrepreneurs are engaged in establishing collection and bulking enterprises (CBEs) for raw milk (MoALF 2010a). However, purchase and maintenance of milk-chilling, -testing and -holding equipment is expensive (Kruse 2012, MoALF 2010a, ACET 2015). NMCS, for example, spends KES150,000 annually on repair and maintenance of their three cooling hubs (interview with S.G. Maina).

DFCSs and larger farmers also move into processing and marketing ("forward integration") (ACET 2015); however, major constraints preventing DFCSs investing in processing equipment are the cost and ensuring capacity utilization (interview with S.G. Maina).

KMDP has promoted international linkages between Kenyan farmers/companies and Dutch input and service providers and has had success with medium- and large-scale farmers. However, the Dutch private sector is still quite hesitant to invest much in developing trade relations with the Kenyan dairy sector. The general impression among Dutch private enterprises is that Kenyan farmers are unwilling or unable to pay premium prices for quality products and services (Jansen 2015a). In addition, Dutch products and services are not always a good fit, as the technology may be too advanced for the Kenyan market (Jansen 2015a), for example where tractors, harvesters and barn equipment are dependent on complex software. Recently, several companies – such as Agripoort and Ante BV– have started selling used and refurbished dairy and farm equipment, providing an opportunity to Kenyan farmers.

While the use of refurbished equipment provides an opportunity for DFCSs – just as for farmers – the challenge is to ensure the quality of the refurbished equipment. For instance, the interview with NMCS revealed that they received – through support from a public actor – a refurbished milk-vending

machine that had functioned in both China and India, but which broke down almost immediately after arrival at NMCS (interview with S.G. Maina).

2.2.1.5 Access to credit[2]

Much emphasis in the literature is on the provision of credit to dairy farmers, while other DVC actors remain more or less out of sight, except for Kruse (2012) noting that that milk transporters can easily obtain loans for motorcycles. Thus, PPD Consultants' (2013) call for identification of the less bankable parts along the DVC seems justified: support is to be concentrated on those spots that enable further development of the DVC.

Kenyan farmers can access credit to invest in their farming business in roughly five ways: a) microcredit and saving within cooperative groups (SACCOs); b) microcredit from microfinance institutions (MFIs); c) loans from commercial banks; d) loans from government-affiliated funds; and e) credit from DVC partners. From the literature review and interviews (e.g. with Chase Bank Kenya) it appears that loans from commercial banks are mainly suitable for medium- to large-scale farmers, while smallholders rely mostly on credit from DVC partners and on microcredit from SACCOs. Below is a discussion of the various financial strategies used to improve access to credit:

a. *Commercial banks* so far have provided few appropriate financial products for the dairy sector (Makoni et al. 2014). The main bottlenecks are the strict loan conditions (Muriuki 2011, MoALF 2010a), the high interest rates of 15–20% and processing fees of 1–3% (interview with Kirwa and Limo; MoALF 2010a). For commercial banks, dairy businesses represent relatively high risk due, for example, to dependence on variable weather, unclear markets, and financial illiteracy of many dairy farmers (SEGURA Partners 2013; interview with Ndonga and Njuguna) and that they lack formal collateral because of the inadequate property registration system (SEGURA Partners 2013, MoALF 2010a). Yet some banks are developing financial products and services geared towards dairy farmers, and most banks will allow the assets to be procured to function as collateral (MoALF 2010a), or will accept cash flow as evidence of business performance (Makoni et al. 2014) or are even allowing the dairy herd to be used as the guarantee for loans (interview with Kirwa and Limo).
b. *Collateral guaranteeing*–a fund from USAID's Development Credit Authority guarantees 50% of collateral demand on Kenya Commercial Bank loans, reducing the collateral constraint and allowing the bank to provide loans to small- and medium-scale enterprises. Most banks now reduce investment risk by combining credit and insurance in one package and encourage borrowing as collective (interview with J. Chepkoech; MoALF 2010a).
c. *Value chain financing* –different actors in the DVC provide credit to dairy farmers, most notably DFCSs, input suppliers and milk buyers such as traders and processors. DFCSs allow their members to access advance payment for their milk or access loans through CBE-affiliated SACCOs. CBEs are the most important source of loans for smallholders (Makoni et al. 2014); they use "check-off systems" for credit against future milk payments. Processors such as Githunguri DFCS, Kinangop Dairy and New Kenya Cooperative Creameries (New KCC) work with a similar structure (interview with D. Menjo; Makoni et al. 2014). Brookside provides credit on inputs provided by Sidai Africa Ltd through a check-off arrangement called a "controlled credit system". Similarly, some milk traders pay farmers before milk is delivered, which provides a form of credit and binds the farmers (ACET 2015). An important benefit of this "trade credit" is that both the sale and the price is secured for both parties, and the farmer obtains cash that can function as working capital. Limitations are that side-selling can take place and the quality and quantity of produce is not assured and is uncertain (Miller 2012). Smart Dairy – a company offering an integrated dairy farming concept in a franchisee model – is planning to provide major loans to its franchisees which the franchisees will pay back through milk deliveries (interview with F. Campbell).
d. *Microfinance institutions and government-affiliated funds* include the Agriculture Finance Corporation (AFC), Youth Enterprise Development Fund (YEDF), Women Enterprise Fund (WEF), Kenya Livestock Finance Trust and National Fund for the Disabled of Kenya (NFDK). Research is

[2]Access to the other production factors are discussed in the following chapters: land in Chapter 3: Reliable institutional governance; labour in Chapter 4: Resilient innovation support systems.

required to understand how microfinance institutions aid innovation in the dairy sector. AFC loan conditions are said to be similar to those of commercial banks (interview with Kirwa and Limo; Muriuki 2011). The YEDF, WEF, and NFDK are discussed in Annex 2.

e. *The African Enterprise Challenge Fund* (AECF) is a USD 200 million multi-donor trust fund supported by Western donors. AECF is an outstanding example of a streamlined and well-coordinated fund in that partners work synergistically to maximize the fund's effectiveness (interview with Ndonga and Njuguna; AECF n.d.).
f. *Capacity enhancement* of (dairy) farmers is another strategy to reduce investment risk. Equity Group Foundation has been training dairy farmers in milk production and financial planning. The Foundation "feel[s] like the risk has been reduced because [they] are working consistently with [the farmers] and they are receiving trainings" (interview with J. Chepkoech).
g. *Bank partnerships* have been used to leverage better financial access. For instance, in 2012 Chase Bank partnered with Rabobank to learn from Dutch agri-finance experiences in developing affordable financial solutions for dairy farmers in Kenya (interview with Ndonga and Njuguna).

2.2.1.6 Access to land

A major threat to the dairy sector is the decreasing size of land holdings among smallholder dairy farmers who continue uptake of dairy enterprise, particularly in peri-urban areas (Makoni et al. 2014). It is a threat because it reduces the capacity to produce enough quality fodder to feed dairy cows, which in turn negatively affects cost of production. Small-scale farmers on average keep three dairy cows on 0.2–3 hectares of land devoted to dairy production (ACET 2015, Ettema 2015). In the Rift Valley, dairy production is less intensive; in areas such as Eldoret and Nanyuki, large tracts of land are available, resulting in farms of 20–2,000 hectares (Makoni et al. 2014).

2.2.2 Milk marketing issues

2.2.2.1 Secure milk supply

With four dairy processors dominating the market (ACET 2015), farmers and their cooperatives need to ascertain their ability to supply milk throughout the year to maintain bargaining power with the processors. The two biggest challenges for the cooperatives include the seasonality of milk production and the competition in milk procurement with informal sales (side-selling) , which members engage in to diversify milk income streams to the household.

Side-selling is possible because of a ready alternative market available to farmers: milk traders, local markets and neighbours offer direct cash and prices that are up to 70% higher under informal or contractual agreement with the traders (ACET 2015; Kruse 2012; interview with S. Langat). The establishment of processor-owned bulking points closer to the farm also provides an incentive for farmers to sell their milk there rather than to the cooperative (Kruse 2012). The relationship between traders, processors and cooperatives is complex, as some traders do source milk from cooperatives and sell milk to processors as well (ACET 2015).

Seasonality is linked to fodder and feed access as already described. Lack of consistent milk supply in the formal DVC leads to underutilization of bulking and cooling capacity in the dry season at both CBE and processor level, compromising business profitability and risking inflation of consumer prices (Makoni et al. 2014). In contrast, during the wet season, milk bulking and chilling capacity is insufficient.

The dairy hub model promoted in the EADD program (see Box 4) has stimulated farmers' investment in chilling tanks for bulking and integrated the hub model that enables access to inputs and services as a way of building farmer loyalty and mobilizing large volumes of milk (Kruse 2012, Kilelu et al. 2013). Yet, results have been mixed as an EADD-I project evaluation showed that there were "tremendous difficulties" related to keeping farmers "loyal, active and engaged" (Firetail 2013, Kilelu et al. 2013).

Another strategy to improve farmer loyalty is by offering a year-round stable milk price at competitive levels. The alternative for farmers is to accept significant reductions in farm gate prices and processor-imposed ceilings on collected volumes at the onset of the glut season. New KCC as well as Meru Central Dairy Farmers Cooperative Union (MCDFCU) have employed this model, and, they report realising improved farmer loyalty (interviews with K. Gitonga; D. Menjo).

Box 4: Dairy business hubs and strengthening the supply chain –the EADD experience

While the growth of the dairy sector in Kenya presents many opportunities along the value chain, most smallholder dairy producers are unable to transition from subsistence to commercialized production. Key limiting factors include high transaction costs and other bottlenecks in accessing inputs and services (Kilelu et al. 2016). The dairy hub model is one innovative approach developed to address this challenge. The dairy hub entails a farmer-owned and -managed milk stock and chilling centres established in various rural areas. These centres become agribusiness centres that support and attract a network of businesses delivering inputs and services to the farmers who supply milk to the farmer-owned enterprise (Kruse 2012). The East African Dairy Development (EADD) project in Kenya aimed to support the development and scaling up of dairy hubs in the Rift Valley and Central Kenya regions (Mutinda et al. 2015)

The dairy hub aims to build a robust dairy supply chain through a variety of business strategies and social relationships that are formed with the interests of all value chain actors in mind. Hubs can create opportunities for and transform private sector participation in the dairy sector. They have been proven to be potentially strong platforms for improving access to markets, inputs and services for men and women smallholder dairy farmers alike. Indeed, they are transforming rural regions (Kilelu et al. 2016, Mutinda et al. 2015).

CBEs add services and supplies such as agro-vet shops, animal health assistance, veterinary services, AI services and extension services. Farmers delivering to the chilling hubs have a credit facility based on their milk delivery. When they need input supplies or services, these are "checked off" from their balance. Hence the chilling hub functions as a financial intermediary trusted by all parties.

A possibility to prevent side-selling would be the development of contract farming with a contract enforcement clause. In the Kenyan dairy sector there are no examples known of this (as yet, although Smart Dairy's model comes close). Much can be learned from other sectors, such as the Malaysian French bean and Senegalese peanut sectors, where contract farming is practised with beneficial success (Wiggins and Keats 2013).

2.2.2.2 Access to market (bargaining power)

Dairy cooperatives lack bargaining power against processors in an oligopolistic market where milk sellers are essentially price-takers (PPD Consultants 2013). An example of the bargaining power of Brookside was described in the interview with NMCS (interview with S.G. Maina). NMCS had negotiated a milk price of KES 37 per litre for a year with Brookside. Yet when milk volumes started to increase and reached levels above 60,000 litres daily, Brookside decided to cut the milk price for the volume above 60,000 litres, paying only KES 32–35 per litre. When the daily milk volumes declined below 50,000 litres, Brookside also cut the milk price. NMCS cannot sell the extra volume to other processors, because it is too small to negotiate a good milk price; also, other processors suffer the same glut, so they just have to accept the price offered by Brookside.

In theory, an opportunity for dairy cooperatives would be to move into processing (forward integration). In practice, many DFCSs lack the scale and the management capacity to succeed in processing. DFCSs can successfully invest in processing at union/secondary cooperative level if they can access affordable credit and mount aggressive market campaigns, as demonstrated by successes of Githunguri Dairy Farmers Cooperative Society and MCDFCU (interview with M. Munene; Rademaker et al. 2016). From the interview with NMCS, it appeared that the two barriers withholding them from moving into processing are affordable credit to invest in a processing plant and the dominance of Brookside in the retail market, making it very hard to penetrate that market with a new product (interview with S.G. Maina). Clearly, those barriers are not particular to the situation of NMCS but apply broadly to Kenyan DFCSs.

2.2.2.3 Milk prices and profitability

Most farmers consider the current milk prices to be low compared to the cost of production (PPD Consultants 2013). Milk prices vary greatly by region and type of milk buyer, the general impression being that higher milk prices are paid by milk traders, close to urban areas. According to a farmer close to Nakuru, a milk trader pays KES 45–50 per litre (interview with S. Langat); in Eldoret, delivery

to institutional customers will yield KES 60 per litre (interview with Kirwa and Limo), while farmers receive KES 32–37 for bulk milk.

As previously noted, the cost of production in Kenya is relatively high, which is attributed to inadequate management, high external input use and low economies of scale of the primary producers (Muriuki 2011). Farmers using a zero-grazing system with high input costs are particularly challenged to make a profit (ACET 2015). However, the production system alone does not explain all the variance, as ACET (2015) reports that farmers using a zero-grazing system around Githunguri had the most profitable businesses – in terms of gross margins – of a sample group that included both zero-grazing and non-zero-grazing systems in multiple regions.

Although the processors have significant bargaining power, their estimated profit margins are not very high (10–20%), which is in line with international standards (TechnoServe 2008). ACET (2015) has suggested that those relatively low profit margins, given processors' strong position, can be explained by the presence of a much larger and highly competitive informal sector. The market dominance of the informal channel was confirmed in the interview with New KCC, during which it was noted that informal milk traders out-compete the processors because traders can pay farmers directly upon delivery (interview with D. Menjo), whereas payment from the processor to the cooperative typically takes two weeks to a month, and it still takes another couple of days before the payment reaches the farmer. Short-term cash flow is important for farmers, and this is a constraint for contract-based production. Processors claim that they cannot pay faster due to slow payments by supermarkets, which have payment periods of 120–150 days (interview with D. Menjo).

The processor profit margins mentioned before are estimates, because figures about profit and cost of production are not widely available (interview with M. Munene). Greater transparency here would greatly facilitate insight to the economic sustainability of the entire dairy sector. What is known though is that the processing cost is impacted by high energy costs, outdated and/or expensive machinery and equipment (e.g. Tetra Pak packaging technology) and poor road infrastructure (PPD Consultants 2013, MoALF 2010a). Githunguri Dairy Farmers Cooperative Society has taken the lead in reducing packaging costs of milk through use of cheaper pouches (ACET 2015, MoALF 2010a).

To compete with the lower prices in the raw milk chain, supermarkets such as Tuskys have started to sell raw milk (ACET 2015), showing that retail sales models will change to reflect consumer preferences for raw milk.

2.2.2.4 Regional milk markets

Due to increased demand in Kenya and relatively low production costs in Uganda, Kenya is currently a net importer of milk (interview with Matoke and Otiang; De Jong et al. 2015). Production of value added products such as milk powder, ghee, yoghurts and cheese is growing, but overall still low. Enforcement of quality standards is insufficient. From an import–export perspective, these are important weaknesses.

A regional market for Kenyan dairy products is widely available because of free movement of dairy products within the East African Community (EAC) and tripartite regional arrangements involving EAC, Common Market for Eastern and Southern Africa (COMESA) and Southern African Development Community (SADC) facilitating regional trade (PPD Consultants 2013). In the broader African region, demand for milk is expected to increase across the board following increasing populations, urbanization and rising incomes (Makoni et al. 2014). The main challenge for Kenya in operating successfully in the regional markets is to improve milk quality and lower the cost of milk production (interview with Oosterwijk and Ndungu; MoALF 2010a). In this regard, the regional East African Dairy Regulatory Authorities Council (EADRAC) shows promise in facilitating the harmonization of dairy product regulations and standards within the EAC. Record keeping from the farm level up will also be of utmost importance to enable traceability, which is a prerequisite for penetration of regional markets. Exporting to North African countries will be challenging because of competition from cheap exports from Europe and Australia to that region.

2.2.2.5 Supporting infrastructure for the dairy value chain

In this section we describe the supporting infrastructure for the dairy value chain, including the electricity grid and the road network. ICT as infrastructure that supports innovation and knowledge is described in Chapter 4. Industry organizations are described in section 4.2.

2.2.2.6 Electricity grid

Milk bulking and chilling centres and processing plants need electricity to prevent deterioration of milk quality, especially the evening milk in areas where milk is only collected in the morning (ACET 2015). Before rural electrification reached many villages, CBEs and processors invested in diesel generators, also to manage the frequent interrupted supply, which drive up operational costs. Electricity costs are prohibitive for small cooperatives (Makoni et al. 2014, PPD Consultants 2013, MoALF 2010a). Thus, providing cheaper electricity and solar power, are investment opportunities for the public and private sectors, to foster the development of the dairy sector (Makoni et al. 2014) and to enhance energy efficiency in the DVC to also address climate change concerns.

There are isolated attempts to adopt renewable energy technologies, such as solar panels, to power cooling systems of chilling tanks to reduce costs (interview with Kirwa and Limo). For example, the cooling plant owned by Mr Kirwa is run on solar power; if this proves viable, it may be that the technology can be applied in other dairy farms.

2.2.2.7 Road network

Costs of transportation in Kenya are relatively high due to the poor state of rural roads in the areas where milksheds are (ACET 2015, PPD Consultants 2013, MoALF 2010a). Connections between major towns such as Nairobi, Nakuru, Eldoret and Kakamega are generally good, with tarmac roads. Poor roads contribute to spillage as well as spoilage occasioned with the delays in milk delivery to collection centres and processing plants (ACET 2015, MoALF 2010a), which result in rejection on basis of quality deterioration (Muriuki 2011). Poor roads are also a challenge for delivery of AI services. For instance, in Nyandarua County only 30% of farmers are serviced with all-weather roads, which contributes to the fact that only 43% of farmers have access to AI services (ACET 2015). Investment in the national road network by the GoK and development partners is a priority to facilitate further development of the dairy sector (Makoni et al. 2014). A positive development by county governments (e.g. Murang'a and Nyandarua) is joint investments in build roads and bridges to connect milk producers and markets (ACET 2015).

2.3 Environmental aspects of the value chain

The dairy sector faces several environmental challenges with respect to soil erosion, water pollution, waste and manure management and greenhouse gas emissions. However, there is limited awareness of the environmental impact of the sector (Muriuki 2011, Makoni et al. 2014). The prevailing mixed farming systems offer opportunities to address some of these challenges, for example, through use of manure for crop fertilization (Herrero et al. 2010). There are ongoing efforts to mainstream environmental issues in the sector with upscaling of climate smart agriculture, both for addressing climate change and for dairy development (CCAFS 2015).

2.3.1 Erosion and water pollution

Negative environmental impacts of the dairy sector in Kenya include loss of vegetation through overgrazing of natural pastures (Muriuki 2011). As extensive grazing is mostly practised in the Rift Valley region, uptake of more intensive dairy production across ecosystems in the country is contributing to changes in land use, with more land needed to produce feed for dairy cows (Bebe et al, 2002). Another issue is surface water pollution from bulking and processing activities (Muriuki 2011). There is an opportunity to produce biogas from dairy wastewater (Fischer et al. 2010).

2.3.2 Packaging waste

Another issue related to milk processing is the widespread use of plastic materials for packaging of dairy products (Muriuki 2011), without sufficient attention to reduction of these materials and/or the development of plastic recycling systems.

2.3.3 Manure handling

The handling of manure in urban and peri-urban areas may lead to eutrophication and pollution of groundwater. Muriuki (2011) notes that such concerns over environmental pollution within urban and peri-urban areas may lead governments to limit dairying in those areas, which poses a threat to the dairy sector. An opportunity is to improve manure management on farms which can save expensive fertilizers and improve soil quality (Makoni et al. 2014) through the application of increased amounts of organic matter from manure. Furthermore, dairy manure can be transformed into biogas. The International Fund for Agricultural Development (IFAD), GIZ (the Deutsche Gesellschaft für Internationale Zusammenarbeit), the Kenya National Farmers Federation (KENAFF), SNV and Hivos all support the construction of biogas mini-plants on dairy farms (Kimanthi 2015, interview with Kembe and Kibiego). The uptake of biogas by farmers is however constrained by low levels of education and awareness of the technology, financial access, non-fit with production system used and limited land tenure security (Mwirigi et al. 2009).

2.3.4 Greenhouse gas emissions

Dairy farming contributes to greenhouse gas emissions, with relatively higher emissions for lower yielding cows and cows fed on lower quality feed and fodder (interview with P. Wanjugu). Increasing the efficiency of milk production through increasing milk yields and/or changes in dairy cow rations provides opportunities to reduce relative greenhouse gas emissions and also has economic efficiency advantages (Makoni et al. 2014). Ongoing work among smallholders in Kiambu, Uasin Gishu, Meru and Kisii Counties (Nyaanga et al. forthcoming) and Nandi County (interview with P. Wanjugu) reveal that from an agronomic perspective, much room exists for improvement of manure management and for investments to increase farmers' income and reduce costs of production.

2.3.5 Agrobiodiversity –loss of indigenous cattle breeds

Many development efforts emphasize breeding for improved dairy cow performance, usually meaning higher milk yields. These efforts promote superior genetic material that are mainly exotic dairy breeds. These development strategies expose indigenous cattle breeds such as Zebu to increased risk of extinction (Mwai et al. 2015; Ruto et al. 2008). At least from the perspective of agrobiodiversity and resilient production systems, conservation of such breeds with superior resilience deserves attention linked to unique attributes of their products.

2.4 Social aspects of the dairy value chain

2.4.1 Processor oligopoly and level playing field

As described before, the Kenyan DVC is characterized by what is sometimes called a "processor oligopoly", where four processors hold the majority of the processed market share (ACET 2015). This concentration of power can be seen as problematic, as abuse of this power position is a continual temptation for processors and a threat to the livelihood of smallholder milk suppliers. This trend towards power consolidation is not peculiar to the Kenyan dairy sector, but a trend in agricultural value chains worldwide (EcoNexus 2013). For further discussion, see Chapter 3: Reliable Institutional Governance.

MoALF reports that the general impression in the dairy industry is that New KCC, as a parastatal, enjoys favourable treatment from the GoK, such as supply orders from government institutions (MoALF 2010a). Hence, the broader industry is calling for complete privatization of New KCC (MoALF 2010a). The perspective of New KCC is that it has the challenge of increasing profits while having to buy the excess milk on the national market – which happens during the wet season – and processing it into milk powder for stocking. It therefore receives funding from the GoK Strategic Food Reserve to help cushion any risk associated with delivering its national mandate (interview with D. Menjo).

An opportunity to break the trend towards a processor oligopoly is facilitation of a cottage industry, coupled with support to increase consumption of other dairy products such as cheese (ACET 2015).

Currently, some 150 cottage industry–level outfits are active in Kenya, providing a broad base to work on. Successful and innovative cottage industries include Raka Cheese, Brown Cheese and Happy Cow.

Another opportunity would be lobbying by consumer organizations to enforce milk quality standards (EcoNexus 2013, PPD Consultants 2013). This would first require significant improvements in the effectiveness of consumer associations, such as the relatively inactive Consumer Federation of Kenya. In any case, it is most important to have public discussion about whether and how to regulate market power and/or enforce regulations.

2.4.2 Public health risks

Dairy farming and milk consumption pose several disease threats for humans, which in the Kenyan context mainly concerns brucellosis, tuberculosis, cryptosporidiosis and aflatoxicosis (Arimi et al. 2005; FMV 2010; Kang'ethe et al. 2007, 2010, 2012; Namanda et al. 2009; Yard et al. 2013).

The unprocessed milk chain is typically accused of facing severe milk quality issues, among which are high levels of hazardous bacteria, aflatoxins, preservatives and drug residues, as well as adulteration of milk. An often-mentioned and significant factor in high bacteria counts in milk is the use of plastic jerry cans by farmers and milk traders, which are hard to clean (MoALF 2010a; interviews with Oosterwijk and Ndungu, Odede and Kipkoech). This practice has even been called unethical (interview with Oosterwijk and Ndungu). Yet, bacterial loads above KeBS standards (<30,000 cfu/ml for total bacteria counts) have been reported for both raw and processed milk (Omore et al. 2005). Langat et al. (2016) found that aflatoxin-content of processed milk was lower than in raw milk, which was attributed to the heat treatment that milk undergoes in the factory (more on this below). Antibiotic drug residues are found in equal amounts in raw and processed milk samples (6% at market level and 9% at consumer level for raw milk samples and 8% for processed milk samples), as heat treatment does not affect drug residue levels (Omore et al. 2005).

Processors have also been blamed for preserving milk with illegal preservatives such as hydrogen peroxide. Clearly, more research is needed here to identify critical control points (e.g. Ndungu et al. 2016, Orregård 2013).

In Kenya, milk is mainly used in tea and the milk is heated before being consumed. This heating of the milk effectively reduces the risk of obtaining brucellosis and tuberculosis via the milk (Kang'ethe et al. 2010, Namanda et al. 2009, Arimi et al. 2005), but the effect of boiling on the risk of getting aflatoxicosis is not clear, with some studies reporting reduction of aflatoxin-content in the milk and others showing no reduction (see discussion in Langat et al. 2016). Yard et al. (2013) mention several interventions to reduce aflatoxin exposure that have proved effective in controlled studies. These include the planting of *Aspergillus flavus*–resistant cultivars, spraying atoxigenic strains of *A. flavus* on maize to crowd out toxigenic strains and developing strategies to assist smallholder farmers with appropriate drying and storage techniques.

Business models to improve milk quality include a quality-based milk payment system (QBMPS) with which Happy Cow is experimenting, supported by KMDP (Oosterwijk and Ndungu). In this system, dairy farmers are paid according to the quality of milk they supply. A challenge with QBMPS is, however, that the processor needs to pay a premium price for the milk to provide for an incentive for farmers to deliver the milk to them, as alternative markets are available.

2.4.3 Inclusive dairy value chain – youth, gender and resource-poor farmers

Dairy farming is dominated by the older generation. According to officers at MoALF, the average dairy farmer is 60 years old; young people are underrepresented because they want quick money, while dairy farming is hard work (interview with Matoke and Otiang). However, a study by Sulo et al. (2012) identified lack of access to capital and resources such as land, lack of skills and inadequate financial services as the main constraints preventing youth from participating in dairy farming. It is estimated that 64% of youth in Kenya is unemployed (Njenga et al. 2013), so creation of employment opportunities is a strong priority in rural areas.

There are opportunities for the youth to engage in other DVC nodes, including in feed businesses and milk bars/vending (Sulo et al. 2012). Many young men are getting into the milk transporting business

because roads are in poor condition and milk loads may be heavy – up to 200 kg – so the physical strength they have to handle the motorbike is their advantage (Kruse et al. 2012; interview with M. Munene). Young people also enter farming when they inherit land from their parents; they can become entrepreneurs if they are willing to commercialize the farm (De Jong et al. 2015). Usually young people increase their productivity by using the land they own as well as fallow land they lease from other farmers, on which they put extra dairy cows (De Jong et al. 2015).

The issues of access to land, extension services, information and training, and credit affect women differently from men (Makoni et al. 2014, Kristjanson et al. 2014, MoALF 2010a), hindering female-headed households from tapping into economic opportunities in the sector. Because land in dairy farming mainly serves to produce fodder, lack of access to land by female-headed households is not problematic if feed can be bought on the market (Kristjanson et al. 2014). Land is also important because it may be accepted as collateral to obtain loans, despite some challenges (see section 2.2.1.5 Access to credit). Women overcome the issues of access to credit by forming cooperative microfinance systems; indeed, credit and savings funds of women's groups are common in Kenya (Kristjanson et al. 2014). Although loans obtained from such women's groups typically go to non-income-earning activities, some groups allow loans for dairy production purposes (Kristjanson et al. 2014). Specific credit opportunities for women are available through the Kenya Women Microfinance Bank and the parastatal Women Enterprise Fund (WEF) (see Annex 2).

In Kenya, most peri-urban dairy farmers are women. They keep about the same number of cattle as men, but men are more likely to own improved dairy cattle (Kristjanson et al. 2014). However, in most cases women's roles are mainly as managers of dairy cattle, while men do the marketing. This division of roles and responsibilities increases the risk of abuse by men, as they are in control of the money (Makoni et al. 2014). The GoK is committed to achieving gender equity as enshrined in the 2010 Kenyan Constitution (RoK 2010).

Female participation in leadership positions is low in dairy cooperatives, unions and associations (Bebe et al. 2016). Yet it was noted during an interview that the most successful cooperative boards are balanced in terms of expertise, age and gender (interview with I. Baltenweck).

In the interviews it appeared that most people are in favour of a move away from a supply-driven approach towards a market-led approach in the sector. But this raises the question of what further commercialization will mean for the livelihoods of the estimated 1.8 million or more small-scale dairy farmers (ACET 2015). It is to be expected that with increasing investments in the dairy sector, small-scale farmers' production costs will remain uncompetitive (resulting in "hanging in" – i.e. being stuck in), except for those that transition to commercial farming ("stepping up" – i.e. being pushed into) or change to other livelihoods ("stepping out" – i.e. being pushed out) (for labels, see Dorward et al. 2009). However, given the high unemployment rate among youth, especially in rural areas, the question is what other livelihood options are, or will be, available for those who quit dairy farming. Clearly, more research, as well as inclusive stakeholder collaboration, is needed here to explore different development scenarios for the sector.

2.4.4 Animal welfare

Animal welfare is generally not considered an important and urgent (policy) issue in the Kenyan dairy sector. This is not to say that providing good care to animals is not considered important, especially in relation to improving productivity (interview with G. Katothya). According to Makoni et al. (2014), important factors influencing poor husbandry practices of farmers are lack of resources, limited education and small land holdings.

Currently, there are no development projects known with improving animal welfare conditions as an explicit focus. Yet, several aspects of animal welfare are crucial for improving dairy milk production as well, such as good housing, feeding and watering, and veterinary care. It seems likely that the issue of animal welfare will increase in urgency and importance when Kenya enters more into export markets, because of differing views on animal welfare across countries.

3 Reliable institutional governance

Reliable institutional governance refers to public–private cooperation, co-innovation and a public economic policy framework that supports private investment and enhances opportunities for (inter)national trade. This chapter focuses on how policies, standards and markets are supportive from a trade perspective, that is, the degree to which they provide an enabling environment for private investment and enhance trade opportunities.

Since 2010 in Kenya, the development of supportive dairy sector policy frameworks is the responsibility of the GoK, while county governments implement service delivery including veterinary, breeding and T&E services (interview with Matoke and Otiang). The discussion of regulatory instruments here refers mostly to the GoK policy and laws (see **Figure 3-1** for an overview), while in the next section on economic and soft instruments, policy and implementation strategies of the counties are discussed as well. The discussion is limited to those policy instruments that hold a clear relationship to the DVC issues discussed in the previous chapter.

The strengths, weaknesses, opportunities and threats associated with the policy instruments discussed in this chapter are reviewed in **Table 3-1**.

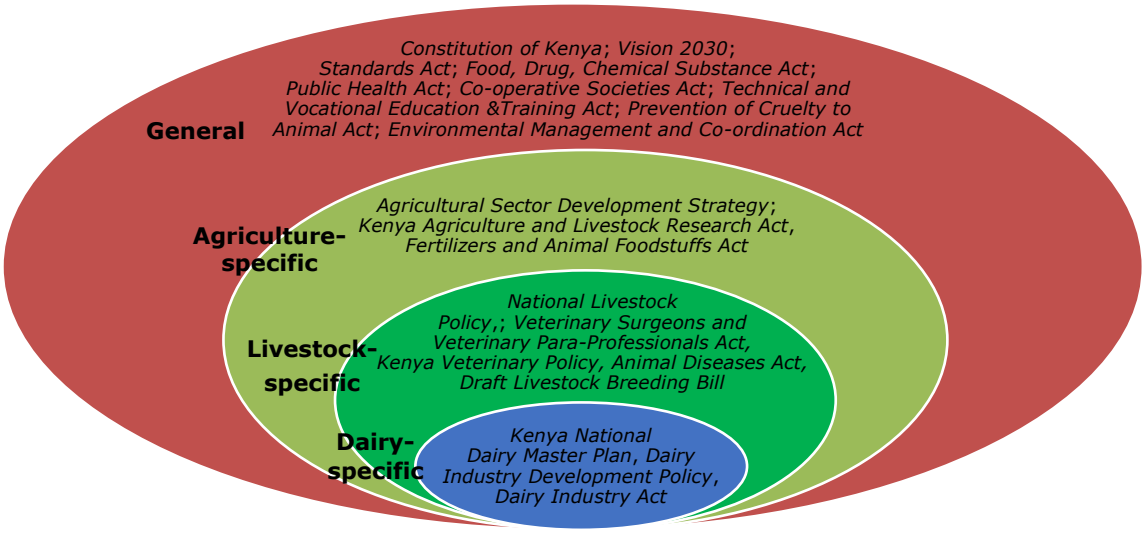

Figure 3-1 *The Kenyan dairy sector is regulated by a range of policies and laws, depicted here in concentric circles; wider circles represent policies and laws that less specifically target the dairy sector*

3.1 Regulations and policies

Regulations are legal instruments that regulate social and market interactions and are typically obligatory, with threats of sanctions in case of non-compliance (Borrás and Edquist 2013). The relationship between regulatory instruments and innovation can be direct, where the design of the regulation is to encourage knowledge and innovation activities, or indirect, where the design is to produce a different effect, but knowledge and innovation activities are fostered (Borrás and Edquist 2013). An example of the latter is when the use of some – polluting – industrial compounds is prohibited on the grounds of public health, which induces companies to seek alternative compounds or innovative production processes (Borrás and Edquist 2013).

Table 3-1 *SWOT analysis for institutional governance in the dairy sector*

Institutional context	Strengths	Weaknesses	Opportunities	Threats
Regulations	- Regulations on environmental quality and public health exist - Revised (2012) *Dairy Industry Act* confirming the roles of KDB in dairy development and regulation and registration of primary producers - EADRAC established to promote intra-regional trade and development of shared quality standards	- Weak regulatory framework on milk marketing - Uncoordinated and inefficient QA systems for feed, fodder and milk - Poor compliance of milk procurement contracts - Poor compliance with quality and safety requirements - Uncontrolled drug prescription and usage - Concentrated processor segment - Weak governance and management in cooperative sector, resulting in malfunctioning - Feed policy developed at national level is yet to be approved	- Development of QA systems for feed, fodder and milk - Regulation and QA of private investments - Formalization of milk traders that may enable better regulatory monitoring - Contract enforcement mechanisms for milk procurements between farmers, CBEs and processors - Enforcement of regulations on drug prescription and use - Restructuring of the role of KDB to play a larger role in regulation and compliance	- Increasing regulation of unprocessed milk chain may drive up milk prices
Economic instruments	- Regional trade: free movement of most goods within EAC market - Tripartite regional arrangements involving EAC, COMESA and SADC facilitating regional trade - Beneficial tax regime proposed for investment in processing facilities and feed ingredients - Strong GoK and county government support to and investments in the dairy industry	- Sector support interventions by the GoK and county governments subject to political goodwill	- County governments investing in dairy sector support (AI services, sexed embryos, equipment) - Reduction of 60% import levy on dairy products likely to reduce consumer milk price	- Subsidized exports from Europe threat to Kenyan export opportunities to North Africa - Market distortion through subsidized inputs and services by county governments. - Reduction of 60% import levy on dairy products threat for Kenyan milk producers
Soft instruments	- KeBS has developed a Code of Practice for hygienic milk production and handling - KDB and county platforms offer opportunities for consultation among sector actors - Promotion of milk drinking culture through school milk program - Awareness of environmental issues increasing through national education systems and media coverages	- Actors have insufficiently articulated and shared vision for the sector - Lack of effective and sustainable sector platforms to drive sector vision and agenda - Low compliance with KeBS's Code of Practice	- Strengthen PPPs to address extension and service delivery and marketing - National promotional campaigns of nutritive value of milk	

3.1.1 DVC policies

Two overarching policy documents set a vision for the growth of the Kenyan dairy sector: The *National Livestock Policy* (MoLD 2008) and the *Kenya National Dairy Master Plan* (MoALF 2010a), and both are anchored on the *Agricultural Sector Development Strategy and Vision 2030* (RoK 2007). The strategic vision of the *Kenyan National Dairy Master Plan* is "to transform milk production and trade into an innovative, commercially oriented and globally competitive dairy value chain by 2030". There are four strategic action plans for realising this and their focus is increasing productivity and competitiveness; efficient delivery of demand-driven services by public and private sectors; formulating beneficial working policy and regulations, infrastructure and enforcement; and mainstreaming cross-cutting issues into dairy value chain development.

However, these policies are yet to receive the robust implementation needed to build a shared vision for the dairy sector among the actors, because the policy development process involves very limited consultation (PPD Consultants 2013). The *Kenya National Dairy Master Plan* (MoALF 2010a) promotes development of the processed, value added milk chain, yet consumers continue to strongly prefer raw milk (ACET 2015).

A more recent policy document is the *Kenya Veterinary Policy* (MoALF 2015b)2015a). This policy is provided for in the Fourth Schedule of *The Constitution of Kenya* (RoK 2010) and aims to align developments in the Kenyan livestock sector to the Constitution and to Kenya Vision 2030 as well as to the international animal health laws, treaties and conventions ratified by Kenya (MoALF 2015a). The veterinary policy provides a framework for operationalizing a Veterinary Medicines Directorate to regulate manufacturing, importation, exportation, registration, distribution, prescription and dispensing of veterinary medicines and poisons. The policy also encourages private sector investment in vaccine production; establishing a Kenya Animal Genetics Resources Board to coordinate breeding activities, livestock registration, data collection and management for performance evaluation; and developing and promoting preservation of Kenya's animal genetic resources by KAGRC. Although the veterinary policy contains several opportunities to facilitate the development of a robust value chain, its implementation will need significant attention to materialize those opportunities. The policy overlaps with several other pieces of legislation that are already operationalized, meaning harmonization will be necessary for its effective implementation. For example, the *Kenya Veterinary Policy* supports the establishment of the Kenya Animal Genetics Resources Board (MoALF 2015a), while another policy document – the Draft Livestock Breeding Bill (MoALF 2015b) – proposes to establish the Kenya Livestock Breeding Board, which in turn is to establish a Kenya Livestock Breeding Bureau.

3.1.2 DVC regulations

Kenya is supporting economic robustness of the dairy sector with several policy instruments summarised in Annex 3. To be consistent with the categorization already adopted in Chapter 2, policy instruments are categorized by their influence on economic, environmental and social robustness and where in the value chain the influence is directed.

The regulations are broadly in two classes, either directed to influence robustness of the entire value chain (the *Dairy Industry Act*) or directed to influence robustness in specific areas within the industry. The specific regulations affect several areas, including trade (*Standards Act*, *Fertilizer and Animal Feedstuffs Act*), utilization and conservation of animal genetic resources (*State Cooperation Act on Breeding and Breeding Services*), regulating professionalism (*Veterinary Surgeon and Veterinary Para-professionals Act*), and disease control (*Animal Disease Act*). Other regulations are specific to conducting research, compliance with public health and environmental requirements and land tenure.

These regulatory policy instruments as implemented have not sufficiently stimulated deployment of Science, Technology and Innovation (STI). Firstly, policies that directly target dairy research and T&E are not yielding the needed innovations for the sector because of low engagement between relevant institutions on the one hand (MoALF, KALRO, colleges and universities), and between farmers and input suppliers on the other. This is related to limited end-user relevance of ongoing research and T&E. An opportunity here is to expand the use of economic transfer instruments through the creation of PPPs for a dairy research agenda that is shared by stakeholders.

Secondly, limited enforcement of regulations and standards negatively affects development of knowledge and innovative activities, because established practices – for instance, antibiotic residue contamination of milk – can continue with impunity.[3]

Thirdly, the Acts are weak in addressing environmental and social issues – such as manure management and animal welfare –already observed in the previous chapter. Such issues require review and strengthening of regulatory policy instruments. The review needs to be extended to harmonizing different regulations dispersed in different Acts of parliament to bring coherence between them and about enforceability.

3.2 Economic instruments

3.2.1 Financial facilities for dairy enterprise development

The GoK attempts to improve access to financial services for farmers –particularly for women, youth and people with disabilities – through several easy-access funding facilities which are also accessible for dairy farmers. These include WEF, YEDF, NFDK, and AFC, as described in Annex 2.

3.2.2 Cess, levies and taxes

The KDB collects statutory revenues classified as cess, levies, penalties, licenses or permits to dairy sector players to raise funds needed to exercise regulatory and promotional functions under its mandate in the DVC. However, many chilling hubs do not see benefits accruing from the statutory payment and instead see it as constraining the growth of their business (PPD Consultants 2013).

Statutory revenues are collected from processed traded milk, but this is only 30% of total milk traded (ACET 2015) because most farmers and cooperatives operate on the raw milk market by selling to neighbours and milk traders. Processors are concerned that this creates an unfair playing field, as they are paying VAT, taxes, cess and levies, while people operating on the unchilled, raw milk market are not (interview with Oosterwijk and Ndungu; PPD Consultants 2013).

There are unrealized tax opportunities for the dairy sector, which include removal of VAT on dairy equipment, liquid processed milk and feed ingredients in ration formulation (Ettema n.d.). In the 2016/2017 national budget, tax levied on raw materials needed for the manufacture of animal feeds was to be removed (interviews with Kinoti; Matoke and Otiang) but this applied to only 3 out of 17 ingredients. VAT removal would lower animal feed prices, an important constraint in the sector already observed in the previous chapter.

An additional burden was introduced in 2013, when the GoK widened the range of goods that is subject to the 16% VAT regime and in 2015 reintroduced a capital gains tax (Makoni et al. 2015). Another issue is that Investors could face an unpredictable tax environment as the county governments propose new taxes on many items important to development of the dairy sector (Makoni et al. 2015).

3.2.3 Import tariffs

The EAC has a free trade arrangement for dairy products – excluding infant formula – and a 60% common external tariff (CET) for dairy products from outside the EAC (Makoni et al. 2014; interview with Oosterwijk and Ndungu). The separate EAC states charge additional 15% VAT to the CET (Bingi and Tondel 2015). The 60% CET protects the domestic milk industry, which some actors consider too high an import tariff and the main factor for high consumer (processed) milk prices (e.g. interview with Oosterwijk and Ndungu). According to the latter interviewees, experimenting with lower import tariffs – as in the Economic Community of West African States – is expected to lower consumer milk prices, but may create adverse conditions for current small-scale and resource-poor farmers.

[3] Please note that enforcement of standards and regulations can work (1) to penalize those who consciously violate such standards and regulations, and (2) to create awareness about the hazards that the standards and regulations intend to prevent.

3.2.4 Subsidies

The GoK and county governments provide subsidies to farming youth, women and poor households, aimed to create inclusive growth. Some specific cases are discussed below.

Many county governments prioritize dairy development in inclusive growth initiatives for poverty alleviation and food security. For instance, Kakamega County Government is implementing a 'One Cow Initiative' (interview with F. Anunda; MoALF 2014), targeting poor households. Murang'a County is implementing 'One Youth One Cow' (*Kenya Today* 2015, *The Star* 2015), targeting youths and people with disabilities. While these initiatives have value, there are also issues. For example, they focus on enabling access to quality dairy stock without adequate attention to the more serious constraints preventing the target vulnerable groups. from engaging in the dairy industry. Access to land and financial services was the most limiting factor for youth in Uasin Gishu County to get involved with dairy farming. What is more, on average every young person with an average age of 29 years was already owning at least one dairy cow (Sulo et al. 2012).

Therefore, better strategies for county governments may be to encourage voluntary land consolidation through stakeholder platforms (a so-called soft policy instrument; see below), (further) stimulate a "land market", provide incentives to investors to generate employment, and diversify activities in rural areas to increase jobs (Makoni et al.2014).

Other targets of subsidies are AI, sexed embryos and nitrogen cylinders so that farmers can afford quality breeding stock and services (Makoni et al.2015, Thuo 2016). The subsidies are about half the market rates in the counties (of Uasin Gishu, Kakamega, Nyandarua, Bomet, Bungoma, Embu, Murang'a, Machakos and Taita Taveta), where subsidized semen costs KES 700 and sexed semen KES 2,500–3,000 (interviews with Langat and Angello; F. Anunda). The county governments buy semen from KAGRC and provide it to farmers through DFCSs (Uasin Gishu County) and franchisees (Kakamega County). Also, the GoK is investing in Namandala ADC farm, a parastatal farm in Kitale, to produce locally sexed semen and embryos in an effort to improve farmers' access to affordable quality stock (interview with Matoke and Otiang).

The subsidies extend to milk-cooling tanks being donated to cooperatives (in Uasin Gishu, Nandi, Bomet, Nyamira and Nakuru counties) through the Smallholder Dairy Commercialization Program (SDCP) (interview with Kembe and Kibiego) and the GoK, in partnership with donors. With support from the Polish government, the GoK has planned to invest in the supply, installation, testing and commissioning of 1,000 milk-cooling tanks (interview with Langat and Angello; Matoke and Otiang). There are, however, concerns that the milk-cooling tanks may not meet specific design requirements for East African conditions (interview with Oosterwijk and Ndungu), which are characterized by a hot climate in combination with long transportation times over poor roads in rural areas.

Chilling down the milk fast enough to stop bacterial proliferation requires plate-heat exchange coolers ("ice banks") (interview with Oosterwijk and Ndungu). These investments would be needed for production of value added products that require high quality milk with low bacterial count, for example, cheese.

The substantial investments being directed to hardware development (milk-cooling tanks) is currently at the expense of development of software solutions, such as data recording, collection and analysis (interview with A. Medjdoub). Yet data recording and collection are key bottlenecks in the dairy sector (ACET 2015, Makoni et al. 2014, MoALF 2010a).

The public and donor support to private sector development (for farmers and cooperatives) needs policy review because it has the potential to distort the market in creating an unfair playing field for non-subsidized market players utilizing milk coolers, breeding stock and AI services (Makoni et al. 2014). The criterion of additionality as developed by the Donor Committee for Enterprise Development (DCED) (Heinrich 2014) can provide guidance here for both donors and county governments. The criterion of additionality comprises eight sub-criteria and aims to ensure that only investments and activities which would not otherwise have happened are supported.

In addition, lessons can be learned from KMDP's Innovation Fund that has (co-)funded high risk innovation projects directed at improving on-farm data management and practical skills development. One such lesson is that thorough assessment of the market potential of projects is needed before they are implemented, as a first review of the Innovation Fund activities showed (De Jong et al. 2015).

3.3 Soft instruments

3.3.1 Public–private partnerships

The latest GoK report on public–private partnerships (PPPs) shows that only one out of the currently fifty-nine registered PPPs focuses on the agricultural sector and only to some extent (RoK 2014). However, there are various initiatives that resemble PPPs.

One is the AI subsidy scheme described in section 3.2.4, which is a positive development, but still reflects the fragmented nature of the DVC as financial support from processors and cooperatives in these PPPs is lacking. Yet the latter is an important condition for success for creating ownership and enabling the development of a shared vision for the sector (Makoni et al. 2014, p. 55).

Another is the joint venture Smart Dairy (Kenya) Ltd. in which Kakamega Dairy Development Company, a company of the Kakamega County Government, and Smart Dairy Cooperative from the USA have partnered with 30% and 70% share capital respectively. The county input share includes the provision of land from twelve polytechnics (interview with F. Anunda). Smart Dairy claims to use a "holistic approach" as it simultaneously tries to tackle systemic constraints such as lack of access to capital, technology, quality genetics, T&E services, transparent market and production of quality milk (interview with F. Campbell). The joint venture is still new – it was formed in 2015 – and, like many PPPs, it is dealing with different stakeholder expectations and interests (interview with F. Campbell).

A third initiative is a school milk program recently set up by Mombasa and Migori counties that provides opportunities for stimulating local markets and encouraging milk consumption (interview with M. Munene). Free milk is provided to about 28,000 pupils every weekday in Mombasa County and to about 78,000 pupils twice a week in Migori County (USAID 2016, Beja 2015). Other partners in the program include USAID's Kenya Agricultural Value Chains Enterprises (KAVES) project, the KDB and processors (USAID 2016). KAVES provides technical support to the counties to set up the necessary regulatory framework for the school milk program. More counties are planning to implement similar school milk programs (USAID 2016).

3.3.2 Innovation platforms

The KDB has a mandate to provide a platform for dairy sector players to collaborate and discuss urgent matters, such as milk quality problems and the high import tariffs. Almost 20 dairy groups are normally hosted by KDB (interview with P. Cherono), but stakeholders are concerned that over the years KDB has not done much for the dairy industry and dairy farmers. A number of issues prevent KDB from becoming such a platform facilitator, including insufficient staff to cover the entire country and a lack of public awareness about the KDB mandate. There have been attempts to support multi-stakeholder platforms, including the national Dairy Task Force supported through Kenya Dairy Sector Competitiveness Program, but this became dormant after the project ended. Key operational challenges are due to stakeholders being focused on self-interest, without looking at the bigger picture of developing a 3R sector.

At the county level, some counties provide a platform for dairy sector stakeholders to align dairy development activities and to prevent duplication of efforts and waste of resources (interview with Langat and Angello). The structure of such county platforms could be used to create innovation platforms where not only dairy activities are aligned, but also creative solutions for sector problems are deliberated. The problem of low stakeholder involvement and lack of financial resources could be tackled by using a PPP structure in which the GoK and county governments, research institutes, private sector processors, input suppliers and farmer cooperatives contribute, for example, through a milk levy (Makoni et al. 2014, p. 55).

Many development programs work extensively with DVC actors, promoting various forms of innovation in the dairy sector. For instance, the EADD, KMDP and KAVES are supported respectively by the Bill and Melinda Gates Foundation, EKN and USAID. KMDP has been a matchmaker between Kenyan and foreign (Dutch) companies to tackle DVC systemic bottlenecks (see Chapter 2: Robust value chains). KMDP has built local partnerships and dealer arrangements with the Dutch companies UNIFORM-Agri, CowSignals/Vetvice, Roodbont, The Friesian, Delta Instruments, Eric de Jong, Dekker, and Fieten (De Jong et al. 2015). The challenge is that cooperation and coordination between donor innovation platforms is limited to specific targeted beneficiaries (De Jong et al. 2015).

3.3.3 Codes of conduct

In 2000, KeBS developed a Code of Practice for DVC actors to improve milk quality along the DVC to guide stakeholders in the hygienic production, bulking, handling, processing and distribution of milk and dairy products (KeBS 2000). The code provides guidelines on mycotoxin contents of feed and veterinary drug residues in milk, which are major public health concerns in the DVC. However, stakeholders are yet to realize benefits from the code due to limited operationalization of the code at the farm level (ACET 2015) and low capacity of the KDB to enforce this code of practice. There is a challenge with a lack of buy-in and awareness of the code, because there was insufficient involvement of value chain actors in drafting it.

There are some starting points for self-regulation, including the development and establishment of a code of good practice for animal feed manufacturers, standard operating procedures and good manufacturing practices (GMP) (ABS TCM 2013). This opportunity need be extended to the (dairy) feed industry (ABS TCM 2013) to give AKEFEMA the mandate to self-regulate and charge appropriate levies from its members. This will require an amendment of the *Fertilizers and Animal Foodstuffs Act* (RoK 2012a).

4 Resilient innovation support system

This chapter describes the key knowledge and innovation support system actors, including research, T&E and business development services engaged in the dairy sector. We analyse how the innovation support system interacts with the supply chain and policy and regulatory actors to support dynamic and continuous technical, institutional and social innovation in the sector, in areas such as technology development, new institutional arrangements and partnerships, processing and products development and marketing. The analysis looks at the capabilities of innovation support actors and how different types of innovation support structures contribute to supporting such innovation. Finally, the physical and virtual infrastructure that supports innovation will be analysed in terms of presence and quality. This focus on actors, institutions, interactions and infrastructure is in line with Wieczorek and Hekkert (2012). **Table 4-1** summarizes the strengths, weaknesses, opportunities and threats discussed in this chapter.

4.1 Innovation support system actors and structures

The Kenyan dairy sector is characterized by a diverse and complex innovation support system, ranging from universities, technical colleges, public and private extension services, private advisory and consultants, to various business service providers. **Table 4-2** lists a selection of dairy innovation support actors in Kenya in order to show the variety of actors present, rather than to be exhaustive.

Capacity building and research in dairy is a shared responsibility among national, regional and international organizations in Kenya. A range of colleges and universities offer programmes in dairy from certificate to degree levels, for example in veterinary science, animal production, extension, and dairy technology and management. The leading colleges and universities in dairy training are DTI at Naivasha, which has a national mandate to train mid-level technical staff in dairy technology. Implementation of its competency-based curriculum is delayed by the process of acquiring SAGA registration (Jansen 2015a). Egerton University and the University of Nairobi offer diploma and degree training and research in dairy (Makoni et al. 2014). Tegemeo Institute specializes in policy research across the agricultural domain. KALRO, at its Naivasha research facility, hosts a Regional Dairy Centre of Excellence with the mandate to conduct applied research and to provide training and capacity building in the East African dairy sector (KALRO n.d.). At the international level, ILRI conducts strategic research with relevance to global challenges in securing food, nutrition, health and wealth for poor farm households.

In general, training and research at these institutes is criticized for being supply-driven and lacking relevance to labour market requirements and priority needs, partly due to little interaction between the institutes and the labour market and also due to insufficient funding (Kurwijila and Bennett 2011, MoALF 2010a, Muriuki 2011; interviews with Jansen and Muchina, G. Katothya, P. Ngaruiya). It is the feeling of industry stakeholders that graduates across all levels do not acquire sufficient practical skills to meet the needs of the industry. For instance, the Smart Dairy project is currently behind schedule with setting up dairy farms, as they cannot find sufficient adequately trained people to manage them (interview with F. Campbell).

These issues affect the resilience of the innovation support system, as inflow of new information, innovations and knowledge through this channel is limited.

The liberalization of the dairy sector in the 1990s resulted in a vacuum in T&E services for farmers (Makoni et al. 2014, Muriuki 2011). While the GoK cut budgetary provisions drastically and withdrew as the primary T&E and training service provider, the private sector failed to effectively fill the vacuum as expected. NGOs have tried to fill the gap, but this is reported to be inadequate; service delivery is not effectively regulated, and most producers are not willing or able to pay for services (Bebe et al. 2016, Makoni et al. 2014). Meanwhile, extension delivery by researchers and universities is generally limited. A positive exception is Egerton University's Seeds of Gold section in the Saturday Nation

Table 4-1 *SWOT analysis of dairy innovation support system*

Enablers and barriers	Strengths	Weaknesses	Opportunities	Threats
Actor-related	- Educated working class available for employment in sector - Egerton University and University of Nairobi offer courses on veterinary science and animal production across all levels	- Weak organizational capacity of industry associations prevent effective lobbying and investment facilitation - Limited focus of research and education institutes on outputs/personnel needed in industry - Donors focus too much on tackling hardware issues (equipment, inputs, etc.) and too little on data collection and dissemination	- Training key players in the raw milk chain to improve sanitation and quality	
Interactions and institutions-related	- Increasing sense of urgency to address quality and loyalty issues in the DVC - Experimentation with input and service provision by private and third sector actors: PDTCs, private advisory services, training calendars, ISP contracting	- Lack of entrepreneurship/commercial approach to dairy farming - Record keeping not common practice among farmers (little incentive) - Poor farmer skills leading to poor animal husbandry, breeding, disease control and feeding practices - Lack of trust along the DVC; mutual processor-cooperative-farmer contract violation; feed manufacturing and trade malpractices - Mismatch between competence of graduates and industry needs, especially on practical training - No official accreditation for practical training through PDTCs, making trainees unrecognizable on the market - Research not really client-oriented; weak linkages between research institutes and dairy industry - Uncoordinated transition of service provision from public to private actors resulted in gaps in extension, AI and veterinary services - No systemic integration of universities into extension models - Difficult for foreign input suppliers to find qualified dealers in Kenya	- Private service provision for T&E farmers to improve on current farming and milk-handling practices - Training of DVC actors on milk handling, with respect to QA system - Inclusion of training in soft skills on training farms and mid-level curricula - Possibility to reclaim training costs for staff from the Ministry of Labour - Match-making role for county governments and the GoK to link input suppliers to producers - Knowledge linkages with Dutch companies and institutions	- Lack of consumer trust
Infrastructure-related	- Good climatic conditions for dairy farming - Training on GMP available to all DVC partners at DTI - Range of training materials available from development projects and universities - Mobile platforms for money transfer and integrated money deduction widely established	- Weak dairy research, especially for sector policy and productivity at production, processing and marketing levels - Extension services are weak: services liberalization has not attracted substantial private sector participation, is not linked to private industry development of the DVC and has not attracted coordinated private sector and farmer group participation - Lack of valid and reliable dairy sector data - Lack of access to ICT services, especially for on-farm and cooperative management	- Department of Technical and Vocational Education and Training can provide a regulatory framework and give guidelines to the PDTCs for practical training - Awareness-building of environmental issues through national education system	

Table 4-2 *Overview of dairy innovation support actors in Kenya*

Kenyan	Other
Research institutes	
KALRO Tegemeo Institute (part of Egerton University) KIPPRA-Kenya Institute for Public Policy Research and Analysis	International Livestock Research Institute International Food Policy Research Institute International Center for Tropical Agriculture World Agroforestry Centre
Universities	
Egerton University, Universities of Nairobi, Jomo Kenyatta University of Agricultural Technology, , Baraton, University of Eldoret	Universities include American, Australian, British, Canadian and Dutch universities including Wageningen University and Research Centre (NL)
Mid-level colleges	
Dairy Training Institute Naivasha (ATC) Bukura and Baraka Agricultural Colleges AHITI colleges	Hogeschool Van Hall Larenstein (NL) CAH Vilentum (NL) HAS Den Bosch (NL)
Training farms	
Latia Resource Center Lewa (Baraka), Mawingu and Willens PDTCs Cheptebo AIC Resource Centre Mtakatifu Clara Mwangaza Centre	Dairy Training Centre Oenkerk (NL)
Private research and advisory service providers	
Dairy advisory services: Perfometer, PMD, PPD Consultants, ABSTCM Laboratories: Analabs	Vetvice, CowSignals, PUM, Unique SoilCares
NGOs and development actors	
	IFAD, Land O'Lakes, Heifer Int.,TechnoServe, SNV, Agriterra, AgriProFocus, PUM

Source: 3R team knowledge and De Jong et al. (2015)

newspaper, which is part of a broader media platform that includes television shows and the internet for disseminating knowledge and information aimed at increasing farm productivity, linking agricultural value chain actors and expanding market access. The platform has received national and commonwealth recognition for being an effective tool for agricultural extension and support to agribusiness development (Opinya 2016).

Recently, a large number of private input and advisory service providers have emerged to undertake various knowledge brokering and transfer functions in the dairy sector. Examples are included in **Table 4-2**. The services range from advice and training to business development services. KMDP has supported private dairy advisory services (PDAS), but they face start-up challenges, including limited practical technical knowledge and a limited portfolio of products and services (Katothya and van der Lee 2016, De Jong et al. 2015). An opportunity is to stimulate the formation of strategic business plans by private PDAS providers, based on market assessment (De Jong et al. 2015). Research and analytics service providers include Analabs, for laboratory services related to milk quality, and SoilCares, a Dutch research company, for soil analysis services coupled with real-time fertilizer advice; it is also setting up an animal feed laboratory with near-infrared technology (Jansen 2015b). Nevertheless, there is a lack of testing protocols for animal feeds and ingredients and low demand for feed analysis laboratories (ABS TCM 2013).

4.2 Innovation support system interactions and institutional factors

The governance of the Kenyan dairy sector is influenced by how the dairy sector actors are organized and coordinated and how the relationships among them are mediated to support sustainable competitiveness. Various private industry organizations exist that can play important governance roles in the dairy sector at different levels, from production to the consumer. At the farmer level, there are

numerous farmer-led organizations, including DFCSs, cooperative unions, associations and farmer apex organizations (e.g. KENAFF). The DFCSs are the backbone of smallholder production and are promoted as organizations that can strengthen the market position and bargaining power of their members, most of whom are smallholders. However, most DFCSs have faced governance and leadership challenges over time that resulted in poor performance and, in many cases, collapse. Some have been successful, for example Muki Farmers' Cooperative Society, Meru Central Dairy Farmers Cooperative Union (MCDFCU), and Githunguri Dairy Farmers Cooperative Society (GDFCS) (Ciuri 2014, Makoni et al. 2014). More DFCSs are being formed with the support of county and national extension programmes (Bebe et al. 2016). It remains to be seen what the key factors are that enable the success of these DFCSs. The apex farmer organizations' role is to advocate for the benefit of their members, who are predominantly smallholders, at a higher level

The other industry organizations at the input, service and market level include Association of Kenya Feeds Manufacturers (AKEFEMA), Kenya Livestock Breeders Organization (KLBO), Kenya Dairy Processors Association (KDPA), and Kenya Dairy Producers Organization (KENDAPO). Most of these organizations bring together different types of actors with the aim of championing their interest but this is usually not in tandem with developing shared value for sustainable growth of the sector, particularly noting their minimal impacts on the needs of smallholder dairy farmers (Makoni et al. 2014). If well-functioning, these organizations can support various private sector led governance mechanism including industry-set quality and safety standards, codes of conduct. The ineffectiveness of these organizations may be an indication of the need to support their capacity enhancement.,

The weak state of the industry organizations coupled with a lack of coordination mechanisms to facilitate and work toward a shared sector vision points to a weak dairy innovation system and the need to strengthen the interactions between public and private governance systems to build reliable institutional governance

It is widely recognized that there are weak linkages between the multiple sources of knowledge and innovation support system actors and other various dairy sector actors, and that this hinders the development of a dairy innovation system. Such linkages characterize the nature of collaborative relationships that exist between actors and are important in understanding the systemic issues that limit innovation in the sector (Odame et al. 2009). This is what Wieczorek and Hekkert (2012) outlines as "soft institutions", such as common habits, routines and shared concepts that are organized through hard institutions such as regulatory and policy frameworks, as discussed in Chapter 3. The institutional set-up is determined around sociocultural contexts.

Limited collaboration between the various research organizations and other actors at different levels in the sector– farms, supply chains, policies and regulations, civil society – hinders alignment of research agendas to the needs of the Kenyan dairy sector (Kurwijila and Bennett 2011; Makoni et al. 2014; interview with S.G. Maina). According to ministry officials, there is limited collaboration between government agencies and universities in providing research evidence for shaping policy, purportedly due to lack of a forum (interview with Matoke and Otiang). While KALRO engages in partnership projects to enable collaborative research and innovation, many sector actors express dissatisfaction with the relevance of the research. For example, it was noted in one interview that KALRO research on fodder crops is not responsive to emerging challenges, which is linked to the long culture of supply-driven research, and organizational challenges that include limited research funding and human resource capacity gaps as authorities froze recruitment for new scientists; most of the older generation is set to retire (interview with F. Wandera). Similarly, the KDB, as regulatory agency, indicates that researchers tend to focus on highlighting negative findings in the sector, based on limited case studies, rather than working with the sector actors to propose solutions. Nonetheless, KDB is open to more cooperation with researchers in order to facilitate dairy sector innovations (interview with P. Cherono). Thus, the weakness of these links arises out of mistrust and lack of a collaborative culture.

The issue of trust between actors has a long history. The relationship between farmers and their cooperatives has a checked history, where improper governance structures resulted in financial mismanagement and collapse of many cooperatives and market structures, leading to breakdown of trust (ACET 2015, Kruse 2012). Linkages between research organizations, extension services and dairy producers reflect similar institutional challenges (Kurwijila and Bennett 2011). The public extension staffing has been reduced to a bare minimum, further entrenching its ineffectiveness and its

negative effects on many smallholders. Private service providers that have emerged in the sector have been criticized for poor quality services and inputs. Lack of trust and dependability is also noted in relation to supply loyalty issues between suppliers and dairy processors, as seen through issues of side-selling and contract violations by farmers, cooperatives and processors alike (Kilelu et al. 2013). Allegations of feed and milk trade malpractices seriously undermine trust. Feed trade malpractices include the offloading of substandard feeds in retail markets (MoALF 2010a), while milk trade malpractices include adding illegal preservatives to raw milk (Muriuki 2011; interview with Oosterwijk and Ndungu).

Moreover, there is need for a mechanism that can support coordinated interactions to enable producers, the private sector, knowledge institutes, the public sector and civil society organizations to articulate and direct sector research and innovation agendas. Recently, there were efforts to support such systematic linkages in the dairy sector through the national Dairy Task Force, convened by the KDB with support of the Kenya Dairy Sector Competitiveness Program. But this project-led initiative did not sustain momentum after the program ended in 2012. Additionally, in response to some of the criticism related to skill, Egerton University in partnership with the DTI has implemented the DairyTrain project, funded by the Netherlands Government, which aimed to deliver competent graduates that can enhance innovation and competitiveness in the DVC (Katothya and van der Lee 2016). Other actors, such as the Eastern and Southern Africa Dairy Association, also seek to partner with Egerton University to promote short technical training courses geared towards continuous learning for those already working in the sector (interview with P. Ngaruiya). In Uasin Gishu, the county government is collaborating with Moi University on continuous education for its extension staff.

Box 5. Strengthening innovation support systems – the role of emerging practical dairy training centres

The practical skill gap among dairy farmers and farm managers is a critical obstacle to the development of a competitive sector. KMDP supports three dairy farms that have gone into training as a business, to become practical dairy training centres (PDTCs). By collaborating with various actors, including Dutch experts, the PDTCs can offer farmers market-driven one-day and five-day practical short courses (pdtc.cowsoko.com). PDTCs have proven to be an important innovation in the KMDP T&E approach, although it is yet early to evaluate their impact. They are meeting and creating demand for practical skills in dairy production across a diverse clientele of dairy entrepreneurs.

A recent project review indicates a number of positive outcomes attributed to PDTCs (Katothya and van der Lee 2016). Firstly, interviewed lead farmers were unanimous that their participation in a five-day practical skills training at a PDTC triggered changes in their dairy farms. Secondly, six youths (all males) running the Bidii dairy promoter's enterprise interviewed in Meru attributed the successful start-up of their silage business to the five-day training at the Mawingu PDTC. They also reported that the exposure has triggered them to establish/improve their own dairy farming enterprises. Thirdly, the DFCS T&E staff interviewed also spoke highly of the effects of the five-day PDTC training on their role as facilitators of practical training to DFCS farmers. Fourthly, the PDTC manager interviewed highlighted three indicators that signal the increasing realization of the relevance of PDTCs: a) an increase in the number of enquiries and visitors to the PDTC; b) the interest that technical training institutes have been expressing for partnerships; and c) the high turnover of PDTC staff as a result of being poached by farmers and input supplier companies following contact made during visits to the PDTCs. Apart from the practical skills orientation of the training at PDTCs, other positive factors identified were the incorporation of new knowledge and innovations through international experts from Netherlands (training of trainers).

Despite this positive feedback about the relevance and impact of PDTCs, managers of PDTCs highlighted the inability to operate optimally as a major challenge to the new concept. This manifests itself in the inability to attract a break-even number of clients in an evenly spread schedule throughout the year. Reasons mentioned included the inadequate marketing of PDTC services and little willingness to pay for T&E services among potential clients.

Sources: De Jong et al. 2015, Katothya and van der Lee 2016, Otieno et al. 2015.

As Odame et al. (2009) found, there are pockets of coordinated action between innovation support actors and other actors at different levels that are driving innovation in the Kenyan dairy sector. This includes at production and input levels, processing, marketing and financing. The drivers for this innovation are research and development (R&D) within firms that rely on customer feedback, market intelligence and links with different networks. This is seen, for example, with dairy processors who have developed a wide range of products. Collaborative partnership projects, primarily donor-funded, are an important catalyst for building innovation support systems. As an example, the KMDP supported PDTCs, which is an institutional innovation aimed at bridging the knowledge and skills gap in the Kenyan DVC (Otieno et al. 2015). As there is a great need for practical trained people in the dairy sector, the PDTCs are supported to become innovative business models around practical training, with a view to upscale this concept through formal training institutions (such as DTI, Baraka Agricultural College, Egerton University and the University of Eldoret [Otieno et al. 2015]). PDTCs are commercial dairy farms that have moved into providing short-course training as an additional business activity while keeping overhead costs low (De Jong et al. 2015; interview with Jansen and Muchina) (see Box 5). However, there are challenges with staff retention as well as the absence of a regulatory framework that allows official accreditation of PDTCs (Katothya and van der Lee 2016).

To address the personnel gaps in the sector, with regards to both quantity and quality, KMDP has explored various interventions. One has been to partner with the DTI to support transition into a semi-autonomous institute with a market-oriented curriculum. However, this was not successful due to a "good deal of politics" (Jansen 2015a). Another effort was to work with Dutch dairy experts from PUM (an organization of Dutch senior experts) and others to provide technical assistance with an emerging cadre of local capacity-builder consultants, such as Perfometer, in providing innovation support through a total farm management approach. This linkage was premised on the understanding that elements of Dutch knowledge and expertise in dairy farming can be transferred and adopted in the Kenyan context (Ettema 2015, Rademaker et al. 2016).

The Dutch Dairy Training Centre in Oenkerk is creating an e-learning platform for training where certificates, diplomas and degrees can be obtained (interview with G. Katothya). The aim is to recruit local institutes to franchise the training package; five training institutes have done so, with opportunity for more. KMDP has enabled the linking up of these institutes. So far, linking of PDTCs to "formal" training institutions has remained limited (Otieno et al. 2015), yet remains an opportunity to combine theoretical and practical training.

Other programs such as EADD supported the hub model to enhance DFCSs interactions with research organizations (e.g. ILRI, the World Forestry Centre [ICRAF]) and public and private extension and advisory services to enhance knowledge exchange and application (Kilelu et al. 2013). Similarly, the SDCP and the Smallholder Dairy Development Program facilitated the development of innovation support systems through a business development services approach, where private input and service providers delivered knowledge and technologies to farmers (interview with M. Munene). This approach was intended to better match demand for innovation support with supply. However, as Bebe et al. (2016) show, the cost and willingness of producers to pay for these services is a challenge. Meanwhile, there is significant interest from processors to set up a training fund through a levy on processed milk; donors are willing to partner in such a scenario, for example to co-fund initial investments in infrastructure, curriculum development and training of trainers (Jansen 2015a).

These new approaches to supporting knowledge transfer and innovation support are occurring in a changing institutional context in the dairy sector which has undergone a paradigm shift from a supply-driven and top-down approach to a demand-driven and market-led approach to dairy development. This relates to the promotion of the concepts of "dairy farming as business", "commercial dairy farming", competitiveness and entrepreneurship and underlines a push for change in practices and attitudes among actors in the dairy sector.

A focus on this institutional shift is important not only for analytical reasons, but also because the way dairy farmers are categorized (co-)determines who benefits from innovation support system investments, including international linkages. Will the beneficiaries only be the already-successful (medium- and large-scale) dairy farmers? Or will the smallholders who continue to "hang in" also be supported to improve their business – however defined (Dorward et al. 2009)? This is especially urgent in the context of increasing privatization of research; ensuring everyone has access to sustainable economic development is a major issue, as formulated in the Sustainable Development

Goals (UN n.d.). Currently, a focus on growth and competitiveness (as shown in PPD Consultants 2013 and Makoni et al. 2014) seems to leave behind many of the currently estimated 1.8 million small-scale dairy farmers. A big question therefore is where and what are the options for those who "step out" (or are forced out) of dairy farming, considering the current high unemployment rate (Dorward et al. 2009). Additionally, what is missing is an integrated sector support approach that galvanizes a shared ambition of the sector, translating into a coordinated action agenda to support a robust and resilient dairy sector.

In line with the Dutch Scientific Council for Government Policy's call for "intervention ethics" in international development cooperation (Van Asselt et al. 2010), a more explicit focus is needed in dairy development cooperation, not only on specific areas that often have ethical issues – such as gender – but also on the implicit normativity in, for example, technological innovations. An example of the latter is the widespread promotion of sexed semen technology in Kenya, which can be questioned from an ethical perspective (Olsson et al. 2006, Sandøe et al. 1999). In this discussion, the cultural background understanding of ethical issues cannot be ignored (Van der Stoep and Strijbos 2011).

4.3 Infrastructure supporting innovation

In this section we focus on the infrastructure that has an effect on the performance of innovation support systems. This includes physical, financial and knowledge infrastructure.

4.3.1 Research, extension, and training infrastructure

The various research and training institutions including universities, applied colleges and the KALRO research centres maintain research facilities including laboratories, although some are not adequately equipped and resourced (**Table 4-1**). DTI Naivasha has a dairy unit, mini-processing plant and lab that are, however, non-operational, while students graduate with a low skill and knowledge level (SNV 2013, Jansen 2015a). Only on few occasions do the private actors approach universities for research on particular products. For instance, the start-up company MolaPlus had its probiotic product (for poultry) tested by Egerton University's Animal Nutrition Group (Atela et al. 2015). Further promotion of linkages between private actors and universities provides an opportunity to stimulate both development and validation of innovative products and services.

Various research institutions have the mandate to conduct research, and develop and disseminate technologies and knowledge that is appropriate for sector actors. There is a wide range of tools and manuals that have been developed through applied research that provide information on various aspects of dairy farming and entrepreneurship. For example, the EADD program has produced a dairy nutrition manual for farmers and extension officers that is available on the web (Lukuyu and Gachuiri 2012). In addition, the KMDP-supported website www.cowsoko.com provides free access to a range of studies and resource material, including the Cow Signals manual – a practical guide to dairy management in the East African context. Promotion and enabling access to extension materials published by development projects and universities would offer an opportunity to make knowledge more widely available to the dairy sector in order to enable innovations. The creation of a *knowledge hub* provides an opportunity to facilitate knowledge-sharing among PDTCs, DTI, study groups for medium- and large-scale farmers, producer organizations with a lead-farmer approach and private advisory service providers (interview with G. Katothya). Such a knowledge hub could be virtual rather than physical.

4.3.2 ICT infrastructure

Development of information and communication technology (ICT) infrastructure has provided new opportunities for strengthening innovation support systems for the dairy sector. Makoni et al. (2014, p. 57) note that "efficiency of communication networks influence[s] all the components of the DVC". Kenya has a well-established mobile phone technology network with many users. The widely used mobile payment platform M-Pesa facilitates cash transfers even for non–bank account holders.

The ICT infrastructure has enabled the development of dairy-specific applications that enable information and knowledge-sharing. For instance, iCow provides an agricultural information service

through which dairy farmers– via text messages – can access information on good dairy husbandry. According to Irungu et al. (2015), iCow's platform has enabled users to increase milk production by 50% and incomes by 42%. Another example is UNIFORM-Agri, which, through the KMDP's Innovation Fund, has established a foothold in Kenya to sell dairy farm management software to farmers, cooperatives and processors (interview with A. Medjdoub). In a further example, Agritrace is involved with the KDB in an e-dairy project which encompasses national dairy livestock identification and traceability, e-breeding, a dairy web portal, e-dairy, e-commerce and a mobile payment platform (Macharia n.d.). Cooperatives are also now providing multiple services –business hubs – that employ integrated ICT payment platforms to administrate milk payments and user service uptake. New KCC is developing a software platform integrating milk suppliers and service providers. As mentioned before, Sidai is working towards a similar structure together with Brookside Dairy. Equity Group Foundation, in its project Unlocking Agricultural Potential through Medium-Sized Farms in Kenya, is developing a mobile platform where input suppliers, insurance providers, banks, farmers, market buyers and agro-dealers are integrated into one "ecosystem" that can be accessed from a mobile phone to make orders and payments and access loans (interview with J. Chepkoech). So far, however, this is operating only in the horticulture industry, because no strong partner in the dairy sector has been found yet (interview with J. Chepkoech).

While many of these ICT initiatives are promising, uptake and effectiveness depend – as with all innovations –on a range of factors including technical quality, user friendliness, costs and fit within actor networks.

5 Conclusions and recommendations

5.1 Conclusions

This chapter looks back at the research question: "**How does the Kenyan dairy sector perform in terms of the robustness of the supply chains, the reliability of the institutional governance and the resilience of the innovation system?"** The findings from the literature review, stakeholder interviews and a validation workshop implemented within a SWOT analysis framework provide some insights into the strengths, weaknesses, opportunities and threats of relevance to 3R sustainability of the dairy sector in Kenya. We present these to inform policy engagement and action in the transition of Dutch government bilateral engagement in Kenya from development aid–support to a trade approach in the agricultural sector, with highlights on partnering opportunities to drive competitive market-oriented dairy sector development that attracts investment opportunities.

The Kenyan dairy sector is experiencing strong growth in demand for milk, which offers many opportunities to Kenyan and international actors that can translate into new investments and inclusive sector development. Opportunities in increasing milk production lie in a) increasing productivity through entrepreneurial dairy farm management skills linked to effective inputs and services delivery, and b) in buffering seasonality in feed and milk supply. Opportunities in milk marketing lie in lowering milk production costs and improving milk quality in order to access the growing domestic milk processing capacity and the regional free trade markets.

However, for the dairy sector to be robust, resilient and reliable, much more is needed than reacting to market opportunities. It will require better DVC integration to enhance efficiency and sustainability of the sector through integrating best practices along the DVC, improved linkages and trustworthy interactions between production, inputs and services, bulking, processing and retail chain actors to reduce high transaction costs and strive to improve on milk quality and safety issues. Better DVC integration dovetails with dependable regulatory, policy and innovation support systems that ensure dynamic innovation of the sector through responsive knowledge systems, facilitation of stakeholder innovation platforms and fostering of individual innovations.

Widening the discussion beyond economic robustness towards social and environmental robustness will offer opportunities to evaluate other pressing issues, such as inclusive development of the sector and reduction of environmental impact. While attention for some social robustness indicators is strong – such as inclusiveness of smallholders and youth, and gender equity – attention for other indicators or environmental robustness indicators is minimal, such as viability of smallholder livelihoods, animal welfare, agro-biodiversity, water pollution, packaging waste, manure handling and greenhouse gas emissions.

While the GoK policy ambition for the sector, embodied in the Kenya National Dairy Master Plan (MoALF 2010a), is to increase the share of the formal processed chain in the milk market and to improve milk quality, little headway has been made. The market share of the formal sector remains under 30% because of the strong domestic market for raw milk (chilled and unchilled) sustained by consumer preferences, consumer purchasing power and insufficient price and quality advantages of processed milk. The latter is a prime cause for inhibited growth of exports as well. However, the sector does show diverse market pathways to development that could roughly be distinguished as:

- **Conventional** – Processed dairy products for the middle class, with focus on volumes, market share and profit, and less focus on quality
- **Niche** – Quality products such as cheeses and healthy dairy products for upmarket consumer segments; these require QA systems along the DVC to ensure milk intake that is free of antibiotics, aflatoxin and deliberately introduced hazardous substances; the price premium covers extra costs
- **Local bulk** – Raw milk marketing with emphasis on low costs, trust, speed and/or affordability for consumers; it ranges from home delivery to milk bars to ATMs in supermarkets.

What seems to be missing in the sector is debate on the relative advantages of and opportunities for the various pathways.

5.2 Recommendations for the sector

Below is a summary of the main recommendations from this sector scan in relation to 3R in the value chain, institutional governance and innovation support system.

I. Robustness of the value chain

Sustained and sustainable growth of the sector will require addressing the following key issues related to building a robust DVC:

A1. Economic robustness – (I) Productivity

- **Increase availability of quality fodder throughout the year** to reduce seasonality in milk supply and associated problems of underutilization of processing capacity; further promote commercial fodder production and improved fodder conservation practices at farm level; improve access to quality fodder seeds; T&E to individual dairy farmers and through DFCSs (opportunities for inclusiveness of resource-poor farmers); promote contracting services; promote high quality refurbished equipment for farmers and DFCSs
- **Improve quality of concentrate feeds sold** – develop QA system; promote GMP; promote standard feed ingredient analysis upon procurement and links to feed laboratory equipment suppliers and private feed laboratories
- **Improve access to reliable veterinary and AI services and good quality heifers** – support farmers who experiment with sexed semen technology; support private investment in vaccine production; scale up franchise business models to deliver vaccines
- **Reduce barriers in access to credit** to address the high interest rates and collateral requirements; support financial packages that combine insurance with credit; encourage borrowing in collectives; promote international linkages between banks to co-create new solutions; promote DVC-integrated payment systems
- **Consider alternative sector development pathways** next to conventional pushing of market share of the formal supply chain.

A2. Economic robustness – (II) Competitiveness, cost of production and quality assurance of milk

- **Address high cost of production of milk** due to high and rising costs of feed and fodder, herd replacement, veterinary drugs and high disease prevalence; promote farm/chain-level tools to monitor and reduce costs of production; promote recording at farm level through T&E; promote DFCSs to work together as unions for processing and service provision
- **Further develop traceability and QA systems** to guarantee quality of milk; support establishment of milk traceability and QA systems; develop QBMP system that is owned by all shareholders; build capacity of consumer associations to lobby for enforcement of milk quality standards and consumers' access to court; enhance capacity of EADRAC and KDB to stimulate ratification and implementation of dairy product standards; establish a national dairy database hosted by the KDB with capacity to regularly capture, analyse and share with stakeholders
- **Increase loyalty in the DVC,** likely leading to better bargaining relationship between farmers/CBEs and processors as well as better profitability of CBEs; support transformation of DFCSs, self-help groups and farmer groups into CBEs; strengthen existing chilling hubs; experiment with contract farming
- **Provoke current paradigm of sector development** by experiments with alternative pathways; support cottage industries; promote cheese consumption through national school milk program and other programs.

B. Environmental robustness of the value chain

- **Utilize the opportunities offered by mixed-farming systems in Kenya**– stimulate sustainable farming practices; deliver further T&E in biogas production from manure and dairy wastewater

- **Raise awareness**– which generally is low among DVC actors –about environmental degradation and its consequences

C. Social robustness of the value chain – safety, equity and inclusion

- **Address inclusion** of youth, women and resource-poor farmers in all three dairy value chains
- Address (internationally) processor oligopoly and associated consequential risks for farmers and consumers
- **Raise awareness on credit facilities and suitability for dairy investment targets** including special grant funds for youth, women and disabled people; earmark funds for dairy funds for youth, women and disabled people; earmark funds for dairy
- **Promote inclusiveness of business incubators**
- **Address serious public health hazards**, notably aflatoxin and antibiotic drug residue contents; implement QA systems along the feed chain; deliver T&E for feed manufacturers on ingredient analysis at procurement; facilitate linkages to feed analysis equipment suppliers / service deliverers; promote QBMPS; address upcoming bottlenecks
- **Awareness raising on animal welfare** considerations is important if it is to be improved.

II. Reliable institutional governance

To work towards reliable institutional governance along the Kenyan DVC, recommendations include:

- **Promote DVC actor collaboration** – through enhanced horizontal and vertical DVC coordination
- **Ensure a level playing field for private sector actors** in cases where public sector instruments are used to provide support that might distort markets; promote adoption of DCED 'additionality' criterion for PPPs
- **Promote and advocate for enforcement of standards and regulations** already in place, e.g. on feed and milk quality; support capacity enhancement of regulatory bodies to enforce the regulatory framework; promote enforcement of standards to convince feed manufacturers and milk traders to comply with GMP and trading practices and payment of taxes, contributing to a level playing field for all actors
- **Promote coherence of policies** and of the organizational roles for governance of the dairy sector, especially following devolution
- **Review appropriateness of the CET of 60%** on dairy products from outside the EAC; discuss appropriateness of tariffs; experiment with a lower CET; learn from experiences in other countries
- **Explore opportunities for self-regulation of industry organizations** establish codes of conduct and GMP in feeds and milk quality; adapt relevant legal regulations, reactivate sensitization and uptake of KeBS' code of conduct to improve milk quality.

III. Resilient innovation support system

The actors and agents in the dairy sector can build necessary capacities to responsively adapt to the economic, ecological, political and social dynamics in the dairy sector through:

- **Improved linkages between DVC actors and knowledge support actors** to increase end-user relevance of ongoing research, education, T&E; apart from the usual focus on hardware –such as provision of milk coolers – address key bottlenecks of skills, competences, governance, data recording and collection; rework curricula to include practical skills and competences; consult with sector actors about sector competence needs; develop platform for interaction between knowledge institutes and DVC actors; as it is unclear who can fulfil facilitator roles, design a facilitation platform that is owned by all stakeholders; explore ways to establish a platform without falling into old divisive patterns.
- **Foster innovations** – use instruments such as AECF; use PPPs to facilitate dairy sector research; develop shared national or county-level research agendas; support (digital) media extension services to supplement practical dairy training; break through artificial divisions between "small-scale" and "large-scale" farmers, which stem from development aid, to promote learning between entrepreneurial farmers of different scales and types
- **Strengthen governance in DFCSs farmer-led organizations** to enable them gain market positioning advantages and economies of scale in production and demand for quality services.

5.3 Recommended interventions for 3R

A dairy stakeholders workshop held on 19–20th July 2016, to which the preliminary results of this study were presented, recommended a number of focus areas that were deemed to be of key importance to the sector's development (see Annex 4 for tables with a full list of focus areas and the summarized list of options).

This report seconds this selection of priority areas as being meaningful and in line with the analysis in this study. We consider gaps in entrepreneurial skills and chain fragmentation as the key limiting factors that inhibit growth in these areas in particular, and overall growth to a robust, reliable and resilient sector in general. The 3R Kenya project's involvement in the sector should focus on approaches that counter these key limiting factors. It can do so when focusing on the priority areas that provide the entry points for action planning and engagement for the project:

- Improving quality of feeds and fodder and quality of milk
- Skill development for producers with focus on the T&E approaches as well as on governance issues in producer organizations
- Developing reliable and competitive markets with reduced costs of production.
- In these areas, priority cross cutting issues include policy lobbying and regulatory issues, and the inclusion of women and youth in dairy growth opportunities (see **Table A4.3**, Annex 4).

Draft work plans for these four issues are included in Annex 5, and a summary of the proposed approaches is included in **Table 5-1**.

Table 5-1 *Proposed approaches and actors for priority thematic areas in the Kenyan dairy sector*

Theme	Proposed approaches	Proposed actors
Feed and milk quality	**TECHNOLOGY INNOVATIONS** (i) Explore technology in milk testing (akin to the modern handheld technology in soil testing) (ii) Create awareness about quality issues of feed/fodder to raise market demand for improved quality; use efficient feed and forage analysis equipment (private labs); use organized lobby groups (iii) Develop or import fodder maize for silage to eliminate competition with maize for human consumption. **UPSCALING EXISTING MODELS** (i) Build on the lessons of ongoing QBMPs (ii) Build on the successes of commercial fodder production; promote large-scale investments in fodder/forage production, e.g. commercial Lucerne fields (iii) Promote inclusive DVC by processors, where processors invest in the production process rather than just collect milk	(i) *Government departments/county government* (ii) *Processors* (iii) *Producers* (iv) *Cooperatives* (v) *Private labs* (vi) *Researchers* (vii) *Feed manufacturers* (viii) *Regulators – KDB* (ix) *Investors* (x) *Seed companies*
Capacity building	(i) Select youth who can be trained in computer-assisted ration formulation (ii) Train dairy farmers to cultivate alternative fodder crops (iii) Deliver farmers training on calculating costs of production and profitability to promote efficiency (iv) Provide targeted and specific support to progressive farms as pilots of good dairy farming practices (v) Promote market-led private extension; upscale the successful service provider enterprises cases, e.g. Meru, Nyeri, Nyandarua (vi) Deduct training fee at the cooperative or at processor level to fund capacity development in the sector	(i) *Producers* (ii) *Processors* (iii) *Cooperatives* (iv) *Development projects* (v) *Financiers* (vi) *Private extension* (vii) *Dairy Training Centres*
Reliable and competitive markets	(i) Develop and facilitate different levels of lobby groups – to drive the competitiveness agenda (ii) Support market diversification (beyond processors): ATMs, export dairy products with proper quality regulation (iii) Develop financial products to bridge cash flow gaps among processors that are mostly caused by delay of payments by outlets (iv) Use education promotions to consumers to increase demand for processed (high value) products	(i) *Processors* (ii) *Market outlets* (iii) *Regulators* (iv) *Investors* (v) *Researchers* (vi) *Development projects*

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Appendix 1 Methodology

The interviews were conducted by a team consisting of two to four interviewers. The interviewers came from different organizations and backgrounds, notably Egerton University (Prof. B.O. Bockline), African Centre for Technology Studies (C. Tonui) and Wageningen University and Research Centre (C.J. Rademaker and Dr C. Kilelu). Interviews were semi-structured, using open questions and a checklist. Interviews were recorded after permission to do so was granted.

Potential interviewees were sent an email beforehand to ask for their participation. In some cases, consent for the interview and appointment of date and time was communicated via email as well. In other cases, the emails were followed up by phone to see whether people were willing to cooperate and to agree a suitable date and time. Due to difficulties in making interview appointments, the resulting set of interviews shows an underrepresentation of input suppliers and retailers.

Table A1-1 *List of stakeholders interviewed*

Date of Interview	Stakeholders	Interviewee(s)
18/05/2016	SNVKMDP	Mr Anton Jansen, Mr Cosmas Muchina
18/05/2016	ABSTCM	Dr Nathaniel F. Makoni
19/05/2016	Land O'Lakes (LOL)	Dr Mary Munene
19/05/2016	Ministry of Agriculture, Livestock and Fisheries	Mr Samuel Matoke, Mrs Joan Otiang
20/05/2016	Kenya Agricultural and Livestock Research Organization	Mr F. Wandera
21/05/2016	MUT Consult doing assessment on T&E for SNV's KMDP	Mr Gerald Katothya Mutinda
23/05/2016	Nyala Dairy Cooperative Society	Mr Stanley G. Maina
23/05/2016	Department of Livestock, Nyandarua County Government	Mr Samuel Kariuki
24/05/2016	Smallholder Dairy Commercialization program – MoALF & IFAD supported program	Mr Moses. A. Kembe Mr M.B. Kibiego
24/05/2016	Dairy Farmer	Mrs Sally Langat
24/05/2016	Happy Cow Ltd	Mr G. Oosterwijk; Mrs T. Ndungu
25/05/2016	Uasin Gishu County Government	Dr Simon Langat; Mr Angello
25/05/2016	Dairy Farmers	Mr Willy Kirwa, Mr Limo
25/05/2016	Sidai Africa Ltd	Dr Rezin Odede Mr Kipkoech
25/05/2016	PhD Student	Ms Phyllis Wanjugu
26/05/2016	Smart Dairy Kenya	Mr F. Campbell
26/05/2016	Kakamega County Government	Mr Francis Anunda
27/05/2016	International Livestock Research Institute	Dr Isabelle Baltenweck
29/05/2016	Eastern and Southern Africa Dairy Association	Mr Peter Ngaruiya
29/05/2016	Equity Group Foundation	Ms Jacqueline Chepkoech
30/5/2016	KDB stakeholder forum	Mr Kinoti
31/05/2016	New KCC	Mr Dominic Menjo
07/06/2016	Kenya Dairy Board	Dr Philip Cherono, Mrs Mildred Kosgei; Stephen M. Murimi
09/06/2016	Chase Bank	Mr Samuel Ndonga
14/06/2016	UNIFORM-Agri	Mr A. Medjdoub
Other interviews		
08/10/2015	MCDFCU	Mr Kenneth Gitonga

Appendix 2 Financial facilities for farming and microenterprise development

The GoK tries to improve access to financial services for farmers – specifically for women, youth and people with disabilities – through several easy-access funding facilities. These are also accessible for dairy farmers. They include WEF, YEDF, NFDK, and AFC.

- The Women Enterprise Fund (WEF) was established in 2007 "to mobilize resources for sustainable access to affordable financial and business support services to empower Kenyan women" (WEF n.d.). The WEF is directed at micro, small and medium enterprises, and a review of its first five years of existence shows that women were able to purchase dairy cows with WEF loans (Kiraka et al. 2013). However, the loans were considered to be too low to enable viable new business start-ups. Kiraka et al. (2013) recommended a business incubator be created at WEF – not earmarked for dairy only – that can bear the high risk of start-ups relevant to dairy business development.
- The Youth Enterprise Development Fund (YEDF) was established by the GoK in 2006 with the purpose of reducing unemployment among youth aged between 18 and 35. It has released KES 3.8 million (YEDF n.d.) for this purpose. It currently offers six loan products, of which two are earmarked for agribusiness development: the Poultry Incubator Loan, targeting poultry business development, and the Agri-Vijana Loan, targeting horticulture development (YEDF n.d.). No loan product exists specially for dairy, but youth involved in dairy can apply for several of the other loan products. A review of the loan policy is needed to make access to the loans easier for promising entrepreneurs and to make the requirements more accommodating to dairy investment (Sulo et al. 2012).
- The National Fund for the Disabled of Kenya (NFDK) provides cash grants to people with disabilities (NFDK n.d.) to help them have a high quality of life. It also provides money to institutions that run income-generating projects, including dairy projects. It is of interest to assess how this funding facility has performed in dairy business development.
- Agriculture Finance Corporation (AFC) has operated for many years but has been found to be of limited value for farmers. A thorough evaluation is urgently needed.

Appendix 3 Kenyan Acts that directly or indirectly regulate the DVC

Table A3-1 *Overview of (proposed) Kenyan Acts that directly or indirectly regulate (specific parts of) the DVC; a year between brackets indicates the previous edition*

	Supply chain part affected	Act	Year of drafting	Aim	Responsible organization	Challenges ©/ Opportunities (O)	References
Economic robustness	Entire chain	*Dairy Industry Act*	2012 [1984]	Regulation, development and promotion of dairy sector	KDB	C: Accusations of being too much focused on collection of cess and levies, the issuing of licenses, and dairy policing, at the expense of promotional activities; lacks capacity to meet stakeholder expectations and to monitor market milk volumes; underappreciates consumers' preferences for raw milk; lacks the regulatory framework, resources and government arrangements to carry through EADRAC's agenda; ability to suffice in own funds from levies, etc. dropped to 53% between 2013 and 2014 O: Restructuring of the KDB to focus more on regulation and compliance and promotional campaigns	ACET 2015, KDB 2014, PPD Consultants 2013, RoK 2012b, Kurwijila and Bennett 2011, Muriuki 2011
	Feed supply	*Standards Act*	2012 [1981]	Setting and controlling standards or codes of practice for commodities produced or imported into Kenya	KeBS	C: Lack of personnel to enforce regulations on feed quality	interview with Matoke and Otiang; RoK 2012c
		Fertilizers and Animal Foodstuffs Act	2012 [1985]	Regulation of the importation, manufacture and sale of agricultural fertilizers and animal foodstuffs and substances of animal origin intended for the manufacture of fertilizers and foodstuffs	MoALF Department of Veterinary Services	C: Lack of adequate personnel at KeBS to enforce regulations on feed quality; conflict between State Department of Livestock and Department of Veterinary Services in supervision and enforcement of feed industry regulations; new Feed Act to come out O: Harmonization of conflicting legislation to increase fruitful cooperation between government agencies to better monitor and control the feed sector; alternative forms of regulation such as self-regulation (through AKEFEMA); establishment of an Animal Feed Inspectorate Service Board which is responsible for registration and licensing of all feed firms or individuals involved in commercial feed production	interview with Matoke and Otiang; Guguyu 2015; ABS TCM 2013; RoK 2012a; MoLD 2008
	Repro-ductive services and breeding	*State Corporations Act*, with respect to Order No 112 and Gazette Notice No L.N. 110	2012 [2010] (Act) and 2011 (Order/ Notice)	Production, preservation and conservation of animal genetic material (semen, embryo, tissue and live animals) and rearing of breeding bulls for provision of high quality disease-free semen to meet the national and export demand	KAGRC	C: Reliance on government subsidies; not subject to import levies and quality checks; a difficult and unfair market situation for private players O: Growing demand for animal genetic materials in domestic and regional export markets for business; formulation and implementation of the East African Community (EAC) Regional Strategy for the Conservation and Rational Utilization of Animal Genetic Resources	Makoni et al. 2015, RoK 2012d, EAC website

	Supply chain part affected	Act	Year of drafting	Aim	Responsible organization	Challenges ©/ Opportunities (O)	References
		Draft Livestock Breeding Bill	2015	Regulation of livestock breeding and establishment of a livestock breeding board	Proposed: Kenya Livestock Breeding Board	C: Fragmentation of livestock breeding services in Kenya makes coordination of breeding activities, livestock registration, data collection and management for performance evaluation difficult O: Implementation of a Board to coordinate breeding activities, coupled with provision of incentives for farmers to register livestock	MoALF 2015a, 2015b
Economic robustness	Veterinary services	*Veterinary Surgeons and Veterinary Para-professionals Act*	2012 [2011]	Training, registration and licensing of veterinary surgeons and veterinary para-professionals and provision for matters relating to animal health services and welfare	KVB	C: Lack of enforcement of existing regulations on authorized use of veterinary drugs O: Allowance of paraprofessionals with diploma, certificate training and experience to treat animals; operationalization of Veterinary Medicines Directorate to regulate the manufacture, importation, exportation, registration, distribution, prescription and dispensing of veterinary medicines and poisons; KVB pushing for qualified veterinary experts to handle genetic materials and AI services; amend Act to allow para-professionals with diploma, certificate training and experience to treat animals	RoK 2012e, 2013c
		Animal Diseases Act	2012 [1989]	Regulating matters related to animal diseases	MoALF Department of Veterinary Services	C: Lack of capacity (management and machinery); innovative vaccines wanting; being government-subsidized, a difficult and unfair market situation for private players O: Private sector investment in vaccine development and production	interview with Odede and Kipkoech; Makoni et al. 2015; MoALF 2015a; RoK 2012pq
		State Corporations Act, with respect to Legal Notice No. 223	2012 (Act) [2010] and 1990 (Notice)	Undertaking research and development with respect to new vaccines and the production and distribution thereof	Kenya Veterinary Vaccines Production Institute		
	Land tenure	*Land Act*	2012	Giving effect to Article 68 of the Constitution, revising, consolidating and rationalizing land laws; provision for the sustainable administration and management of land and land-based resources	Various councils and boards	C: Despite range of Acts governing land tenure, they are unable to address increasing land fragmentation; threat of resource-poor dairy farmers losing land in times of great need O: Hosting of stakeholder platforms to discuss strategies for voluntary land consolidation and provision of incentives by local governments to generate employment (enabling dairy farmers to "step out"); further exploration of how customary tenure systems can provide sufficient tenure security	Makoni et al. 2014; IOB 2011; RoK 2012f,g,h,i,j,k,l; Place 2009
		Land Consolidation Act	2012 [1977]	Provision for the ascertainment of rights and interests in, and for the consolidation of, land in the special areas; for the registration of title to, and of transactions and devolutions affecting, such land and other land in the special areas			
		Land Adjudication Act	2012 [2010]	Provision for the ascertainment and recording of rights and interests in Trust land			

	Supply chain part affected	Act	Year of drafting	Aim	Responsible organization	Challenges ©/ Opportunities (O)	References
		Land (Group Representatives) Act	2012 [1970]	Provision for the incorporation of representatives of groups who have been recorded as owners of land under the *Land Adjudication Act*			
		Trust Land Act	2012 [2010]	Provision for Trust land, that is, land held in trust by the government but on which customary law is operating			
		Land Registration Act	2012	Revising, consolidating and rationalizing the registration of titles to land and giving effect to the principles and objects of devolved government in land registration			
		Land Control Act	2012 [2010]	Provision for controlling transactions in agricultural land			
Economic robustness	Research, extension, and training	*Kenya Agricultural and Livestock Research Act*	2013	Promotion, streamlining, coordination and regulation of agricultural and livestock research and expedition of equitable access to research information, resources and technology and promotion of the application of research findings and technology in the field of agriculture	KALRO	C: Lack of engagement with dairy sector needs	interviews with G. Katothya; M. Munene; Oosterwijk and Ndungu; RoK 2013b
		Dairy Industry Act	2012 [1984]	Regulation, development and promotion of dairy sector	KDB	C: Although KDB is mandated to promote dairy market research, it lacks a research agenda, and research that is being done is of limited relevance to end users	RoK 2012b, MoALF 2010a
		Technical and Vocational Education and Training Act	2013	Licensing, registration and accreditation of institutions and trainers, as well as regulation on training institute organization and training quality and relevance	TVET Board, TVET Curriculum Development Assessment and Certification Council	C: Training provided by PDTCs is not officially accredited; licensing process cumbersome for PDTCs to offer training services O: Provision for a regulatory framework within which PDTC training can be accredited	interview with G. Katothya; RoK 2013c
Environmental robustnes	Milk bulking, chilling, and processing; feed manufacturing	*Environmental Management and Co-ordination Act* / and Regulations (Waste Management)	2012 [1999] / 2006	Environmental protection, impact assessment, monitoring and restoration / streamlining of handling, transportation and disposal of various types of waste to protect human health and the environment	National Environment Management Authority	-	RoK 2012m

	Supply chain part affected	Act	Year of drafting	Aim	Responsible organization	Challenges ©/ Opportunities (O)	References
	Breeding (bio-diversity conser-vation)	*State Corporations Act*, with respect to Order No 112 and Gazette Notice No L.N. 110	2012 [2010](Act) and 2011 (Order/Notice)	Production, preservation and conservation of animal genetic material (semen, embryo, tissue and live animals) and rearing of breeding bulls for provision of high quality disease-free semen to meet the national and export demand	KAGRC	C: Main focus seems to be to on meeting short-term market semen needs, rather than securing long-term livestock genetic biodiversity O: Divert activities from focusing on short-term market needs with respect to semen to securing a public good for future generations	MoALF 2015a, RoK 2012d
Social robustness	Entire DVC (public health)	*Public Health Act*	2012 [1986]	Making provisions to ensure public health and food safety	Central Board of Health (CBH)	C: Lack of enforcement of milk quality standards, due to purported lack of human and technical capacity; KDB is represented in the EADRAC but lacks the regulatory framework, resources and government arrangements to carry through EADRAC's agenda; none of the EADRAC standards have been ratified and implemented O: Harmonized dairy product standards exist within the EAC for raw milk, pasteurized milk, UHT milk, powdered milk, sweetened and condensed milk, butter, yoghurt and dairy ices and ice-cream	Bingi and Tondel 2015; RoK 2012n,o; Jensen et al. 2010
		Food, Drugs and Chemical Substances Act	2012 [1992]	Making provision for the prevention of adulteration of food, drugs and chemical substances	Public Health (Standards) Board		
	Animal health and production (animal welfare)	*Prevention of Cruelty to Animals Act*	2012 [1983]	Making provision for the prevention of cruelty to animals and to control experiments on animals	–	C: Only monitoring veterinary practices, veterinary laboratories and animal welfare service providers; roles and responsibilities for securing animal welfare not specified; limited T&E on animal welfare, as well as limited capacity to monitor cruelty to animals O: Review and amend the *Prevention of Cruelty to Animals Act* to address those issues	RoK 2012p, MoLD 2008, KVB n.d.
		Veterinary Surgeons and Veterinary Para-professionals Act	2012 [2011]	Training, registration and licensing of veterinary surgeons and veterinary paraprofessionals and provision for matters relating to animal health services and welfare	KVB		RoK 2012e

Appendix 4 Summary of priority issues proposed in stakeholder workshop

Table A4-1 *Summary of focus areas generated at cluster level (column 1 = 1st, column 2=2nd, and column 3=3rd priority)*

	PINK (1)	LIGHT GREEN (2)	YELLOW (3)
Researchers	Common and agreed methodology of computing cost (of production) per litre	Consumers preference for milk and milk products to drive the industry for niche markets	Explore employment opportunities along the value chains including the youth and women
Govt. Agencies	Develop strategies to address feed quality and availability	Develop strategies to promote market access for quality and safe milk/ milk products	Develop appropriate policy and regulatory framework to support feed quality, breeding and animal health, quality based payment system.
Non-Governmental Organizations	Market based solutions, knowledge delivery, service and inputs delivery	Cost quantification, price per litre	Strengthening farmers organization for lobbying for policies/regulations
Producers and Cooperatives	Provision of capital to farmers	Addressing feed quality	Capacity building for farmers
Service providers	Training – Demand driven sustainable extension services	Inputs – Improved access to quality inputs and quality assurance standards	Markets: Reliable and profitable, competitive milk prices
Processors	Use of ICT platforms to enhance real-time payment to suppliers – partnerships with financial institutions Enhance lobbying among processors to unlock funds from large retail	Reducing fragmentations by promoting co-packing e.g. county governments to utilize installed capacity	Address issues of quality and competitiveness to address un-tapped potential

Table A4-2 *Consolidation and ranking of the priority issues*

Colour Code	Selected Option in Summary	Frequency
	Addressing feed and milk quality	6
	Lobbying for policy and regulatory environment	3
	Capacity building for producers for skills development	2
	Reliable and competitive markets	2
	Cost quantification/ Litres – Farm profitability	2
	Provision of capitals to VC actors, Producers, Processors (cash flow finance)	2
	Inclusion of women and Youth in the value chain	1
	Partnerships between processors and counties on packing milk	1

Table A4-3 *Three priority areas identified from ranking*

Appendix 5 Work plans for priority issues

Table A5-1 *Suggested interventions for feed and fodder quality*

How (Ways to achieve this)	Who (Actors/ stakeholders)	Role of the actors or stakeholders
R&D · Perform analysis on existing practices and business models promoting commercial fodder production approaches / fodder market development, including aspects of quality, availability, storage, delivery and financing models (for fodder producers as well as farmers) to draw out lessons on best practice · Explore accessible financing models through DFCSs/SACCO's and MFIs enabling farmers' access to finance and reducing the cash-flow challenge - enabling farmers to increase milk production and revenues to enable them pay for feeds and services	· Researchers · Producers · Govt agencies	· Conduct research to assess existing approaches to commercial fodder production on the noted issues · Provide research evidence
PLATFORM FOR POLICY DEVELOPMENT AND LOBBYING (FEED) · Platform with dialogue between farmer organizations and feed millers (AKEFEMA) - based on research input on specific issues · Focus on concentrate feed (quality, quantity and pricing): AKEFEMA => MoU to guarantee Qty2 self-regulation (lobby for it to be functional, but also raise awareness with farmers /groups and other DVC actors · Develop guidelines for standardization of feed quality · Improve access to feed testing labs, KeBS accredited private feed labs · Compliant handling protocol · Promote contract farming for feed and fodder production	· DFCSs/farmer groups · AKEFEMA · Regulatory agencies: KeBS, MoALF · Consumer Federation of Kenya · Financiers, Investors · NGOs	· Lobbying and advocacy · Engage in dialogue · Engage feed producers to get into MOU on quality · ·
FARMER MOBILIZATION · Focus on forage farmers (incl. young/female farmers), organise them in stakeholder groups to coordinate geographical spread and seasonal availability and demand and costing (smallholders can benefit from medium/large scale farmers with excess); exchange best/bad fodder practices – following assessment of practices · Organise commercial hay producers to promote increased acreage on hay and address bottlenecks in fodder chain; link commercial hay producers to farmers/coops · Awareness creation and sharing of best practices on market-led approaches to enhancing access to quality fodder · Promote production of protein feed, alternative fodder crops by farmers themselves, incl. proper storage and utilization methods · Change culture of fodder/feed production; produce silage from maize in case the maize is not suitable for human consumption, etc.	· Farmers · Extension agents · Banks · County governments · Researchers · DFCSs and processors · Private labs · KMDP	· Involvement in study groups and exchange visits · Support promotion of best practice
WOMEN and YOUTH ENGAGEMENT · Include youth in feed ration calculation for other groups members (using ICT) (KALRO Naivasha example)	· Specialised forage farmers · Feed mills · AKEFEMA · DFCSs/farmer groups · KARLO and other Researchers	· Fodder/forage farmers -develop business as forage farmers · Researchers conducting analysis on best/bad practices · All actors engage in platforms to advance issues on feed/forage quality

Table A5-2 *Suggested interventions for milk quality*

How? (Ways to achieve this)	Who (Actors/ stakeholders)	Role of the actors or stakeholders
R&D · Assess what is out there in the sector related to quality based milk payment/markets · Explore affordable technical options that can enable farm level quality tracing (c.f.. soil testing portable labs that are now affordable like SoilCares Model)	· Researchers · Processors · Farmer organizations	· Provide research evidence
PLATFORM FOR POLICY DEVELOPMENT ANDLOBBYING · Dialogue between processors and farmers - based on research input on specific issues · MoU on milk quality by stakeholder groups · Draw lessons on innovative quality based payment systems or systems driving quality milk · Access to milk testing labs · Compliant handling protocol for milk quality · Processors take responsibility for (inclusive) extension: different packages from breeding, feeding (production of protein feeds/enriched feeds, storage and utilization), to housing, to husbandry and to milk hygiene (milking, storage and transport)	· KDPA / Processors · Farmer organizations · KDB · KeBS · KMDP	· Lobbying and advocacy · KMDP as a case for learning · MOU among stakeholders in promoting milk quality · Stakeholder engage in platforms to promote quality · Working with processors to support extension/capacity building linked to quality
FURTHER QBMPS DEVELOPMENT / UPSCALING · Scale up quality based milk payment systems linked to product diversification and positioning (building on the KMDP pilot) · Reward high quality milk; awareness raising with farmers and consumers by processors · Enhance quality control during collection, processing, and transportation	· Processors · DFCSs/farmer groups · Private labs · Farmers · KDB · KeBS	· Collaborate in promoting milk quality and providing insights on what is working · Explore affordable technical options that can support

Table A5-3 *Suggested interventions for capacity building / practical skill development for farmers and service providers*

How? (Ways to achieve this)	Who (Actors/ Stakeholders)	Role of the actors or stakeholders
R&D · Assess extension and advisory services models promoting market orientation to draw lessons on best practices and scaling · Standardize methodology in analysing cost of production/gross margin assessment at farmer level and at different points of DVC · Lesson learning from extension approaches like lead farmers, study groups, PDTCs · Targeted information package development	· Researchers · County governments · DFCSs/farmers groups · NGOs	
PLATFORM · Processors deduct a training fee from the milk price dedicated to a common training/extension fund · County govt to prioritize their development agenda towards extension (compared to other activities that are less stringent)	· County governments · Processors · DFCSs/farmers groups · Service providers · Learning institutions · NGOs county government	
CAPACITY BUILDING / MOBILIZATION · Development of entrepreneurial / Pareto farmers extension servi-ces for on-farm capacity building - hygiene, nutrition, management · Include capacity building for commercial hay production, feed quality, milk quality (see above) · Promote result-oriented capacity building practices that also emphasis cost and profit analysis (e.g. New KCC model being piloted) · Empower market led extension service providers (ToT model farmers/PDTC/KALRO training on ground/backstopping) · Univ. starting business incubators should think about including a viable extension component	· Private extension service providers · Expertise centres · Counties' extension · Processors · Financiers · DFCSs/farmer groups	· extension and training support efforts · Uptake of skills and packages · Development and delivery of services

Table A5-4 *Suggested interventions for promotion of reliable and competitive markets / reducing production cost*

How? (Ways to achieve this)	Who (Actors/Stakeholders)	Role of the actors or stakeholders
R&D		
· Cost evaluation along the DVC at stakeholder platform level (including supermarket stakeholder) to build "mutual" understanding · Assess ATM as a possibility to increase the intake by processors, but might also be a direct outlet for the well-established producers	· Researchers · Processors	· Conducting analysis and presenting at stakeholder platforms for learning to lead to change
PLATFORM FOR POLICY DEVELOPMENT ANDLOBBYING		
· Engage key stakeholders in the dairy sector to address underlying issues, including weak regulatory system, pricing, the politics in the sector, cost of production, import and export barriers/opportunities and quality · Address cash-flow issues: have a MoU with supermarkets to reduce the cash flow issues for processors · Processor level look at co-packing with other processors and government and to look at external markets (within Africa and after the cost efficiency internally has become competitive) to increase the efficiency · Standardise milk market prices · Regulate alternative selling channels e.g. ATMs	· All actors need to engage in these deliberations · Processors · Farmers · Supermarkets · Ministry / Counties · KDB	· Advocacy/lobbying on the cash flow challenge of supermarkets
IDENTIFY AND PROMOTE OPTIONS TO ENHANCE EFFICIENCY IN PRODUCTION		
· Improve accessing and utilization of protein forage · Optimal utilization of fodder · Fodder and pasture management · Upscale energy efficient chilling mechanisms · Alternative packaging · Efficient raw milk procurement systems · Develop and promote alternative dairy products	· Dairy farmers · Research institutions · Seed companies · Service providers · Processors · KEPHIS	· Uptake of skills · Research on fodder/efficiency of operating chilling plants · Provide seeds · Efficient in processing chain · Facilitating seed companies

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